Bell Technologies MPE 386 Computer System

System Guide

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1. Things You Should Know

This section introduces you to the MPE 386 Computer System ("MPE"). It tells how to use this manual for installation and operation. It provides you with important cautionary notices that must always be observed.

This manual describes the MPE 386 Model 400, which includes 4MB of memory on the system board. For less than 4MB of memory the Model 400 is often shipped with no memory on the system board and 1 or 2 MB of RAM installed in a 32 bit expansion memory card. Except for memory size, such 1 or 2 MB configurations are identical to those described here.

CAUTION! Your MPE uses electricity and contains dangerous levels of electricity inside the chassis during operation. **Always disconnect the power cord from both the MPE and the wall socket before opening the chassis for any type of service or configuration.** Always make sure your system is turned **OFF** before commencing any type of work on it. The inside of the MPE power supply should be serviced only by factory-trained technicians. Dangerous amounts of electricity are present inside the power supply even after it has been turned OFF and disconnected from the power cord.

CAUTION! Incorrect configuration, assembly, or installation of your system can cause permanent damage to system components. Do NOT plug in your system or turn power ON without first consulting the System Checklist section of this manual. Consult the System Checklist even if you are experienced with AT standard machines.

Your MPE system must be correctly configured before operation. Configuration involves several steps:

1) Unpacking.

2) Installation or verification of internal options such as video cards, disks, tape drives and so on.

3) Attachment of external options such as keyboard, monitor, printer, and terminals.

4) Setting up the system's internal configuration memory using the SETUP diskette provided.

5) Loading the operating system and desired software and commencing operations.

This manual covers the first four steps as well as general system hardware related operations. Consult your operating systems manual for information on your operating systems software.

You may have received your MPE already setup by your dealer or systems vendor. If so, after Unpacking you may proceed directly to the External Options Installation chapter.

If your MPE has been shipped a long distance you may want to verify that all internal options have been correctly installed and have not been visibly damaged. You should then follow through both the Internal and External Options chapters.

2. Your MPE Uses AT Standards

We designed the MPE to take advantage of the largest industry standard in the world for computer: IBM's "AT" architecture machines. Tens of thousands of vendors world wide support this architecture. Those computer users who use the AT standard enjoy by far the best performance, the best price, and the best quality of any computer system.

The basic parameters of the AT standard such as system board size, expansion slot placement and pinout, power supply form factor, chassis form factor, bus signals and CPU architecture all derive from IBM's original 16 bit PC AT design, which used the Intel 80286 processor. The AT architecture is so powerful, however, that certain aspects of it such as the 16 Megabyte (MB) memory capacity are underutilized with 16 bit processors and are much better matched to the world of 32 bit computing.

Your MPE extends the AT architecture to the world of 32 bit supermini computing. The 32 bit 80386 processor employed in the MPE provides an extremely sophisticated and powerful 32 bit CPU. In addition to its 32 bit architecture, the 80386 provides dedicated hardware compatibility with earlier Intel processors such as the 80286, 8086, and 8088. This enables the 80386 to run DOS and other software written for 16 bit PC AT's and 8 bit PC's as well as 32 bit software like UNIX derived from the world of VAX and other 32 bit minicomputers.

Unlike other AT standard machines, the MPE was designed explicitly for superior operation in UNIX and Xenix as well as with DOS. All components used in the MPE are selected for certified use with UNIX and Xenix. This includes the special selection of full "EE" series 32-bit 80386 chips and Intel Erratum 21 suppression with proprietary Bell Technologies circuitry. Bell Technologies supplied the 80386 AT compatible machines on which UNIX for the 80386 was developed by Intel, AT&T, and Interactive Systems. Every bit of that experience was used to make the MPE a superior UNIX and Xenix engine without sacrificing total AT standards compatibility.

True AT compatibility revolves about three factors: mechanical compatibility, system architecture compatiblity, and firmware/software compatibility.

Your MPE chassis provides perfect mechanical compatibility with the AT standard. All dimensions match the standard perfectly. The MPE chassis has been manufactured from industrial grade materials to provide a far more rigid and durable frame than is common in AT compatibles.

All system board mechanical details match the AT standard as well. Placement and size of expansion bus, keyboad connectors, mounting holes, and overall size and shape of the Printed Circuit Board (PCB) match the AT standard exactly.

The system board architecture provides complete compatiblity with the AT standard at the system level. All Direct Memory Access (DMA) channels, interrupt vectors, memory mapped i/o locations and other factors match the AT standard perfectly. See the reference section on the system board for more information. Extension to 32-bit architecture has been accomplished without compromising either AT compatibility or 32-bit performance.

Perhaps the largest component of AT standard compatiblity in actual use is the performance of the Read Only Memory (ROM) firmware known as the Basic Input Output System (BIOS). Bell Technologies ships only the industry standard BIOS firmware, either Phoenix or Award. This manual describes the Phoenix BIOS.

2.1 The Modular AT Architecture

One of the nicest things about the AT standard is its modularity. System components may be interchanged within a large family of parts from thousands of different vendors. All standard parts conform to size, electrical interface, and systems compatibility. By using standard modules, you or your systems vendor can configure your MPE to perform any function known to the computing world. The primary classes of standard AT parts are as follows:

2.2 System Board

The MPE System Board (also called the "motherboard") is the central part of your MPE. It provides a complete computer system on a single board. The expansion slots it provides can host any standard AT or PC option card to provide additional capabilities. The MPE System Board is a Bell Technologies 2116-4 four Megabyte (MB) system board manufactured in the United States. Series 2116 system boards may be inserted into any standard AT chassis. Certain accessories are directly related to the function of the system board:

- **Lithium Battery** - The system board contains a small amount of Random Access Memory (RAM) which is powered by this battery. Because of the battery power supply this small area of RAM "remembers" data stored into it even after the system power switch is turned OFF. This area of RAM is used to store system configuration information known as "setup" data.

- **Audio Speaker** - AT standard machines use a small audio speaker to generate sound. This is useful to create "beeps" and other sounds that communicate the status of hardware or software.

- **Front Panel Switches and Signals** - The front panel reports important system status and provides two control switches. Status is reported through Light Emitting Diodes (LEDs) for power ON and hard disk activity. The switches are used to reset the system and to lock or unlock the chassis and keyboard functioning.

- **Parallel and Serial Port Cables** - Your MPE provides two serial ports and a parallel port. The cables and connectors for these attach directly to the system board.

2.3 Chassis and Cover

The chassis provides a metal frame on which system components are mounted. The MPE chassis supports the system board and power supply. In addition, it provides mounting points for accessories directly related to the system board (Lithium battery, speaker, front panel, serial and parallel cables). One DB25 style parallel port connector mounting point and one DB9 style serial port mounting point is also provided.

The chassis provides five half-height device bays configured as one stack of two device bays and one stack of three device bays. The three device bay stack is accessible through the front of the system cover. Grounding wires for peripherals that may be inserted in the device bays are also included.

The cover slides onto the chassis from the front. It provides protection to the system internals as well as completing the cosmetic appearance of the system. The MPE chassis and cover

accept any AT standard system board and power supply.

2.4 Power Supply

The MPE utilizes an AT form factor standard 220 watt power supply with output connectors for the system board and four peripheral devices. The power supply may be switched from 115 to 230 volts for use worldwide. It automatically accomodates 50 or 60 HZ line frequencies. The power supply provides an auxiliary switched AC power outlet for use with a monitor or other accessory. The MPE power supply incorporates a voltage sense capability that is used to shut the supply down in case of shorts or excess current conditions. In addition, it provides a power good signal to the system board which holds the system in reset on startup until all voltages reach operating levels. The MPE power supply should not be replaced except with an equivalent grade AT standard supply providing a minimum of 220 watts output.

2.5 Keyboard

The MPE system board's keyboard connector and related circuitry accept any AT standard keyboard. Shipments from Bell Technologies provide the Enhanced AT standard keyboard with 101 keys and a separate cursor key pad. You may also use the basic AT standard keyboard which does not provide a separate cursor key pad. Many other AT keyboard standard interface accessories will also attach to the MPE keyboard connector, such as "wedge" style bar code and magnetic card readers.

2.6 Mathematics Co-Processor

The MPE system board includes a socket for insertion of an Intel 80387 mathematics co-processor chip. The 80387 provides floating point arithmetic capability hundreds of times faster than that possible using software floating point procedures in the main 80386 processor. The 80387 will provide faster floating point than that found on some $200,000 32-bit "superminis."

On a technical note, your MPE system board has been designed to minimize the impact of Intel Erratum 21, a technical issue that affects all 80386 chips manufactured to date when used with 80387 mathematics co-processors. Unlike most other AT standard machines, the MPE will run essentially error-free even software that has not been written with Erratum 21 in mind. For total elimination of Erratum 21 under all circumstances the Bell Technologies Math Adaptor may be inserted in your system as well. See the reference section on the system board for more details.

2.7 Expansion Cards

The basic "single board computer" provided by the MPE system board is of limited use without peripherals. In the AT standard peripheral functions such as video display monitors, floppy disks and hard disks are provided by a combination of circuit cards which plug into the system board's expansion slots and peripherals which plug into the expansion circuit cards. Some peripherals such as floppy disks are mounted inside the MPE chassis while others such as video monitors and terminals are placed outside. Some peripherals such as tape backup units or modems may be procured in either internal or external versions.

In the AT standard, expansion cards may be either "8-bit" or "XT" cards (referring to their origin in IBM's PC and PC XT line of computers) or they may be "16-bit" or "AT" cards (referring to cards developed for AT class machines and not intended to be backwards compatible with the

XT class as well). Because the AT architecture provides compatiblity with the earlier class of XT machines, XT cards may be used in AT's as well.

The MPE system provides six expansion slots which are combination XT/AT connectors. In addition, it provides two expansion slots which are combination XT/32-bit connectors. The 32-bit connectors provide full 32-bit bandwith for extremely high performance expansion cards used with the MPE.

"XT" style cards have a shorter card edge connector and plug into only half of the expansion slot connectors provided on the system board, the half which is closest to the back of the system board.
An XT card may be plugged into any MPE expansion slot.

"AT" style cards have two card edge connectors. These may be inserted into any of the six XT/AT slots provided in the MPE. **Do not insert AT cards into the XT/32-bit MPE slots**.

The 32-bit expansion slots are reserved for use by Bell Technologies 32-bit cards and other cards, approved by Bell Technologies, specifically designed for use in the MPE.

If the additional capabilities provided by the extra AT bus slot are not required for functionality, many expansion card vendors will implement their cards using the XT slot only in order to be able to sell the card to XT users as well as AT users. For certain types of cards (monochrome video, for example) there is no performance penalty associated with using an XT style card instead of an AT style card. In other cases maximum performance (hard disk controllers, for example) demands the use of the full AT bus.

Expansion cards generally come in two sizes: full size and half sized. Full size cards extend completely from the rear of the MPE chassis to the front. "Half cards" extend from the rear only part of the way to the front of the chassis. Many half cards do not extend beyond the bus connectors. There is no functional difference between full sized cards and half cards. Since some AT or PC standard machines have restricted room inside the chassis, expansion card vendors will often try to fit their circuitry onto a half card in order to be able to sell to users of such restricted space machines. Full-sized cards may be used in all MPE expansion bus slots.

Some older style XT cards use a "drop down" to extend the amount of space on the card available for circuitry. Such cards violate the AT standard and cannot be plugged into XT/AT connectors. The MPE does not support the use of such cards.

For immediate functionality, the MPE is almost always equipped with a video card and monitor and with a disk controller card and disk drives. These cards and others are covered in the following synopsis of common expansion cards.

- **Video Display Cards** - A video card is used to control a video monitor. In the AT standard world, basic video cards are the Monochrome Display Adaptor (MDA), the Color Graphics Adaptor (CGA), the Extended Graphics Adaptor (CGA), the Professional Graphics Adaptor (PGA), and the new Virtual Graphics Adaptor (VGA). The MDA provides basic character display while the others provide varying resolutions of color text and graphics display. These are almost invariably half size, XT style cards. Very often a video card will also provide a parallel port as well. The Bell Technologies Monochrome Graphics Adaptor (MGA) provides a Hercules compatible display adaptor for monochrome text and 640 x 480 monochrome graphics as well as a parallel port. Far more advanced graphics display capability can be attained by

using workstation graphics cards in the MPE (see below).

Use extreme care when attaching display cards to monitors: do not connect color monitors to monochrome cards and vice versa. Doing so can damage both the card and the monitor.

- **Disk Controller Cards** - In the AT standard, a single AT style card is used to control hard disk and floppy disk drives. A single AT disk controller can control up to two hard disks and up to two floppy disks. Most software that runs on AT standard machines expects to see a disk controller card which is architecturally equivalent to the "WD" style controller utilized by IBM. Bell Techologies utilizes only "WD" compatible controllers in its entire line of disk controllers. There are four standard Bell Technologies controllers: ST506-MFM, ST506-MFM Cache, ST506-RLL, and ESDI. These controllers provide varying levels of disk capacity and performance with varying levels, of course, of cost. The floppy disk interface circuitry on all of these controllers is equivalent and exactly compatible with the AT/WD standard.

- **Memory Expansion Cards** - Your MPE features four MB of high speed, 32-bit Random Access Memory (RAM) on the system board. Additional 32-bit high speed memory may be added by installing Bell Technologies 1, 2, 4, or 8 MB 32-bit RAM cards in the XT/32-bit expansion slots. 1 or 2 MB MPE systems may be configured by installing no RAM chips on the system board and installing a single 32 bit RAM card equipped with 1 or 2 MB of RAM. If you have such a system, a simple service procedure enables you to add 4MB of additional RAM simply by plugging the required RAM chips into the open sockets on the system board [When adding RAM to a 1 or 2 MB MPE system, you must change a PAL chip on the system board - consult the service procedure for more details]. The MPE can also utilize industry standard AT memory cards inserted in the AT expansion slots; however, performance will be much better when 32-bit memory is used.

- **Tape Backup Controllers** - Bell Technologies provides a wide array of tape backup products for use in UNIX, Xenix, or DOS. Two styles of controllers are used: QIC-02 half cards and QIC-36 full sized cards. Each is available in both an internal version (where the tape cable runs from the controller card to a tape mechanism mounted inside the MPE chassis) and an external connector version (where the tape cable runs outside the MPE chassis to a tape mechanism mounted in an external box).

- **Basic Serial and Parallel Port Cards** - The AT standard provides for two serial ports and two parallel ports that are directly "hooked" into the system architecture. Parallel ports are usually used for printers, and serial ports may be used for any serial device: printers, modems, terminals, or other devices. In earlier days, the two serial and two parallel ports were added to AT standard systems through the use of expansion cards which had one serial port and one parallel port each. The MPE system board includes two serial ports and one parallel port that are identically equivalent to those on the previously optional serial/parallel cards. Since most video cards provide an additional parallel port, the typical base MPE configuration includes two serial ports and two parallel ports. This renders obsolete the use of basic serial/parallel cards.

- **Serial Port Expansion Cards** - When running UNIX or Xenix the MPE delivers a multiuser computing solution far superior to typical supermicro multiuser machines. Bell Technologies serial port expansion cards may be used to provide additional serial ports. The Intelligent Channel Controller (ICC) expansion card provides six serial ports

that are controlled by a dedicated 80186 16-bit processor and one-half megabyte of RAM. Four ICCs may be installed for up to 24 serial ports and 24 users. The HUB6 expansion card provides six serial ports in a non-coprocessor card for lighter duty applications or where costs must be kept low. Up to four HUB6 cards may be installed for up to 24 HUB6 serial ports. ICC and HUB6 cards may be intermixed on the same MPE system.

- **Modems** - While many modems are implemented as internal plug-in cards, we recommend the use of external modems connected to serial ports. Most internal modems appear as a serial port in the system architecture and will require you to disable a serial port on your MPE system board. External modems, on the other hand, do not require you to lose a serial port and may be moved from machine to machine as well.

- **Local Area Network Cards** - Ethernet and other local area networks are becoming extremely popular for linking together computer systems. A host of networking cards are available for AT standard machines that implement every networking protocol in common use on all popular operating systems. The Bell Technologies Ethernet card provides high performance, low cost Ethernet connectivity in UNIX or DOS. In UNIX, the Bell Technologies Ethernet card supports full RFS, SNAP! and TCP/IP.

- **Workstation Graphics Cards** - High performance workstation graphics can be yours on the MPE with the Bell Technologies Blit Express workstation graphics engine card. The Blit provides 1660 x 1200 monochrome graphics resolution on 19" big screen monitors as well as 640 x 480 x 8 bit resolution on color monitors. It runs X Windows, SUN NeWS and most popular UNIX workstation software. When operated on your MPE, the Blit outperforms workstations that cost four or five times as much from other UNIX workstation vendors. Graphics cards from other vendors may be used in the MPE for extremely high resolution and performance color graphics as well.

- **Nine-Track Tape Controllers** - A variety of nine-track tape controller cards are available for operation in UNIX, Xenix, and DOS. These cards control an external nine-track tape mechanism to allow interchange of nine-track reel-to-reel tapes with mainframes and other large computers.

In addition to the Bell Technologies products described above, the MPE will accept AT or XT standard expansion cards from any other vendor as well.

2.8 Hard Disks, Floppy Disk Drives, and Tapes

AT standard machines use mass storage peripherals in 5.25" form-factor. Hard disks, floppy disk drives, and tape mechanisms that are mounted inside the MPE chassis should all be this standard form-factor. 5.25" devices are available in full-height or half-height sizes. Two half-height devices are exactly the same height as a single full-height device.

Most large capacity, high performance hard disks are full-height devices. Many lower capacity or lower performance hard disks are half-height devices. Most floppy disk drives are half-height devices. Most tape backup units are also half-height devices, although some special purpose tape units are full-height devices. The mounting locations in the chassis used to mount half-height and full-height devices are called "device bays."

The MPE provides five half-height device bays organized as a stack of three half-height bays

on the right hand side of the chassis and two half-height bays in the center of the chassis just behind the front panel.

Since the center two half-height bays are not accessible from the outside once the cover is in place, they are usually used for hard disk or other devices which do not need to be handled during operation. They are usually used for a single full-height hard disk or for two half-height hard disks mounted one above the other.

Since the right hand device bays may be accessed from the outside with the cover in place, they are usually used for floppy disk drives or tape mechanisms or other devices that need to be handled during operation. As shipped from the factory, only two of the right hand bays are visible through the front cover. The plastic insert in the front cover just below the two visible bays may be removed in order to expose the third, lowest bay as well.

A typical MPE configuration would have one floppy drive and one tape unit in the right hand bays with one full-height hard disk unit in the center bays. A system with two hard disks usually comes in two configurations:

1) Two half-height hard disks in the center bays with a floppy and a tape in the right hand bays; or

2) A full-height hard disk in the center bay with another full-height hard disk located in the lower two right-hand device bays underneath a single floppy. In this case the tape drive would be an externally-mounted device.

Another popular configuration is one hard disk in the center bay with two floppies (which could be two different formats) and an internal tape in the right-hand three bays. In this case, the plastic front panel insert would be removed to expose the third right-hand bay.

Every standard MPE will include at least one floppy disk drive, and virtually all will include a hard disk as well. Most units containing hard disks will also include a tape mechanism for data backup and interchange since it is very inconvenient to backup a large hard disk with floppy diskettes.

Hard disks, floppy disk drives, and tape mechanisms come in many different sizes and capacities as follows:

- **Floppy Disk Drives** - The AT standard floppy drive is a half-height 5.25" unit that stores 1.2 MB per floppy diskette. This is also called a "high density" floppy since it replaces the earlier XT standard 5.25" floppy diskette drive that could only store 380 to 720 KB of data. The lower capacity XT floppy drives are called "low density" units. AT floppy drives can read XT floppies reliably, but cannot reliably format or write low capacity diskettes. Some MPE users, therefore, install a low capacity half-height floppy drive in addition to the AT floppy drive. Another emerging standard is 1.44 MB floppy diskette drives that use hard-shell 3.5" form-factor diskettes. Your MPE firmware and hardware are capable of running any of these standard drives, although some operating systems or other software packages may not be able to handle 3.5" media.

- **Hard Disk Drives** - The BIOS firmware installed in the MPE supports over 40 different hard disk drives. Bell Technologies ships the MPE with several different hard disks, ranging from 38 to 380 Megabytes capacity. Typical capacities are quoted by Bell

Technologies as unformatted capacity because formatted capacity will differ slightly depending on the operating system used. Bell Technologies uses ST506-MFM, ST506-RLL, and ESDI drives. A typical MPE configured for multiuser installations will utilize the Bell Technologies B130 130 Megabyte hard disk with 23ms average access speed and 7.5 Megabit/second transfer rate. This disk provides approximately 110 MB formatted data storage. With the right controller installed, any 5.25" form-factor drive listed in the BIOS firmware hard disk drive table may be used in the MPE. Other drives will require modification of the BIOS hard disk drive table or special software.

- **Tape Backup** - Bell Technologies utilizes half-height tape mechanisms using QIC-02 and QIC-36 controller interfaces and QIC-24 standard recording formats. Tapes using quarter inch tape cartridges provide 60 to 150 MB capacities, while mechanisms using compact cassette media provide 60 MB capacity. If possible (and affordable!) it is very convenient to have the tape capacity equal or exceed the capacity of the hard disk being used. Thus the T125i Bell Technologies tape with 125 MB total storage capacity is a good match for the B130 hard disk with 110 MB formatted capacity.

Mass storage devices are mounted in the MPE chassis by first attaching slide rails to each side of the device. The device is then inserted into the chassis and two fastening screws are attached between the front of the rails and the chassis.

2.9 Monitors

Many supermicro computers do not have console video displays; rather, they use a terminal attached through a serial port as the main system console. In the AT standard architecture, the system console consists of the keyboard attached to the system board and video output consisting of a monitor attached to a video adaptor card plugged into the system board. Even when the MPE is being used as a classic multiuser UNIX machine, the system console continues to be this PC style console.

Monitors must be matched to the video display card being used. MDA and MGA or similar video display adaptor cards utilize IBM compatible monochrome display monitors. Such monitors are available in a variety of phosphor colors, with green and amber being most popular.

CGA, EGA, and PGA cards require specialized color monitors which are incompatible with monochrome display cards. Perhaps the most popular monitors are EGA compatible color monitors. Gaining rapidly in popularity despite their slightly higher cost are multiple synchronization monitors like the NEC Multi-Sync series and similar. Multi-Sync style monitors may be used with CGA, EGA, and PGA cards. Some can even be used with monochrome cards.

Workstation Graphics cards like the Bell Technologies Blit require special purpose monitors. In monochrome mode, the Blit should only be used with Bell Technologies supplied or approved monitors or damage to the Blit and to the monitor will result. In color mode, the Blit may be used with NEC Multi-Sync or compatible monitors.

Warning! Do NOT use color monitors with monochrome display cards. Do NOT use monochrome monitors with color display cards. Do NOT use any monitor with the Blit workstation graphics card except monitors approved by Bell Technologies for use with the Blit.

Since many video display adaptors use similar connectors, it is easy to make a mistake when plugging monitors in. Be careful. Double check connections before turning power on to your system.

2.10 Terminals

Hundreds of terminals types may be used with the MPE. Either HUB6 or ICC multiport cards allow the addition of any standard RS232 serial terminals for use with the MPE.

2.11 Printers

Any IBM compatible printer may be used with the MPE's parallel ports. The ports provide a Centronics style interface identically equivalent to that used in the AT standard by IBM. MPE system board serial ports or expansion serial ports provided by ICC or HUB6 cards may be used with any RS232 compatible printer.

2.12 System Features

The following are features of standard model MPE system boards and complete MPE systems:

System Board

* 16MHZ Intel 80386 32 Bit Processor
* 16MHZ 80387 Mathematics Co-Processor Socket
* 256K to 512K ROM on Board
* Phoenix or Award BIOS
* 4MB RAM memory on-board
* 8742 Processor-based IBM AT compatible keyboard interface
* Keylock Interface
* Real-Time Clock with Battery-Backup CMOS Setup RAM
* Sixteen Interrupts
* Seven DMA Channels
* Two IBM Compatible Serial Ports
* DB9 Serial Port headers
* One IBM Compatible Bidirectional Parallel Port
* 8 XT Slots, 6 AT Slots, 2 32-Bit Slots
* Audio Speaker Connector
* On-Board Configuration DIP Switch
* Reset Connector
* Flexible Wait State Selector
* Socketed Crystal
* Exact AT Form Factor for Mounting
* 40+ Hard Disks Supported in BIOS
* All Memory is 32 Bit
* 640K in DOS Base Memory

* Up to 16MB 32 Bit memory with standard BIOS.

* 4 Gigabyte Physical Memory Addressing.

System Features

* Industrial Grade Chassis

* Front Panel Reset Switch

* Front Panel Chassis and Keyboard Lock

* Five half-height Device Bays, Three accessible

* 220 Watt Power Supply

* 115 / 230 Volt and 50 / 60 HZ Operation.

* Enhanced and Standard Keyboards

* 380KB, 720KB, 1.2MB Floppy Diskette Drives

* 38 to 760MB Total Hard Disk Capacity

* 60 to 160MB Integrated Tape Backup

* Full Support for All Video Standards

* Integrated Workstation Graphics

* Integrated Local Area Networking

* Full compatibility with UNIX, SCO Xenix, Xenix, Interactive 386/ix, Microport, DOS, and OS/2.

2.13 System Specifications

Following are power and environmental specifications for standard model MPE systems. Voltages are in Volts AC or DC as indicated with currents in Amps. Temperatures are in degrees centigrade.

Power Supply Input Requirements		
Range	Voltage	Current
115 Vac	Minimum 100 Maximum 125	Maximum 5.0
230 Vac	Minimum 200 Maximum 240	Maximum 3.0

Note: Power consumption: 220 Watts (Maximum)

TABLE 1. Power Supply Input Requirements

Power Supply Output		
Nominal	Max. Current	Regulated To
+ 5 Vdc	22.6	+5% to -4%
- 5 Vdc	0.4	+10% to -8%
+ 12 Vdc	8	+5% to -4%
- 12 Vdc	0.4	+10% to -9%

TABLE 2. Power Supply Output Specifications

Output Sense Level	
Level (Vdc)	Minimum (Vdc)
+ 5	+ 4.5
- 5	- 3.75
+ 12	+ 10.8
- 12	- 10.4

TABLE 3. Power Supply Output Sense Levels

System Dimensions	
Length	440 mm
Width	540 mm
Height	162 mm

TABLE 4. MPE System Dimensions

Operating Environment	
Operating Temperature	0 to 40 C
Operating Humidity	5 % RH Minimum 80% RH @ 40 C Maximum
Non-Operating Shock	30g

TABLE 5. MPE System Environmental Requirements

3. Unpacking

Assembly consists of installation or verification of internal options followed by assembly and installation of external options. Internal options include video display adapator card, disk controller card, other option cards and mass storage peripherals such as floppy disk drives and hard disks. External assembly includes site selection, attachment of keyboards, video monitors, terminals and other external options.

Do NOT plug the system in or turn power ON until you have reviewed the System Checklist.

MPE systems are shipped in three boxes: the system unit box, the keyboard box, and an accessories box. Most shipments will have all three boxes shipped within an outer container for additional protection during shipment. Monitors are shipped separately. Any peripherals or option cards not installed at the factory will also be shipped in separate boxes.

3.1 Shipping Damage

All Bell Technologies equipment has been thoroughly inspected and carefully packed before leaving the factory. Responsibility for its safe delivery was assumed by the freight carrier at the time of shipment. Claims for loss or damage to the contents should therefore be made upon the carrier as follows:

Concealed Loss or Damage: Concealed loss or damage means loss or damage which does not become apparent until the equipment has been unpacked. The contents may be damaged in transit due to rough handling even though the carton may not show external damage. When the damage is discovered upon unpacking, make a written request for inspection by the freight carrier's agent within fifteen days of the delivery date. Then file a claim with the carrier since such damage is the carrier's responsibility. By following these instructions carefully, we guarantee our full support of your claims to protect you against loss from concealed damage.

Visible Loss or Damage: Any external evidence of loss or damage must be noted on the freight bill or express receipt and signed by the carrier's agent. Failure to adequately describe such external evidence of loss or damage may result in the carrier refusing to honor a damage claim. The form required to file such a claim will be supplied by the carrier.

Carefully remove all components from their packages and inspect each for possible shipping damage [Do NOT remove any components from their protective anti-static bags until you have read the section in this chapter on static control]. If the container or any of the components appears to have received damage during shipping, immediately contact the shipper who delivered your package and request they come out and inspect the damage as described above.

The Bell Technologies warranty does not include damage due to shipping. Therefore, it is very important that any such damage claims be made against the shipper to prevent any further expense on your part.

If you see any shipping damage, make sure to retain all packing materials in case you need to file a claim against the shipper.

3.2 Save All Packing Materials

Your MPE ships in specially designed boxes for maximum protection. These boxes are designed to provide protection for sensitive internal components such as hard disk drives. In addition, other options ship in special protective boxes and packing materials. Do not discard any of these materials as they will be required should you ever decide to transport your MPE system to another location. You will also need the original packing material should you ever need to transport your MPE for warranty service.

Remove and save the shipping insert placed inside your floppy disk drive. This insert should be used anytime you transport your MPE even if you do not pack the system completely. It protects the floppy disk drive recording head from vibration that occurs during transportation when a floppy diskette is not inserted.

Remove and save the shipping insert placed in your cartridge tape mechanism if you have a tape unit installed. This insert keeps the tape cartridge mechanism from popping into the load position during transportation and possibly damaging the locking bar.

3.3 Static Precautions

Numerous components in the MPE system and options contain static sensitive components that must be protected against static electricity. Always observe the following precautions:

Ground Yourself - Touch a metal component connected to ground to discharge any static electricity accumulated on your body before opening any static bag containing components. Touching a metal part of the chassis usually suffices. When working extensively with static sensitive components (such as repair or large scale chip removal and insertion) it is best to work at a static-controlled area: a table top that is grounded and sprayed with antistatic solution together with a wrist or ankle static discharge strap attached to ground.

Safe Transport - Carry static sensitive components in anti-static protective bags only. Merely carrying a circuit card across a carpeted floor in wintertime can damage static sensitive components. Components inside of a closed MPE chassis are safe to transport as long as you are careful not to touch exposed connectors at the rear of the chassis.

Safe Adaptor Card Handling - Carry circuit cards by their edges only. Do not touch the card edge connector or any other connector.

Safe Peripheral Handling - Carry hard disks, floppy disks, and tape mechanisms only by their metal frames. Do not touch their connectors.

Safe System Configuration - When the cover is removed from your MPE system, be careful to ground yourself by touching the outer shell of the power supply before installing or removing any card options. Do not touch any exposed connectors or shunts inside the system. Insert or remove cards by holding them along their top edges only.

3.4 Hard Disk Handling

Hard disks are the most fragile part of modern computing systems. The glass CRT tube, for example, will take far greater shocks than a hard disk without losing its ability to function.

Hard disks are so fragile because they are built to tolerances of millionths of inches. Our drives are built to take G shocks of 40 G's when ruggedized for shipping. They are some of the toughest, if not the toughest drives made today. Nonetheless, you may be surprised by how fragile even a really tough hard disk is.

Despite the foam protection surrounding the drive when packed for shipping, a drop of 36 inches onto hard concrete or other surface will exceed 40 G's. Dropping the unprotected drive 5 or 10 inches onto a hard table top may damage it. Simply moving the drive, even gently like an eggshell, when it is powered up may cause trouble. This information is not intended to scare you, but to provide you with procedures that will allow you to move and use your hard disks with confidence. We suggest the following procedures:

- TREAT ANY HARD DISK AS THOUGH IT WERE AN EGGSHELL.
- NEVER move a hard disk or a system containing a hard disk that is powered up. DO NOT move it even one inch!
- Never allow any hard disk to thump when you set it down on any hard surface.
- Never ship any hard disk without packing it in its original, undamaged shipping container.
- When transporting any hard disk or any computer containing a hard disk by vehicle, keep it on a car seat, not in the trunk, unless it is packed in the original shipping container.

3.5 Handling MPE Systems

Treat all MPE systems with care, especially if they contain hard disks. In addition to the handling precautions specified for hard disks observe the following:

- Avoid extremes of hot or cold. If your system is exposed to extremes of heat or cold, allow it to reach standard office temperatures before attempting to operate it. This may take hours if it is not unpacked. Removing the system cover will decrease the time it takes to reach ambient temperature. Do NOT turn it on to "self heat" its way to ambient temperature.

- Protect it from exposure to moisture. Do not allow your MPE to become wet or to be exposed to dewpoint conditions. Conditions near dewpoint may cause condensation inside the MPE chassis and damage to components.

- Do not jolt or strike your MPE. Hammering on the cover to loosen it for removal is very hard on the floppy disk drive and hard disks.

- Never force connectors. The MPE connectors are designed to operate reliably for decades with no more than firm, gentle pressure to insert or remove attachments. While it may be possible that a connector has failed or is damaged, if you need to use excessive force it is far more likely you are doing something wrong and may be damaging the system.

- Use the shipping inserts with floppy disk drives and tape mechanisms when transporting the system even a small distance. These keep the internal parts of these sophisticated devices safe from possible damage. If you do not have a shipping insert for the floppy handy, you may use a "scratch" diskette instead for short distances.

- Remember to remove the shipping inserts before operating your MPE system!

4. Internal Options Installation

This section describes how to remove the cover of your MPE system and to configure internal options.

Read the sections on cover removal, installing option cards, and on installing peripherals. These provide a guide to procedures you will follow for specific cards and peripherals.

Before installing any options, verify the settings of system board shunts and DIP switch. It is easier to verify these when no cards or cables or peripherals are installed in the system.

Finally, proceed to the sections on configuring and installing the particular options you wish to use with your MPE system.

If you are confident all internal options are correctly installed, proceed to External Options Installation.

4.1 Cover Removal

Tools required for cover removal are a medium Phillips screwdriver. Proceed as follows:

1) Turn OFF your system unit power switch.

2) Turn OFF power to all external accesories attached to your system.

3) Make sure the Key Lock on the front panel is in the unlocked position. Turn the Key Lock fully clockwise and remove the key. Keys are usually taped to the rear of the MPE chassis.

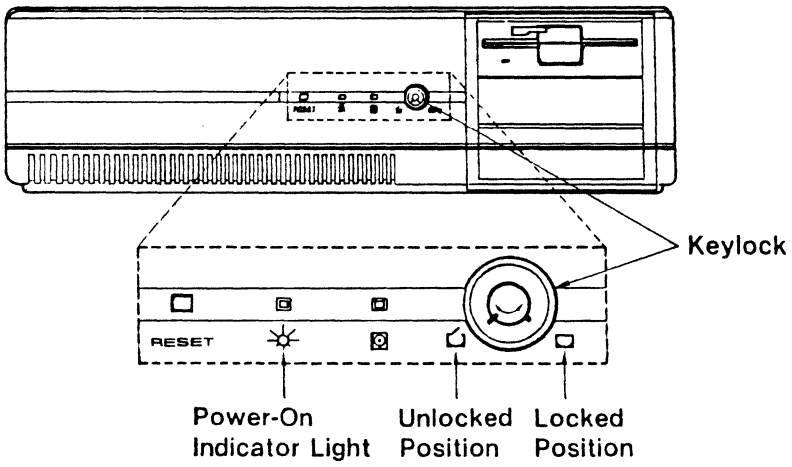


Figure 1. Front Panel and Key Lock

4) Unplug your MPE system's power cord from the back of the MPE. Unplug the power cord from the wall outlet.

5) Unplug all cables and accessories attached to the back of your MPE system unit.

6) Remove the five cover mounting screws.

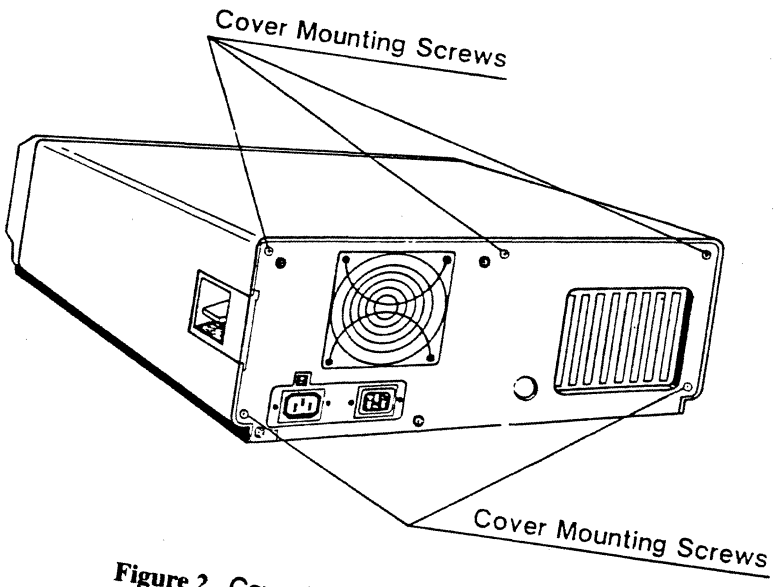


Figure 2. Cover Mounting Screws

7) Slide the cover towards the front until it clears the chassis.

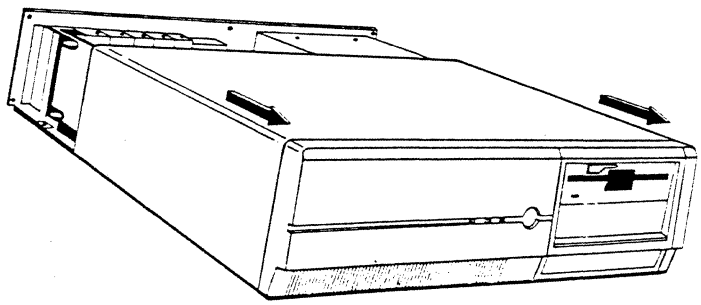


Figure 3. Removing the Cover

4.2 Replacing the Cover

Replacing the cover is the reverse of removing it. When replacing the cover, make sure not to snag any cables in the interior of the system with the nut lug protruding from the upper center of the cover's rear edge.

Before closing the top cover, take a moment to check your system for any loose nuts or tools. Verify that all required cables are connected. Check the positions of DIP switches. Record the settings of DIP switches for future reference when setting up software. Verify all expansion cards are firmly screwed down with screws at their attachement brackets. Verify that power cables and ground wires are attached to the peripheral devices. Push the cables down out of the way between the disk device bays and the power supply so that they do not snag the cover.

To install the cover, slide it onto the system chassis with the lower sides of the cover underneath the metal flanges on the lower sides of the system chassis.

As you slide the cover back, pull the cover up against the metal flanges on the side of the system chassis; this motion allows the upper rear edge of the cover to clear the top of the back panel of the chassis. Reinsert the five cover screws.

Did you keep a copy of the hard disk's bad block map?

4.3 System Board Configuration

The illustration below identifies major parts of the system board. The W and J identifiers refer to jumpers and connectors which are described in the following pages. This section provides a quick reference guide to configuring your MPE system board. The only shunt which you may have to change from its factory setting is W8 which defines whether a monochrome or color display is the primary display. This is inconveniently located almost underneath the center disk drive bay. For additional information on system board components, see the reference section of this manual.

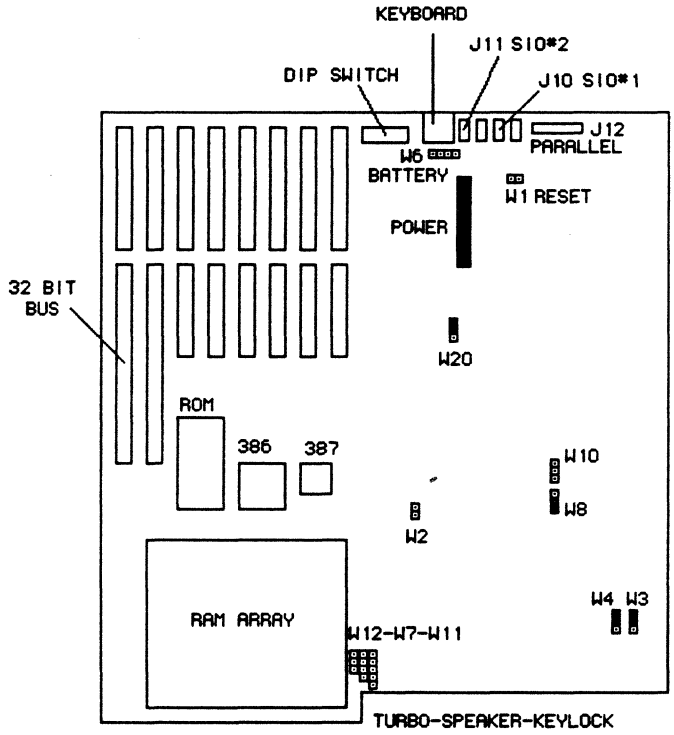


Figure 4. Locations of Items on System Board

The following tables provide a quick reference guide to the various jumper headers and connectors installed on your MPE system board. For two pin jumpers, ON means a shunt is installed, and OFF means no connection. N/C means no connection. For jumpers installed parallel to the long axis of the chips, Pin 1 is closest to the front of the board.

Jumper Settings		
Jumper	Default	Options
W2	ON	ON: two 32-bit wait states, OFF: one 32-bit wait state
W3	2-3	1-2: one 16-bit wait state, 2-3: two 16-bit wait states
W4	2-3	1-2: four 8-bit wait states, 2-3: five 8-bit wait states
W8	1-2	1-2: Mono display primary, 2-3: Color display primary
W10	N/C	N/C: High speed, 1-2: Low speed, 2-3: 8742 BIOS select
W20	2-3	2-3: Required Setting

TABLE 6. Quick Reference to Jumpers

DIP Switch Array Defaults									
1	2	3	4	5	6	7	8	9	10
OFF	ON	OFF	OFF	ON	OFF	OFF	ON	OFF	ON

TABLE 7. DIP Switch Array Default Settings

Connectors	
Connector	Definition
W1	Reset switch connection
W6	CMOS RAM battery connector
W7	8 Ohm Speaker Connector
W11	Keylock / Power LED connector
W12	Turbo LED connector (use pins 1-2)
J2	Main System Power Connector
J6	Keyboard Connector
J10	On-board serial port #1
J11	On-board serial port #2
J12	On-board parallel port
J13	Not used
J14	Not used

Note: W12 is not connected in the MPE system.

TABLE 8. Quick Reference to Connectors

4.3.1 System Board Default Settings

MPE systems are factory configured to run at 16MHZ 1 wait state with an MGA or MDA monochrome display adaptor installed as the primary display adaptor. Serial port 1 and the parallel port are enabled at their standard interrupt lines. Serial port 2 is located at the standard interrupt but is not enabled.

4.3.2 DIP Switch Array Settings

The DIP switch array controls whether the serial ports and parallel port are turned on and which interrupt lines they use. You should not need to change the setting of the DIP switch array unless you need to install a peripheral device that uses one of the interrupt lines assigned to either of the serial ports or to the parallel port.

If you are using a modem or other device that requires access to one of the serial port or parallel port interrupts, you should disable the associated port or move it to a different interrupt line, if available. The reference section of this manual provides detailed information on DIP switch array settings.

4.3.3 Configuring For Color Displays

If you will be using a color display adaptor and color display as your primary display you will need to change the setting of shunt W8 and re-run the SETUP program. This shunt is located in an almost inaccessible place at the rear of the center device bay, almost underneath the bay. It is most easily located and accessed if the center device bay is not occupied by a hard disk drive.

If there is a hard disk drive located in the center device bay, consult the section of this manual on installing peripherals to see how to loosen the front panel and move it out of the way. Disconnect the cables to the hard disk and move them out of the way. It may be helpful to move the floppy disk drive cable out of the way as well. Remove the screws attaching the hard disk drive rails in place and slide the hard disk partly out of the center device bay. This should make it far easier to see and to access shunt W8.

To run a color display as your primary console display, move the shunt at jumper pad W8 so that it connects pins 2 and 3. Pins 2 and 3 are the two pins closest to the rear of the system. Various EGA compatible cards require the system to be set for "Monochrome" as the primary display. If your EGA compatible card does not work with W8 set to Color, try again with W8 set to Monochrome.

After setting shunt W8 correctly, reconnect the disk cables, slide the drive back into place and re-insert the holding screws, then replace the front panel assembly. Run SETUP to tell your system you have a color display installed as the primary display.

4.3.4 Installation of 80387 Co-Processor

Remove the system board from the system chassis before installing the 80387. This is an advanced procedure which is discussed in the service section of this manual. Because of the pressure required to firmly insert the 80387 socket, attempting to insert a 80387 without removing the system board from the chassis can overstress the system board PCB.

Working at a static controlled station, lay the system board on a firm horizontal surface. Orient

the 80387's notched off corner to the notched off corner in the 80387 socket. Note that the notched off corner orientation is different in the 80386 placement on the MPE system board than in the 80387 placement. Insert the 80387 carefully and then press very firmly.

Bell Technologies uses a very expensive machined pin socket as an 80387 socket. This type of socket is proof against any contact problems caused by oxidation or bad contacts but requires a higher level of insertion force. To fully insert the 80387, you will have to bear down with 25 pounds or more of force. Thus it is important to have the system board lying flat against solid backing. Do not pound on the 80387: press with a firm and continuous motion with the heel of your hand.

To remove the 80387, use a Pin Grid Array large chip puller tool or with extreme care, a wide flat screwdriver. Pry up the chip only a little bit at a time, working in increments along each of the edges. You should pry the chip up in such small increments that it takes two or three times around the four edges to work it free. Take your time.

4.3.5 Installing the Second Serial Port

The second serial port is not enabled because this interrupt location is used for the HUB6, modem cards, and other accessories. In addition, it is not accessible from the outside of the system without a cable and slot bracket connector accessory option. If you are not using the HUB6 multiport serial card or other accessory that utilizes the second serial port interrupt, you may wish to install the second serial port connector and to turn on serial port #2.

Enable serial port #2 by moving the number 2 switch in the DIP switch array to the OFF position (this is backwards from what one might expect it to be).

To install the second serial port connector/bracket accessory, first read through the following section on "Installing Adaptor Cards" to learn how to handle adaptor cards and to install them. After doing so, move the disk controller card over one slot to the left from its usual rightmost position. This opens up an expansion slot and bracket location immediately adjacent to the lithium battery.

The second serial port connector is mounted on an expansion card bracket. Install the connector/bracket in the empty bracket slot next to the lithum battery. Plug the header connector at the end of the flat ribbon cable into connector J11, the serial port connector closest to the lithium battery. Make sure that the dark line on one edge of the flat ribbon cable faces towards the inside of the system chassis, just like on the ribbon cable attached to J10 (the serial port 1 connector).

4.4 Installing Adaptor Cards

Before installing cards, make sure your system power is OFF and the system is disconnected from the power cord. Review the precautions for protection from static. Remember, ground yourself before opening the option card's antistatic bag and do not touch the card's connectors. Handle only by the card's edges and insert by holding the top edge only.

1) Locate an unoccupied slot of the type required by your card (XT, AT, or 32 bit slot). You may use any unoccupied slot of the type required for your card.

2) Remove the screw that holds the expansion slot's cover in place and set the screw aside in a safe place.

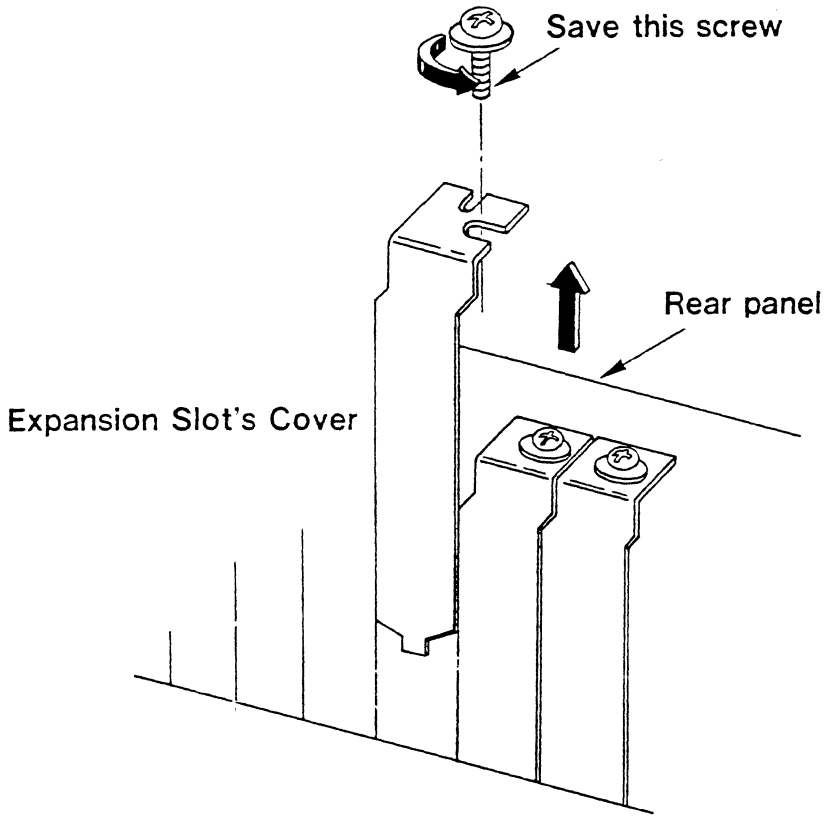


Figure 5. Remove the Expansion Slot Cover

3) Ground yourself by touching the power supply metal case, and then remove the option card from its protective antistatic bag.

4) Verify that all DIP switches, shunts, and other options are correctly set on the card before you insert it into the system.

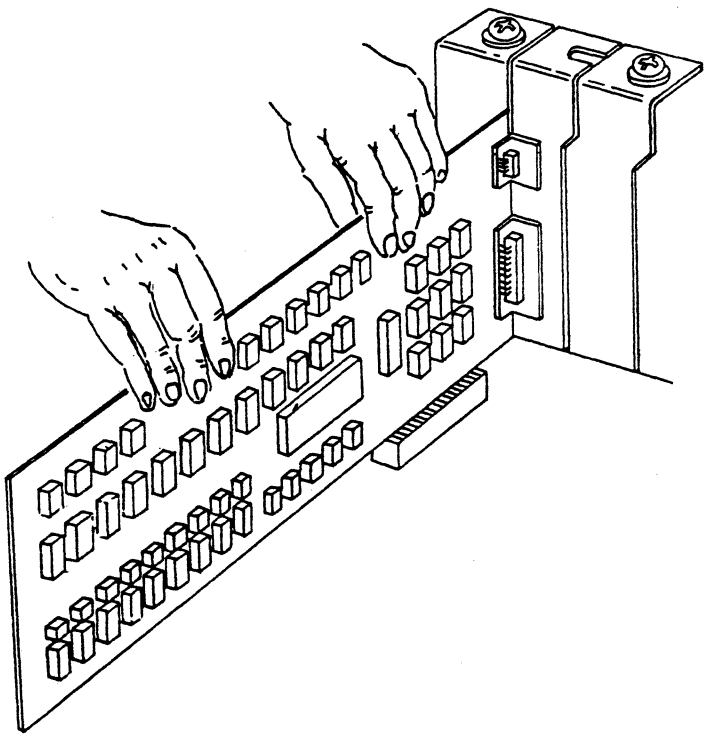


Figure 6. Installing an Option Card

5) Hold the option card by its top edge and firmly press it into the expansion slot while making certain the adaptor card edge (for full-length cards) is in the supporting card edge slide at the front of the chassis.

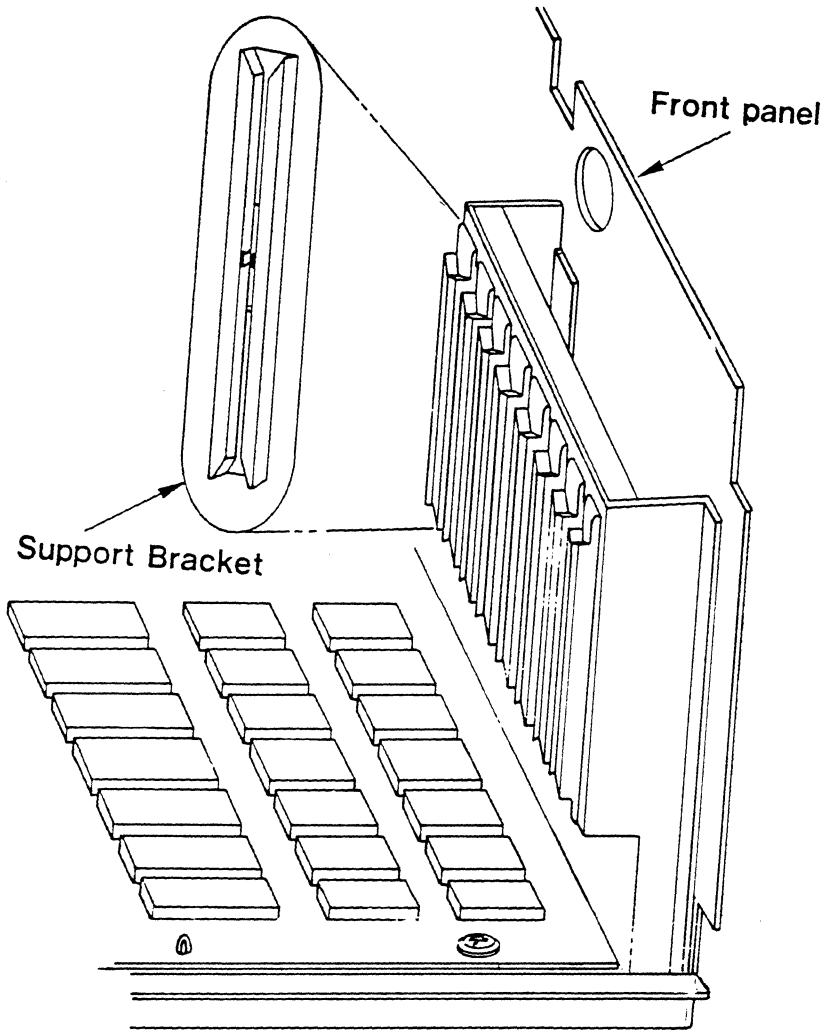


Figure 7. Card Edge Supporting Slide

6) If the card seems "hung up" at the support bracket at the rear of the MPE chassis, look closely at the bottom of the bracket. The reduced width tang at the bottom of the bracket is intended to insert into a slot cut in the bottom of the MPE chassis just below the rectangular expansion slot opening. Occasionally the bottom of the tang may catch on the bottom of the expansion slot opening, or the bottom of the tang (because the lower part of the option card's bracket is bent slightly) may not go into the slot cut for it. In that case, simply bend the tang slightly outwards (the usual case) or inwards so that it glides into the slot for it when the option card is pressed into the expansion bus connectors.

7) Press the option card into position to make sure it is inserted all the way into the expansion slot connector.

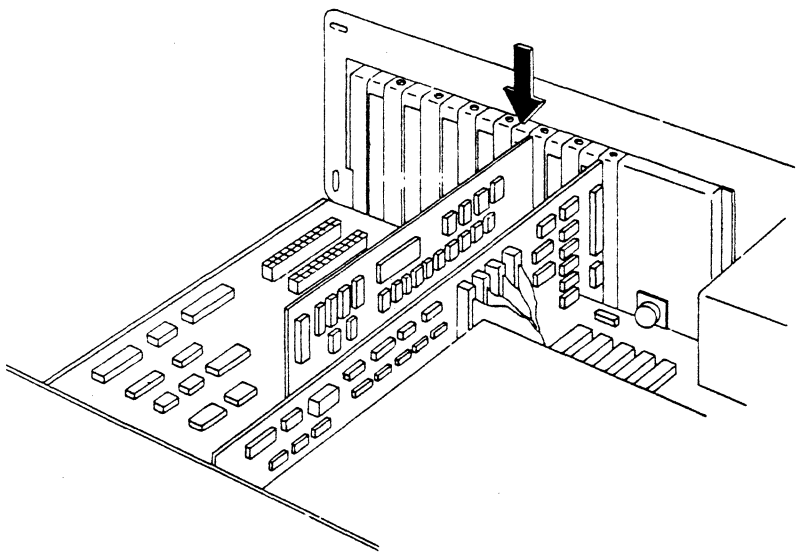


Figure 8. Press Firmly on the Option Card

8) Replace the screw removed earlier. This will keep the option card firmly in place.

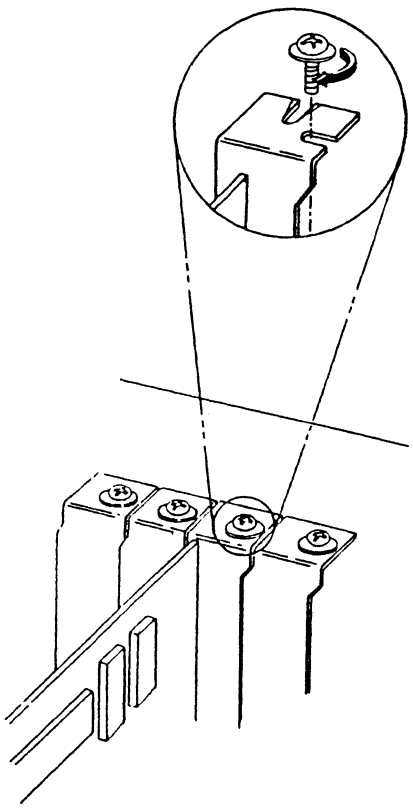


Figure 9. Replace the Bracket Screw

4.5 Installing Disks, Tapes, and Other Devices

This section provides a general introduction to installing devices in the MPE system chassis device bays. It is applicable to all 5.25" form-factor peripheral devices intended for use in AT standard machines. The illustrations show installation of a full height hard disk device into the center device bays.

1) Turn system power OFF and disconnect the system power cord from the system and from the wall outlet.

2) Remove the system cover. Ground yourself by touching the metal case of the power supply.

3) Make sure your peripheral device is correctly configured with DIP switch settings, shunts, terminator resistors, etc., before you install it. If you are installing a hard disk, make a copy of the bad block map for later use with your software.

4) Locate the device bay you intend to use. If you are installing a full height device, you will need to use two half-height bays.

5) If you will be using the center device bay, unscrew the front panel screws and move the front panel out of the way. There is no need to disconnect the front panel wires as they have enough slack in them to allow the front panel to be moved out of the way of the device bays.

6) The center bays may not be covered with a metal cover plate. If not, they will have two or more screws in place which are to be used to hold the peripheral device rails in place after installation. Remove these for use later.

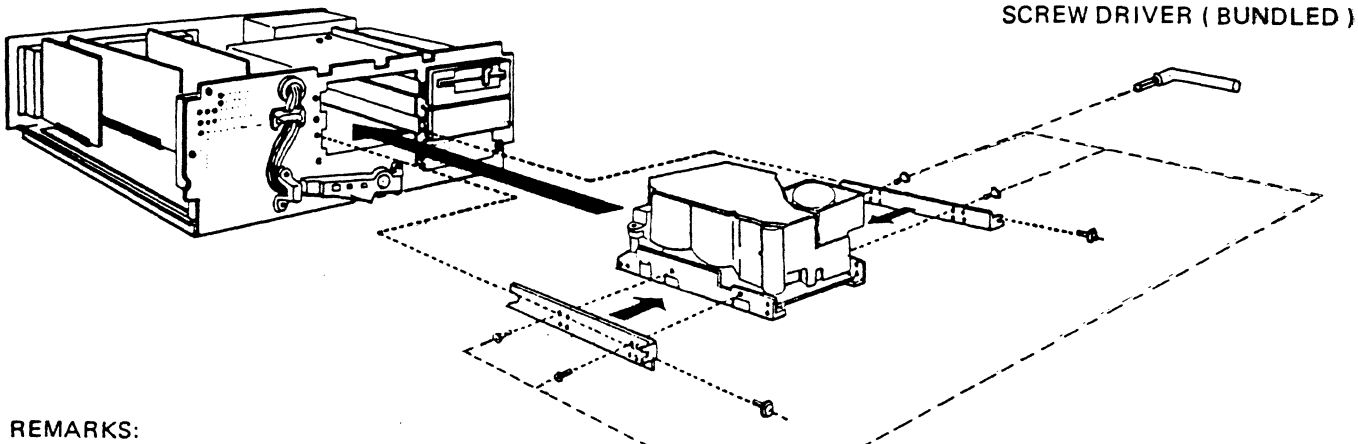
7) If the device bay you wish to use is covered by a metal plate, remove the plate by unscrewing its two mounting screws. Save these screws for use in installing your peripheral device. Save the cover plate in case you wish to remove the peripheral device at a later time.

8) If you wish to use the lowest device bay on the right hand side and need to have access to the device during operation, remove the plastic insert in the front cover which covers this bay. To do so, simply remove the two screws which hold it in place. Save the plastic insert and its screws in case you wish to replace it at a later date.

9) Your system includes mounting rails for devices. These are screwed to the sides of the peripheral device with the attached mounting screws. Use a regular screwdriver or the supplied TORX screwdriver. Since some peripherals are tapped for metric screws and others for English screws, several sets of screws are provided with each rails kit. See the illustration following. Note that one rail is attached with the screw flange at the very front on the upper side of the rail, while the other rail has the screw flange on the lower side of the rail.

10) Slide the peripheral device into the device bay. If you cannot fit it into the device bay, you may have mounted the slide rails onto the device using the wrong set of holes. Several sets of holes are provided to accomodate different peripherals. Try using a different set.

11) If you cannot insert the device the last few millimeters, remove it. Check the back ends of the rails for any excess plastic edges left over from injection molding. These may prevent the rails from sliding all of the way in.



REMARKS:

1. The screw driver is for installing and removing HDD.
2. The screw size is TORX floorboard screw # T–10.

Figure 10. Installing a Peripheral Device

12) Use two of the screws removed earlier to attach the front flange of the rails to the chassis. This will keep the peripheral device from sliding out of the chassis.

13) If you removed the front panel assembly earlier, replace it now.

14) Most peripherals intended for use in AT standard systems include a grounding lug. Attach one of the black grounding wires screwed in to the top of the chassis to the grounding lug for your peripheral device.

15) Locate the power connector for your peripheral device. This almost certainly will be located in an inconvenient and hard to see place. Note the orientation of the power connector, and which way the keyed diagonally cut corners of it are pointing. This tells you which way to insert the peripheral power cable from your MPE system power supply, which is keyed to match the power connector on the peripheral device.

16) The MPE system power supply has four power connectors intended for use with peripherals. These connectors have four wires each and are keyed for correct insertion into the peripheral device's power socket. Attach any of the four peripheral power connectors to your peripheral device. Do NOT force the connection. If you have to force the connection, you are probably trying to plug the connector in upside down.

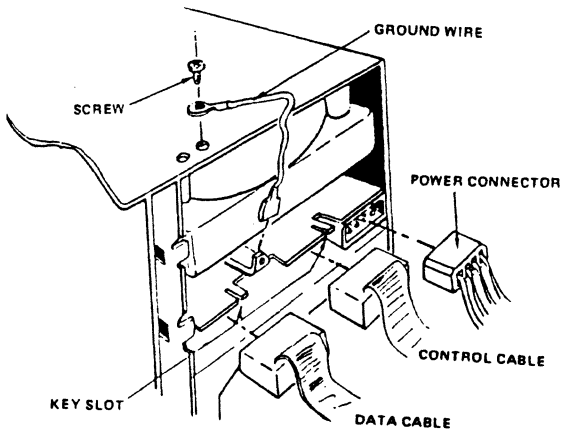


Figure 11. Cable Connections to Peripheral Device

17) Attach any cables running from the peripheral device to the card which controls it.

18) Double check all cable connections. Make sure any keyed cables are correctly inserted.

19) Replace the cover to your MPE system before turning power ON.

5. External Options Installation

This section describes how to install your system together with external components like monitors and keyboards.

5.1 Site Selection and Preparation

The following parameters are important when choosing a site for your MPE system. These factors are important both to your safety as well as to the safety of your system:

- Locate your MPE system in a clean, dry area that enjoys well regulated temperatures. Avoid placing the system too close to heaters, radiators, or other sources of heat. Do not locate the system where direct sunlight may cause it to heat up above ambient temperatures.

- Select a well-constructed work table or support surface for your MPE system. Do not place the MPE on an unstable cart, stand or table. If the system falls from an inadequate table serious damage could result.

- Slots and openings in the chassis and cover are provided for ventilation; to ensure reliable operation of the MPE system and to protect it from overheating these openings must not be blocked or covered. The openings should never be blocked by placing the product on a soft surface like a rug, sofa, or similar surface. Do not install the MPE system in a built-in cabinet or rack unless proper ventilation is provided.

- The MPE system must be operated from the type of AC power source indicated on the rear panel markings. If you are not sure of the type of power available, contact your system vendor or local power company.

- This product is equipped with a 3-wire grounding type plug, a plug having a third (grounding) pin. This plug will only fit into a grounding-type power outlet. This is an important safety feature. If you are unable to insert the plug into the outlet, contact your electrician to provide a grounding-type outlet. Do not defeat the purpose of the grounding-type plug.

- Do not allow anything to rest on the power cord. Do not locate the MPE system where persons will walk on the power cord.

- If an extension cord is used with the MPE system, make sure that the total of the ampere ratings on the products plugged into the extension cord does not exceed the extension cord ampere rating. In addition, make sure that the total of all products plugged into the wall outlet does not exceed 15 amperes or the maximum amperes supported by your wall outlet, whichever is less.

- Never push objects of any kind into the MPE 386 through the chassis or cover slots. They may touch dangerous voltage points or short out parts that could result in a risk of fire or electric shock. Do not locate the MPE system where liquids of any kind may be spilled on it.

5.2 Getting Ready For Operation

Set the MPE system in its operating location. Ready it for operation with the following steps:

1) Remove the shipping inserts from the floppy disk drive and tape mechanism, if installed.

2) Make sure the 115V - 230V voltage selector switch is set to the right voltage. In the United States, set the switch to 115V.

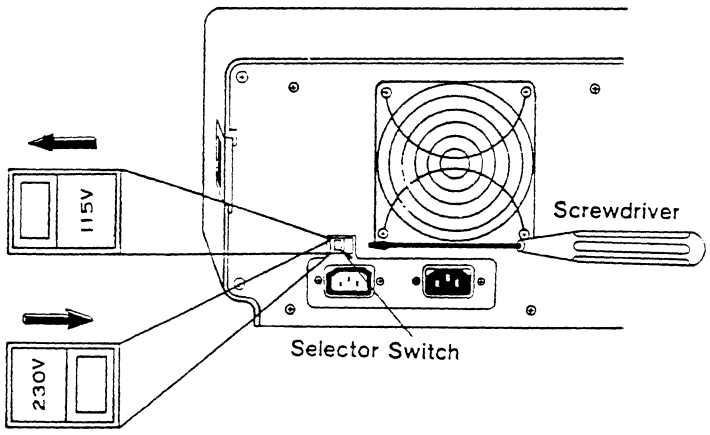


Figure 12. Set the Voltage Selector Switch

3) Your video display card should already have been installed. If it has not, consult the section in this manual on installing adaptor cards in Internal Assembly.

4) Place your video display monitor on top of the system or conveniently nearby. Connect the monitor signal cable.

5) If your monitor is equipped with a power cord designed to draw power from the MPE system unit switched AC power output (as illustrated below) connect the power cable to the MPE system unit. Some monitors have power cords designed to connect directly to a wall outlet. After verifying that the monitor is OFF, connect it to the wall outlet.

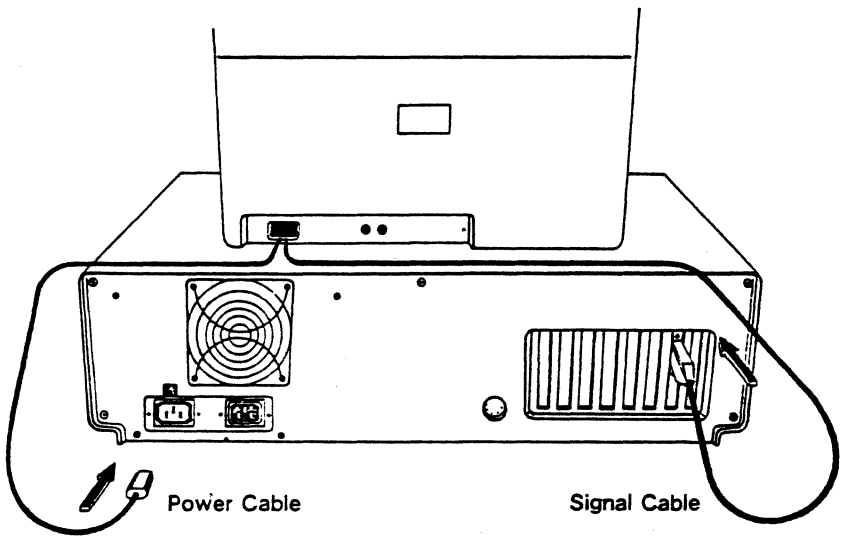


Figure 13. Connect Monitor Cables

6) Connect the keyboard cable to your unit. The basic AT standard keyboard is illustrated and may be used. MPE systems also ship with the 101 key Enhanced AT standard keyboard.

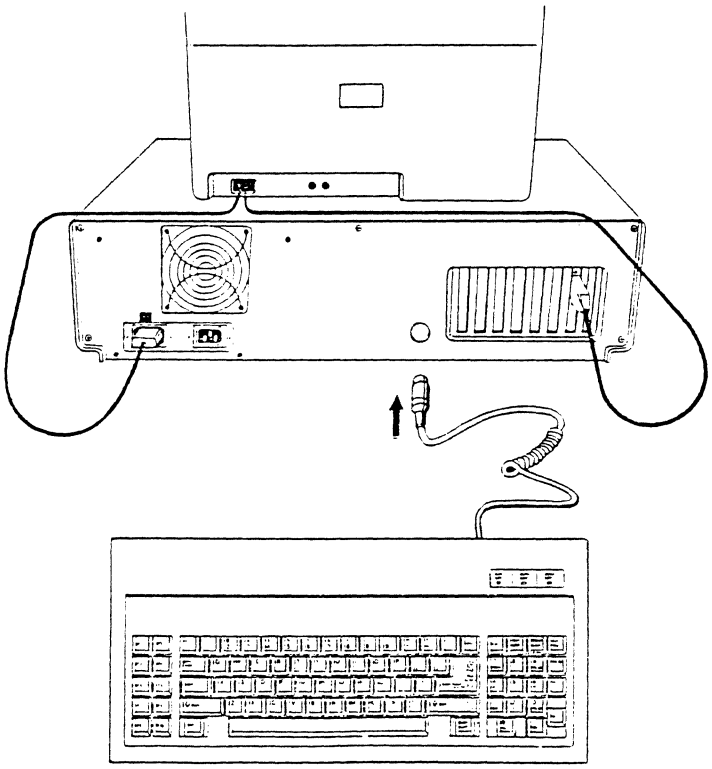


Figure 14. Connect Keyboard

6. System Checklist

Follow this checklist before turning on your MPE system. It will help you avoid errors that might cause damage to your system.

_____ The MPE system unit power switch is turned OFF.

_____ Floppy and tape shipping inserts are removed.

_____ The 115V-230V voltage selector switch in the rear of the chassis is set to the correct AC line voltage being used.

_____ The system cover is installed and all five cover screws are inserted tightly.

_____ The video monitor data cable is plugged into the appropriate adaptor card. **Caution**: Make sure you have not plugged a color monitor into a monochrome display card or vice versa.

_____ The video monitor power cable is plugged into the MPE system unit or into a wall outlet, as appropriate.

_____ The video monitor brightness and contrast adjustments are turned all the way up. Turn these knobs clockwise on Bell Technologies monitors for maximum brightness.

_____ Power switches on the monitor and other external devices are turned OFF.

_____ The keyboard is connected.

_____ Connect the AC power cord to the MPE system unit and to the AC wall outlet.

_____ You are now ready to operate your MPE system. To operate it, turn your monitor's power switch ON and then turn ON your MPE system unit's power switch. After you are satisfied your system is operating correctly, turn power ON to your printer, terminals, and other external options.

_____ A newly-installed system usually will have to be "setup" using the SETUP diskette provided. After that, you will need to load the operating system and desired applications software.

7. Power On Self Test (POST)

The contents of this section depend on the ROM BIOS being used. This manual describes use with the Phoenix ROM BIOS; the Award BIOS is similar.

Every time you turn system power on, a diagnostic software program contained in your system ROM memory tests various parts of your system. This is called the Power On Self Test (POST). If POST finds something amiss, it attempts to signal you what is wrong.

The following sequence occurs within POST every time you power up the MPE system:

1) Keyboard lights blink on and off.

2) Phoenix copyright message appears on the monitor screen.

3) The RAM memory test proceeds, with readout of what memory has been tested in the upper left hand corner of the screen. If you wish to abort the RAM memory test, simply press any key on the keyboard and POST will continue with the other tests.

4) POST tests functions in the system.

5) The boot process begins.

If at any time POST detects an error, it will cause the speaker to beep twice and will display a diagnostic message on the monitor screen. If POST believes it cannot display a message on the monitor or if an error occurs before the video display circuitry has been initiallized, it will signal an error with three beeps. Different sequences of beeps convey information on errors detected by POST and will be of interest to service personnel.

There are three classes of POST errors that may be found:

System Board Fatal Error - If POST detects something gravely wrong with the system board, it will beep (if it can) and halt.

System Board Non-Fatal Error - POST will signal the error with two beeps, display the error found on the monitor and prompt "Press F1 to continue." By "F1" POST means the function key on the keyboard marked F1.

Errors Not on System Board - If POST finds an error in a system component not on the system board (the video display adaptor, for example) it will report the error found and prompt you to press F1 to continue.

If you have not yet run the SETUP program on a newly installed system, POST will report an error in the configuration information, suggest you run SETUP, and then prompt you to hit F1 to continue.

7.1 The Boot Process

The MPE system firmware first will attempt to boot from a floppy diskette inserted in the first floppy drive, referred to as "Drive A:". If no diskette is inserted in Drive A: or if the floppy disk lever is not engaged to fully load the diskette, then the MPE system will attempt to boot from "Drive B:", the second floppy drive (if installed).

If the MPE cannot boot from floppy, it will attempt to boot from hard disk.

Since MPE systems will always on power-up attempt to boot from any diskette inserted into floppy drive A:, it is bad policy to leave systems running unattended with random diskettes inserted into Drive A:. If AC power is interrupted, the system will restart, attempt to boot from the diskette inserted in Drive A:, and will hang with an error message ("Not system diskette") displayed. While this will not harm data on the diskette or on the hard disk, it does prevent automatic re-booting if AC power fails when the machine is unattended.

On a newly installed system if the hard disk has not been initialized correctly or if it is not formatted as expected by the MPE, the system will take a long time (a minute!) before it "times out" on the hard disk during POST and commences the floppy boot. This is normal for non-Bell Technologies supplied hard disks. All Bell Technologies hard disks are formatted at the factory.

8. The SETUP Program

The contents of this section depend on the ROM BIOS being used. This manual describes use with the Phoenix ROM BIOS; the Award BIOS is similar.

Your MPE system includes a small amount of RAM, called "CMOS RAM," which is used to store configuration information. The lithium battery inside your MPE provides enough power to keep this configuration information, once set, valid for over two years.

The configuration information includes the following:

- Date and time
- Number and capacity of floppy disk drives
- Number and type of hard disks
- Amount of base memory
- Amount of expansion or extended memory
- Type of primary video display adaptor.

When you first install your MPE system, you need to run the SETUP program to load the above configuration information into the battery-backed CMOS RAM. You will also have to run the SETUP program should you ever change any of the above parameters (say, by adding or deleting RAM) or if the battery is ever disconnected from the the system board.

To run the SETUP program, insert your 80386 MPE SETUP diskette (provided with your system) in the floppy disk drive, close the door, and turn power on. Note that 286 SETUP programs as provided for use with 80286 based AT compatible systems will not work. After POST your system will boot from the floppy and automatically run SETUP. SETUP will display a list of current configuration found (nonsense values on a new system) and will prompt you with a series of menus to enter the correct information.

When responding to SETUP, you need to press the ENTER key on your keyboard after every response.

In general, SETUP displays the values currently stored and asks you if these are correct. If you reply 'N' for no, it will ask for your the correct information.

SETUP will first ask you for the date and time, and then it will display a list of configuration information stored and ask you if it is correct. If it is not, you reply "N" for no and supply the correct information.

8.1 Date and Time

When entering the date, you must provide it in the following format: month/day/year. You must uses slashes "/" between the month, day, and year figures. January is month 01 and December is month 12. You must type out the full year, as in "1988". For example, February 6, 1988 would be entered as:

02/06/1988

To enter the time, you must use an hour:minute:second format with 24 hour nomenclature used for the hours. If you do not want to enter seconds exactly, simply enter a 00 for the seconds field. 9:52 AM would be entered as:

09:52:00

1:30 in the afternoon would be entered as:

13:30:00

11:42 at night would be entered as:

23:42:00

8.2 Floppy Diskette Drives

It is very important to supply the correct floppy diskette drive information. SETUP presents you with a menu of floppy diskette drive types based on their capacities.

Standard AT floppy diskette drives as shipped by Bell Technologies are 1.2 Megabyte capacity.

The first floppy diskette drive installed in your system is always referred to as "Diskette Drive A:". The second floppy diskette drive is "Diskette Drive B:".

If you have one standard floppy drive in your machine, you should tell SETUP that Diskette Drive A: is 1.2 Megabyte capacity and Diskette Drive B: is not installed.

8.3 Fixed Disks

SETUP refers to hard disks as "fixed" disks. It will first need to know how many hard disks are installed in your system. It will then need to know what "type" the installed disks are. Since hard disks require more configuration information than just the capacity size, the "type" is a number from 1 to 47 which refers to a table of hard disk types stored in the BIOS ROM memory.

Following DOS nomenclature, SETUP refers to the first hard disk installed as "Fixed Drive C:" and to the second hard disk installed as "Fixed Drive D:".

The following table presents the hard disk drive types for hard disks shipped by Bell Technologies to date (capacities are unformatted values):

Bell Hard Disk Types		
Disk	Type	Capacity
B38	8	38MB
B86	37	86MB
B130	30	130MB

TABLE 9. Bell Hard Disk Types

Other Bell Technologies hard disk drives will have their type marked on their bad block lists, or clearly indicated in their accompanying documentation.

If you do not know your hard disk type, you can usually determine what type it should be if you have information on its operating parameters. Parameters of interest are: Number of cylinders, number of heads, the Precomp value, landing zone cylinder, and number of sectors per track. It is usually safe to assume that the last cylinder is the landing zone.

You can get a list of disk drive types supported by your MPE system by entering ? to SETUP as prompted when it asks you for the type disk you are using. By comparing the parameters for your hard disk to those in the table offered by SETUP, you can usually find the right type. If not, please contact your system vendor for help.

Caution: The system has no way of knowing if the disk drive type you have supplied it is wrong. Providing the wrong disk drive type can cause incorrect operation and may erase data on the disk. If you don't know the right disk drive type, don't guess!

Examples

If you have one Bell Technologies B130 disk drive, you should tell SETUP that Fixed Disk C: is Type 30 and Fixed Disk D: is not installed.

If you have one Bell Technologies B86 disk drive installed as your first drive and a B38 as your second drive, tell SETUP your Fixed Disk C: is Type 37 and Fixed Disk D: is Type 8.

8.4 Base Memory and Extended Memory

Because of the limitations of DOS and earlier Intel processors, memory in AT standard machines is organized as "Base Memory" plus "Extended Memory." Base memory is that memory addressable by non-protected mode operating systems such as DOS and is limited to a maximum of 640K. Extended memory is the rest of memory.

In MPE systems Base Memory is always 640K. To get extended memory, simply take the total amount of memory in megabytes, multiply by 1024 and subtract 640. The result is the value of Extended Memory.

MPE systems with no added memory have 4MB of memory on the system board. Base Memory is 640K, Extended Memory is 3456K. If you are adding memory to the system, here are the values of Extended Memory up to 16MB of total system RAM:

Extended Memory Values	
Total RAM	Extended Memory
4 MB	3456 K
5 MB	4480 K
6 MB	5504 K
7 MB	6528 K
8 MB	7552 K
9 MB	8576 K
10 MB	9600 K
11 MB	10624 K
12 MB	11648 K
13 MB	12672 K
14 MB	13696 K
15 MB	14720 K
16 MB	15744 K

Note: Base Memory is always 640 K

TABLE 10. Extended Memory Values for SETUP

8.5 Video Display Adaptor

The SETUP program provides four choices for video display adaptor. It wants to know which one is the primary adaptor because AT standard systems in DOS allow the use of more than one adaptor (MDA and CGA, for example) at a time.

If you have an EGA adaptor installed, you must tell SETUP that this is the primary adaptor in order to allow it to set up the EGA properly.

SETUP refers to the CGA as the "Color graphic" display adaptor. Since standard CGA cards allow two text modes, 40 column or 80 column, the SETUP program asks which mode you want to be the default if you have selected the CGA as your primary display adaptor.

The MDA, MGA, and other AT standard monochrome display cards are lumped together as "Monochrome" for the purposes of SETUP.

8.6 Exiting SETUP

Once you have entered the correct information to SETUP, it will prompt you to exit with the following prompt:

> Your system must now be rebooted. Insert the DOS disk and Press <enter>

SETUP's provincial attitude notwithstanding, you are not limited to only running DOS! When you press ENTER the system will commence the boot cycle by attempting to boot first from floppy and then from whatever operating system is loaded on the hard disk.

Once your machine has been SETUP, if your operating system has not been loaded on your hard disk by your system vendor the next step is to load the operating system on your hard disk.

In UNIX and Xenix, this is usually a menu-driven process that commences by booting off the first diskette in the distribution set, the "boot diskette". When you see the above exit message from SETUP displayed, you can start your UNIX or Xenix system load by inserting the boot diskette and pressing ENTER.

9. MPE System Board Reference

This chapter provides more detailed technical information to users of the Bell Technologies MPE system boards. It provides DIP Switch settings, shunt settings, connector pinouts, and complete electrical and design specifications. It should be used by any owner of a Bell Technologies MPE system board, and by all systems integrators using the MPE system.

For Bell Technologies MPE system users, this manual should be used in conjunction with the other systems, software, and peripherals manuals provided by Bell Technologies.

Additional useful documentation is the IBM PC AT Technical Reference and other IBM documentation for the PC AT. Although the specific details of the MPE such as DIP switches and shunt settings are different, the objective of IBM PC AT compatibility means that most of the IBM documentation applies directly to the MPE.

Other useful documents are databooks provided by Intel Corporation and other semiconductor vendors. These databooks provide extremely detailed technical information on the various chips used in the MPE system board.

9.1 Introduction

The Bell Technologies MPE System Boards provide perfect AT compatibility in a third generation 80386 true 32 bit design. The MPE uses 1MB x 1 DRAM for 4MB on the system board.

MPE system boards provide 8 XT compatible connectors, 6 AT compatible connectors, and 2 true 32 bit bus expansion connectors. Boards are fabricated as 4 layer PCBs and are populated with only the very highest quality components. All major components are socketed for very low cost maintenance. The MPE runs with all major 80386 AT compatible BIOS ROMs, as well as with the original IBM PC AT ROM BIOS.

MPE system boards normally run at 16MHZ with one wait state. Optional OEM population allows operation at 20MHZ with one wait state (20MHZ processor and 80ns RAM required).

The design has been optimized for high yield manufacturability and long life in the field. By using stable, throroughly debugged circuit components, the discrete component design avoids the known and as-yet-unknown quirks of chip set based design. By employing readily available RAM components, the MPE design makes for a sensibly priced DOS machine as well as an optimal UNIX or Xenix platform. The entire 32 bit interface between processor and RAM has been designed to allow easy addition of large amounts of low cost RAM: perhaps the single most important factor affecting overall system throughput in SCO Xenix as well as UNIX System V.

9.2 Installation and Removal of Chips

Bell Technologies uses only premium sockets on its board level products. In particular, the sockets used for 80386 and 80387 are designed for high reliability. Unfortunately, high quality sockets require that a higher degree of force be used when inserting and removing chips.

Remove the system board from the system before inserting and removing chips. Use a firm backing material (wood, etc) pressed flat up against the back of the system board when inserting parts. Use "chip pullers" to remove parts. Avoid flexing the Printed Circuit Board when inserting or removing chips. Work only at an approved static control station. Ground yourself before touching the system board or any component. Take your time.

Your system board is a high quality piece of engineering. With proper care it will last a lifetime.

9.3 System Board Features

The illustration below identifies major parts of the system board. The W and J identifiers refer to jumpers and connectors which are described in detail in the following pages.

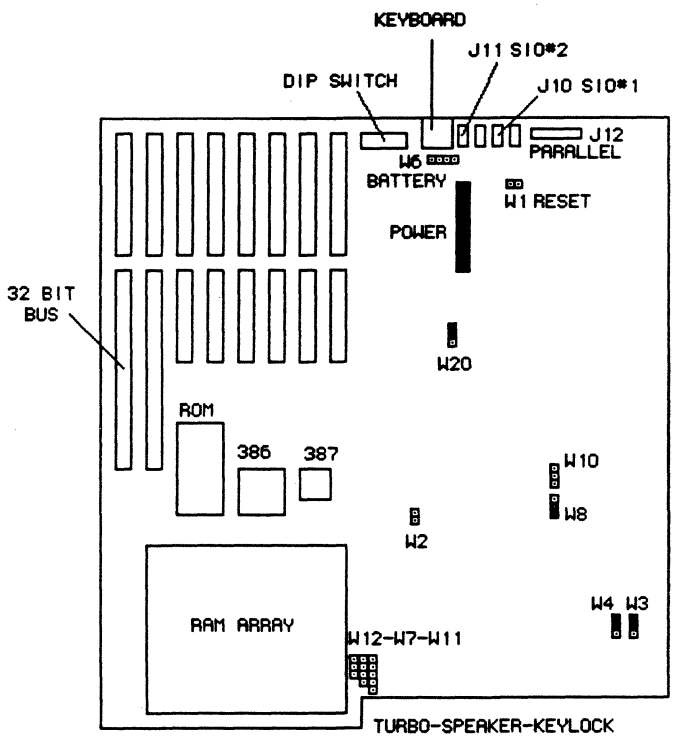


Figure 15. Locations of Items on System Board

9.3.1 80386 Processor Socket

MPE systems use Intel's 80386 32 bit microprocessor. This advanced microprocessor is upwardly compatible to the 8088, 8086, 80186 and 80286 microprocessors. It incorporates the following additional features:

- 32 data lines, enabling true 32 bit data word operation.
- 32 address lines to provide a physical address space of 232 bytes (4 gigabytes) in protected modes and a virtual address space of 246 bytes (64 terabytes). All address lines are brought out on the MPE to the 32 bit expansion connectors to provide addressability well beyond 16MB.
- Virtual 8086 mode to provide hardware support for 8086 emulation while multitasking, thus greatly improving the performance of DOS/UNIX merge systems.
- Hardware support for demand paged memory.

Bell Technologies ships only "EE" tested and certified 32 Bit 80386's. Processor speed is selected by the crystal oscillator inserted at socket Y4. The 80386 and 80387 processor clock is one-half of the crystal's speed, and the bus clock is one-fourth the crystal's speed. The crystal speed may be varied up or down for OEM purposes, but should not exceed 40MHZ. 100ns RAM is required to run at 16MHZ 1 wait state and 80ns RAM is required at 20MHZ 1 wait state.

Although all MPE systems were designed to 20MHZ operating specifications, units populated with 16MHZ 80386 chips and 100ns RAM are only warranted when run at 16MHZ (using the standard 32MHZ crystal).

To remove the 80386, use a PGA large chip puller tool or with extreme care, a wide flat screwdriver. Make sure you are prying the chip out of its socket and not the socket out of the system board. Pry up the chip only a little bit at a time, working in increments along each of the edges. You should pry the chip up in such small increments that it takes two or three times around the four edges to work it free. Take your time.

9.3.2 80387 Math Co-Processor Socket

The MPE system board includes a socket for insertion of an optional Intel 80387 Mathematics Co-Processor. The 80387 socket is clocked at the same speed as the main CPU. Installation of an 80387 will provide floating point performance exceeding that of some super-minis. The socket is configured to accept standard 68 lead PGA (Pin Grid Array) 80387 chips.

When correctly setup by the BIOS, the 80387 in the MPE design is compatible with DOS and other programs written for the 80287 or 8087. Thus, earlier generation software programs written for these predecessor math co-processors will run on the MPE and will be able to take advantage of the dramatically greater speed of the 80387. Programs written to take explicit advantage of the 80387 will go even faster.

Remove the system board from the system chassis before installing the 80387. Lay the system board on a firm horizontal serface. Orient the 80387's notched off corner to the notched off corner in the 80387 socket. Note that the notched off corner orientation is different in the 80386 placement on the system board than in the 80387 placement. Insert the 80387 carefully

and then press very firmly.

Bell Technologies uses a very expensive machined pin socket as an 80387 socket. This type of socket is proof against any contact problems caused by oxidation or bad contacts but requires a higher level of insertion force. To fully insert the 80387, you will have to bear down with 25 pounds or more of force. Thus it is important to have the system board lying flat against solid backing. Do not pound on the 80387: press with a firm and continuous motion with the heel of your hand.

To remove the 80387, use a PGA large chip puller tool or with extreme care, a wide flat screwdriver. Pry up the chip only a little bit at a time, working in increments along each of the edges. You should pry the chip up in such small increments that it takes two or three times around the four edges to work it free. Take your time.

9.3.2.1 Intel Erratum 21 Management

All 80386 chips manufactured to date incorporate an erratum described by Intel as Erratum 21. Erratum 21 occurs when the 80386 is in paged mode and an attempt is made to use a mathematics co-processor (either an 80387 or 80287). When Erratum 21 occurs, the system usually crashes but a floating point calculation error may also result. Erratum 21 does not occur on every co-processor instruction. Its frequency of occurance depends on the software run as well as on details of system design.

The Bell Technologies MPE system board circuit design functions to essentially eliminate Erratum 21. The circuitry minimizes the occurance of Erratum 21 to such a great degree that Erratum 21 has never been observed in MPE system boards during testing at Bell Technologies. Although we have not been able to cause Erratum 21 to occur in our MPE system board, it may well be possible that some programs may trigger it.

Since Erratum 21 is an actual defect in **all** 80386 chips the only way to guarantee elimination of it is to insert a special daughterboard. The Bell Technologies 80386 Math Adaptor is a small, business card sized daughterboard that implements a fix to Erratum 21 in hardware. Although principally designed for use in other 80386 systems (where the Erratum strikes almost instantly), the 386 Math Adaptor may be used in MPE systems as well. Bell Technologies customers may purchase 386 Math Adaptors at a special discount rate.

9.3.3 Timers

The MPE uses an IBM PC AT compatible timer generation chip, the Intel 8254, to provide three programmable timers. Each uses a timing frequency of 1.19MHZ. The timers are used as follows:

Timer 0 Output tied to interrupt request line 0 (IRQ0).

Timer 1 Used to trigger dynamic RAM refresh.

Timer 2 Provides speaker tone. May be altered under program control.

9.3.4 System Memory

The MPE system board uses 1Mbit x 1 DRAM parts (100ns or faster) to provide 4 MB of memory with parity on the system board. MPE system boards are populated with 18 pin DIP

sockets in the RAM array. Do not populate the 18 pin 1MB chip sockets with 16 pin 256K parts. The 4MB version of the MPE will accept 1Mbit x 1 RAM chips only. All four rows for a total of 4MB must be populated.

The system memory map is as follows:

System Memory Map	
0 - 640 KB	DOS Base Memory
641 - 768 KB	DOS Expansion Cards, Etc.
769 - 1024 KB	Reserved for ROM BIOS
1025 KB - 15.768 MB	Extended Memory
15.769 - 16 MB	Reserved for ROM BIOS

TABLE 11. System Memory Utilization

Bell Technologies provides 32 bit RAM cards for use in the 32 bit expansion bus slots on your MPE. The RAM12 provides 1 or 2MB of RAM utilizing 256K x 1 chips. The RAM48 provides 4 or 8MB of RAM utilizing 1Mbit x 1 chips. RAM12's and RAM48's may be intermixed on MPE system boards.

9.3.4.1 Expansion Memory Boards

The MPE will work with standard AT compatible expansion memory boards installed in either the 16 bit AT bus connectors or with Bell Technologies or compatible 32 bit expansion memory installed in the 32 bit expansion slots. Performance is vastly greater with the 32 bit expansion slots.

WARNING! - Do not attempt to run 16 bit AT boards in the 32 bit expansion slots!

The memory in Bell Technologies 32 bit memory boards is organized as two banks, each of which represents one half of the card's total memory capacity. Only one bank, the "lower" bank, may be populated with RAM chips to provide only one-half capacity. For example, if only the lower bank of the RAM48 card is populated with chips then the board will provide 4 MB of RAM capacity. If both the lower and upper banks are populated, then the card will provide a full 8 MB of RAM.

RAM12 boards provide 1 or 2 MB of RAM using 16 pin 256K x 1 DRAM chips, 100ns or faster access. RAM48 boards provide 4 or 8 MB of RAM using 18 pin 1Mbit x 1, 100ns or faster

DRAM.

When populating either the RAM12 or the RAM48, the bank farthest away from the edge connector is populated first. Light emitting diodes (LED's) at the top of the card show which bank is active at any given instant. If you are adding chips to RAM48 boards, you must use 1Mbit x 1 18 pin RAM only. Do not attempt to use 16 pin 256K x 1 RAM chips in the 18 pin sockets of the RAM48.

RAM12 and RAM48 boards may be used together on any MPE system board. Either board may be plugged into either MPE 32 bit expansion bus connector.

9.3.4.2 System ROM

MPE system boards shipped from Bell Technologies contain Phoenix or Award IBM PC AT compatible ROM BIOS. The system boards provide four sockets for ROM, two of which are normally populated with 27256 ROM chips to provide 256K of ROM.

Note that given AT compatible RAM ordering, the 256K *bits* of ROM represent an actual 64K *bytes* of code. The two ROM chips thus provide 64KB and are mapped in the 64KB space immediately below the 1MB and the 16MB boundaries. If four ROM chips are inserted, the second pair (64KB worth) is mapped immediately below the initial pair's 64KB space for a total of 128KB of ROM.

If 27512 series ROMs are used, one pair of ROMs provides 128K of storage and two pairs of ROMs provide 256K of storage, the maximum set aside in the AT memory map for BIOS ROM.

The four ROM sockets are labeled High Odd, Low Odd, High Even, Low Even. Populate the sockets labeled High Odd and High Even first.

The ROM chips labeled Odd contain the "odd" byte (bits 8 to 15) of each 16 bit word while the other ROM chips contain the "even" byte (bits 0 to 7) of each 16 bit word.

ROM is mapped into the upper 256K of the first megabyte of memory as well as at the upper 256K of the fifteenth megabyte of memory. In protected mode, it is available at each set of locations. With optional OEM PAL chips, the ROM may be mapped if desired nearly anywhere in RAM and can even be placed at the absolute top of the 4 gigabyte memory of the 80386.

ROM accesses occur over an internal 16 bit data path used for ROM only. ROM chips with 250ns or faster access times are required.

9.3.5 ROM BIOS Supplied

Bell Technologies ships with Phoenix or Award BIOS in ROM. Neither BIOS includes BASIC in ROM, thus the IBM BASIC or BASICA interpreters do not run on the MPE. As with any other AT compatible system if you wish to run BASIC you should procure Microsoft's GW-BASIC package or similar.

Both BIOS's define the industry standard for compatibility. If a program does not run on the MPE equipped with a Bell Technologies supplied BIOS, in all likelihood it will not run on any AT compatible.

Note that any AT compatible BIOS must include programming for the Intel 8742 keyboard

control microprocessor. MPEs are available to OEM's without the 8742 controller installed, or with no BIOS ROM chips but with generic 8742 programming in place. See the Intel Microcontroller Handbook for more information on the 8742.

The programming on Bell Technologies supplied 8742 recognises both the original IBM PC AT keyboard as well as the "enhanced" version (now standard) which provides a separate cursor pad. Since the enhanced keyboard generates slightly different codes than the original, there are some programs which may experience difficulty when running on systems equipped with enhanced keyboards. Of course, any program which experiences difficulty running on IBM's own AT equipped with an enhanced keyboard will experience the same difficulty on a Bell Technologies MPE equipped with an enhanced keyboard.

9.3.6 Expansion Card Slots

The MPE has a total of eight expansion card connector slots. The eight slots consist of eight PC XT ("8 bit") connectors combined with two 32 bit connectors and six PC AT ("16 bit") connectors.

PC XT ("8 bit") expansion cards may be plugged into any of the eight XT style connectors.

PC AT ("16 bit") expansion cards may be plugged into any of the six slots providing XT/AT connectors. **Do not** plug AT style cards into the 32 bit connectors.

Bell Technologies and Bell Technologies compatible cards may be plugged into the two 2-bit expansion slots. At the present time, only memory expansion cards are available for these slots. **Do not** plug Intel 32 bit memory cards into these slots.

At last count, there were 15 other manufacturers utilizing the same 32 bit expansion bus as defined in the MPE system boards. However, given the variability that currently exists in AT compatible 32 bit busses do not install non-Bell Technologies cards in these slots without checking with us first. Do not plug any other manufacturer's 32 bit card into these slots without first receiving written permission from Bell Technologies, or your warranty is void.

All standard production MPE boards have the XT connectors matched with an AT or a 32 bit connector.

The following sections present specifications for each of the slots.

9.3.6.1 XT Slots

These slots are clocked at 1/4 the crystal oscillator frequency resulting in an 8MHZ bus clock with the standard 32MHZ crystal. With 20 address bits and 8 data bits, these slots provide addressing up to 1MB with 8 bit data transfers. Pinout is as follows:

XT Connector			
GND	B1	A1	/IOCHK
DRVST	B2	A2	SD7
(+5) VCC	B3	A3	SD6
IRQ9	B4	A4	SD5
-5 V	B5	A5	SD4
DRQ2	B6	A6	SD3
-12 V	B7	A7	SD2
/OWS	B8	A8	SD1
+12 V	B9	A9	SD0
GND	B10	A10	IOCHRDY
/SMEMW	B11	A11	AEN
/SMEMR	B12	A12	SA19
/IOW	B13	A13	SA18
/IOR	B14	A14	SA17
/DACK3	B15	A15	SA16
DRQ3	B16	A16	SA15
/DACK1	B17	A17	SA14
DRQ1	B18	A18	SA13
/REFRESH	B19	A19	SA12
BUSCLK	B20	A20	SA11
IRQ7	B21	A21	SA10
IRQ6	B22	A22	SA9
IRQ5	B23	A23	SA8
IRQ4	B24	A24	SA7
IRQ3	B25	A25	SA6
/DACK2	B26	A26	SA5
T/C	B27	A27	SA4
BALE	B28	A28	SA3
VCC	B29	A29	SA2
14 MHZ	B30	A30	SA1
GND	B31	A31	SA0

TABLE 12. PC XT Connector Pinout

9.3.6.2 AT Slots

The AT form factor connectors combine with the XT connectors to form six IBM PC AT compatible expansion card connectors. The XT/AT combination provides 16 data bits and 24 address bits. Addressing reaches up to 16MB with 16 bit data transfers. In addition, the extended AT interrupts are also available. Bus clock is still 1/4 the crystal oscillator frequency for a bus clock of 8MHZ with the standard crystal. Pinout of the AT connectors is as follows:

AT Connector			
/MEMCS16	D1	C1	/SBHE
/IOCS16	D2	C2	LA23
IRQ10	D3	C3	LA22
IRQ11	D4	C4	LA21
IRQ12	D5	C5	LA20
IRQ15	D6	C6	LA19
IRQ14	D7	C7	LA18
/DACK0	D8	C8	LA17
DRQ0	D9	C9	/MEMR
/DACK5	D10	C10	/MEMW
DRQ5	D11	C11	SD8
/DACK6	D12	C12	SD9
DRQ6	D13	C13	SD10
/DACK7	D14	C14	SD11
DRQ7	D15	C15	SD12
VCC	D16	C16	SD13
/MASTER	D17	C17	SD14
GND	D18	C18	SD15

TABLE 13. PC AT Connector Pinout

9.3.6.3 32 Bit Slots

Connectors J3 and J4 provide a general purpose 32 bit bus interface that ties directly into the internal 32 bit bus used by the system for interfacing to the 80386 chip and RAM array. **These slots are for Bell Technologies or compatible 32 bit card products only.** Do not insert AT cards into these slots.

The 32 bit slots operate at 1/2 the frequency of the crystal oscillator, that is, at 16MHZ with the standard 32MHZ crystal. Signal definitions and pinout is as follows (for timings, refer to the general system timing diagram available from Bell Technologies under non-disclosure.):

Signal Definitions for 32 Bit Expansion Slot:

A0:A31	CPU Address lines, not to be driven by the 32 bit slot.
D0:D31	CPU Data lines, bidirectional to the 32 bit slot.
PIN0:PIN3	Parity IN data to 32 bit slot.
POUT0:POUT3	Parity OUT data from 32 bit slot to the system. Checked by system logic at the end of each read cycle.
BDSEL-	Output by the 32 bit slot to tell the system that the address was recognized and is being responded to.
HLDA+	High level indicates that the 386 has given up the bus to an alternate master.
MEMCMD+	Active high signal indicating that the A0:A31 lines are valid and that a read or write is taking place.
BAMEMW-	Active low signal indicating a write cycle.
REFRESH-	Active low signal indicating a dynamic RAM refresh cycle. Refresh address is valid on A0:A8. Rate is every 14-15 microseconds.

32 Bit Connector			
A2	1	2	D0
A3	3	4	D1
A4	5	6	D2
GND	7	8	D3
A5	9	10	D4
A6	11	12	D5
A7	13	14	D6
A8	15	16	D7
A9	17	18	VCC
A10	19	20	D8
A11	21	22	D9
A12	23	24	D10
GND	25	26	D11
A13	27	28	D12
A14	29	30	D13
A15	31	32	D14
A16	33	34	D15
A17	35	36	D16
A18	37	38	D17
A19	39	40	D18
A20	41	42	D19
GND	43	44	VCC
A21	45	46	D20
A22	47	48	D21
A23	49	50	D22
A24	51	52	D23
A25	53	54	D24
A26	55	56	D25
A27	57	58	D26
A28	59	60	D27
GND	61	62	D28
A29	63	64	D29
A30	65	66	D30
A31	67	68	D31
BD0	69	70	VCC
BE1	71	72	PIN0
BE2	73	74	POUT0
BE3	75	76	PIN1
/BDSEL	77	78	POUT1
HLDA	79	80	PIN2
MEMCMD	81	82	POUT2
/BAMEMW	83	84	PIN3
/REFRESH	85	86	POUT3

TABLE 14. 32 Bit Connector Pinout

9.3.7 I/O Address Map

The MPE has i/o memory mapped to be exactly equivalent to the IBM PC AT. The memory map is as follows (see IBM PC AT Technical Reference Guide for more information.):

Legend:

DMA - Direct Memory Access
PIC - Programmable Interrupt Controller
NMI - Non-Maskable Interrupt
PIO - Parallel Input Output
All Addresses are in hexadecimal.

System I/O Memory Map	
Address	Connected To
00-1F	DMA Controller #1, 8-bit transfers (Intel 8237A-5)
20-3F	PIC #1 (Intel 8259A)
40-5F	Timer/Counter (Intel 8254)
60-64	Keyboard Controller (Intel 8742)
61	On-board testing registers
70,71	Clock/Calendar (Motorola MC146818)
70, bit 7	NMI Mask
78	On-board test stimulus register
80-8F	DMA Page Register (74LS612)
90-9F	DMA Page Register (74LS612)
A0-BF	PIC #2 (Intel 8259A)
C0-DF	DMA Controller #2, 16-bit transfers (Intel 8237A-5)
F0	Clear Busy signal of math co-processor
F1	Reset math co-processor
F8-FF	80387 Math Co-Processor
278-27F	On-board parallel port, if configured as PIO #2
2F8-2FF	On-board serial port #2
378-37F	On-board parallel port, if configured as PIO #1
3F8-3FF	On-board serial port #1

TABLE 15. System I/O Memory Map

Note: In 80286 based PC AT's, the i/o addressing to the DMA page register in the range 80-9F is actually a reference to the DMA page register implemented with a single 74LS612 in the range 80-8F which is duplicated in the range 90-9F as well. The MPE provides a second 74LS612 in the range 90-9F to handle DMA for the upper 8 address lines (A24:A31) to handle DMA addressing in the 16MB to 4 Gigabyte range for the uniquely ambitious programmer. We recommend limiting refrences to only 80-8F if true compatibility with AT architecture is desired.

9.3.8 Interrupt Controllers

The MPE uses two Intel 8259A Programmable Interrupt Controllers (PICs) to manage hardware interrupts in the system. One is a Master and the other is a Slave. The original PC and PC XT had a limited number of interrupt channels available. The AT extended the number of interrupts available by providing more interrupt lines on the AT expansion connector. The following chart shows the interrupt lines available, their priorities, on which bus connector they are available, and how they are wired to the Master and Slave PICs:

Interrupt Line Usage		
Priority	Usage and Location	Connected To
NMI	Parity Error	80386 NMI Input
0	Timer Channel 0	Master PIC, Interrupt 0
1	Keyboard Controller	Master PIC, Interrupt 1
2	Slave PIC	Master PIC, Interrupt 2
3	Clock/Calendar	Slave PIC, Interrupt 0
4	PC Slot, IRQ 9	Slave PIC, Interrupt 1
5	AT Slot, IRQ 10	Slave PIC, Interrupt 2
6	AT Slot, IRQ 11	Slave PIC, Interrupt 3
7	AT Slot, IRQ 12	Slave PIC, Interrupt 4
8	Math Co-Processor Busy	Slave PIC, Interrupt 5
9	AT Slot, IRQ 14	Slave PIC, Interrupt 6
10	AT Slot, IRQ 15	Slave PIC, Interrupt 7
11	PC Slot, IRQ 3, Serial Port 2	Master PIC, Interrupt 3
12	PC Slot, IRQ 4, Serial Port 1	Master PIC, Interrupt 4
13	PC Slot, IRQ 5, Parallel Port 2	Master PIC, Interrupt 5
14	PC Slot, IRQ 6, Floppy Disk Drive	Master PIC, Interrupt 6
14	PC Slot, IRQ 7, Parallel Port 1	Master PIC, Interrupt 7

TABLE 16. Interrupt Line Usage

9.3.9 DMA Controllers

The MPE uses two Intel 8237A-5 Direct Memory Access (DMA) controller configured as a Master and a Slave. The Slave handles 8-bit transfers, while the Master handles 16-bit transfers. Again, because of the historical evolution of the PC and PC/XT into the AT, some DMA signals are found on the PC bus while others are found only on the AT connector.

The 8237's operate at one eighth of the fundamental crystal oscillator frequency. With a default crystal speed of 32MHZ, the DMA chips are clocked at 4MHZ. DMA channel utilization is as follows:

DMA Channels		
DMA Channel	Controller	Slot and Usage
0	Slave, 8-bit	AT Slot, DRQ0
1	Slave, 8-bit	PC Slot, DRQ1
2	Slave, 8-bit	PC Slot, DRQ2
3	Slave, 8-bit	PC Slot, DRQ3
4	Master, 16-bit	Slave Controller Input into Master
5	Master, 16-bit	AT Slot, DRQ5
6	Master, 16-bit	AT Slot, DRQ6
7	Master, 16-bit	AT Slot, DRQ7

TABLE 17. DMA Channels

9.3.10 Clock/Calendar and CMOS RAM

The MPE uses a standard AT compatible Motorola MC146818AP chip to provide perfect AT compatibility with on-board clock, calendar, and CMOS RAM used for system Setup information. Battery power applied to this circuit will keep system time, date, and Setup information valid even if the main power supply is shut down. Battery power should be 6V, 1 ampere hour lithium battery. This will maintain the time and setup information for over two years in normal use.

The Motorola MC146818AP contains a real-time clock and 64 bytes of CMOS RAM. 14 of these bytes are used by the internal circuitry of the real-time clock. The remaining bytes are used to store configuration and other setup information for your system in accordance with standard usage among AT compatibles. The memory map for the Motorola MC146818AP follows:

Clock/Calendar - CMOS RAM Memory Map	
Location	Usage
00-0D*	Real-Time Clock Information
0E*	Diagnostic Status Byte
0F*	Shutdown Status Byte
10	Diskette Drive Type Byte - drives A and B
11	Reserved
12	Fixed Disk Type Byte - drives C and D
13	Reserved
14	Equipment byte
15	Low base memory byte
16	High base memory byte
17	Low expansion memory byte
18	High expansion memory byte
19-2D	Reserved
2E-2F	2-Byte CMOS Checksum
30*	Low expansion memory byte
31*	High expansion memory byte
32*	Date century byte
33*	Information flags (set during power on)
34-3F	Reserved

TABLE 18. Clock/Calendar and CMOS RAM Memory Mapping

* These bytes are not included in checksum calculation and are not part of the configuration record. Consult the IBM PC AT Technical Reference Guide for additional information.

9.4 DIP Switch Options

A ten position Dual In-line Package (DIP) switch array is located at SW1 immediately adjacent to the keyboard connector at the rear of the MPE system board. The ten individual switches of the array may be set to specify various options involving the on-board parallel port and two serial ports. The individual switch closest to the keyboard connector is Switch 1. The farthest is Switch 10.

SW1 - Ten Position DIP Switch Array		
Switch	Default	Function
1	OFF	OFF: Enable Serial Port 1, ON: Disable Serial Port 1
2	ON	OFF: Enable Serial Port 2, ON: Disable Serial Port 2
3	OFF	OFF: Enable Parallel Port, ON: Disable Parallel Port
4	OFF	OFF: Enable as Parallel #1, ON: Enable as Parallel #2
5	ON	ON: Select IRQ 4 for Serial Port 1, else OFF Only one
6	OFF	ON: Select IRQ 3 for Serial Port 1, else OFF may be ON
7	OFF	ON: Select IRQ 4 for Serial Port 2, else OFF Only one
8	ON	ON: Select IRQ 3 for Serial Port 2, else OFF may be ON
9	OFF	ON: Select IRQ 5 for Parallel Port, else OFF Only one
10	ON	ON: Select IRQ 7 for Parallel Port, else OFF may be ON

TABLE 19. Ten Position DIP Switch Array - Location SW1

Note: Only 1 switch of pairs 5-6, 7-8, 9-10 may be ON. The other switch in the pair must be OFF. Do not select the same IRQ line for Serial Port 1 and Serial Port 2. You must use a different interrupt line for each port.

DIP Switch Array Defaults									
1	2	3	4	5	6	7	8	9	10
OFF	ON	OFF	OFF	ON	OFF	OFF	ON	OFF	ON

TABLE 20. DIP Switch Array Default Settings

The default setting matches the usual IBM PC AT practice: Serial port 1 and the parallel port are turned on. The parallel port is defined to be parallel port 1. Serial port 1 uses interrupt 4, serial port 2 (if enabled) uses interrupt 3, and parallel port 1 uses interrupt 7.

Bell Technologies HubCard users please note: the default setting utilizes interrupt 3 for COM2, the second serial port. This conflicts with the default installation of the HUB6 software which also uses interrupt 3, so COM2 is not enabled. If you do not have a HUB6 card installed you may enable serial port 2 by setting Switch 2 OFF in the DIP switch array. In many operating systems, you may enable COM2 **and** use the HUB6 by reconfiguring the HubCard software to use a different interrupt. Consult the HUB6 manual for the procedure to use the HUB6 with a different interrupt.

9.5 System Board Connectors and Pinouts

All connectors found on the IBM PC AT keyboard which are duplicated on the MPE are identically equivalent in pinout and function. The MPE also provides additional connectors for added value and functionality which are not found on the IBM PC AT. A "Berg Strip" connector is often referred to as a "Molex" style connector.

Each connector is identified on the circuit board by a "W" series or "J" series small white name tag printed onto the circuit board. The numbers are not in order by position; for example, W12, W6 and W11 are all together at the front of the circuit board while W1 and W6 are located to the rear.

In general, "Molex" or "Berg Strip" style connectors and jumper strips are identified by W numbers while all other connectors are identified with a J number. The exception is that the parallel and serial port output connections are also identified with J numbers.

9.5.1 Battery Connection for CMOS RAM

The clock/calendar and Setup RAM chip requires connection to a 4.5V to 6V, 1 ampere-hour lithium cell battery to retain memory when power is turned off in the system. This connector is near the keyboard connector:

W6 - Battery Connector, Berg Strip 4 Pin	
Pin	Function
1	+6 Volts from Battery
2	Key (pin usually removed)
3	Ground (minus side from battery)
4	Ground (minus side from battery, optional)

TABLE 21. Battery Connection - Location W6

Note: Some boards may not have the key pin removed. Pin 1 is marked by a diagonal cut corner on the silkscreen outline for W6. In addition, Pin 1 is the pin closest to the expansion bus connectors.

9.5.2 Keylock Connector and LED Power Source

This connector (located between the RAM array and the crystals) is usually attached to a keylock-style switch. When the switch is in the locked position, the keyboard interface circuitry is disabled thus preventing use of the system. The LED power source is attached to the front panel "Power" LED to indicate that system power is on.

W11 - Keylock Connector, Berg strip 5 pin	
Pin	Function
1	Power source for front panel "power on" LED
2	Key (pin usually removed)
3	Ground
4	Keyboard Inhibit
5	Ground

TABLE 22. Keylock Connector - Location W11

Note: Some boards may not have the key pin removed. Pin 1 is marked by a diagonal cut corner on the silkscreen outline for W11. In addition, Pin 1 is the pin farthest from the expansion bus connectors.

9.5.3 Speaker Interface

The MPE provides a speaker driver circuit for audio output. The speaker circuit should be connected to an 8 ohm speaker. This connector is located immediately adjacent to the keylock connector between the RAM array and the system crystals.

W7 - Speaker Connector, Berg strip 4 pin	
Pin	Function
1	Data Out (speaker output drive)
2	Key (pin usually removed)
3	Ground
4	+5 Volts DC

TABLE 23. Speaker Connector - Location W7

Note: Some boards may not have the key pin removed. Pin 1 is marked by a diagonal cut corner on the silkscreen outline for W7. In addition, Pin 1 is the pin farthest away from the expansion bus connectors. Speakers are omnidirectional, thus the speaker wires may be connected either way across Data Out and Ground.

9.5.4 Turbo Indicator Output

This connector is at the same position as a three pin jumper on the IBM PC AT system board, but the function is different. The IBM jumper is used to select ROM chips being used. Since this function is obsolete given availability of 256K ROMs, we use this position and connector as a power source to drive a "Turbo" indicator LED.

MPE system boards can operate at their full clock speed (nominal 16MHZ) or at a reduced 6MHZ rate. The lower speed may be desirable when installing certain copy-protected programs the copy-protection schemes of which are dependent upon system speeds. Speed may be selected by keyboard control or by positioning a jumper on the system board. This connector provides a power source to a front panel LED which is enabled whenever the system board is operating at 16MHZ. OEMs may wish to connect this signal to a front panel LED labeled "Turbo" or some other indication that the machine is operating at high speed.

The Turbo LED is not connected on the Bell Technologies MPE 386 system since we recommend setting the system to always run at 16MHZ: the way to deal with copy protection schemes that would have you run your '386 as if it were an 8088 is to procure a good software copying program and delete the copy protection mechanism.

W12 - Turbo LED Connector, Berg strip 3 pin	
Pin	Function
1	Ground
2	Turbo LED Power Source
3	Ground

TABLE 24. Turbo LED Connector - Location W12

9.5.5 Keyboard Connector

The MPE utilizes a 5 pin, 90-degree printed circuit board mounting DIN style connector for perfect compatibility with any PC AT compatible keyboard. The connector is mounted and aligned to match any standard AT compatible chassis. Pinout is as follows:

J6 - Keyboard Connector, DIN 5 pin	
Pin	Function
1	Keyboard Clock
2	Keyboard Data
3	Spare (No connection)
4	Ground
5	+5 Volts DC

TABLE 25. Keyboard Connector - Location J6

Note: When viewed from the outside of the AT chassis, the keyboard connector pins are in clockwise order from the upper right: 1, 4, 2, 5, 3.

9.5.6 Main Power Connector

The main power connector is a 12 pin Berg strip style heavy-bladed male connector. It is identically equivalent to the standard AT power connector. Power supplied should be a standard AT compatible power supply, 185 Watts or greater. The MPE system utilizes a 220 Watt power supply. Connector pinout and nominal power consumption are as follows:

J2 - Main Power Connector, 12 pin	
Pin	Function
1	Power Good
2	+5 Volts DC
3	+12 Volts DC
4	-12 Volts DC
5	Ground
6	Ground
7	Ground
8	Ground
9	-5 Volts DC
10	+5 Volts DC
11	+5 Volts DC
12	+5 Volts DC

TABLE 26. Main Power Connector - Location J2

NOTE: Pin 1 is closest to the keyboard connector.

9.5.7 Power Requirements

The following table provides nominal and maximum power requirements for a 4MB on-board memory MPE system board. These figures are for the system board only. System power will be substantially larger when peripherals such as hard disk drives and their controller cards are added.

Power Requirements of 4MB System Board		
Voltage	Nominal Current	Max Current
+5 V +- 5%	4.7 A	5.5 A
+12 V +- 10%	.04 A	.07 A
-12 V +- 10%	.03 A	.06 A

TABLE 27. Power Requirements of 4MB System Board

9.5.8 Parallel Port Connector

Header connector J12 near the back edge of the board provides a bi-directional parallel port which is Centronics compatible and compatible with the IBM add-in parallel port for the PC AT. The port is implemented using a Paradise PC AT compatible parallel port chip. The parallel port may be enabled LPT1 or LPT2 and may be set to use Interrupt 5 or Interrupt 7. Pinouts to the chip have been made so that a press-on Insulation Displacement Connector (IDC) at the connector header as well as the DB25 connector can be used without any need for manual wiring of pins.

The pinout is as follows:

J12 - Parallel Port Connector, 26 Pins	
Pin	Function
1	STROBE
2	DATA 0
3	DATA 1
4	DATA 2
5	DATA 3
6	DATA 4
7	DATA 5
8	DATA 6
9	DATA 7
10	ACK
11	BUSY
12	PE
13	SLCT
14	AUTO FD XT
15	ERROR
16	INIT
17	SLCT IN
18	GND
19	GND
20	GND
21	GND
22	GND
23	GND
24	GND
25	GND
26	N/C

TABLE 28. Parallel Port Connector - Location J12

Note: Pin 1 is the pin closest to the "J" in the "J12" label for this connector.

9.5.9 Serial Port Connectors

The two on-board serial ports are made available at connectors J11 and J10. J13 and J14 are not currently connected or available for use. J10 is the "COM1" primary serial port and J11 is the "COM2" secondary serial port. Either port may be mapped to Interrupts 3 or 4. Both serial ports are Data Terminal Equipment (DTE). The electrical interface is RS232-C compatible.

Pinouts to the ports have been made so that a press-on Insulation Displacement Connector (IDC) at the connector header as well as the DB9 connector can be used without any need for manual wiring of pins. The pinout is as follows:

J10, J11 - Serial Port Connectors, 10 Pin Dual Row Headers		
	J10: Serial Port 1	J11: Serial Port 2
Pin	Function	Direction
1	Carrier Detect	input
2	Receive Data	input
3	Transmit Data	output
4	Data Terminal Ready	output
5	Signal Ground	common
6	Data Set Ready	input
7	Request to Send	output
8	Clear To Send	input
9	Ring Indicator	input

TABLE 29. Serial Port Connectors - Locations J11 and J10

Note: Pin 1 is the pin closest to the "J" in the "J11" and the "J10" labels on the circuit board.

9.5.10 Reset Switch

The reset switch is connected to W1. Connecting the two pins of W1 causes a system reset. This connector is not found on an IBM PC AT system board. On Bell Technologies MPE 386 systems, this connector is attached to the front panel RESET switch. For OEM applications, any simple switch that closes the circuit and then releases is adequate. No debouncing circuitry is necessary.

9.6 System Board Jumpers

The MPE system board utilizes "jumpers" or "shunts" at several locations to enable setting of user-selectable options. The jumper locations are all designated with "W" labels. The jumper pads consist of 1, 2, or 3 pin Berg strip style headers together with black connecting shunt units. To connect pins on the jumpers, small black "shunts" are used. To keep a shunt handy even if you do not want to connect two pins together simply press it onto a single pin at the jumper pad. That way it will stay in place should you ever need to use it in the future, but it will not actually make a connection.

In the following definitions, when we say the "front" of the system board, we mean the side opposite the keyboard connector. "Right" means the right hand side of the system board when viewed from the front.

9.6.1 Video Select - W8

True IBM compatible systems report to the ROM BIOS the default video display which is to be used as the primary display. This jumper allows you to select whether the monochrome or the color display is the primary display. The default setting is for monochrome display as primary. We regret that both this jumper and W10 are both located inconveniently underneath a popular spot for hard disk devices in most AT chassis. Usage is as follows:

W8 - Video Select Jumper, Berg strip 3 pin	
Shunt At	Resultant Function
1-2	Monochrome Display is Primary Display
2-3	Color Display is Primary Display
Default: 1-2 connected.	

TABLE 30. Video Select Jumper - Location W8

Note: Pin 1 is closest to the front of the system board.

9.6.2 CPU Speed Control Source - W10

The MPE system board is capable of sourcing the fundamental crystal oscillator frequency from two different crystal sources: the primary socketed 32 MHZ crystal as well as a secondary 12 MHZ alternate crystal. The 12 MHZ alternate crystal is used to run the MPE in "low speed" mode with an effective CPU clock of 6MHZ.

Jumper pad W10 allows the speed and its source to be controlled. This location is inconveniently located adjacent to the 8742 keyboard controller chip at the far right hand side of the board.

If no shunt is applied the CPU will always run at high speed. This is the default setting. If a shunt is applied between pins 1 and 2, the CPU will always run at low speed. If the shunt is applied between pins 2 and 3, the CPU speed will be determined by an output of the 8742 keyboard controller. OEM ROM BIOS capable of switching clock speeds depending on keyboard input can then select which speed the CPU is to run at. This option is not currently supported by BIOS firmware shipped by Bell Technologies.

W10 - CPU Speed Source Select, Berg strip 3 pin	
Shunt At	Resultant Function
None	Run at high speed all of the time.
1-2	Run at low speed all of the time.
2-3	Run at speed selected by 8742 BIOS / keyboard control.
Default: No connection.	

TABLE 31. Video Select Jumper - Location W10

Note: Pin 1 is closest to the front of the system board.

9.6.3 32 Bit Memory Wait State Selection - W2

The MPE system board may be configured to run with 1 wait state or 2 wait states used with 32 bit system memory. Standard operating procedure is to use one wait state. Two wait states may be used if you are having problems with lower speed RAM chips or are unable to acquire a supply of higher speed RAM chips. In general, 100ns or better chips are required for 1 wait state operation at 16MHZ, and 80ns or better chips are required for 1 wait state operation at 20MHZ.

W2 - 32 Bit Wait States, 2 pin	
Shunt At	Resultant Function
None	1 Wait State
1-2	2 Wait States
Default: No connection.	

TABLE 32. 32 Bit Memory Wait State Selection - Location W2

9.6.4 16 Bit and 8 Bit Memory Wait State Selection - W3 and W4

The MPE system will run just fine with either 16 bit (PC AT compatible) expansion memory cards, or with even 8 bit (PC XT compatible) expansion memory; however, some 16 bit or 8 bit memory cards cannot handle the faster memory accesses typical of the 32 bit 80386 even at the slower bus clock of 8MHZ. Additional wait states are required for such slow memory devices.

Jumper pads W3 and W4 enable selection of wait states for use with memory and I/o access on the 16 and 8 bit bus connectors to match 16 bit and 8 bit expansion bus memory performance. By default, these are set to the larger number of wait states allowed since the performance of 8 or even 16 bit memory is so much slower than full-bandwith 32 bit memory that an additional wait state is not significant. These jumper pads are located near the front right corner of the system board.

W3 - 16 Bit Wait States, 2 pin	
Shunt At	Resultant Function
1-2	1 Wait State
2-3	2 Wait States
Default: No connection.	

TABLE 33. 16 Bit Memory Wait State Selection - Location W3

W4 - 8 Bit Wait States, 2 pin	
Shunt At	Resultant Function
1-2	4 Wait States
2-3	5 Wait States
Default: No connection.	

TABLE 34. 8 Bit Memory Wait State Selection - Location W4

9.6.5 Manufacturing Test Jumper - W20

The jumper pad at this location is used for manufacturing test and other procedures at Bell Technologies. It must be jumpered correctly for the 80387 socket to be enabled. It is always jumpered with a shunt between pins 2 and 3.

Note: Pin 1 is closest to the front of the system board. The silkscreen outline printed in white on the MPE circuit board immediately underneath jumper pad W20 is wrong: the silkscreen shows Pin1 as being farthest from the front of the system board. This is wrong. As with all the other fore-and-aft aligned jumper pads, **Pin 1 is closest to the front of the system board.**

W20 - Manufacturing Test Jumper	
Shunt At	Function
2-3	Required for correct 80387 operation

TABLE 35. Manufacturing Test Jumper - Location W20

9.7 Quick Reference Guide To Jumpers and Connectors

The following provides a quick reference guide to the various jumper headers and connectors installed on the MPE system boards.

For two pin jumpers, ON means a shunt is installed, and OFF means no connection. N/C means no connection. WS means Wait States. For jumpers installed parallel to the long axis of the chips, Pin 1 is closest to the front of the board.

Jumper Settings		
Jumper	Default	Options
W2	ON	ON: two 32-bit wait state, OFF: one 32-bit wait state
W3	2-3	1-2: one 16-bit wait state, 2-3: two 16-bit wait states
W4	2-3	1-2: four 8-bit wait states, 2-3: five 8-bit wait states
W8	1-2	1-2: Mono display primary, 2-3: Color display primary
W10	N/C	N/C: High speed, 1-2: Low speed, 2-3: 8742 BIOS select
W20	2-3	2-3: Required Setting

TABLE 36. Quick Reference to Jumpers

Connectors	
Connector	Definition
W1	Reset switch connection
W6	CMOS RAM battery connector
W7	8 Ohm Speaker Connector
W11	Keylock / Power LED connector
W12	Turbo LED connector (use pins 1-2)
J2	Main System Power Connector
J6	Keyboard Connector
J10	On-board serial port #1
J11	On-board serial port #2
J12	On-board parallel port

TABLE 37. Quick Reference to Connectors

DIP Switch Array Defaults									
1	2	3	4	5	6	7	8	9	10
OFF	ON	OFF	OFF	ON	OFF	OFF	ON	OFF	ON

TABLE 38. DIP Switch Array Default Settings

10. Maintenance

MPE systems are designed to be essentially maintenance free. The following operating conditions, however, are extremely important. These recommendations apply to any modern computer system and are common practice at the facilities of most computer systems manufacturers.

Peripherals Floppies and tape drives need to be maintained regularly for correct operation. Tapes **must** be cleaned regularly, after every eight hours of operation. Use a tape cleaning cartridge to clean the tape heads and mechanism. Failure to do so will result in data errors. In addition, the end-of-tape (EOT) sense holes in the tape mechanism must be kept free of dust or the tape mechanism will start "eating" tapes by running them off of their spools. Keep the EOT sense holes dust free by blowing the dust out of them with photographers' "canned air". The floppy diskette drive should also be cleaned with a cleaning kit once every year or more often if more intensively used. See your peripheral manual for more information.

Cooling When enclosed in a system chassis, the system board and other electronic components must be provided with adequate cooling airflow, especially in hot climates. The MPE system chassis provides cooling airflow driven by a fan enclosed in the power supply. Do not obstruct this cooling airflow with overly-dense cables, paperwork or other obstructions inserted between the front panel and the main chassis, or by closing up the air holes in the chassis.

Power Clean, adequate power is perhaps the single most important factor affecting the longevity of your MPE system. Running the MPE with overvoltage or undervoltage conditions will cause aging and premature failure of perfectly good components. Spikes and other electronic hazards can immediately destroy your systems. The MPE system power supply provides exceptionally clean power when used together with surge and spike protection on your AC power line.

Static Like all modern electronic systems, the MPE is vulnerable to damage from static electricity. Work with the system board and other components only at an approved static workstation and only after grounding yourself with a wrist or ankle ground strap. Transport components only enclosed in the static protection bag in which they were shipped to you, or inside of a system chassis. Simply walking across a carpeted floor with an unprotected motheboard during dry weather conditions can generate enough static to damage the circuit cards.

Heat/Cold Extreme temperature variations can damage your MPE system, especially when coupled with power on and off cycles. Like most modern office electronics, your MPE has been designed to perform at typical ambient office conditions. If your MPE system has been exposed to extremes of heat or cold, allow it time to gradually arrive at ambient office temperatures before turning it on. When a cold system is immediately turned on, the sudden, almost immediate, rise in operating temperatures in the silicon dies inside of the chips can cause thermal expansion effects relative to the still-cold IC package or system board PCB. Such effects can give rise to premature chip failure. A chilled system which is brought in from the outside and left in its packaging

will still be cold for over an hour. Unpacking the system or removing the cover will allow internal components to rapidly match ambient temperatures. Note that powering up cold systems can cause immediate damage to hard disk drives.

Dust When operated continuously for years the MPE system board and surrounding accessories will accumulate a heavy layer of dust. Too great a dust accumulation will result in impaired cooling and potential electronic noise trouble. We recommend that every year or two you thoroughly clean out the interior of your system. Spray a fine brush with antistatic spray (available at most computer stores) and use that with a vacuum cleaner to remove the dust.

Water The MPE system board by itself is reasonably impervious to immersion in water, but we do not recommend immersion in water for any length of time except in strictly controlled factory conditions. Other components inside the MPE chassis, such as peripherals and power supply, will almost certainly be ruined upon immersion in water. If any water or other fluid should find its way into the MPE chassis, immediately turn power OFF and do not operate the system until it has been checked by a qualified systems technician.

Sockets To greatly reduce the cost of repair and to dramatically improve repair response time, major components on your MPE system board have been socketed. Only premium sockets have been used. Nonetheless, over a period of many years or decades, repeated thermal cycling may cause "socket creep" which loosens the chips in their sockets or oxidation that affects the electrical contact between chip and socket. During your one or two year spring cleaning of your system, you may wish to firmly press down on each socketed chip to make sure it is firmly seated. If problems develop after a few years, a simple service procedure is to one-by-one remove all socketed chips and to then re-insert them. This procedure breaks any layer of oxidation that might have formed. This procedure is not necessary with the 80386 or 80387 chips since they are installed using machined-pin sockets that are impervious to oxidation.

Cards Never install or remove any component, especially bus expansion cards, while power is applied to the system or the system is plugged into AC power. Unexpected shorts pose an extreme hazard to both you and your system. Use care when inserting or removing expansion cards. If an expansion card does not seem to be inserting or removing under firm (but gentle) pressure, DO NOT FORCE IT. Mounting brackets and other hardware will sometimes prevent a card from being inserted or withdrawn. Correct the hardware problem: do not break the edge connector. After heavy, unusual insertion and removal of expansion cards the system board card edge connectors may become dirty. Vacuum out any PCB grit that may accumulate and clean the contacts using a cotton swab and a high quality electronic contact cleaning solution.

Cleaning The exterior of your MPE system may be cleaned with any mild soapy cleaner. Apply any cleaner sparingly and wipe clean and dry immediately. Do not use cleaners containing abrasives or bleach. Avoid spraying cleaning solution inside the MPE chassis or directly onto MPE system connectors.

When operated and maintained to the above recommendations, your MPE system board may be operated continuously for decades without a failure expected.