AMTELCO

Host Media Processing
E&M Board

TECHNICAL MANUAL

Documentation Revision 0.2: April 1, 2018

This manual applies to the PCI and the PCI Express versions of the board. Because of the differences between the bus interface, there are minor differences in the boards These differences have been noted where appropriate.

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The Host Media Processing E&M Board Technical Manual
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The Host Media Processing E&M Board

FCC Part 15 Requirements

WARNING: This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instruction manual, may cause interference to radio communications. Operation of this equipment in a residential area is likely to cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.

The authorized repair center is:

American Tel-A-System, Inc.
800-356-9148
4800 Curtin Drive
McFarland, WI 53558

There are no user serviceable components on the board. All repairs should be accomplished by returning the board to Amtelco with a description of the problem.

WARNING: This device contains Electrostatic Sensitive Devices. Proper care should be taken when handling this device to avoid damage from static discharges.

Product Safety

The telephone cable(s) must remain disconnected from the telecommunications system until the card has been installed within a host which provides the necessary protection of the operator.

If it is subsequently desired to open the host equipment for any reason, the telephone cable(s) must be disconnected prior to effecting access to any internal parts which may carry telecommunications network voltages.

This board is not intended to be connected directly to the PSTN network.

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European Approvals

CE Approval

EN55032 EMC declaration

This is a class A product. In a domestic environment, this product may cause radio interference in which case the user may be required to take adequate measures.

No changes or modifications to the Host Media Processing E&M card are allowed without explicit written permission from American Tel-A-Systems, Inc., as these could void the end user's authority to operate the device.

Notice: The PC chassis containing this device shall be placed in a secure location with access restricted to qualified service personnel.

The Host Media Processing E&M Board

Declaration of Conformity

PCI Board
Model Number: 266L002 4 Port HMP E&M
Model Number: 266L003 4 Port HMP E&M with echo canceller

PCIExpress Board
Model Number: 267L002 4 Port HMP E&M
Model Number: 267L003 4 Port HMP E&M with echo canceller

Standards to which the conformity is declared: EN55032, FCC Part 15B: 2018 ICES-003, EN55024 and EN60950-1
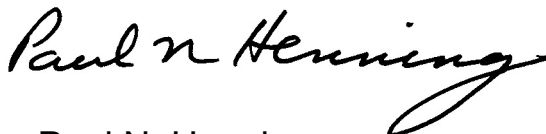
The undersigned declares that the equipment specified above:
- conforms to the above Standards,
- is in conformity to all the essential requirements of Low Voltage Directive 2014/35/EU.

Manufacturer: Amtelco

Company name: American Tel-A-Systems Inc.
                DBA - Amtelco

Address: 4800 Curtin Drive
                McFarland, Wisconsin 53558
                USA

Signature: *Paul N Henning*

Printed Name: Paul N. Henning

Position: Director of Research and

Development Date: 1 April 2018

The Host Media Processing E&M Board

1.0 Introduction

The Host Media Processing E&M Board is designed to provide four E&M interfaces for use in PC based telephony systems running Asterisk or similar software. Each interface or port provides both audio transmission and control support for basic line functions such as hook status indication and detection for Type I, Type IV and Type V interfaces. Each port can be programmed to conform to various national standards and practices.

There is a version of the board in both the PCI bus and the PCI Express form factor. This manual covers both versions. For the purposes of this manual, the PCI and PCI Express busses will be referred to as the PCI bus except where it is important to differentiate between them.

Unlike earlier computer telephony bus standards such as H.100, Host Media Processing relies on the processor of the PC to move the audio data between ports and to handle the details of port control. Specialized software that runs on the PC is used to accomplish this.

Asterisk, one such software platform, was devised by Digium, Inc. to allow for the easy development of custom telephone systems. It is intended for add-in boards using the PCI or PCI Express form factor. A wide variety of boards are available from a number of different vendors that will run under the Asterisk software.

1.1 Features and Capabilities

This section presents an overview of the features and capabilities of the Host Media Processing E&M Board.

1.1.1 The E&M Interface

Four independent ports are provided on the board. Each port on the board provides a complete E&M interface, including both the audio and signaling (E and M leads) connections. Type I, Type IV and Type V E&M interfaces are supported for either the trunk or the signaling side of the connection. The audio may be transmitted using either a 2-wire or a 4-wire interface. The 4-wire interface separates the transmit and receive pairs. The signaling and audio interface type are software selectable on a port by port basis without using jumpers.

Associated software provides support for the common address signaling protocols such as immediate start, wink start, and delay-dial for both incoming and outgoing calls. Calls can use DTMF or other forms of signaling of the address digits. For special applications such as interfacing to two-way radio transceivers, the M-lead can be controlled directly by the application.

1.1.2 Asterisk

Asterisk is open-source software that was developed by Digium, Inc. that can be used to develop customized PBX's or other telephony applications. It runs under the Linux operating system. Boards from a number of vendors supporting a variety of telephony interfaces are available along with the necessary software drivers needed to work with Asterisk.

Asterisk, unlike earlier telephony systems such as the H.100 bus, uses the processor of the host PC to carry out the switching and audio

processing functions. This allows for the use of lower cost hardware which leads to very economical systems. Note that in Asterisk the term "channel" is synonymous with the terms "interface" or "port."

1.1.3 Echo Cancellation

Some applications may require the use of echo cancellation. This is particularly likely in 2-wire applications, however, depending on the nature of the circuit to which the board is being connected, it may be useful in 4-wire applications as well. On the Host Media Processing E&M board, echo cancellation is provided by an add on module that is plugged onto the board.

1.2 How to Use This Manual

The first five sections in this manual are organized in the order you should read and use them to get started with your HMP E&M Board. We recommend that you begin with these three steps.

1. Read section 2.0 (Initialization) to familiarize yourself with the E&M interface.

2. Follow the instructions in section 3.0 (Installation) and 4.0 (Software). These sections will allow you to get your board operating correctly within your system.

3. Read section 5.0 (Using the HMP E&M Board) for an overview of the features available with the E&M Board.

The Appendices contain information on power requirements and obtaining assistance that may be helpful when installing your E&M Board.

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2.0 The E&M Interface

2.1 E&M Interfaces

E&M interfaces have a long history of usage in connecting various pieces of analog equipment together or to the public switched telephone network. It has also been used for interfacing telephony equipment to radio transmitters or two-way radio transceivers.

The important features of the E&M interface are that it separates the audio transmission path from the signaling leads, and that positive supervision is provided by the signaling leads in both directions, that is that either side of the connection can indicate an on-hook and an off-hook state.

It is important to note that E&M interfaces are not intended for direct interconnection with the common "loop" type phone circuits or to directly drive a standard telephone instrument. The signaling and wiring of an E&M circuit are not compatible with such connections.

The hook status signaling is carried on two leads, the E-lead which is the signal in one direction and the M-lead in the other direction. The origin of this nomenclature is that the E-lead is the signal for the listening or "Ear" direction, while the M-lead is the signaling for the talking or "Mouth" direction. However, as the E&M interface is bidirectional, much confusion can result as to which lead is which. Some versions of the interface include two additional leads designated SB and SG which are associated with the M and E lead respectively. These leads are used to provide a return path for the signaling leads and are connected to either ground or the negative power supply on the side with the current sensor.

The earliest forms of E&M interfaces were asymmetrical, with one side referred to as the trunk circuit and the other side the signaling circuit. Different signaling systems were used in each direction. In these interfaces, the M-lead carried the signaling information from the trunk to the signaling circuit and the E-lead carried information from the signaling circuit to the trunk circuit. Some later versions of the interfaces are symmetrical, which makes the determination of which lead is the M-lead and which the E-lead more ambiguous. For purposes of the Host Media Processing E&M Board, the lead used to signal is always referred to as the M-lead and the lead on which a signal is received is always called the E-lead. This is due in part to the fact that a port can be configured as either the trunk or the signaling side under software control which will change the form of the signal, but not the actual wire carrying the signal.

2.2 Types of Interfaces

The E&M interface has evolved over the years with a number of different variations in use. These different variations are distinguished from one another by referring to them as "Type" followed by a Roman numeral, i.e. Type I or Type II. Each type has a specific scheme of referencing the E and M leads to ground, battery, or open for the on-hook and off-hook cases. Types I and V use only a single lead in each direction, while Types II, III, and IV use additional leads, referred to as the SB and SG leads, which essentially serve as ground references.

The signaling leads are distinct from the wires that carry the audio signal. This means that each interface type may use either one or two pairs of wires for the audio. A full specification of an interface will include information on both the signaling and audio leads. For example an interface might be a 2-Wire Type I or a 4-wire Type V.

The Host Media Processing E&M Board can support the Type I, Type IV and Type V interfaces. Type I has both a Trunk and a Signaling side

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which are different. The Type IV and V interfaces are symmetrical, that is both sides are identical. In the case of a Type IV or Type V interface, the M-lead of one side can be connected to the E-lead of the other side and vice versa. The first table lists the interfaces and the signals present for the on-hook and off-hook states.

Unless equipment using the E&M interface is well documented, it can sometimes be difficult determining exactly which lead is which. A voltmeter and the second table can be used to determine which type of interface is being used by equipment that is to be connected to. It can also be used to determine which lead on the E&M board to connect to.

E&M Signaling States

Type	Lead	On-hook State	Off-hook State
I - Trunk Circuit	M-lead	Ground	Battery
I - Signaling Circuit	E-Lead	Open	Ground
IV - Both	Both	Open	Ground
V - Both	Both	Open	Ground

Note, that for a Type I interface, the port on the E&M board must be set to the opposite side from the equipment to be connected to. For example, if the equipment is configured as a Trunk Circuit the port must be configured as a Signaling Circuit.

Because of PC power supply limitations, the Host Media Processing E&M Board uses a -24 V battery level.

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Levels of Corresponding Leads

Type	Lead	On-hook State	Board Lead
I-Trunk Circuit	E-Lead	-24 V	M-lead
	M-Lead	Ground	E-Lead
I-Signaling Circuit	E-Lead	Open	E-Lead
	M-Lead	Ground	M-Lead
IV - Trunk Circuit	E-Lead	-24 V	M -Lead
	M-Lead	Open	E-Lead
IV - Signaling Circuit	E-Lead	Open	E-Lead
	M-Lead	-24 V	M-Lead
V-Trunk Circuit	E-Lead	-24 V	M-Lead
	M-Lead	Open	E-Lead
V-Signaling Circuit	E-Lead	Open	E-Lead
	M-Lead	-24 V	M-Lead

2.3 Signaling

The signaling that can take place over the E and M leads can indicate the on-hook or off-hook states. When used in this manner, the signaling works in a manner similar to that of a telephone set.

E&M Interfaces may also be used to pass information indicating the number of the destination or originating party. This is known as address signaling or DID which stands for direct-inward-dialing. While this information may be carried in the form of pulses on the E and M leads, it is much more common for the information to be carried as inband

signals on the audio leads using DTMF or MF tones.

Some address signaling protocols require the sending of an acknowledgment signal from the receiving side known as a "wink." This signal, which consists of a brief off-hook pulse, is carried on the E and M leads.

These leads can also be used to transmit hook-flashes which are sometimes used to get the attention of a piece of equipment such as a PBX to set up a transfer or conference.

E&M interfaces may also be used to interface phone equipment to two-way radios. In this case, the signaling lead may take the place of a "push-to-talk" switch indicating when the phone equipment wishes to transmit.

As there are many different applications and signaling protocols used on E&M interfaces, the user should have some knowledge of the requirements of the equipment to which the board is to be connected.

As the interface type and the signaling protocols are set by the driver, they are defined by entering the information in the appropriate configuration file.

2.4 Audio Connections

The audio portion of an E&M interface is carried on one or two pairs of wires, and are referred to as 2-wire or 4-wire interfaces. Note that this does not include the E and M leads. In the 2-wire case, the single pair carries audio in both directions much like a standard loop. In the 4-wire case, one pair is used for the audio in each direction. Note that the transmit pair on one side is connected to the receive pair on the other side of the interface. In both cases, the audio pair is "dry", that is no talk battery is present.

2.5 Cabling & Power Considerations

Connections to the board are made through the four RJ-45 connectors on the rear panel of the board. There is one connector for each of the four ports, and each connector contains both the audio and signaling wires. The connector pinout is described in section 3.2.

Power for the telephony signaling voltages is obtained from the PC's internal power supply so that no external supply is required. However, the PC supply must have enough capacity to handle the requirements. In most applications this will not be a problem. Consult Appendix A for power requirements.

3.0 Installation

This section describes how to install your Host Media Processing E&M Board into your PC.

3.1 PC Requirements

The Amtelco Host Media Processing E&M Board comes in both a PCI and a PCI Express version. As the boards conform to the PCI and PCI Express standards, there are no switches to set to configure the HMP E&M Board's memory address, I/O addresses, or interrupt. The PC's BIOS will automatically configure the board at boot time to avoid conflicts with other boards in the system.

Before attempting to install the board in your computer, you must make sure that you have the correct version (PCI or PCI Express) for the connector in your PC's backplane. Attempting to plug a board in the wrong type of slot may damage both the board and the backplane. The type of board may be determined by examining the edge connector on the bottom of the board (see the board outlines in the figures).

As the PC power supply is used to generate the telephony signal voltages, you must determine that it can supply sufficient current to power the board. In addition, it must have both +3.3 V and +5 V supplies for PCI slots and +3.3 V and +12 V supplies for PCI Express slots.

Of course, the PC must also have enough memory and have a fast enough processor to run the operating system and software platform such as LINUX and Asterisk, that the board is to be used with.
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The Host Media Processing E&M Board
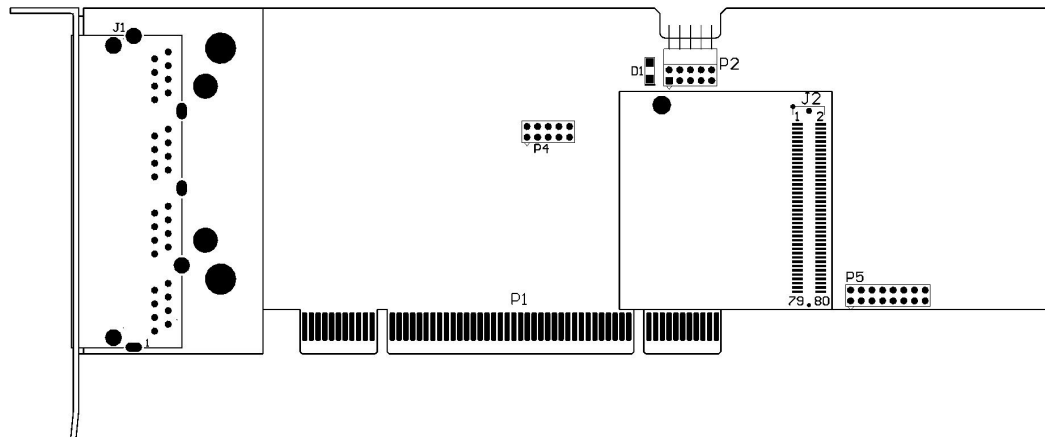
Figure 1: Location of Connectors and Headers for the PCI E&M Board, includes the Echo Cancellation Module

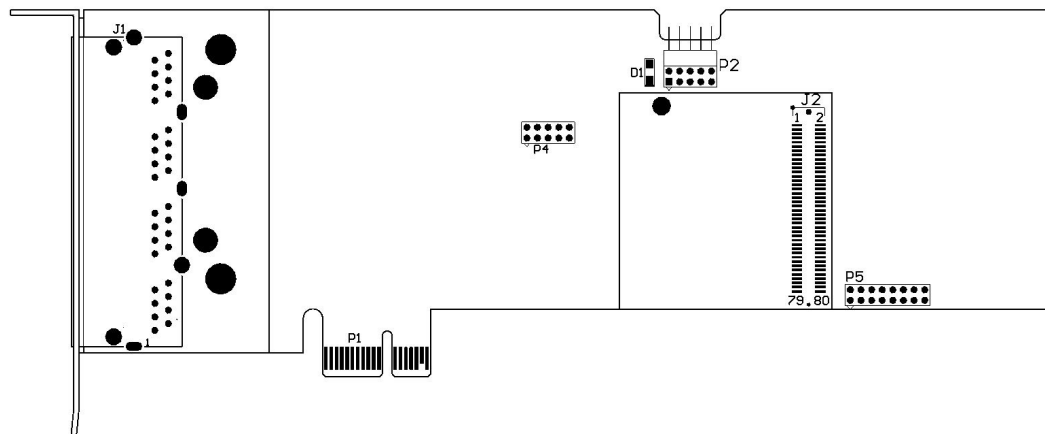*Figure 2:* Location of Connectors and Headers for the PCI Express E&M Board, includes the Echo Cancellation Module

3.2 Connectors: P1- P5, J1 and J2

P1   The PCI or PCI Express connector. This plugs into the appropriate backplane connector.

P2   Connector for synchronizing clocks on multiple boards.

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P3   Connector for J1 RJ-45 module. (not shown)

P4   Programable logic programming connector. Do not use.
                 For factory use only.

P5   JTAG test connector. Do not use. For factory use only.

J1   Analog telephone connections. This connector is a quad
                 RJ-45. One Connector is used for each port, with the
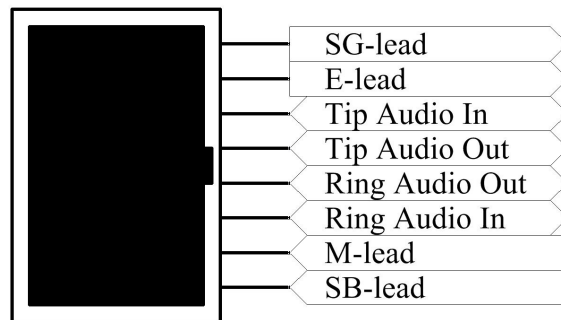   pinout listed below. See Figure 3.

| SG-lead |
| E-lead |
| Tip Audio In |
| Tip Audio Out |
| Ring Audio Out |
| Ring Audio In |
| M-lead |
| SB-lead |

PORT 4
PORT 3
PORT 2
PORT 1

Figure 3: RJ-45 Pinout   *Figure 4:* Rear
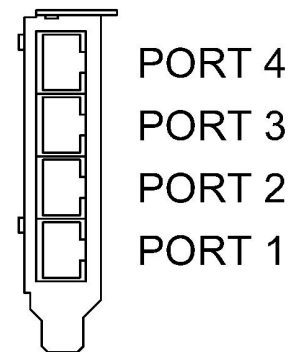   Panel

J2   Connector for attaching the Echo Cancellation Module.

3.3 Cabling

Connections to other pieces of telephony equipment are made via cables,
one end of which is an RJ-45 plug that fits into the RJ-45 jacks on the
rear panel of the board. The pinout of these jacks is given in *Figure 3*
above. The termination and pinout of the other end will depend on the
equipment to which the board is connected. Providing the proper cable
is the responsibility of the user. As the implementation of the E&M
interface varies widely with the application, no standard cable can be
provided. However, helpful information on determining the details for
a specific application may be found in Section 2.2.

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3.4 Installation

To install the Host Media Processing E&M Board in your system:

1. Turn off the PC power. Remove the PC cover.

2. Do not connect the telephone cables. Verify that the board is the appropriate type for the PC backplane connector.

3. Install the echo cancellation module on the board if desired.

4. Insert the board into the chassis. Seat it properly in a PCI or PCI Express slot as appropriate in the PC chassis and tighten the screw in the back of the board to secure the board.

5. Reinstall the PC cover. Connect the PC to the mains supply using a socket-outlet with protective earthing connection and connect any additional protective earthing used.

6. Connect the telephone cable(s) to J1. The telephone cable terminates in an RJ-45 male connector.

If it is subsequently desired to open the host equipment chassis for any reason, the telephone cable must be detached prior to effecting access to any internal parts which may carry telecommunications network voltages.

The PC chassis containing this device shall be placed in a secure location with access restricted to qualified service personnel.

4.0 Software

This section describes the procedures necessary to install, configure and run the software for the Host Media Processing E&M Board.

4.1 Installing the Drivers

The current drivers for the board may be downloaded from Amtelco's FTP site. The accompanying README file will give details of the procedure to install this driver. For details on accessing the FTP site, contact your Amtelco representative.

4.2 Configuration Files

In order for the driver to correctly set up the ports on the E&M board, it is necessary to add information to several configuration files. Sample files are supplied with the driver software available on the FTP site as indicated in the accompanying README files.

The file **amtelco_hmp.conf** provides information which is used by the channel driver to configure the board. This file must be placed in the Asterisk configuration directory for the channel driver to function. It is used to configure ports for the E&M signaling behavior, the E&M signaling type, 2 wire or 4 wire operation, DID behavior and so on. A detailed explanation of the syntax used to set these configuration options is given in the sample file.

To include the HMP E&M board in the Asterisk dial plan, information will have to be added to the Asterisk configuration file **extensions.conf**. Examples of the various options for this file are given in the sample **extensions.conf.sample** file.

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4.3 Running Asterisk

Asterisk is open source software that may be used to develop telephony applications. It may be downloaded from the site www.asterisk.org. Details of installing and running Asterisk are contained in various files in this package.

In addition, there is a variety of documentation and other information available at this site to assist the developer.

Note, that with the HMP E&M Board the Asterisk term "channel" is synonymous with the terms "port" and "interface."

5.0 Using the HMP E&M Board

In addition to the basic capabilities of providing hook-status control and audio transmission, the Host Media Processing Board has a number of advanced features that may be useful. This section describes how those features may be enabled and used.

5.1 Overview of the Advanced Features

E&M interfaces are used in a number of applications. One of the common applications is to provide an interface to PBX's for add on systems such as voice mail or help desks. In such applications, it may be useful to pass information about the calling or called party through the use of address signaling. The E&M Board can accommodate a number of different signaling formats and protocols.

Another application is to provide an interface between a phone system and a two-way radio. In this application, the M-lead is used to control the transmit function of the radio.

The E&M Board also supports a number of advanced features such as echo suppression that may be useful in a variety of applications.

5.2 Features Provided by Asterisk

Many of the standard telephony features are provided as part of the Asterisk environment. These include the ability to detect and generate the DTMF tones used for signaling as well as the generation of the various call progress tones such as busy, reorder, and audible ringback. In addition, Asterisk provides the means of playing announcements or

recording and playing back speech as in voice-mail. The user should consult the Asterisk documentation to learn how to use these features.

5.3 Configuring the Software for Features

Several steps are necessary when configuring the board. The Asterisk file **extensions.conf** must be modified to include the HMP E&M board in the Asterisk dial plan. The file **amtelco_hmp.conf** must be included in the Asterisk configuration directory /etc/asterisk. This file contains information used to configure the type and operation of the board. Details on these files are given in sample files in the HMP driver package (see section 4.2).

5.4 Advanced Features

This section describes how to use the various features supported by the board and the associated software that go beyond the standard features provided by Asterisk.

5.4.1 Address Signaling Protocols

E & M interfaces are sometimes used to interface to PBX's or channel banks. In these applications, a single interface may be used to direct calls to more than one destination or for more than one phone number. In these applications which are sometimes called Direct Inward Dialing or DID, one or more digits of information is sent by the originating interface to indicate the ultimate destination. These digits are referred to as "address" digits and can be sent as either DTMF or MF-R1 signals on the audio pairs or as pulses on the E-lead. There are several standard protocols that define the timing of the digits, i.e. the time from the off-hook signal till the digits can begin and the time between digits, and the form of the acknowledgment or ready signal sent by the destination interface.

The acknowledgment, if required, takes the form of a momentary off-hook signal or "wink" on the M-lead. If no acknowledgment is required before the digits are sent, it is referred to as "immediate start". If a "wink" is required, it is referred to as "wink start." The "wink" is typically 200 msec. long. A variation called "delay dial" starts the wink and ends it when the digit detector is ready to accept digits.

The option **didconfig** in the file **amtelco_hmp.conf** must be set to appropriate values for DID operation.

5.4.2 Direct Control of the M-Lead

For some applications such as controlling a two-way radio transceiver, it may be desirable for an application to directly control the M-lead. To configure a port to operate in this mode, the option signaling must be set to the value "em_manual" in the file **amtelco_hmp.conf.** The M-lead may then be controlled through the command AHMPExec. The sample **extensions.conf** file gives details on the syntax and operation of this command.

As an example of how to implement this feature the following would activate the M-lead for one second when the extension 110 is dialed.

exten => 110,1,AHMPExec(M_Lead,AHMP/10:0:2,Close)
exten => 110,n,Wait(1)
exten => 110,n,AHMPExec(M_Lead,AHMP.10:0:2,Open)
exten => 110,n,Hangup()

5.4.3 Push To Talk Feature

To facilitate interfacing to radio transceivers, the HMP E&M Board includes a Push To Talk feature which may be used to key the transceiver when voice energy is detected in the outgoing direction of a port. Details of the operation of this feature may be found in the

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sample **amtelco_hmp.conf** file.

To set a port for this mode of operation, the signaling option for the port in the **amtelco_hmp.conf** file must be set to be equal to the value "em_vox."

Additional options for configuring the operation of this feature are available. These include VOX_level, to set the audio level to trigger the feature, emvoxdisconnect to specify a DTMF string to cause the port to hang up, emvoxhanguptone to play the congestion tone when the far end hangs up the port, and emvoxmode to enable incoming calls.

5.5 Echo Cancellation

Telephony systems may under some circumstances experience the phenomena of excessive echo where speech is reflected from the far end with a noticeable delay. This is particularly true when the call involves VoIP or satellite links. To combat this echo, the HMP E&M board may be equipped with an echo cancellation module that is plugged onto the board.

In particular, echo may be a problem with the E&M board if it is used in a 2-wire mode rather than the 4-wire mode. Because separate pairs of wires are used for the transmit and receive audio, echo tends to be less of a problem with 4-wire circuits. However, there still may be situations where echo cancellation is desirable with 4-wire circuits depending on what it is on the far end.

This module may also provide additional capabilities such as the detection of DTMF digits on the board which may enhance system performance.

Appendix A: Environmental Specifications

The Host Media Processing E&M Board meets the following environmental specifications:

TEMPERATURE EXTREMES:

Operating: 0°C (+32°F) to +50°C (+122°F).
Storage: –40°C (–40°F) to +70°C (+158°F).

AMBIENT HUMIDITY:

All boards will withstand ambient relative humidity from 0% to 95% non-condensing in both operating and storage conditions.

MECHANICAL:

All E&M boards conform to the PCI-SIG mechanical specifications for PCI or PCI Express cards.

ELECTRICAL REQUIREMENTS:

PCI HMP E&M Board:
+3.3 volts   60 mA typical, 100 mA maximum w/o echo canceller
              300 mA typical, 800 mA maximum with echo canceller
+5 volts   1.0 A typical, 1.5 A maximum

PCI Express HMP E&M Board:
+3.3 volts   100 mA typical, 150 mA maximum w/o echo canceller
              350 mA typical, 850 mA maximum with echo canceller
+12 volts   500 mA typical, 750 mA maximum

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MTBF:

50,000 hours.

Appendix B:
Service Information

If problems should arise with your HMP E&M board or technical assistance be required, call Amtelco at 1-608-838-4194 ext. 168.

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