



Little Board[™]/PC

Technical Manual

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TRADEMARKS

Little Board, StackPlane, MiniModule, MiniBackplane: Ampro Computers, Inc.

dBASE: Ashton-Tate

Hercules: Hercules Computer Technology

IBM, XT, AT: International Business Machines Corporation

LOTUS 1-2-3: Lotus Development Corp.

MS-DOS, Flight Simulator: Microsoft Corp.

DR DOS: Digital Research, Inc.

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PREFACE

This manual is for integrators and programmers of systems based on the Ampro Little Board/PC single board computer. It contains information on hardware requirements and interconnection, and details of how to program the system. There are five chapters, organized as follows:

- **Chapter 1 Introduction** -- General information pertaining to the Little Board/PC, its major features, and a brief functional description.
- **Chapter 2 Hardware Configuration** -- Descriptions of the external components necessary to construct systems based on the Little Board/PC with floppy and hard disk drives. Included are tables listing the pin outs of each of the board's connectors, board jumper configuration, and considerations and specifications concerning peripheral devices.
- **Chapter 3 -- Software Configuration** An overview of the system features, configuration options, and utilities that are available under the "DOS" (PC-DOS, MS-DOS, or DR-DOS) operating system, including system setup guidelines.
- **Chapter 4 Theory of Operation** -- Detailed technical information on Little Board/PC hardware.
- **Chapter 5 Programmers' Reference** -- Port addresses and other programming considerations for custom programming of the Little Board/PC, including information pertaining to use of the Ampro SCSI/BIOS.

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 SCSICOPY
 SCSIFMT
 SCSIPARK
 SCSITool
 SETWAIT

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CHAPTER 1

INTRODUCTION

1.1 GENERAL DESCRIPTION

The Little Board/PC provides system designers with a highly compact, self-contained, low power, PC-compatible *single board system* that requires no more space than a half height 5-1/4" disk drive. This unique single board system is functionally equivalent to a PC/XT motherboard and three or four expansion cards.

The Little Board/PC is ideally suited for embedded microcomputer applications where PC software and bus compatibility are required, and where low power consumption (4 watts), small size (5.75" x 8" x 1.1", wide temperature range (0-70⁰ C), and high reliability are critical. In addition, its ability to use rugged media like EPROM and nonvolatile RAM instead of disk drives makes the Little Board/PC especially well suited for use in rugged or harsh operating environments.

Typical applications for the Little Board/PC include:

- Data acquisition
- Portable instruments
- Protocol conversion
- Telecommunications
- Security systems
- Vending machines
- Robot and machine control
- Diskless workstations
- Remote data logging
- Point-of-sale terminals
- Network servers
- Distributed processing
- Medical instruments

The Little Board/PC includes a CMOS NEC V40 enhanced 8088-compatible microprocessor, up to 768K bytes of on-board RAM, and a full complement of PC compatible controllers. Peripheral controllers are included for serial, printer, keyboard, speaker, and floppy interfacing. In addition, two industry standard system expansion buses -- a PC Expansion Bus and a Small Computer System Interface (SCSI) -- offer system expansion flexibility.

An expansion connector is provided onboard for Ampro MiniModule expansion boards which attach directly to the Little Board/PC. When installed, a MiniModule fits entirely within the Little Board/PC's outline dimensions.

Standard PC bus plug-in cards can be connected to the Little Board/PC using a ribbon cable from the PC bus expansion connector. The innovative Ampro StackPlaneTM expansion option permits a PC bus card to be mounted parallel to the Little Board/PC without additional hardware. Also available is a compact 2-slot passive backplane, which accommodates two PC bus cards.

Support for SCSI direct access devices as boot or data devices is included directly in the board's ROM-BIOS. This SCSI/BIOS feature allows a wide variety of hard disks, floppy drives, bubble memory drives, tape drives, and other SCSI devices to be used interchangeably, greatly enhancing the ease and flexibility of system integration, maintenance, and upgrades.

Sockets on the Little Board/PC allow onboard EPROM (up to 256K bytes) or battery backed RAM (up to 64K bytes) to function as a bootable PC-DOS compatible "Solid State Disk" (SSD) drive. SSD operation offers several key advantages, including improved speed, reliability, and ruggedness, and reduced power consumption. Ampro's optional SSD support soft-

ware converts DOS based applications into EPROM format automatically, without the need for special programming techniques. In addition, Ampro's SSD Expansion board, which matches the 5.75" x 8" form factor of the Little Board/PC, can be used to add sixteen additional byte-wide devices (EPROM or battery-backed RAM) for larger SSDs.

A key advantage of the PC compatibility of the Little Board/PC is that it runs the thousands of software applications and utility packages developed for the IBM PC. Language compilers, debugging aids, and software support packages for graphics, windowing, multi-tasking, user interfaces, etc., are readily available. In addition there is a large and growing selection of DOS programs targeted at industrial and commercial applications such as communications, data acquisition and control, terminal emulation, protocol conversion, etc.

The Little Board/PC is a member of Ampro's growing family of IBM compatible single board systems. These products offer a broad range of price, performance, and feature alternatives in a consistent physical and functional format.

1.2 LITTLE BOARD/PC FEATURES

- All the functions of a PC/XT motherboard and 4 expansion cards in the space of a half-height 5-1/4" disk drive
- Up to 768K bytes RAM, 256K bytes EPROM
- Two serial ports and a parallel printer port
- Mini/Micro floppy controller (360K, 720K, 1.2M, 1.44M byte formats)
- SCSI controller for hard disks, tape, other SCSI devices, or general purpose digital I/O
- Diskless operation using onboard byte-wide sockets for Solid State Disk
- Small size, +5V only operation, and low power consumption; ideal for embedded applications
- Expandable with Ampro MiniModules or standard PC bus cards

1.3 LITTLE BOARD/PC SPECIFICATIONS

CPU And Onboard Memory

- NEC V40 CPU (8088 superset), 7.16 MHz
- 256K, 512K, or 768K bytes DRAM with parity
- PC-compatible ROM-BIOS with Ampro extensions
- Two spare 28-pin byte-wide memory sockets at E0000h to EFFFFh and F0000h to F7FFFh. Used with:
 - 27256 32K byte EPROMs
 - 27512 64K byte EPROMs
 - 27011 128K byte page mode EPROMs
 - 62256 32K byte static RAMs
 - 32K byte nonvolatile RAMs

PC-Compatible Controllers

- Standard DMA/Interrupt/Timer support
 - 7 interrupt channels
 - 3 DMA channels
 - 3 programmable counter/timers
- Two RS232C ports with software controlled baud rates
 - PC-compatible COM port (8250) with full handshaking
 - Nonstandard OEM serial port with two active handshake lines
 - Onboard +/- 9VDC generation

- Parallel printer port
- Standard PC keyboard port
- Speaker port with 0.1 watt drive
- Optional battery-backed time-of-day clock with 10 year internal lithium battery
- PC-compatible mini (5-1/4") and micro (3-1/2") floppy controller
 - 2 drive selects, 1-2 sided, 150/500K bps data rates
 - ROM-BIOS supports all standard formats (320K/720K/1.2M/1.4M)
 - Reliable all-digital phase-locked loop and write precompensation
 - Disk change sense line supported

SCSI Interface

- Ansi X3.131 (SCSI) compatible
- Based on popular 53C80 SCSI bus controller
- Usable as 16 (9 bidirectional, 7 input only) general purpose programmed digital I/O lines (48 mA sink)
- Up to 800K byte/sec data throughput

Physical

- Size: 8.0" x 5.75" x 1.1" (5-1/4" disk drive form factor)
- Provision for one onboard Ampro MiniModule
- Power requirements: +5V +/- 5% at 800 mA (typical)
- 4-layer PCB, with full ground and power planes for low noise
- Operating temperature: 0-70° C, 5-95% relative humidity (non-condensing)
- Storage temperature: -55° to +85° C
- Weight: 8.9 oz. (includes 3 SIMM RAM modules)

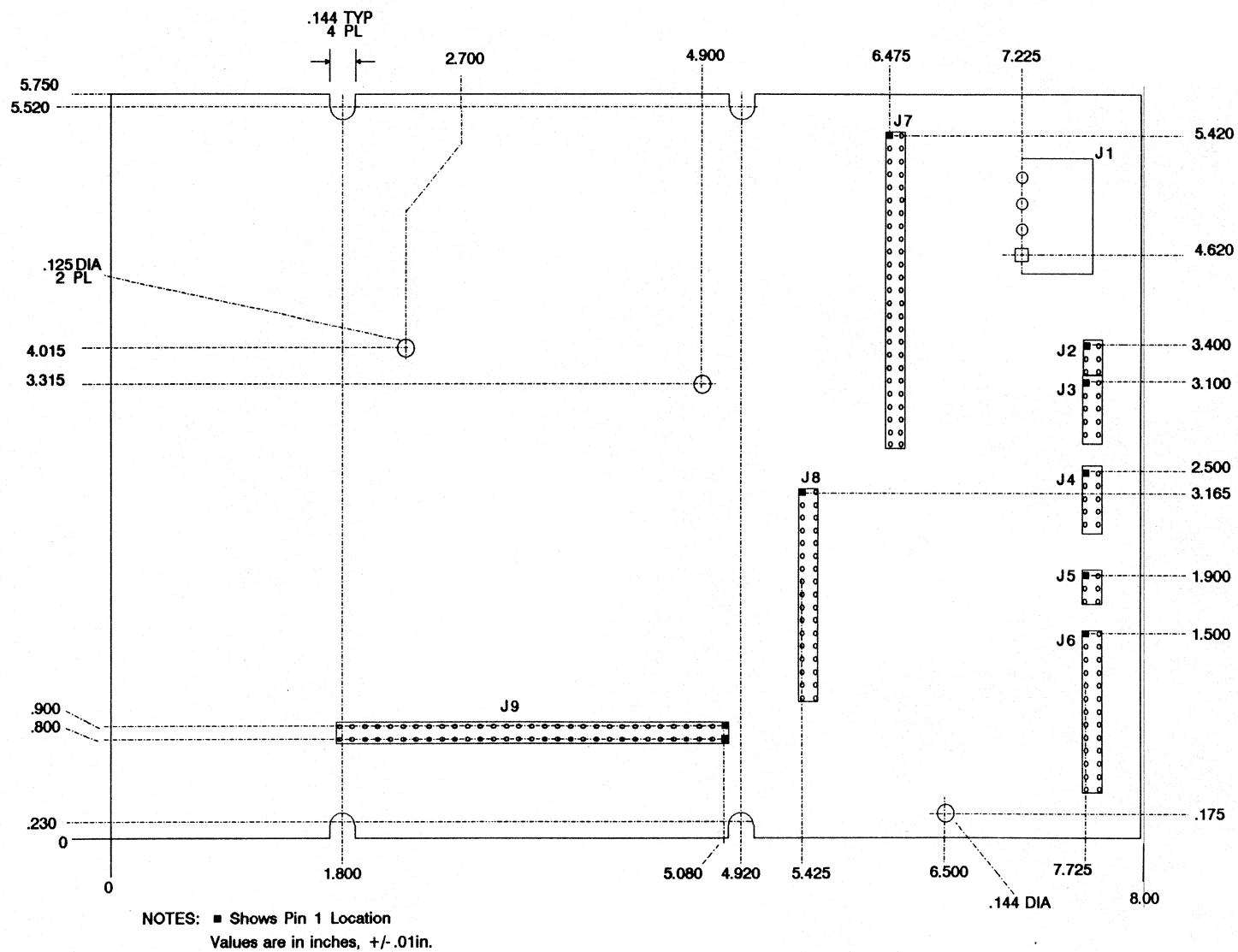


Figure 1-1. Mechanical Dimensions

CHAPTER 2

HARDWARE CONFIGURATION

2.1 INTRODUCTION

This chapter describes what is required to integrate the Little Board/PC with a wide variety of external devices, including keyboards, printers, modems, floppy and hard disk drives, and monitors. Information is provided regarding the board's connector signals and pinouts, external device requirements, interconnection cable wiring, and board configuration.

Also covered in this chapter is the configuration and initialization requirements of standard and optional onboard devices. These include both the standard items such as the DRAM memory, battery-backed real time clock, and CPU speed control functions, as well as several optional additions such as EPROM and NOVRAM *Solid State Disk drives*, and a variety of onboard expansion modules including the Ampro MiniModule video controllers.

It is important to note, however, that many of the board's functions are software rather than hardware controlled. Therefore, many of the features and functions described in this manual assume the presence of the board's standard ROM-BIOS for their operation. Refer to Chapter 3 for typical software configuration information, and to Chapters 4 and 5 for technical details regarding the board's hardware and software functions.

2.1.1 Interface Connectors

Figure 2-1 shows the board's interface connectors (J1-J10). Table 2-1 summarizes the board's connectors interface assignments. Connector pinouts and signal definitions are provided in the sections of this chapter that cover each connector interface.

All of the board's peripheral I/O interface connectors (J2-J8) are dual row male header connectors, of varying sizes. Each of these headers can be mated with either flat ribbon (IDC) or discretely wired connectors. J2, J3, J4, J5, and J6 have been placed together at one end of the board so that a single 64-position header plug can mate with the entire group.

In some applications it is preferable to plug a specialized PC board assembly onto several or all of the I/O connectors (J2-J8). This allows you to eliminate cables, meet packaging requirements, add EMI filtering, or in other ways customize the installation of the Little Board/PC in your application. In addition, one dual-row male header provides the PC expansion bus for onboard MiniModule expansion.

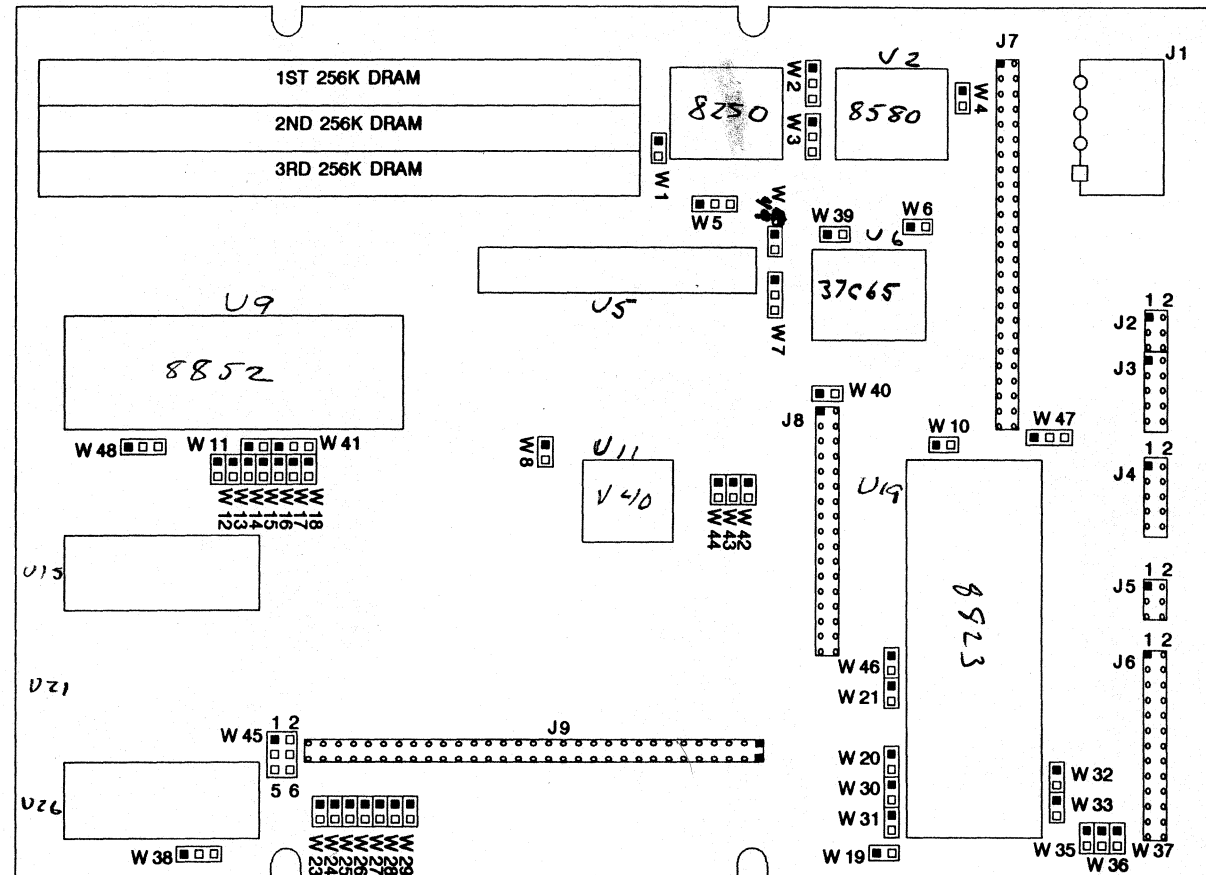


Figure 2-1. Connector and Jumper Locations

Table 2-1. Summary of Connector Usage

SEGMENT	FUNCTION	SIZE
J1	Power Input	4-pin
J2 (*)	V40 Serial	6-pin
J3 (*)	PC Serial	10-pin
J4	Utility	10-pin
J5	Keyboard	6-pin
J6	Printer	26-pin
J7	SCSI	50-pin
J8	Floppy	34-pin
J9	PC Bus	64-pin
J10	Math Option	40-pin
(*) J2 and J3 are combined on a single 16-pin connector.		

2.1.2 Jumper Options

For normal PC compatible operation, no special jumpering of the Little Board/PC is required. As shipped from the factory, the board can be connected to appropriate peripherals and operated immediately. Typically, the only jumpers you need be concerned with are the following:

- **Floppy drive quantity.** See Table 2-16; default = 2 drives.
- **Floppy drive type.** See Table 2-17 and 2-18; default = 360K drives.
- **Video mode.** See Table 2-21; default = color.
- **SCSI bus disable.** See Section 2.5; default = enabled.

Note

If you do not use SCSI, be sure to use the disable jumper as discussed in Section 2.5, as it eliminates system boot delay.

Each of the board's jumper options is referred to by a "W" number (i.e. W1-W47). In nearly every case, the jumper option consists of a pair of pins which is either shorted or unshorted by installing or removing a shorting block. Several jumper options consist of three pins. For these jumper options, there are three choices: shorting pin 1 to pin 2; shorting pin 2 to pin 3; or shorting neither. One exception is W45, which has 6 pins -- labeled on the board.

The pin numbering convention for all jumper options (except W45) is as follows: assuming the orientation of the Little Board/PC shown in Figure 2-1, pin 1 is either the one on the *left* or the one on the *top*, depending on which axis the jumper group occupies.

2.2 DC POWER INPUT - J1

The power connector pinout is identical with that of power connectors on nearly all 5-1/4 inch floppy disk drives, except that only the +5 volt and ground connections are used. Note that pin 1 on J1 is reversed from that of the header connectors on the Little Board/PC (see Figure 2-1). Refer to Table 2-2 for power connections and mating connector information, and Figure 2-2 for typical connector wiring. Refer to Table 2-3 for typical power consumption requirements.

Table 2-2. Power Connector Usage (J1)

PIN	SIGNAL NAME	FUNCTION
1	---	(not used)
2	Ground	Ground return
3	Ground	Ground return
4	+5VDC	+5VDC +/- 5%
Housing: AMP 1-480424-0 Pins: AMP 60619-1		

Caution

Be sure the power plug is correctly wired before applying power to the board! (See Figure 2-2.)

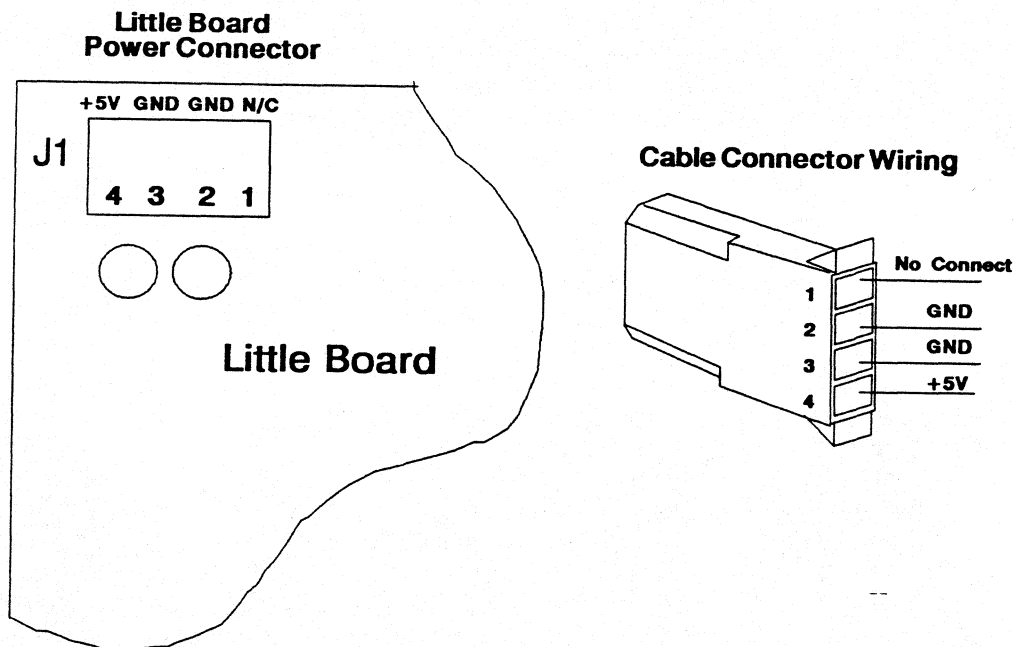


Figure 2-2. Power Connector Wiring

The precise power requirements of the Little Board/PC depend on a number of factors, including what functions are present on the board, whether the SCSI bus is terminated, and what peripherals are connected to the board's I/O ports. For example, PC keyboards draw their power from the keyboard connector on the board, thus add to the total power drawn by the board from its power supply. Similarly, boards connected to the PC Expansion Bus may draw their power through the Little Board/PC.

Table 2-3 gives the typical power consumption of the standard configurations of the Little Board/PC. All versions shown in the table include both serial ports, the printer, speaker, and keyboard ports, the floppy disk controller, and the PC Expansion Bus.

Note that the SCSI bus terminators consume approximately .8 watts of power by themselves; the power values shown in Table 2-3 include the SCSI terminators when the configuration includes the SCSI interface logic.

Table 2-3. Power Consumption vs. Configuration

RAM (*)	WITH SCSI LOGIC		WITHOUT SCSI	
	CURRENT	POWER	CURRENT	POWER
256K	649 mA	3.3 W	449 mA	2.3 W
512K	691 mA	3.5 W	491 mA	2.5 W
768K	734 mA	3.7 W	534 mA	2.7 W
(*) Assumes "3-chip" SIMMs				

2.3 ONBOARD OPTIONS

This section includes the onboard device options which can be added to the Little Board/PC. These include DRAM and byte-wide memory devices, nonvolatile RAM cartridges, a real time clock module, and a variety of onboard expansion MinModules including the Ampro MiniModule video controllers.

2.3.1 DRAM Memory

Jumper pairs W42-W44 must be set to correctly indicate the amount of *onboard* SIMM DRAM memory which is to be utilized.

Note that the configurations which utilize onboard memory above 640K are only usable under special circumstances. These are the restrictions which govern the use of memory above 640K:

- Do not jumper for more than 640K if a CGA, EGA, or VGA-compatible video controller is in use.
- Do not jumper for more than 704K if an MDA or Hercules-compatible, video controller is in use. This includes the Ampro MiniModule/CGA in monochrome mode.

Generally speaking, the 768K memory configuration is only usable when the DOS display device is rerouted to a serial port, as discussed in Chapter 3. Also observe the following note if you plan to use 768K:

Note

The 768K option also requires that the video mode jumpers be set to the EGA/VGA option; i.e. jumpers W19 and W31 must be on.

Table 2-4 provides the jumper information for the eight possible onboard DRAM memory configurations.

Table 2-4 Onboard DRAM Memory Size Jumpering

AMOUNT	SIMM1	SIMM2	SIMM3	W42	W43	W44
0K	no	no	no	open	open	open
64K	yes	no	no	short	open	open
128K	yes	no	no	open	short	open
256K	yes	no	no	short	short	open
512K	yes	yes	no	open	open	short
640K	yes	yes	yes	short	open	short
704K(*)	yes	yes	yes	open	short	short
768K(**)	yes	yes	yes	short	short	short
Default: either 256K, 512K, or 640K, depending on whether 1, 2, or 3 SIMM DRAM modules are installed.						
(*) NOTE: Do not use with EGA/VGA video controller.						
(**) NOTE: 768K option also requires the EGA/VGA video mode, i.e. jumpers W19 and W31 must be on. Also, no video controller can be present.						

2.3.2 Math Coprocessor (J10)

The Little Board/PC does not support the use of a math coprocessor. The connector at J10 was originally intended for direct connection to an NEC uPD72191, but this device was canceled by NEC.

Caution

Do not connect an 8087 at J10, as damage to both the board and the IC may result.

Jumper option W30 corresponds to "switch 2" of a standard PC motherboard, and indicates whether an 8087 math coprocessor is present in the system. This jumper is shorted by a trace on the board, which indicates that a coprocessor is not present.

2.3.3 Byte-Wide Memory Sockets

The Little Board/PC has two onboard byte-wide memory device sockets that can accommodate a variety of EPROM and nonvolatile RAM (NOVRAM) devices, used for simple program storage or as "Solid State Disk" (SSD) drives.

Some of the byte-wide devices that can be used in these sockets are shown in Table 2-5 and 2-6, along with the jumpering required to support each type of device. The NOVRAM cartridges described in the table connect with a short ribbon cable (Dallas P/N DS9000) to a byte-wide socket: U15 or U26. Devices used in these sockets must be 300 nS (or faster).

Direct Program Access

The memory devices installed in U15 and U26 can be accessed directly by your application software, provided the program knows about them.

The byte-wide memory sockets reside at the following memory addresses:

- U15 is at F0000h
- U26 can start at any of the following addresses, depending on the type of device installed and the setting of the socket configuration jumpers (see Table 2-5):
 - E0000h
 - E8000h
 - EC000h
 - EE000h

Through a technique known as a "ROM-BIOS extension", it is possible to have the system run its entire application from byte-wide socket memory devices, instead of from disk drives. This is discussed in Ampro application note AAN-8702.

Solid State Disk (SSD) Drives

The optional Ampro Solid State Disk (SSD) Support Software, allows you to configure a Little Board/PC system to boot, operate, and even store data using one or two EPROM and/or NOVRAM solid-state "drives" under control of the DOS (version 3.3 or later) operating system. No custom programming is required, other than use of the development tools provided in the SSD Support Software. Using the Ampro SSD software, the byte-wide sockets can serve as individual SSD drives, or they can be combined into one larger drive. SSD drives can be used along with normal (floppy and hard disk) drives. Ampro's SSD Expansion Board provides additional SSD sockets.

Based on these devices, some of the configurations possible using the Ampro SSD support are:

- **Single EPROM Drive:** -- U15 alone, or U15 combined with U26, as a bootable EPROM drive. Up to 128K bytes capacity results from one socket, or 256K bytes if the two are combined.
- **One EPROM drive, and one NOVRAM drive:** -- U15 as a bootable EPROM drive (128K bytes capacity), and U26 as a NOVRAM cartridge drive (up to 512K bytes capacity).

- **Two Independent NOVRAM drives:** -- U15 as a bootable NOVRAM cartridge drive, and U26 as a second NOVRAM cartridge drive (each drive up to 512K bytes).
- **One Combined NOVRAM drive:** -- U15 plus U26 combined to form a single bootable NOVRAM cartridge drive (up to 1 megabyte in capacity).

Byte-Wide Socket Configuration

If the U15 or U26 memory sockets are used, they must be configured by means of jumpers for device type, size, and the starting memory address desired. The supported memory devices and corresponding jumper settings are shown in Tables 2-5 and Table 2-6. The starting address for U15 is F0000h, regardless of device type or size, while U26 can be set to start at several addresses.

Table 2-5. U26 Device Jumpering

SIZE (BYTES)	DEVICE TYPE	TYPICAL DEVICE	ADDRESS	W35	W36	W37	W38	W45
8K	Normal EPROM	2764	E0000h	open	short	short	open	open
8K	Normal EPROM	2764	E8000h	short	short	open	open	1/3
8K	Normal EPROM	2764	EE000h	open	short	open	open	1/3
16K	Normal EPROM	27128	EC000h	short	open	open	1/2	1/3
32K	Normal EPROM	27256	E0000h	open	short	short	1/2	1/3
32K	Normal EPROM	27256	E8000h	short	open	short	1/2	1/3
64K	Normal EPROM	27512	E0000h	short	short	short	1/2	3/5
128K	Page-addr EPROM	27011	E0000h	open	short	short	2/3	2/4
8K	28-Pin SRAM	6264	EE000h	open	short	open	2/3	open
32K	28-Pin SRAM	62256	E0000h	open	short	short	2/3	4/6
32K	28-Pin SRAM	62256	E8000h	short	open	short	2/3	4/6
32K to 512K	NOVRAM cartridge	DS1217x	E0000h	open	short	short	2/3	4/6
0K	None	-----	-----	open	open	open	open	open

Note

When a byte-wide memory device is enabled, its memory address space is unavailable for use by other devices on the PC bus. A byte-wide socket must be marked as "disabled" (jumpers W35-W38, W45 "open") before its memory space can be used for other purposes.

Table 2-6. U15 Device Jumpering

SIZE (BYTES)	DEVICE TYPE	TYPICAL DEVICE	W12	W13	W14	W15	W16	W41	W8
8K	Normal EPROM	2764	short	open	short	open	open	2/3	short
32K	Normal EPROM	27256	short	open	short	short	open	2/3	open
128K	Page-addr EPROM	27011	short	open	short	open	short	2/3	open
8K	28-Pin SRAM	6264	short	open	open	open	short	open	short
32K	28-Pin SRAM	62256	short	open	short	open	short	1/2	open

2.3.4 Battery-Backed Clock Module

An Ampro SmartClock battery-backed real time clock module can be plugged into any of the board's three 28-pin memory option sockets (U15, U21, or U26).

If a memory device is also required in the socket used for the clock option, it can be plugged directly into the 28-pin socket on the clock module. When this is done, the memory device is accessed as though the clock option is not present.

A software utility is provided with the SmartClock option which can be used to initialize the clock module for correct date and time, as well as to automatically set the DOS system clock from the hardware real time clock on system powerup.

2.3.5 Video Display Mode Jumpering

No matter what type of video display controller is used, two jumper options (W19 and W31) on the board must be properly configured to indicate the desired video mode to the ROM-BIOS. Table 2-7 shows the video display mode jumper settings.

Table 2-7. Video Display Mode

VIDEO MODE	W31	W19
EGA/VGA	short	short
640 X 200 CGA	short	open
320 X 200 CGA	open	short
Monochrome (80 X 25)	open	open

W19 and W31 correspond to switches 5 and 6 of a standard PC motherboard, and are used to specify the powerup default of the video display controller. Not that the EGA/VGA video mode (W19, W31 both on) must be set when a memory configuration of 768K is to be used, as described elsewhere in this chapter.

Refer to the video controller's technical manual for its proper jumper settings.

2.3.6 I/O Wait State Option

A timing limitation in the original NEC V40 microprocessors used in the Little Board/PC required several wait states to be inserted on all I/O cycles. The NEC V40 microprocessors now shipping no longer require the wait states. A jumper, W48, controls whether the wait states are enabled or disabled, as shown in Table 2-8.

Table 2-8. I/O Wait States W48

WAIT STATE	PINS
Disables Automatic I/O Wait States. Actual number of I/O wait states is determined by the internal wait state generator (use Ampro's SETWAIT utility)	1/2
Enables Automatic I/O Wait States. Wait states are automatically inserted on all I/O cycles.	2/3

To ensure compatibility with older version of the Little Board/PC, the board is shipped with automatic wait states *enabled*.

Note

If possible, you should reconfigure jumper W48 to *disable* the automatic wait states. With automatic wait states disabled, they can be set to the desired value under software control using the SETWAIT utility.

2.4 PERIPHERAL INTERFACE CONFIGURATION AND CONNECTIONS

This section discusses the interface requirements of the board's external device interface connectors. Connector pinouts, signal definitions, device characteristics, and jumpering information is included.

2.4.1 Utility Connector - J4

A single 10 pin connector (J4) provides four functions: Speaker, System Reset, Power Indicator LED, and auxiliary power to the PC Expansion Bus connector (J9). The pinout and signal definitions of the Utility Connector are shown in Table 2-9. Note that the power connections indicated are not required for operation of the Little Board/PC, and are only used to supply power to the pins indicated on the PC Expansion Bus connector.

Table 2-9. Utility Connector (J4)

PIN	SIGNAL NAME	FUNCTION
1 2	Audio return Audio	+5 volts through 33 ohms Speaker signal
3 4	Ground RESET	To one side of Reset switch To other side of Reset switch
5 6	LED Cathode LED Anode	Ground return Current source
7 8 9 10	Ground +12V -5V -12V	Ground return To J9 pin B9 To J9 pin B5 To J9 pin B7

Speaker

The board provides a PC compatible speaker output on two pins of the Utility Connector. The speaker signal is buffered by a transistor amplifier to provide approximately .1 watt of audio power to an external speaker. Typically a small general purpose 2 or 3 inch diameter permanent magnet speaker with an 8 ohm voice coil is used.

Speaker tones can be generated either by directly "bit-banging" the speaker control port or by setting timer 2 to a desired frequency tone and enabling the tone with an enable port. See Chapter 4, or a PC technical reference manual, for additional programming details.

System Reset

Two pins of the Utility Connector provide for the connection of an external normally-open momentary switch to manually assert a system reset signal.

Power Indicator LED

Two pins of the Utility Connector provide for the connection of an external power indicator LED device. 15 mA of sourced current is available (+5V through 330 ohms).

PC Bus Power Option

Five pins of the Utility Connector allow the sourcing of +12VDC, -5VDC, and -12VDC for use by devices connected to the board's PC Expansion Bus connector (J9). The Little Board/PC does not itself require these voltages.

2.4.2 Keyboard - J5

A PC (or XT) compatible keyboard can be connected to the board's keyboard port via the 6-pin connector, J5. Normally, PC keyboards include a cable which terminates in a male 5-pin DIN plug for connection to a PC. Table 2-10 gives the board's keyboard connector pinout and signal definitions, and includes corresponding pin numbers of a normal PC DIN keyboard connector.

Note

"AT" keyboards are not compatible with PC (or XT) keyboards, and may not be used with this interface.

Table 2-10. Keyboard Connector (J5)

J5 PIN	SIGNAL NAME	DIN PIN
1	Keyboard Clock	1
2	Keyboard Data	2
3	-Reset	3
4	Ground	4
5	+5V power	5
6	(no connection)	---

2.4.3 Parallel Printer Port - J6

The parallel printer connector (J6) has a pinout that allows the use of flat ribbon cable to a standard DB25 PC printer connector.

Table 2-11 gives the printer connector's pinout and signal definitions. The table also indicates the pin number on the PC compatible DB25 printer connector which corresponds to each of the board connector's pins. Note that the pin numbering convention for the board's header connector differs from that of DB25 connectors, even though direct connection with flat ribbon cable is possible. To clarify this, each signal's corresponding DB25 connector pin number has been included in the table.

Note

Be sure not to exceed approximately 10 feet of total cable length between the board's connector and the printer.

Table 2-11. Parallel Printer Connector (J6)

J6 PIN	SIGNAL NAME	FUNCTION	IN/OUT	DB25 CONN. PIN
1	-DS	Sample input data	out	1
3	Data 0	LSB of printer data	out	2
5	Data 1	:	out	3
7	Data 2	:	out	4
9	Data 3	:	out	5
11	Data 4	:	out	6
13	Data 5	:	out	7
15	Data 6	:	out	8
17	Data 7	MSB of printer data	out	9
19	-ACK	Character accepted	in	10
21	BUSY	Cannot receive data	in	11
23	PAPER END	Out of paper	in	12
25	SELECT	Ready to receive data	in	13
2	AUTOFD	Autofeed	out	14
4	-ERROR	Printer error	in	15
6	-INIT	Initialize printer	out	16
8	SELECT	Select printer	out	17
10,12, 14,16, 18,20, 22,24	GND	Signal ground	---	18-25

Printer Port Jumpering

Three jumper options -- W11, W46, and W47 -- pertain to the functions associated with the board's parallel printer port. The various options are shown in Table 2-12.

Table 2-12. Parallel Printer Configuration

JUMPER	SIGNAL	FUNCTION
W11	To ASIC1	Selects I/O address. open: 378-37Fh short: 3BC-3BFh default: open (378-37Fh)
W46	IRQ7	Connects the on-board printer port to IRQ 7 Default: shorted (trace)
W47-1 W47-2 W47-3	V40 SRDY Handshake Out -INIT	V40 Serial Port handshake option. Default: 1/2

Jumper option W11 allows a choice of two I/O port addresses for the printer port: 378-37Fh, or 3BC-3BFh. Normally, the DOS LPT1 device has address 378-37Fh; however, the ROM-BIOS scans both choices and will install the first one it finds as LPT1 regardless of which option has been configured. The printer port should normally be configured for 378-37Fh (W11 unshorted), unless another parallel port interface is present on the PC bus.

A second jumper option, W46, has been provided to allow the use of the printer port interrupt (IRQ 7) as an extra interrupt on the PC Expansion Bus if you do not require interrupt-based operation of the board's parallel printer port. The print functions in the board's ROM-BIOS do not use the interrupt. However, some PC applications (e.g. spoolers) might require printer interrupts, so it is recommended that you leave this interrupt connected unless you are certain it is will not be needed. To free IRQ 7 for use on the PC Expansion Bus, cut the trace shorting W46 (on the non-component side of the board). IRQ 7 will now be available on the PC Expansion Bus, at J9 pin B21.

The third jumper option, W47, allows the use of the printer port -INIT signal as a Handshake Out signal for the V40 serial port. If that option is employed, the printer port must either not be used for anything else, or must be used in a manner that does not result in erroneous handshake signal usage. As indicated in the table, shorting pin 1 to pin 2 is the normal configuration, which results in the Handshake Out signal being generated by the V40's internal serial controller handshake logic.

2.4.4 PC Compatible Serial Port - J3

The PC compatible serial port appears at header connector J3. Three RS232C output signals and five RS232C input signals facilitate connecting a broad range of serial devices to the Little Board/PC.

This port can be used for connection of a printer, modem, terminal, or other serial device. The main interface consideration is that the device be RS232C compatible. Printers and modems generally require handshaking in one or both directions. Consult the serial device's installation manual for information regarding possible handshake and other interface considerations.

Table 2-13 gives the board's connector pinout and signal definitions. In addition, the pins to which each signal should be wired for compatibility with the COM port external serial connectors of PC's (DB25) and AT's (DB9) are also indicated.

Table 2-13. PC Serial Port Connections (J3)

J3 PIN	SIGNAL NAME	FUNCTION	IN/OUT	DB25 PIN	DB9 PIN
1	DCD	Data Carrier Detect	in	8	1
2	DSR	Data Set Ready	in	6	6
3	RXD	Receive Data	in	3	2
4	RTS	Request To Send	out	4	7
5	TXD	Data Output	out	2	3
6	CTS	Clear to Send	in	5	8
7	DTR	Data Terminal Ready	out	20	4
8	RI	Ring Indicator	in	22	9
9	GND	Signal Ground	--	7	5
10	---	(no connection)	--	--	--

PC Serial Port Jumpering

Three jumpers (W17, W18, and W20) can be used to modify the I/O port address (3F8-3FFh or 2F8-2FFh) and interrupt usage (IRQ3 or IRQ4) of the PC Serial Port. Jumper W20 selects the port's I/O port address, while interrupt channel selection is made using either W17 or W18. Refer to Table 2-14 when making serial channel selection.

Note

Normally, the DOS COM1 device has address 3F8-3FFh and interrupt IRQ4; however, the ROM-BIOS scans both choices and will install the first one it finds as COM1 regardless of which option has been configured.

Table 2-14. PC Serial Port Configuration

I/O ADDRESSING	INTERRUPT	W17	W18	W20
3F8h thru 3FFh	IRQ4	short	open	open
2F8h thru 2FFh	IRQ3	open	short	short
Default:		short	open	open

2.4.5 V40 Serial Port - J2

A non-standard RS232C serial port, based on the V40's internal serial controller function, appears at connector J2. This port can be used for connection of many types of RS232C serial devices. However, because this port is not compatible with the serial ports normally used in PC's, off-the-shelf communications programs cannot be used without modification.

This port requires the use of customized or modified software, unless it is to be used as a serial console device (see Chapter 3). One additional limitation of the V40 serial port is that it cannot be used in an interrupt driven mode, unless the board's keyboard interrupt is not required (see Chapter 4).

A single active handshaking signal in each direction is available, for use with printers, modems, and other devices, to control the flow of data. Consult the external serial device's installation manual for information regarding appropriate handshake protocols, and other interface considerations.

Table 2-15 gives the board's connector pinout and signal definitions. In addition, the pins to which each signal should be wired for compatibility with a subset of the COM port external serial connectors of PC's (DB25) and AT's (DB9) is also indicated. One output signal (J2-5, DTR) provides a means of sending an EIA TRUE to the attached device, if needed. In some applications it may be necessary to connect either the input handshake signal (CTS), output handshake signal (RTS), or output EIA True signal level (DTR) to different pins of either the DB25 or DB9 connectors than those shown in the table.

Table 2-15. V40 Serial Port Connections (J2)

J2 Pin	SIGNAL NAME	FUNCTION	IN/OUT	DB25 PIN	DB9 PIN
1	RXD	Receive Data	in	3	2
2	RTS	Handshake Out	out	4	7
3	TXD	Transmit Data	out	2	3
4	CTS	Handshake In	in	5	8
5	DTR	EIA True	out	20	4
6	GND	Signal Ground	---	7	5

V40 Serial Port Jumpering

The only jumper option pertaining to the board's V40 serial port is the selection of the source of the Handshake Out signal (RTS). W47, a 3 pin jumper group, allows the Handshake Out signal to be driven by either the V40's serial controller handshake output logic, or by the printer interface's -INIT signal.

As shipped from the factory, this signal is connected to the handshake signal (SRDY; V40 pin 36) generated by the serial controller within the V40 microprocessor. As utilized by the ROM-BIOS, the V40's handshake signal automatically goes true when the receive buffer is ready to receive data, and false when the receive buffer is full.

Alternatively, the Handshake Out signal source can be jumpered to the printer port -INIT signal. This provides a signal source which is completely under software control, but is only useful if the printer port will not be used, or if the applications running on the board will not use the -INIT signal when using the printer port.

To select the V40's handshake output logic, insert a shorting block between W47 pins 1 and 2; to use the printer -INIT signal, short pins 2 and 3. The default is normally the V40's handshake output signal.

2.4.6 Floppy Disk Interface - J8

The board's floppy disk controller subsystem and ROM-BIOS support one or two floppy disk drives in any of the standard DOS formats shown in Table 2-16.

Table 2-16. Supported Floppy Formats

Capacity	Tracks	Drive Size	Data Rate	DOS Version
360K	40	5-1/4"	250 KHz	2.1+
1.2M	80	5-1/4"	500 KHz	3.0+
720K	80	3-1/2"	250 KHz	3.2+
1.44M	80	3-1/2"	500 KHz	3.3+

As you can see from Table 2-16, nearly any type of soft-sectored, single or double-sided, 40 or 80 track, mini or micro floppy disk drive is usable. Naturally, the higher the quality of the drives you use, the better your system's reliability.

Here are some considerations regarding the selection, configuration, and connection of floppy drives to the Little Board/PC:

- The drives used must be compatible with the board's floppy disk interface. In general, any standard PC or AT compatible 5-1/4" or 3-1/2" floppy drive will work. 720K, 1.2M or 1.44M floppy drives used must provide an IBM PC/AT compatible "disk change" signal. Any 5-1/4" AT compatible 1.2M drive can be expected to supply the required signal. The following 3-1/2" 720K and 1.44M floppy drives are known to provide the required signal:

<u>Brand</u>	<u>720K Drive</u>	<u>1.44M Drive</u>
Fujitsu	M532K-19A	M2537K-19A
Teac	FD-235-F-100U	FD-235-HF-101-U
Panasonic	JU-253-09P	JU-257-14PF
Mitsubishi	MF353C-12UJ	MF-355C-12UJ

- High quality, DC servo direct drive motor floppy disk drives are recommended.
- Any combination of supported drives can be used. See Table 2-14.
- The computer board must be jumpered for the number and type of floppy drives to be used. (Details follow.)
- The drives must be jumpered to the second drive select. Use a floppy cable with a segment of wires twisted, as is the usual practice in PC and AT compatible systems.
- Resistive terminations should be installed only on the drive connected to the last interface cable connector (*farthest from the computer*).
- When using drives with a Head Load option, jumper the drive for "head load with motor on" rather than "head load with drive select."
- Sometimes a thin metal shield is required when mounting the board directly to a floppy drive due to electromagnetic interactions.

Note that the Little Board/PC's ROM-BIOS provides dual-capacity use of 1.2M or 1.44M drive: that is, 360K floppies can be read in a 1.2M drive, and 720K floppies can be read in a 1.44M drive. However, it is *not* recommended that a low-density floppy be written in a high-density drive, as incomplete erasure may occur.

Table 2-17 shows the pinout and signal definitions of the floppy disk interface connector (J8). J8 is identical in pinout with the floppy connector of a standard PC. Note that in a PC, both drives are normally jumpered *the same* -- as the second drive. The drives are differentiated by swapping a group of seven wires (conductors 10-16) in the cable between the board and the first physical drive (drive A).

Table 2-17. Floppy Disk Interface Connector (J8)

PIN	SIGNAL NAME	FUNCTION	IN/OUT
2	-RPM/-RWC	Speed/Precomp (option)	out
4	---	(Not used)	--
6	---	(Not used)	--
8	-IDX	Index Pulse	in
10	-M01	Motor On 1	out
12	-DS2	Drive Select 2	out
14	-DS1	Drive Select 1	out
16	-M02	Motor On 2	out
18	-DIRC	Direction Select	out
20	-STEP	Step	out
22	-WD	Write Data	out
24	-WE	Write Enable	out
26	-TRK0	Track 0	in
28	-WP	Write Protect	in
30	-RDD	Read Data	in
32	-HS	Head Select	out
34	pullup	330 ohms to +5V	--
1-33	(all odd pins)	Signal grounds	--

Floppy Interface Jumpering

Nine jumper options allow you to customize the operation of the floppy disk controller subsystem. The main concerns are:

- Jumpers W32 and W33 must be set to indicate the quantity of drives connected, as shown in Table 2-18. Only 1 or 2 actual floppy disk drives can be interfaced by the board's floppy controller. However, when using the Ampro SSD Support Software, two additional SSD drives (emulating additional floppy drives) can be supported in addition to the two actual floppy disk drives, so the choices of 3 or 4 apply in this case.

- Be sure to also set the four drive type jumpers (W26-W29) to specify what kind of floppy disk drives to be used, as indicated in Table 2-19 and Table 2-20. Table 2-19 applies to Drive A, and Table 2-20 applies to Drive B. Any combination of two drives is allowed.
- On boards that currently ship, jumper W49 must be shorted. (This configuration is the default as shipped.)
- If nothing is connected to the SCSI connector (J7) insert a shorting block on J7 pins 1 and 2 to disable attempted system boot from SCSI. This speeds up booting from floppy.

Table 2-18. Floppy Drive Quantity

W33	W32	DRIVES
short	short	1
open	short	2
short	open	3 (*)
open	open	4 (*)
Default: 2 drives (*) Not supported, except with Ampro's SSD Support Software.		

Table 2-19. Drive A Type Selection

CAPACITY	TRACKS	DRIVE SIZE	DATA RATE	DOS VERSION	W26	W28
360K	40	5-1/4"	250 KHz	2.1+	open	open
1.2M	80	5-1/4"	500 KHz	3.0+	open	short
720K	80	3-1/2"	250 KHz	3.2+	short	open
1.44M	80	3-1/2"	500 KHz	3.3+	short	short
Default: 360K, 5-1/4" drive					open	open

Table 2-20. Drive B Type Selection

CAPACITY	TRACKS	DRIVE SIZE	DATA RATE	DOS VERSION	W27	W29
360K	40	5-1/4"	250 KHz	2.1+	open	open
1.2M	80	5-1/4"	500 KHz	3.0+	open	short
720K	80	3-1/2"	250 KHz	3.2+	short	open
1.44M	80	3-1/2"	500 KHz	3.3+	short	short
Default: 360K, 5-1/4" drive					open	open

Two additional options, shown in Table 2-21, allow you to alter the DMA channel and interrupt channel assignment. Changing these from the defaults is not recommended because it would sacrifice compatibility with the board's ROM-BIOS.

Table 2-21. Floppy Interface Options

JUMPER	SIGNAL	FUNCTION
W5-1 W5-2 W5-3	DACK1 DACK to FDC DACK2	DMA acknowledge channel option. Default: 2/3 (DACK2), via a trace.
W7-1 W7-2 W7-3	DRQ1 DRQ from FDC DRQ2	DMA request channel option. Default: 2/3 (DRQ2), via a trace
W10	IRQ6	When shorted, connects board's floppy controller to interrupt request IRQ6. Must be shorted if the board is equipped with a floppy disk controller. Default: shorted
W26- W29		Select floppy drive type for drives A and B, as shown in Tables 2-19 and 2-20. Default: all unshorted
W32 W33	PC Switch 8 PC Switch 7	Drive quantity, as shown in Table 2-18. Default: W32 on, W33 off.
W39	PCVAL	Write precompensation value. Unshorted selects 125 nS. Shorted selects 187 nS. Default: unshorted
W40	DRV	Drive type. Unshorted selects single speed drives. Shorted selects dual speed drives. Default: unshorted
W49		Must be shorted. Default: shorted

2.5 SCSI INTERFACE - J7

The SCSI interface (J7) uses a 50-pin male header connector to interface with SCSI compatible peripherals. Table 2-22 shows the pinout and signal definitions of this interface. Refer to your SCSI device documentation, or the ANSI X3.131 SCSI specification (referred to in Chapter 4) for detailed information on the signal functions. Be sure that the maximum total SCSI bus cable length, from the board's connector to the most distant SCSI peripheral, does not exceed 18 feet, and that the SCSI bus is properly terminated at both ends.

Note

If the SCSI interface is not needed, you should disable it by placing a shorting block on pins 1 and 2 of the SCSI connector (J7). When the shorting block is in place, the system bypasses any attempt to boot from the SCSI device, which can speed up the boot process.

Table 2-22. SCSI Interface Connector (J7)

PIN	SIGNAL	FUNCTION
1 - 49	(All odd pins)	Signal grounds
2	-DB0	Data Bit 0 (LSB)
4	-DB1	" " 1
6	-DB2	" " 2
8	-DB3	" " 3
10	-DB4	" " 4
12	-DB5	" " 5
14	-DB6	" " 6
16	-DB7	" " 7 (MSB)
18	-DBP	Data Parity
20,22,24	Ground	Signal Ground
25	---	(Not used)
26	TERMPWR	Termination +5VDC
28,30	Ground	Signal Ground
32	-ATN	Attention
34	Ground	Signal Ground
36	-BSY	Busy
38	-ACK	Transfer Acknowledge
40	-RST	Reset
42	-MSG	Message
44	-SEL	Select
46	-C/D	Control/Data
48	REQ	Transfer Request
50	-I/O	Data direction

2.5.1 Normal Use of SCSI

The board's SCSI bus interface can serve a variety of purposes, including connection of hard disk controllers, tape controllers, text scanners, and printer and communications servers. Support is provided by the board's ROM-BIOS for booting of DOS from a SCSI device such as a hard disk. Virtually any device compatible with the SCSI Common Command Set for *direct access devices* can be used through the ROM-BIOS support. Some examples of direct access SCSI devices that can be accessed as DOS drives are hard disk drives, magnetic bubble drives, high density floppy drives, and some tape drives.

The Little Board/PC comes with a diskette containing software utilities for normal DOS operation using hard disks and other SCSI direct access devices. A powerful SCSI formatting utility is included that allows low-level formatting, changing the interleave, and mapping out bad sectors. Refer to Chapter 4 for information on software setup and drive preparation.

PC-DOS version 3.x requires that drives larger than 32 megabytes be partitioned into more than one "partition", while DR-DOS, MS-DOS 4.x, and PC-DOS 4.x allow such drives to be used without partitioning. Under PC-DOS or MS-DOS 3.x, each drive can be logically partitioned into as many as four partitions, 32 megabytes or smaller, allowing the use of physical drives as large as 128 megabytes. DR-DOS, MS-DOS 4.x, and PC-DOS 4.x support a maximum drive size of 512M bytes.

There are several other types of SCSI devices besides direct access devices. SCSI's additional device types include *sequential access devices* (e.g. tape), *printer devices*, *read-only devices* (e.g. CD-ROM), and *processor devices* (e.g. CPU's). In general, these other device types require special application programs, utilities, or driver software for use.

Hard disk support for operating systems other than DOS may or may not be automatically available through the board's ROM-BIOS resident hard disk driver. This depends on whether the operating system in question uses BIOS calls exclusively for the hard disk function, and whether the operating system has any special ROM-BIOS constraints (such as re-entrancy). Some operating systems -- multitasking ones in particular such as Unix -- interface directly with the hardware (e.g. attempt to directly program a bus hard disk controller) and bypass BIOS. In those situations, the operating system must be modified to add an appropriate SCSI hard disk driver to use the to take advantage of the board's SCSI interface.

2.5.2 The Ampro SCSI/BIOS

Through the universal bus interface and command protocols offered by SCSI, it is possible to connect a wide variety of mass storage devices to a computer system with virtually no changes to system software. To this, Ampro has added a further layer of universality: the *SCSI/BIOS*.

As its name implies, the SCSI/BIOS consists of a set of low level functions which have been incorporated into the ROM-BIOS to provide a hardware independent interface between system software and peripheral devices connected to the SCSI bus. The advantage of the Ampro SCSI/BIOS is that programmers can write software that uses devices connected to the SCSI bus without having to be concerned with the details of operating the board's SCSI bus interface. Also, software can be ported to the Little Board/PC from other hardware environments much faster due to the presence of the SCSI/BIOS, and with less difficulty and risk.

The board's SCSI interface, and the Ampro SCSI/BIOS within the board's ROM-BIOS are discussed in greater detail in Chapters 4 and 5. In addition application note AAN-8804, available from Ampro, provides details of the SCSI/BIOS functions available to programmers.

2.5.3 Simple Bidirectional I/O

When the board's SCSI bus is not needed for interfacing to standard SCSI devices, it can be used instead as a general purpose digital input/output port. The SCSI bus then becomes a set of programmable I/O signals, with TTL signal levels and open collector output drivers capable of sinking 48 mA. In this case, sixteen SCSI bus signals can be used; of these, nine are capable of bidirectional use, and seven are input-only.

The available SCSI port output signals can be "bit-banged" (i.e. software activated) to generate a wide variety of signal timings and operations. For example, it is even possible to interface with optically isolated AC and DC input and output modules, and to a number of off-the-shelf data acquisition and control interfaces.

Ampro application note AAN-8801 discusses a typical non-SCSI application. Refer also to Chapters 4 and 5 for typical system configuration information, and for technical information about the board's SCSI bus interface.

2.5.4 SCSI Interface Configuration

Several items associated with the board's SCSI interface should be configured according to your system needs:

SCSI Bus Termination

Three 8-pin 220/330 ohm SIP resistor networks (RP4, RP5, and RP6) provide bus termination. The termination networks should be present on two, *and only two*, SCSI bus devices. An improperly terminated SCSI bus may interfere with normal system operation due to indeterminate signal levels.

Note

Be sure that the SCSI termination networks are oriented in their sockets so that pin 1 of each SIP network, generally marked with a dot, is at the top end of the board as shown in Figure 2-1.

Internally, pins 2-7 of the SIP networks have 220 ohm resistors connected to +5 volts (pin 8), and 330 ohm resistors connected to ground (pin 1).

Note that the SCSI Bus termination networks consume significant power (.8 watt). If power consumption is critical, consider having the bus termination external to the board, and externally powered.

SCSI ID Jumpering

Three jumper pin pairs (W23-W25) normally are used to provide a three bit SCSI Initiator ID, for use by the board's ROM-BIOS and other support software. The jumper assignments are shown in Table 2-23. These jumper pins can be used for other purposes if the SCSI interface is not required. (See Chapter 5).

Table 2-23. SCSI Initiator ID Jumpering

SCSI Bus ID	W25	W24	W23
0	short	short	short
1	short	short	open
2	short	open	short
3	short	open	open
4	open	short	short
5	open	short	open
6	open	open	short
7	open	open	open
Default: 7	open	open	open

External Termination Power Option

A jumper option (W4) allows the connection of +5 volts termination power to the SCSI bus TERMPWR signal (pin 26). Please observe the following caution regarding this function:

Caution

No termination power protection diode is provided on the board. Consequently, *W4 must NOT be installed if any other bus device supplies termination power, or damage to the board may result.*

The default jumpering of this option is unshorted; i.e., termination power is not normally supplied by the Little Board/PC.

Enhanced SCSI Speed Option

The SCSI support within the ROM-BIOS offers a "SCSI Halt Mode" option, which can be enabled by shorting two configuration jumpers on the board. When SCSI Halt Mode is enabled, the processor halts while SCSI DMA read/write data transfers are occurring, allowing the DMA channel full bus bandwidth. SCSI Halt Mode can provide as much as 25 percent improvement in SCSI data throughput rate, depending on the specific application.

To enable the SCSI halt mode, install shorting jumpers at W1 and W6 on the Little Board/PC. W1 is located between U1 and SIMM2; W6 is located between U2 and U6 (refer back to Figure 2-1). When these two jumpers are left off, SCSI Halt Mode is disabled. The default configuration, as shipped, is SCSI Halt Mode *disabled*.

Alternate DMA Channel Option

The SCSI interface can be configured to use either DMA channel 1 or 3 for data transfer control. DMA Channel 3 corresponds to a standard PC's fixed disk adapter, and is used as the default by the board's SCSI/BIOS. You can alter these assignments relative to the defaults, but this will sacrifice SCSI/BIOS and SCSI utilities compatibility. These SCSI interface configuration options are shown in Table 2-24.

Table 2-24. SCSI Interface Option Jumpers

JUMPER	SIGNAL	FUNCTION
W1	PCTC	Connects DMA END (TC) signal to 53C80's -EOP input. Default: unshorted.
W2-1 W2-2 W2-3	DRQ3 DRQ from 53C80 DRQ1	DMA request channel option. Default: 1/2 (DRQ3), via a trace. (W2-1 is at top.)
W3-1 W3-2 W3-3	DACK3 DACK to 53C80 DACK1	DMA acknowledge channel option. Default: 1/2 (DACK3), via a trace. (W3-1 is at top.)
W4	Term Power	Provides +5 volts termination power to pin 26 of the SCSI Bus. Default: unshorted.
W6	53C80 IRQ	Connects 53C80's interrupt output to PC bus IRQ5. Default: unshorted
No termination power protection diode is provided on the board. W4 must NOT be installed if any other bus device supplies termination power, or board damage may result!		

2.6 PC EXPANSION BUS - J9

A PC compatible expansion bus appears at connector J9, except that it is brought out to a *header connector*, rather than edgcard connectors.

The board's PC Expansion Bus connects to the first 62 pins of J9; the two additional pins of J9 (A32, B32) offer additional ground signals, for enhanced system reliability. PC Expansion Bus connector pinouts are given later in this chapter.

Table 2-25 shows the pinout and signal functions of the signals on the board's PC Expansion Bus and MiniModule headers. Further information about these signals is available in numerous publications, including the IBM technical reference manuals for the PC computer, and from the reference documents listed in the beginning of Chapter 4.

Note that the board's PC Expansion Bus and MiniModule connector pins are numbered differently from the other header connectors on the board, so that they correspond to the scheme normally used on the PC Expansion Bus. Specifically, rather than being designated *numerically* (1, 2, 3, etc.) the signals of the PC Expansion Bus are designated *alpha-numerically* (A1, A2, ..., B1, B2, ..., etc).

PC Expansion Bus signals are buffered on the board and provide approximately 4 mA source and sink currents for peripheral cards, with TTL compatible signal levels at a logic "low" level of 0.4 Volts.

2.6.1 Onboard MiniModule Header and Bus Expansion

An important feature of the Little Board/PC is its onboard MiniModule header. A header connector at J9 provides a PC Expansion Bus interface for use with one of Ampro's 3.6" x 3.8" expansion MiniModules. When installed on J9, the onboard expansion module fits within the Little Board/PC's space envelope. The onboard expansion module provides a *bus pass-through* connector, allowing additional external bus expansion when the module is installed.

Several options are available for mounting multiple MiniModules on the Little Board/PC:

- **Stacker/MM** -- Allows two MiniModules to be stacked together and mounted as a single unit.
- **StackPlane/MM** -- Provides two expansion bus header connectors for mounting MiniModules on a Little Board form-factor board. When used with the Stacker/MM, up to four MiniModules can be attached. The SSD Expansion board also offers two expansion bus header connectors for mounting MiniModules.

Ampro currently offers several display controller MiniModules which offer a wide variety of standard PC and AT video modes, including VGA, EGA, CGA, MDA, and Hercules display compatibility, on CRT monitors, LCD panels, and electroluminescent (EL) panels. Ampro also offers additional MiniModules, including serial/parallel interfaces, modems, etc. Contact Ampro for information on additional MiniModules.

2.6.2 Using Standard PC Bus Cards

There are several options available from Ampro which allow you to add expansion cards to the Little Board/PC system:

- **StackPlane/PC Expansion Adapter** -- a board having the identical dimensions and mounting points as the Little Board/PC. This adapter converts a single short (8 inches or less) PC add-on card to the Little Board form factor. The StackPlane/PC adapter piggy-backs above or below the Little Board/PC and connects to the PC Expansion Bus by means of a short ribbon cable. Several StackPlane/PC adapter assemblies can be stacked.
- **MiniBackplane/PC** -- two-slot PC bus passive backplane with PC bus header for cable connection to the PC Expansion Bus header on the Little Board/PC.
- **PC Backplane Adapter** -- small circuit card which plugs into one edgecard connector on any PC bus passive backplane, and provides a PC bus header for cable connection to the PC Expansion Bus header on the Little Board/PC.
- **Cable-Mount Edgecard Sockets** -- 62-pin edgecard connectors can be used to construct a ribbon cable which can connect the Little Board/PC's PC Expansion Bus *directly* to a PC plug-in expansion card using ribbon cable only. The edgecard sockets are available from

PCD Connectors
Winchester, MA
(617) 721-1280

RF31-2582-5 (62-conductor edgecard socket)

Contact an Ampro sales representative for further information on these optional bus expansion products.

2.6.3 Expansion Bus Cable Considerations

Here are several points regarding the use of the board's AT Expansion Bus:

- **Cable Length** -- *Keep the ribbon cable used as short as possible.* Expansion bus cables in excess of six inches can result in reduced system reliability. We recommend:
 - For cable lengths up to 6 inches, use a high quality ribbon cable, such as 3M part number 3365/64 (64 conductor).
 - For cable lengths between 6 and 12 inches, use a high quality ribbon cable *with ground plane*, such as 3M part number 3353/64 (64 conductor).
 - Cable lengths in excess of 12 inches are not recommended.

- **Backplane Quality** -- Be sure to use a high quality backplane having minimal signal crosstalk. Use of power and ground planes, and ground guard traces between bus signals is recommended.
- **Reset Deglitching** -- Some PC bus expansion cards have asynchronous TTL inputs that are especially vulnerable to cable noise and crosstalk. In particular, the active high RESET line is one to watch out for. If this signal is found to be susceptible, a 200pf to 500pf capacitor connected between the RESET signal and ground can be used to prevent false expansion card resets. This RESET deglitching capacitor is included on the Ampro MiniBackplanes.

2.6.4 Expansion Bus Connector Pinouts

Tables 2-25A and 2-25B indicate the pinout and signal functions of the signals on the board's PC Expansion Bus connectors. Further information about these signals is available in numerous publications, including the IBM technical reference manuals for the PC computer, and from the reference documents listed in the beginning of Chapter 4.

The board's PC Expansion Bus header connector (J9) pins have been numbered differently from the other header connectors on the board, so that they correspond to the scheme normally used on PC bus edgecard connectors. The even numbered pins correspond to the "B" row of the PC bus; and the odd numbered pins correspond to the "A" row (e.g., J9 pin 1 is labeled "B1"). The first 62 pins of J9 (beginning at A1 and B1) are the ones which correspond to the 62 conductors of the PC Expansion Bus of the PC backplane. The last two pins are spare grounds.

Note that the Little Board/PC does not generate +/- 12VDC or -5VDC for the PC Expansion Bus. If devices on the PC Expansion Bus require these voltages, they can be supplied to the PC Expansion Bus connector from the board's utility connector (J4).

Table 2-25A. PC Expansion Bus Connector, A1-A32 (J9)

PIN	SIGNAL NAME	FUNCTION	IN/OUT
A1	-I/O CH CK	Memory parity error	in
A2	D7	Data bit 7	i/o
A3	D6	Data bit 6	i/o
A4	D5	Data bit 5	i/o
A5	D4	Data bit 4	i/o
A6	D3	Data bit 3	i/o
A7	D2	Data bit 2	i/o
A8	D1	Data bit 1	i/o
A9	D0	Data bit 0	i/o
A10	I/O CH RDY	Processor Ready Ctrl	in
A11	AEN	Address Enable	out
A12	A19	Address bit 19	out
A13	A18	Address bit 18	out
A14	A17	Address bit 17	out
A15	A16	Address bit 16	out
A16	A15	Address bit 15	out
A17	A14	Address bit 14	out
A18	A13	Address bit 13	out
A19	A12	Address bit 12	out
A20	A11	Address bit 11	out
A21	A10	Address bit 10	out
A22	A9	Address bit 9	out
A23	A8	Address bit 8	out
A24	A7	Address bit 7	out
A25	A6	Address bit 6	out
A26	A5	Address bit 5	out
A27	A4	Address bit 4	out
A28	A3	Address bit 3	out
A29	A2	Address bit 2	out
A30	A1	Address bit 1	out
A31	A0	Address bit 0	out
A32	GND	Ground	---

Table 2-25B. PC Expansion Bus Connector, B1-B32 (J9)

PIN	SIGNAL NAME	FUNCTION	IN/OUT
B1	GND	Ground	---
B2	RESET	System reset signal	out
B3	+5V	+5 volts power	---
B4	IRQ2	Interrupt request 2	in
B5	-5V	From J4 pin 9	
B6	DRQ2	DMA request 2	in
B7	-12V	From J4 pin 10	
B8	N/C	(no connection)	
B9	+12V	From J4 pin 8	
B10	GND	Ground	---
B11	-MEMW	Memory Write	out
B12	-MEMR	Memory Read	out
B13	-IOW	I/O Write	out
B14	-IOR	I/O Read	out
B15	-DACK3	DMA Acknowledge 3	in
B16	DRQ3	DMA Request 3	out
B17	-DACK1	DMA Acknowledge 1	out
B18	DRQ1	DMA Request 1	in
B19	-DACK0	Memory Refresh	out
B20	CLOCK	7.16 MHz clock.	out
B21	IRQ7	Interrupt Request 7	in
B22	IRQ6	Interrupt Request 6	in
B23	IRQ5	Interrupt Request 5	in
B24	IRQ4	Interrupt Request 4	in
B25	IRQ3	Interrupt Request 3	in
B26	-DACK2	DMA Acknowledge 2	out
B27	T/C	DMA Terminal Count	out
B28	ALE	Address Latch Enable	out
B29	+5V	+5 volts power	---
B30	OSC	14.31818 MHz clock	out
B31	GND	Ground	out
B32	GND	Ground	out

CHAPTER 3

SOFTWARE CONFIGURATION

3.1 INTRODUCTION

This chapter provides an overview of the system features, configuration options, and utilities that are available under the DOS operating system. A combination of standard DOS and Ampro-supplied utilities and drivers allows you to create a highly customized system based on the Little Board/PC.

Assuming you have connected the Little Board/PC to a monitor, keyboard, and floppy drive as described in Chapter 2, you should have no difficulty booting the system under DOS. You will probably want to take advantage of the flexibility designed into the Little Board/PC ROM-BIOS and utilities software to create a customized DOS-based installation. You can tailor your software configuration to a wide variety of hardware configurations, as indicated in Chapter 2. This chapter provides a discussion of how to configure the operating system and utility software for many typical installations.

Some familiarity with DOS (PC-DOS, MS-DOS, or DR-DOS) is assumed. Please refer to the appropriate IBM, Microsoft, or Digital Research DOS reference manuals for further information on the use of the DOS operating system and its drivers and utilities. In addition, Appendix A of this manual contains detailed descriptions of each of the Ampro Little Board/PC driver and utility programs.

3.1.1 Conventions

In the descriptions of the use of software utilities, keyboard inputs which you will make to the system are shown underlined. This has been done to make it easy for you to distinguish between the computer's prompts and the operator's keystrokes. For example,

A>DIR<Enter>

means that you type "DIR" and then press the <Enter> key on your keyboard. (On some keyboards this key may also be labeled <Return>.)

In most cases, upper and lower case letters can be used interchangeably when you supply parameters to a program. For example:

A>SCSIPARK<Enter>

has the same effect as:

A>scsipark<Enter>

3.2 OPERATION WITH DOS

The Little Board/PC and its ROM-BIOS have been designed to allow the use of IBM PC-DOS, Microsoft MS-DOS, or Digital Research DR-DOS, versions 2.x or 3.x, and PC-DOS or MS-DOS version 4.01, as the board's operating system. Throughout this chapter, the term "DOS" will be used to refer to any of these operating systems, except in cases where a difference in operation exists.

Caution

Many variations of MS-DOS exist which have been customized for operation on specific computer systems. These cannot be expected to function properly on the Little Board/PC, and should not be used. Use "IBM PC-DOS", or use the "generic IBM compatible" version of MS-DOS *supplied directly by Microsoft on an OEM basis*, if you do not choose to use the DR-DOS operating system supplied by Ampro.

In addition to supporting the standard DOS functions, the board's ROM-BIOS internal functions are highly compatible with those of the "standard PC", allowing software which makes direct ROM-BIOS calls to function properly, without modification.

Nearly all of the hardware ports and controllers on the Little Board/PC are identical in function with those of the "standard PC". This includes the floppy controller, keyboard port, speaker port, PC serial port, parallel printer port, counter/timers, and interrupt controller. In addition, the optional Ampro MinModule/VGA, MiniModule/EGA, MinModule/CGA, and MiniModule/LCD onboard display controller modules offer the most popular PC-compatible video modes: VGA, EGA, CGA, MDA, and Hercules monochrome graphics on either CRT or LCD displays.

Although the board's DMA controller is not totally compatible, special logic in the board's ASIC devices in combination with support within the board's ROM-BIOS result in software compatibility.

The board's 8250-based "PC Serial Port" can be jumpered as either the DOS "COM1" or "COM2" port. The Parallel Printer port can be jumpered as either "LPT1" or "LPT2". These devices, as well as the keyboard and speaker ports, are supported by the ROM-BIOS in a PC-compatible manner.

The board's non-compatible "V40 Serial Port" can be substituted as a system console port (using the Ampro CONDRV device driver) command, for applications which can use a serial device for keyboard and display. Refer to the discussion of "Serial Console Option," presented later in this chapter.

The DOS and ROM-BIOS time-of-day clocks are supported in the usual manner. They can be initialized automatically by a utility to the value stored in the optional battery-backed clock module on system reset or powerup. Refer to the documentation supplied with the battery-backed clock for further details.

DOS version 3.2 (or later) is required for operation with 80-track (720K) mini- or micro-floppy drives. DOS version 3.3 (or later) is needed for use with 1.44 megabyte microfloppies, and with the optional Ampro Solid State Disk support utilities. DOS version 3 or later is required for SCSI hard disk usage under the board's ROM-BIOS and SCSI support software. In addition, support for hard disks larger than 32 megabytes is available under DR-DOS version 3.4 (or later), or under MS-DOS or PC-DOS versions 4.0 (or later).

3.2.1 Configuration Options

A wide degree of system configurability is available through options provided by: (1) the DOS operating system and its drivers and utilities; (2) the Ampro Little Board/PC Utilities; and (3) the Ampro SCSI Utilities.

The configuration options include:

- Console selection and setup
- Parallel and Serial port selection and setup
- Modem interface
- A variety of floppy disk drives
- A SCSI hard disk drive

Examples of how a typical system can be configured for many of these options are given in later in this chapter.

The following section briefly summarizes the features of the software included in the Ampro Little Board/PC utilities and drivers. Appendix A contains detailed program descriptions.

3.2.2 Little Board/PC Utilities Overview

The following drivers and utilities are contained on the Little Board/PC Utilities diskette at this time. Actual utility names and descriptions may vary, in which case appropriate "DOC" files are included on the diskettes. Each of these programs are described in Appendix A of this manual (alphabetically arranged).

- **CONDRVR.SYS** -- Allows serial display/keyboard devices connected to the non-standard V40 serial port to be used as the DOS console device.
- **PRNDRVR.SYS** -- Remaps the DOS parallel printer function to the non-standard V40 serial port.
- **SETWAIT** -- Sets CPU wait states for memory (three regions) and I/O access cycles, and for DMA and refresh operations. Two batch files, SLOW.BAT and TURBO.BAT, are provided as a convenient means of switching between the 4.77 MHz CPU emulation mode and the 7.14 MHz CPU speed.
- **SCSI-ID** -- SCSI Initiator ID test. Allows testing of the SCSI Initiator ID of the board on which the utility runs. Results testable from within batch files.
- **SCSICOMP** -- SCSI device block compare utility.
- **SCSICOPY** -- SCSI device block copy utility.

- **SCSITool** -- SCSI device exerciser and debugger.
- **SCSIFORMAT** -- Formats SCSI hard disk drives.
- **SCSIPARK** -- Hard disk park.

3.3 WAIT STATE (CPU SPEED) INITIALIZATION

One of the most important system parameters to configure is the number of wait states for the various types of CPU operations. The ROM-BIOS assumes the slowest types of devices, so that the system can boot successfully regardless of what is present in the system. Consequently, to obtain maximum performance from your system, you should set the wait state values to the minimum needed for reliable operation. This is easily accomplished with the Ampro SETWAIT utility, which is described in detail in Appendix A.

Assuming you are using the Little Board/PC in the normal manner, system RAM is all on-board and requires a single wait state. In general, PC Expansion Bus plug-in cards can run in fast PC's (like the Little Board/PC), and also only require a single wait state. The turbo configuration can be set using the SETWAIT utility, with the following long command line:

A>SETWAIT UMB32 LMB512 UMW0 MMW1 LMW1 IOW1 RFW1 DMAW1<Enter>

A batch file, TURBO.BAT, is included on the Little Board/PC Utilities diskette containing the preceding SETWAIT command line. Use the following command:

A>TURBO<Enter>

A corresponding batch file, SLOW.BAT, sets your system wait states to emulate the speed of a standard 4.77 MHz PC. You can easily switch your system between "standard" PC and "turbo" PC modes by using the SLOW and TURBO commands. (The corresponding .BAT files must be present in the system.)

You can include the SETWAIT command (from the TURBO.BAT) file as the first command in your AUTOEXEC.BAT file if you wish your system to boot in the turbo mode.

3.4 USING A PARALLEL PRINTER

No special configuration is required for using the system with a Centronics type parallel printer. Simply refer to the parallel printer as the DOS LPT1 device, and be sure the parallel printer port is properly configured as described in Chapter 2. Most application software uses LPT1 as the default printer port, so printing to the parallel printer interface is automatic if the port is jumpered that way.

For example, the following DOS commands will result in printing to the parallel printer:

A>COPY CONFIG.SYS LPT1<Enter>

..... prints contents of CONFIG.SYS

A>DIR >LPT1<Enter>

..... prints the directory

In addition, the <PrtSc> ("Print Screen") key will print the contents of the video screen to the LPT1 device. Also, the "Printer Echo" function can be used to cause all characters written to the console to also be written to the LPT1 device. The Printer Echo function is enabled with <Ctrl-P>. Printer Echo remains enabled until another <Ctrl-P> is entered.

3.5 USING THE PC COMPATIBLE SERIAL PORT

This section discusses several uses of the board's PC compatible serial port, and provides some examples of typical installations. Use of the board's non-standard V40 serial port is discussed in Section 3.6.

3.5.1 Serial Port Initialization

In general, before the board's PC compatible serial port can be used, it must be properly configured and initialized. This is sometimes done directly by the application program which will access the port's hardware, but is usually done as part of the system configuration and boot process.

The PC compatible serial port must be jumper configured as either the *primary* or *secondary* device, as described in Chapter 2.

Note

The "COMn" (n=1,2) designation is a logical value, not a physical value. During the system boot sequence, the ROM-BIOS scans both sets of serial port addresses, and installs the first serial port it locates as the COM1 device, and the second, if found, as COM2. Therefore, if you configure the board's PC serial port as a secondary port, it will be installed as "COM1", not "COM2"! There must be a COM1 (primary serial port) device elsewhere in the system for an onboard secondary serial port to be accessed as COM2.

Prior to operation, the port's baud rate and data characteristics must be initialized to match the requirements of the external devices that will be connected. One way to set (and alter) the PC compatible serial port's baud rate and data characteristics is by means of the DOS MODE command. Here is how you might use the MODE command to initialize the primary port (COM1) port to 9600 baud, no parity, 8 data bits, and 1 stop bit:

```
MODE COM1:9600,n,8,1
```

In many cases it is not necessary to use a mode command, because the software which will operate the serial port will initialize the port when it loads.

3.5.2 Using a Serial Printer

Serial printers can be connected to the board's PC compatible serial port as well.

You can instruct DOS to print to the appropriate serial port (COM1 or COM2) instead of to the Parallel Printer port (LPT1 or LPT2) with the DOS MODE utility. For example, the following command makes the COM1 serial device become the system's default printer device:

```
A>MODE LPT1=COM1<Enter>
```

Now you can print to the serial printer as though it is connected to the system's parallel printer port.

You can return the printer device to the Parallel Printer port with the following command:

```
A>MODE LPT1<Enter>
```

If desired, MODE commands can be included in your system's AUTOEXEC.BAT startup file to assign the printer function to a serial port. Also, additional MODE commands can be used in other batch files to dynamically reassign the DOS printer device function as often as required during system operation.

Printer Cabling and Setup

The printer must be set for a suitable baud rate, and appropriate data and handshake signals must be connected between the computer's and the Printer's serial connectors. In particular, be sure to connect the serial port's "Ready to Receive Data" handshake output signal to the serial port's Clear to Send (CTS) input handshake input signal. In addition, the board's Data Set Ready (DSR) *input handshake signal must be true*, for the ROM-BIOS to send output data, so connect that signal to an appropriate handshake output signal from the printer, or loop it to the board's DTR output signal.

3.5.3 Using a Serial Modem

Most PC communications programs control the serial port hardware directly, rather than using DOS or ROM-BIOS functions. When configured as described in Chapter 2, the board's PC compatible serial port is fully compatible with those of standard AT's and PC's, so all such software should work properly.

When connecting a serial modem, be sure to connect appropriate input and output handshake signals, depending on what is required by the communications software you use. Most communications programs take care of initializing the serial port baud rate and data characteristics; if not, be sure to use the DOS MODE command to initialize the port.

A number of powerful communications programs are available which can be used to control communications applications via a modem. Several of these programs offer powerful "script" languages which allow you to generate complex automatically functioning applications with very little programming effort. Examples are: PCTALK, PROCOMM, XTALK, and MIRROR.

3.6 USING THE NON-STANDARD V40 SERIAL PORT

As discussed previously, the non-standard V40 serial port generally requires custom or modified software for its use. Chapters 4 and 5 provide technical information for use by engineers and programmers regarding use of this port.

Two Ampro device drivers simplify the use of this port as either a serial console port or as a serial printer port. These applications are discussed briefly in the following paragraphs, and are described in detail in Appendix A.

3.6.1 Serial Console Option

In many *embedded* applications it is desirable to substitute an RS232C serial device (terminal, remote computer, or other serial device) for the video controller, monitor, and keyboard normally used as the PC console device. The serial console device can be connected to the board's non-standard V40 serial port. The Ampro CONDRVR.SYS device driver contains the required support for serial console input and serial console output. Serial console support parameters are specified in the CONFIG.SYS file, using the CONDRVR.SYS device driver as described in Appendix A.

Note

Many DOS programs use ROM-BIOS display control functions, or write directly to video RAM. Such software cannot be used on a serial console device (e.g. ASCII terminal), with the exception of programs intended to be used with the DOS ANSI.SYS driver if the terminal is ANSI compatible. On the other hand, programs which output appropriate terminal control strings to the console, or which are specifically installed for the particular serial display device, can be used.

3.6.2 Serial Printer Option

By using the Ampro PRMDRVR.SYS device driver supplied with the Little Board/PC, you can use the board's non-standard V40 serial port as a DOS LPT1 printer device. This is useful in installations where use of a serial printer is required.

For additional information, refer to the description of the PRNDRVR.SYS device driver in Appendix A.

3.7 USING FLOPPY DRIVES

DOS compatible floppy disk functions are provided within the ROM-BIOS. Diskettes may be copied, formatted, verified, etc. using the standard DOS commands. This includes all of the DOS mini (5-1/4") and micro (3-1/2") floppy formats -- 160K, 180K, 320K, 360K, 720K, 1.2M, and 1.44M -- provided the appropriate version of DOS is used (see Chapter 2). In addition, dual capacity use of high density floppy drives is supported, which means that 360K floppies can be read in a 1.2M 5-1/4" drive, and 720K floppies can be read in a 1.44M 3-1/2" drive.

The Little Board/PC has a number of configuration jumpers which must be set according to the number and type of floppy drives connected to the system. Be sure to set the jumpers as described in Chapter 2.

One handy feature of DOS is its built-in support for single-drive systems. If you jumper the board for only one floppy drive, the operating system will automatically assign drive letters "A" and "B" to the single floppy drive. With this configuration, you can copy files between two diskettes on one drive, as though your system has two drives; DOS will prompt you to change diskettes when needed.

3.8 USING SCSI HARD DISK DRIVES

One unique feature of the Little Board/PC is that its ROM-BIOS contains PC/XT compatible hard disk support functions which map to the board's Small Computer System Interface, rather than to a standard PC bus hard disk controller. This has the advantage of offering the added flexibility of SCSI device support, with its benefits of interchangeability of peripherals, flexibility of configuration, and ease of system upgrading and support.

A hard disk device accessed via the board's SCSI interface is available to DOS through standard ROM-BIOS functions (INT 13), supplied by the Ampro SCSI/BIOS contained within the board's ROM-BIOS. The ROM-BIOS hard disk support allows direct system booting from a SCSI Common Command Set *direct access device*. In addition to hard disks, other types of SCSI *direct access devices* can be used interchangeably to provide a fully compatible hard disk function. These include bubble memory drives, RAM disks, optical disks, and tape drives.

Virtually all DOS applications run normally in this SCSI-based hard disk environment, because programs nearly always use either DOS or ROM-BIOS functions for disk drive access. It is extremely rare for DOS environment software to attempt to access hard disk controller *hardware* directly. If a program does require disk controller *hardware* access, it will need to be modified to use the board's SCSI hardware or SCSI/BIOS functions. In this case, low level SCSI functions available within the board's ROM-BIOS can be used to simplify the task.

In most cases, a SCSI hard disk drive can be used without the need for custom programming. The board's ROM-BIOS and SCSI support software allow the use of one hard disk drive under PC-DOS, MS-DOS, DR-DOS.

A combination of Ampro and DOS utilities are used in the formatting and preparation of SCSI hard disk drives. Included on the Ampro utilities diskette are utilities for SCSI drive formatting, parking, and other SCSI functions.

3.8.1 Hardware Preparation

Both the Little Board/PC and the SCSI device must be configured prior to use. The following information describes points to consider when configuring the board and the SCSI device.

- **SCSI Initiator ID** -- The Ampro Little Board/PC is the SCSI *Initiator* in its transactions with SCSI *Target* devices such as hard disk drives. Every SCSI device (Target or Initiator) must have a unique ID, between 0 and 7. Usually, the Ampro Little Board/PC is set for "7", because this is the highest priority ID, and because the Ampro SCSI/BIOS performs a SCSI bus Reset function on system powerup or reset when the CPU board's ID is 7. Set the Little Board/PC's ID to 7, as described in Chapter 2.
- **SCSI Target Device ID and LUN** -- Every SCSI Target device must have a SCSI ID, between 0 and 7, normally set by jumpers or switches on the device. For use as a DOS boot device, the SCSI drive must be configured as Target ID 0, LUN 0, as defined in the SCSI device's technical documentation.

3.8.2 Preparation for DOS Use

Before you can use a hard disk drive connected to the board's SCSI port, it must be properly connected and jumpered, as indicated above. In most cases, formatting and other preparation for use with DOS is a simple process, and can be accomplished as indicated in this section. For additional details on the installation and preparation of SCSI disk drives, refer to the detailed program descriptions in the Appendix of this manual.

The following is a brief procedure you can use to prepare a SCSI hard disk drive for use with DOS:

1. **"Low Level" Formatting** -- The low level format erases all data from the drive and prepares it for use. In many cases, the low level format function eliminates bad blocks from the usable area of the drive, by using spare blocks to replace bad ones. Most embedded SCSI drives are factory formatted. However, it is best to perform a low level format prior to using a drive for the first time. Use the Ampro SCSIFMT utility (see Appendix A) to perform the low level format of the drive. The drive must be SCSI *Common Command Set* ("CCS") compatible, to be formatted by the SCSIFMT utility.
2. **Drive Partitioning** -- Reboot the system from a floppy diskette in drive A containing the operating system, and run the DOS FDISK utility in the manner described in your DOS documentation. You may be creating one or multiple partitions, depending on the size of the drive and the partition limitations of the particular DOS you are using.
3. **Final Preparation for System Access** -- Again, reboot the system from a floppy diskette in drive A. What you do next varies, depending on what operating system you are using.

DR-DOS: Run the DOS "SYS" command, to copy the operating system to the hard disk drive that you have created in the above steps. Finally, copy anything else you need to the drive, and then reboot the system *without the floppy diskette in drive A*, to verify that everything has been installed properly.

PC-DOS or MS-DOS: Use the "FORMAT /S" command, to copy the operating system to the DOS *boot* drive ("drive C"); or the "FORMAT" command, in case of drive partitions other than the DOS boot partition. Finally, copy anything else you need to the drive, and then reboot the system *without the floppy diskette in drive A*, to verify that everything has been installed properly.

CHAPTER 4

THEORY OF OPERATION

4.1 INTRODUCTION

This chapter is intended to provide a basic technical understanding of the Little Board/PC for hardware engineers, programmers, and system integrators.

The functioning of many of the board's devices is dependent on a variety of programming options. Therefore, to explain the normal functions performed by these devices as used on the Little Board/PC, some reference is made to the board's ROM-BIOS default device configurations and programming.

Figure 4-1 shows a block diagram of the Little Board/PC's onboard functions.

4.2 TECHNICAL REFERENCES

To fully understand the capabilities and functioning of the board, refer to the following technical documents:

Technical data on the V40 CPU:

uPD70208/70216 User's Manual
NEC Electronics Inc.
Corporate Headquarters
401 Ellis Street
P.O. Box 7241
Mountain View, CA 94039
Phone: (415) 965-6158

Technical data on the 37C65B Floppy Controller:

37C65B Technical Specification
Western Digital Corporation
2445 McCabe Way
Irvine, CA 92714

Technical data on the 53C80 SCSI Controller:

53C80 SCSI Interface Chip Design Manual
NCR Microelectronics Division
1635 Aeroplaza Drive
Logic Products Marketing
Colorado Springs, CO 80916
Phone: (800) 525-2252

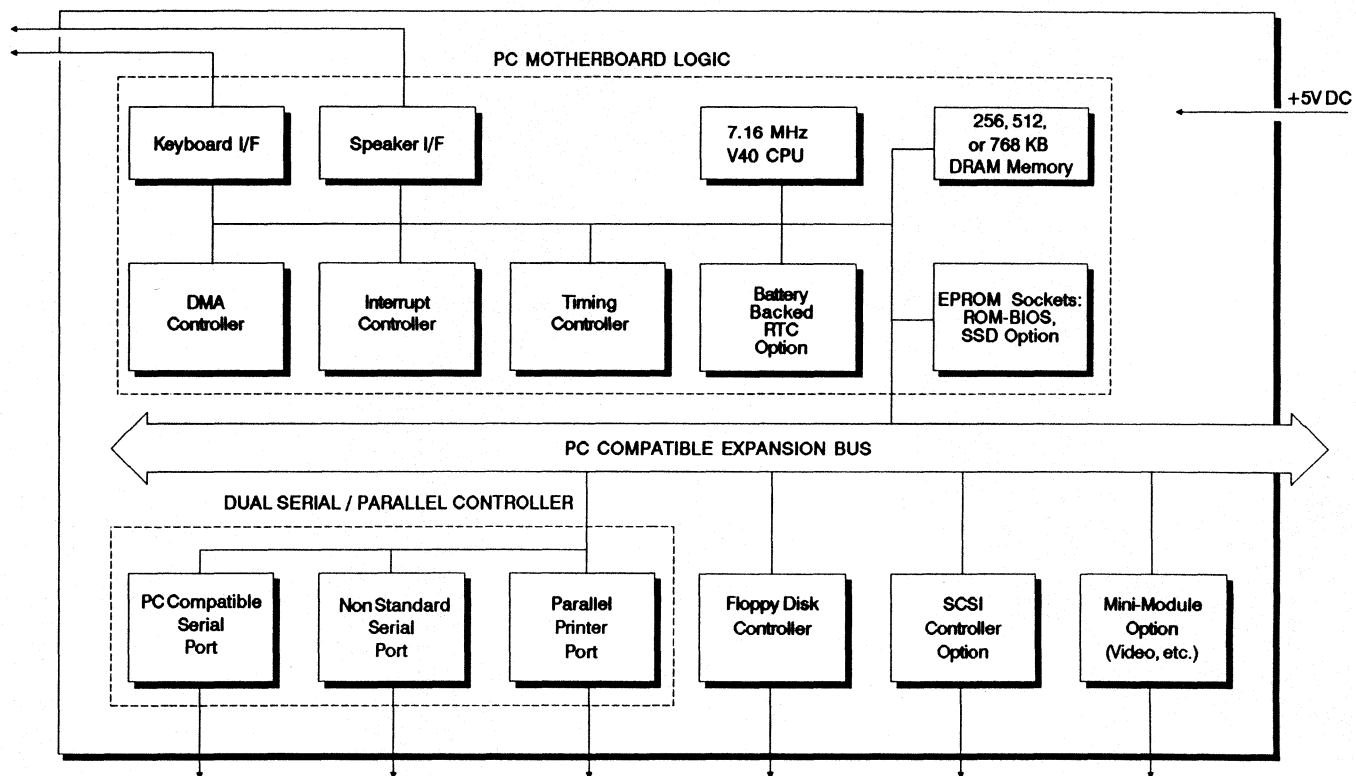


Figure 4 - 1. Little Board / PC Block Diagram

Technical data on the 8250 Serial Controller:

8250 Technical Specification
National Semiconductor Corporation
2900 Semiconductor Drive
Santa Clara, CA 95051

Technical data on the RS223C buffers:

MAX232 Data Sheet
Maxim Integrated Products, Inc.
510 N. Pastoria Avenue
Sunnyvale, CA 94086

The specification on the Small Computer System Interface (SCSI) can be obtained from:

ANSI X3.131 Specification
American National Standards Institute
1430 Broadway
New York, NY 10018

In addition, the following general references are recommended:

The Peter Norton Programmer's Guide to the IBM PC
Microsoft Press
A Division of Microsoft Corporation
10700 Northrup Way
Box 97200
Bellevue, Washington 98009

Interfacing to the IBM Personal Computer
Lewis C. Eggebrecht
Howard W. Sams & Co., Inc.
A Subsidiary of Macmillan, Inc.
4300 West 62nd Street
Indianapolis, IN 46268 USA

4.3 CPU AND GENERAL ARCHITECTURE

The V40 CPU, operating at a 7.16 MHz clock frequency, is the central element in the Little Board/PC. It supports a superset of the Intel 8088/8086 microprocessor instructions, including compatibility with the 80188/80186 extensions. The V40 also provides an 8080 emulation mode which allows it to execute 8-bit 8080 programs.

The V40 CPU can directly address 1 megabyte of memory via 20 address lines. The V40's address, data, and control signals are demultiplexed by a set of latches, buffers, and part of an application specific IC, "ASIC1." The demultiplexed addresses form the internal system address bus, and are also brought out directly to the PC bus as the system address lines. The demultiplexed data lines are distributed as an internal system data bus. On this internal system bus are the three byte-wide memory sockets, three SIMM DRAM modules, and the printer, keyboard, and speaker interfaces.

Buffers and control logic, including a second application specific IC ("ASIC2"), generate the board's "PC Expansion Bus" interface. In addition to its function as a system expansion bus, the PC Expansion Bus is also utilized as an onboard bus, for access to three key onboard peripheral interface subsystems: the floppy disk interface; the SCSI bus interface and ID port; and the PC serial port.

4.4 V40 INTERNAL PERIPHERALS

In addition to its function as an 8088/8086/8080 compatible CPU, the V40 provides a substantial portion of the CPU peripheral functions needed to make up the PC architecture. These include:

- Interrupt controller
- Counter/timers
- DMA controller
- DRAM refresh controller
- Programmable wait state generator
- Full duplex asynchronous serial port

All of these peripheral devices are completely internal to the V40. They are configured and accessed by reading and writing a set of reserved I/O ports. These internal V40 devices (except the serial port) are described further in the following paragraphs. The serial port is described later in this chapter.

4.4.1 Interrupt Controller

The interrupt controller within the V40 provides a superset of the functionality of the 8259A interrupt controller normally used in a standard PC, and is software compatible with that device. Six of the seven interrupt sources are connected directly to the corresponding signals on the board's PC Expansion Bus. In addition, they are normally assigned to the board's onboard I/O interfaces in the following manner, which maintains compatibility with the PC:

- IRQ7 -- Parallel printer
- IRQ6 -- Floppy disk controller
- IRQ5 -- Available (SCSI controller option)
- IRQ4 -- PC serial port
- IRQ3 -- Available (PC serial port option)
- IRQ2 -- Available
- IRQ1 -- Keyboard
- IRQ0 -- Hard-wired (within the V40) to counter/timer channel 0

As indicated, interrupt input IRQ0 is hard-wired internally to counter/timer channel 0, which corresponds to the PC's real-time clock interrupt. IRQ5, though available for the on-board SCSI bus controller, is not currently used.

4.4.2 Counter/Timers

The counter/timer controller (CTC) within the V40 provides the same functionality as the 8253 CTC device normally used in a standard PC, and is software compatible with that device.

The 7.16 MHz master system clock is divided by 6 within ASIC1, resulting in a 1.193 MHz timebase clock which is provided to the V40's "TCLK" input for use by the CTC. This provides a PC-compatible timebase for use by each CTC channel.

The V40's three counter/timers are normally utilized by the board's ROM-BIOS as follows:

- CTC0 -- Generates 18.2 interrupts per second via IRQ0. Used by DOS to maintain the system's real time clock.
- CTC1 -- Used for baud rate generation to support the V40's internal serial port. (On a PC this channel is used for DRAM refresh timing.)
- CTC2 -- Generates tones for the speaker. The output of timer channel 2 is connected to ASIC2 and acts as the basic tone source for the Little Board/PC's sound circuits.

In a standard PC, timer channel 1 is used to trigger DMA channel 0 for DRAM refresh cycles. Since the Little Board/PC has its own refresh control unit, this timer channel is available for the internal serial port's baud rate generator.

4.4.3 DMA Controller

The V40 CPU has four independent DMA channels. They provide full 20-bit address registers and 16-bit byte count registers. In addition the V40's DMA controller features:

- Three types of transfer modes: single byte, demand, and block.
- Two types of bus access priority modes: release and hold.
- Two types of channel access priority: fixed and rotating
- Automatic channel reinitializing.

The modes and methods used to program the V40's DMA controller are described in detail in the V40's User's Manual.

Although the V40 DMA controller's 20-bit address registers are useful in directly accessing the system's full memory space, this and other slight differences from a standard PC's 8237A DMA controller would tend to result in incompatibilities with PC software that attempts to directly access the DMA controller's internal registers.

To make the Little Board/PC's DMA "compatible", special hardware (in ASIC1) has been included, which masks the differences between the V40's DMA controller and the 8237A DMA controller used on a standard PC. This "8237A emulation" is completely transparent to software, with the result that software that runs on PC's and compatibles can run without modification on the Little Board/PC.

8237A Emulation

To accommodate the board's 8237A emulation, the V40's DMA controller registers are actually located at unique I/O port addresses, rather than at the I/O addresses normally occupied by the PC's 8237A DMA controller (see Chapter 5). The 8237A emulation logic recognizes CPU accesses to the DMA controller and issues an NMI (non-maskable interrupt). The board's PC compatible ROM-BIOS detects when NMI's are generated by access to the DMA controller (as opposed to other NMI sources) and converts the 8237A-like DMA controller software sequences into proper V40 DMA controller accesses.

DMA Channel Mapping

Because the V40's DMA Channel 4 shares several pins with its internal serial port, the two functions cannot both be used simultaneously. On the Little Board/PC, the serial port option rather than the DMA Channel 4 option is implemented. Therefore only channels 0, 1, and 2 of the V40's DMA controller are available for use in system I/O. Similarly, the standard PC's 8237A DMA controller provides four DMA channels, but only three of these are available for use in system I/O because DMA channel 0 is used for DRAM refresh.

Consequently, to provide PC DMA channel compatibility, the Little Board/PC's 8237A emulation logic and software perform a second function, which is to remap the three available V40 DMA channels (0, 1, and 2) into the three required PC DMA channel assignments (1, 2, and 3). This is illustrated in Table 4-1.

Table 4-1. DMA Channel Remapping

STANDARD PC DMA CHANNEL	ACTUAL V40 DMA CHANNEL	ASSIGNMENT
1	0	Available to user
2	1	Floppy disk controller
3	2	SCSI controller (fixed disk)

Since DMA channel 0 in a PC is used for DRAM refresh, the PC Expansion Bus does not provide a pin for "DRQ0." "DACK0" does appear on the PC Expansion bus, to let expansion cards know when a DRAM refresh cycle is taking place. The Little Board/PC also provides a DACK0 signal, based on the V40's DRAM refresh signal.

One unique characteristic of the V40'S DRAM refresh logic is that it will often do "burst" refreshes in which several refreshes occur back-to-back with no other CPU cycles intervening. Be sure not to use PC bus expansion cards whose proper functioning depends on regular 15 microsecond refresh pulses.

Emulation Performance

Although the board's 8237A emulation logic allows the board's DMA controller to be accessed like a PC DMA controller in the "normal" manner, the board's DMA controller can actually be accessed in two ways:

- (1) Indirectly (via the 8237A emulation logic and BIOS routines), as an 8237A, using the standard PC channel assignments and I/O addresses.
- (2) Directly, as a V40 DMA controller (which it is!), using the actual channel assignments (see Table 4-1) and I/O addresses (see Chapter 5).

Since the DMA controller's internal registers are only accessed once for each block of DMA data transferred, the overall system performance is not significantly affected by using indirect access via the 8237A emulation function. However, to obtain maximum performance, the V40 DMA controller's internal registers can be directly accessed instead.

4.4.4 Wait State Control

The number of wait states for memory, I/O, refresh, and DMA are all independently controlled by the programming of a group of internal registers within the V40. As a set, these are called the WCU or Wait Control Unit. Up to three wait states can be inserted. In the case of memory, the address space can be divided into three regions, and each region can be independently specified. The default programming of the V40's WCU is shown in Chapter 5.

The requirements for on-board memory wait states are discussed in the sections on onboard memory options, below. If memory devices are to be added via a plug-in card on the PC bus, it may be necessary to increase the number of wait states.

In general, two memory wait states are required to approximate the timing of a standard 4.77 MHz PC's expansion bus memory access cycle. This is calculated as follows:

At 4.77 MHz (a standard PC clock rate), a clock period is approximately 210 nsec. Memory accesses on a PC are four cycles long, or 840 nanoseconds. At 7.16 MHz (the clock rate of the Little Board/PC), a clock period is approximately 140 nsec. Therefore, to calculate the factor needed to emulate the standard PC's timing on the Little Board/PC, divide 840 by 140, which results in a requirement for six 7.16 MHz cycles per memory access. This means that two wait states should be added to each memory access cycle.

It is also possible to approximate the I/O timing of a standard PC by adding wait states. In the standard 4.77 MHz PC, all I/O cycles have one wait state and therefore take five clock cycles. A calculation similar to that shown above for PC expansion bus memory accesses results in a requirement for three wait states, to simulate standard PC I/O accesses on the PC Expansion Bus.

Onboard DRAM memory timing requires that refresh cycles have a single wait state. If slower DRAM memory is added to the system via the PC expansion bus, the number of refresh wait states may have to be increased, up to the available maximum of three.

Little Board/PC DMA transfers require either 9 or 5 cycles, depending on the setting of W48. Regardless of the setting of W48, 4 cycles for the DMA transfer occur. If W48 is jumpered to 2/3, 5 additional wait states are automatically added by the board's hardware. If W48 is jumpered to 1/2, one or more additional wait states are added by the V40's wait state logic. The Ampco SETWAIT utility is typically used to initialize the V40's wait state logic. A single additional wait state is usually sufficient unless there are slow devices present on the PC expansion bus.

Check the specifications of any expansion cards you will be using, to see if additional wait states are actually required. Most expansion boards are now designed to be used with "turbo" PC's and AT's, and should handle the Little Board/PC's fast bus access without the requiring additional wait states.

4.5 ONBOARD MEMORY

The Little Board/PC provides sockets for four categories of onboard memory, including dynamic RAM (DRAM), EPROM, and byte-wide volatile and nonvolatile static RAM. These are now discussed further.

4.5.1 DRAM Sockets

The board has three positions for "SIMM" DRAM modules each of which consist of nine 256K x 1 bit DRAM IC's (or two 256 x 4 bit and one 256K x 1 bit IC's) and provide eight bits of RAM plus parity.

Control timing for the three SIMM DRAM modules is generated by ASIC1. It multiplexes the address lines into row and column addresses, and generates the required RAS and CAS signal timing. A single RAS signal and three CAS signals (one for each SIMM module) are provided.

DRAM refresh in a standard PC is accomplished by using CTC channel 1, DMA channel 0, and several additional external devices. On the Little Board/PC, these are not required due to the availability of a dedicated refresh controller within the V40 CPU. In addition, the V40's refresh request (REFRQ) signal is used to generate the DACK0 signal on the PC Expansion Bus, providing a refresh signal for expansion cards plugged into the bus.

Like the standard PC, the Little Board/PC includes a parity bit for each byte of DRAM storage. The parity bit is set or reset when a byte is written to the DRAM, and tested when the byte is read. (The parity bit is set true if there is an odd number of 1's in the memory byte, and set false if there is an even number.) The parity control logic is contained within ASIC2. When a parity fault is detected, ASIC2 generates an NMI to the CPU, whereupon PC-DOS displays an error message and halts the computer.

Jumper W21 on the board allows you to use 8-bit SIMM DRAM strips (without the parity bit) when it is shorted.

The SIMM DRAM requires at least one wait state for 150 nanoseconds access time DRAM's. It is not possible to use faster DRAM's to eliminate this wait state.

4.5.2 EPROM Socket (U21)

The socket at U21 normally contains a 27256 (32K byte) EPROM, programmed with a PC compatible ROM-BIOS and Ampro SCSI/BIOS. This socket is enabled with a strobe generated by ASIC1 for system memory reads in the address interval F8000h through FFFFFh.

Note that the Little Board/PC must have an EPROM installed in this socket to provide the V40's startup jump vector. At startup (following reset), the V40 executes the instruction at memory location FFFF0h, which is usually a jump to the beginning of the system initialization code.

Devices with an access time of 250 nanoseconds or less can be used without wait states.

4.5.3 Byte-Wide Sockets (U15 and U26)

The two 28-pin byte-wide memory sockets at U15 and U26 support a variety of 28-pin JEDEC pinout memory devices, including EPROM, static RAM, EEPROM, page-addressed EPROM, and nonvolatile RAM (NOVRAM) modules and cartridges. Chapter 2 includes a table indicating the types and capacities of the memory devices each socket will hold. Ampro's solid state disk (SSD) support within the ROM-BIOS and optional SSD support software treats these sockets as one or two DOS disk devices, containing as much as 1 megabyte of SSD storage (both sockets combined).

U15 is enabled with a strobe generated by ASIC1, conditioned by the board's memory control logic, for system memory reads or writes in the memory address interval F0000h through F7FFFh. The configuration of a set of jumpers determines whether the strobe for this socket decodes a 32K or 8K address block, and whether the device is read-only or read/write, and what type of device is installed.

U26 is enabled with a strobe generated by the board's memory control logic, for system reads within the address interval E0000h through EFFFFh. A number of board jumper options are provided to configure the starting memory address (eight choices) and installed device type.

Devices with an access time of 200 nanoseconds or less can be used in either U15 or U26 without wait states. When using wait states, add 140 nanoseconds of access time for each wait state programmed. The default on power-up is two wait states.

4.6 ONBOARD I/O INTERFACES

The Little Board/PC has seven on-board I/O interfaces, which can be architecturally divided into two sections: "internal" and "external" (see Figure 4-1).

The internal section includes four I/O interfaces which are accessed by means of the system's internal address, data, and control buses. They are:

- V40 serial port
- Parallel printer port
- Keyboard port
- Speaker port

The external section includes three I/O interfaces that are connected to the board's PC Expansion Bus as though they were PC bus plug-in cards. They are designed to mimic entire individual peripheral expansion cards normally present on a PC bus. Due to advances in component technology, each functional element is essentially contained within a single VLSI integrated circuit. The three external I/O interfaces are:

- SCSI controller (and ID port)
- Floppy disk controller
- PC compatible serial controller

The internal and external peripheral controllers are described in the following paragraphs.

4.6.1 V40 Serial Port

As mentioned previously, the Little Board/PC implements the V40's internal serial port controller rather than the 4th DMA channel option. In this mode, the V40's "DACK3" and "DRQ3" pins become serial data out and serial data in, respectively.

Because of limitations in the V40's interrupt logic, the V40 serial port cannot be interrupt driven unless the interrupt (IRQ1) normally used for keyboard interrupt is not required. IRQ1 is internally multiplexed within the V40, and the ROM-BIOS initialization routines select the external IRQ1 input (driven by the keyboard logic) as the source of IRQ1 rather than the V40 internal serial controller logic.

Baud rate generation for the V40 serial port is entirely internal to the V40, and is based on the V40's internal counter/timer channel CTC1. Standard baud rates up to 19.2K bits/second are supported (limited by the RS232C drivers).

The V40 serial port's TTL-level serial I/O signals are converted to and from RS232C signal levels by unique +5-volt-only RS232C interface IC's which internally generate the +/-9 volts needed to support the RS232C output signal levels.

Handshake Signals

In addition to data input and output, the V40 Serial Port's RS232C interface includes one active handshake signal in each direction and one always-true output signal. These are typically utilized as Request to Send (RTS) and Clear to Send (CTS) signals, but can be used in any desired manner. The always-true output signal can be used by peripherals that require a Data Terminal Ready (DTR) or similar static signal.

The input handshake signal is part of the same I/O input port that contains the board's SCSI ID and floppy configuration bits. It appears as the most significant bit (bit 7) of the 8-bit read-only port at I/O address 338h.

The active output handshake signal can be driven by one of two sources, determined by the setting of a jumper. One source is the V40's internal serial controller handshake output signal, which appears on pin 36 of the V40. As programmed by the ROM-BIOS, this signal becomes true whenever the V40 serial input function is enabled and the input buffer is not full.

The other source for the output handshake signal is the printer port's -INIT signal. If the -INIT option is used, it must be controlled directly by software in a manner appropriate to the application. Use of the -INIT signal for output handshake precludes its normal printer port function.

4.6.2 Parallel Printer Port

The board's parallel printer port is a Centronics compatible parallel port, and is identical in function and interface with that found in a standard PC. It has a data transfer rate of up to approximately 1000 bytes per second. Output data and all interface control signals are TTL compatible. Note that this port does not support data input.

The logic for the parallel printer port is contained within the board's two ASIC devices. IRQ7, the printer interrupt, is generated by ASIC2. As in the PC, a choice of two I/O addresses (278h and 3BCh) is provided, programmed by a jumper option.

If the printer port is not used in an application requiring interrupts from the port, IRQ7 can be disabled by a jumper option (W46), allowing its use by external devices on the PC bus. The ROM-BIOS and DOS do not require the printer port interrupts, but some application and utility programs do.

4.6.3 Keyboard Interface

ASIC2 provides the logic for a serial interface compatible with the standard PC keyboard. The keyboard is generally connected by means of a five-wire cable consisting of +5 volts, ground, reset, and two bidirectional signal lines, one for data and one for clock.

A keyboard need not be connected to this port for the system to operate. The ROM-BIOS power on self test does not halt if a keyboard is not found.

4.6.4 Speaker Interface

ASIC2 provides the logic for a PC compatible speaker port. The speaker logic signal is amplified by a Darlington transistor circuit which provides approximately .1 watt of audio power to an external 8 ohm speaker. As in the standard PC, the speaker circuit's output frequency is based on one of two sources: The V40's CTC Channel 2; and the programming of two bits, 0 and 1, in I/O port 61h.

The system's 7.16 MHz master clock is divided down to 1.193 MHz by a divide by six counter in ASIC1, which is used as the input time base for the V40's CTC channel 2. Bit 0 of I/O port 61h is used to enable CTC Channel 2, so that a logic 1 on this bit causes CTC channel 2's programmed frequency to appear on the V40's output pin, and at the input of ASIC2. A logic 0 causes CTC channel 2's output pin to stay at a logic 1.

In addition, Bit 1 of I/O port 61h is one term of a 2-input AND gate in ASIC2, the other term being the output from CTC Channel 2. Thus, setting bit 1 to a logic 1 enables the output of CTC Channel 2 to the speaker, and a logic 0 disables it.

If the V40's CTC Channel 2 is disabled (by setting bit 0 of port 61h to a 0), then bit 1 of port 61h can be used to *directly* control the speaker.

4.6.5 PC Configuration Switches

The configuration switches normally used in a PC system to inform the BIOS and operating system of hardware setup information is supported by a set of jumpers connected to ASIC2. The use of these switches is discussed in Chapter 2, under the jumper configuration sections of the appropriate board devices.

4.6.6 PC Serial Port

An 8250 serial controller device provides a full duplex asynchronous communications channel having compatibility with the COM1 or COM2 serial port on a standard PC. As in the PC, the device contains an internal oscillator and baud rate generator, supporting asynchronous data transfer rates of up to 19.2K baud, based on a 1.8432 MHz crystal (limited by the RS232 drivers).

As in the PC, this serial port offers a choice of two I/O port address blocks (2F8-2FFh and 3F8-3FFh) and two system interrupts (IRQ3 and IRQ4), programmable via jumpers on the board. These selections determine whether the port is the primary or secondary serial device.

The serial controller's TTL level serial I/O signals are converted to and from RS232C signal levels by unique +5-volt-only RS232C interface IC's which internally generate the +/-9 volts needed for the RS232C output signal levels.

4.6.7 Floppy Disk Controller

A 37C65B floppy disk subsystem controller provides the equivalent of an entire PC compatible floppy disk controller plug-in card, within a single LSI device. This "superchip" integrates:

- Formatter/controller
- Digital data separation
- Digital write precompensation
- Data rate selection
- Clock generation
- Drive interface drivers and receivers
- Drive motor control
- PC (and AT) compatible control registers

The 37C65B and associated internal logic are completely compatible with the industry standard NEC765 floppy controller, and associated external devices, as implemented in a standard PC. The 37C65B floppy controller offers data rates of 125, 250, 300, and 500K bits/second. However, the board's ROM-BIOS does not support the 300K bits/second option, and a crystal must be added in a specified position on the board to allow use of that data rate.

The 37C65B's internal data separator contains a highly reliable all-digital 2nd order, "type 2" phase locked loop. Its internal high current drive outputs can sink up to 48 mA current on the floppy disk drive interface. Write precompensation is also generated within the 37C65B, with a choice of two values, 125 nS and 187 nS, set via a jumper on the board.

The board's ROM-BIOS reads four bits of floppy subsystem configuration data through a read-only input port, located at I/O address 338h. These bits are used to determine the type of floppy drives installed as drives A and B (four choices for each drive). The remaining four bits of this 8-bit input are used for other purposes (serial handshake input and SCSI ID). The four floppy type bits reflect the state of four jumpers on the board, W26-W29. They appear in bits 4-6 of the input I/O port. When a jumper is on, the corresponding bit will be read as a 0; when a jumper is off, the bit will be read as a logic 1. If no floppy subsystem is used (onboard or off), the four floppy type bits, as programmed by their respective jumpers, are available for other purposes.

4.6.8 SCSI Bus Interface

A Small Computer System Interface replaces the hard disk controller normally found in a standard "XT" computer. The SCSI bus interface is completely controlled by a 53C80 SCSI protocol controller device. The 53C80 provides an interface which meets the ANSI X3.131 specification for SCSI, including Initiator role, Target role, Arbitration, and the Disconnect-Reselect function. The Ampro SCSI/BIOS automatically maps ROM-BIOS hard disk related functions to this interface, using the SCSI direct access device "Common Command Set" for compatibility with a wide variety of SCSI disk drives.

The 53C80 SCSI controller contains eight internal read/write ports (beginning at 330h), allows full programmable control of 17 bidirectional bus signals, and provides both buffered (low leakage) bus inputs and high current (48 mA) bus output drive capacity. Chapter 5 provides a list of the internal registers and their I/O port addresses as implemented on the Little Board/PC. Please refer to the 53C80 technical manual referenced earlier in this chapter for complete technical and functional information on the 53C80.

The interrupt output of the 53C80 can optionally be connected to the IRQ5 system interrupt via a jumper (W6), as this is optionally supported by the Ampro SCSI/BIOS. The 53C80's DMA request output signal normally connects to DMA channel DRQ3 via a jumper (W2), but can alternatively be connected to DRQ1 if necessary. See Chapter 2 for jumpering information.

Socketed 220/330 ohm bus termination is provided on the board, as well as a jumper for optionally powering the SCSI "TERMPWR" external termination option. Note that no on-board diode protection is provided between the board's +5V power and the SCSI TERMPWR line, so the option should be used with caution.

The 4-bit SCSI Initiator ID, used by the ROM-BIOS, is read in the least significant three bits of a read-only input port, at I/O address 338h. The remaining five bits in this 8-bit input port are used for other purposes (serial handshake input and floppy drive configuration). The three SCSI ID bits reflect the state of three jumpers on the board, W23-W25. When a jumper is on, the corresponding bit will be read as a 0; when a jumper is off, the bit will be read as a logic 1. If the SCSI subsystem is not used, the three ID bits, as programmed by their respective jumpers, are available for other purposes.

4.7 PC BUS INTERFACE

An I/O channel compatible with the PC bus found on standard PC's is provided on a 64-pin dual-row header connector labeled "J9" on the board. This I/O channel contains an 8-bit bidirectional data bus, 20 address lines, 6 levels of interrupt, three DMA channel handshake lines, a number of other control lines, and power and ground for expansion cards.

To a great degree, the signals on this interface match their PC counterparts. However, since the Little Board/PC uses a 7.16 MHz clock and the standard PC uses a 4.77 MHz clock, there are some timing differences. By choosing the number of memory and I/O wait states, the board's PC Expansion Bus can be made to approximate the timing of the bus of a standard 4.77 MHz PC. See the section on wait states, earlier in this chapter, and Chapter 5 for additional programming information.

The V40's 7.16 MHz clock is brought out to the PC Expansion Bus as the "CLOCK" signal (pin B20). Specifications on the standard PC indicate that this signal can be used for "synchronization," but the actual signal frequency is not specified. Most standard PC's provide 4.77 MHz, "AT's" provide 8 MHz, and "turbo" PC's often provide 7.16 MHz or 8 MHz. The duty cycle of this signal is also unspecified; the Little Board/PC supplies approximately 50% duty cycle.

Another bus clock signal, "OSC" (pin B30), is generally specified to have a frequency of 14.31818 MHz, a frequency chosen because it is a useful timebase for video controllers. The IBM "AT" computer provides this signal, even though it serves no specific purpose on the AT motherboard. The synchronization of this clock signal is not specified, and expansion card designers generally do not count on its being synchronous with any other PC bus signal. In the Little Board/PC this signal is 14.31818 MHz, with a duty cycle of approximately 50%.

In standard PC's, DMA channel 0 is used to refresh DRAM. The request line for DMA 0, "DACK0," is used by some expansion cards to detect when refresh is occurring. The Little Board/PC provides its onboard refresh signal, generated by the refresh controller within the V40, on this same PC bus pin, providing the necessary DACK0 signal.

Although the function of DACK0 refresh signal is the same as that in a PC, its timing is somewhat different in one respect: the V40 CPU occasionally does a rapid "burst" of refresh cycles, as close as 200 nS apart, with no other intervening CPU cycles. This is in contrast to the nearly constant refresh rate -- one every 15 microseconds -- found in most PC's. This should pose no problem with PC expansion add-in cards, unless they use the expected refresh frequency for functional timing, or cannot accept the rapid refresh bursts.

In the IBM "XT" computer, an input signal, "CARD SLCTD," is provided on pin B8 of the 8th expansion slot. This signal is intended to support an IBM bus expansion subsystem. This signal is not provided by the Little Board/PC's PC Expansion Bus, but should not cause problems, as it is seldom used.

All the other signals on the bus conform to what is found on a standard PC's expansion bus, but with slightly less drive current. For details, consult the technical references listed in the beginning of this chapter.

The +12VDC, -12VDC, and -5VDC voltages of the PC bus are not generated by the Little Board/PC for the PC Expansion Bus (J9) connector. If those voltages are required, they can be connected via the board's Utility Connector (J4).

CHAPTER 5

PROGRAMMING INFORMATION

5.1 INTRODUCTION

This chapter provides information useful to programmers who intend to program Little Board/PC hardware directly. Normally the operating system, or the application software program itself, handles the hardware for you, so that you need not be concerned with direct programming of the board's hardware. In addition, the Little Board/PC's ROM-BIOS provides a high degree of compatibility with the IBM PC ROM-BIOS. Consequently, there should be little need for custom programming.

Be sure to read Chapter 4 (Theory of Operation) before attempting to program the board's hardware. In addition, the references listed in the beginning of Chapter 4 are highly recommended, and in some cases contain information which will be essential to your direct programming of the board's controllers.

5.2 SYSTEM MEMORY MAP

The V40's memory address space is specified by 20 address bits. Therefore, it can address 1 megabyte of memory. The board's 1 megabyte of memory space is decoded as indicated in Table 5-1.

5.3 I/O ADDRESS MAP

The V40's I/O address space is specified by sixteen address bits. However, as in the standard PC architecture, the Little Board/PC only decodes the lower ten of these address bits. Cards designed for use in a PC Expansion Bus must therefore reside within this I/O address space.

Table 5-2 provides a detailed listing of the I/O port assignments used on the Little Board/PC. In many cases, the ROM-BIOS functions provide all of the "hooks" that are required for accessing devices connected the board's I/O ports. If direct programming of the board's peripheral interfaces is necessary, refer to the individual technical data sheets for the components used. These are available from the device manufacturers or through Ampro.

When adding cards to the PC Expansion Bus, be sure to check for I/O address conflicts. Note that the I/O port addresses listed in Table 5-2 cannot be applied to the PC expansion bus.

Table 5-1. Little Board/PC Memory Map

MEMORY ADDR	FUNCTION
F8000 - FFFFFh	BIOS PROM Socket at U21 (Required). Generally occupied by a PC compatible ROM-BIOS with Ampro SCSI/BIOS extensions. Contains a startup vector at address FFFF0h.
F0000 - F7FFFh	Read/write byte-wide memory socket at U15.
E0000 - EFFFFh	Read/write byte-wide memory socket at U26. Jumpers allow the origin of the device to be at E0000h, E8000h, EC000h, or EE000h.
C0000 - DFFFFh	Not used on the Little Board/PC.
A0000 - BFFFFh	Normally reserved for video RAM, as follows: CGA Video: B8000 - BFFFFh Monochrome: B0000 - B7FFFh EGA Video: A0000 - AFFFFh Jumpers allow the use of SIMM3 onboard DRAM memory within this restricted video area.
80000 - 9FFFFh	General purpose memory. Can be accessed via onboard DRAM socket "SIMM3," or via the board's PC Expansion Bus (determined by jumpers).
40000 - 7FFFFh	General purpose memory. Can be accessed via onboard DRAM socket "SIMM2," or via the board's PC Expansion Bus (determined by jumpers).
00000 - 3FFFFh	General purpose memory. Can be accessed via onboard DRAM socket "SIMM1," or via the board's PC Expansion Bus (determined by jumpers).

Table 5-2. Little Board/PC I/O Map

I/O ADDRESS	FUNCTION									
FFF0 - FFFFh	V40 internal control registers									
0400 - FFEFh	Not available.									
03F8 - 03FFh	PC Serial Port "primary" option									
03F0 - 03F7h	Floppy disk controller ports (37C65B) 3F2 - FDC Digital output register (LDOR) 3F4 - FDC Main status register 3F5 - FDC Data register 3F7 - FDC Control register (LDCR)									
03BC - 03BFh	Parallel printer "secondary" option									
0378 - 037Fh	Parallel printer "primary" option									
0338h	Jumper input port. SCSI ID, floppy type, and V40 serial port handshake input.									
0330 - 0337h	SCSI controller ports (53C80) (See 53C80 table later in this chapter.)									
02F8 - 02FFh	PC Serial Port "secondary" option									
00F0 - 00F3h	V40 Serial Port									
00A0 - 00AFh	NMI Enable register									
0080 - 0083h	DMA page registers ("emulated") 80 - reserved 81 - PC DMA Channel 2 82 - PC DMA Channel 3 83 - PC DMA Channel 1									
0060 - 0063h	Speaker control ports 61 - Bit 0 = CTC2 output gate 61 - Bit 1 = Speaker enable signal									
0040 - 004Fh	Counter/Timer Controller ports 42 - Frequency count/status register 43 - Timer mode register									
0020 - 002Fh	Interrupt controller ports									
0010 - 001Fh	V40 DMA controller registers ("actual")									
0000 - 000Fh	"8237A DMA controller" registers ("emulated")									
<p style="text-align: center;">NOTE</p> <p>The following I/O port addresses cannot be applied to the PC expansion bus:</p> <table><tr><td>00-0Fh</td><td>60-6Fh</td><td>A0-AFh</td></tr><tr><td>20-2Fh</td><td>72h,73h</td><td>C0-CFh</td></tr><tr><td>40-4Fh</td><td>80-8Fh</td><td>E0-EFh</td></tr></table>		00-0Fh	60-6Fh	A0-AFh	20-2Fh	72h,73h	C0-CFh	40-4Fh	80-8Fh	E0-EFh
00-0Fh	60-6Fh	A0-AFh								
20-2Fh	72h,73h	C0-CFh								
40-4Fh	80-8Fh	E0-EFh								

5.4 V40 INTERNAL REGISTERS

The V40 CPU has the following internal controllers:

REFU	Refresh Control Unit
WCU	Wait State Control Unit
CTC	Counter/Timer Controller
SCU	Serial Control Unit
ICU	Interrupt Control Unit
DMAU	DMA Control Unit

The V40 accesses the internal peripherals using normal I/O addressing. The addresses assigned to these internal peripherals are not available for general use. Note, though, that these addresses are situated at the very top of the 16-bit I/O address space. Since the PC architecture only uses the lowest 1024 I/O addresses, there is no conflict.

Table 5-3 contains a list of the internal V40 peripheral addresses and a brief description of their function. These are for reference only. To program any of these registers, you must refer to the V40 User's Manual for the detailed bit definitions.

5.5 V40 INITIALIZATION

Table 5-4 describes the state of the internal peripheral control ports after they have been initialized by the Little Board/PC's ROM-BIOS. The description field shows the resulting state of the internal peripherals.

The wait state values used in the ROM-BIOS are intended to allow the system to boot and begin operation from the widest possible range of on-board and bus devices. Any of these values may be changed by writing a short program that outputs different values to the indicated I/O addresses. Such a program is provided as part of the Little Board/PC Support Software, and should be used to set appropriate values following system boot. This can be done as part of the DOS AUTOEXEC.BAT function.

Table 5-3. V40 Internal Peripheral Control Registers

I/O ADR	NAME	DESCRIPTION
FFFFh		Reserved
FFFEh	OPCN	On-chip Peripheral Connection register. Selects between DMA3 and V40 serial.
FFFDh	OPSEL	On-chip Peripheral Selection. Enables SCU, CTC, ICU, and DMAU
FFFCh	OPHA	On-chip Peripheral High Address. Sets the upper byte of the I/O address assigned to the SCU, CTC, ICU, DMAU.
FFFBh	DULA	DMAU Low Address. Sets the lower byte of the I/O address assigned to the DMAU.
FFFAh	IULA	ICU Low Address. Sets the lower byte of the I/O address assigned to the ICU.
FFF9h	TULA	CTC Low Address. Sets the lower byte of the I/O address assigned to the CTC.
FFF8h	SULA	SCU Low Address. Sets the lower byte of the I/O address assigned to the SCU.
FFF7h		Reserved
FFF6h	WCY2	Wait Cycles 2. Sets the number of wait cycles for DMA and refresh cycles.
FFF5h	WCY1	Wait Cycles 1 Sets the number of wait states for each of three memory regions and for I/O cycles.
FFF4h	WMB	Wait Memory Boundary. Defines the boundary addresses of the three memory wait state regions.
FFF3h		Reserved
FFF2h	RFC	Refresh Control. Enables/Disables refresh by the RFU and sets the refresh interval.
FFF1h		Reserved
FFF0h	TCKS	Timer Clock Selection. Selects the clock source (internal or external) for the CTC and the divisor by which the frequency of the internal clock is divided.

Table 5-4. ROM-BIOS Default V40 Initialization

REG	I/O ADR	CONTENTS	DESCRIPTION
OPCN	FFFEh	00000011	Pin function options: IRQ1, IRQ2, RXD, TXD, SRDY
OPSEL	FFFDh	00001111	Enable all peripherals
OPHA	FFFCh	00000000	Set High Address = 00h
DULA	FFFBh	00010000	DMAU Low Address = 10h
IULA	FFFAh	00100000	ICU Low Address = 20h
TULA	FFF9h	01000000	CTC Low Address = 40h
SULA	FFF8h	11110000	SCU Low Address = F0h
WCY2	FFF6h	00001110	Wait States: DMAU = 3 RFU = 2
WCY1	FFF5h	01010000	Wait States: I/O = 3 * Upper Memory = 0 Middle Memory = 2 Lower Memory = 1
WMB	FFF4h	01010000	Wait Memory Boundaries: Low = 256k High = 32K
RFC	FFF2h	10000110	Refresh Control: Refresh enabled 8 * 12 / 7.16 MHz = 13.4 microsec
TCKS	FFF0h	00011100	Timer Clock Control: TCT #0 = TCLK TCT #1 = TCLK TCT #2 = TCLK
* Fixed at 5 wait states if W48 is jumpered to 2/3			

5.6 SCSI INTERFACE

The 53C80 SCSI Protocol Controller device, which generates the board's SCSI interface, contains eight readable and eight writable registers, which begin at the base address of 330h. The 53C80's internal registers are shown in Table 5-5.

Table 5-5. 53C80 Internal Registers.

I/O ADR	INPUT/OUTPUT	FUNCTION
0330h	Input	Current SCSI Data
0331h	Input	Initiator Command Register
0332h	Input	Mode Register
0333h	Input	Target Command Register
0334h	Input	Current SCSI Bus Status
0335h	Input	Bus & Status Register
0336h	Input	Input Data Register
0337h	Input	Reset Parity/Interrupt Command
0330h	Output	Output Data Register
0331h	Output	Initiator Command Register
0332h	Output	Mode Register
0333h	Output	Target Command Register
0334h	Output	Select Enable Register
0335h	Output	Start DMA Send Command
0336h	Output	Start DMA Target Receive Command
0337h	Output	Start DMA Initiator Receive

The SCSI interface has a wide variety of applications, including:

- Use with SCSI disk, tape, optical drive controllers, and other SCSI devices
- Use as a bidirectional I/O port

The Ampro SCSI/BIOS and SCSI Support Software provides SCSI support for "generic SCSI" random access devices (i.e. hard disk controllers and drives), which use the SCSI "Common Command Set." So that you can use SCSI devices and functions not supported by the standard Ampro drivers and utilities, a function has been included in the Ampro SCSI/BIOS which can be accessed through an extension of the INT 13 support. This is discussed below.

If you plan to program the SCSI interface directly, you will probably require copies of both the NCR 5380-53C80 SCSI Interface Chip Design Manual and the ANSI X3.131 SCSI specification. Sources for both of these documents are referenced in the beginning of Chapter 4.

5.6.1 SCSI Programming

When using the SCSI interface with SCSI disk controllers and drives, special programming is not generally required; the Ampro SCSI/BIOS and SCSI Support Software drivers and utilities accommodate many types of disk controllers and disk drives. Installation of the hard disk software is all that is generally required, providing you are using controller and drive types supported. (Refer to Chapter 3.)

When using the 53C80 in SCSI applications, care must be taken to meet the specified timing constraints. For detailed timing information, consult your peripheral controller's technical manual, and the ANSI SCSI specification referenced above.

5.6.2 Simple Bidirectional I/O

If you plan to program the 53C80 yourself, you will need a copy of the NCR 53C80 design manual mentioned above. The 53C80 has 17 bidirectional I/O lines, which may be used as inputs or outputs under software control, and also offers the option of a variety of interrupts based on specific transitions of I/O signals.

Basically, the 53C80 has two operating modes: Initiator and Target modes. In Initiator mode, several conditions are required before data output to the I/O bus can be active. If the device is used in the Target mode, however, these special conditions are not applicable. Consequently, the 53C80's Target mode results in more flexible operation for simple bidirectional I/O.

The 53C80 is placed in Target mode by writing 40h to the Mode Register. Once in Target mode, all 17 I/O signals except ACK and ATN may be used as both inputs and outputs. In Target mode, ACK and ATN are inputs only. The data lines (DB0-7,P) are outputs when bit 0 ("Assert Data Bus") of the Initiator Command Register is a 1, and inputs when bit 0 of that register is a 0.

It is also possible to utilize the 53C80's internal interrupt generation logic to perform interrupt-based I/O with the device. One user has taken advantage of this feature to monitor and store the data transmitted by a Centronics type printer port of a computer, using the SCSI bus interface as an interrupt-driven 8-bit input port.

Three additional input bits, normally used to indicate SCSI ID to the ROM-BIOS, are available for I/O input via the Jumper Input Port (discussed below). The other five Jumper Input Port bits can be used for general purpose inputs, if they are not used for their normal functions. The parallel printer port can also provide an additional set of eight outputs and five handshake signals, if it is not required as a printer interface.

Refer to Ampro application note AAN-8801 for additional information on bidirectional I/O use and programming of the SCSI hardware.

5.6.3 Jumper Input Port

This port reads eight signals. Seven of this port's eight bits reflect the state of seven jumper pairs (W23-W29); the eighth bit reflects the state of the input handshake signal of the V40 Serial Port's RS232C connector.

The status of the Jumper Input Port is sensed by reading I/O port 338h. The low order seven bits of this port reflect the jumpering of the seven pairs of pins at the locations labeled W23-W29 on the board. The input data for these bits will be 0 (low) when the corresponding jumper is in, and 1 (high) when the jumper is out. Bit 7 is the RS232C input handshake for the V40 Serial Port.

Table 5-6 shows the functions of the bits of the Jumper Input Port. If it is not needed for its intended uses by the board's ROM-BIOS, the Jumper Input Port can also be used for general purpose data input.

Table 5-6. Jumper Input Port

Bit 7	6	5	4	3	2	1	0
HSI	W29	W28	W27	W26	W25	W24	W23
Bit		Signal/Function					
7		HSI - Handshake input signal for the V40 Serial Port. Must be polled by software if active input handshaking is required. Can be used for CTS, DCD, or other desired purpose.					
3-6		W26,27,28,29 - These four bits reflect the states of the corresponding jumper positions. A jumper "on" results in the data bit being a "0", while "off" results in a "1." These bits are normally used by the ROM-BIOS to determine the type of floppy drives.					
0-2		W23,24,25 - These three bits reflect the states of the corresponding jumper positions. A jumper "on" results in the data bit being a "0", while "off" results in a "1." These bits are normally used by the ROM-BIOS to determine the board's SCSI Initiator ID.					

5.6.4 Ampro SCSI/BIOS

To make it easy to use SCSI devices and functions not supported by the standard Ampro drivers and utilities, functions have been included in the board's ROM-BIOS which allow the use of the SCSI interface without the need for direct hardware programming. This support is accessed through an extension of the INT 13 ROM-BIOS support, and is known as the Ampro *SCSI/BIOS*.

The Ampro SCSI/BIOS adds an additional layer of standardization to SCSI, by providing a high level interface for software that eliminates the need for direct programming of the SCSI bus interface hardware. This standard software interface is accomplished through an extension to the INT 13 support normally provided in a PC ROM-BIOS for hard disk access. SCSI drivers and utilities written around the Ampro SCSI/BIOS INT 13 extensions will run on any system in which the INT 13 extensions are available. (This includes all of Ampro's DOS compatible Little Board *single board systems*.)

Detailed information on the SCSI/BIOS functions provided within the Little Board/PC ROM-BIOS is available in application note AAN-8804, available from Ampro.

If you plan to support SCSI devices using the SCSI/BIOS, you will probably need to become acquainted with the SCSI bus and its protocols. To obtain a copy of the ANSI SCSI specification, contact the American National Standards Institute referred to previously in this chapter.

APPENDIX A
LITTLE BOARD/ PC UTILITIES SOFTWARE

APPENDIX A

LITTLE BOARD/ PC UTILITIES SOFTWARE

INTRODUCTION

This Appendix contains detailed information on each of the driver and utility programs supplied on the Little Board/PC Utilities diskette. Each program's description explains what the program does and how it is used. Program descriptions are in alphabetical order, so this chapter can serve as a handy reference.

Each program is identified by a version and revision level. When the program is run, its version number (and a revision level) generally appear in a sign-on message such as the following:

Ampro Hard Disk Format Utility
Copyright (C) 1986 Ampro Computers, Inc.
Version 4.00

In this case the program is version 4, revision "00". Versions of a program which have the same "version" number operate in the same manner. When a change is made to a program which necessitates a new description, its version number is changed, indicating that the old description is no longer accurate.

Note

Read the contents of the ".DOC" files on your Little Board/PC Utilities diskette (filenames of the form "PROGRAM.DOC"). They contain information on recent program revisions, enhancements, or additions relative to the published user's manual.

Additional programs and features, offered on an on-going basis, will be available to you through software updates, at a nominal charge. Contact Ampro Customer Service for information on the availability of updated software.

CONDRVR.SYS

DESCRIPTION

CONDRVR.SYS is a support utility for the Ampro Little Board/PC which allows you to use an RS232 serial device connected to the board's V40 serial port as the system console, instead of the IBM style keyboard, display adapter, and monitor normally used. This can be especially useful in embedded applications in which only occasional keyboard/display access is required, and graphics output is not used. It is also valuable as a means for remote control, via a serial connection, of a system based on a Little Board/PC. Using CONDRVR.SYS for console I/O connection over the V40 serial port can also result in a savings of cost, space, and power consumption.

The driver uses the Little Board/PC's V40 serial port as the console port, and supports interrupt driven keyboard input, providing the usual keyboard buffering function. Baud rate (110 - 38,400) and data characteristics are fully programmable, as defined by parameters included on the CONFIG.SYS installation command line.

The driver performs two basic functions:

1. Remaps console output to the V40 serial port - the BIOS video output function (INT 10) is redirected. Characters to be written to the system console through the INT 10 "Write TTY" function are sent out the V40 serial port instead of being sent to a normal video display adapter. All characters are simply passed through to the serial port.

Only the "Write TTY" (Function 14) portion of INT 10 is supported; all other INT 10 function requests are ignored (no error returned). Terminal dependent display controls for functions such as cursor position, screen clearing, half intensity, etc., must be programmed via ASCII character "escape sequences" by the application program.

2. Remaps keyboard input to the V40 serial port - the board's keyboard hardware interrupt input is reassigned to the V40's internal serial port, disabling the normal PC keyboard input. The system keyboard input device thus becomes the V40's internal serial port, instead of the normal PC keyboard port.

Note

Only software which uses DOS or BIOS (INT 10, Function 14) for display output can be used via this driver. You must carefully test each application for compatibility.

Use

To install the console driver, place a command line as the first line in a CONFIG.SYS file on the drive from which your system will boot. The required line is of the form:

device = condrv.sys Bb Dd Ss Pp h

where: b = Baud rate: 110, 150, 300, 600, 1200, 2400, 4800,

9600, 19200, or 38400
d = Data bits: 7 or 8 (no parity if 8 bits)
s = Stop bits: 1 or 2
p = Parity: O, E, or N (odd,even,none)
h = Hardware handshake option, as follows:
 ha = enables hardware handshake on "Model 4A" boards
 hb = enables hardware handshake on "Model 4B" (or later) boards
 h = enables hardware handshake; driver will attempt to figure out
 which type of board (Model 4A or 4B) is being used

For example,

DEVICE = CONDRVR.SYS B19200 D8 S1 PN

In this example, the serial communications data rate is 19200 baud, and the data characteristics are 8 data bits, 1 stop bit, and no parity. Handshaking is none.

Note that the xon/xoff console handshaking is normally handled by DOS, but hardware handshaking may be preferred in some applications. The three parameters (B, D, S, P) may be placed in any order on the command line.

If no parameters are declared on the command line, then a default value of 9600 baud, 8 data bits, 1 stop bit, and no parity is used.

Note also that you must **RESET** or **POWERUP** the system with the new **CONFIG.SYS** command line to have the driver take effect.

PRNDRVR.SYS

DESCRIPTION

PRNDRVR.SYS is a support utility for the Ampro Little Board/PC which allows you to use the board's V40 serial port for a RS-232 serial printer.

The driver performs two basic functions:

1. Remaps printer output to the V40 serial port - the BIOS parallel output function (INT 17) is redirected. Characters to be written to the system printer through the INT 17 function are sent out the V40 serial port instead of being sent to the normal parallel port.
2. All functions that open the PRN device for writing are directed to the V40 serial port.

Use

To install the console driver, place a command line as the first line in a CONFIG.SYS file on the drive from which your system will boot. The required line is of the form:

device = prndrvr.sys Bb Dd Ss Pp h

where:

- b = Baud rate: 110, 150, 300, 600, 1200, 2400, 4800, 9600, 19200, or 38400
- d = Data bits: 7 or 8 (no parity if 8 bits)
- s = Stop bits: 1 or 2
- p = Parity: O, E, or N (odd,even,none)
- h = Hardware handshake option, as follows:
 - ha = enables hardware handshake on "Model 4A" boards
 - hb = enables hardware handshake on "Model 4B" (or later) boards
 - h = enables hardware handshake; driver will attempt to figure out which type of board (Model 4A or 4B) is being used

For example,

DEVICE = PRNDRVR.SYS B19200 D8 S1 PN

In this example, the serial communications data rate is 19200 baud, and the data characteristics are 8 data bits, 1 stop bit, and no parity. Handshaking is none. Note that both xon/xoff and hardware handshaking are supported by the driver. The three parameters (B, D, S, P) may be placed in any order on the command line.

If no parameters are declared on the command line, then a default value of 9600 baud, 8 data bits, 1 stop bit, no parity, and xon/xoff handshake is used.

Note also that you must RESET or POWERUP the system with the new CONFIG.SYS command line to have the driver take effect.

SCSI-ID

DESCRIPTION

The Ampro SCSI-ID utility reports the system's SCSI Initiator ID to the console, and also sets the DOS ERRORLEVEL so it may be tested in a batch file. One use of the SCSI-ID utility is that it allows you to easily verify the SCSI ID setting of your Little Board. An interesting use of this program is to allow multiple Little Boards to boot from a single SCSI device, yet automatically begin execution of unique applications based on each board's SCSI ID.

COMMAND LINE OPERATION

To use the program, simply enter the program's name on the DOS command line or in a batch file. For example, if your system's SCSI ID is 7 and you use the following command line:

```
C>SCSI-ID <Enter>
```

SCSI-ID will display:

```
My SCSI ID is 7
```

BATCH FILE OPERATION

In addition, SCSI-ID sets the DOS ERRORLEVEL to a number corresponding to the Little Board's SCSI-ID setting, for testing within batch files. Using the program in this manner, it is possible to boot multiple Ampro Little Boards from a single SCSI drive under PC-DOS, yet have each board come up running a different application.

To accomplish this, the AUTOEXEC.BAT file on the boot must test for "ERRORLEVEL" and branch to a unique batch file appropriate for the specific Little Board. Then, each Little Board is set for a different SCSI ID, between 1 and 7, and the boot device is jumpered for ID 0.

Ampro application note AAN-8803 discusses the use of SCSI-ID in a PC-DOS system composed of multiple Ampro Little Boards.

SCSICOMP

DESCRIPTION

The Ampro SCSICOMP utility allows you to compare the contents of two SCSI direct access devices (e.g. hard disk drives). Although the program must be run from DOS, SCSICOMP pays no attention to the contents of the source and destination SCSI devices, and does not care what (if any) operating system has been used to write data to them.

You can specify any two SCSI controller ID's, drive Logical Unit Numbers (LUN's), SCSI block range to be compared.

OPERATION

To run the program, type its name at the DOS command line:

A>SCSICOMP<Enter>

The program will display a sign-on message and will then prompt you to press the <Enter> key to continue. After you press the <Enter> key, the program will prompt you for information required, including the first SCSI ID, first logical unit number, second SCSI ID, second logical unit number, starting block number, and number of blocks to compare. Then, the program will compare the specified segments of the two SCSI devices and report on any errors or differences that occur during the comparison.

The required parameters are defined as follows:

- **SCSI ID** - Each device's SCSI ID is determined by the jumpering of the device's SCSI controller and is in the range 0 through 7.
- **Logical Unit Number (LUN)** - Each device's logical unit number is based on how the device is connected to the controller and may also depend on the setting of jumpers on the device; it is generally 0 or 1.
- **Block Number** - A SCSI "block" is 512 bytes of data; the first block on the device is numbered 0.

The current version of SCSICOMP requires that the block starting numbers on the two drives be the same, so only one starting block number is requested by the program.

EXAMPLE

In this example, 2000 blocks (10,240,000 bytes) of data are compared, between LUN 0 on SCSI ID 0 and LUN 1 on SCSI ID 1.

What is the first SCSI ID and logical unit number?

SCSI ID (0-7): 0<Enter>

Logical unit number (0-3): 0<Enter>

What is the second SCSI ID and logical unit number?

SCSI ID (0-7): 1<Enter>

Logical unit number (0-3): 1<Enter>

Starting block number: 0<Enter>

Number of blocks: 2000<Enter>

You are about to compare:

From: SCSI ID: 0	To: SCSI ID: 1
LUN: 0	LUN: 1

Starting with block 0, for 2000 blocks.

Is this correct (Y/N)? Y<Enter>

Press the <Enter> key to begin or the <ESC> key to start over: <Enter>

Compare completed, 0 errors.

Compare another (Y/N)? N<Enter>

A>__

SCSICOPY

DESCRIPTION

The Ampro SCSICOPY utility allows you to copy a block of data between two SCSI direct access devices (e.g. hard disk drives). Although the program must be run from DOS, SCSICOPY pays no attention to the contents of the source SCSI device, and does not care what (if any) operating system has been used to write data to it.

You can specify any two SCSI controller ID's, drive Logical Unit Numbers (LUN's), and any block range.

Warning!

- (1) SCSICOPY will destroy data on the destination device within the specified block range. Use with extreme care!
- (2) Copying less than the full drive may leave part of the destination device unusable.

OPERATION

To run the program, type its name at the DOS command line:

A>SCSICOPY<Enter>

The program will display a sign-on message and will then prompt you to press the <Enter> key to continue. After you press the <Enter> key, the program will prompt you for information required, including the first SCSI ID, first logical unit number, second SCSI ID, second logical unit number, starting block number, and number of blocks to copy. Then, the program will copy the specified segment between the two SCSI devices and report on any errors that occur during the process.

The required parameters are defined as follows:

- **SCSI ID** - Each device's SCSI ID is determined by the jumpering of the device's SCSI controller and is in the range 0 through 7.
- **Logical Unit Number (LUN)** - Each device's logical unit number is based on how the device is connected to the controller and may also depend on the setting of jumpers on the device; it is generally 0 or 1.
- **Block Number** - A SCSI "block" is 512 bytes of data; the first block on the device is numbered 0.

The current version of SCSICOPY requires that the block starting numbers on the two drives be the same, so only one starting block number is requested by the program.

EXAMPLE

In this example, 2000 blocks (10,240,000 bytes) of data are copied from LUN 0 on SCSI ID 0 to LUN 1 on SCSI ID 1.

What is the first SCSI ID and logical unit number?

SCSI ID (0-7): 0<Enter>

Logical unit number (0-3): 0<Enter>

What is the second SCSI ID and logical unit number?

SCSI ID (0-7): 1<Enter>

Logical unit number (0-3): 1<Enter>

Starting block number: 0<Enter>

Number of blocks: 2000<Enter>

You are about to copy:

From: SCSI ID: 0
 LUN: 0

To: SCSI ID: 1
 LUN: 1

Starting with block 0, for 2000 blocks.

Is this correct (Y/N)? Y<Enter>

Press the <Enter> key to begin or the <ESC> key to start over: <Enter>

Copy completed, 0 errors.

Copy another (Y/N)? N<Enter>

A>__

SCSIFMT

DESCRIPTION

SCSIFMT is the Ampro SCSI hard disk formatter utility. It is used to perform the low-level format for SCSI hard disk drives, prior to final preparation of the drive using the standard drive preparation utilities offered by your operating system.

SCSIFMT supports the SCSI Common Command Set (CCS) direct access devices (typically hard disk drives). Consult the specific SCSI hard disk controller manual for information as to compatibility with the SCSI CCS.

SCSIFMT can be used to completely reformat the target drive, and to map out bad blocks. The list of bad blocks is appended to the on-disk bad block table, which is furnished by the disk manufacturer.

OPERATION

Warning!

All data on the drive you format will be destroyed!

The general format of SCSIFMT is as follows:

SCSIFMT **i** **l** [**L**] [**Zz**] [**F**] [**M**[**m**]] [**Y**]

- i** The SCSI ID number, 0 through 7, of the SCSI device that is to be accessed. This parameter is required.
- l** The Logical Unit Number (LUN) of the SCSI device that is to be accessed. If not supplied, the default value is 0.
- z** The disk interleave factor, which only has meaning when used with the **F** (format) option. If not specified (or set to 0), the interleave factor is left unchanged from the drive's current setting. A typical value is 2; most fast drives when used with Ampro's SCSI/BIOS can support an interleave factor of 1.
- F** The "format" option. It must be specified if you wish to format the drive (and optionally change the interleave factor).
- M** The "map out" option. When selected, any bad blocks (blocks with read errors, write errors, or both) are mapped out of the drive's block allocation table. If data exists in the bad block, an attempt is made to safely copy the data to another block.
- m** The number of clean passes for the bad-block map out. Specifies how many passes must be made with no bad blocks found. If not specified, defaults to 1. The maximum value is 255. A new pass begins when a bad block is found in the current pass.

Y Confirm bypass option. If used, SCSIFMT does not ask for a confirming "Y" keystroke before continuing with the format. **USE WITH CAUTION!**

Parameters may be entered in any order and in upper or lower case.

Examples

A:>SCSIFMT I4 L0 M5 <Enter>

This example searches the SCSI device with SCSI ID 4, LUN 0, for bad blocks and maps out any bad blocks that are discovered. Five clean passes must be performed before the command completes.

A:>SCSIFMT I0 F Z1 <Enter>

This example formats the SCSI device with SCSI ID 0, using an interleave factor of 1.

A:>SCSIFMT I2 F Y <Enter>

This example formats the SCSI device with SCSI ID 2 *without asking for confirmation*.

After the format is complete, you still must prepare the drive in the standard manner for access by your operating system.

Refer to Chapter 3 for detailed step-by-step SCSI hard disk installation procedures.

SCSIPARK

DESCRIPTION

The Ampro SCSIPARK utility is used to position the read/write head(s) of a SCSI drive to a predefined safety zone on the disk surface, to guard against accidental data loss due to either power on/off glitches in the drive electronics or media damage due to mechanical shock. You should always use SCSIPARK to "park" your drives' heads prior to switching off AC power, or during extended periods of time during which the drives will not be accessed.

The current version of SCSIPARK supports the following SCSI controllers and drives:

- Adaptec ACB-4000 and ACB-5000 family controllers
- Seagate ST225N SCSI drive
- Most "Common Command Set" SCSI drives

OPERATION

To use SCSIPARK to park a drive's heads, type the program's name followed by one or more SCSI ID(s) of the controller(s) to which the drive(s) are connected. All drives on each SCSI controller will be parked by the single command. For example:

C><u>SCSIPARK 0 1</u><Enter>

will park all drives detected on SCSI controllers with ID's of 0 and 1. You can also use an asterisk (*), to have all possible SCSI ID's parked. That is,

C><u>SCSIPARK *</u><Enter>

will park drives on all SCSI controllers detected. "SCSIPARK *" is equivalent to "SCSIPARK 01234567".

Note

**Be sure not to access a hard disk drive after it is parked,
as this will move the drive's heads off the landing zone.**

You can simplify the use of the SCSIPARK utility by creating a DOS "batch" file containing the required command line.

SCSITOOl

DESCRIPTION

The Ampro SCSITOOl utility is a powerful and flexible SCSI debugging tool which allows you to demonstrate, test, and debug SCSI commands and devices. Options are provided which allow you to create any desired SCSI command, and write or read desired data patterns to or from any type of SCSI device. Although the program must be run from DOS, SCSITOOl pays no attention to the contents of the SCSI devices accessed, and does not care what (if any) operating system has been used to write data to them.

Warning!

SCSITOOl can destroy data on the destination SCSI device. Use this utility with extreme care!

OPERATION

The SCSITOOl utility is very easy to use, but you need to understand SCSI command principles in general, as well as the specific SCSI command set of the SCSI Target devices you will be accessing. Refer to the technical information supplied by the SCSI Target devices' manufacturers, and to the ANSI X3.131 SCSI Specification for a full functional specification of the SCSI interface protocols.

To begin program operation, type the program's name at the DOS command line:

A>SCSITOOl<Enter>

The program will display a brief sign-on message, followed by the SCSITOOl command prompt:

Command (C,D,E,R,S,?,<ESC> to quit): __

Entering a "?" results in the display of SCSITOOl's command menu:

Commands available:

- C - Enter command buffer
- D - Enter data buffer
- E - Execute SCSI command
- R - Reset SCSI bus
- S - Set SCSI ID
- ? - Display this help message

Command (C,D,E,R,S,?,<ESC> to quit): __

When you use either the C (Enter command buffer) or D (Enter data buffer) options, the program will display the current contents of the SCSI command or data buffer in one area of

your screen, and will position the cursor over the first byte of data on the command or data buffer entry line.

For example:

Command (C,D,E,R,S?,<ESC> to quit): C

The Command Buffer currently contains:

```
0  1  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19
-- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
```

Enter the new values in hexadecimal. The <Spacebar> leaves a digit unchanged, while the <Enter> key stops editing and returns to the list of commands.

0 _ <-- cursor on first command byte

You can use the <Spacebar> key to move through the buffer to one or more bytes which you wish to modify. A little experimentation will make the process clear.

Similarly, you view and optionally edit data in the SCSI data buffer with the D (Enter data buffer) option, if data is to be sent or received from the SCSI device. The data buffer size is actually 5K bytes, but only the first 512bytes are available through this program's D command. Since the entire 512bytes of the data buffer display do not fit entirely on one screen, use <CTRL-S> to pause the display when necessary (and any other key to resume display).

Do not execute a SCSI command with the E (Execute SCSI command) option until you have first used the S (Set SCSI ID) option to specify the SCSI ID of the device to which the command will be issued.

EXAMPLES

Example #1: Test Unit Ready command. Enter all 0's in the command buffer with the C command; set the appropriate SCSI controller ID with the S command. Then use the E command to perform the Test Unit Ready function. (This example assumes LUN 0.)

Example #2: Rezero Unit command. Enter 01 in the first command byte, and all 0's in the rest of the command buffer, with the C command; set the appropriate SCSI controller ID with the S command. Then use the E command to perform the Test Unit Ready function. (This example assumes LUN 0.)

SETWAIT

DESCRIPTION

The Ampro SETWAIT utility is used to initialize the V40 microprocessor's wait state control registers to other than the ROM-BIOS defaults. Since the defaults within the ROM-BIOS are set for the slowest possible device access times, it is usually desirable to use this utility to increase the speed of system operation immediately following system boot. This is done by placing a SETWAIT command line in the system's AUTOEXEC.BAT file.

Caution

SETWAIT provides a high degree of system configuration flexibility, and even allows you to create setups which may not work. Use configurations other than the "normal" examples given with caution. Refer to the Ampro Little Board/PC and NEC V40 Microprocessor technical manuals for additional hardware details.

OPERATION

Use the SETWAIT utility by typing the program's name, followed by one or more optional parameters, at the DOS command prompt; or include such a command line in the AUTOEXEC.BAT file. The SETWAIT command line is of the following form:

**SETWAIT [UMBs] [LMBs] [UMWn] [MMWn] [LMWn] [IOWn] [RFWn]
[DMAWn] [/]**

Where:

UMB and LMB -- specify the size of the upper and lower memory blocks

UMW, MMW, and LMW -- specify the number of wait states in the upper, middle, and lower memory blocks defined by UMB and LMB

IOW -- specifies the number of I/O wait states

RFW -- specifies the number of refresh wait states

DMAW -- specifies the number of DMA wait states

/ -- if used, results in display of status after completion

And:

s = 32, 64, 96, 128, 192, 256, 384, 512

n = 0, 1, 2, or 3 (0 is not recommended except for UMW!)

Parameters can be placed in any order on the command line. Letters can be upper or lower case. The brackets, [], surrounding each parameter indicate that each is optional. Only the

parameters you specify will be changed. If no parameters are included on the command line, SETWAIT will provide a brief help screen. If the slash (/) is included, SETWAIT will show the new settings when it runs.

EXAMPLE

The following SETWAIT command corresponds to the contents of the "TURBO.BAT" file on the Little Board/PC Utilities diskette, and is recommended for systems which have all system RAM on-board, and which do not require slow I/O devices on the PC Expansion Bus:

```
SETWAIT UMB32 LMB512 UMW0 MMW1 LMW1 IOW1 RFW1 DMAW1
```

Alternatively, the software execution speed and bus timing of a 4.77 MHz PC can be simulated by the using the following SETWAIT command, which corresponds to the contents of the "SLOW.BAT" file on the utilities diskette:

```
SETWAIT UMB32 LMB512 UMW2 MMW2 LMW2 IOW3 RFW2 DMAW3
```

THEORY OF OPERATION

SETWAIT allows you to control eight wait state options, which correspond to the parameters controlled by the WCY1, WCY2, WMB, and RFC registers within the V40 microprocessor.

The V40's wait state control logic treats memory as three blocks, with an independent number of wait states used for each. These blocks are referred to as "Low Memory", "Middle Memory", and "Upper Memory", and the boundaries between them are defined by two values, "LMB" and "UMB". SETWAIT allows you to set these two boundaries, thereby defining the three memory blocks. For example, the SETWAIT command

```
A>SETWAIT UMB32 LMB512<Return>
```

defines Upper Memory as the upper 32K bytes, Lower Memory as the lower 512K bytes, and Middle Memory as that between these two blocks.

In addition, SETWAIT allows you to specify wait states for each memory block. Normally, the Lower Memory and Middle Memory blocks are occupied by on-board RAM, and the Upper Memory block is occupied by the on-board ROM-BIOS. Assuming this to be the case, a typical system would require zero wait states in the Upper Memory block, and one wait state in the Middle Memory and Lower Memory blocks. This can be set by the following SETWAIT command:

```
A>SETWAIT UMW0 MMW1 LMW1<Return>
```

The other three parameters which can be set by SETWAIT are the values for I/O, refresh, and DMA wait states. These can be set individually, together, or at the same time the memory boundary and wait state values are set. For example:

```
A>SETWAIT IOW1 DMAW1 RFW1<Return>
```

specifies one wait state for all I/O, DMA, and refresh cycles.

There are two restrictions regarding the use of the I/O, DMA, and refresh wait state parame-

ters:

- (1) Unlike the memory wait state control parameters (UMW,MMW,LMW), there are no address boundaries for the I/O, DMA, and refresh wait state parameters.
- (2) The values for DMA wait states (DMAW) and refresh wait states (RFW) are independent of the values specified for ordinary memory access cycles (UMW,MMW,LMW) and ordinary I/O access cycles (IOW).

Since DMA cycles generally involve both memory and I/O devices, the values for DMA wait states (DMAW) and refresh wait states (RFW) must be set to the greatest number required by associated memory or I/O devices regardless of the settings of the memory and I/O wait state parameters. For example, if DMA can occur between on-board DRAM (1 wait state) and a slow I/O device on the PC Expansion Bus (3 wait states), then DMAW must be set to 3. Similarly, if the system has dynamic memory on the PC Expansion Bus requiring 2 wait states, then RFW must be set to 2.

All of these operations are usually performed in a single command, as indicated by the above examples.