Host Media Processing T1/E1 Board

TECHNICAL MANUAL

Documentation Revision 0.0d
25 July 2019

266M003D

This manual applies to the PCI and PCI Express versions of the HMP T1/E1 Interface boards. Because of the differences between the bus interfaces, there are minor differences in the boards. These differences have been noted where appropriate.

Table of Contents

The Host Media Processing HMP T1/E1 Board Technical Manual

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266M003D

FCC Part 15 Notice

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.

Product Safety

The telephony cable(s) must remain disconnected from the telecommunications system until the board 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 telephony cable(s) must be disconnected prior to effecting access to any internal parts which may carry telecommunications network voltages.

If trouble is experienced with the HMP T1/E1 Board, please contact:

American Tel-A-Systems, 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.

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 HMP T1/E1 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.

Declaration of Conformity

PCI Boards without Echo Cancellation
Model Number: 266L023 8 Port HMP T1/E1 Board
Model Number: 266L029 4 Port HMP T1/E1 Board

PCI Boards with Echo Cancellation
Model Number: 266L016 8 Port HMP T1/E1 Board
Model Number: 266L019 4 Port HMP T1/E1 Board

PCI Express Boards without Echo Cancellation
Model Number: 267L016 8 Port HMP T1/E1 Board
Model Number: 267L017 4 Port HMP T1/E1 Board

PCI Express Boards with Echo Cancellation
Model Number: 267L009 8 Port HMP T1/E1 Board
Model Number: 267L011 4 Port HMP T1/E1 Board

Standards to which the conformity is declared: EN55032, EN55024, EN50082-1 and EN60950-1, TBR4, TBR12, TBR13, FCC Part 15B, 2018 ICES-003

The undersigned declares that the equipment specified above:
- conforms to the above Standards,
- is in conformity to all essential requirements of Directive 2014/35/EU.

Manufacturer: Amtelco

Company name: American Tel-A-Systems, Inc. dba Amtelco

Address: 4800 Curtin Drive
McFarland, Wisconsin 53558
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Signature: 

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Date: 1 April 2018

1.0 Introduction

The Host Media Processing HMP T1/E1 Board is designed to provide up to eight digital interfaces for use in PC based telephony systems running Asterisk or similar software. The board can support both the T1 and E1 standards for use in North America and Europe respectively. In addition to support for Primary Rate ISDN, the board supports robbed-bit and Channel Associated Signaling protocols.

The board is available in both PCI and PCI Express form factors. This manual covers both versions. For the purposes of this manual, the PCI and PCI Express buses 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 audio data between channels. Specialized software that runs on the PC is used to accomplish this.

Asterisk is one software platform that can be used to create custom host media processing telephone systems. It provides interfaces to a wide variety of boards from a number of different vendors for connecting to traditional telephony devices.

1.1 Features and Capabilities

This section presents an overview of the features and capabilities of the Host Media Processing HMP T1/E1 Board.

1.1.1 The T1 and E1 Interfaces

The board is available in versions with four or eight interfaces. These interfaces can be configured for T1 standards (North America) or E1 standards (Europe and most of the rest of the world). Support is provided for Primary Rate ISDN, robbed-bit, and Channel Associated Signaling.

When configured for ISDN, each interface or span includes a D-channel for call control and either 23 (T1) or 30 (E1) B-channels for audio data. The on-board processor handles all of the details of Layers 1, 2, and 3 of these protocols freeing the host processor for higher level functions. Each interface may be configured as either an NT (network termination) or a TE (terminal equipment) interface.

The board also supports a number of supplementary services such as those defined in the QSIG or National ISDN standards.

In addition to the ISDN mode, spans may be configured for either robbed-bit (T1) or Channel Associated Signaling (E1), in which the digital interfaces emulate various analog line types. In this case 24 (T1) or 30 (E1) audio channels are available.

1.1.2 Asterisk

Asterisk is open-source software that was developed by Digium, Inc. that can be used to develop customized PBXs 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 term “B-channel.”

1.1.3 Monitoring Capability

In addition to acting as a Network Termination or Terminal Endpoint, the interfaces on the HMP T1/E1 Board can be used to passively monitor a T1 or E1 circuit, providing access to both the audio and control signaling on that circuit. Full duplex monitoring of a circuit requires the use of two interfaces on the board, one to monitor each end.

1.1.4 Echo Cancellation

Some applications may require the use of echo cancellation. The HMP T1/E1 Board may be purchased with a hardware-based echo canceller to provide this function.

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 T1/E1 Board. We recommend that you begin with these three steps.

1. Read section 2.0 (T1 and E1 Interfaces) to familiarize yourself with the telephone line interfaces.

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 T1/E1 Board) for an overview of the features available with the Board.

The Appendices contain information on power requirements and obtaining assistance that may be helpful when installing your HMP T1/E1 Board.

2.0 T1 and E1 Interfaces

2.1 The T1/E1 Interface

The T1 and E1 standards define a type of digital circuit in which multiple phone conversations are transported on a pair of wires as a sequence of ones and zeros rather than as an analog voltage. They fall into a class of what are called Time Division Multiplexed circuits or TDM. In TDM, the bit stream is divided into frames, each one of which is 125 microseconds long. Each frame is further subdivided into time slots which are eight bits long. Each timeslot is used to encode the level of a single phone conversation at the time the frame is sent. Timeslots are interleaved in the frame so that the first eight bits encode the first conversation, the second eight bits the second, and so on until the end of the frame when the process starts over again with the values for the next frame. In addition to the digitally encoded voice signal, some of the bits in the bit stream are used for signaling purposes. Exactly how these signaling bits are encoded is dependent on the specific type of interface.

2.2 Types of Interfaces

While T1 and E1 circuits operate on the same general set of principles, there are differences between the two. The T1 interface was developed in North America and is used in both the United States and Canada. The E1 interface originated in Europe and is used in most of the world outside of North America. Japan uses a modified form of the T1 interface designated as J1.

The major difference between the T1 and E1 standards is the bit rate (number of bits sent each second), with the T1 rate being 1.544 Mbits/s and the E1 rate being 2.048 Mbits/s. Because of this difference, the number of timeslots or voice channels that are supported are different for the two types of interfaces, with T1 circuits supporting 24 channels and E1 circuits supporting 30 voice channels. It should be noted that on an E1 circuit there are two additional timeslots: one is used for signaling purposes and the other is used for various maintenance functions.

In addition to the voice channels and signaling information, the bit streams are used to carry certain other types of information. This includes framing information which is used to indicate where the frame begins as well as support for a number of maintenance functions such as the ability to place an interface into a loopback condition for line testing.

Both the T1 and E1 standards have evolved over time so that there are a number of variants of each. As these variants are not compatible with each other, it is important when installing equipment that it be configured for the correct variant for the circuit. For T1 circuits, the most common variants are D4 and ESF (Extended Super Frame), with ESF being the more recent and the most common. The most common E1 type is CRC4 which refers to an error detection scheme, but non-CRC4 circuits do exist. T1 and E1 circuits also employ zero-suppression methods. The zero suppression method setting must match that of the circuit for proper operation. T1 circuits typically use a scheme called B8ZS while E1 circuits mostly use a method called HDB3. Some older T1 or E1 circuits may use a method called AMI. While the details of these variants are beyond the scope of this document, it is important that the configuration settings of the interface match those of the circuit.

T1 and E1 circuits are point to point connections, i.e. circuits connecting two endpoints with no intervening connections. One endpoint is called the Network Termination or NT while the other is designated the Terminal Equipment or TE. The NT is the endpoint at the central office or CO, and the TE is the user's or customer's endpoint. When connecting two pieces of user equipment such as two PBXs, one will operate as the NT while the other will be the TE. As the two terminations are not symmetrical, it is important that equipment is configured to be the appropriate type of endpoint.

One other item that is important when configuring equipment is the issue of clocking. T1 and E1 circuits do not use a separate clocking signal to ensure synchronization, but instead use certain repetitive signals within the bit stream for this purpose. The clocking should always originate from the NT end of the circuit. Improper configuration of the clocking may result in bits being lost from or extra bits being added to the bit stream. When this happens it is called *slip*. Excessive slip may degrade the performance of the

circuit. If one or more of the interfaces on the board are configured as a TE, then one of the TE interfaces should be chosen as the clocking reference for the board. An NT should not serve as the clock reference under most circumstances.

2.3 Signaling

For a phone circuit to be useful, it is necessary for it to convey certain types of control information to signal such things as the intended destination as well as the beginning and end of a call. A number of different schemes have been deployed for encoding this signaling information. In general, these schemes fall into two categories. One category involves encoding that emulates the signals on an analog phone circuit. These schemes include Robbed-Bit Signaling which is used in North America and Channel Associated Signaling which is used in Europe. The other type of signaling is purely digital in nature and involves the sending of messages with the control information from one end of the circuit to the other.

2.3.1 Robbed-Bit Signaling

In Robbed-Bit Signaling, the least-significant bit in the eight bits of each frame which is used to encode the voice signal is instead used for signaling purposes. Bits from four sequential frames are combined to create a four bit value which represent specific conditions. These bits are labeled A, B, C, and D. As an example, when the A, B, C, and D bits are all set to 0 it may indicate that the circuit is on-hook and when they are all set to 1 the circuit is off-hook. Using this scheme, various types of analog circuits can be emulated including loop-start (the standard residential circuit), ground-start, and E&M circuits. Conditions such as ringing can also be signaled by this scheme. An older version of this scheme only uses two bits, the A and B bits.

2.3.2 Channel Associated Signaling

Channel Associated Signaling is similar to Robbed-Bit Signaling in that it also uses four bits to represent the various states of an analog line. However, instead of robbing a bit from the voice channel bits, it uses one of the two spare timeslots to transport the signaling bits. The timeslot used for this is

the seventeenth timeslot in the stream. Sixteen sequential frames are grouped as a superframe and in each frame, the CAS timeslot carries the bits for two of the voice channels. These bits are also referred to as the A, B, C, and D bits and encode the channel states in a similar manner. As with robbed-bit signaling various line types may be emulated.

2.3.3 Primary Rate ISDN

ISDN or Integrated Services Digital Network is a scheme that uses one of the timeslots on the T1 or E1 circuit to carry messages that control all of the voice channels on that circuit. This timeslot is called the D-Channel or Data Channel. The voice channels are referred to as B-Channels or Bearer Channels. On a T1 interface, the D-channel is in the last timeslot and there are 23 B-channels supported. On an E1 interface, the seventeenth timeslot carries the D-channel and there are 30 B-channels available.

ISDN is defined in a number of international and national standards. These standards describe a hierarchy of interfaces with different capacities which include Basic Rate (which is designed primarily for residential access and carries two B and one D channel) and Primary Rate (which is designed for commercial use and is carried on either a T1 or E1 circuit). The most important of the ISDN standards are Q.921 which describes the mechanism for message transport, and Q.931 which defines the messages used for call control.

One of the major advantages of ISDN is that the messages can carry additional information about the call besides the call state. This information can include the caller’s phone number, the called party’s number, and the B-channel the call is on. Information for various supplementary services can also be included including the caller’s name, whether the call has been redirected from another number, and control information for various forms of call transfer.

2.4 Cabling & Power Considerations

T1 and E1 cabling consists of two pairs of wires, one pair for the transmitted signal and the other for the received signal. The connector used on the HMP

T1/E1 board is an RJ-45. This is an eight pin connector and each connector carries the signals for two T1 or E1 circuits.

Because of the high frequencies used on these circuits, matching impedances is important. T1 circuits can be configured for different cable lengths. This is called build-out, and ensures the proper signal level and impedance of the equipment. E1 interfaces typically have an impedance of either 75 or 120 ohms. The build-out and impedance values are selectable as part of the configuration process and should be set to the appropriate values for the particular installation.

3.0 Installation

This section describes how to install your Host Media Processing HMP T1/E1 Board into your PC.

3.1 PC Requirements

The Amtelco Host Media Processing HMP T1/E1 Board comes in both PCI and PCI Express versions. As the boards conform to the PCI and PCI Express standards, there are no switches to set to configure the HMP T1/E1 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 below).

Of course, the PC must 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.

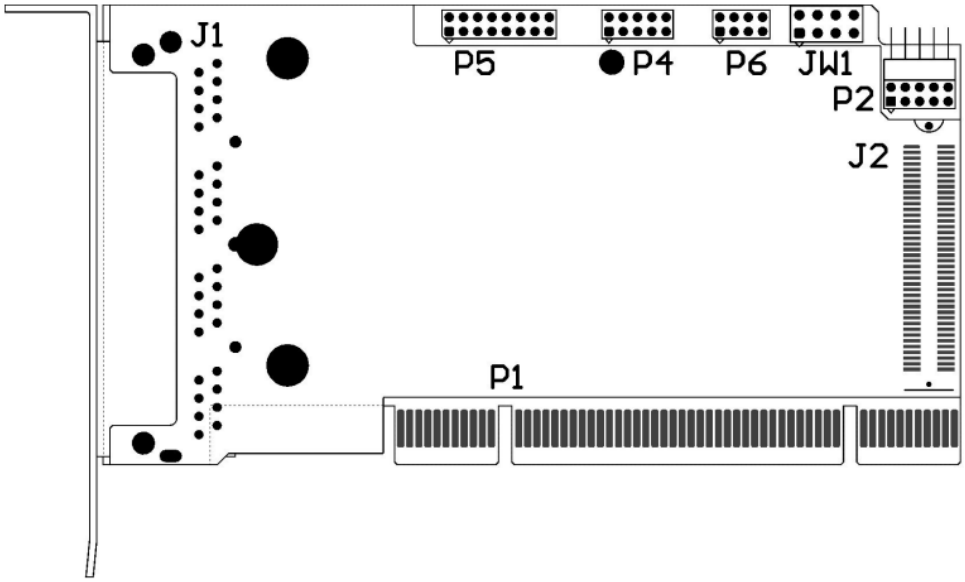

Figure 1: HMP PCI T1/E1 Interface

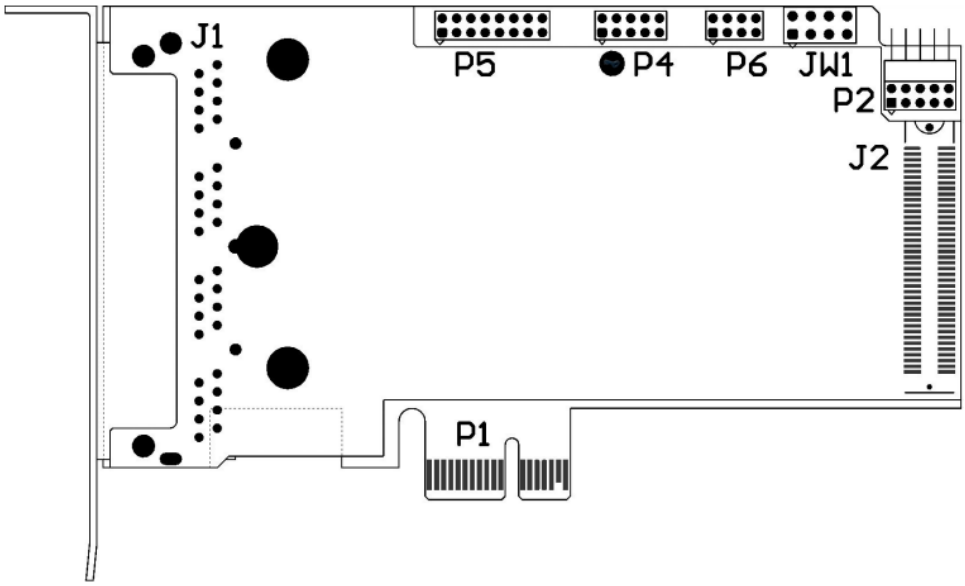

Figure 2: HMP PCI Express T1/E1 Interface

3.2 Connectors: P1 – P6, J1, and JW1

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

P2 Connector for synchronizing clocks on multiple boards.

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

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

P6 Diagnostic Connector. Do not use. For factory use only.

J1 T1/E1 interface connections. This connector is a quad RJ-45. One connector is used for two spans.

JW1 Diagnostic jumpers. Use only if instructed to by Amtelco service. No jumpers should be installed for normal operation.

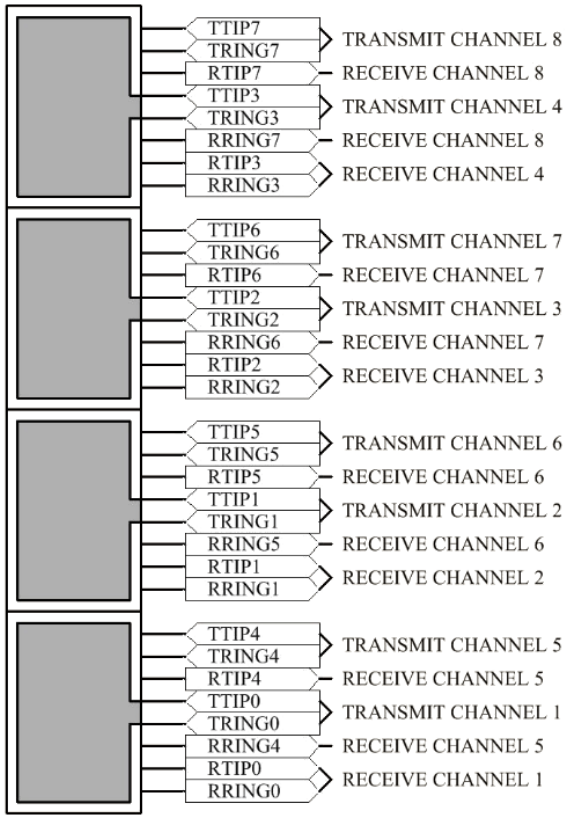

Figure 3: J1 Connector Pinout

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.

3.4 Installation

To install the HMP T1/E1 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. 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.

4. 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.

5. 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.

3.5 Configuring the Interfaces

The HMP T1/E1 Board is capable of supporting a number of different framing schemes and signaling protocols. Therefore, before the board can be used, it is necessary for the host software to configure the interfaces in a manner appropriate for the particular installation. For those applications using Asterisk, selecting the proper options is handled by a configuration file which is described in the next section. For non-Asterisk applications, configuration of the board is done through a series of messages as described in the *Host Media Processing T1/E1 Board Operations Manual.*

The first and most important configuration choice is to select whether an interface is to operate as a T1 or E1 interface. The interfaces on the board are divided into two halves which can be configured separately, so that all interfaces may be set to T1 or E1 or half may be set to T1 while the other half are set to E1. Each half is either two or four interfaces depending on whether the board has a four or eight interface module installed.

The next configuration choice has to do with selecting the framing options. This can be selected on an interface by interface basis. For a T1 interface the choices are D4 or ESF, and for an E1 interface the choices are CRC4 or non-CRC4. The zero suppression scheme must also be set. For a T1 interface the choices are AMI or B8ZS and for an E1 interface the choices are AMI or HDB3. The most common settings for a T1 circuit are ESF and B8ZS and for an E1 circuit, CRC4 and HDB3.

The signaling method is another option that must be selected. For a T1 interface the choices are no signaling, robbed-bit signaling, or primary rate ISDN. For the E1 interface the choices are no signaling, Channel Associated Signaling (CAS), or primary rate ISDN.

It is also necessary to specify the build out value if the interface is a T1 or the impedance value if the interface is an E1. The T1 build out value is a number from 0-7 where the choices are:

0 DSX-1 (0 to 133 feet)/0dB CSU
1 DSX-1 (133 to 266 feet)

2 DSX-1 (266 to 399 feet)
3 DSX-1 (399 to 533 feet)
4 DSX-1 (533 to 655 feet)
5 -7.5dB CSU
6 -15dB CSU
7 -22.5dB CSU

For an E1 interface the impedance can be set to either “B” (75 ohms) or “R” (120 ohms). Note that the letters B and R refer to the type of connectors typically used with each impedance, BNC or RJ-45.

If one or more of the interfaces is configured as a TE, one of the TE interfaces should be chosen as the clocking reference. Preference should be given to a TE which is connected directly to the public network. The clocking reference is selected using the **SCx** command where **x** is the interface that is to be the reference.

If an interface is set to use robbed bit or CAS signaling, it will also be necessary to specify the signaling emulation for each voice channel on the interface. The choices are:

ES - E&M signaling emulation
LS - loop start station emulation
LO - loop start central office emulation
GS - ground start station emulation
GO - ground start central office emulation
QS - Q.421 station emulation
QO - Q.421 central office emulation
XS - direct bit control
NS - no signaling

4.0 Software

This section describes the procedures necessary to install, configure and run the software for the Host Media Processing T1/E1 Board.

4.1 Installing the Drivers

The current device drivers and channel drivers (for use with Asterisk) 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 HMP T1/E1 board, it is necessary to add information to several configuration files. Sample files are supplied with the channel 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 interface type, proper signaling behavior, 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 T1/E1 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.

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 regard to the HMP T1/E1 Board the Asterisk term “channel” is synonymous with the term “B-channel”. The term “interface” refers to the T1 or E1 span.

5.0 Using the HMP T1/E1 Board

In addition to the basic capabilities of providing call control and audio transmission, the HMP T1/E1 Board has a number of advanced features. This section describes how those features may be enabled and used.

5.1 Features Provided by Asterisk

Many standard telephony capabilities are provided as part of the Asterisk environment. These include the ability to detect and generate DTMF tones used for signaling and the generation of the various call progress tones such as busy, reorder, and audible ringback. In addition, Asterisk provides voice mail features such as playing announcements or recording and playing back speech. The user should consult the Asterisk documentation to learn how to use these features.

5.2 Configuring the Software for Asterisk

Several steps are necessary when configuring the board. The Asterisk file **extensions.conf** must be modified to include the HMP T1/E1 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).

5.3 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.

5.3.1 Alarms

T1 and E1 interfaces report a number of alarm conditions to indicate the status of the circuit. The HMP T1/E1 board monitors these alarms and

reports them to the channel driver. The channel driver prints these alarms to the log file.

For T1 circuits, alarms have traditionally been color coded as green, yellow, blue, and red, with green indicating a fully functioning circuit and the other colors indicating impairments in increasing order of severity. This scheme has also been followed for E1 circuits, though the precise definition of the alarm conditions are slightly different.

For T1 circuits the alarm conditions are:

Green The circuit is up and functional.
Yellow Remote Alarm Indication (RAI). The far end has detected an error condition.
Blue Alarm Indication Signal (AIS). An unframed all-ones signal has been detected.
Red Loss of signal (LOS).

For E1 circuits the alarm conditions are:

Green The circuit is up and functional.
Yellow Remote Alarm Indication (RAI). The far end has detected and error condition.
Blue Alarm Indication Signal (AIS). An all-ones signal has been detected.
Red Receive Carrier Loss (RCL).

For E1 circuits using Channel Associated Signaling (CAS), there are several other alarm signals that may be detected. These are:

Receive Distant Multiframe Alarm or RDMF when the far end has set bit 6 of timeslot 16 in frame 0 of two consecutive multiframes.

Receive Signaling All 1's when timeslot 16 contains fewer than three 0's over 16 consecutive frames.

It should be noted that for both T1 and E1 circuits, calls can only be originated if the circuit is in the “Green” alarm state.

5.3.2 DID Address Signaling Protocols

Line interfaces are sometimes used to interface to PBXs 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. There are several standard protocols that define the timing of the digits, i.e. the time from the off-hook signal until 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 battery reversal signal or "wink". 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 ms 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 Passive Monitoring Capability

The HMP T1/E1 Board can be used to passively monitor a T1 or E1 circuit, that is, provide access to the signaling and audio on a circuit without disturbing the circuit's operations. To accomplish this, the receive pair of wires of an interface is connected to one of the two pairs of the circuit to be monitored. To monitor the circuit in both directions, therefore, two interfaces are required, one to monitor the TE side and one to monitor the NT side. The transmit pair on the monitoring interfaces are disabled and not connected to anything.

When using an interface in the monitor mode, it is necessary to set the type of the interface appropriately. In the case of an interface that is being used to monitor an NT interface, the interface should be set to type "M" and for an interface being used to monitor a TE interface, the type should be set to "O".

5.5 Echo Cancellation

Telephony systems may under some circumstances experience 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 T1/E1 board may be purchased with an echo cancellation module that is plugged onto the board.

Appendix A Environmental Specifications

The Host Media Processing T1/E1 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 5% to 95% non-condensing in both operating and storage conditions.

MECHANICAL:

All T1/E1 boards conform to the PCI-SIG mechanical specifications for PCI or PCI Express cards.

ELECTRICAL REQUIREMENTS:

PCI HMP T1/E1 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 T1/E1 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

MTBF:

50,000 hours

Appendix B Service Information

If problems should arise with your HMP T1/E1 Board or if technical assistance is required, call Amtelco at 1-608-838-4194 ext. 168.