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EPC®-5A
Hardware & Software Reference Manual

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1. Product Description

Purpose

This manual was written to provide detailed hardware reference information for OEMs, system integrators, and other engineers using the EPC-5A as a component of their VMEbus systems. The reader should be able to install the EPC-5A and configure the system based on the information in this manual.

About this Manual

This manual assumes that the reader has good familiarity with PC systems based on the Intel x86 architecture and familiarity with VMEbus architecture. For more information about EPConnect, which is the RadiSys programming interface to the Microsoft Windows APIs, consult the appropriate EPConnect/VME manual.

The information in this manual is organized into the following sections:

Front Matter	Warranty Information, Table of Contents, List of Figures and Tables.
Chapter 1	*Product Description*. Provides an introduction to the EPC-5A, a brief description of the features provided, and a table of specifications.
Chapter 2	*Before Installation*. Covers the details of configuring the EPC-5A, selecting the proper slot location, and installing backplane jumpers.
Chapter 3	*Installation*. Describes the process installing the EPC-5A in a VME mainframe using a subplane, and connecting peripherals.
Chapter 4	*Configuring the BIOS Setup*. Provides detailed information about how to configure the EPC-5A's BIOS.
Chapter 5	*Theory of Operation*. Describes the processor board, memory, ROM shadowing, video, front panel LEDs, and EXM expansion.

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Chapter 6 *Programming the VMEbus Interface*. Describes Slot-1 controller functions, slave- and self-accesses, and initializing and programming the VMEbus interface.

Chapter 7 *Connectors*. Describes pinouts for the serial and parallel port connectors, plus the keyboard, speaker, and battery headers.

Chapter 8 *Upgrades*. Lists possible memory upgrades for the EPC-5A.

Chapter 9 *Troubleshooting and Error Messages*. Describes various error conditions and recovery procedures.

Chapter 10 *Support and Service*. Provides contact information for RadiSys Technical Support.

Appendix A *Chipset and I/O Map*.

Appendix B *Interrupts and DMA Channels*.

Appendix C *Flash Boot Device*.

Appendix D *Pformat.* For use with EXM-2A.

Appendix G *Glossary*. A guide to terminology and acronyms used in this manual.

Notational Conventions

The following notational conventions are used throughout this manual.

FFh — Hexadecimal numbers are indicated by an “h” suffix.

* — In signal definitions, the asterisk (*) following a signal name indicates an active low signal; for example IOCHECK*.

Note
Notes are used to provide the reader with important information or explanatory information.

CAUTION
Cautions are used to indicate the potential for equipment damage, software failure, or minor personal injury.

WARNING
Warnings are used to indicate potential risk of serious physical harm or injury.

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Product Overview

The EPC-5A is a PC/AT compatible embedded CPU module containing the following:

- 100 MHz Intel486 DX4 processor
- RadiSys R400EX chipset
- 16 Kbytes of cache and math co-processor on-chip
- 4 MB to 256 MB of DRAM memory
- Keyboard interface
- 2 standard 9-pin DTE serial ports (COM1 & COM2)
- 1 standard output-only parallel port (LPT1)
- Time-of-day clock with user-replaceable battery
- Phoenix 486 BIOS version 4.05
- VMEbus interface
- EXM expansion interface

The EPC-5A form factor has been designed to the VMEbus specification (6U). It provides direct communication to all three VMEbus address spaces (A32, A24, & A16). The EPC-5A DRAM permits dual-ported access from both the PC side and the VME side.

The EXM expansion interface is electrically similar to the 16-bit PC/AT ISA bus. Video is provided through an add-in card called an EXM (EXpansion Module). Mass storage can be added via the EXP-MX Mass Storage module inside the VME chassis or externally via other EXMs that provide an IDE or a SCSI interface. Other EXMs are available to provide additional peripherals such as serial ports (RS232 or RS422), an internal modem, flash memory (and accompanying flash file system drivers), timer/counter, PCMCIA adapter and Ethernet controllers. Also, an adapter module (EXP-AM) can be used to install a single 8-bit PC/AT add-in short card.

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Specifications

Environmental				
Temperature	operating	0° to 60° C		
	storage	-40° to 85° C		
Humidity	operating	5 - 95% (non-condensing)		
	storage	5 - 95% (non-condensing)		
Vibration	operating	.015"PP 2.5g (max) 5-2000 Hz		
	storage	.030"PP 5g (max) 5-2000 Hz		
Shock	operating	30g 11 msec duration		
	storage	50g 11 msec duration		
Electrical				
		+5V	+12V	-12V
100 MHz - DX4	maximum	6.5 A *	100 mA	100 mA
	typical	5.5 A *	100 mA	100 mA

* Use of the P2 connector is recommended to support the current requirements of the EPC5A.

Table 1-1. EPC-5A Environmental and Electrical Specifications.

Differences Between EPC-5 and EPC-5A

The EPC-5A differs from the EPC-5 in the following ways:

1. The System BIOS is based on Phoenix Technologies NuBIOS revision 4.05. The EPC-5 uses an Award BIOS.
2. The EXP-MS SCSI module is not supported.
3. BIOS setup configuration is available only during the boot sequence, it is not available after the OS boots. The CTRL-ALT-ESC key sequence no longer invokes setup.
4. The EPC-5A supports CMOS Save and Restore (CSR) that allows backup and restoration of the contents of CMOS RAM to and from the Flash Boot Device (FBD).
5. Flash File System (FFS) support for flash EXMs is based on Phoenix Technologies PicoFlash and includes read/write capability. *The Xformat based FFS is no longer supported for flash. It is still used for SRAM and VME boot image creation.Use the Pformat utility that ships with this product.*

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6. Support for “User BIOS Extensions” which allows, through BIOS extensions, booting from VME or EXM-2A, etc. Note that EXM-2A’s are supported while the EXM-2 is not.
7. The System BIOS supports disk autotyping and disks larger than 528MB capacity.
8. The Flash File System can be installed as a DOS device driver, therefore flash can be installed as the second drive even when SCSI is the boot device (EXM-16).
9. IRQ 12 is only available to the EXMBus as a build-time option.
10. Slave memory is mapped to the VME bus in the following increments: 2MB, 4MB, 8MB, 10MB, 16MB, 32MB, 64MB. However, system memory increments are no longer restricted to this set.
11. AT bus mastering is not supported.

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NOTES

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2. Before Installation

Unpack the EPC-5A and inspect it for shipping damage.

⚠ **CAUTION**
Do not remove the EPC-5A module from its anti-static bag unless you are in a static-free environment.

The EPC-5A, like most electronic devices, is susceptible to electrostatic discharge (ESD) damage. ESD damage is not always immediately obvious. It can cause a partial breakdown in semiconductor devices that might not result in immediate failure.

Configuring the EPC-5A

The EPC-5A can be user-configured to provide standard VMEbus Slot-1 functionality. The Slot-1 configuration option is enabled (default) by installing the Slot-1 shunt (jumper) on the processor board (see Figure 1, page 4). Removing the jumper disables Slot-1 functionality. When the EPC-5A is configured as the Slot-1 controller, it performs all the standard VMEbus system control functions. See Chapter 5, *Theory of Operation*, for more details on Slot-1 controller functions.

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2 2

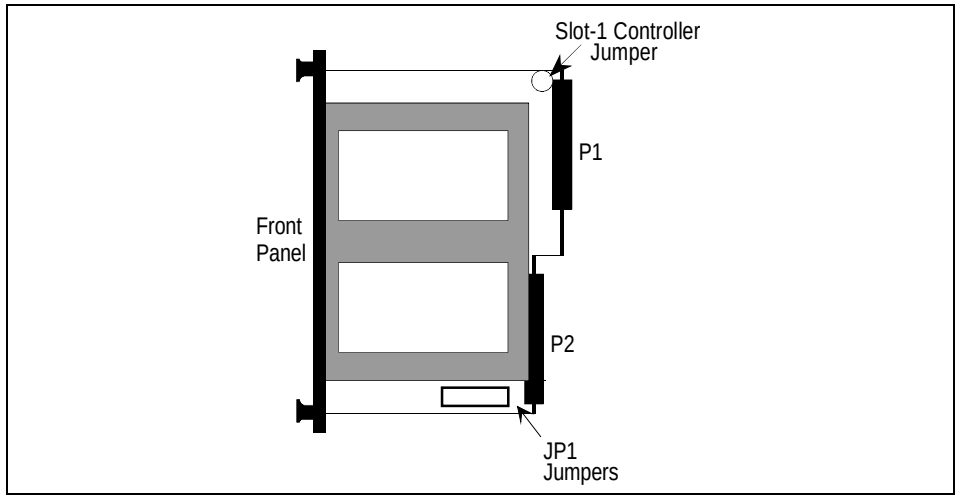


Figure 2-1. Slot-1 Jumper Location.

Additionally, the EPC-5A has another jumper (see Figure 2-1 above) that rarely needs to be changed - the MODID jumper on JP1. The EPC-5A uses pin 30, Row A of the P2 connector for module identification. If the J2 backplane is other than a standard VME or VXI backplane (e.g., a VSB backplane) or Pin 30, Row A is defined for another purpose, remove this jumper.

Selecting the EPC-5A Slot Location

There are two main considerations in determining where the EPC-5A should be positioned in the chassis.

- When used as a Slot-1 controller, and per the VMEbus specification (Rule 3.3), a Slot-1 controller must be in Slot 1. All other boards must be to the right of the Slot-1 controller.
- The EPC-5A connects to its peripherals via a subplane which extends to the right of the EPC-5A. Make sure that the location you choose provides sufficient room for all the attached peripherals (EXMs and mass storage module).

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The EPC-5A plus EXM expansion modules plus any mass storage module can be considered together as a single subsystem. Use the following worksheet to determine the total number of VME expansion interface slots your particular subsystem configuration requires.

Product	VME Slots	Total
EPC-5A (Includes first two EXM modules)	2	
Additional EXP-MC(s) (Holds additional two EXM modules)	1 each	
EXP-AM	2	
Mass Storage Module (EXP-MX including EXP-MX200A and greater) or EXP-MX200	2 3	
Total VMEbus slots used		

Table 2-1. VME Slots Available.

Once you have determined where the EPC-5A subsystem will be physically located in the chassis, the VME backplane must be jumpered appropriately.

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2 2

Installing the VMEbus Backplane Jumpers

The VMEbus specification provides four bus grant signals (BG0 - BG3) and one interrupt acknowledge signal (IACK) via daisy-chain lines. Per the VMEbus specifications, all boards (that plug into the backplane) are required to correctly handle these signals. All slots that do not have a board plugged into the backplane (i.e. empty slots and slots occupied by EXMs or mass storage modules), need to be jumpered to allow the signals to pass through to other boards in the system.

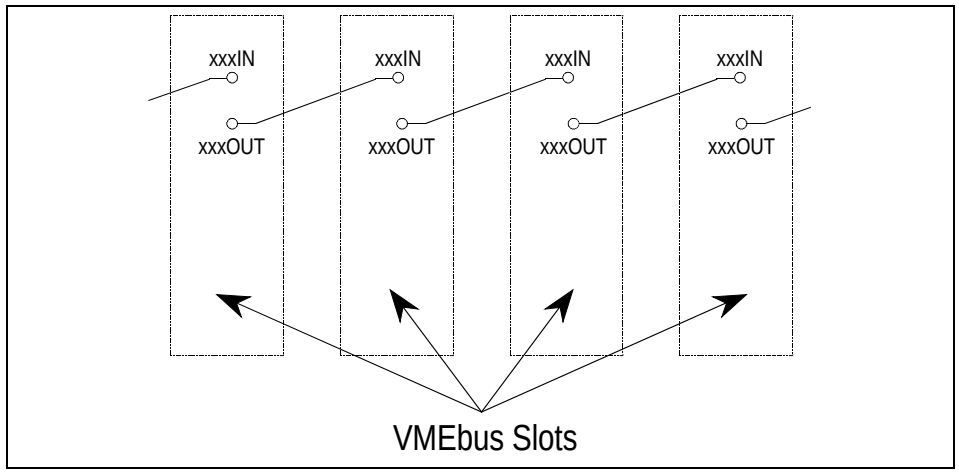


Figure 2-2. Daisy-Chain Signal Concept.

The Slot-1 controller board initiates each daisy-chain signal. Each VMEbus slot to the right of the Slot-1 controller must pass through each of the daisy-chain signals. For each VMEbus slot, xxxIn pin must be connected to its corresponding xxxOut pin (e.g. BG0In to BG0Out, BG1In to BG1Out,...,IackIn to IackOut) either through the board in that slot or by jumpers. Some boards correctly pass all of these signals, some boards handle some of these signals and not others, and some boards (typically “dumb” slave boards) may not handle any of these signals. Check the manual for each board to be installed to determine if these signals are passed through correctly. If they are not, or if the VMEbus slot is empty, all (or some) of these signals must be jumpered. See the following figures for examples.

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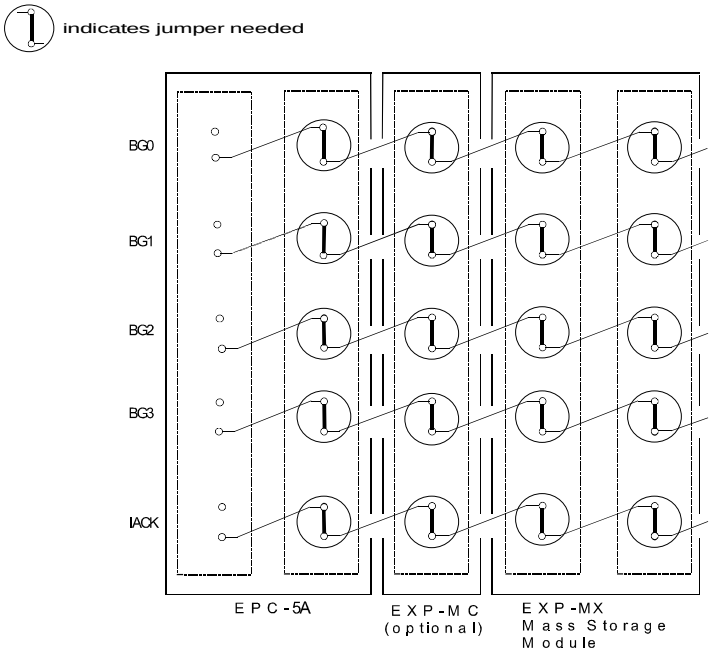


Figure 2-3. Backplane Jumpers Required for EPC-5A Subsystem.

The figure above shows the EPC-5A subsystem. Note that the left-most slot does not require any jumpers. All other slots occupied by the subsystem require all five jumpers be installed.

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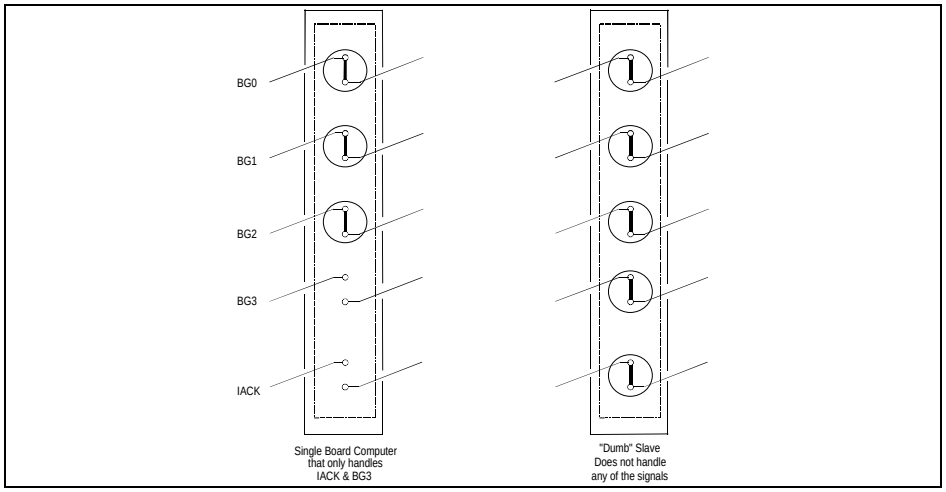


Figure 2-4. VMEbus Backplane Jumper Examples.

Once you have determined where the jumpers need to be, you must determine how to jumper your particular backplane. Different backplane manufacturers handle this in different ways; some provide stake pins on the rear of the backplane while others provide stake pins on the front of the backplane. These stake pins can be located in several different places.

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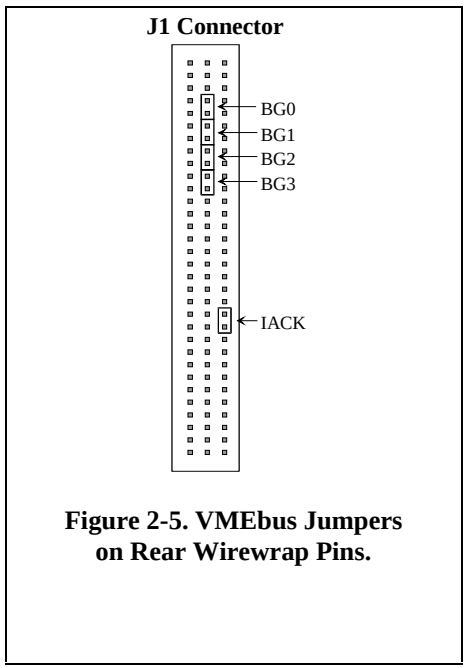


Figure 2-5. VMEbus Jumpers on Rear Wirewrap Pins.

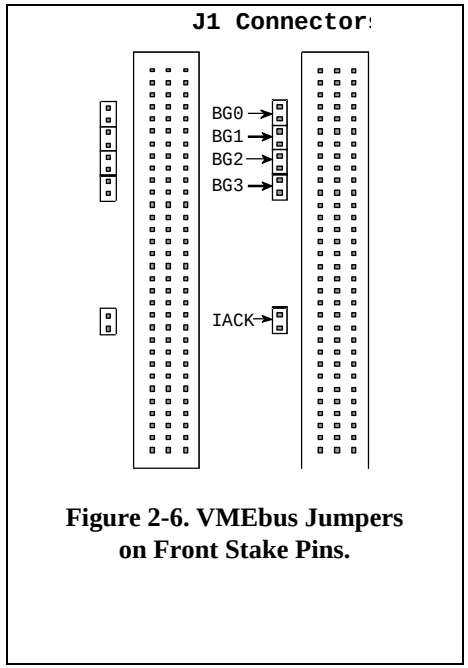


Figure 2-6. VMEbus Jumpers on Front Stake Pins.

If the stake pins are on the rear of the backplane, the most common location is in the middle of the J1 connector as shown in Figure 2-5 below. This can be just these pins extended or all pins extended for wirewrapping.

The stake pins (front or rear) can also be located adjacent to the slot being jumpered as shown in Figure 2-6 above. Typically, the stake pins are located between the slot being jumpered and the next lower-numbered slot (e.g. jumpers for Slot 6 would be located adjacent to Slot 6 between Slots 5 and 6).

Consult your VME chassis reference manual or contact the chassis manufacturer if you are unsure where to jumper your particular system.

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2 2

Jumpers

The complete table of EPC-5A jumpers is shown below. Jumpers are shown in Figure 2-1.

Jumper	Function	Description
POST (JP1 [1-2])	Manufacturing loop enable	Install this jumper to enter the manufacturing POST loop.
FFLASH (JP1[3-4])	Force BIOS recovery	Install this jumper to force a BIOS recovery during the boot process.
BBEN (JP1 [5-6])	FBD boot block write enable	Install this jumper to enable writes to the boot block of the FBD.
FWEN (JP1 [7-8])	FBD write enable (except boot block)	Install this jumper to enable writes to the FBD main blocks #1, #3, and #4 and parameter blocks #1 and #2.
MODID (JP1 [9-10])	Mod ID routing	Remove this jumper for non-standard VME backplanes.
SPEAKER (H2)	Speaker	Speaker header.
SLOT1 (H5)	Slot 1 Functionality	Install this jumper to enable Slot 1 functionality.

Table 2-2. EPC-5A Jumpers.

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3. Installation

⚠ **CAUTION**
During all of this installation process, make sure that power to your system is OFF.

The EPC-5A is not designed to be inserted or removed while the chassis is powered up.

⚠ **CAUTION**
Make sure that the installation process described here is performed in a static-free environment.

Do not remove any modules from their anti-static bags unless you are in a static-free environment. The EPC-5A module, like most other electronic devices, is susceptible to electrostatic discharge (ESD) damage. ESD damage is not always immediately obvious. It can cause a partial breakdown in semiconductor devices that might not result in immediate failure.

⚠ **CAUTION**
The EXP-MX mass storage module contains a delicate hard disk. Use care during installation.

Subplane Installation

Subplanes are printed-circuit boards with connectors on both sides. A subplane provides several functions. Primarily it acts as the PC/AT bus. Additionally, it provides power from the VMEbus backplane to the EPC-5A and expansion modules. How subplanes function is discussed in detail in Chapter 5, *Theory of Operation*.

Locate the appropriate subsection for the subplane you are using either by name or by picture. Follow the directions in the appropriate subsection. A small bag of bolts, nylon washers, and nuts is provided for optionally securing the subplane to the VME backplane. If these are used, be careful not to over tighten the bolts. Over-tightening causes the subplane to bend and may cause EXM failure due to poor contact.

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3 3

EXP-BP2 Subplane

This subplane is used in the smallest configuration, where only the EPC-5A processor module occupies VME slot space. It provides connectivity for two EXM modules within the EPC-5A (e.g., a graphics controller and a network or disk controller). The EXP-BP2 is an L-shaped board with three connectors on each side.

After jumpering the backplane, plug the subplane into the VMEbus backplane such that the P2 connector on the back of the 4-row DIN is pressed into the J2 connector of the left-most VMEbus slot that the EPC-5A subsystem will occupy.

The subplane has holes for optional bolting to the VMEbus backplane using the screws included.

The lower EXM connector is denoted as EXM slot 0 and the upper as slot 1 as shown in the diagram. This information will be needed later when configuring the installed EXMs.

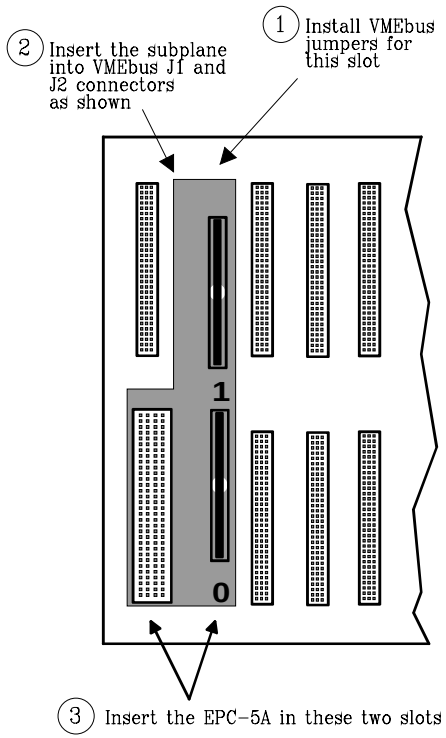


Figure 3-1. EXP-BP2 Subplane.

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EXP-BP4 Subplane

The EXP-BP4 subplane is used to couple an EPC-5A processor module with an EXP-MX Mass Storage module. The EXP-BP4 is a T-shaped board with four connectors on the front side and three on the rear.

After jumpering the backplane, plug the subplane into the VMEbus backplane such that the P2 connector on the back of the 4-row DIN is pressed into the J2 connector of the left-most VMEbus slot that the EPC-5A subsystem will occupy.

The subplane has holes for optional bolting to the VMEbus backplane using the screws included.

The EXM slot numbers are shown in the drawing.

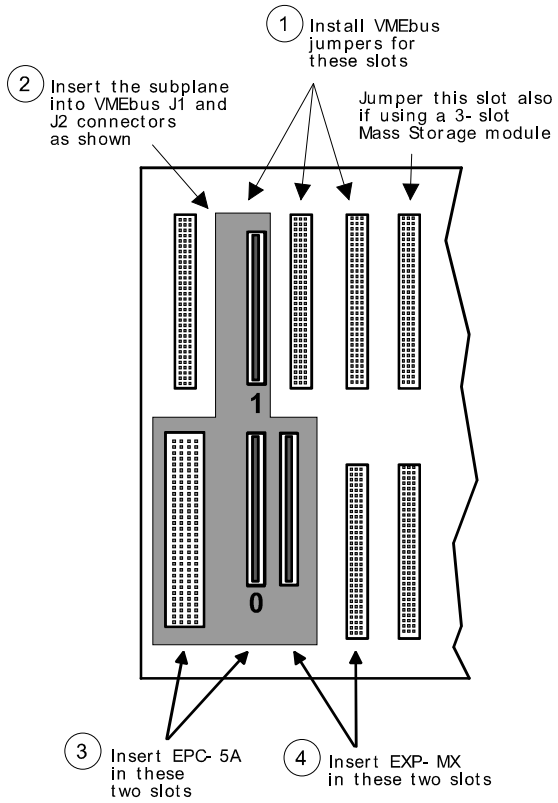


Figure 3-2. EXP-BP4 Subplane.

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3 3

EXP-BP3A Subplane

The EXP-BP3A subplane is used to add an EXP-MC Module Carrier for the addition of one or two more EXM modules to an EPC-5A processor module. The EXP-BP3A has five connectors on each side.

After jumpering the backplane, plug the subplane into the VMEbus backplane such that the P2 connector on the back of the 4-row DIN is pressed into the J2 connector of the left-most VMEbus slot that the EPC-5A subsystem will occupy.

The subplane has holes for optional bolting to the VMEbus backplane using the screws included.

The EXM slot numbers are shown in the drawing.

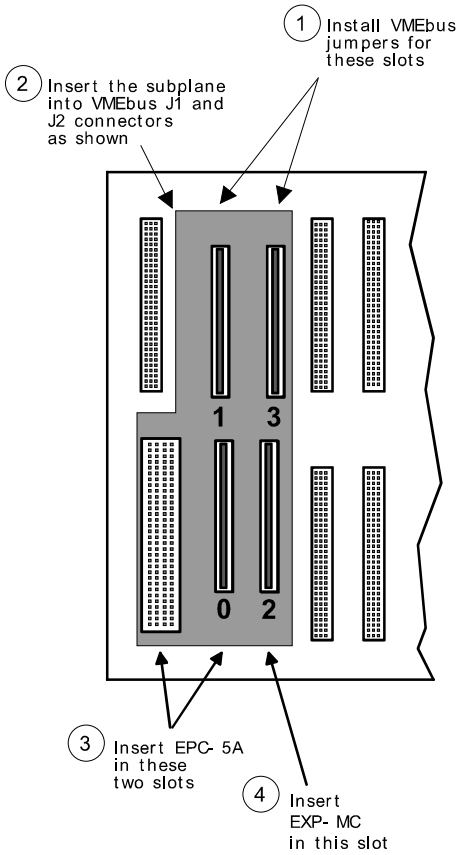


Figure 3-3. EXP-BP3A Subplane.

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EXP-BP5 Subplane

The EXP-BP5 subplane is used in a configuration to couple an EPC-5A processor module with an EXP-MC Module Carrier and an EXP-MX Mass Storage module. The EXP-BP5 has six connectors on the front side and five on the rear.

After jumpering the back-plane, plug the subplane into the VMEbus backplane such that the P2 connector on the back of the 4-row DIN is pressed into the J2 connector of the left-most VMEbus slot that the EPC-5A subsystem will occupy.

The subplane has holes for optional bolting to the VMEbus backplane using the screws included.

The EXM slot numbers are shown in the drawing.

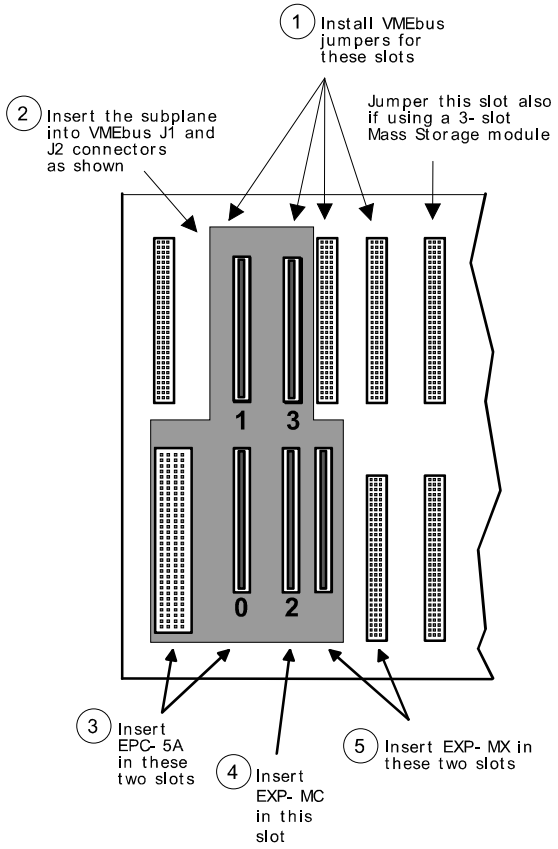


Figure 3-4. EXP-BP5 Subplane.

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3 3

EXP-BP4A Subplane

The EXP-BP4A subplane is used to add either

- two EXP-MC Module Carriers

or

- one EXP-AM Adapter Module.

The EXP-BP4A has seven connectors on each side.

After jumpering the backplane, plug the subplane into the VMEbus backplane such that the P2 connector on the back of the 4-row DIN is pressed into the J2 connector of the left-most VMEbus slot that the EPC-5A subsystem will occupy.

The subplane has holes for optional bolting to the VMEbus backplane using the screws included.

The EXM slot numbers are shown in the drawing.

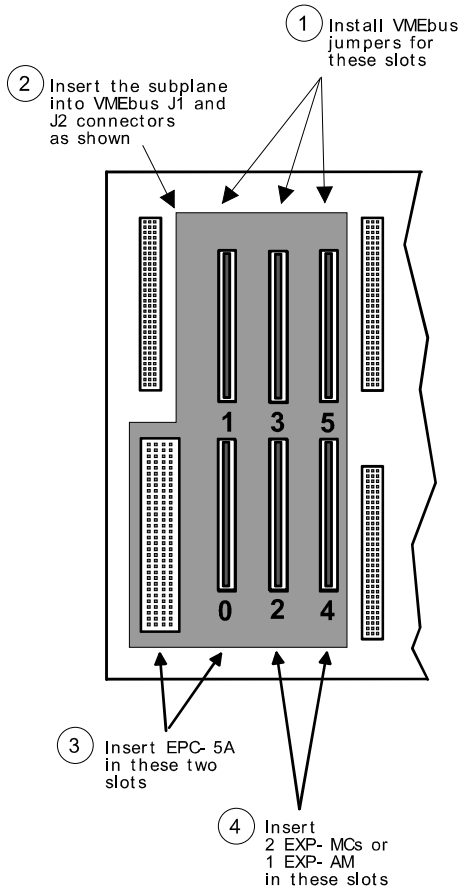


Figure 3-5. EXP-BP4A Subplane.

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EXP-BP6 Subplane

The EXP-BP6 subplane is used in a configuration to couple an EPC-5A processor module with an EXP-MX Mass Storage module and either

- two EXP-MC Module Carriers

  or

- one EXP-AM Adapter Module.

The EXP-BP6 has eight connectors on the front side and seven on the rear.

Plug the subplane into the VMEbus backplane such that the P2 connector on the back of the 4-row DIN is pressed into the J2 connector of the left-most VMEbus slot that the EPC-5A subsystem will occupy.

The subplane has holes for optional bolting to the VMEbus backplane using the screws included.

The EXM slot numbers are shown in the drawing.

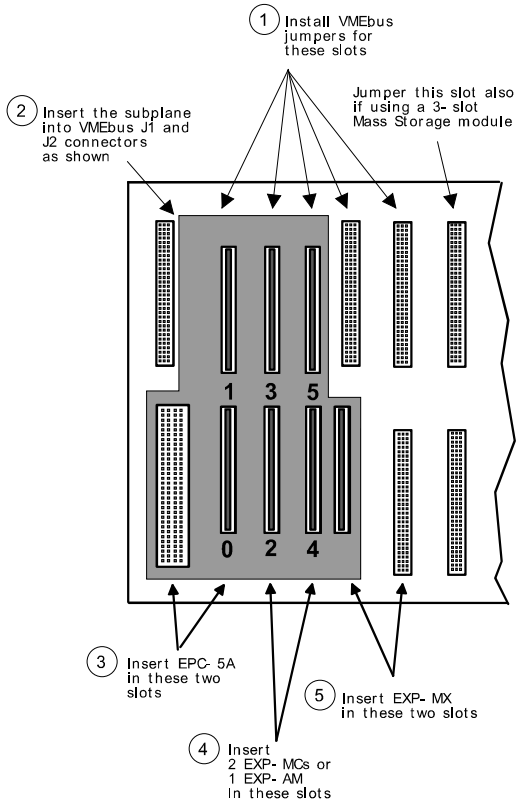


Figure 3-6. EXP-BP6 Subplane.

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3 3

EPC-5A Insertion

After installing the subplane, the EPC-5A processor module can be inserted into the VMEbus chassis.

⚠ **CAUTION**
Make sure that power to your VME system is off. The EPC-5A module is not designed to be inserted or removed from a live backplane.

⚠ **CAUTION**
When inserting the EPC-5A module, avoid touching the circuit board and connector pins, and make sure the environment is static-free.

- ❑ Make sure the ejector handles are in the normal (non-eject) position. (Push the top handle down and the bottom handle up so that the handles are not tilted.)
- ❑ Slide the EPC-5A module into the left-most slot occupied by the subplane. Use firm pressure on the handles to mate the module with the connectors.
- ❑ Tighten the retaining screws in the top and bottom of the front panel to ensure proper connector mating and prevent loosening of the module due to vibration.

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EXP-MC Module Carrier Insertion

If one or more EXP-MC Module Carriers are part of the configuration, they are inserted into the slot(s) immediately to the right of the EPC-5A. The Module Carrier can only be used in a VMEbus slot where the subplane has both EXM connectors. Simply slide the Module Carrier into place and tighten the two top and bottom retaining screws.

The following figure shows a side view of an EXP-MC containing two EXMs plugged into a subplane that is plugged into a VMEbus backplane.

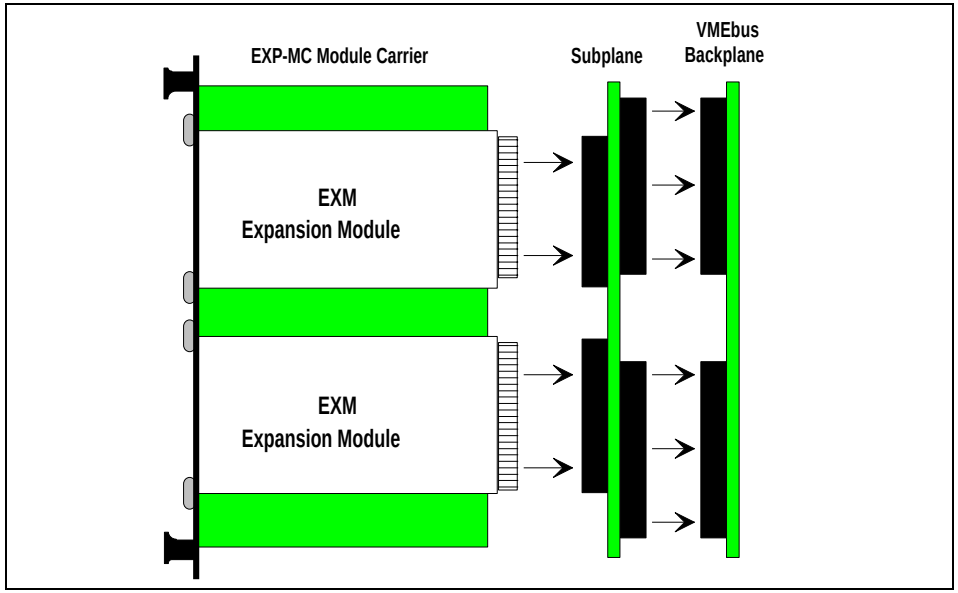


Figure 3-7. EXP-MC Module Carrier (side view).

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3 3

EXP-MX Mass Storage Module Insertion

⚠ **CAUTION**
Handle the mass storage module with care. Avoid sudden drops or jolts.

⚠ **CAUTION**
When inserting the module, avoid touching the circuit board and connector pins, and make sure the environment is static-free.

The EXM-MX Mass Storage module is always inserted as the rightmost module of the EPC-5A subsystem. Insert it so that its rear connector mates with the lower rightmost connector of the subplane. Insert it using adequate continuous force rather than tapping or hammering on it. Tighten the top and bottom front-panel screws to hold it firmly in place.

EXM Module Insertion

One or two EXMs may be installed through the front panels of the EPC-5A and each EXP-MC Module Carrier. To install an EXM:

- ❑ Remove and save the blank face plate from the desired slot.
- ❑ Slide the EXM into place in the card guides. Push firmly on the EXM front panel until the EXM card-edge connector is firmly seated in the subplane connector.
- ❑ Tighten the thumb screws on the EXM's face plate.

Each EXM must be configured in the EPC-5A's BIOS to set how the EXM should be initialized on power-up. This information is slot specific. Although EXMs can be installed in any available carrier slot, once an EXM is installed, it cannot be moved without re-configuring the BIOS setup. Configuring the BIOS setup is discussed in the next chapter.

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Connecting Peripherals to the EPC-5A

CAUTION
Do not plug in any cable connector into the front panel connectors while the system is powered on. In general, electronic equipment is not designed to withstand potential damage that could arise from fluctuations in power. Never plug in a serial or parallel device, keyboard, transceiver, monitor, or other component while the system is on.

The final step of installation is connecting peripherals, typically a video display and keyboard, but also perhaps a mouse, modem, printer, etc. Unless otherwise noted, all connectors are compatible with those found on IBM-compatible desktop PCs, and therefore pin-by-pin details are not given in this chapter. Pin-outs are specified in Chapter 7, *Connectors*.

Monitor

Connection of a monitor requires the use of an EXM video controller. Consult the video controller manual for details.

The monitor should be attached and powered on prior to applying power to the EPC-5A. If this is not done, the EPC-5A cannot detect the monitor type and the video adapter may not be initialized correctly.

Keyboard

The front panel contains a round 6-pin mini-DIN jack for connecting a keyboard. The jack is compatible with that of some newer PCs, and is not compatible with the previous style of larger 5-pin PC/AT keyboard connectors. However, an adapter cable is provided with the EPC-5A so either type of PC keyboard can be used with the EPC-5A.

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Serial Ports

The front panel contains two DB-9 DTE serial-port connectors. They are standard RS-232 serial communication ports that are 16C450-compatible. Many current PC/AT computers now incorporate 16C550 UARTs.

The EPC-5A serial ports may be used for connecting a mouse, modem, serial printer, RS-232 link, etc.

Parallel Printer Port

The output-only parallel port on the front panel is a DB-25 connector that is completely compatible with the corresponding LPT1 connector on IBM PCs and compatibles. Typically it is used to connect printers and software security keys.

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4. BIOS Configuration

Introduction

The EPC-5A uses the Phoenix NuBIOS to configure and select various system options. This section details the various menus and sub-menus that are used to configure the system. This section is written as though you are setting up each field in sequence and for the first time. Your system may be pre-configured and require very little setup.

Some error messages might occur during the execution of the BIOS initialization sequence. If errors occur during the power-on self-test (POST), the BIOS will display the error on the appropriate line of the screen display and, depending on how your system is configured, will either pause or attempt to continue.

BIOS Setup Screens

The EPC-5A's BIOS contains a setup function to display and modify the system configuration. This information is maintained in the EPC-5A's nonvolatile CMOS RAM and is used by the BIOS to initialize the EPC-5A hardware.

The BIOS Setup can only be entered during the system reset process, following a power-up, front panel reset, or equivalent. Press the F2 key when prompted to enter Setup.

Note

The "Press F2 to Enter Setup" prompt may be suppressed (see Boot Options Sub-menu, Setup Prompt), but the F2 key still invokes the BIOS Setup program during system reset.

BIOS setup is accomplished by making selections from a series of menus, as shown in the following figure.

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4

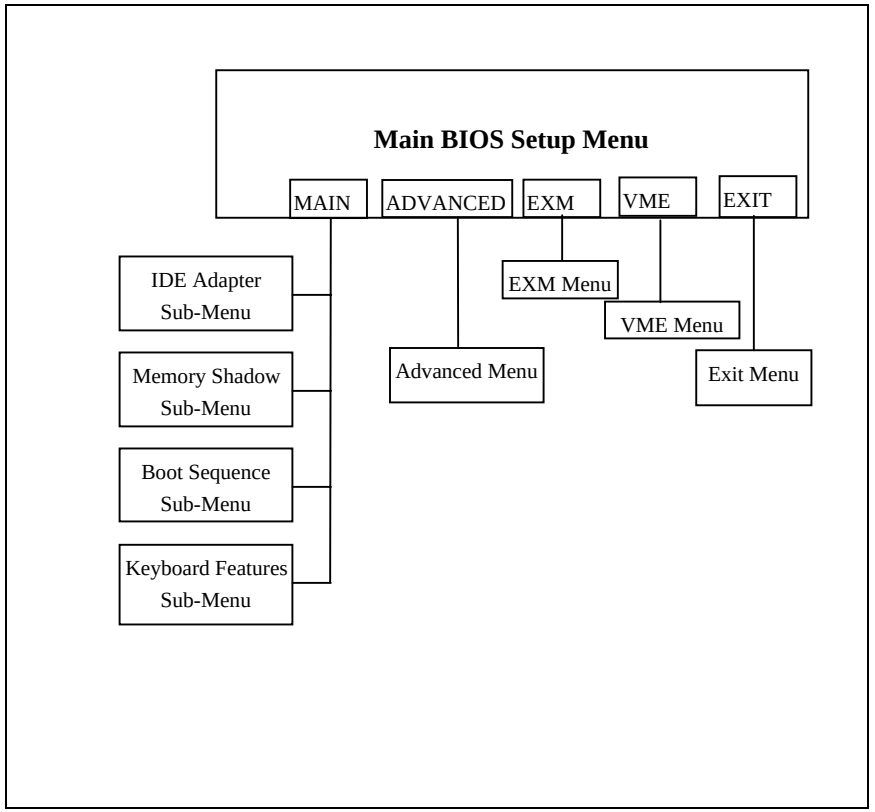


Figure 4-1. BIOS Setup Menu Map.

Use the up and down cursor (arrow) keys to move from field to field. Use the right and left arrows to move between the menus shown in the menu bar at the top of the screen. If you use the arrow keys to leave a menu and then return, your active field is always at the beginning of the menu. If you select a sub-menu and then return to the main menu, you return to that sub-menu heading.

Fields with a triangle to the left are actually sub-menu headings; press Enter when the cursor rests on one of these headings to reach that sub-menu. For most fields, position the cursor at the field and from the numeric keypad, press the + and - keys to rotate through the available choices. Certain numeric fields can also be entered via the keyboard. Once the entry has been changed to appear as desired, use the up and down arrow to move to the next field.

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Main BIOS Setup Menu

The Main BIOS Setup Menu is shown below.

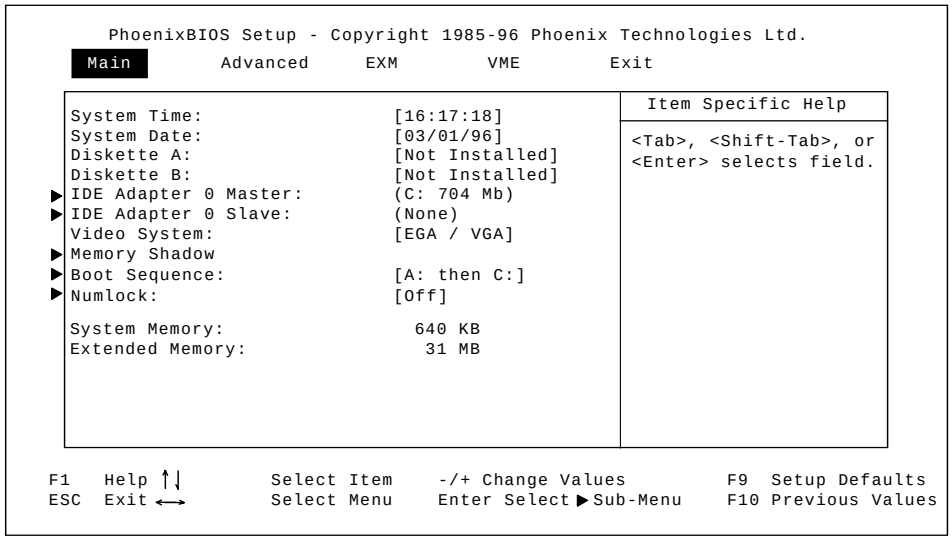


Figure 4-2. Main BIOS Setup Menu.

The fields in each menu and sub-menu are explained below. Additional help information is available in the help area on the Setup screen.

System Time:/System Date

These values are changed by moving to each field and typing in the desired entry. Use the Tab key to move from hours to minutes to seconds, or from months to days to years.

Diskette A:/Diskette B

This field identifies the type of floppy disk drive installed as the A:/B: drive. Possible settings are **Not Installed**, **360 KB, 5¼"**, **720 KB, 3½"**, **1.2 MB, 5¼"**, **1.44 MB, 3½"**, and **2.88 MB, 3½"**. The BIOS defaults to **Not Installed** for drives A: and B:.

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IDE Adapter 0 Master/Slave: Sub-menus

These fields are headings for menus that allow entering complete disk drive information. Once the information is entered for the drive, the entry in the Main Menu shows the drive selected. See *IDE Adapter Sub-Menus* for more information.

Video System

Use this field to select among the different video options available. Select from EGA/VGA, CGA 80x25, or monochrome. The default is “EGA/VGA”. The EPC-5A’s video is VGA, supplied by an EXM Video Module.

Memory Shadow Sub-menu

The term “Memory Shadow” refers to the technique of copying information from an extension ROM into DRAM and accessing it in this alternate memory location. See *Memory Shadow Sub-Menu* for more information.

Boot Sequence Sub-menu

The Boot Sequence Sub-menu allows you to change the boot delay, the boot sequence, and to disable several displays during the boot process, such as the SETUP prompt, POST errors, floppy drive check, and summary screen. When the boot sequence has been specified in the Boot Sequence sub-menu, the sequence is displayed in the Boot Sequence field of the Main menu.

Keyboard Features (Numlock) Sub-menu

Use this menu to enable or disable various keyboard features, including the Numlock key, the key click, and the keyboard auto-repeat rate and delay. The Numlock entry in the Main Menu displays the Numlock setting.

System Memory

This field is not editable and displays the amount of conventional memory (below 1MB). No user interaction is required.

Extended Memory

This field is not editable and displays the amount of extended memory (above 1MB). No user interaction is required.

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IDE Adapter Sub-menus

There are a total of two IDE adapter sub-menus for the primary hard disk controller, in a master and slave drive configuration. The EPC-5A hard disk is controlled by the settings for IDE Adapter 0 Master. To see or reconfigure the detailed characteristics of the primary hard disk, select the IDE Adapter 0 Master item from the Main BIOS Setup. The IDE Adapter 0 Master sub-menu is shown below.

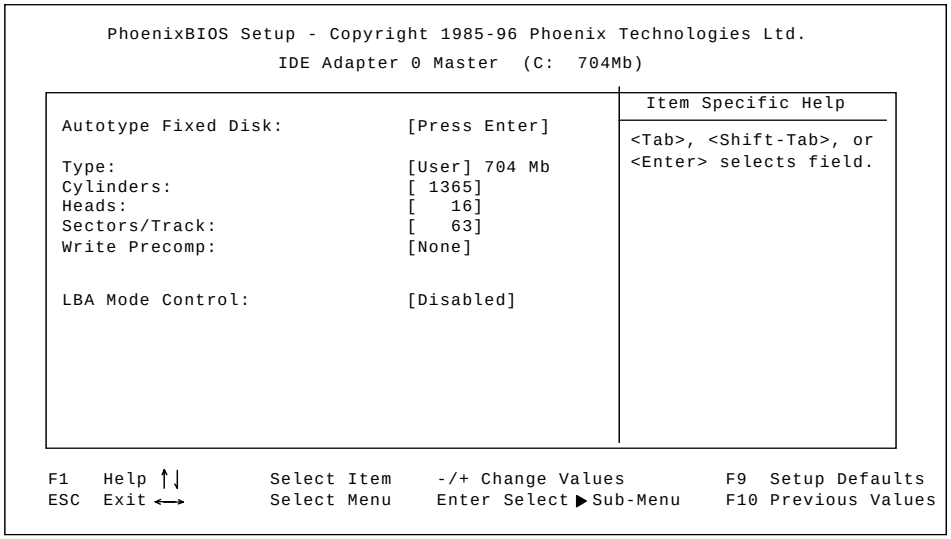


Figure 4-3. IDE Adapter Sub-menu.

Autotype Fixed Disk

Use this option when setting up new disks. This option allows the BIOS to determine the proper settings of the disk based on information on the disk, which is detected by the EPC-5A BIOS for drives that comply with ANSI specifications. Press the Enter key to invoke this function.

Existing (formatted) disks must be set up using the same parameters that were used originally when the disk was formatted. You must enter the specific cylinder, head, and sector information. This information is usually listed on the label attached to the drive at the factory. Select the “User” type described below to describe an existing formatted disk.

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Type

If you are using a pre-configured system, you probably have an IDE hard disk drive. Select “None” if you are not using an IDE hard disk drive. In the case for which you have an IDE disk but cannot employ the “Autotype” feature, then select “User” for the Type and enter the correct drive values for cylinders, heads, sectors/track, and write precompensation from the label attached at the factory. For disks not supplied by RadiSys, consult the disk drive’s documentation.

If you specify “Auto” for the hard disk type, the BIOS will query the hard disk for its parameters whenever the POST runs. If a hard disk type is set to “Auto”, but no hard disk is actually present, the BIOS will continue to query the (non-existent) hard disk until it times out, adding a number of seconds to the duration of the POST.

Note that there are some restrictions when setting up devices on the EPC-5A. If you plan to boot from a non-IDE device, such as a SCSI hard disk, set the C: drive type as “None” and use the BIOS extension.

LBA Mode Control

When enabled, this option allows the System BIOS to reference hard disk data as logical blocks instead of using the traditional Cyliners/Heads/Sectors (CHS) method. This option can only be used if both the hard disk being configured and the operating system support Logical Block Addressing (LBA). If disabled, then CHS mode is used. Note that autotyping may change this value if the hard disk reports that it supports LBA. The default is “Disabled.”

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Memory Shadow Sub-Menu

The term “shadowing” refers to the technique of copying BIOS extensions from ROM into DRAM and accessing them from DRAM. This allows the CPU to access the BIOS extensions much more quickly and generally increases system performance if many calls to the BIOS extensions are made. The Memory Shadow Sub-menu is shown below.

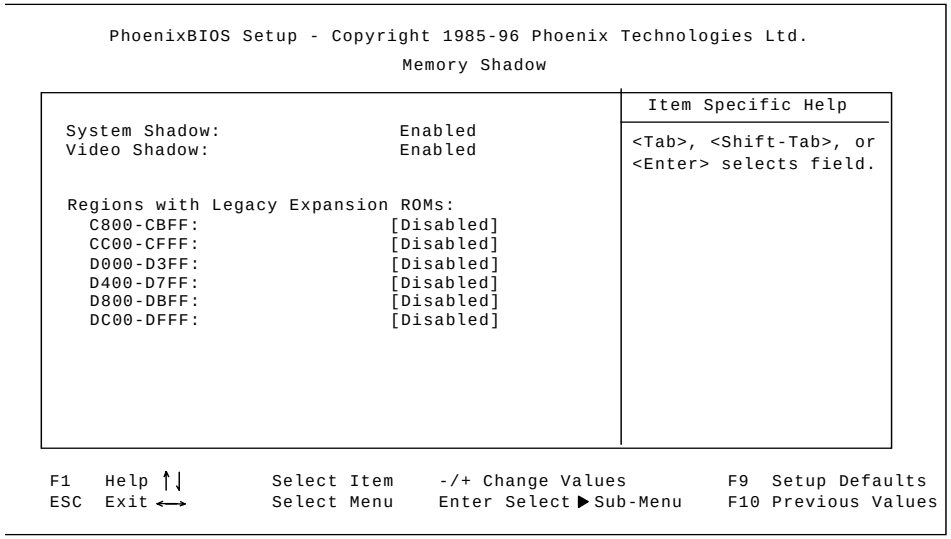


Figure 4-4. Memory Shadow Menu.

The shadow regions should be used only if an EXMbus card is installed in the system that contains a BIOS extension (ROM) although there is no effect on the system if a region is shadowed that does not contain a BIOS extension. Note that each shadow region in the setup menu is 16KB in size. Multiple shadow regions may have to be enabled if the BIOS extension to be shadowed is larger than 16KB.

System Shadow/Video Shadow

These options are not editable since the System and VGA BIOS are always shadowed.

Shadow Memory Regions

These options enable or disable shadowing for the associated memory region. The default is “Disabled”.

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Boot Options Sub-menu

Use the Boot Options sub-menu to change the boot sequence options. Select the Boot Options sub-menu by clicking on the Boot Sequence item in the Main BIOS Setup screen. The Boot Options Sub-menu is shown below.

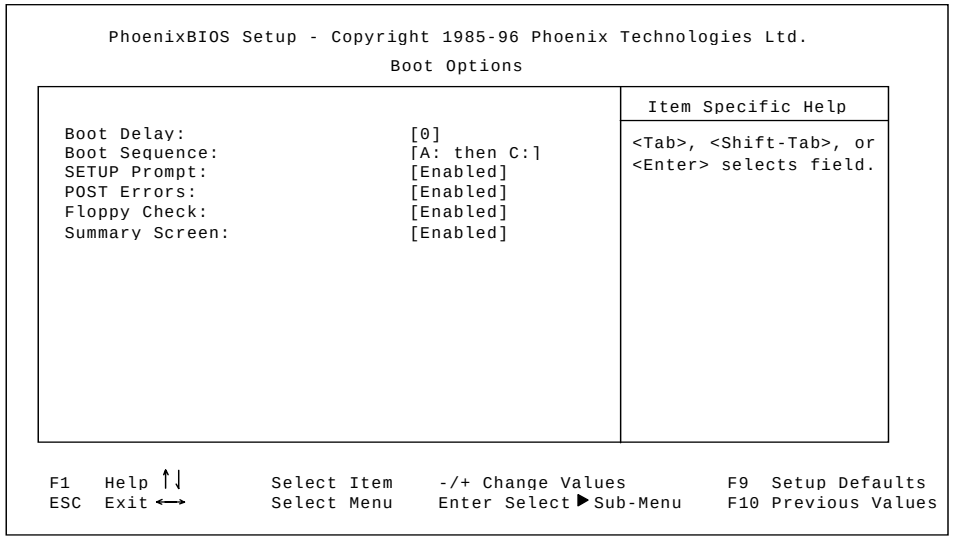


Figure 4-5. Boot Options Sub-menu.

Boot Delay

Use this option to set the system to delay booting for a time period from 0 through 255 seconds. This allows for long start up times on boot devices that spin up slowly. The default is “0” seconds.

Boot Sequence

This option is used to define how the system treats floppy drive A: when booting. Booting can occur from a floppy in the A: drive or directly from the fixed disk drive. To reduce the amount of time required to boot, the boot sequence should be set to “C: only”. Note that the C: drive may be either an IDE, VME or Flash drive. The options are as follows:

1. A: then C: Used to boot from the floppy drive, or if no floppy disk is present in the A: drive, boot from the C: drive.

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2. C: then A: Used to boot from the C: drive, or if none is present, boot from the A: drive.

3. C: only: Used to boot from the C: drive without searching for an A: drive.

The default is “A: then C:”.

The setting chosen here displays in the Boot Sequence Sub-Menu prompt in the Main BIOS Setup screen.



Setup Prompt

This option is used to enable or disable the message “Press F2 to enter Setup.” Even if the message is disabled, the F2 key can still be pressed at the appropriate time to enter the Setup Menu. The default is “Enabled”.

POST Errors

This option is used to stop during the boot process if the POST encounters errors. Otherwise, the system continues to attempt to boot despite any startup error messages that display. Note that this option only affects those errors defined as boot failures. See *Chapter 9, Troubleshooting and Error Messages,* for a list of those failures defined as boot failures that are configured to halt the system. The default is “Enabled”.

Floppy Check

This option is used to enable or disable the floppy drive search during the boot. To speed up booting, the floppy check should be disabled. It is still possible to boot from the A: drive even with the floppy check disabled. The default is “Enabled”.

Summary Screen

This option is used to enable or disable a summary of the system configuration, which displays before the operating system starts to load. To speed up booting, disable the summary screen. The default is “Enabled”.

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Keyboard Features Sub-menu

The Keyboard Features Sub-menu allows you to enable or disable various keyboard features. To access the keyboard Features menu, select Numlock in the Main BIOS Setup screen. The Keyboard Features Sub-menu is shown below.

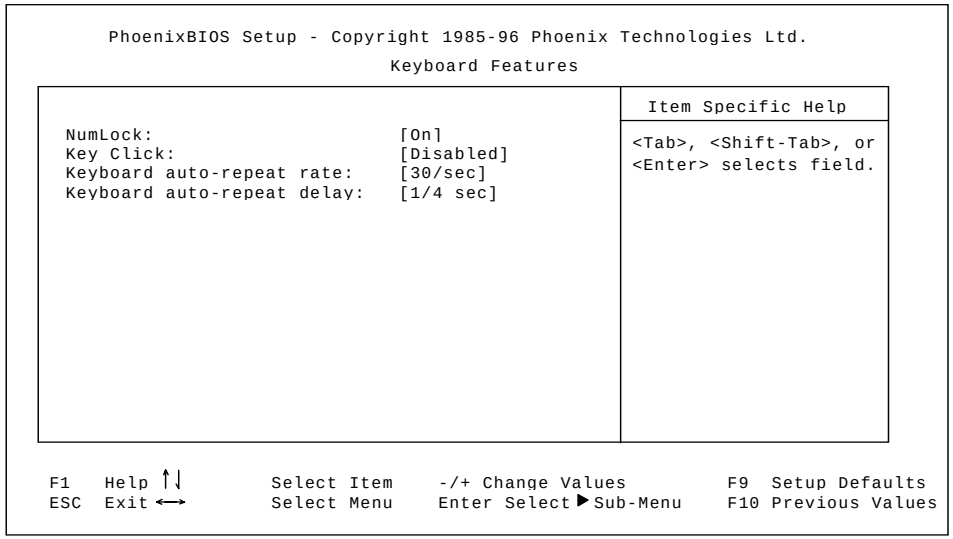


Figure 4-6. Keyboard Features Sub-menu.

Numlock

Use this option to enable or disable the Numlock feature of the keyboard. Numlock on enables the use of the keypad numbers. The default is “Auto.”

Key Click

Use this option to enable or disable the key click feature on the keyboard. If enabled, the keyboard produces an audible click each time a key is pressed. The default is “Disabled”.

Keyboard auto-repeat rate

Use this option to set the auto-repeat rate if you hold a key down on the keyboard. The rate can be set to one of: “2/sec”, “6/sec”, “10/sec”, “13.3/sec”, “18.5/sec”, “21.8/sec”, 26.7/sec”, and “30/sec”. The default rate is “30/sec”.

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Keyboard auto-repeat delay

Use this option to set the delay between when a key is pressed and when the auto-repeat feature begins. The options are “1/4 sec”, “1/2 sec”, “3/4 sec”, and “1 sec” . The default delay is “1/4 sec”.

When you are finished with this menu, press ESC to exit back to the Main BIOS Setup screen.

Advanced Menu

This menu controls advanced setup features, such as the 486 internal L1 cache , large disk access modes, and user BIOS extension addresses. You access this menu by selecting Advanced from the Main BIOS Setup menu.

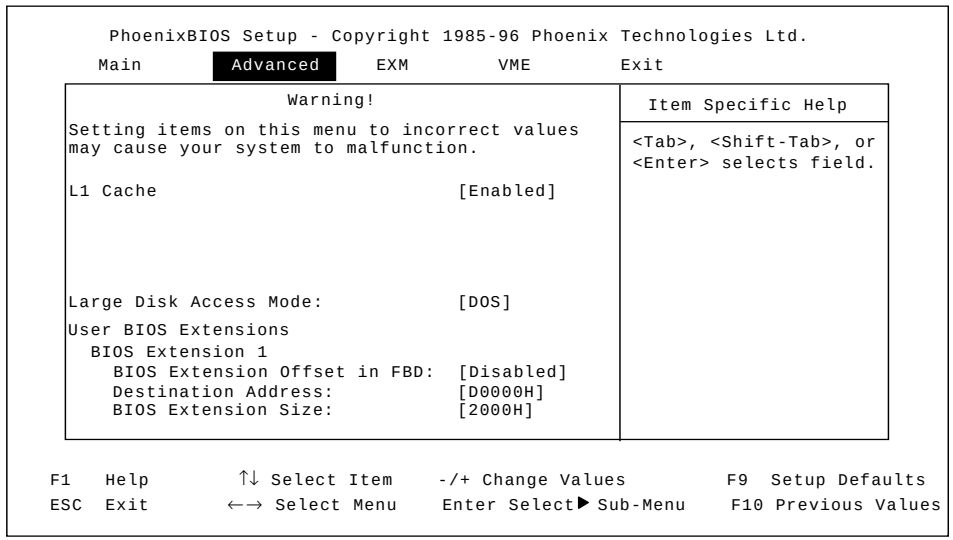


Figure 4-7. Advanced Menu.

L1 Cache

This option controls the internal cache. The default is enabled. Disabling the internal cache can negatively impact system performance.

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Large Disk Access Mode

If a hard disk larger than 528MB is being used, this selection should be set to “DOS” if running MS-DOS, or set to “Other” if using a different operating system. When set to “DOS”, this selection causes the System BIOS to perform cylinder/head translation if the drive is configured in Setup to have more than 1024 cylinders. The default is “DOS”.

User BIOS Extensions

These items control the loading (shadowing) of BIOS extensions contained in the FBD main block #3. Note that there are actually three groups of Setup items to control the shadowing of up to three BIOS extensions. The screen graphic only shows the first group.

Two extensions ship with the EPC-5A. The PicoFlash BIOS offset is 48000h, and the size is 2000h. The vRom BIOS offset is 4A000h, and the size is 4000h.

BIOS Extension Offset in FBD

This option selects the source address of the BIOS extension located in the FBD. The address is an offset from the base of the FBD. The offset range is between 46000h through 5FFFFh in 8KB increments. The default is “Disabled”.

Destination Address

This option selects the target address of the BIOS extension which can range from C0000h through DFFFFh in 8KB increments. The default is “C8000h”.

BIOS Extension Size

This option selects the number of bytes to copy from the FBD into shadow memory. BIOS extension sizes can be selected in 8KB increments from 2000h through 10000h. The default is “2000h”.

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EXM Menu

Use the options in this menu to select and configure the available EXM slots.

The required configuration information is found in the hardware reference manual shipped with each EXM expansion module. The EXM Menu is shown below.

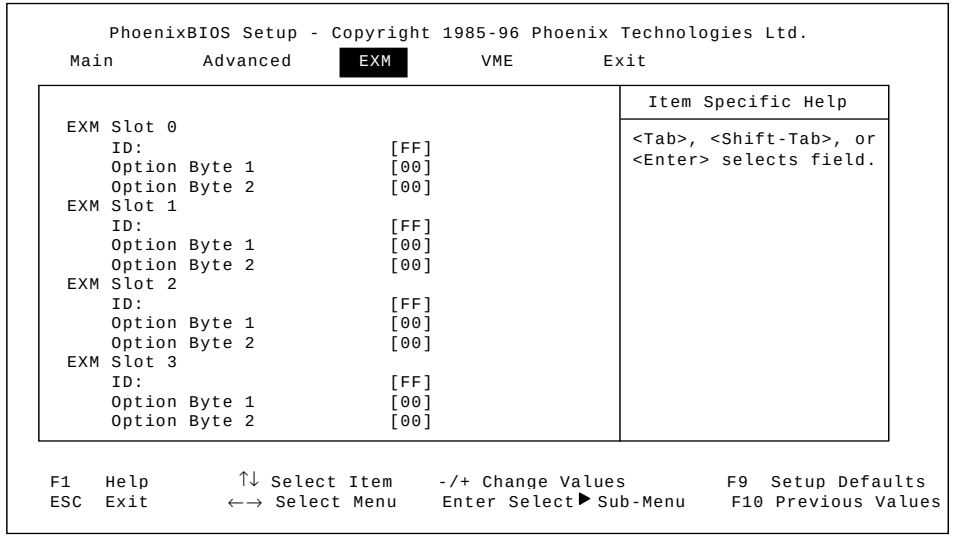


Figure 4-8. EXM Menu.

ID

This option is used to select the EXM ID byte value for the EXM card intended to reside in this slot. If the BIOS finds that the ID set with this option does not agree with the ID of the card actually installed in the slot, an EXM configuration error occurs and the card is not configured. For a slot with no EXM card installed, enter FFh, the default value.

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Option Byte 1

This option is used to select the first option byte value for the EXM card intended to reside in this slot. Option byte 1 typically defines bit 0 as the card enable bit. Other bits in the option byte are defined by the particular EXM card installed. The proper value of this option for a slot with no EXM card installed is not defined. The value typically used is 00h, the default value.

Option Byte 2

This option is used to select the second option byte value for the EXM card intended to reside in this slot. Option byte 2 is defined by the particular EXM card installed. The proper value of this option for a slot with no EXM card installed is not defined. The value typically used is 00h, the default value.

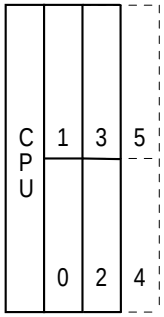


Figure 4-9. Slot Numbering.

All slots **not** occupied by an EXM module should show an ID of FF and OB1/OB2 of 00 00 indicating that no EXM is present.

Consult the appropriate EXM manual for the correct configuration information for each EXM expansion module installed. Note: Most EXM hardware reference manuals depict a different BIOS Setup Screen than the one shown here. The ID/OB1/OB2 information is still valid.

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When using EXMs with configurable interrupts, DMA channels, I/O addresses, and/or memory addresses, avoid conflicts with built-in functions of the EPC-5A. Guidelines are:

1. If an interrupt is needed, use IRQ3, IRQ4, IRQ5, IRQ9, or IRQ15. IRQ7 can be used if the printer port is not being used. IRQ3 should not be used if the COM B port is being used. IRQ4 should not be used if the COM A port is being used.
2. Use DMA channels 1, 3, 6, and 7.
3. Do not select I/O addresses that conflict with those in the EPC-5A. A complete list appears in Appendix A. For instance, I/O addresses in the 300-33F range can be used.
4. If the EXM needs to use upper memory addresses, they must be in the C8000h-DFFFFh range. Note that E0000h - 0EFFFFh is used for VMEbus access and is not available.



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VME Menu

The options in the VME menu are used to configure the EPC-5A's VME interface. The VME Menu is shown below.

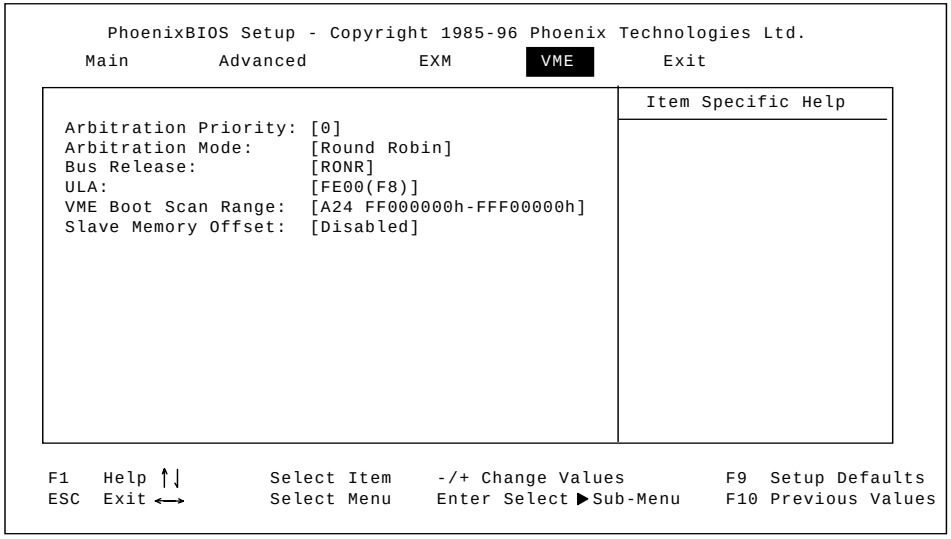


Figure 4-10. VME Setup Menu.

Arbitration Priority

This option is used to select among the four (0 through 3) VMEbus priority levels used when the EPC-5A requests the bus for a VME access. Priority level 0 is the lowest priority while priority level 3 is the highest priority. The default is priority level "0".

Arbitration Mode

This option is used to select the arbitration algorithm that the EPC-5A's VMEbus arbiter uses when the EPC-5A is the slot 1 controller. Selecting "Round Robin" configures the arbiter to "scan" the bus request lines from highest priority down to lowest priority and grant the bus to the first requester it finds. Selecting "Priority" configures the arbiter to grant the bus to the highest priority requester at any time. The default is "Round Robin".

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Bus Release

This option is used to select the method that the EPC-5A uses to release the VMEbus for other bus masters to use. Selecting “ROR” (Release on Request) allows the EPC-5A to perform better since it releases the VMEbus only if another bus master requests the bus. Selecting “RONR” (Request on No Request – also known as VXI fair-requester mode) causes the EPC-5A to release the VMEbus when its current bus access has completed. This has the effect of increasing the performance of other bus masters. The default is “ROR (VME)”.



Unique Logical Address

This option is used to select the ULA for the EPC-5A. This logical address is used to uniquely identify and access the EPC-5A in a VXI system. The default is ULA “F8”.

VME Boot Scan Range

This option is used to select the scan range when booting from VME (vROM). The ranges are as follows:

A24SD searches from `FF000000h - FFF00000h` on 100000h boundaries
A24SD searches from `00000000h - 00F00000h` on 100000h boundaries
A32SD searches from `00000000h - FFF00000h` on 100000h boundaries

Slave Memory Offset

This option is used to select the slave memory of the EPC-5A. Possible selections are:

18000000h (A32)
19000000h (A32)
1A000000h (A32)
1B000000h (A32)
1C000000h (A32)
1D000000h (A32)
1E000000h (A32)
1F000000h (A32)
000000h (A24)
400000h (A24)
800000h (A24)
C00000h (A24)
disabled (default)

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Exit Menu

The options in this menu allow saving settings and exiting, or abandoning changes and exiting to the system, or controlling the backup and restoration of CMOS RAM to the FBD. The Exit Menu is shown below.

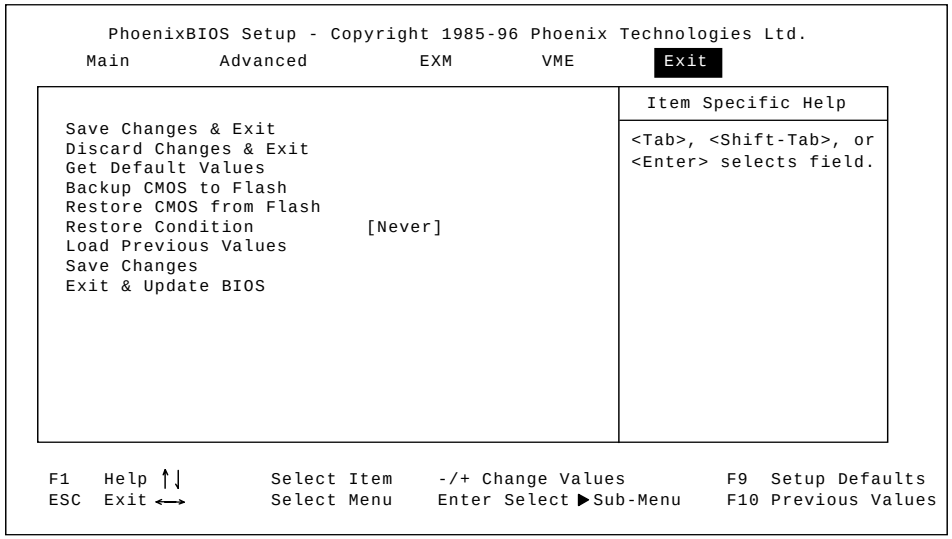


Figure 4-11. Exit Menu.

About CMOS Backup and Restore

You can save and restore your setup configuration in preparation for an event such as battery failure or corrupt CMOS RAM. This feature also allows systems without batteries to boot properly while still allowing you to configure the system via Setup, which stores user settings in CMOS RAM. This feature allows automatic or manual restoration, and selective CMOS RAM restore conditions.

The CMOS RAM configuration backup is stored in FBD parameter block #2. This entire block is reserved for this purpose and cannot be shared.

The available selections from the Exit setup menu that would force a CMOS restoration are: *Always* restore, *Never* restore, and restore on *Corrupt CMOS*. The default setting is to restore on *Corrupt CMOS.*

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The System BIOS software searches the FBD for the unterminated string "RadiSysCMOS--->" at power-up. This footprint marks the beginning of the CMOS parameter block storage structure. The structure contains a 16-bit CRC of the CMOS RAM data that is calculated at backup time and recalculated at restoration time. If the CRC verification fails, the restoration is skipped.

If the System BIOS succeeds in restoring a backup image to CMOS RAM, the system beeps 1 long and 5 short tones.

Restoration is inhibited for warm boots (CTRL-ALT-DEL from DOS) and when a restore is attempted but no valid CMOS image exists in the FBD.



Save Changes & Exit

This option is used to save into CMOS the values that have been entered, then reboot.

Discard Changes & Exit

This option is used to discard the changes just made and revert to the state when Setup was entered. The system reboots with the old values.

Get default values

This option is used to reset the Setup values to the original, default values that were set at the factory, before any suppliers or other end users made changes.

Backup CMOS to Flash

This option is used to immediately save current Setup settings from CMOS into flash. This is useful for backing up complicated setups.

Restore CMOS from Flash

This option is used to immediately restore CMOS settings from flash.

Restore Condition

This option is used to determine under what conditions the System BIOS restores CMOS RAM from the FBD when booting. The restore conditions are: "Always", "Never", and "Bad CMOS". The default is "Bad CMOS".

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Load previous values

This option is used to load the system with the previous values before an editing session started.

Save Changes

This option is used to save the edits made during a session.

Exit & Update BIOS

This option is used to initiate a System BIOS update.

Note
Do not select this exit option unless you have already obtained BIOS update replacement software from your supplier and have reviewed the documentation and procedures provided with that distribution.

If you select this option by mistake, any changes made to the BIOS are lost unless you have already saved them using the **Save Current Values** option. The system automatically begins searching for the update program that should be on the floppy disk inserted in drive A. If there is no floppy, you get two series of beep codes: a long and two short beeps, followed by three short beeps that repeat. Cycle the power to reset the system to its previous state.

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5. Theory of Operation

The EPC-5A is a PC/AT compatible processor. Most of the standard functions of the PC architecture is embodied in the RadiSys R400 chip set. In addition, the EPC-5A has two proprietary interfaces: one for the EXM expansion interface and the other for the VMEbus.

Processor board

The EPC-5A processor board conforms with the VMEbus standard 6U form-factor.

Processor and Coprocessor

The processor in the EPC-5A is an Intel486-DX4 running internally at 100 MHz with an external interface at 33 MHz.

The 486 has a built-in math coprocessor and 16K cache.



Core Logic

The system uses the RadiSys R400EX system controller. The R400EX was developed by RadiSys to provide flexibility (of different system designs), ease of use, and low system cost. It is intended as a long-life core logic solution for the 486.

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The core logic system support provided by the R400EX includes the following:

RadiSys R400EX PC-Compatible Features	Real Time Clock	Provides Motorola 146818A-compatible real time clock and alarm with 114 bytes of battery-backed CMOS memory. The RTC also generates a periodic interrupt. Access to the CMOS memory is through registers 070h and 071h in an index/data fashion.
	Keyboard/Mouse Controller	Implements a 8042-Compatible keyboard controller.
	Cache	Supports L1 write-through cache.
	Shadow	Shadow BIOS in DRAM.
	PC Speaker/Port B Functionality	Port B register is located at 061h.
RadiSys R400EX Core System Support Features	DRAM Refresh Controller	Supports two banks of SIMMs as Fast Page Mode (FPM), Extended Data Out (EDO) or Flash SIMMs. Second bank start address is configurable. Supports EDO/FPM memory type detection. SIMM types cannot be mixed.
	Power Management Support	*This interface is not used on the EPC-5A.*
	Programmable Chip Select Units (4)	*This interface is not used on the EPC-5A.*
	IDE Interface	*This interface is not used on the EPC-5A.*

Table 5-1. R400EX Features.

Memory

The following memory options are available: 4 MB, 8 MB, 16 MB, 32 MB and 64 MB. (Check with RadiSys Technical Support for 128 MB and 256 MB configurations.) Two SIMM sockets are available. See Chapter 8, *Upgrades*, for memory upgrade instructions.

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Memory Map

The 2^{32} byte physical address space seen by the Intel486 occupies three areas:

1. Addresses between 0 and 1 MB, which are largely defined by the IBM PC/AT architecture.
2. Addresses between 1 MB and 256 MB, which largely depend on how much DRAM is installed in the EPC-5A.
3. Addresses above 256 MB, which provide direct mapping to the VMEbus with a variety of address modifiers and byte orderings. See Chapter 6, *The VMEbus Interface*, for more information about this feature.

Memory at addresses between 0 and 1 MB (0FFFFFh) is mapped as follows:

Range	Content
000000 - 09FFFF	DRAM (first 640 KB)
0A0000 - 0BFFFF	Mapped to EXM interface; almost always used by a video controller as video RAM
0C0000 - 0C7FFF	Write-protected DRAM containing video BIOS
0C8000 - 0DFFFF*	Uncommitted; mapped to EXM interface
0E0000 - 0EFFFF	User-mappable hardware window onto VMEbus
0F0000 - 0FFFFF	Write-protected DRAM containing BIOS

***** 0C8000 - 0DFFFF may be used either as page frames (i.e. for Ethernet, etc.) or may be used by DOS as upper memory blocks if an EMM driver is installed or may be used for BIOS extensions.

For a 4 MB EPC-5A, the extended memory address space is defined as

00100000	003FFFFF	3 MB DRAM extended memory
00400000	00FEFFFF	Uncommitted; mapped to EXM interface

For an 8 MB EPC-5A, the extended memory address space is defined as

00100000	007FFFFF	7 MB DRAM extended memory
00800000	00FEFFFF	Uncommitted; mapped to EXM interface

For a 16 MB EPC-5A, the extended memory address space is defined as

00100000	00FFFFFF	16384 KB DRAM extended memory

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For a 32 MB EPC-5A, the extended memory address space is defined as

00100000	01FFFFFF	32764 KB DRAM extended memory

For a 64 MB EPC-5A, the extended memory address space is defined as

00100000	20000000	65536 KB DRAM extended memory

Note that since the EXM expansion interface has 24 address lines, some of the "uncommitted; mapped to EXM interface" address areas map repeatedly, or wrap-around, in the EXM interface's address space.

Peripheral Components

The EPC-5A uses the TI-16C452 controller to provide legacy I/O device support. This chip provides two NS16C450-compatible serial ports and a parallel port. Since LPTOEN ties to low, this port is output-only.

The serial ports signal interrupts on IRQ3 and IRQ4 and are accessible at the standard PC-AT architecture I/O base addresses of 3F8h and 2F8h respectively. The parallel port signals interrupts on IRQ7 and is accessible at the standard PC-AT architecture I/O base address of 378h.

Real Time Clock

The system contains a real time clock module that is compatible with the Motorola 146818A. The RTC is implemented in the R400EX and contains 114 bytes of CMOS RAM. The RTC and PC/AT CMOS RAM are addressable at the standard PC/AT architecture I/O addresses of 70h and 71h and interrupts are signaled on IRQ8. The System BIOS initializes the RTC on coldstarts if the RTC contains bad values.

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Keyboard Controller

The R400EX contains an Intel 8042-compatible keyboard controller. The keyboard controller is addressable at the standard PC-AT architecture I/O addresses of 60h and 64h. Keyboard interrupts are signaled on IRQ1.

ROM and ROM Shadowing

The EPC-5A contains a 28F004-B*-T Flash Boot Block. The Flash device is mapped into the top of the processor's 32-bit address space. The Flash device contains the PC BIOS, some peripheral BIOS code, and user extensions.

For best possible performance, the BIOS initialization software copies the ROM contents into DRAM (called shadowing) at addresses 0F0000-0FFFFF. The BIOS also searches for the existence of a video adapter containing a video BIOS (e.g., an EXM-13A). If a video BIOS is found, it is copied into the 0Cxxxx area of DRAM. After copying into these areas, the BIOS write-protects them. Subsequent writes to these areas complete successfully but do not alter the data.



Embedded Shadow

The EPC-5A supports several different boot methods and operating systems. In order to boot from VME or flash, it is necessary to first load and execute a BIOS extension. The FBD has an unused 96KB region in main block #3 that lies between the end of the PicoFlash extension and start of the System BIOS that can be used for BIOS extension storage. In order to use this area for BIOS extensions, it is necessary to first program the image into the FBD (using REFLASH.EXE) and then, at run time, copy the BIOS extension from the FBD into DRAM, and have the System BIOS scan that region for BIOS extensions. Multiple BIOS extensions can be programmed into the user block of the FBD. Setup items allow the user to select up to 3 BIOS extensions in the FBD and load them into DRAM between C8000h through DFFFFh.

Bootable Device Precedence

There are several bootable devices for the EPC-5A. Depending on the configuration, either the EXM-2A, VME, SCSI or IDE can be the boot device. This section documents the order in which these devices are installed in the boot chain. BIOS extensions supersede IDE as a bootable device.

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If there is more than one BIOS extension, the extension that is located at the highest physical memory location is the first device in the boot chain.

Only two drives are visible as BIOS extensions.

The following denotes which devices are installed in the system when the devices are enabled.

VME Booting: When booting from VME, the second BIOS recognized may be SCSI. If SCSI is selected as the second BIOS recognized device, Flash can be accessed under DOS by loading an OS-based driver. With this configuration, IDE drives are not visible to the system.

SCSI Booting: If the boot device is SCSI, either VME or Flash can be selected as the second BIOS recognized device. If VME is selected as the second BIOS recognized device, Flash can be accessed under DOS by loading an OS-based driver. IDE drives are not visible to the system.

Flash Booting: If the boot device is Flash, either VME or SCSI can be selected as the second BIOS recognized device.

IDE Booting: If the boot device is IDE, either VME or Flash can be used only after loading the device driver. SCSI can be selected as the second BIOS-recognized device.

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Battery

The battery powers the CMOS RAM and TOD clock when system power is not present. At 60°C, the battery should have a shelf life of over four years at 50% duty cycle. In a system that is powered on much of the time and where the ambient power-off temperature is less than 60°C, the battery is estimated to have a life of 10 years.

The battery supplied with the EPC-5A is mounted on the underside of the metal frame and connected to a header on the processor board. Should the battery fail, you may obtain and install a replacement from RadiSys Technical Support.

Replacing the battery is a simple task. However, removing the battery **will** invalidate the CMOS setup parameters. It is recommended that all setup parameters be written down while the battery is still good. Additionally, use the Backup CMOS to Flash feature in the BIOS Exit Menu.

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Video Controllers

The EPC-5A can operate with or without a video controller (such as the EXM-13B or EXM-13A). The BIOS searches for an EXM having an EXM ID in the range E8h-EFh (a range reserved for video controllers). The search is done by EXM slot number, beginning at slot 0. If no EXM video adapter is found, the BIOS looks for a PC add-in card video controller in an EXP-AM Adapter module. The error message EXM CONFIGURATION ERROR may appear if the video controller EXM or the EXP-AM has not been configured via the setup screen.

In either case, the BIOS automatically initializes and uses the first one found. If no video controller is present, the BIOS operates without one. Programs that use the standard operating system and BIOS character output functions can be run successfully (the output is ignored). However, programs that rely on specific video modes, that write directly into the video RAM, or that directly call video BIOS functions will fail.

Front Panel LEDs

The EPC-5A has five LEDs in the top left corner of the front panel. These LEDs are described below:

RUN	This LED is lit whenever the EPC-5A's CPU is performing bus cycles. It first comes on at power-up and should remain lit as long as the system is running.
SYSFAIL	This LED is only active when this EPC-5A is jumpered to be the Slot-1 controller. It comes on whenever the system receives a hardware reset and remains on until the initial power-on self-tests have completed. It also comes on whenever the VMEbus SysFail line is asserted.
TEST	This LED is lit whenever the system is running its power-on self-test. This only occurs during a hardware reset.
MASTER	The Master LED is lit whenever the EPC-5A is accessing the VMEbus.
SLAVE	The Slave LED is lit whenever another master on the VMEbus is accessing the EPC-5A's memory.

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Resetting the EPC-5A

There are a number of ways to reset (reboot) the EPC-5A.

Power-off, Power-on
: This causes all boards in the VMEbus to reset. The system runs the power-on self-tests and reboots the operating system.

Front-panel Reset button
: The Reset button causes the EPC-5A to perform a hardware reset. The system runs the power-on self-tests and reboots the operating system.

Ctrl+Alt+Del
: This keyboard sequence is called a “warm boot”. The EPC-5A does not reinitialize all of the processor's hardware. The power-on self-test does not run. However, the operating system is reloaded.

VMEbus SysReset
: The EPC-5A can be software-configured to respond or not respond to the VMEbus SysReset line. Asserting this bit causes a hard reset of the system if the VME YSRESET bit is asserted. See bit 7 (SRIE), register 8144h.

VMEbus Register Reset
: The EPC-5A can also reset another master asserting the reset bit of a register mapped to the VMEbus. Asserting this bit causes a hard reset of the system. See bit 0 (RSTP), register 8144h.

5 5

EXM Expansion Interface

The EXM expansion interface is electrically similar to the PC/AT ISA (16-bit data) bus. In addition, it contains a signal `-EXMID` used for dynamic recognition and configuration of EXMs. EXMs respond to one or more I/O addresses in the range 100h - 107h only when their `-EXMID` line is asserted. EXMs are required to return a unique EXM ID byte in response to a read from I/O address 100h.

This ID byte is the same identification byte discussed earlier in Chapter 4, *Configuring the BIOS Setup,* in the section on the *EXM Setup Menu*.

The EXM expansion interface is provided on rows A, C, and D of the EPC-5A's 4-row DIN P2 connector. The subplane carries the EXM interface to other modules, such as to EXM modules and the EXP-MX Mass Storage module. These EXM interface signals are not passed through to the VMEbus.

Further information on the EXM expansion interface, its connectors, and standards for building EXMs is available upon request.

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6. The VMEbus Interface

This chapter describes the EPC-5A VMEbus interface as seen by a program. Users should avoid direct use of most of these facilities. Whenever possible, the VMEbus interface should be accessed through the EPConnect software, an easy-to-use, high-level interface that frees you from most machine-dependent considerations.

Connectivity

The EPC-5A module connects to the VMEbus J1 connector directly and uses all of the defined VMEbus lines except SERCLK, SERDAT, and +5V STDBY. Connection to the J2 connector is through the subplane's 4-row DIN connector B row. The only connections to the VME J2 backplane on the B row are power and ground, address lines A31-A24, and data lines D16-D31. Pin 30, Row A, the VXI-defined module identification (MODID) line is also connected. Pin A30 is an input driving one gate input and an 825-ohm pull-down resistor. It may be disabled by removing the MODID jumper on the EPC-5A. If necessary, see Chapter 2, *Configuring the EPC-5A*.

VMEbus System (Slot-1) Controller Functions

Every VMEbus system must have a System (Slot-1) Controller. The Slot-1 controller provides the following functionality:

- Serves as the bus arbiter (priority or round-robin)
- Drives the 16 MHz SYSCLK signal
- Starts the IACK daisy chain
- Provides Bus Timer function

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When configured as the Slot-1 controller, the EPC-5A detects and terminates data transfer bus timeouts. Once it sees either the DS0 or DS1 lines asserted, a counter is started. If the counter expires before both DS0 and DS1 are deasserted, the EPC-5A asserts the VMEbus BERR signal until both data strobes are deasserted. The duration of the VMEbus timeout counter is 100-120 µsecs. When the EPC-5A is configured as the slot-1 controller, this timeout cannot be disabled and the duration cannot be changed.

Although the EPC-5A provides the required timeout function for data transfer time-out, it does not provide the optional bus grant timeout. If another master has been granted permission to use the data bus but does not access (or relinquish) the data bus, the bus will be "hung" indefinitely.

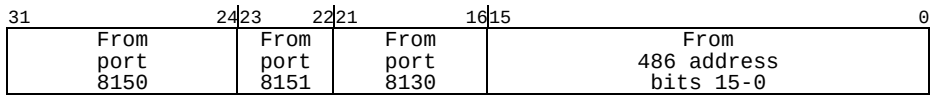
6 6

Concepts

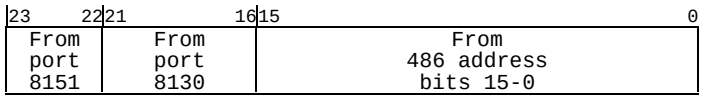
Memory Map

VMEbus accesses are available by mapping a 64K segment of the VMEbus through the 0E0000h -0EFFFFh window or by direct mapping above 256 MB. The following summarizes the source of the VMEbus address lines for accesses through the VME memory window.

A32



A24



A16

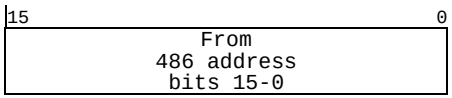


Figure 6-1. Source of VMEbus Address Lines (Via VME memory window).

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It should be noted that the EPC-5A drives all 32 address lines even when performing an A24 or A16 access. Therefore, all the above registers (8150, 8151, 8130) should be set for every access using the VME memory window. Make sure that those registers not directly supplying address lines are set to "FF" values in the appropriate bit positions.

Direct VMEbus Accesses

An alternate way to perform VMEbus accesses, provided that the EPC-5A is running in protected mode, is to perform reads and writes at 486 addresses above 10000000h (256 MB). For instance, a 4-byte read at address 40000000h will result in a 4-byte VMEbus read access at address 00000000 with an address modifier specifying A32, supervisory data and no byte-swapping (little-endian mode).

With the EPC-5A, addresses above 256 MB, with one exception for PC compatibility, map onto the VMEbus. When direct "protected-mode" addressing of A24 or A16 space, the high-order nibble is used to define the access mode and byte ordering. For A32 space, the high-order 2 bits define the access mode leaving 30 bits available for addressing. Thus, only the first 1 Gigabyte of VMEbus A32 space is directly addressable. All A24 and A16 space is directly addressable. The chart following shows how this direct mapping is used.

Address Range	Access Mode	Byte Order
1xxx0000 - 1xxxFFFF	VME A16 supervisory data	little endian
2x000000 - 3xFFFFFF	VME A24 supervisory data	little endian
40000000 - 7FFFFFFF	VME A32 supervisory data (mapped to VME 00000000-3FFFFFFF)	little endian
80000000 - BFFFFFFF	VME A32 supervisory data (mapped to VME 00000000-3FFFFFFF)	big endian
Cxxx0000 - DxxxFFFF	VME A16 supervisory data	big endian
Ex000000 - ExFFFFFF	VME A24 supervisory data	big endian
F0000000 - FFFEFFFF	Mapped to EXM expansion interface	
FFFF0000 - FFFFFFFF	486 upper ROM area	

Table 6-1. Direct Mapping.

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When accessing the VMEbus in this manner, the source of the VMEbus address lines is defined below.

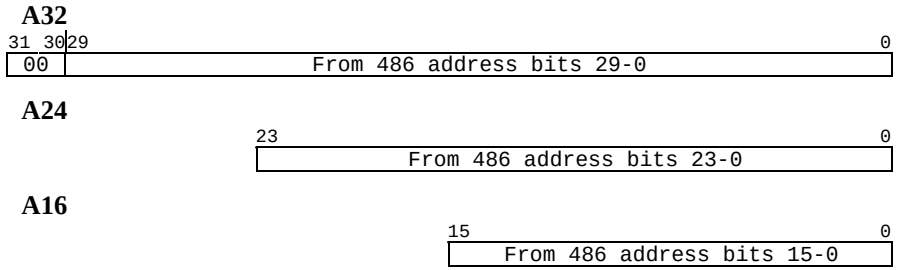


Figure 6-2. Source of VMEbus Address Lines (Via Direct Mapping).

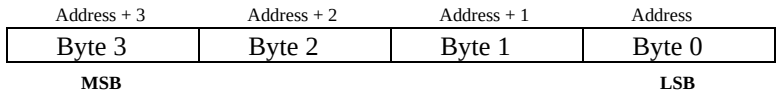
The main purpose of the direct VMEbus access mechanism, as opposed to the VME memory window mechanism, is for multitasking 32-bit operating-system environments, where multiple tasks need to make VMEbus accesses. Without this, the tasks would have to coordinate their use of the VME memory window mapping registers.

When using the EPC-5A this way to perform VMEbus accesses, one would typically set up the VME memory window for interrupt acknowledge accesses. Also note that the direct access mappings do not cover the entire VMEbus A32 address range and do not provide all VMEbus-defined address modifier encodings, but one can use the VME memory window mechanism if needed to provide these.

Byte Ordering

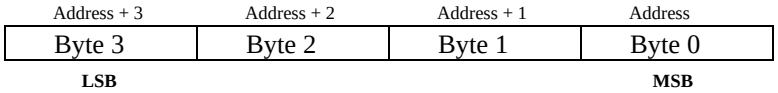
There are two fundamentally different ways of storing numerical values in byte locations in memory:

- Little endian, characteristic of Intel microprocessors, where the **least**-significant data byte (LSB) is stored in the lowest byte address.



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- Big endian, characteristic of Motorola microprocessors and the VMEbus environment in general, where the **most**-significant data byte (MSB) is stored in the lowest byte address.



The EPC-5A contains programmable byte-swapping hardware to allow programs to read or write VMEbus memory in either byte order. When using the VME memory window to access the VMEbus, the order is selected by bit 5 (BORD) in the VME modifier register (8151).

When using direct memory mapping, the order is address-range dependent (e.g., E0000000-E0FFFFFF accesses the A24 space with big endian byte ordering, and 20000000-20FFFFFF accesses the A24 space with little endian byte ordering).

When performing a single byte (D08) access, the byte order makes no difference. However, word (D16) or double-word (D32) accesses may require byte-swapping.

When little-endian is selected, bytes pass straight through unchanged. Little endian should only be used when reading or writing data between two Intel processor systems. The results of using little-endian byte ordering to transfer a double-word integer between an Intel processor and a Motorola processor are shown below.

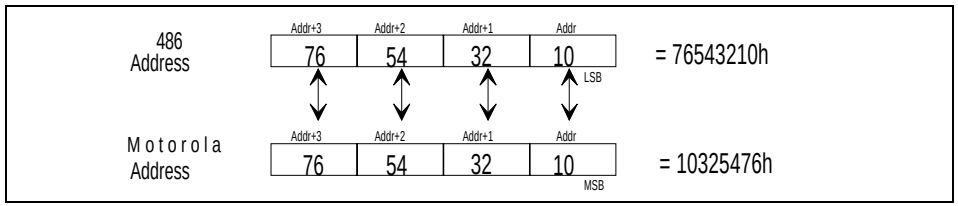


Figure 6-3. Little-Endian Byte Order.

Since the 486 processor uses Addr as the least-significant byte and the Motorola processor uses Addr as the most-significant byte, the processor receiving the data gets a “scrambled” value.

When big-endian is selected, the bytes are swapped between the 486 and VME. See the diagram below.

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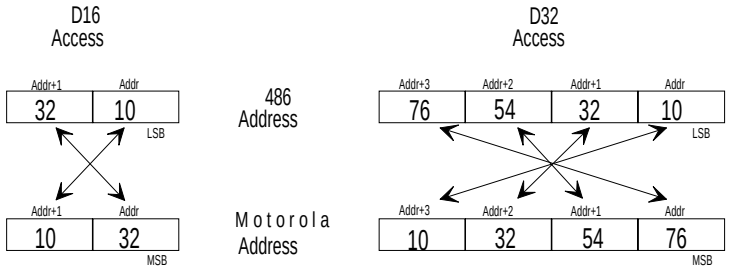


Figure 6-4. Big-Endian Byte-swapping.

When using big-endian byte ordering, care must be taken to assure that the VME address is aligned on a boundary; for D16 accesses the VME address must be on a word boundary (address evenly divisible by 2) and for D32 accesses the VME address must be on a double-word boundary (evenly divisible by 4).

If this is not done, the results will be "scrambled" data. Although the VMEbus address must be boundary-aligned to match the data width (word or double-word), the 486 address does not need to be boundary-aligned.

Another consideration is the compiler being used. Some compilers produce two 16-bit accesses when a 32-bit access is desired. When this occurs, again the data will be "scrambled."

When transferring a 32-bit floating-point number, special care must be taken to assure that both processors use the same floating-point format; and that both systems expect the mantissa and exponent in the same byte locations. As long as this is correct, transferring a floating-point number will work correctly. Since transferring a 64-bit floating-point number is not supported in hardware, two 32-bit transfers must be used with little-endian byte order and then byte-swapping must be accomplished in software.

⚠ **CAUTION**
Byte swapping applies only to EPC-5A initiated (master) accesses; it does not apply to slave accesses from other VMEbus masters to the EPC-5A's DRAM.

The EPConnect Bus Manager software provides a means of selecting the byte ordering during memory-copy operations.

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Slave Accesses from the VMEbus

When SLE (Slave Enable) in the status/control register (8145h) is set, the EPC-5A's dual-ported memory will respond to accesses from other VMEbus masters.

All types of VME accesses (reads, writes, and read-modify-writes of all lengths) are supported, except for block transfer cycles. The EPC-5A responds to supervisory, non-privileged, program, or data access modes.

The amount of memory that will be dual-ported is limited to the first (lowest address) 4 MB in A24 space or all available memory in A32 space. In both cases, the slave memory's local (PC) address starts at Segment 0000, Offset 0000. This, of course, means that it is possible to overwrite the memory space occupied by the operating system. As such, care must be taken in writing to the EPC-5A's memory.

When such an access is fielded by the EPC-5A, the EPC-5A's A24 or A32 base address is effectively subtracted from the VMEbus address value, and the result is treated as if the access came from the 486.

However, note the following:

1. Any access that maps to local addresses 000A0000h - 000BFFFFh, 000D0000h 000EFFFFh, to addresses mapped to the EPC-5A's EXM expansion interface, and to addresses beyond the extent of the installed DRAM cause the EPC-5A to respond with BERR (bus error).
2. Write accesses to write-protected DRAM terminate normally (DTACK response), but with no effect on the DRAM.

Enabling of the EPC-5A as a slave and specification of the address space (A24 or A32) and the base address is controlled by the registers discussed in the following section, *Registers Specific to the EPC-5A*. The easiest way to set up these registers is to do so via the BIOS setup screen.

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Self Accesses Across the VMEbus

Since the EPC-5A's DRAM can be mapped into the VMEbus A24 or A32 address space, the EPC-5A can access its DRAM in an alternate way - by generating VMEbus accesses to addresses mapped as the EPC-5A's VME slave memory. This can be of use in multiple-processor systems where some of the EPC-5A's DRAM is used as shared global memory; it means that the EPC-5A can access the global memory with the same addresses as used by other processors without needing to understand that the memory is actually on-board.

This ability is also useful in system checkout (i.e., checking operation of the backplane) and in giving an EPC-5A program the ability to view its memory in big endian format.

A24 and A32 slave accesses result in accesses to the on-board DRAM and never to the cache. Because the EPC-5A's cache is a write-through cache, there is never a discrepancy between data in the cache and the DRAM. When a slave access results in a *write* into the DRAM, the EPC-5A automatically purges the cached entry, if it exists.

Given the above, another subtle use for the ability of the EPC-5A to access its own DRAM via a VMEbus access is selective purging of the cache. For instance, if the EPC-5A is mapped at address base 18000000h in the A32 space and a program is meant to purge location 0000AB00h from the cache, a read from 0000AB00h followed by a write of the read data back to 1800AB00h will accomplish the task.

Read-Modify-Write Operations

VMEbus RMW (read-modify-write) cycles can be performed through use of the LOCK instruction prefix with certain instructions. All of these instructions perform a read followed by a write. When such a read occurs that is mapped to the VMEbus, the EPC-5A treats it as the start of a VME RMW cycle. The next VME access from the CPU is treated as the write that terminates the RMW cycle. Keep in mind that accesses that cross a 32-bit boundary are actually performed as two accesses. For this reason, RMW accesses that cross a 32-bit boundary will not behave as expected.

The EPC-5A provides synchronization integrity in its local DRAM between accesses from the CPU into the DRAM and RMW VME accesses from other masters into the DRAM.

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When a VMEbus slave read access occurs to the local DRAM, the EPC-5A watches the VMEbus data and address strobes to determine if the cycle is an RMW cycle. If it is, accesses by the CPU are held up until the terminating access of the RMW cycle occurs.

When the CPU performs a locked access (e.g., via an instruction using the LOCK instruction prefix) to the local DRAM or the cache, VMEbus slave accesses are held up until the last locked access completes.

One more case of interest is when the EPC-5A performs a locked access that results in a self access. These function correctly (i.e., as if the access was not a self access), providing that operating-system tables (e.g., page tables) that are accessed by the CPU by implicit locked accesses are not mapped into VME. This would only be a concern for user-written operating systems.

VMEbus Interrupt Response

When the EPC-5A's Interrupt Generator register (815F) is used to assert an interrupt, the EPC-5A formulates a status/ID value that is transmitted on the bus as the response to a matching interrupt acknowledgment cycle. The EPC-5A acts as both a D08(O) and D16 interrupter. For D08 interrupt acknowledge cycles, the status/ID value is the EPC-5A's logical address (11111aaa, where aaa is the value of ULA as defined in port 814A). For D16 and D32 interrupt acknowledge cycles, the status/ID value consists of 16 bits. The upper eight bits are the upper half of the response register (the value in I/O port 814B) and the lower eight bits are the logical address.

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Registers Specific to the EPC-5A

Registers in the I/O space that are specific to the EPC-5A are defined below.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	I/O Port
Res	Res	Res	MEMSIZE			VME	Res	8104h

VMEbus and Memory Controller Configuration

VMEbus Address bits 21-16						Res	Res	8130h

VME A21-16 Address Register

1	1	1	0	1	1	0	0	8140h

ID Register, lower

1	0	0	A32	1	1	1	1	8141h

ID Register, upper

1	1	0	0	0	1	0	0	8142h

Device Type Register, lower

0	Slave Size		1	1	1	1	1	8143h

Device Type Register, upper

SRIE	RELM	ARBPRI		READY	PASS	NOSF	RSTP	8144h

Status/Control Register, lower

SLE	MODID	SYSR	SYSF	ARBM	1	1	1	8145h

Status/Control Register, upper

1	1	1	1	1	1	1	1	8146h

Slave Offset Register, lower

0	0	0	1	1	SLAVE BASE			8147h

Slave Offset Register, upper

1	1	1	1	1	1	1	1	8148h

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Protocol Register, lower

0	1	0	1	1	1	1	1	8149h

Protocol Register, upper

LOCK	1	ABMH	1	1	ULA			814Ah

Response Register, lower

0	0	0	0	1	RRDY	WRDY	1	814Bh

Response Register, upper

RAM								814Ch

Message High Register, lower

RAM								814Dh

Message High Register, upper

RAM								814Eh

Message Low Register, lower

RAM								814Fh

Message Low Register, upper

VMEbus Address bits 31-24 (WA31-24)								8150h

Message A31-24 Address Register

VME WA23-22		BORD	IACK	AM5	AM4	AM2	AM1	8151h

VME Modifier Register

IRQ7	IRQ6	IRQ5	IRQ4	IRQ3	IRQ2	IRQ1	MSGR	8152h

VME Interrupt State Register

IRQ7	IRQ6	IRQ5	IRQ4	IRQ3	IRQ2	IRQ1	MSGR	8153h

VME Interrupt Enable Register

1	1	1	1	1	ACFA	BERR	SYSF	8154h

VME Event State Register

1	1	1	1	1	ACFA	BERR	SYSF	8155h

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VME Event Enable Register

DONE	AS	DS0	DS1	1	1	(res.)	1	8156h

Module Status/Control Register

1	1	1	1	1	INTERRUPT-OUT	815Fh

Interrupt Generator Register

Where a bit position has been described by a 0 or 1, the bit is a ROM bit, and writing to it has no effect. Unless otherwise noted below, all registers and bit values are readable and writeable.

VMEbus and Memory Controller Configuration (8104h)

			MEMSIZE	VME	

This register controls the DRAM memory controller and certain aspects of BIOS write protection and the VMEbus interface. The bits in this register are cleared by an "AT reset" (that is, when the RESET button is pushed or power is applied to the system).

MEMSIZE Memory Size. These bits tell the memory controller how much SIMM DRAM memory is present on the EPC-5A. This field is set by the BIOS when power is applied to the EPC-5A, and contains one of the following values: 001 = 4 MB, 010 = 8 MB, 111 = 16 MB, 110 = 32 MB. Larger memory sizes are not yet defined.

VME If set (1), this bit allows VME accesses through the DOS window or through shared memory above 256 MB in protected mode. When clear (0), the VMEbus cannot be accessed. This bit is automatically set by the BusManager software when using EPConnect.

Note
Except for the VME access bit, the bits in this register are manipulated by the BIOS. User software should manipulate only the VME access bit in this register.

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VME A21-16 Address Register (8130h)

VMEbus Address bits 21-16	Res	Res

When an access is performed by the EPC-5A in its window (address range 0E0000h-0EFFFFh), the access is mapped onto the VMEbus. The least-significant 16 of the VME address bits are provided directly (from the 486), and the remaining 8 (for an A24 access) or 16 (for an A32 access) bits must come from somewhere else. Six of them come from this register. Bit 7 of this register is used as VME address bit 21, bit 6 as VME address bit 20, and bit 2 as VME address bit 16.

The two low-order bits are reserved RAM bits. On writes, assign them the value 0.

For compatibility with EPC-1, this register is aliased at I/O port addresses 8132h, 8134h, and 8136h.

ID Register (8140h & 8141h)

1	1	1	0	1	1	0	0	Lower
1	0	0	A32	1	1	1	1	Upper

This read-only register adheres to the VXIbus specification. It defines the EPC-5A as a message-based device and the manufacturer as RadiSys Corporation.

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A32 If set (1), the EPC-5A's DRAM is mapped into the VMEbus A32 address space. If clear, the DRAM is mapped into the A24 address space. This read-only bit is influenced by the value stored in the SLAVE-SIZE field of the next register.

Device Type Register (8142h & 8143h)

1	1	0	0	0	1	0	0	Lower
0	Slave Size		1	1	1	1	1	Upper

This register adheres to the VXIbus specification. Only bit 6 is writeable. Bit 5 is automatically set to match bit 6. If bit 6 is set, the value of the register is 7Fh and the A32 bit in the previous register is 1. This denotes that the EPC-5A responds to a 16 MB range in the A32 space.

If bit 6 is clear, the value of the register is 1Fh and the A32 bit in the previous register is 0. This denotes that the EPC-5A responds to a 4 MB range in the A24 space.

The remaining ROM bits define the EPC-5A as having a model code of 4036.

Status/Control Register (8144h & 8145h)

SRIE	RELM	ARBPRI		READY	PASS	NOSF	RSTP	Lower
SLE	MODID	SYSR	SYSF	ARBM	1	1	1	Upper

This register adheres to the VXIbus specification and also contains EPC-5A specific bits.

SRIE SYSRESET input enable. If set, assertion of VME SYSRESET generates a reset of the EPC-5A. One use of this bit is having EPC-5A software reset other VME devices (via bit SYSR) without resetting the EPC-5A.

RELM Bus release mode. If set, the bus release mode is ROR (release on request); otherwise it is the VXI RONR "fair requester" mode (request on no request). Altering this bit via the VME-mapped location of this register has no effect.

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ARBPRI Arbitration priority. This defines the level at which the EPC-5A arbitrates for the VMEbus. 11 means 3, 10 means 2, 01 means 1, 00 means 0. Like for RELM, altering this field via the VME-mapped location of this register has no effect.

READY This is a RAM bit defined by the VXI specification. In a VXIbus software environment, if READY=1 and PASS=1, the EPC-5A is ready to accept VXI-defined messages. *In the EPC-1 and in early versions of the EPC-3 manual, this bit was named EXTE. Its implementation hasn't changed, but it was renamed to correspond to the renaming of the bit in revision 1.3 of the VXIbus specification.*

PASS If set (1), the EPC-5A has completed its self test successfully. If this bit is clear, the Test LED on the EPC-5A front panel is lit.

NOSF SYSFAIL inhibit. If set, the EPC-5A cannot assert the VMEbus SYSFAIL line.

RSTP Reset EPC. Setting this bit resets the EPC-5A.

SLE Slave enable. If set, the EPC-5A responds to certain A24 or A32 accesses on the VMEbus.

MODID This readable bit is connected to pin 30 in row A of the VMEbus P2 connector. If clear (0), it denotes that the pin is being pulled high. (This is used in VXI systems for module identification.)

SYSR SYSRESET. The EPC-5A asserts the VME SYSRESET line while this bit is 1. When using this bit, it is the software's responsibility to ensure that the VME-specified minimum assertion time of SYSRESET is met.

SYSF SYSFAIL. The EPC-5A asserts the VME SYSFAIL line while this bit is 0. (The polarity of the bit is reversed from that of SYSRESET so that an EPC-5A reset - which clears this bit - causes SYSFAIL to be asserted until the BIOS stores a 1 in this bit.)

ARBM Arbitration mode. This bit is pertinent only if the EPC-5A is jumpered to be the VMEbus system controller. If set, the EPC-5A is a priority arbiter; otherwise it is a round-robin arbiter. Like for RELM, altering this field via the VME-mapped location of this register has no effect.

Slave Offset Register (8146 & 8147)

1	1	1	1	1	1	1	1	Lower
0	0	0	1	1	SLAVE BASE			Upper

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If A32 and SLE are set, the value in port 8147 defines the base address of the EPC-5A's memory in the VMEbus A32 address space. This register can hold the values 18 - 1F, which correspond to the base addresses 18000000h - 1F000000h.

If A32 is clear and SLE is set, the two low-order bits of SLAVE BASE define the base address of the EPC-5A's memory in A24as follows: 00 - 000000h, 01 - 400000h, 10 - 800000h, 11 - C00000h.

Protocol Register (8148h & 8149h)

1	1	1	1	1	1	1	1	Lower
0	1	0	1	1	1	1	1	Upper

This read-only register is defined by the VXIbus specification. In VXI systems, it defines the EPC-5A as being a servant and commander, having no signal register, being a bus master, and not providing fast handshake mode.

Response Register (814Ah & 814Bh)

LOCK	1	ABMH	1	1	ULA			Lower
0	0	0	0	1	RRDY	WRDY	1	Upper

With the exception of LOCK, this register is defined by the VXIbus specification. It contains control bits associated with the message registers.

LOCK — If set, the message register can be locked for the sending of a message. If clear, the message register has been locked.

ABMH — This bit is cleared when the message high register is read or written. It serves as a location monitor for determining whether a message is 16 or 32 bits in length.

ULA — Unique logical address. This determines the base of the registers in the VMEbus A16 space. 0 denotes FE00h, 1 denotes FE40, 2 denotes FE80h, 3 denotes FEC0h, 4 denotes FF00h, 5 denotes FF40h, 6 denotes FF80h, and 7 denotes FFC0h.

RRDY — Read ready. As defined by VXI, a 1 denotes that the message registers contain outgoing data to be read by another device. RRDY is cleared when the message low register is read.

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WRDY Write ready. If set, the message registers are armed for an incoming message. When a write occurs into the message-low register, WRDY is cleared and the MSGR interrupt condition is asserted.

When the response register is read from the VMEbus, the current value of the register is read, and then LOCK is cleared. The protocol for sending a message to the EPC-5A, if there are multiple potential senders, is the following. The sender first reads the response register. If both WRDY and LOCK are 1, the sender may then proceed to send the message. For a 16-bit message, the sender writes into the message-low register. For a 32-bit message, the sender writes first into the message-high register and then the message-low register.

Message High Register (814Ch & 814Dh)

RAM	Lower
RAM	Upper

This register is an extension of the following register for 32-bit messages. An access to this register clears flag ABMH in the response register.

Message Low Register (814Eh & 814Fh)

RAM	Lower
RAM	Upper

This register is typically used as an incoming message register by doing a D16 write into it from the VMEbus (this register, as are many others, is mapped into the VMEbus A16 address space, as discussed later).

VME A31-24 Address Register (8150h)

VMEbus Address bits 31-24 (WA31-24)

This register is one of several that supply the VMEbus address bits when the EPC-5A makes an access in its memory window. This register supplies VME address bits A31-A24.

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VME Modifier Register (8151h)

VME WA23-22	BORD	IACK	AM5	AM4	AM2	AM1

This register is also used when the EPC-5A makes an access through its VME memory window to the VMEbus. Bits 7 and 6 provide VME address bits A23 and A22, respectively. Bits 3-0 define the value placed on the associated VMEbus address-modifier lines. Register bits are not defined for the VMEbus address-modifier AM3 and AM0 lines since, for all defined address-modifier values in the VMEbus specification, AM3 is 1 and AM0 is the inverse of AM1. Therefore these two bit values are generated by hardware. Note that because AM3 and AM0 are hardware generated, the EPC-5A does not support user-defined address-modifiers.

BORD Byte order. This bit controls the ordering of data bytes for D16 and D32 VMEbus accesses. If 0, the bytes are transmitted in little endian (Intel) order; if 1, byte-swapping hardware transmits the bytes in big endian (Motorola) order. Refer to the previous section in this chapter on byte ordering.

IACK This bit, when set, is used to define the VMEbus access as an interrupt acknowledge cycle. The interrupt being acknowledged must be encoded by software as a value on VME address lines A1-A3.

VME Interrupt State Register (8152h)

IRQ7	IRQ6	IRQ5	IRQ4	IRQ3	IRQ2	IRQ1	MSGR

This read-only register defines the state of the VMEbus and message interrupts.

IRQx If clear (0), the associated VMEbus interrupt line is asserted.

MSGR If clear (0), a message interrupt is being signaled. MSGR is clear if both bits RRDY and WRDY in the response register are clear.

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VME Interrupt Enable Register (8153h)

IRQ7	IRQ6	IRQ5	IRQ4	IRQ3	IRQ2	IRQ1	MSGR

This is a mask of the interrupt conditions in the interrupt state register. A 1 denotes that the corresponding interrupt is enabled. If any bit in this register is a 1 and the corresponding bit in the interrupt state register is a 0, the EPC-5A IRQ10 interrupt is asserted. Software may then examine the interrupt and event state registers to determine the cause.

VME Event State Register (8154h)

1	1	1	1	1	ACFA	BERR	SYSF

Similar to the interrupt state register, this register defines additional conditions that may result in an IRQ10 interrupt. If the bit is 0, the condition is present.

ACFA VMEbus ACFAIL is asserted.

BERR An access from the EPC-5A to the VMEbus was terminated with a BERR (bus error).

SYSF VMEbus SYSFAIL is asserted.

All bits are read-only except BERR. BERR is a sticky bit that is cleared whenever an access from the EPC-5A is terminated by a bus error, and remains clear (0) unless changed by software (by writing any value to this register).

VME Event Enable Register (8155h)

1	1	1	1	1	ACFA	BERR	SYSF

This is a mask of the interrupt conditions in the event state register. A 1 denotes that the corresponding event is enabled as an interrupt. If any bit in this register is a 1 and the corresponding bit in the event state register is a 0, the EPC-5A IRQ10 interrupt is asserted. Software may then examine the interrupt and event state registers to determine the cause.

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Module Status/Control Register (8156h)

DONE	AS	DS0	DS1	1	1	(res.)	1

This register contains miscellaneous status and control bits.

DONE This read-only bit is 0 whenever the EPC-5A has a VMEbus access outstanding. It is used for determining when a pipelined VMEbus write is complete.

AS This read-only bit is 1 whenever the VMEbus AS (address strobe) signal is asserted. It may be used for bus monitoring.

DS0 This read-only bit is 1 whenever the VMEbus DS0 (data strobe) signal is asserted. It may be used for bus monitoring.

DS1 This read-only bit is 1 whenever the VMEbus DS1 (data strobe) signal is asserted. It may be used for bus monitoring.

(res.) This bit should always be set (1).

The EPC-3 contains two additional bits in this register - ENMI and DEAD - for breaking deadlock situations on its dual-port DRAM. These situations cannot exist in the EPC-5A so the signals are not implemented.

VME Interrupt Generator Register (815Fh)

1	1	1	1	1	INTERRUPT-OUT

This register is used to assert one of the VMEbus interrupt signals. If the INTERRUPT-OUT bits are zero, no interrupt line is asserted by the EPC-5A. If the lower three bits are set to 001, VMEbus IRQ1 is asserted. If set to 010, VMEbus IRQ2 is asserted, and so on. If and when an interrupt acknowledge cycle is sent to the EPC-5A, the INTERRUPT-OUT bits are cleared.

You can also deassert a previously asserted interrupt by writing 0 into the register.

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VMEbus Mapped Registers

The EPC-5A follows the lead of the VXIbus specification in defining a standard set of configuration registers that are mapped into the VMEbus A16 space and thus accessible by other VMEbus modules. These registers are 16-bit registers occupying 64 bytes of A16 space at a base address defined by the EPC-5A's logical address. The base address is

1111 111a aa00 0000

where aaa is the value of the ULA field in the response register at I/O port 814A.

The VME-mapped registers are a subset of those defined previously as I/O ports in the EPC-5A. The registers are dual-ported in that they are accessible both from VME and from within the EPC-5A as ports in its I/O space. The VME mapped registers are defined below.

Offset from ULA	Upper byte	Lower byte
0	ID (8141h)	ID (8140h)
2	Device type (8143h)	Device type (8142h)
4	Status/control (8145h)	Status/control (8144h)
6	Slave offset (8147h)	Slave offset (8146h)
8	Protocol (8149h)	Protocol (8148h)
A	Response (814Bh)	Response (814Ah)
C	Message high (814Dh)	Message high (814Ch)
E	Message low (814Fh)	Message low (814Eh)

The registers occupy the first 16 bytes of the 64-byte space; the remainder of the space is undefined. (Actually, the registers are mapped into each 16-byte chunk of the 64-byte space.)

Reads and writes of the registers from VME and as I/O ports have identical results and effects except for the following:

1. Changing the RELM, ARBPRI, and ARBM fields of the status/control register from VME will appear to have changed the fields (i.e., if the register is then read), but the new values will not effect the EPC-5A's bus-control logic. To use these fields for their intended purpose, they must be set by I/O port accesses.

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2. A read of the response register from VME clears the LOCK bit (immediately after the current value of the response register is returned).

Register State after Reset

A hardware reset of the EPC-5A (not a keyboard CTRL+ALT+DEL reset) clears all of the register bits to 0, except for RELM, ARBM, ARBPRI, and the registers at ports 8130h, 8150h, and 8151h, which may be in an undefined state. (All bits, however, are cleared by a power-on reset.) However, this may not be apparent because the BIOS initialization sequence then reinitializes values in these register fields, largely as a result of the non-volatile configuration information specified in the setup screen.

The BIOS clears the interrupt enable and event enable registers.

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Supported Address Modifiers

2Dh	A16 supervisor
39h	A24 non-privileged data
3Ah	A24 non-privileged program
3Dh	A24 supervisor data
3Eh	A24 supervisor program
09h	A32 non-privileged data
0Ah	A32 non-privileged program
0Dh	A32 supervisor data
0Eh	A32 supervisor program

Table 6-3. Support Address Modifiers.

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Low-Level Programming the VMEbus Interface

It is recommended that rather than performing accesses in this low-level hardware dependent form, the Bus Manager component of the EPConnect software package be used instead.

VMEbus Accesses

Two examples are given here including both a verbal description and the Microsoft C source code for performing VMEbus accesses through the memory window.

Example #1 performs a 16-bit read from the VMEbus A16 space.

1. Set the VME access bit in Register 8104h.

2. Determine the correct address modifier for A16 supervisory access (2Dh).

3. The unused address lines A31-A16 may float when not being used. Registers 8150h and 8130h must be set so that each line is a 1.

   Set register 8130h to FCh and register 8150h to FFh.

4. Set the access mode in the VME Modifier Register (8151h) as follows:

VME WA23-22	BORD	IACK	AM5	AM4	AM2	AM1

(Note that register bits are not defined for the VMEbus address modifier lines AM3 and AM0 since, for all defined address modifier values in the VMEbus specification, AM3 is 1 and AM0 is the inverse of AM1. Therefore these two bit values are generated by hardware.)

Bits 7 & 6 Since the A16 space does not use VMEbus address lines A23 & A22, set these values to 1.

VME WA 23-22 = 11

Bit 5 Set the byte order to “little endian”.

BORD = 0

Bit 4 Clear the IACK bit so this is not an interrupt acknowledge cycle.

IACK = 0

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Bits 3-0 Use the address modifier (in binary form) to determine the appropriate values for these bits. 2Dh = 00**10**1**10**1b

Bit 3 (Address Modifier bit 5) = 1
Bit 2 (Address Modifier bit 4) = 0
Bit 1 (Address Modifier bit 2) = 1
Bit 0 (Address Modifier bit 1) = 0

Thus, 8151h should be set to 1100 1010 or CAh.

5. Map the address.

Add the A16 address to the memory window address

Addr ← E0000000h + A16 address

6. Read the data.

Data ← value pointed to by Addr

Microsoft C code for Example 1 -

```
#define WORD  unsigned short
#define LWORD unsigned long

WORD addr;   /* 16-bit A16 address */
WORD data;
WORD far * wptr;

outp(0x8104,(inp(0x8104)|2));        /* set VME access bit */
outp(0x8130,0xFC);
outp(0x8150,0xFF);
outp(0x8151,0xCA);  /* Set address modifier to A16 supervisory access */
wptr = (WORD far *) (0xE0000000L + addr);
data = *wptr;       /* Read through window */
```


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Example #2 performs a byte (8-bit) write into the VMEbus A32 space. Here the upper 16 bits of the VME address need to be stored in the appropriate registers.

1. Set the VME access bit in register 8104h.

2. Set register 8150h with the value corresponding to the 8 high-order address bits.

VMEbus Address bits 31-24	WA31-24

3. Determine the correct address modifier for A32 supervisory access.

4. Calculate the value and set register 8151h as follows:

VME WA23-22	BORD	IACK	AM5	AM4	AM2	AM1

Bits 7 & 6	VME address bits 23-22
Bit 5	BORD = 0
Bit 4	IACK = 0
Bits 3-0	Bit 3 (Address Modifier bit 5)
	Bit 2 (Address Modifier bit 4)
	Bit 1 (Address Modifier bit 2)
	Bit 0 (Address Modifier bit 1)

5. Set register 8130h with the value corresponding to bits 21-16 of the VMEbus address with the two low order bits of the register set to 0.

VMEbus Address bits 21-16	Res	Res

6. Map the address.

7. Write the data.

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Microsoft C code for Example 2 -

```
LWORD addr;   /* 32-bit A32 address */
BYTE  data;
BYTE  far * wptr;


outp(0x8104,(inp(0x8104)|2));                /* set VME access bit */
outp(0x8150,(WORD)(addr >> 24));          /* A31-A24 */
outp(0x8151,2 | (((addr << 8) >> 30) << 6));
  /* A23-A22 and address modifier for A32 supervisory data access */
outp(0x8130,(WORD)((addr << 10) >> 24);  /* A21-A16 */
wptr = (BYTE far *) (0xE0000000L + (addr & 0X0000FFFFL));
*wptr = data;                             /* Write through window */
```

The success of the access can be checked either by enabling BERR as an interrupt or by looking at the BERR bit in the event state register (8154h) after each access. Since writes are pipelined, software that looks at the BERR bit should first wait until the DONE bit is set.

6 6

Low-Level Handling of VMEbus Interrupts

The following is a description of how VMEbus interrupts (IRQ1-IRQ7), VXIbus message interrupts and error interrupts (BERR, ACFAIL, WDTG, etc.) should be handled on the EPC-5A. Note that, in general, the use of EPConnect is highly recommended to handling interrupts.

- Enable the appropriate registers (VME Interrupt enable (8153h) and VME Event enable (8155h) registers) to allow the interrupts you want to respond to.
- Enable IRQ10 on the EPC's equivalent of the 8259h interrupt controller.
- A VXIbus message interrupt is generated when a master (this EPC-5A or another master) writes to the Message Low register (16-bit) or the Message High and Message Low registers (32-bit) from the VMEbus. A message interrupt does not occur when the EPC-5A writes to its own message register(s) from the PC I/O space.

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- Keep in mind that while PC/AT interrupts are edge sensitive, VMEbus interrupts are level sensitive. As such, you must ensure that

  1) The 8259 interrupt controller is enabled to capture interrupts before a VMEbus interrupt occurs (otherwise VMEbus interrupts will be totally missed) and

  2) You must handle all pending VMEbus interrupts before returning from the interrupt handler.

- When an interrupt occurs, first acknowledge the interrupt to the PC/AT 8259 interrupt controllers by sending both interrupt controllers an End-of-Interrupt (EOI).

- You must make sure that your interrupt handler code is not re-entered while dispatching interrupts. Either all interrupts should be disabled or IRQ10 should be masked after doing the EOI to the interrupt controller. Remember to re-enable them prior to leaving the interrupt handler.

- If you are using DOS, you may need to switch to an internal stack. This may or may not be necessary in other environments and applications. You should also store the state of the VMEbus (i.e., current byte ordering, bus mappings and address modifiers) if you expect the state to change. Be sure to restore the state before leaving the interrupt handler.

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Start of Loop

- Determine the source of the interrupt or event. This can be done by reading the VME Interrupt State register which should be ANDed with the VME Interrupt Enable register. As described above, the VME Event State register and VME Event enable register may also be potential sources for the generation of IRQ10. Keep in mind that all pending interrupts must be handled.

- If the interrupt is a VMEbus interrupt 1-7;

  Acknowledge the interrupt to the VMEbus device generating the interrupt as follows:

  1. Set the IACK bit in the VME Modifier register

  2. Establish a byte-ordering for the status/ID to be read. Whether this is an 8-bit or 16-bit read is dependent on the card issuing the interrupt

  3. The address modifiers and transfer length are dependent on the hardware generating the interrupt.

  4. Perform a read of the VMEbus where the address being read reflects the interrupt level being responded to. Address lines A3-A1 must reflect the interrupt level in binary form. Multiply the interrupt level by 2 and use that as the address of the read operation.

  5. After the read operation, clear the IACK bit in the VME Modifier register.

- If the interrupt is a VXIbus message interrupt, the interrupt is acknowledged and cleared by reading the appropriate register(s), followed by setting the WRDY bit in the VME Response register.

- Call your interrupt handling routine.

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- Upon returning from the interrupt handling routine, go back to the beginning of the loop until no more interrupts are active. In other words, you must handle all other active interrupts. This includes all other interrupts and errors which come in prior to calling the interrupt handling routine as well as any new interrupts and errors which may occur during this process. Only when all interrupts and error conditions are handled may you return from the overall interrupt handler. Again, if you miss any interrupts or errors, no other interrupts or errors are recognized.

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7. Connectors

This chapter specifies the details of the connectors on the EPC-5A. Please note, however, that all the connectors adhere to existing standards. The EXM expansion interface connectors are not defined here; their definition is available upon request. Connectors on EXMs and the EXP-MX are described in the separate manuals for those products.

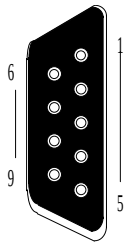
All but the battery and speaker headers are on the front panel. Pins are labeled from the point of view of looking into the front of the connector on the EPC-5A.

Serial Ports

The COM1 and COM2 serial ports are DB-9 DTE connectors defined in the following table.

Pin	Signal	Pin	Signal
1	Carrier detect	6	Data set ready
2	Receive data	7	Request to send
3	Transmit data	8	Clear to send
4	Data terminal ready	9	Ring indicator
5	Signal ground		

Table 7-1. Serial Port Pinout.





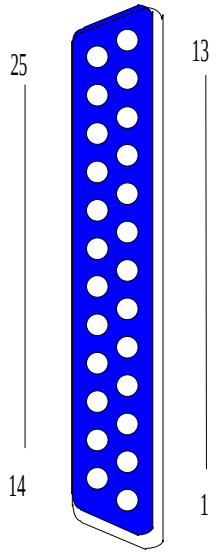
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Parallel Port

The DB-25 LPT1 parallel port connector is an Output-Only device defined as:

Pin	Signal	Pin	Signal
1	Strobe	14	Auto line feed
2	DB0	15	Error
3	DB1	16	Initialize printer
4	DB2	17	Select in
5	DB3	18	Signal ground
6	DB4	19	Signal ground
7	DB5	20	Signal ground
8	DB6	21	Signal ground
9	DB7	22	Signal ground
10	Acknowledge	23	Signal ground
11	Busy	24	Signal ground
12	Paper end	25	Signal ground
13	Select		

Table 7-2. Parallel Port Pinout.



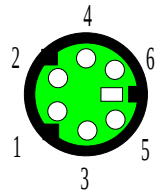
7 7

Keyboard

The keyboard connector is a 6-pin DIN defined as:

Pin	Signal	Pin	Signal
1	Data	4	+5V
2	not used	5	Clock
3	Ground	6	not used

Table 7-3. Keyboard Connector Pinout.



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Speaker Header

The speaker header is located on the EPC-5A circuit board and is defined as:

Pin	Signal	Pin	Signal
1	Reference voltage	2	Speaker tone



Table 7-4. Speaker Header Pinout.

Battery Header

The battery header is located on the EPC-5A circuit board and is defined as:

Pin	Signal	Pin	Signal
1	VBATT	3	Ground
2	(key)	4	Ground

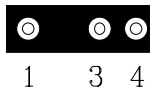


Table 7-5. Battery Header Pinout.

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8. Upgrades

⚠ **CAUTION**
Do not handle the EPC-5A module unless you are in a static-free environment.

Memory

The EPC-5A can be configured for various memory sizes. The 100 MHz EPC-5A memory configurations use SIMMs with the following specifications:

- 72 pin
- fast page mode
- 60 nanosec. (or better)
- single-sided

For 8 MB:	Use 2 each 1M x 36 SIMMs RadiSys P/N 70-0074
For 16 MB:	Use 1 each 4M x 36 SIMMs RadiSys P/N 70-0075
For 32 MB:	Use 2 each 4M x 36 SIMMs RadiSys P/N 70-0075
For 64 MB:	Use 2 each 8M x 36 SIMMs RadiSys P/N 70-0150

The SIMMs used in the EPC-5A are publicly available. Contact RadiSys Technical Support for more information.

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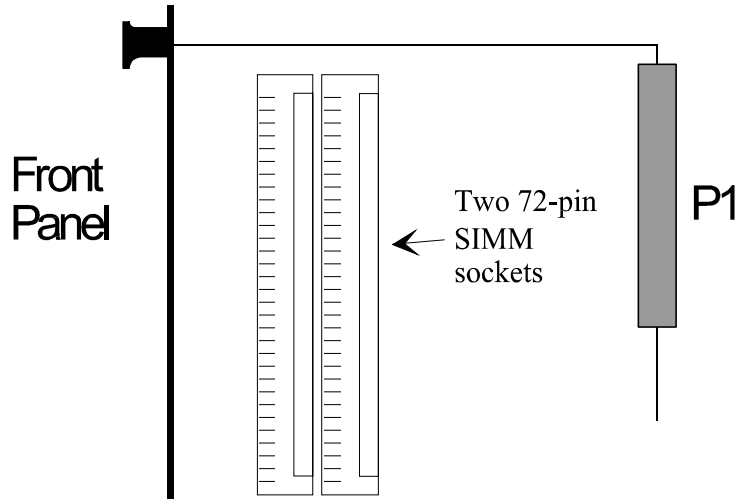


Figure 8-1. SIMM Memory Location.

After upgrading the memory, power up the machine and press F2 to enter the Main BIOS Setup Menu. Verify that the top line of this screen shows the correct amount of memory. Save and reboot. The system reboots and no error messages should be displayed.

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9. Troubleshooting & Error Messages

Troubleshooting

This section deals with problems that you may encounter that do not provide an error message. If an error message is displayed, see the next section of this chapter, Common Error Messages. Always attempt to solve the problem yourself. If you are unable to solve the problem, call RadiSys Technical Support. Make sure you have detailed system configuration available before starting your phone call.

Symptoms	Possible cause(s)	Solution
System appears to boot (evidenced by RUN LED being on, floppy and hard disk being accessed) but provides no video.	Video adapter not fully seated in subplane.	Remove the video adapter. If the subplane is secured to the VMEbus backplane by retaining screws, check for over tightening of the screws. Reinsert the video adapter and verify seating into the subplane.
	Monitor or cable problem.	Verify that the cable pins are not bent and the cable is fully seated in the video adapter. Try the monitor on another system to verify that the monitor is good.
	Video adapter failure.	Call RadiSys Technical Support.
	Subplane failure.	Call RadiSys Technical Support.
	EPC-5A cannot talk to EXM expansion interface.	Call RadiSys Technical Support.

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Symptoms	Possible cause(s)	Solution
System fails at power-up - will not run power-on self-test.	The system is not getting power.	Check the backplane and verify that +5V power is good. Verify that the subplane is fully seated in the VME backplane and the EPC-5A is fully seated in the subplane.
	Hardware failure.	This cannot be diagnosed in the field. Call RadiSys Technical Support.
Serial port(s) do not work.	Bad power.	Verify that backplane +12V and -12V are good.
	Interrupt conflicts	An EXM module is using the same interrupts as COM1 and/or COM2. Verify that no other card in the EPC-5A subsystem is using IRQ3 or IRQ4.
	Port hardware failure.	Call RadiSys Technical Support.
System will not talk across VMEbus.	The VMEbus backplane may not be jumpered correctly.	See the section *Installing the VMEbus Backplane Jumpers*, in Chapter 2.
	More than 1 master may be set to provide Slot-1 functions.	Make sure that only 1 system is configured as the Slot-1 controller and that it is the left-most system in the chassis.
	EPC-5A or subplane may have bent pins.	Remove the EPC-5A and the subplane and verify that no pins are bent. Then reinsert the subplane and the EPC-5A.
	VMEbus interface failure.	Call RadiSys Technical Support.

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Common Error Messages

This section contains a summary of error and warning messages alphabetized by message text. These are messages generated by the BIOS and MS-DOS that may be related to your hardware configuration.

BAD OR MISSING COMMAND INTERPRETER

Problem: The DOS operating system cannot find the Command line interpreter.

Solution(s): Either COMMAND.COM is not present at the specified (or default) directory level of the boot disk or the "SHELL=" statement in your CONFIG.SYS lists the file incorrectly (wrong directory or misspelled).

CMOS CHECKSUM INVALID

Problem: Something in the nonvolatile CMOS RAM is incorrect.

Solution(s): Run the BIOS setup program to determine what is wrong, and correct it. If the error occurs repeatedly, the EPC-5A's battery has failed.

CMOS RAM ERROR, CHECK BATTERY / RUN SETUP

Problem: Something in the nonvolatile CMOS RAM is incorrect.

Solution(s): Run the BIOS setup program to determine what is wrong, and correct it. If the error occurs repeatedly, the EPC-5A's battery has failed.



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DISK BOOT FAILURE, INSERT SYSTEM DISK AND PRESS ENTER

Problem: No boot disk could be found.

Solution(s): This could occur in several different ways.

Your hard disk may not have been partitioned into logical drive(s). PCs look for logical drives to boot from. Hard disks are physical drives; partitions are logical drives.

Your BIOS setup screen has all disks disabled, or your hard disk is disabled and no floppy diskette is inserted in the A: drive. Run the BIOS setup program and verify that all disk parameters are correct. If they are, insert a bootable floppy disk in the A: drive and press enter. If a hard disk is present, verify that it is properly partitioned and formatted as a system disk and one partition is set active.

DISKETTE DRIVES OR TYPES MISMATCH ERROR - RUN SETUP

Problem: The floppy diskette(s) installed in the system do not match the configuration information listed in the BIOS setup screen. This may be due to incorrect entries in the BIOS setup screen or one or both drives may not be responding at power-up.

Solution(s): Run the BIOS setup program. Make sure the BIOS setup entries relating to floppy drives correctly reflect the attached floppy drives. If you are using the EXP-MX module, drive A should be set to "1.4M". If no second floppy drive is attached, set drive B to NONE. If you have no floppy drives, both drive A and drive B should be set to none.

Also, verify that all floppy drives are firmly connected (via subplane or ribbon cable) and that each drive has power.

If you are using an external floppy drive via a front panel connector, verify that the end of the ribbon cable is not shorting to the front panel and pin 1 on the front panel connector is connected to pin 1 on the drive.

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ERROR INITIALIZING HARD DISK 0

Problem: The IDE disk controller for drive C cannot be initialized.

Solution(s): If you are using an EXP-MX mass storage module, ensure that the module is fully seated in the subplane and that the +5V and +12V LEDs indicate that the module has power.

If you are using the EXM-9 to cable to an external disk, make sure that you have power to the disk, the ribbon cable is good and correctly oriented, and that the end of the ribbon cable is not shorting to the front panel of the EXM-9.

If you are not using an IDE drive, enter the BIOS setup program. Press F3 to enter the Fixed Disk Menu. Change the drive type to match the device being used.

EXM CONFIGURATION ERROR

Problem: The EXMs installed (or not installed) do not match the configuration information in the CMOS Setup.

Solution(s): Run the BIOS setup program. Enter the EXM menu. Verify the information listed on the screen, save any changes and reboot.

If necessary, refer to the section *EXM Setup Screen* and/or your EXM manual(s) for more details.

FLOPPY DISK CNTRLR ERROR OR NO CNTRLR PRESENT

Problem: The configuration information in the BIOS setup says that one or more floppy disk drives are expected, but a floppy disk controller could not be found.

Solution(s): If you have no floppy diskette drives, enter the setup program and set both floppy drives to “NONE.”

If you are using an EXP-MX module, verify that the EPC-5A, subplane, and EXP-MX are properly seated, and check the LEDs on the front panel of the EXP-MX to ensure that both the +5V and +12V supplies are available.

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GENERAL FAILURE READING DRIVE ...

Problem: This almost always indicates the presence of an unformatted hard disk partition or diskette.

Solution(s): Format the partition or diskette using the utilities supplied by your operating system.

INVALID DRIVE SPECIFICATION

Problem: You are trying to access a logical drive (e.g., A:, B:, ...) that is not known to the operating system.

Solution(s): Select a different logical drive. If you are trying to access a hard disk, you may need to create the logical partition.

KEYBOARD ERROR OR NO KEYBOARD PRESENT

Problem: This message indicates that the system did not recognize a keyboard at power-up or you pressed a key during the power-on self test.

Solution(s): Check the integrity of the keyboard connector.

If you think you pressed a key during power-up, reboot the system using the front panel reset button.

Some keyboards are designed with a switch (or jumper) to allow the user to configure the keyboard for use with an AT machine or an XT machine. If this is the case with your keyboard, verify that the switch is in the AT position.

The keyboard may not be a valid PC/AT keyboard (e.g., it is a PC/XT-only or PS/2 keyboard). If this is the case, replace the keyboard with a PC/AT style keyboard.

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MEMORY PARITY INTERRUPT AT ...

Problem: This could be a software error (reading a nonexistent memory area) or a true hardware failure.

Solution(s): Attempt to repeat the error. If the error occurs during the execution of your own proprietary software, verify that the memory location specified in your software is valid.

MISSING OPERATING SYSTEM

Problem: Although the system could read the hard disk and find the active partition, the operating system files could not be found.

Solution(s): This can be caused by using a drive type number in the Fixed Disk Menu that does not match the type number used to format the hard disk. Run the BIOS setup program. Enter the Fixed Disk Menu. Select the correct drive type to match the type used to format the disk originally. Save the changes and reboot the system.

This can also occur if the hard disk is partitioned and one partition is set active, but the partition was not formatted.

NON-SYSTEM DISK OR DISK ERROR
REPLACE AND PRESS ANY KEY WHEN READY

Problem: This is caused by an attempt to boot from a disk or diskette that is not recognized as a system disk; that is, no system files exist on the disk or diskette.

Solution(s): Most often it results when you reboot with a non-system diskette in the floppy drive, because the BIOS always attempts to boot from the floppy drive if a diskette is installed.

If you are trying to boot from the hard disk, make sure that you do not have a diskette in the A: drive and press any key.

If you are trying to boot from floppy, insert a known good bootable system diskette in the A: drive and press any key.



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NOT READY READING DRIVE ...

Problem: This is usually caused by not fully inserting a diskette into the floppy drive.

Solution(s): Eject the floppy diskette and reinsert making sure that the diskette seats completely into the floppy drive.

PARITY ERROR IN SEGMENT ...

Problem: This could be a software error (reading a nonexistent memory area) or a true hardware failure.

Solution(s): Attempt to repeat the error. If the error occurs during the execution of your own proprietary software, verify that the memory location specified in your software is valid.

PRESS A KEY TO REBOOT

Problem: A C: drive partition exists but is not set active.

Solution(s): Run your operating system disk partitioning program (like FDISK) and set the primary partition active.

REAL TIME CLOCK ERROR - RUN SETUP

Problem: The battery-backed TOD clock is incorrect.

Solution(s): Run the BIOS setup program to determine what is wrong, and correct it. If the error occurs repeatedly, the EPC-5A's battery has failed.

TESTING VME (VXI) INTERFACE FAILED

Problem: The BIOS Post has detected that the VME or VXI registers are invalid.

Solution(s): Attempt to repeat the error. Check all hardware and cable connections. If the problem persists, there is a hardware error. Contact RadiSys Technical Support.

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Boot Failures

The System BIOS attempts to display an error message on the display and halts when it encounters the following error conditions:

1. Fixed disk error
   Causes :
   - No drive connected
   - Configured for 0 cylinders
   - Controller reset failed
   - Drive not ready
   - Track 0 seek timed out
   - Drive initialization failed
   - Drive recalibration failed
   - Last track seek failed
2. Timer error
   Causes :
   - System timer (0) failed
3. I/O chip error
   Causes :
   - I/O conflicts exist for serial and parallel ports, hard disk (any or all)
4. Other error
   Causes :
   - IRQ conflicts

The System BIOS *prints* an error message *but does not halt* when it encounters the following error conditions:

1. RTC error
   Causes :
   - RTC lost power
2. CMOS error
   Causes :
   - RTC battery failed
   - CMOS checksum failed
3. Configuration error
   Causes :
   - Previous POST execution was incomplete

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Phoenix™ NuBIOS Checkpoints

The Phoenix™ NuBIOS writes a number of checkpoints to I/O port 80h just before they are executed. Note that the execution order of the POST tests generally follows the order listed in the tables below, but not exactly. In addition, some checkpoints are not implemented, but the entire table is presented here for completeness.

Beep Code	Post Code	Checkpoint Description
	02h	Verify Real Mode
	04h	Get CPU type
	06h	Initialize system hardware
	08h	Initialize system controller registers with initial POST values
	09h	Set in POST flag
	0Ah	Initialize CPU registers
	0Bh	Enable CPU cache
	0Ch	Initialize cache to initial POST values
	0Eh	Initialize I/O
	0Fh	Initialize localbus IDE
	11h	Load alternate registers with initial POST values
	12h	Jump to UserPatch0
	14h	Initialize keyboard controller
1-2-2-3	16h	BIOS ROM checksum
	18h	8254 timer initialization
	1Ah	8237 DMA controller initialization
	1Ch	Reset programmable interrupt controller
1-3-1-1	20h	Test DRAM refresh
1-3-1-3	22h	Test 8742 keyboard controller
	24h	Set ES segment to register to 4GB
	28h	Autosize DRAM
	2Ah	Clear 512KB base RAM
1-3-4-1	2Ch	Test 512KB base address lines
1-3-4-3	2Eh	Test low byte of 512KB base memory
1-4-1-1	30h	Test high byte of 512KB base memory
	32h	Test CPU bus-clock frequency
	34h	Test CMOS RAM
	35h	Initialize alternate system controller registers
	36h	Warmstart shutdown entry point
	37h	Reinitialize the system controller

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	38h	Shadow system BIOS ROM
	39h	Reinitialize the cache
	3Ah	Autosize cache
	3Ch	Configure advanced system controller registers
	3Dh	Load alternate registers with CMOS values
	40h	Set initial CPU speed
	42h	Initialize interrupt vectors
	44h	Initialize BIOS interrupts
2-1-2-3	46h	Check ROM copyright notice
	47h	Initialize manager for PCI Option ROMs
	48h	Check video configuration against CMOS
	49h	Initialize PCI bus and devices
	4Ah	Initialize all video adapters in system
	4Bh	Display QuietBoot™ screen
	4Ch	Shadow video BIOS ROM
	4Eh	Display copyright notice
	50h	Display CPU type and speed
	51h	Initialize EISA board
	52h	Test keyboard
	54h	Set key click if enabled
	56h	Enable keyboard
2-2-3-1	58h	Test for unexpected interrupts
	5Ah	Display prompt “Press F2 to enter SETUP”
	5Ch	Test RAM between 512KB and 640KB
	60h	Test extended memory
	62h	Test extended memory address lines
	64h	Jump to UserPatch1
	66h	Configure advanced cache registers
	68h	Enable external and CPU caches
	6Ah	Display external cache size
	6Ch	Display shadow message
	6Eh	Display non-disposable segments
	70h	Display error messages
	72h	Check for configuration errors
	74h	Test real-time clock
	76h	Check for keyboard errors
	7Ah	Test for key lock on
	7Ch	Set up hardware interrupts vectors
	7Eh	Test coprocessor if present
	80h	Disable onboard I/O ports



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	82h	Detect and install external RS232 ports
	84h	Detect and install external parallel ports
	85h	Initialize PNP ISA devices
	86h	Re-initialize onboard I/O ports
	88h	Initialize BIOS Data Area
	8Ah	Initialize Extended BIOS Data Area
	8Ch	Initialize floppy controller
	90h	Initialize hard disk controller
	91h	Initialize localbus hard disk controller
	92h	Jump to UserPatch2
	93h	Build MPTABLE for multiprocessor boards
	94h	Disable A20 address line
	95h	Install CDROM for boot
	96h	Clear huge ES segment register
1-2	98h	Search for option ROMs (beep for bad checksum)
	9Ah	Shadow option ROMs
	9Ch	Set up power management
	9Eh	Enable hardware interrupts
	A0h	Set time of day
	A2h	Check keylock
	A4h	Initialize typematic rate
	A8h	Erase F2 prompt
	AAh	Scan for F2 keystroke
	ACh	Enter SETUP
	AEh	Clear in-POST flag
	B0h	Check for errors
	B2h	POST done--prepare to boot operating system
	B4h	One beep
	B5h	Display MultiBoot menu
	B6h	Check password (optional)
	B8h	Clear global descriptor table
	BCh	Clear parity checkers
	BEh	Clear screen (optional)
	BFh	Check virus and backup reminders
	C0h	Try to boot with INT19

Table 9-1. Phoenix™ NuBIOS Checkpoint Codes.

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Beep Code	Post Code	Checkpoint Description
	D0h	Interrupt handler error
	D2h	Unknown interrupt error
	D4h	Pending interrupt error
	D6h	Initialize option ROM error
	D8h	Shutdown error
	DAh	Extended block move
	DCh	Shutdown 10 error

Table 9-2. Phoenix™ NuBIOS Auxiliary Checkpoint Codes.

Beep Code	Post Code	Checkpoint Description
	E2h	Initialize the system controller
	E3h	Initialize refresh counter
	E4h	Check for forced flash
	E5h	Check HW status of ROM
	E6h	BIOS ROM is OK
	E7h	Do a complete RAM test
	E8h	Do OEM initialization
	E9h	Initialize interrupt controller
	EAh	Read in bootstrap code
	EBh	Initialize all vectors
	ECh	Boot the flash program
	EDh	Initialize the boot device
	EEh	Boot code was read OK

Table 9-3. Phoenix™ NuBIOS Boot Block Checkpoint Codes.

9 9

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10. Support and Service

In North America

Technical Support

RadiSys maintains a technical support phone line at (503) 615-1100 that is staffed weekdays (except holidays) between 8 AM and 5 PM Pacific time. If you have a problem outside these hours, you can leave a message on voice-mail using the same phone number. You can also request help via electronic mail or by FAX addressed to RadiSys Technical Support. The RadiSys FAX number is (503) 615-1150. The RadiSys E-mail address is ***support@radisys.com***. If you are sending E-mail or a FAX, please include information on both the hardware and software being used and a detailed description of the problem, specifically, how the problem can be reproduced. We will respond by E-mail, phone or FAX by the next business day.

Technical Support Services are designed for customers who have purchased their products from RadiSys or a sales representative. If your RadiSys product is part of a piece of OEM equipment, or was integrated by someone else as part of a system, support will be better provided by the OEM or system vendor that did the integration and understands the final product and environment.

World Wide Web

RadiSys maintains an active site on the world wide web. The home-page URL is ***http://www.radisys.com*.** The site contains current information about the company and locations of sales offices, describes new and existing products, provides contacts for sales, service, and technical support information, and offers news about the company. You can also send E-mail to RadiSys using the web site. All requests for sales, service, and technical support information receive a prompt response.

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Repair Services

Factory Repair Service is provided for all RadiSys products. Standard service for all RadiSys products covers factory repair with customers paying shipping to the factory and RadiSys paying for return shipment. Overnight return shipment is available at customer expense. Normal turn-around time for repair and re-certification is five working days.

Quick Exchange services (immediate shipment of a loaner unit while the failed product is being repaired) or other extra-cost services can be arranged, but need to be negotiated in advance to allow RadiSys to pool the correct product configurations. RadiSys does not maintain a general “loaner” pool. Units are available only for customers that have negotiated this service in advance.

RadiSys does not provide a fixed-price “swap-out” repair service, as customers have indicated that issues of serial number tracking and version control make it more convenient to receive their original products back after repair.

Warranty Repairs

Products under warranty (see warranty information in the front of this manual) will have manufacturing defects repaired at no charge. Products sent in for warranty repair that have no faults will be subject to a recertification charge. Extended Warranties are available and can be purchased at a standard price for any product still under warranty. RadiSys will gladly quote prices for Extended Warranties on products whose warranties have lapsed; contact the factory if this applies.

Customer induced damage (resulting from misuse, abuse, or exceeding the product specifications) is not covered by the standard product warranty.

Non-Warranty Services

There are several classes of non-warranty service. These include repair of customer induced problems, repairs of failures for products outside the warranty period, recertification (functional testing) of a product either in or out of warranty, and procurement of spare parts.

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All non-warranty repairs are subject to service charges. RadiSys has determined that pricing repairs based on time and materials is more cost-effective for the customer than a flat-rate repair charge. When product is received, it will be analyzed and, if appropriate, a cost estimate will be communicated to the customer for authorization. After the customer authorizes the repair and billing arrangements have been made, the product will be repaired and returned to the customer.

A recertification service is provided for products either in or out of warranty. This service will verify correct operation of a product by inspection and testing of the product with standard manufacturing tests. There is a product-dependent charge for recertification.

There are only a few components that are generally considered field-repairable, but, because RadiSys understands that some customers want or need the option of repairing their own equipment, all components are available in a spares program. There is a minimum billing charge associated with this program.

Arranging Service

To schedule service for a product, please call RadiSys RMA Dispatcher directly at (800) 256-5917. Have the product model and serial numbers available, along with a description of the problem. An RMA Dispatcher will issue a Returned Materials Authorization (RMA) number, a code number by which we track the product while it is being processed. Once you have received the RMA number, follow the instructions of the RMA Dispatcher and return the product to us, freight prepaid, with the RMA number clearly marked on the exterior of the package. If possible re-use the original shipping containers and packaging. In any case, be sure you follow good ESD-control practices when handling the product, and ensure that anti-static bags and packing materials with adequate padding and shock-absorbing properties are used.

Ship the product, freight prepaid, to:

Product Service Center
RadiSys Corporation
5445 NE Dawson Creek Drive
Hillsboro, Oregon 97124

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When shipping the product, include the following information: return address, contact names and phone numbers in purchasing and engineering, and a description of the suspected problem. Any ancillary information that might be helpful with the debugging process will be appreciated.

Other Countries

Contact the sales organization from which you purchased your RadiSys product for service and support.

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Appendix A:Chip Set & I/O Map

The following defines the I/O addresses decoded by the EPC-5A. It does not define addresses that might be decoded by EXMs and the EXP-MX.

First (8-bit) DMA controller: R400 chip emulating 8237 of PC/AT		
I/O Addr	Functional group	Usage
000	DMA	Channel 0 address
001		Channel 0 count
002		Channel 1 address
003		Channel 1 count
004		Channel 2 address
005		Channel 2 count
006		Channel 3 address
007		Channel 3 count
008		Command/status
009		DMA request
00A		Command register (R)
		Single-bit DMA req mask(W)
00B		Mode
00C		Set byte pointer (R)
		Clear byte pointer (W)
00D		Temporary register (R)
		Master clear (W)
00E		Clear mode reg counter (R)
		Clear all DMA req mask(W)
00F		All DMA request mask

First Interrupt controller: R400 emulating 8259 of PC/AT		
I/O Addr	Functional group	Usage
020	Interrupt controller 1	Port 0
021		Port 1

R400 controller:		
I/O Addr	Functional group	Usage
024	R400 Controller	Data register
026		Index register

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Counter-Timer functions: R400 emulating 8254 of PC/AT		
I/O Addr	Functional group	Usage
040	Timer	Counter 0
041		Counter 1
042		Counter 2
043		Control (W)

Keyboard Port: Intel 8242 emulating 8742 of PC/AT		
I/O Addr	Functional group	Usage
060	Keyboard controller	Data I/O register
061	NMI status	NMI status
064	Keyboard controller	Command/status register

Time-of-Day Clock: R400 emulating MC6818 of PC/AT			
I/O Addr	Functional group	Usage	
070	Real-time clock	RTC index reg / NMI enable	
071		RTC data register	
		0	seconds
		1	seconds alarm
		2	minutes
		3	minutes alarm
		4	hours
		5	hours alarm
		6	day of week
		7	date of month
		8	month
		9	year
		A	status A
		B	status B
		C	status C
		D	status D
		E	RAM
		...	
		3F	RAM

DMA Page Registers: R400 emulating 74LS612 of PC/AT		
I/O Addr	Functional group	Usage
081	DMA	Channel 2 page register
082		Channel 3 page register
083		Channel 1 page register
087		Channel 0 page register
089		Channel 6 page register
08A		Channel 7 page register
08B		Channel 5 page register
08F		Refresh page register

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Second Interrupt Controller: R400 emulating 8259 of PC/AT		
I/O Addr	Functional group	Usage
0A0	Interrupt controller 2	Port 0
0A1		Port 1

Second (16-bit) DMA Controller: R400 emulating 8237 of PC/AT		
I/O Addr	Functional group	Usage
0C0	DMA	Channel 4 address
0C2		Channel 4 count
0C4		Channel 5 address
0C6		Channel 5 count
0C8		Channel 6 address
0CA		Channel 6 count
0CC		Channel 7 address
0CE		Channel 7 count
0D0		Command/status
0D2		DMA request
0D4		Command register (R)
		Single-bit DMA req mask(W)
0D6		Mode
0D8		Set byte pointer (R)
		Clear byte pointer (W)
0DA		Temporary register (R)
		Master clear (W)
0DC		Clear mode reg counter (R)
		Clear all DMA req mask (W)
0DE		All DMA request mask

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Coprocessor Interface: On the EPC-5A, 486's built-in coprocessor replaces the 80287 of PC/AT		
I/O Addr	Functional group	Usage
0F0	Coprocessor	Clear coprocessor busy
0F1		Reset coprocessor

Serial I/O (ComB) Port: TI 16C452 emulates PC/AT chipset		
I/O Addr	Functional group	Usage
2F8	COM2 serial port	Receiver/transmitter buffer
		Baud rate divisor latch (LSB)
2F9		Interrupt enable register
		Baud rate divisor latch (MSB)
2FA		Interrupt ID register
2FB		Line control register
2FC		Modem control register
2FD		Line status register
2FE		Modem status register

Parallel I/O (LPT1) Port: TI 16C452 emulates PC/AT chipset		
I/O Addr	Functional group	Usage
378	LPT1 parallel port	Printer data register
379		Printer status register
37A		Printer control register

Serial I/O (ComA) Port: TI 16C452 emulates PC/AT chipset		
I/O Addr	Functional group	Usage
3F8	COM1 serial port	Receiver/transmitter buffer
		Baud rate divisor latch (LSB)
3F9		Interrupt enable register
		Baud rate divisor latch (MSB)
3FA		Interrupt ID register
3FB		Line control register
3FC		Modem control register
3FD		Line status register
3FE		Modem status register

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EPC-5A Memory Mapping Registers: No PC/AT equivalent		
I/O Addr	Functional group	Usage
8130	VME and misc control	VME map WA21-16
8132		Alias of 8130
8134		Alias of 8130
8136		Alias of 8130
8140		ID low
8141		ID high
8142		Device type low
8143		Device type high
8144		Status/control low
8145		Status/control high
8146		Slave offset low
8147		Slave offset high
8148		Protocol low
8149		Protocol high
814A		Response low
814B		Response high
814C		Message high low
814D		Message high high
814E		Message low low
814F		Message low high
8150		VME map WA31-24
8151		VME modifier
8152		VME interrupt state
8153		VME interrupt enable
8154		VME event state
8155		VME event enable
8156		Module status/control
815F		VME interrupt generator

Refer to Chapter 6 for more information about VMEbus registers.

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NOTES

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Appendix B:Interrupts and DMA Channels

B B

Interrupts

The assignment of interrupts for the EPC-5A is shown in the following table:

NMI	DRAM parity error, EXM expansion interface I/O channel check
IRQ0	timer
IRQ1	keyboard
IRQ2	IRQ8 - IRQ15 cascade through IRQ2
IRQ3	COM B serial port
IRQ4	COM A serial port
IRQ5	unassigned
IRQ6	usually needed for floppy disk controller
IRQ7	LPT1 parallel port
IRQ8	clock
IRQ9	unassigned
IRQ10	VME interrupt/event
IRQ11	unassigned
IRQ12	unassigned
IRQ13	coprocessor
IRQ14	used by optional IDE disk controller
IRQ15	unassigned

Table B-1. EPC-5A Interrupts.

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B B

DMA Channels

The assignment of DMA channels for the EPC-5A is shown in the following table.

0	unassigned (8-bit)
1	unassigned (8-bit)
2	usually needed for floppy disk (8-bit)
3	usually needed for SCSI disk (8-bit)
4	(Channel 0 - Channel 3 cascade through Channel 4)
5	unassigned (16-bit)
6	unassigned (16-bit)
7	unassigned - not connected to EXM expansion interface (16-bit)

Table B-2. EPC-5A DMA Channels.

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Appendix C: Flash Boot Device

C C

The system BIOS is based on the Phoenix™ NuBIOS version 4.05 implemented as a Flash BIOS using the Intel 28F004BV-T SmartVoltage Boot Block Flash Device (hereafter referred to as the Flash Boot Device or FBD). System BIOS code and data reside in the 16KB boot block, parameter block #1, parameter block #2 (CMOS data), and the 96KB main block (#4). Additional BIOS extensions are stored in the uppermost 128KB main block (#3). The lower 256KB main block #1 is used for application storage. The System BIOS is shadowed and write-protected at F0000h through FFFFFh (64KB) upon any system reset (warm boot, shutdown, power-up or "reset button" reset).

The boot block is protected against accidental writes by a jumper. This jumper (JP1, 5-6, BB_ENB) is provided on the board should a code change to the boot block become necessary.

Main blocks #1, #3, #4 and both parameter blocks are protected against accidental writes by a write enable bit in the R400EX accessible by the System BIOS. Jumper JP1, 7-8 also protects the FBD.

An INT15 Flash Control API interface can be used to control the write protection of the FBD blocks.

A "force recovery" jumper (FRC_UPDT) is provided. This jumper is readable by the boot block and can force the boot block to initiate a recovery sequence should the other methods of initiating the sequence become inaccessible (for example, the system BIOS becomes corrupted such that the system cannot boot to MS-DOS™).

The system's BIOS allows booting without a keyboard attached and is configured to not halt if the previous boot has failed.

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C C

The Flash Boot Device is organized according to the following diagram:

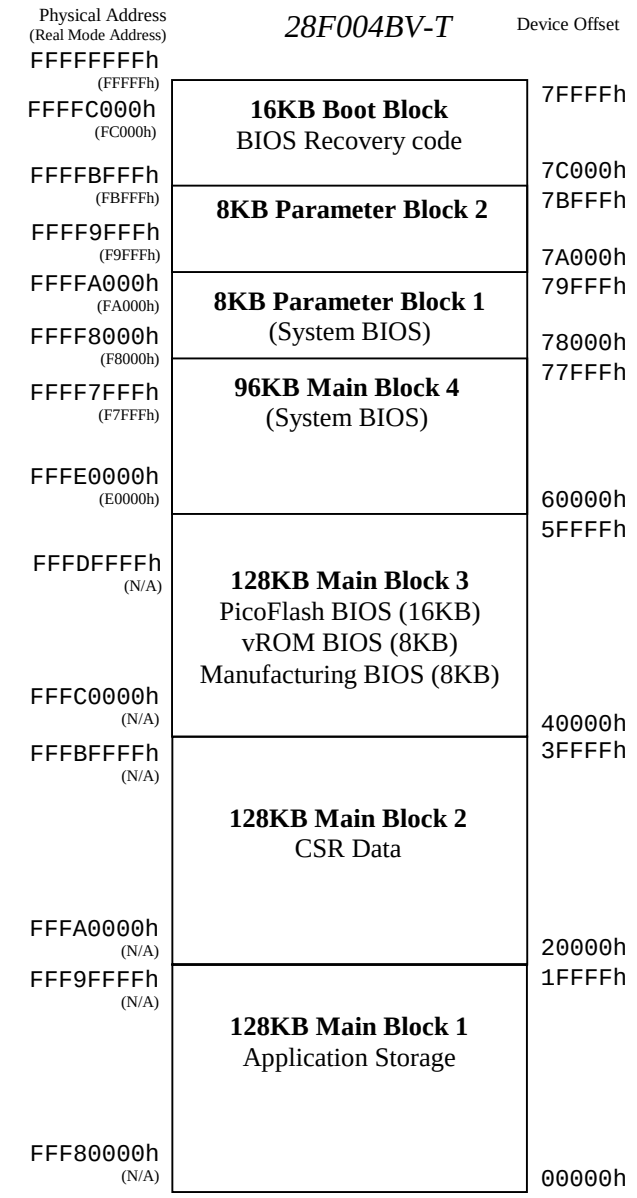


Figure C-1. Flash Boot Device Memory Map.

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The following table describes the exact sizes and placement of the various code and data objects present in the FBD:

Object Name	FBD Offset	Object Size	Write Enable
Boot and Recovery Code	7C000h	16KB	JP1 jumper (BB_ENB)
CMOS data	78000h	8KB	JP1 jumper (BB_ENB)
System BIOS	60000h	104KB	JP1 jumper (BB_ENB)
PicoFlash BIOS Extension	50000h	16KB	JP1 jumper (BB_ENB)
vROM BIOS Extension	48000h	8KB	JP1 jumper (BB_ENB)
Mfg. BIOS Extension	40000h	8KB	In system controller
Unused	20000h	128KB	Always enabled
Unused	0h	< 1KB	In system controller

Table C-1. FBD Object Placement.

Flash Boot Device Reflashing

The EPC-5A System BIOS is updated by using a special boot diskette that contains code to perform the update as well as the System BIOS image itself. The floppy update mechanism is standard to the Phoenix NuBIOS and requires that a standard PC floppy diskette drive be installed in the system. References in this section to "MS-DOS" refer to MS-DOS® 6.22 or the Windows® 95 command line interface available during the boot process before the Graphical User Interface (GUI) is started. There is no native reflashing support for other protected mode operating systems such as Windows NT®, OS/2®, QNX®, etc. Reflashing on these operating systems must be accomplished by using the recovery process outlined below or by first booting to MS-DOS via floppy or multi-boot capability and executing PHLASH.EXE from a real mode MS-DOS environment.

The process of reflashing is defined as an *update* if the System BIOS is not corrupt and can be executed.

The process of reflashing is defined as a *recovery* if the System BIOS is corrupt or the force recovery jumper is installed or the user selected to update the System BIOS via Setup. System BIOS corruption is detected by calculating an 8-bit checksum over the area occupied by System BIOS code (main block #4 and both parameter blocks).

Images suitable for update or recovery use 256KB absolute binary format (8-bit data, little endian byte ordering) files.

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C C

The update process occurs as a self-hosted FBD update when the system can boot to MS-DOS. The Phoenix update program, PHLASH.EXE, may be executed on the EPC-5A after it has booted to MS-DOS. The user may initiate the update by changing to the drive containing the PHLASH.EXE and executing it on the EPC-5A. Note that the PHLASH.EXE program can only be executed from MS-DOS (and without MS-DOS memory managers installed) due to its use of protected mode memory access routines.

When the recovery process is initiated, the boot block proceeds with a floppy update assuming that a floppy diskette drive is connected. The user is then prompted by speaker beeps (one long followed by two short) to insert the special BIOS Update diskette in the floppy diskette drive. If a floppy diskette drive is not currently attached to the system, then the boot block continually (forever) fails in reading the nonexistent drive. The user must power down the system, install a 3.5" 1.44MB floppy diskette drive, and power up the system to continue the recovery process. The diskette is inserted into the floppy diskette drive and the recovery process is automatically initiated after the boot block emits three beeps. There is no video display during the recovery process. The user can determine that the recovery is in progress by a series of beeps. The first set of beeps denotes the reading of the BIOS image file while the last set of beeps denotes the erasing and programming of the FBD. A final long beep denotes that the system is about to reset after having successfully recovered the FBD. The force recovery jumper, JP1 (FRCUPDT), must be removed after the recovery process begins and before the recovery process is complete, otherwise a new recovery sequence is initiated.

The BIOS Update diskette is a special floppy that is created using Phoenix-supplied tools. It is not intended that this diskette be shipped with each EPC-5A, but only when the customer requires a System BIOS update.

In any of the above situations, the FBD is not actually erased and programmed if the BIOS Update diskette is not inserted in the floppy diskette drive. Only the programs on the diskette contain the actual code that performs the recovery. Therefore, if the user accidentally selects the "Update BIOS and Exit" option from the setup screen or accidentally installs the "force recovery" jumper, he may abort the operation by performing a hard reset (power-on or reset button). Four conditions initiate a System BIOS update or recovery:

1. The user runs the PHLASH.EXE program from MS-DOS on the EPC-5A, causing a self-hosted update.
2. The user selects "Exit and Update BIOS" from the "Exit" menu in Setup.
3. The "force recovery" jumper (JP1, FRCUPDT) is installed to force a recovery sequence.
4. The System BIOS is corrupt, forcing a recovery sequence.

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The update process is outlined in the following flow chart:

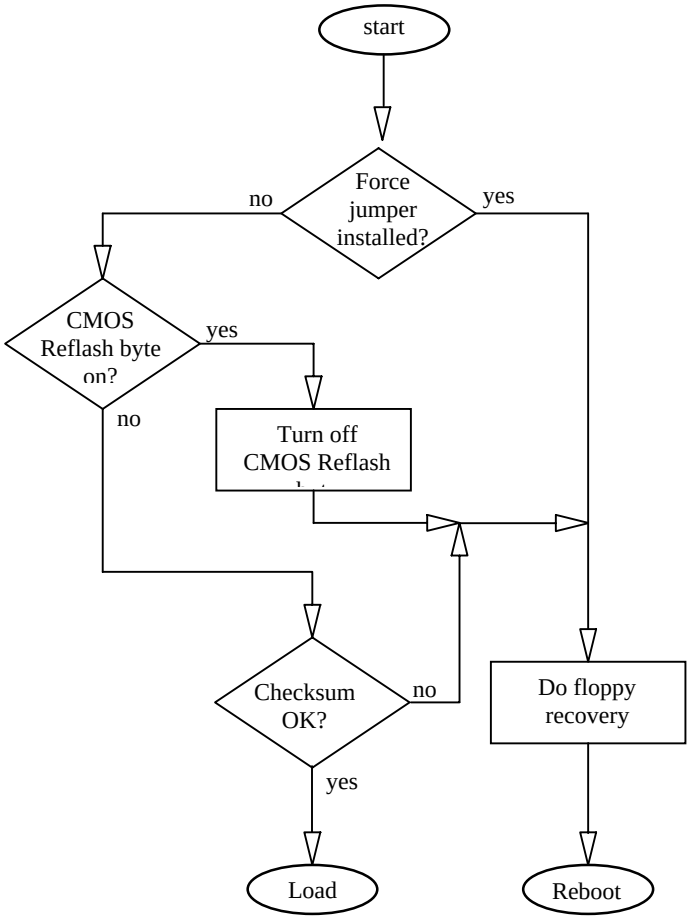


Figure C-2. Flash Boot Device Recovery Mechanism.

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C C

System BIOS recovery operates in detail as follows:

1. The boot block prepares the system hardware (DMA and interrupt controllers, DRAM, etc.) to boot the recovery floppy.
2. The boot block loads the special boot sector on the recovery diskette (written to the diskette by MAKEBOOT.EXE - a special Phoenix-supplied MS-DOS tool) and jumps into it.
3. The boot sector loads MINIDOS.SYS from the floppy and jumps into it. This file implements a very small set of MS-DOS functions that allow reading and writing the FAT file system on the recovery diskette.
4. MINIDOS.SYS then loads PHLASH.EXE, which in turn reads PLATFORM.BIN (customized for the EPC-5A) and BIOS.ROM from the floppy.
5. PHLASH.EXE uses the information and code in PLATFORM.BIN to properly erase and program the FBD with the FBD data in BIOS.ROM.

Note that the recovery floppy diskette cannot be duplicated using a file by file copy method but rather by a sector by sector method (such as MS-DOS' s DISKCOPY.EXE). The latter method also copies the special boot sector required by the recovery process. If the boot sector is not copied correctly or is somehow corrupted, the recovery process does not function correctly. The boot sector is not required, however, for updates.

Reflashing using REFLASH.EXE

The FBD can also be reprogrammed using the RadiSys MS-DOS™ utility REFLASH.EXE. This is a flash read/modify/write utility that is useful for reprogramming the entire FBD or programming a single BIOS extension into the FBD while leaving the rest of it intact. REFLASH.EXE is an MS-DOS™ only program and cannot be executed with any memory managers loaded. REFLASH.EXE version 2.4 and above makes an INT15 call to attempt to control the write protect mechanism for the FBD. The system supports this interface by manipulating the FBD write protection in the chipset.

Reflash reprograms the blocks of the flash device specified on the command line. Files-to-be-flashed are specified by using the **/F=**<filename> /**O**=<offset> [/**P**=<base address>] command line parameters. Files are copied into the target device from low to high memory addresses. Multiple files can be flashed in one **Reflash** invocation, but each file must be followed by an offset and base address parameter.

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The **Reflash** Flash *update* program requires the /F and /O command line arguments; the /P is optional. This information may be displayed by typing **Reflash** with no parameters:

/F=<filename>	File to be flashed; multiple file names may be specified.
/O	Offset to begin flashing; offsets are relative to the lowest address of the flash device; these are ***not*** PC addresses. For example, an offset of zero specifies that flashing is to begin at the very first byte of the flash device.
/C	Erase CSR data if it exists and invalidate CMOS data parameter data. This option is recommended for BIOS reflashes. If the System CMOS data map changes, the CMOS data and its map will be inconsistent.
/S	Suppress rebooting after successful execution. This option is useful for execution from batch files.
/P	Physical base address of the region to be flashed. This parameter does not apply to the EPC-5A. If this switch is omitted, the FBD is the default reflash target.

To *update* the FBD, follow the instructions below:

1. Run: **Reflash /F=[update_file_name] /O=0** to begin the *update*.
2. The following message displays:

   "Update completed successfully. Press any key to reboot."



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C C

User BIOS Extensions

The EPC-5A supports several different boot methods and OSes. In order to boot from VME or flash, it is necessary to first load and execute a BIOS extension. The FBD has an unused 96KB region in main block #3 that lies between the end of the PicoFlash extension and start of the System BIOS that can be used for BIOS extension storage. In order to use this area for BIOS extensions, it is necessary to first program the image into the FBD (using REFLASH.EXE) and then, at run time, copy the BIOS extension from the FBD into DRAM, and have the System BIOS scan that region for BIOS extensions. Multiple BIOS extensions can be programmed into the user block of the FBD. Setup items in the Advanced menu allows the user to select up to 3 BIOS extensions in the FBD and load them into DRAM between C8000h through DFFFFh.

The following is an example of selecting a BIOS extension located in the FBD and shadowing (copy then write protect) it to a location in DRAM.

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PicoCard Flash File System

The EPC-5A contains a BIOS used to access the Flash as a read/write disk. If the user selects shadowing of the PicoCard memory region, the extension is loaded to initialize the disk.

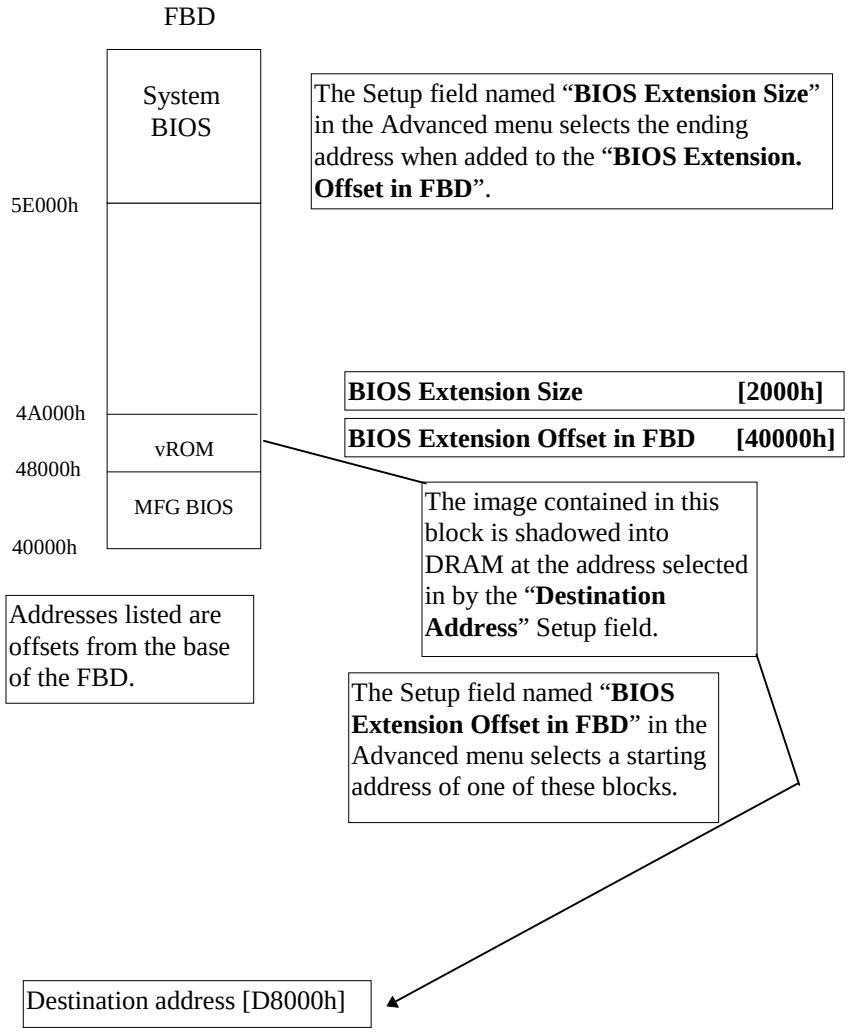


Figure C-3. PicoCard Flash File System.

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NOTES

C C

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Appendix D - PFormat

The EPC-5A supports use of EXM-2A flash cards as Chapter 2 discusses. The supported configurations require the use of appropriate software to provide drivers and a suitable format. This appendix briefly describes the software from RadiSys.



The following is a description of how to bring the RFA up using the PICOFA driver.

Contents of the distribution diskette:

CONFIG.SYS	-	A sample configuration.
PFA2.SYS	-	The device driver.
PFORMAT.EXE	-	The format utility.
PFA2.BIN	-	The BIOS extension.
REFLASH.EXE	-	Utility to flash the BIOS extension.

Step 1: Load the driver (This can be done either as a BIOS extension or as a device driver).

Step 1A (Load as device driver)

Add the line "**DEVICE=PFA2.SYS**" to your **CONFIG.SYS** file.

The jumpers on the board for linear/paged mode and byte/word access to the RFA should be set to byte mode and paged I/O in the BIOS setup menus.

Reboot the system. The driver will load and echo out a message that says which DOS device has been assigned to the RFA. If the setting is not right, the driver will echo a message stating the required RFA mode settings.

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Step 1B (Load as BIOS extension)

Note that if the driver is loaded as a BIOS extension, the system will attempt to boot from the device. This means that the RFA must be formatted and loaded with system files before the driver can be successfully loaded as a BIOS extension.

Flash the device driver into the BIOS:

Using the **REFLASH.EXE** (version 2.0+) utility provided on the diskette, issue the following command:

REFLASH /F=PFA2.BIN /O=4C000

[Note: This step is only necessary if the FBD was changed. The EPC-30 comes default from the factory with this extension installed.] When this process successfully completes, the Picoflash device driver will have been transferred into the 16KB area of memory from 0x4C000 - 0x4FFFF.

Inform the setup menu of how to load the extension:

Now reboot the machine and go into setup (by hitting the F2 key at boot time), and enter the 'Embedded Features' menu. In this menu, one of the three Embedded Shadow Regions, specify the "Offset of BIOS extension in FBD" as 0x4C000, and the BIOS extension size as 04000.

Next, the "Destination Address" needs to be specified. Depending on your particular system configuration, this address may vary. The BIOS extension uses a 16KB I/O window from 0xD4000 to 0xD7FFF. If there are no other extensions installed, use 0xD8000 as your "Destination Address" which will load the BIOS extension into the 16KB window from 0xD8000 to 0xDBFFF.

Final reboot:

Finally, now that the BIOS extension is properly flashed, and the BIOS setup menu knows how to position it, reboot the machine one more time. During this next boot cycle, the BIOS extension for the Picoflash should be loaded at 0xD8000.

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Step 2: Format the drive

Assuming that the driver loaded successfully (either as a device driver or as a BIOS extension), run the **PFORMAT.EXE** utility as follows:

PFORMAT D: /C /V

The /C confirms the format, and the /V switch says to put a volume label on the drive. When the format completes, give the drive a volume label. This should complete the process of making the RFA into a Flash File System. If you are going to use the RFA as a bootable device, the system must be transferred to the RFA device. This can be done by using the DOS 'SYS' command.

The RFA should now be set up for use as a DOS Flash File System. The standard DOS copy, delete, and other utilities for file creation/modification should function correctly.



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NOTES



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Appendix G: Glossary

— A —

Access Time: A factor in measurement of a memory storage device's operating speed. It is the amount of time required to perform a read operation. More specifically, it is the period of time between which the memory receives a read command signal and the time when the requested data becomes available to the system data bus.

Address: A number that identifies the location of a word in memory. Each word in a memory storage device or system has a unique address. Addresses are always specified as a binary number, although octal, hexadecimal, and decimal numbers are often used for convenience.

Advanced Power Management (APM 1.1): A software interface specification that allows operating system device drivers to control the power management functionality of a PC.

American National Standards Institute (ANSI): An organization dedicated to advancement of national standards related to product manufacturing.

AT Bus Attachment (ATA): An interface definition for PC peripherals. See IDE.

Autotype: A convenient method of IDE device detection whereby the system BIOS queries the IDE device to obtain operational parameters. If the device supports autotype, this information is passed to the BIOS where it is used to automatically configure the drive controller.

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— B —

Basic Input/Output System (BIOS): Firmware in a PC-compatible computer that runs when the computer is powered up. The BIOS initializes the computer hardware, allows the user to configure the hardware, boots the operating system, and provides standard mechanisms that the operating system can use to access the PC's peripheral devices.

BIOS Data Area (BDA): BIOS Data Area. A 256 byte block of DRAM starting at address 400H that contains data initialized and used by the System BIOS detailing the system configuration and errors encountered during POST.

BIOS Extension: An object code module that is typically integrated into the FBD or placed into a ROM that is accessible on the peripheral bus (PCI, ISA, etc.) in the address range 0C0000h through 0DFFFFh. BIOS extensions have a pre-defined header format and contain code that is used to extend the capabilities of the System BIOS.

BIOS Image: Information contained in the flash boot device in binary file format consisting of initialization data, setup configuration data, diagnostic sequences, and other instructions necessary to start up a computer and prepare it to load an operating system.

BIOS Recovery: A process whereby an existing, corrupt BIOS image in the flash boot device is overwritten with a new image. Also referred to as a *flash recovery*.

BIOS Update: A process whereby an existing, uncorrupted BIOS image in the flash boot device is overwritten with a new image. Also referred to as a *flash update*.

Bit: A binary digit.

Boot: The process of starting a computer and loading the operating system from a powered down state (cold boot) or after a computer reset (warm boot). Before the operating system loads, the computer performs a general hardware initialization and resets internal registers.

Boot Block: A write-protected 16KB section of the flash boot device located at physical address FFFFC000h to FFFFFFFFh which contains code to perform rudimentary hardware intitialization at system power up. The boot block also contains code to recover the BIOS via floppy disk.

Boot Device: The storage device from which the computer boots the operating system.

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Boot Sequence: The order in which a computer searches external storage devices for an operating system to boot. The boot device must be the first in the boot sequence.

Byte: A group of 8 bits.

— C —

Central Processing Unit (CPU): A semiconductor device which performs the processing of data in a computer. The CPU, also referred to as the microprocessor, consists of an arithmetic/logic unit to perform the data processing, and a control unit which provides timing and control signals necessary to execute instructions in a program.

Chipset: One or more integrated circuits that, along with a CPU, memory, and other peripherals, implements an IBM PC-AT compatible computer. The chipset typically implements a DRAM controller, bus, interface logic, and PC peripheral devices.

Column Address Strobe (CAS): An input signal from the DRAM controller to an internal DRAM latch register specifying the column at which to read or write data. The DRAM requires a column address and a row address to define a memory address. Since both parts of the address are applied at the same DRAM inputs, use of column addresses and row addresses in a multiplexed array allows use of half as many pins to define an address location in a DRAM device as would otherwise be required.

COM Port: A bi-directional serial communication port which implements the RS-232 specification.

Complimentary Metal Oxide Semiconductor (CMOS): A fast, low power semiconductor RAM used to store system configuration data.

Conventional Memory: The first 640 KB of a computer's total memory capacity. If a computer has no extended memory, conventional memory equals the total memory capacity. In typical computer systems, conventional memory can contain BIOS data, the operating system, applications, application data, and terminate and stay resident (TSR) programs. Also called *system memory*.

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CMOS Save and Restore (CSR): A System BIOS feature that allows the user to backup the contents of CMOS RAM (contained within the real time clock) to the BIOS Flash device to be restored later if necessary (such as when the real time clock battery dies).

Cylinders/Heads/Sectors (CHS): A specification of disk drive operating parameters consisting of the number of disk cylinders, disk drive read/write heads, and disk sectors.

— D —

Default: The state of all user-changeable hardware and software settings as they are originally configured before any changes are made.

Disk Operating System (DOS): One or more programs which allow a computer to use a disk drive as an external storage device. These programs manage storage and retrieval of data to and from the disk and interpret commands from the computer operator.

Driver: A software component of the operating system which directs the computer interface with a hardware device. The software interface to the driver is standardized such that application software calling the driver requires no specific operational information about the hardware device.

Dual In-Line Package (DIP): A semiconductor package configuration consisting of a rectangular plastic case with two rows of pins, one row on each lengthwise side.

Dynamic Random Access Memory (DRAM): Semiconductor RAM memory devices in which the stored data will not remain permanently stored, even with the power applied, unless the data are periodically rewritten into memory during a *refresh* operation.

— E —

Electrically Erasable Programmable ROM (EEPROM): Specifically, those EPROMs which may be erased electrically as compared to other erasing methods.

Error Checking and Correction: A feature of the T2 chipset that enables it to detect single or multi-bit errors in DRAM reads and correct single bit errors. This feature requires that all banks of DRAM use x36 (parity) SO DIMMs.

Extended Capabilities Port (ECP): An enhancement of the standard PC parallel port that allows high speed bi-directional data transfers and other features.

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Extended Data Out (EDO): A type of DRAM that allows higher memory system performance since the data pins are still driven when CAS# is de-asserted. This allows the next DRAM address to be presented to the device sooner than with Fast Page Mode DRAM.

Extended Memory: The RAM address space, in a computer so equipped, above the 1 MB level.

Extended System Configuration Data (ESCD): A block of nonvolatile memory that stores information on the devices found and configured by the Plug and Play BIOS.

External Device: A peripheral or other device connected to the computer from an external location via an interface cable.

— F —

Fast Page Mode (FPM): A "standard" type of DRAM that is lower performance than EDO but is less expensive.

Fixed Disk: A hard disk drive or other data storage device having no removable storage medium. Fixed disk storage devices use inflexible disk media and are sealed to prevent data loss due to media surface contamination. Fixed disks generally provide the most storage space for a given cost when compared to semiconductor, tape, and other popular mass storage technologies.

Field Programmable Gate Array (FPGA): A large, general-purpose logic device that is programmed at power-up to perform specific logic functions.

Flash Boot Device (FBD): A flash memory device containing the computer's BIOS. In the EPC-5A, a 512 KB Intel 28F004BV-T semiconductor flash memory containing the system and video BIOS images, the BIOS initializing code and the recovery code which allows self hosted reflashing.

Flash Memory: A fast EEPROM semiconductor memory typically used to store firmware such as the computer BIOS. Flash memory also finds general application where a semiconductor non-volatile storage device is required.

Flash Recovery: See *BIOS Recovery*.

Flash Update: See *BIOS Update*.

Force Update: See *BIOS Recovery*.

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— G —

Gigabyte (GB or GByte): Approximately one billion (US) or one thousand million (Great Britain) bytes. 2^{30} = 1,073,741,824 bytes exactly.

— H —

Hang: A condition where the system microprocessor suspends processing operations due to an anomaly in the data or an illegal instruction.

Header: A mechanical pin and sleeve style connector on a circuit board. The header may exist in either a male or female configuration. For example, a male header has a number and pattern of pins which corresponds to the number and pattern of sleeves on a female header plug.

Hexadecimal (h): A base 16 numbering system using numeric symbols 0 through 9 plus alpha characters A, B, C, D, E, and F as the 16 digit symbols. Digits A through F are equivalent to the decimal values 10 through 15.

Host Bus: The address/data bus that connects the CPU and the chipset.

— I —

Industry Standard Architecture (ISA): A popular microcomputer expansion bus architecture standard. The ISA standard originated with the IBM PC when the system bus was expanded to accept peripheral cards.

Input/Output (I/O): The communication interface between system components and between the system and connected peripherals.

Integrated Drive Electronics (IDE): A hard disk drive/controller interface standard. IDE drives contain the controller circuitry at the drive itself, as compared to the location of this circuitry on the computer motherboard in non-IDE systems. IDE drives typically connect to the system bus with a simple adapter card containing a minimum of on-board logic.

Infra-red Data Association (IRDA or IrDA): A specification for high-speed data communication using infrared drivers and receivers for short-range wireless data transmission.

Interrupt Request (INT): A software-generated interrupt request.

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Interrupt Request (IRQ): In ISAbus systems, a microprocessor input from the control bus used by I/O devices to interrupt execution of the current program and cause the microprocessor to jump to a special program called the *interrupt service routine*. The microprocessor executes this special program, which normally involves servicing the interrupting device. When the interrupt service routine is completed, the microprocessor resumes execution of the program it was working on before the interruption occurred.

Interrupt Service Routine (ISR): A program executed by the microprocessor upon receipt of an *interrupt request* from an I/O device and containing instructions for servicing of the device.

— J —

Jumper: A set of male connector pins on a circuit board over which can be placed coupling devices to electrically connect pairs of the pins. By electrically connecting different pins, a circuit board can be configured to function in predictable ways to suit different applications.

— K —

Kilobyte (KB or KByte): Approximately one thousand bytes. 2^{10} = 1024 bytes exactly.

— L —

Logical Address: The memory-mapped location of a segment after application of the address offset to the physical address.

Logical Block Addressing (LBA): A method the system BIOS uses to reference hard disk data as logical blocks, with each block having a specific location on the disk. LBA differs from the CHS reference method in that the BIOS requires no information relating to disk cylinders, heads, or sectors. LBA can be used only on hard disk drives designed to support it.

— M - N —

Megabyte (MB or MByte): Approximately one million bytes. 2^{20} = 1,048,576 bytes exactly.

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Memory: A designated system area to which data can be stored and from which data can be retrieved. A typical computer system has more than one memory area. See *Conventional Memory* and *Extended Memory*.

— O —

Offset: The difference in location of memory-mapped data between the physical address and the logical address.

Operating System: See *Disk Operating System*.

— P - Q —

PCI Mezzanine Card (PMC): A new standard form factor for PCI add-in modules. PMCs mate with their respective connectors on the motherboard and are secured with screws.

Peripheral Connect Interface (PCI): A popular microcomputer bus architecture standard.

Peripheral Device: An external device connected to the system for the purpose of transferring data into or out of the system.

Personal Computer/Advanced Technology (PC/AT): A popular computer design first introduced by IBM in the early 1980s.

Personal System 2 (PS/2): Computers designed with IBM's proprietary bus architecture known as Micro Channel.

Phase-Locked Loop (PLL): A semiconductor device which functions as an electronic feedback control system to maintain a closely regulated output frequency from an unregulated input frequency. The typical PLL consists of an internal phase comparator or detector, a low pass filter, and a voltage controlled oscillator which function together to capture and lock onto an input frequency. When locked onto the input frequency, the PLL can maintain a stable, regulated output frequency (within bounds) despite frequency variance at the input.

Physical Address: The address or location in memory where data is stored before it is moved as memory remapping occurs. The physical address is that which appears on the computer's address bus when the CPU requests data from a memory address. When remapping occurs, the data can be moved to a different memory location or *logical address*.

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Pinout: A diagram or table describing the location and function of pins on an electrical connector.

Plastic Quad Flat Pack (PQFP): A popular package design for integrated circuits of high complexity.

Power On Self Test (POST): A diagnostic routine which a computer runs at power up. Along with other testing functions, this comprehensive test initializes the system chipset and hardware, resets registers and flags, performs ROM checksums, and checks disk drive devices and the keyboard interface.

Program: A set of instructions a computer follows to perform specific functions relative to user need or system requirements. In a broad sense, a program is also referred to as a software application, which can actually contain many related, individual programs.

Programmable Array Logic (PAL): A semiconductor programmable ROM which accepts customized logic gate programming to produce a desired sum-of-products output function.

— R —

Random Access Memory (RAM): Memory in which the actual physical location of a memory word has no effect on how long it takes to read from or write to that location. In other words, the access time is the same for any address in memory. Most semiconductor memories are RAM.

Read Only Memory (ROM): A broad class of semiconductor memories designed for applications where the ratio of read operations to write operations is very high. Technically, a ROM can be written to (programmed) only once, and this operation is normally performed at the factory. Thereafter, information can be read from the memory indefinitely.

Real Mode: The operational mode of Intelx86 CPUs that uses a segmented, offset memory addressing method. These CPUs can address 1 MB of memory using real mode.

Real Mode Address: A memory address composed of two 16-bit values: a segment address and an offset quantity. A real mode address is constructed by shifting a segment address 4 bits to the left and then adding the offset value. A real mode address is a *physical address*.

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Real Time Clock (RTC): Peripheral circuitry on a computer motherboard which provides a nonvolatile time-of-day clock, an alarm, calendar, programmable interrupt, square wave generator, and a small amount of SRAM. In the EPC-30, the RTC operates independently of the system PLL which generates the internal system clocks. The RTC typically receives power from a small battery to retain the current time of day when the computer is powered down.

Reflashing: The process of replacing a BIOS image, in binary format, in the flash boot device.

Register: An area typically inside the microprocessor where data, addresses, instruction codes, and information on the status on various microprocessor operations are stored. Different types of registers store different types of information.

Register Location: A set up value in the EPC-30 BIOS which defines the base location at which the configuration register block in an ATA PC card may be found.

Reset: A signal delivered to the microprocessor by the control bus, which causes a halt to internal processing and resets most CPU registers to 0. The CPU then jumps to a starting address vector to begin the boot process.

Resident Flash Array (RFA): The RFA represents flash memory that is resident on the hardware platform that is utilized for OS or application purposes.

RS-232: A popular asynchronous bi-directional serial communication protocol. Among other things, the RS-232 standard defines the interface cabling and electrical characteristics, and the pin arrangement for cable connectors.

Row Address Strobe (RAS): An input signal to an internal DRAM latch register specifying the row at which to read or write data. The DRAM requires a row address and a column address to define a memory address. Since both parts of the address are applied at the same DRAM inputs, use of row addresses and column addresses in a multiplexed array allows use of half as many pins to define an address location in a DRAM device as would otherwise be required.

— S —

Segment: A section or portion of addressable memory serving to hold code, data, stack, or other information allowing more efficient memory usage in a computer system. A segment is the portion of a real mode address which specifies the fixed base address to which the offset is applied.

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Serial Port: A physical connection with a computer for the purpose of serial data exchange with a peripheral device. The port requires an I/O address, a dedicated IRQ line, and a name to identify the physical connection and establish serial communication between the computer and a connected hardware device. A serial port is often referred to as a *COM port*.

Shadow Memory: RAM in the address range 0xC000h through 0xFFFFFh used for shadowing. Shadowing is the process of copying BIOS extensions from ROM into DRAM for the purpose of faster CPU access to the extensions when the system requires frequent BIOS calls. Typically, system and video BIOS extensions are shadowed in DRAM to increase system performance.

Single In-Line Memory Module (SIMM): A small, rectangular circuit board on which is mounted semiconductor memory ICs.

Small Outline Dual Inline Memory Module (SO DIMM): A new form factor for memory modules that is smaller and denser than SIMMs.

Standoff: A mechanical device, typically constructed of an electrically non-conductive material, used to fasten a circuit board to the bottom, top, or side of a protective enclosure.

Static Random Access Memory (SRAM): A semiconductor RAM device in which the data will remain permanently stored as long as power is applied, without the need for periodically rewriting the data into memory.

Symmetrically Addressable SIMM: A SIMM, the memory content of which is configured as two independent banks. Each 16-bit wide bank contains an equal number of rows and columns and is independently addressable by the CPU via twin row address strobe registers in the DRAM controller.

SYSCLK: ISAbus System Clock. The ~8.33MHz clock signal present on the ISAbus to which all bus transactions are synchronized.

System Memory: See *Conventional Memory*.

— T —

Terabyte (TB or TByte): Approximately one thousand billion (US) or one billion (Great Britain) bytes. 2^{40} = 1,099,511,627,776 bytes exactly.

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— U —

Universal Serial Bus (USB): A new serial data bus that is intended to eliminate the need for separate serial, parallel, mouse, keyboard, joystick, etc. ports on a PC-compatible. These ports can be conceivably replaced by a few, daisy-chained USB ports, all with identical connectors but capable of much higher throughput, upwards of 12Mbs.

User Editable Drive (UED): A feature of the EPC-5A's Phoenix NuBIOS. When a "User" type hard disk drive setting shows in the IDE Adapter Sub-Menu the BIOS queries the hard disk drive for the purpose of retrieving disk geometry. If the hard disk drive is capable of providing this information, the BIOS uses it to automatically set up the drive for use with the system.

— V —

Video Electronics Standards Association (VESA): A group of hardware and software vendors that define specifications for hardware and software interfaces for a variety of devices.

Video Graphics Adapter (VGA): A popular PC graphics controller and display adapter standard developed by IBM. The standard specifies, among other things, the resolution capabilities of the display device. Display devices meeting the VGA standard must be capable of displaying a minimum resolution of 640 horizontal pixels by 480 vertical pixels with at least 16 screen colors.

— W - X - Y - Z —

Wait State: A period of one or more microprocessor clock pulses during which the CPU suspends processing while waiting for data to be transferred to or from the system data or address buses.

— —

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