



# Infinity Series H.110 Station Board

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## TECHNICAL MANUAL

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258M014A

This manual refers to firmware version 0.1 and later.

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## Infinity Series H.110 Station Board Technical Manual

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• 258M014A •

*The H.110 Station 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.

## FCC Part 68 Registration

This equipment is registered with the FCC under Part 68 as a component device for use with any generic PC Type computer or compatible. In order for FCC registration of this product to be retained, all other products used in conjunction with this product to provide your telephony function must also be FCC Part 68 registered for use with these hosts. If any of these components are not registered, then you are required to seek FCC Part 68 registration of the assembled equipment prior to connection to the telephone network. Part 68 registration specifies that you are required to maintain the approval and as such become responsible for the following:

- any component device added to your equipment, whether it bears component registration or not, will require that a Part 68 compliance evaluation is done and possibly that you have testing performed and make a modification filing to the FCC before that new component can be used;
- any modification/update made by a manufacturer to any component device within your equipment, will require that a Part 68 compliance evaluation is done and possibly that you have testing performed and make a modification filing to the FCC before the new component can be used;
- if you continue to assemble additional quantities of this compound equipment, you are required to comply with the FCC's Continuing Compliance requirements.

The telephone company has the right to request the registration information.

The Digital I/F FIC code for this equipment is 02IS5.

The Service Order code for this equipment is 6.oP.

The network Interface Jack for this equipment is an RJ49C.

The telephone company has the right to temporarily discontinue service. They are required to provide notification and advise of the right to file a complaint.



In case of trouble, you may be required to disconnect the board from the telephone lines until the problem is resolved.

Connection to telephone company coin service is prohibited.

Connection to party lines is subject to state tariffs.

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 PSTN cord(s) and telephony power supply 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 PSTN cord(s) and telephony power supply 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.**

*The H.110 Station Board*

## **Canadian Customers**

CP-01, Issue 8, Part 1

### Section 14.1

**Notice:** “The industry Canada label identifies certified equipment. This certification means that the equipment meets certain telecommunications network protective, operational and safety requirements as prescribed in the appropriate Terminal Equipment Technical Requirements document(s). The Department does not guarantee the equipment will operate to the user’s satisfaction.

Before installing this equipment, users should ensure that it is permissible to be connected to the facilities of the local telecommunications company. The equipment must also be installed using an acceptable method of connection. The customer should be aware that compliance with the above conditions may not prevent degradation of service in some situations.

Repairs of certified equipment should be coordinated by a representative designated by the supplier. Any repairs or alterations made by the user to this equipment, or equipment malfunctions, may give the telecommunications company cause to request the user to disconnect the equipment.

Users should ensure for their own protection that the electrical ground connections of the power utility, telephone lines and internal metallic water pipe system, if present, are connected together. This precaution may be particularly important in rural areas.

**CAUTION:** Users should not attempt to make such connections themselves, but should contact the appropriate electric inspection authority, or electrician, as appropriate.

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

## European Approvals

### CE Approval



### EN55022 EMC declaration

This is a class B 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 H.110 Station 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.

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*The H.110 Station Board*

# 1.0 Introduction

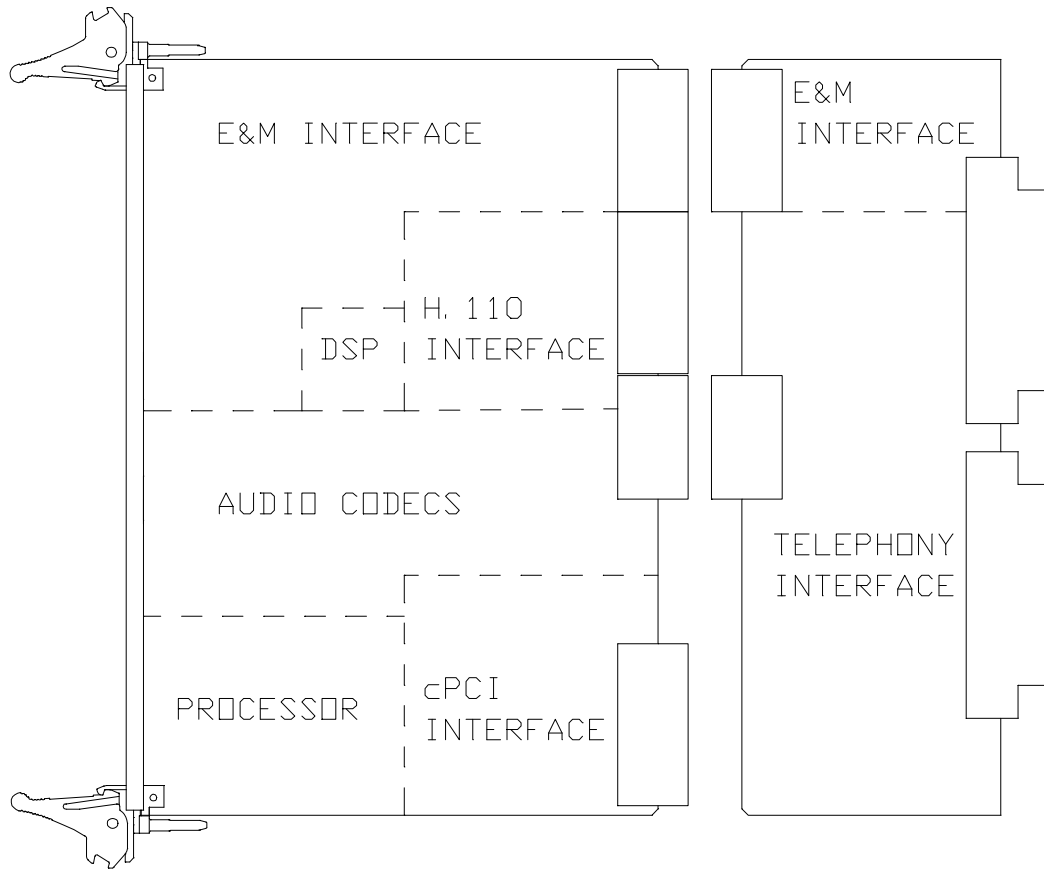
The Infinity Series H.110 Station Board is designed to provide thirty-two Station Set interfaces connected to the H.110 bus on a board with the *CompactPCI* bus form factor. Each interface or port provides support for basic line functions such as battery, ringing, and hook-status detection. The board is equipped with DSP resources to provide tone generation and detection as well as Caller ID information. Each port can be programmed to conform to various national standards and practises.

The H.110 bus was devised by the Enterprise Computer Telephony Forum (ECTF) to provide a single telecom bus for the entire industry. It is intended for add-in boards using the *CompactPCI* form factor. A wide variety of boards are available from a number of different vendors. The H.110 bus also provides for hot swap capabilities for use in high availability applications.

The board is equipped with a processor that can be used to control the lower level functions of the board. The host PC controls the board using messages passed through dual-ported RAM. The board shares a common message passing and control scheme with other Infinity Series H.110 boards.

## 1.1 Features and Capabilities

This section presents an overview of the features and capabilities of the Infinity Series H.110 Station Board.



*Figure 1: The H.110 Station Board Functional Areas*

### **1.1.1 The Station Interface**

Thirty-two independent ports are provided on the board. Each port on the board provides a complete interface for a standard telephone device. Talk battery is supplied along with hook-status detection, and the battery polarity can be reversed under software control. Ringing can be applied in a number of different cadences as well as a signal to turn on a message waiting indicator on appropriately equipped phones. Port timing and characteristics can be set to adapt to different national standards. Ringing is generated internally.

## *The H.110 Station Board*

### **1.1.2 Caller Identity**

Each port is capable of generating and detecting all the signals necessary for Calling Number Delivery and Calling Name Delivery. Calling Identity Delivery on Call Waiting feature is also supported. All timing is done internally on the board without requiring host intervention.

### **1.1.3 DSP Functions**

The H.110 Station Board is equipped with DSP's that perform a variety of functions. DTMF and Energy detectors are available for each port. DTMF generators are available for each port for signaling purposes. Call Progress tones are also available, with dial-tone, busy, reorder, and audible ringback being provided as well as silence and a 1004 Hz. calibration tone. European call progress tones are also available.

### **1.1.4 The H.110 Bus**

The H.110 bus is a digital bus for transporting PCM (Pulse Code Modulation) signals between telephony boards. It was created by the ECTF to provide a common bus structure for future development that would end the "bus wars" between the various legacy busses such as the SCbus and the MVIP bus.

PCM is a standard method of digitizing phone signals. It involves encoding each channel at an 8 kHz rate using eight bits. The signals from multiple channels are then combined into a frame. On the H.110 bus, each frame consists of 128 channels or timeslots. The bit rate of the H.110 bus is 8.192 MHz. Thirty-two wires, also called streams, each carrying 128 timeslots, are combined to form the bus, and provide a total of 4096 timeslots. Two timeslots are required for a full conversation, one for each talker.

In addition to the streams, a number of other signals necessary to maintain synchronization between all the boards in the system are carried on the bus.

These signals provide the clocking and framing information. Redundant clocks are provided to aid in recovery if the primary clock should fail.

The H.110 bus consists of backplane connections on a 6U *CompactPCI* backplane that is used to interconnect the boards in the system. The CT Bus connections are made through the J4/P4 connector. The electrical and mechanical requirements of H.110 boards are tightly specified to insure the reliability and consistent performance of the CT Bus in any valid configuration of conforming boards.

### **1.1.5 Clock Modes**

The H.110 E&M Board can operate in a variety of clock modes. Modes are available so that the master clock can either be derived from the H.110 bus or be provided by an internal source on the H.110 Station Board. The clock redundancy and clock fallback functions of the H.110 bus are also supported so that the H.110 Station Board can be set to provide a clock to the H.110 if the master clock on that bus should fail.

### **1.1.6 Hot Swap Capability**

The H.110 Specification includes “hot swap” capability. This capability allows for the insertion and removal of boards from a live system. Not only are there provisions for controlling the electrical signals to prevent disruption when inserting and removing boards, but also for informing drivers and applications so that the board resources can be managed as they are added or deleted. Each H.110 board is provided with a blue LED that is used to inform an operator when it is safe to insert or remove a board.

### **1.1.7 Message Passing**

The board occupies 8K of memory space on the host PC. This 8K may reside anywhere within the PC’s address space. As a PCI board, the address and interrupt of the board is assigned at boot time. The message passing scheme used by the Infinity Series H.110 Station Board is identical



to that of the other Infinity Series H.110 boards, allowing for the easy combination of a variety of Infinity Series H.110 boards in a single system.

The message passing scheme and message syntax of Infinity Series H.110 boards is similar to that of the older XDS series of MVIP and SCbus boards. At the driver and API level, support is provided for both series of boards so that the H.110 boards may interoperate with legacy boards using a common interface.

### **1.1.8 Flash EAROM for Firmware**

The firmware for both the main processors and for the DSP's is contained in Flash EAROM. This allows for easy upgrades of the firmware on the board in the field without requiring time consuming downloads every time a system boots. Once reprogrammed, the new firmware is retained even when the power is removed. The original, factory programmed firmware is also retained on board and can be accessed by installing a jumper.

### **1.1.9 EEPROM for Configuration Information**

To reduce the burden on the application, the board has an EEPROM capable of providing non-volatile storage for configuration information. This information includes the port type, timing requirements, and the parameters necessary to conform to various national standards, supply voltages, etc. This configuration information, when saved, is automatically restored on a restart, allowing the board to automatically configure itself without host intervention.

## **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 H.110 Station Board. We recommend that you begin with these three steps.

1. Follow the instructions in section 2.0 (Quick Start) and 3.0 (Installation). These sections will tell you if your board is operating correctly within your system. You don't need to be familiar with the board's command set to complete this step.
2. Read section 4.0 (Initialization) to initialize the board within your system. Your application must perform these initialization procedures whenever you power-up your PC in order for the board to communicate with the PC.
3. Read section 5.0 (Communications with the PC) for an overview of how to communicate with the H.110 Station Board. Section 5.0 includes a summary of the commands for constructing your application and details concerning system interrupts.

Before you can actually build your application, read sections 6.0 (The H.110 Bus and Clock Modes) and 7.0 (Using the Station board). These sections explain, with practical examples, how the H.110 Station Board operates and how to use the command set to achieve the desired results. Section 8.0 explains diagnostic and error messages that may occur.

The Appendix contains information on power requirements and interfacing that will be helpful installing your H.110 Station Board.

## 2.0 Quick Start

This section describes the first steps you should perform to determine if your Infinity Series H.110 Station Board is communicating correctly with your PC system. You can perform this quick check without securing the board to the PC chassis or connecting any cables.

The exact procedure will vary depending on which operating system you are running. For each operating systems, drivers are required to interface to the boards. The drivers supplied by Amtelco have tests built into them to verify communications with the boards. These drivers also come supplied with utility programs that allow the developer to test communications with the board. Please consult the appropriate documentation for the driver and operating system you are using.

### Quick Start Procedure

1. With the chassis power off, insert the board into a slot.
2. Turn on the computer.
3. If the Amtelco driver is not already installed, install it now, following the instructions supplied with the driver.
4. Most Amtelco drivers will display a list of boards that are installed (see the documentation for the particular driver that you are using). If the H.110 Station Board is listed, skip to step 6.
5. If the board is not listed, there may be a problem with the board not being seated correctly in the backplane. There may also be a problem with a memory or interrupt conflict. Power down the chassis and check that the board is properly seated.

in the connector and repeat steps 1-4. If this does not remedy the problem, try removing any other computer telephony boards in the system. If your chassis is unable to find the board, consult the number at the end of this section.

6. Run the program "xdsutil" supplied with the driver. Send the message "IN" to the H.110 Station Board. The board should respond with the message "IA".
7. Send the message "VC" to the board. Verify that the Receive Message reads: VCxxxxvvvvHS (where xxxxxvvvv is a variable indicating the firmware version).
8. If the Communications screen shows the correct command responses, your H.110 Station Board is communicating with the host. You may now power down the computer and attach the necessary cables (see section 3.4)

For technical assistance, call Amtelco at 1-608-838-4194 ext.168.

## 3.0 Installation

This section describes how to install your Infinity Series H.110 Station Board into your computer and how to use the jumpers, headers, and connectors. Before you begin the installation procedure, be sure to test the board as described in section 2.0 (Quick Start).

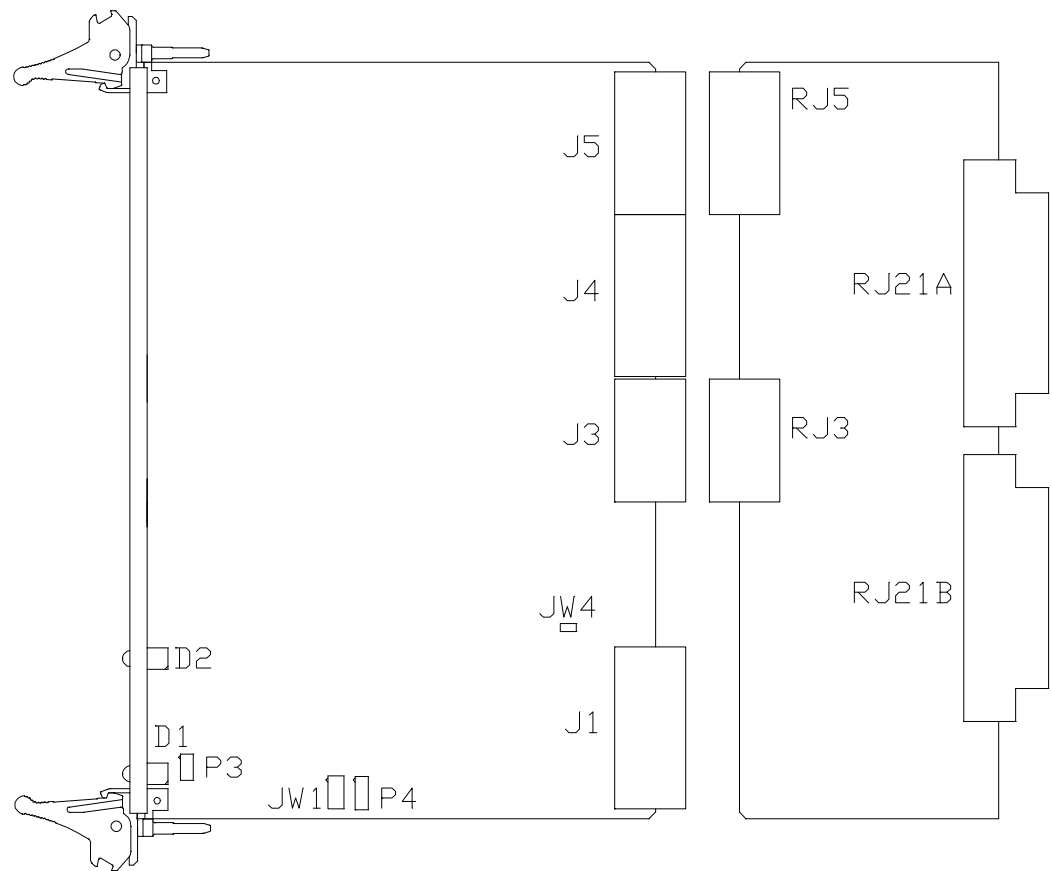


Figure 2: Location of Jumpers, Headers, and Connectors

## 3.1 PCI Configuration

As Infinity Series boards conform to the PCI standards, there are no switches to set to configure the H.110 Station Board's memory address, I/O addresses, or interrupt. The host processor's BIOS will automatically configure the board at boot time to avoid conflicts with other boards in the system.

## 3.2 Jumpers & Headers for the Front Board

The following is a complete list of all jumpers for the H.110 Station Board:

- JW1-1**      Firmware Select. If firmware has been downloaded to the board, this jumper selects whether the downloaded firmware or the factory default firmware is used. When this jumper is installed, the factory default firmware is executed whenever the board is reset. When the jumper is not installed, the downloaded firmware will be executed after a reset if it is present. If no downloaded firmware is present, the factory default firmware is executed after reset.
- JW1-2**      DSP Firmware Select. Two separate firmware programs are included in the EAROM, one for the board processor and one for the DSP. If JW1-2 is installed and downloaded DSP firmware is present, the factory DSP firmware is executed after reset. Otherwise, the downloaded firmware is executed if present. See JW1-1.
- JW1-3**      Undefined, reserved for future use.
- JW1-4**      Undefined, reserved for future use.
- P3**          Diagnostic port. Never install jumpers here.

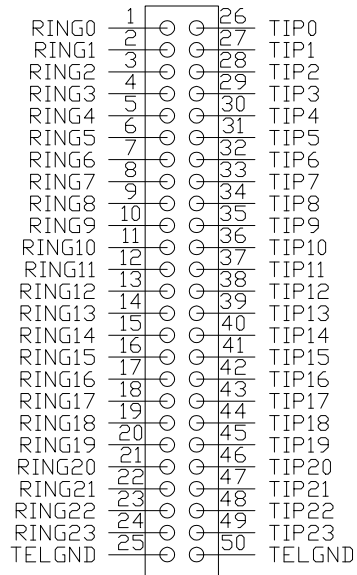
**P4** This header is used for programming internal logic and should never be jumpered.

### 3.3 Rear Board Connectors: RJ21A and RJ21B

**RJ21A** Analog telephone connections for ports 0-23. This connector is a standard RJ21 type 50 pin connector. Each port occupies one pair in order. See Figure 3.

**RJ21B** Analog telephone connections for ports 24-31. This connector is a standard RJ21 type 50 pin connector. Each port occupies one pair in order. See Figure 3.

Figure 3: RJ21 P3 Pin Assignments



## **3.4 Installation**

To install the H.110 Station Board in your system:

1. Do not connect the board to the PSTN. Follow the procedures described in section 2.0 to verify the operation of the board.
2. If the quick check is successful, turn off the chassis power and remove the board from the chassis.
3. Install any necessary board jumpers. See section 3.2 for jumper configurations.
4. Reinsert the front board into the chassis. Seat it properly in a slot in the chassis and secure it with the front panel handles. Do not connect the board to the PSTN.
5. Insert the rear board into the corresponding slot on the rear panel.
6. Connect the host chassis to the mains supply using a socket-outlet with protective earthing connection and connect any additional protective earthing used.
7. Connect the telephone cables to RJ21A & RJ21B. The telephone cable terminates in an RJ21 male connector. Secure with mounting screws.

If it is subsequently desired to open the host equipment chassis for any reason, the PSTN 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 Power Supply Considerations

The H.110 Station Board can operate with a variety of power supply configurations. Primary battery is applied through the J2 connector. For

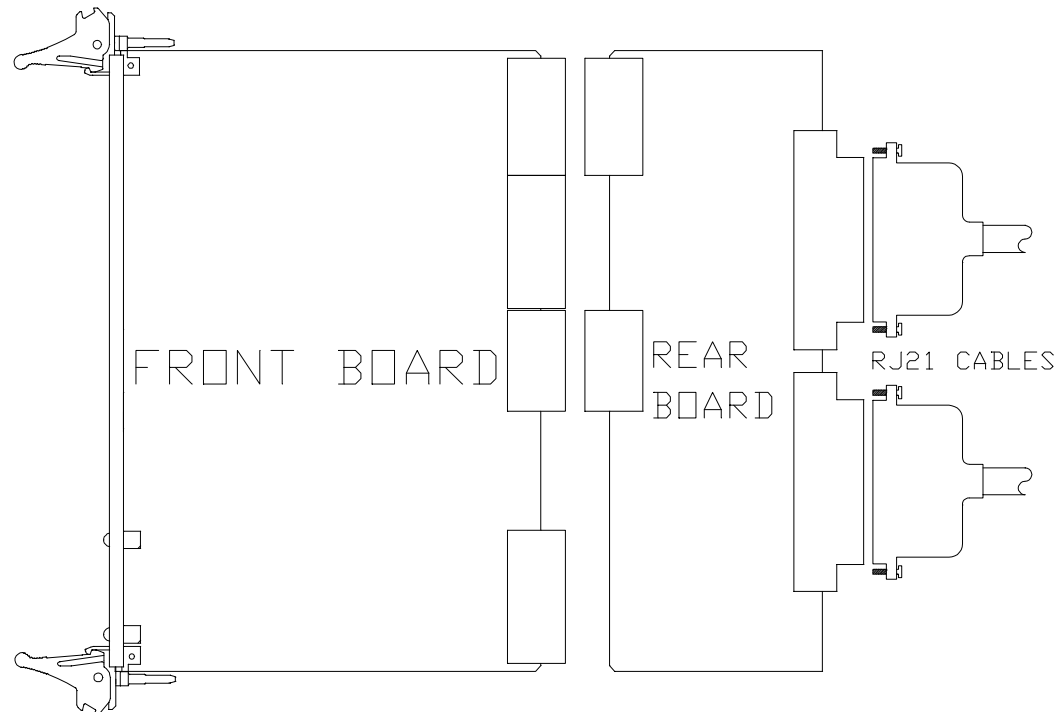


Figure 4: Installing Cables on RJ21A and RJ21B

internal ring generation and message waiting indication, an additional DC voltage between -72 and -140 C may be necessary. This is supplied through the J2A connector.

To prevent overheating, it is recommended that -24 V be used for primary battery. The board does support the use of -48 V primary battery, but the particular application should be evaluated to determine if adequate cooling is available to support -48 V operation. The amount of heat dissipated by the board depends on the primary battery supply (-24 V dissipates less heat than -48 V), the line length (short lines will result in more dissipation on the board than long lines), and whether or not a port is offhook (very little heat is dissipated by onhook ports).

When an auxiliary battery is used it must be more negative than the primary battery. Primary battery may be either -24 or -48 V. The secondary battery may nominally be -24, -48, -72, -96, -120 or -140 V. The value chosen will depend on the requirements for ringing and the message waiting signal. The allowable ranges for these voltages are given in the table below:

The user must program the voltage level into the board so that the profile coefficients may be set appropriately. This is done with a command of the form **SVab** where a is the auxiliary voltage level as used by the fixed profiles and b is the level used by the user programable profiles. The values for a and b are given in the table above. If a or b is set to 0, the board will automatically measure the voltage and adjust the coefficients based on the measured levels. The automatic parameters may only be used if the auxiliary voltage is nominally -24, -48, -96, or -140 V. Parameter b may also be set to "7". If this is done, the coefficients in the user programmable profile will be used.

Nominal Voltage	Range	Parameter
-24 V	22-26 V	1
-48 V	43-56 V	2
-72 V	65-79 V	3
-96 V	90-102 V	4
-120 V	108-132 V	5
-140 V	132-145 V	6

The message waiting indicator voltage may also be programmed for the needs of specific equipment. The default value is -120 V, however, this may be set on a port by port basis to the following values, -80, -90, -100, -110, or -120 V. This is done with a command of the form **WVvvv ... vvv** where each v is the value for a port in order from 0 to 23. The values may be 0 for the default or 1-5 for the voltages between 1 and 5.

It is acceptable to select a voltage level that is actually a greater magnitude than the auxiliary power supply voltage. Doing so will cause the output signal to clip at approximately the voltage of the auxiliary power supply. For ringing, this will result in a somewhat trapezoidal waveform which may work better than sinusoidal ringing in some applications. For example, some telephones may not ring if the auxiliary power supply is -48 V and the board is set to automatically determine the output level. However, selecting the -72 V or -96 V voltage level may enable those telephones to ring reliably.

For message waiting, if the selected voltage will be approximately the same as the power supply. In order for message waiting to work, the auxiliary power supply voltage will generally need to be in the -80 V to -145 V range. Message waiting indicators typically do not work at -48 V.

## **3.6 Hot Swapping a Board**

The Infinity Series H.110 Station Board can be “hot swapped,” that is it can be removed from a functioning system without turning the power off or interrupting applications. However, to be able to do this, the host processor must be equipped with suitable hot swap drivers as well as a hot swap manager which will alert applications when a board has been inserted or removed from the system so that resources can be properly managed. It is beyond the scope of this manual to describe the operation of either the hot swap driver or hot swap manager.

Each H.110 board is equipped with a switch linked to the lower ejector tab and a blue LED. This combination is used to coordinate the actions of an operator with the system software. When inserting a board, the board is pushed in part of the way until the blue LED is illuminated. The insertion may then be completed. When the connection process is complete, the LED will go out. To remove a board, the lower ejector handle is depressed until it is in the unlatched position. When the blue LED comes on, the board may be removed from the system.

The rear board **MUST ALWAYS** be inserted **BEFORE** the front board,

*The H.110 Station Board*

and removed **AFTER** the front board.

To install the front board in a system under power:

1. Insert the board with the ejector tabs spread apart until partially engaged.
2. Wait until the blue LED is illuminated.
3. Finish inserting the board by pushing the ejector tabs towards each other. The LED should then go out.

To remove the front board from a system under power:

1. Depress the lower ejector tab until it is in the unlatched position.
2. Wait until the blue LED is illuminated.
3. Finish removing the board by spreading the ejector tabs apart until the board is ejected.

To insert the rear panel board into a system under power:

1. The rear board should be disconnected from the PSTN. Make sure there is no board in the corresponding front panel slot.
2. Insert the rear board.
3. Connect the telephone cables to RJ21A & RJ21B. The telephone cable terminates in an RJ21 male connector. Secure with mounting screws.
4. Insert the front board as described above.

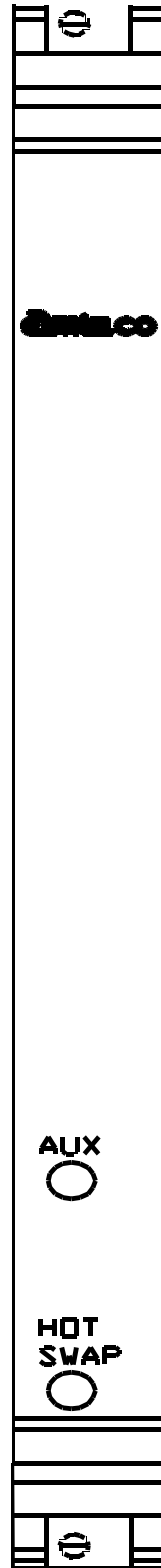
## *Installation*

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To remove a rear panel board from a system under power:

1. Remove the front board as described above.
2. Disconnect the PSTN cables from RJ21A and RJ21B.
3. Remove the rear board from the system.

*Figure 6:* Front Panel with Aux and Hot Swap LED and top and bottom ejector handles



*The H.110 Station Board*

## 4.0 Initialization

This section describes the procedures necessary to initialize the system and enable the PC to communicate with the Infinity Series H.110 Station Board. XDS drivers will implement some of these procedures.

### 4.1 PCI Initialization

The system BIOS is responsible for recognizing PCI boards and mapping them into the I/O and memory spaces as required. It is also responsible for assigning interrupts to the board. This is done through a set of on board registers which contain information specifying the memory, I/O, and interrupt needs of the board. A set of BIOS functions exist for accessing this information. A detailed description of these functions can be found in the *PCI BIOS Specification* published by the PCI SIG, the PCI Special Interest Group.

Normally, the drivers supplied by Amtelco will take care of the process of finding Infinity Series boards and establishing communications. The information in the rest of this subsection is for background only.

The configuration registers of every PCI board contain a vendor ID and device ID code. These codes are unique to each board vendor. All Infinity Series H.110 boards have the same vendor and device IDs. The vendor ID is 14E3h and the device ID is 0101h. A BIOS function exists that will find each instance of a particular vendor and device ID, and which returns with a bus and device number. The bus and device number is then used in functions to read the configuration registers.

The configuration registers contain information on the base address of the memory and I/O assigned to the board by the BIOS. A PCI board may have up to six different base addresses. On Infinity Series H.110 boards,

the first two base addresses are used by the PCI bus interface logic. The third base address which is contained in registers 18-1Bh contains the memory location of the dual-ported memory that is used to pass messages. The interrupt information is contained in register 3Ch. The information in these configuration registers can be used by a driver to address the board.

## 4.2 Initialization Commands

The H.110 Station Board is initialized by sending a sequence of command messages to the board. The process of sending messages is described in detail in Section 5.0, but normally it is accomplished either with a low-level driver XMT command or the API function **xds\_msg\_send**. Response messages are read using the low-level driver RCV command or the API function **xds\_message\_receive**.

To enable communications with the H.110 Station Board, an **IN** command message should be sent to the board. The board will respond with an **IA** message.

The board may be reset using the command message **RA**. The board will respond with an **RA** message.

Your application can now configure the H.110 Station Board using these commands

<u>Command</u>	<u>Purpose</u>
<b>SCmsabb(c)</b>	Sets the clock mode for the board. The parameter <i>m</i> is the clock-mode. The parameter <i>s</i> is the clock sub-mode. The parameters <i>a</i> , <i>bb</i> , and <i>c</i> are used to specify additional clock control information such as compatibility modes, clock rates, local network, and CT_NETREF settings. The default mode on power-up or restart is mode 0. See section 6.0 of this manual for details of clock mode arguments.

### *The H.110 Station Board*



- SEx** Sets the encoding mode for the board. The parameter *x* can be either M for Mu-Law as used in North America and Japan, or A for A-Law as used in Europe and Asia. The default value is for Mu-Law.
- STb(xx...xx)** Set the port type for each port in a bank of sixteen. The bank *b* can be either “L” for ports 0-15 or “H” for ports 16-31. Port types can be “F” for battery feed, “P” for phone, or “N” or “U” for undefined for unused ports. An “\*” may be used to indicate no change. The F type is used when interfacing to equipment such as head sets that do not require ringing or use the hook status for signalling. The P type is used when interfacing to station sets or other phone equipment that require ringing or use hook status for signalling. The port type parameter must be included for each of the sixteen ports in the bank.
- SXsstt** This command is used to set the base timeslot on the CT bus when reserving timeslots to transmit on. The parameters *ss* and *tt* are hexadecimal numbers setting the lowest timeslot of the block of timeslots reserved for the board. This command should only be used when operating with Dialogic software.

## 4.3 Configuration Memory

Much of the configuration information used to initialize the board is fixed in nature, such as the port types, profiles and hook status timing. To simplify initialization of the board, the configuration can be stored in an onboard EEPROM. This information can be recalled upon a restart of the board eliminating the need to send this information to the board each time an application runs. To control the EEPROM, three commands are provided. These are:

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*Initialization*

- SMS** This command saves the current configuration information..
- SML** This command will cause the configuration saved in the EEPROM to be loaded into the processor memory. It is not necessary to use this command on a restart as the information saved in the EEPROM will automatically be loaded into the processor memory.
- SMC** This command will clear the EEPROM. If this command is used, the board will not read the EEPROM on a power up or restart and all required configuration information will have to be sent from the application.

If the board configuration is saved in the EEPROM, it will still be necessary to send the **IN** and **SC** messages to enable messages and set the clock mode.

## 5.0 Communicating with the PC

This section describes how the PC communicates with the Infinity Series H.110 Station Board. It includes the definitions for the H.110 Station Board commands and responses along with a description of the mailboxes used for messaging.

The board is controlled by the host PC through a system of four mailboxes. The messages consist of short NUL-terminated ASCII strings, which are easy for the host software to compose and parse. The board is capable of buffering up to eight messages in either direction and can drive an interrupt line when it has a message for the host. Messages may not exceed 32 characters.

There are two main mailboxes, one for messages to the board and one for messages from the board, and two flags associated with them. A 00h in a flag byte indicates the mailbox is free, a non-zero value indicates that the mailbox is occupied. The mailboxes and their flags are contained in an 8K block of dual-ported memory at the following offsets:

receive mailbox	1F80h
transmit mailbox	1FC0h
transmit flag	1FFCh
receive flag	1FFEh

The board's base address is determined by reading PCI Configuration Space offset 18h. The 32-bit value at this location is the base address for the dual-ported memory on the board.

To send a message, the message is placed in the mailbox and the flag is set to 01h. To read a message, the message is removed from the mailbox and the flag is cleared to 00h. This will clear the interrupt hardware.

## **5.1 Commands and Responses Protocol**

This section describes the necessary step-by-step procedures for the PC to send a command to the board and to remove a response from the board.

### **5.1.1 Sending Commands to the Board**

The basic steps to sending a command to the H.110 Station Board are:

1. Build a command. Broadly speaking, a command is a string of ASCII characters with a NUL (00h) termination character.
2. Check the transmit flag. If the flag is 0, continue with the next step to put the command in memory. If the flag is not 0, wait until the flag is 0.
3. Insert the command in transmit mailbox memory beginning at the address of the transmit mailbox.
4. Write 01h to the transmit flag. This notifies the board that a message is waiting.

### **5.1.2 Reading Messages From the Board**

1. Check the receive flag. If the flag is 0, there is no message. If it is non-zero, a message is waiting. Continue with the next step to read the message.
2. Remove the message from memory, starting at the address of the receive mailbox. Messages are NUL terminated ASCII strings.
3. Write 0h to the receive flag.

### 5.1.3 Reading Board Information

A range of board information is included in memory so that it can be checked without sending a message:

<u>Type of Information</u>	<u>Offset Address</u>
Board ID	1F00-1F03
Firmware Version	1F04-1F07
Shelf and Slot ID	!F08-!F09
Number of transmit timeslots	1F10-1F11
Base timeslot	1F12-1F13
Clock mode settings	1F18-1F1B
Board configuration	1F1C-1F1E
Clock status bits	1F1F

Note: The number of reserved transmit timeslots, and base timeslots are used only in the Dialogic compatibility mode when reserving transmit timeslots.

The board stores its identity upon power up or a hardware restart. The phrase **Restart HS (c) Amtelco 2002** appears in the receive mailbox. The receive flag is not set and no interrupt is generated.

## 5.2 Interrupts

The H.110 Station Board can generate an interrupt to the PC indicating that a message is available. The interrupt for PCI boards is assigned by the BIOS or Operating System at boot time. The assignment is dependent on which PCI slot the board is in. The interrupt line is usually shared by more than one device. If multiple Infinity Series boards are installed they may or may not all share the same interrupt line.

In order for an Infinity Series board to send interrupts to the PC, the PCI Interface circuit on the board must be programmed to enable interrupts. This is accomplished by setting bits 0 and 3 in the board's Interrupt

Control/Status Register. This is a byte-wide register located at an offset of 69h from PCI Base Address 0. PCI Base Address 0 is contained in PCI Configuration Space register 10h. The Base address is a 32-bit value and is mapped into memory.

When an Infinity Series board sends a message, it generates a local interrupt to the PCI Interface circuit on the board. If the PCI Interface circuit has been programmed to generate interrupts to the PC, the local interrupt is passed through to the PC. When the PC receives an interrupt, its Interrupt Service Routine (ISR) should check the Infinity board's receive flag to see if a message is pending (i.e. the receive flag is non-zero). It should then process the message for the board and write a 0 to the board's receive flag.

### **5.2.1 Interrupt Initialization**

1. Read and then clear the board's receive flag.
2. Read the PCI Base Address 0 from PCI Configuration Space offset 10h (this must be a 32-bit access).
3. Set bits 0 and 3 of PCI Base Address 0 + 69h. Do not modify any other bits in this register. This register is a byte-wide memory mapped register.

### **5.2.2 Step-by-Step Interrupt Processing Summary**

1. Check to see if the receive flag is non-zero.
2. Remove the message from the receive mailbox.
3. Write 0h to the receive flag.
4. Re-enable the interrupt controller on the PC.

## **5.3 Commands and Responses**

This section gives a general overview of the H.110 Station Board commands and responses. The commands are grouped by function and then listed in alphabetical order by two-letter command. Refer to sections 6.0 through 8.0 for examples and explanations of how to use these commands.

### **5.3.1 Characteristics of Command Strings**

- < All commands consist of null (00h) terminated ASCII strings.
- < There are no spaces or other delimiters between parameters in the commands.
- < All letters in command strings must be UPPERCASE unless otherwise noted.
- < Lowercase monospaced letters (such as `xx`) in the following command references represent parameters within commands. Each letter represents one ASCII digit.
- < Numeric parameters are always hexadecimal numbers.

### **5.3.2 Command Parameters**

The table below documents the common parameters for many of the commands listed in the next sections.

### Common Command Parameters

Parameter	Definition	Values
xx	port number	00-1Fh
sstt	H.110 bus stream & timeslot number, ss = stream, tt = timeslot on stream	ss = 00-1Fh t = 00-7Fh
aabb	H.110 bus stream & timeslot number, aa = stream, bb = timeslot on stream	aa = 00-1Fh bb = 00-7Fh
bsstt	MVIP-95 terminus, b = bus ss = stream, tt = timeslot	b = H, L ss = 00-1F tt = 00-7F

### 5.3.3 Commands from the PC to the H.110 Station Board

Note that section 7.0 of this manual provide supplemental information for the commands and messages documented here.

#### Port Commands

<b>CAxxsstt</b>	Set Port xx to listen to stream ss timeslot tt
<b>CBxx</b>	Set Port to hold if not busy, else return SBxx
<b>CCxxssttaabb</b>	Connect Port xx to stream ss timeslot tt and from stream aa timeslot bb
<b>CDxx</b>	Disconnect Port (00-1F) or tone (40-4B) xx
<b>CExxdd</b>	Enable energy detection for Port xx, look for energy of duration dd
<b>CExxF</b>	Disable energy detection for Port xx
<b>CHxx</b>	Put Port xx on hold
<b>CIxx</b>	Disable output to CT bus
<b>CLxx</b>	Set Port xx to detect DTMF & Pulse digits, play dial tone
<b>CLxxo</b>	Set Port xx to detect DTMF & Pulse digits, option o F - turn detection off M - monitor mode, maintain existing connections Q - regular mode, suppress dial tone

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<b>CMxx</b>	Enable audio for port xx, no switching or control
<b>CPxxy</b>	Give Port xx call progress tone y where y values are 0 - dial tone                      6 - European dial tone 1 - reorder                        7 - congestion tone 2 - busy                            8 - European busy tone 3 - audible ringback            9 - European ringback 4 - Digital Milliwatt            A - U.K. ringback 5 - silence                        B - Japanese ringback
<b>CRxxc</b>	Ring port xx with cadence c, c = 1-8
<b>CSxxsstt</b>	Play call progress tone to stream ss timeslot tt, xx values 40-4Bh correspond to progress tones 0-5
<b>CTxx(ds)</b>	Send dial string ds to Port xx, valid tones in string are: 0-9, *, #, A-D, U - upper tone (941 Hz.), L - lower tone, (697 Hz.), X - short pause, P - long pause, N - North American dial tone, E - European dial tone, a-i, special & programmable tones
<b>CVxxxxffflffflnnffrr</b>	Generate custom tone on port xx ffff = freq. 1st & 2nd tone, ll = level 1st & 2nd tone nn = on duration, ff = off duration, rr = repetitions
<b>CWxxt(E)</b>	Generate call waiting tone t on port xx, opt. E to enable DTMF detection
<b>CXxxsstt</b>	Set Port xx to transmit on stream ss timeslot tt

**Caller Id Commands**

<b>DAxxaabb...cc</b>	Add octets aa, bb, etc. to custom caller ID message
<b>DCxxaabb..cc</b>	Create custom caller id message, octets aa, bb, etc.
<b>DDxxdate/#</b>	Set caller ID date/time, calling party #
<b>DFa</b>	Set caller ID format, N - North America, E - Europe
<b>DNxx(name)</b>	Set caller ID name field (must be after date & time)
<b>DVxxF</b>	Turn VMWI off for port xx
<b>DVxxN</b>	Turn VMWI on for port xx

**Interrupt Control Commands**

<b>IN</b>	Enable transmit interrupts and messages
<b>IF</b>	Disable transmit interrupts and messages

**MVIP Compatibility Commands**

<b>MDhhD</b>	Disable DTMF detector hh (MVIP) (00-1F)
<b>MDhhE</b>	Enable DTMF detector hh (MVIP) (00-1F)
<b>MEhhdd</b>	Enable Energy detector hh (MVIP) (00-1F) duration dd
<b>MEhhF</b>	Disable Energy detector hh (MVIP) (00-1F)
<b>MGhh(ds)</b>	Generate the dial string (ds) with generator hh (MVIP) (00-1F)
<b>MObssttD</b>	Set_output disable mode, bsstt - output terminus
<b>MObssttEbsstt</b>	Set_output enable mode, bsstt - output terminus, bsstt - input terminus
<b>MObssttPpp</b>	Set_output pattern mode, bsstt - output terminus, pp - pattern value
<b>MPxxD</b>	Disable Dial Pulse detection for port xx
<b>MPxxE</b>	Enable Dial Pulse detection for port xx
<b>MTD</b>	Disable output to the CT Bus (tristate)
<b>MTE</b>	Enable output to the CT Bus (tristate)

**Polarity Commands**

<b>PMxxf</b>	Send a metering pulse on port xx, pulse format f
<b>PNxx</b>	Normal polarity on port xx
<b>PRxx</b>	Reverse polarity on port xx

**Query Commands**

<b>QExx</b>	Query energy levels on port xx
<b>QH0rrrr</b>	Query CT812 chip 0, rrrr = register address
<b>QL</b>	Query geographic information (shelf & timeslot)
<b>QMa</b>	Query level metering for source a, A - IO3, B - IO4
<b>QObsstt</b>	Query Output for terminus bsstt
<b>QPdx(msg)</b>	Send message to DSP d, send only bits 0-3 of x

**Reset Commands**

<b>RA</b>	Reset all (resets ports, DSP functions, H.110 bus)
<b>RD</b>	Reset DSP (resets DSP chip only)
<b>RPxx</b>	Reset port xx

**Setup Commands**

<b>SCmsabb(c)</b>	Set clock mode m submode s, arguments a, bb, & c
<b>SDtffffllffffllnnff</b>	Set custom dialed digit tone tt ffff = freq. 1st & 2nd tone, ll = level 1st & 2nd tone nn = on duration, ff = off duration
<b>SEa</b>	Set Encoding mode a, M = Mu-Law, A= A-Law
<b>SGxxpttpr</b>	Set gain for port xx, ptt - xmit gain, prr - rcv gain
<b>SHxxaabb</b>	Set hookflash detect times for port xx aa = minimum time, bb = maximum time
<b>SItffffllffffllnnffnnff</b>	Set custom information (call progress) tone ii ffff = freq. 1st & 2nd tone, ll = level 1st & 2nd tone nn = 1st & 2nd on duration, ff = 1st & 2nd off duration
<b>SLm</b>	Set AUX LED mode to m
<b>SMC</b>	Clear the EEPROM configuration contents
<b>SML</b>	Load the EEPROM contents onto the board
<b>SMS</b>	Save the configuration in EEPROM
<b>SPb(pp..p)</b>	Set port parameter profiles for bank b (L or H) to p
<b>SPGpdggaabbcc</b>	Set coefficients for gain dgg of profile p to aabbcc
<b>SPQpr</b>	Query coefficients of profile pp, register rr
<b>SPTab</b>	Use profile a as a template for profile b
<b>SPVpr(vv...v)</b>	Set parameter profile values for profile p, register rr, values (vv...vv)
<b>STb(xx...xx)</b>	Set port types for each port in bank b (L or H) where x values are: F - Battery Feed N - No type defined P - Phone or Station Set U - Undefined/unused * - No change to port type
<b>SVab</b>	Set Vbath voltage levels for a - fixed profiles, b - user profiles, values are: 0 - automatic detection 1 - 28 V 2 - 48 V 3 - 72 V 4 - 96 V

5 - 120 V

6 - 144 V

7 - user value (programmable profiles only)

**SXstt** Set SCbus base timeslot to stream s, timeslot tt

### **Version Requests**

**VA** Checksum of alternate segment request

**VC** Version request

**VD** DSP version request

### **Message Waiting Commands**

**WFxx** Message Waiting Indicator off for port xx

**WNxx** Message Waiting Indicator on for port xx

**WVbvvv...vvv** Set Message Waiting voltages for each port in bank

b (L or H) where v values are:

0 - default value for profile

1 - 80 V.

2 - 90 V.

3 - 100 V.

4 - 110 V.

5 - 120 V.

### **Download Commands**

**@xxxx** Download 1K block to address xxxx

**@Es** Erase segment s

**GA** Jump to Alternate Program

**GM** Jump to Main Program

**@Ws** Write from RAM at 8000h to segment s

### **Diagnostics**

**XPxxsstpp** Output pattern pp to H.110 bus using timeslot xx

### **5.3.4 Responses from the H.110 Station Board**

#### **Acknowledgments**

<b>IA</b>	Acknowledge interrupts enabled
<b>RA</b>	Reset all acknowledged
<b>RPdd</b>	Reset port dd acknowledged
<b>SMx</b>	EEPROM operation x = 0 - failure, 1 success

#### **Error Messages**

<b>ECxx</b>	Clock error bit xx
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#### **Query Responses**

<b>QH0rrrrrrddddd</b>	Reply to CT812 query, ddddd is register data
<b>QLaabb</b>	Reply to geographic location query, shelf aa, slot bb
<b>QObssttm(bsstt)</b>	Query_output reply, bsstt - output terminus, m - mode (bsstt) input terminus
<b>QPd(text)</b>	DSP diagnostic responses from DSP d
<b>SPQprrr(vv...vv)</b>	Response to profile parameter query

#### **Port State Change Messages**

<b>SBxx</b>	Port xx is busy (response to CBxx message)
<b>SCxx</b>	Connect on port xx acknowledged
<b>SDxxd</b>	Pulse digit d detected on port xx
<b>SExx</b>	Tone string on port xx completed
<b>SEXhh</b>	Tone string from generator hh ended
<b>SFxx</b>	Port xx off-hook
<b>SHxx</b>	Hold on port xx acknowledged
<b>SIxx</b>	Disconnect on port xx acknowledged
<b>SLxx</b>	Listen on port xx acknowledged
<b>SMxx</b>	Audio enable on port xx acknowledged
<b>SNxx</b>	Port xx on-hook
<b>SPxxr</b>	Energy detection on port xx, r = 1 energy detected, r = 0 energy ended
<b>SPXhhr</b>	Energy detector hh results r
<b>SQxx</b>	Hook flash detected on port xx
<b>STxxd</b>	DTMF digit d detected on port xx
<b>STXhhd</b>	DTMF digit d detected by detector hh (MVIP)

**SXxx** Transmit on port xx acknowledged

**Diagnostic Responses**

**VAxxxx** Checksum of the alternate segmen

**VCxxxxyyyyHS** Version response,  
xxxx = checksum of main segment, yyyy = version  
number, HS = board type

**VDxxxx** DSP version xxxx

**U(msg)** An undefined or unparseable message response

## **6.0 The H.110 Bus & Clock Modes**

The Infinity Series H.110 Station Board provides a means of connecting analog Station interfaces to the digital H.110 computer telephony bus. Through this bus, the Station ports can be connected to other H.110 compatible boards. To accomplish this, the board has complete access to all streams and timeslots on the bus. It is capable of operating in a variety of clock modes compatible with H.110 operation.

### **6.1 The H.110 Bus**

The H.110 bus consists of 32 Pulse Code Modulation (PCM) streams operating at an 8.192 MHz. clock rate. Each stream contains 128 timeslots, for a total of 4096 timeslots. In addition to the PCM data signals, there are a number of bit, frame, and network reference signals that are used to synchronize the operation of multiple boards.

For the purposes of commands, a particular H.110 timeslot is referred to by a four digit hexadecimal number. The first two digits are the stream number, while the last two digits are the timeslot within the stream. Streams range from 00h to 1Fh, and timeslots from 00-7Fh.

The physical H.110 bus is a backplane connection using the J4/P4 connector. The H.110 specification defines allowable impedance and signal lengths on each board so that additional bus termination is not needed to insure the proper operation of the bus. The maximum length of the bus (24.8 in.) and the maximum number of slots (21) are also specified.

Different length pins are also used on the various connectors. This is done so that the various signals are staged in the correct order.

## 6.2 Clock Modes

The H.110 bus specification defines a variety of clock signals. Two clock signals CT bus A and CT bus B are provided for redundancy. In addition, two signals called CT\_NETREF\_1 and CT\_NETREF\_2 are defined which may be referenced to an external clock source such as a T1 or E1 span. These signals exist to aid in recovery if the primary clock source should fail.

The clock mode must be set before any connections can be made with other boards. The clock mode is set using the Set Clock command “SCmsabbc”, where m is the clock mode, s is the sub-mode, and a, bb, and c are additional arguments used to select clock sources and specify compatibility modes. This command takes the same form on all Infinity Series H.100 boards. Because of this, some of the possible options are not relevant to the H.110 boards, but the format is retained to make it easier to create applications that are portable between the two bus structures.

The default clock mode on a power up is to provide a local clock, but to neither source clock signals to the bus or derive the clock from the bus. The possible clock modes are:

- 0 no clocks to or from the bus
- 1 clocks slaved to the CT bus
- 2 the board is clock master CT bus clock A
- 3 the board is clock master CT bus clock B
- 4 the board is secondary master for CT bus clock A
- 5 the board is secondary master for CT bus clock B

Connections are possible only when all boards within a system are synchronized to the same clock. Only one board in a system can provide the H.110 bus clock. The other boards in the system must slave their internal clocks to the master. If the H.110 Station Board is to use the H.110 bus clock, this clock must be provided by another board before switching can be accomplished.



### **6.2.1 Slave Mode**

In the Slave Mode, the H.110 Station Board derives its clocks from one of the clock signals on the CT bus. The clock signal is selected with the submode argument in the **SC** command. The possible clock signals are:

- 0 - CT bus clock A
- 1 - CT bus clock B
- 6 - CT bus clock A, auto-fallback mode
- 7 - CT bus clock B, auto-fallback mode

Argument *a* is used to set the CT\_NETREF mode, while argument *bb* is used to select the source of CT\_NETREF. The choices for argument *a* are:

- 0 - No CT\_NETREF output
- 1 - CT\_NETREF\_1 output is enabled
- 2 - CT\_NETREF\_2 output is enabled

It should be noted that CT\_NETREF\_2 is defined only for the H.110 bus and not the H.100 bus. As the H.110 Station Board does not connect to any external digital networks, only the no CT\_NETREF output selection is valid. The CT\_NETREF source is specified by argument *bb*, and should always be set to 00.

### **6.2.2 Primary Master Mode**

In modes 2 or 3, the board supplies the CT master clocks A or B respectively. Other boards on the H.110 bus will synchronize to one of these clocks. The source of the clock is selected by the submode argument *s*. The choices are:

- 0 - freerun, the board's internal clock
- 1 - CT\_NETREF\_1
- 2 - CT\_NETREF\_2 (not present on the H.100 bus)

For submode 1 and 2, argument *bb* will select the frequency of the

CT\_NETREF signal. The choices are:

- 00 - 8 kHz. (frame rate)
- 01 - 1.536 MHz. (T1 rate)
- 02 - 1.544 MHz. (T1 extended superframe rate)
- 03 - 2.048 MHz. (E1 rate)

For all modes, argument a should be set to 0. On H.100 boards, this argument is used to select the legacy bus compatible clocks that the board will supply. As the H.110 bus is not compatible with the SC or MVIP bus, the only valid option is 0, no compatibility clocks provided.

### **6.2.3 Secondary Master Modes**

When a board is operating as a secondary master, it uses the other clock signal as a source, i.e. if a board is the secondary master for CT clock B, it uses CT clock A as a source and provides CT clock B. If the primary clock fails, the secondary master then becomes the clock master. Typically, one board will be set as the master for clock A and another board as the secondary master for clock B, or vice versa. If the clock source specified by the submode is either of the CT\_NETREF signals or a local network, the board will automatically fall-back on that source if the primary clock should fail. If set to free-run, it will fall back to a PLL that was locked to the primary master clock.

In all secondary master modes, if the primary master fails, the board will automatically become the new primary master. If the original primary master is restored, the clock mode for the original secondary master must be reset.

When operating in secondary master mode, submodes 0-3 are valid, and the arguments a and bb are the same as when operating as a primary master.

## **6.2.4 Clock Fallback**

The H.110 Specification details a scheme for automatically recovering from a clock failure. One of the CT bus clocks, either A or B is designated the master clock. The other clock is the secondary master and is generated by a different board than the primary clock. While the primary clock is valid, the secondary clock is locked to it. If the primary clock should fail, the secondary clock takes over using a local oscillator, CT\_NETREF\_1, CT\_NETREF\_2, or a local network as the source. Boards that are slaves should automatically fall back to the secondary clock. After a failure of the master clock, system software should designate new primary and secondary clocks. The new primary may be the previous secondary clock master. For Infinity Series H.110 boards, this will involve sending a set clock command with the new primary clock information.

When an Infinity Series board is set for automatic fallback, the board will automatically switch to the secondary clock if the primary clock fails. When this occurs, the board will send an “EC” message indicating the failure. When the application designates a new primary master, it should send a new clock mode command to the board even though auto-fallback may have occurred.

## **6.2.5 Clock Errors**

If the board detects a problem with the clocks, it will generate a clock error, which notifies the application that it should take appropriate action. Clock errors are reported in the Clock Error Bit message, **ECxx** where the **xx** is a hexadecimal value in which each bit identifies the specific error. A value of 1 indicates an error condition. The bits are as follows:

<u>bit</u>	<u>Error Description</u>
0	CT bus clock A
1	CT bus clock B
2	SCbus clocks
3	MVIP bus clocks
4	Master PLL error
5	Frame Boundary

As the SC and MVIP bus signals are not present, bits 2 and 3 can be ignored.

## 6.3 Configuration Information

Information on the clock mode setting, stream rates, and other configuration settings is available in the dual-ported memory in an eight byte block beginning at an offset of 1F18h. The first four bytes are the clock mode, the submode, and the a and bb arguments from the set clock command **SC**. The next byte contains the stream rate information from the **SB** command for H.100 boards, with bits 0-1 containing the value for streams 0-3, bits 2-3 for streams 4-7, and so on. On H.100 boards the sixth byte is used indicate the state of the H.100 and MVIP termination and can be ignored for H.110 boards. If bit 7 of the seventh byte is 1, bits 0-3 indicate the BRI interface that is providing the reference for clocks on the board. If bit 7 is 0, the clocks are not being derived from an interface. The eighth byte contains the clock error status bits. These are in the same order as in the **EC** clock error message (Sec. 6.2.5).

## 6.4 Hot Swap

Hot swapping is the capability of being able to insert or remove a board from a live system without having to power down or interrupt the operation of the system. The H.110 specification provides for hot swap capabilities, and these are implemented on the H.110 Station Board.

Each board has a switch that is linked to the ejector tab. This switch is used to assert a signal called ENUM# when a board is inserted or about to be removed. Each board also has a blue LED which is used to indicate the status of the board. Upon insertion, this LED is illuminated until the hardware connection process is complete. The LED is then turned off. When removing the board, the ejector tab is partially depressed to signal that the board is to be removed. The blue LED will then be illuminated indicating that it the board may be fully removed.

The ENUM# signal is used to notify a Hot Swap Driver of the impending insertion or removal of the board. It is the responsibility of the driver to take what ever steps are necessary to connect or disconnect the hardware.

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## 7.0 Using the Station Board

This section describes the process used for controlling the ports on the Infinity Series H.110 Station Board. The steps necessary for configuring a board will be described. Basic functions such as making a connection, generating ringing, playing call progress and DTMF tones, and detecting DTMF tones, dial pulses, and energy will be described. Additional features such as operating message waiting indicators and generating Caller Identity information will also be explained. Examples of making incoming and outgoing calls combining several functions are included.

### 7.1 Overview of the Command Structure

The command set described in this section are called the “C” Commands. Each of these commands instructs the board to take all the actions necessary to perform a function such as making a connection, playing a tone, or detecting DTMF digits. Thus, the command to detect DTMF digits will play dial tone to the port, connect it to a DTMF detector, and activate that detector.

Many of the commands use a common form for the various arguments. The port number is usually the first argument, and will be between 00 and 17.

The arguments used to define the source or destination consist of a four digit hexadecimal number. The first two digits are used to indicate the stream. There are 32 streams defined on the H.110 bus and these range from 00 to 1F. The last two digits are used to indicate the timeslot. H.110 streams have 128 timeslots ranging from 00-7Fh. As an example, the argument **0712** would refer to stream 7, timeslot 12h, or 18 decimal.

## 7.2 MVIP-95 Compatibility Commands

Several commands exist for compatibility with the MVIP-95 driver specification. This specification uses the concept of a “terminus” to define an input or output timeslot. The terminus argument consists of three parts, a bus, a stream within the bus, and a timeslot on that stream. In MVIP compatibility messages, a terminus is represented by a five character string. The first character indicates the bus. Valid bus selections are “H” for the H.110 CT bus, and “L” for the local bus. The local bus provides connections to the station ports and DSP resources as shown in the following table:

Local Stream	Input	Output
0	ports 00-1F	ports 00-1F
1	reserved	reserved
2	none	call progress tones 0-B
3	DTMF & Energy detectors 00-1F	DTMF generators 00-1F

In the MVIP compatibility mode, connections are controlled using the Set Output command **MO**. This command takes the form **MObssttm**, where “bsstt” is the output terminus being controlled, and m is the mode. Valid modes are “D” for disable, “E” for enable, and “P” for pattern output. In the enabled mode, the input terminus follows the mode character, and in the pattern mode, a two digit hexadecimal number representing the value of the byte to be output follows the mode. As an example, the message “MOH0123EL0000” would enable a connection from port 00 to the H.110 timeslot 23h, stream 1. Connections can be made between the H.110 bus and the local bus, or between timeslots on the local bus. To enable audio, it is also necessary to issue a **CMxx** command.

In the MVIP compatibility mode, additional commands are needed to control the DSP resources. The DTMF detectors are controlled with a



command of the form **MDh<sub>h</sub>m** where hh is the detector number or handle and m is the mode, either “D” to disable or “E” to enable the detector. When a detector is enabled, detected digits are reported in a message of the form **STXh<sub>h</sub>d** where hh is the detector number and d is the digit. The Energy detectors are controlled with a command of the form **MEh<sub>h</sub>dd** where hh is the detector number and dd is the minimum duration of the signal to be detected in .1 second increments. To disable an energy detector, the command takes the form **MEh<sub>h</sub>F**. To generate DTMF digits the command takes the form **MGh<sub>h</sub>(string)** where hh is the generator and “string” is the string of DTMF digits. This string may include pauses. Completion of the string is indicated by a message of the form **SEXh<sub>h</sub>** where hh is the generator number. To access the DSP resources, a “MO” Set Output command must be issued to connect the resource to the desired port or H.110 timeslot as well as issuing the resource control command. It is the responsibility of the application to manage the DSP resource in the MVIP compatibility mode.

As an example of detecting digits in the MVIP compatibility mode:

<u>commands</u>	<u>responses</u>	<u>description</u>
MOL0000EL0200		connect port 00 to dial tone
MOL0301EL0000		connect DTMF detector 1 to port 00
MD01E		enable DTMF detector 1
	STX011	digit 1 detected
MOL0000D		disable dial-tone
	STX012	digit 2 detected
	STX013	digit 3 detected
MOL0301D		disable input to detector 1
MD01D		disable DTMF detector 1

A query command **QObs<sub>stt</sub>** is also available to query the state of the output terminus “bs<sub>stt</sub>”. This command corresponds to the Query\_Output command in the MVIP-95 specification. The response takes the form **QObs<sub>sttm</sub>(bs<sub>stt</sub>)** where “bs<sub>stt</sub>” is the output terminus, “m” is the mode, and if the mode is enable, the second “bs<sub>stt</sub>” is the input terminus.

## 7.3 Configuring the Board

Several steps are necessary when configuring the board. The most important item is to select the clock mode. Only one board in the system can generate the Master Clock. If available, an E1, T1, or Primary Rate ISDN board should serve as the master. If no such board exists in the system, and one or more Basic Rate ISDN ports configured as a terminal equipment interface is connected to the public switched telephone network, then one of these ports should be the source of the master clock. (See Sec. 6.2 for clock mode details). The clocks must be configured before any switching can take place.

Several other steps may be necessary to configure individual ports. A port can be configured as unused or undefined, a network termination, or as terminal equipment. The “ST” command is used to configure the ports. It consists of a character to specify the bank of sixteen ports followed by sixteen characters, one for each port, representing the port type. The bank is specified by either an “L” for the low bank (ports 0-15) or and “H” for the high bank (ports 16-31). An “F” defines a port as a “battery feed” port, a “P” as “phone” port, and an “N” or “U” as undefined or unused. A battery feed port is used to interface to equipment that does not require ringing or use hook status to signal such as a headset. A phone port is used to interface to a phone, station set, or other piece of equipment that either requires ringing or uses hook status to signal. As an example, if the first six ports are to operate as battery feed ports, the next six are to interface to station sets, and the rest as unused ports, then the “ST” messages to be sent would be:

```
STLFFFFFFPPPPPUUUU
STHUUUUUUUUUUUUUUU
```

Telephone sets and equipment have different characteristics in different parts of the world. Each port can be set to the required characteristics by selecting the appropriate parameter profile. Ten different profiles numbered 0-9 are provided. Six of these are fixed, while four can be customized for specific needs. The profiles are selected using the “SP” command. This

command consists of “SP” followed by the bank and the profile number of each of the 16 ports in the bank. The profiles are:

- 0 - default does not use CRAM coefficients
- 1 - North American, 20 Hz. ringing
- 2 - North American, 30 Hz. ringing
- 3 - European (ETSI), 25 Hz. ringing
- 4 - European (ETSI), 25 Hz. ringing, 12 kHz metering pulses
- 5 - European (ETSI), 25 Hz. ringing, 16 kHz metering pulses
- 6 - User profile 1
- 7 - User profile 2
- 8 - User profile 3
- 9 - User profile 4

Setting the parameters for the user profiles requires a detailed knowledge of the DuSLIC interface chip and is beyond the scope of this document.

There may be situations because of loop length where it is desirable to add gain or attenuation to a port. This can be done with a command of the form **SGxxpttpr** where xx is the port number, p is the polarity of the gain and tt and rr are the gains. The polarity can be either a “+” or a “-”. The gain is specified in 1 dBm steps with a range from -10 to + 10 dBm. For example, the command “SG00+03-03” would add +3 dBm gain in the transmit direction and -3 dBm gain in the receive direction on port 00.

The port type, parameter profile, and gain information can be stored in the EEROM to be loaded automatically on power up or a restart. See Section 4.3 for details.

## **7.4 Using the “C” Commands**

The analog ports on the H.110 Station Board can be set to provide full-duplex connections as well as half-duplex connections in either direction. They can also be used to send DTMF and call progress tones as well as provide DTMF and energy detection.

Changes in the port state are reported in state change messages. These consist of the letter “S” followed by a letter indicating the change, the port number, and an optional information character. An example is the message **SI00** which indicates that port 00 has returned to the idle state.

### 7.4.1 Making a Connection

A two-way connection can be made with a port using the Connect Command “**CC**”. This command takes the form **CCxxssttaabb**, where xx is the port number, sstt is the destination stream and timeslot and abb is the source stream and timeslot to be connected to. As an example, the message **CC0001020304** would connect port 00 with timeslot 2, stream 1 being the transmit timeslot and timeslot 4, stream 3 the receive timeslot. Note that if a transmit timeslot had been reserved for the port using the “**SX**” command or if this had been done by a timeslot assignment program associated with a driver, the transmit timeslot portion of this command will be ignored and the reserved timeslot will be used. In addition to two-way connections, one-way connections are also possible in either direction. The Audit command “**CA**” is used to create a connection from a timeslot to a port. This command takes the form **CAxxsstt**, where xx is the port number, ss is the stream, and tt the timeslot of the timeslot being audited. As an example, **CA000201** would direct timeslot 1 of stream 2 to port 00.

The Transmit command “**CX**” is used to setup a port to transmit towards the H.110 bus. This command takes the form **CXxxsstt** where xx is the port number, ss is the stream and tt is the destination timeslot. As an example of using a port as an input, if port 01 is to transmit on timeslot 5 of stream 6 the command **CX010605** would be sent.

A connection will be broken by a Disconnect command. The Disconnect command “**CDxx**” will disable the port output and any H.110 bus connection. An idle state change message “**SIxx**” will signal that the port has returned to the idle state. .

A Hold or other port command, such as playing a call progress tone, will also break a connection. The Hold command “**CHxx**” will disable audio to and from the port. If the port was connected to the H.110 bus, a silence

pattern will be output to the H.110 bus. This pattern can be disabled by a “**CDxx**” command. It will also be cleared if a connect or disconnect command is issued for the port.

### **7.4.2 Call Progress Tones**

The on-board DSP can be used to play any of the standard Call Progress tones to a port. The tones supported are dial tone, busy tone, reorder tone, and audible ringback. Silence and a calibration tone of 1004 Hz. can also be played. A set of tones compatible with ETR 187 is also provided for use in Europe along with several ringback formats. The Call Progress command “**CP**” is used to play tones. This message is of the form **CPxxt**, where xx is the port and t is the code of the tone. For example, the command **CP002** will play busy tone to port 00. The tone will stop playing if another command is issued for the port such as a connect.

### **7.4.3 Sending DTMF Tones**

A string of DTMF tones can be sent using the “**CT**” command. Any of the 16 DTMF tones can be sent. Pauses may be embedded that are one or ten digit times (.2 or 2 sec.) Single tones of 697 and 941 Hz. are also possible. The tone string length can be up to 27 characters long. The command consists of **CT** followed by the port number and the string of tones. As an example, the command **CT039P7654321** would send the digit “9”, pause two seconds, and then send the digits “7654321”.

On receiving the command, the board will respond with an “**SL**” state change message to indicate that the port is listening to a DTMF generator. When the tone string has finished, the board will send an “**SE**” message to indicate the string is ended and place the port in the hold state.

### **7.4.4 Detecting DTMF Tones**

The on-board DSP can be used to detect DTMF tones on a port. The Listen for DTMF command takes the form **CLxxo**, where xx is the port

number and o is an option. If no option is given, dial tone will automatically be played to the port until the first tone is detected. If the option is “Q”, then no dial tone will be played. If the option is “M”, then detection will take place without interrupting existing connections. The “F” option will disable detection that is in progress. As an example, the message **CL00** will enable DTMF detection on port 00 and play dial tone.

As each tone is detected, the board will send a Tone detected state change message of the form **STxxd** where xx is the port number and d is the tone. As an example, the message **ST005** indicates that the digit 5 has been detected on port 00. All sixteen DTMF tones can be detected. Detection will remain active until a command is issued for the port.

### **7.4.5 Detecting Dial Pulses**

There may be occasions where it is necessary to interface to older station sets that are equipped with rotary dials or which generate dial pulses instead of DTMF digits. On the H.110 Station Board, dial pulse detection is handled in a manner identical to DTMF detection. The “**CL**” command enables pulse detection as well as DTMF detection. Digits, when detected, will be reported in the same manner as DTMF digits with an “**SD**” message, except that only the digits 0-9 will be reported. There are no parameters to set to adjust for different timings.

If MVIP compatibility commands are being used, detection is enabled with a command of the form **MPxxE** where xx is the port number. Detection is disabled with a command of the form **MPxxD**. Digits are reported in an “**SD**” message. Note that as the dial pulse detection is based on the hook-status current sensor attached to a port, dial pulse detection can not be assigned to another device.

### **7.4.6 Detecting Energy**

Each port is equipped with an energy detection function. The energy detector can be set to look for audio energy with a minimum duration time. When a continuous audio signal has been detected for that time, a message

is sent. Another message is sent when the audio signal stops. This feature can be used to monitor for dial tone restoration or call progress tones. Energy detection does not affect existing connections and can be used in conjunction with DTMF detection.

To enable energy detection on a port the energy command “**CE**” is used. This command takes the form **CExxdd** where xx is the port number and dd is the duration in steps of 100 msec. The range is from .1 to 22.3 seconds or from 01 to DF. For example, the command **CE0714** would enable energy detection on port 7 with a duration of 14h or 2 seconds. When a signal is detected the message would take the form **SP071** in this example where the “1” indicates detection. A “0” would indicate that the signal has stopped.

Energy detection will be disabled when the port changes state due to a command. It can also be disabled without affecting the port state by sending a command where the duration is replaced by a single character “F”. In the example above, this would be **CE07F**.

### **7.4.7 Ringing**

Ringing can be applied to any on-hook port set to the “phone” type. A number of ring cadences are available to match those used in various countries. Ringing is initiated with a “**CRxxc**” command where xx is the port number and c is the cadence code. The cadence codes are as follows:

- 1 - North American standard, 2 sec. on, 4 sec. off
- 2 - North American PBX (as per RS-464), 1 sec. on, 3 sec. off
- 3 - Split ringing, .8 sec. on, .4 sec. off, .8 sec. on, 4 sec. off
- 4 - Distinctive ringing, .4 s. on, .4 s. off, .4 s. on, .4 s. off, .4 s. on, 4 s. off
- 5 - U.K ringing, .4 sec. on, .2 sec. off, .4 sec. on, 2 sec. off
- 6 - European Ringing, 1 sec. on, 4 sec. off
- 7 - European Ringing, .6 sec. on, .2 sec. off, .2 sec. on, 4 sec. off
- 8 - European Ringing, .2 s. on, .2 s. off, .2 s. on, .2 s. off .2 s. on, 4 s. off
- 9 - Japanese Ringing, 1 sec. on, 2 sec. off

Ringing will begin as soon as the command is processed, that is ringing will always begin at the start of a ring cycle with a ring on interval. If a ringing command is issued while a port is ringing, the port will immediately start with the new cadence. Ringing will stop when the station set goes off-hook or when a disconnect command is issued. As an example, **CR001** will apply standard ringing to port 00. If a “CR” command is issued when a port is off-hook, no action will be taken.

Ringing is generated internally and does not require an external ring generator. The ring frequency and voltage are determined by the port profile parameters and power supply. For more details, see the section on “Power Supply Considerations.”

### **7.4.8 Message Waiting Indication**

Some station sets are equipped with a lamp or indicator that can be used to indicate that there is an unretrieved message in a voice mail system. This indicator usually takes the form of a neon bulb or LED that is illuminated when an appropriate signal is applied across the tip and ring of the connection. To turn the indicator on, the “**WNxx**” command is used where xx is the port number. The indicator is turned off with a “**WFxx**” command. When a port goes off-hook or ringing is applied, the message waiting signal will be removed to be restored when the port returns to the on-hook idle condition. Thus it is not necessary to send a command every time a port goes idle. The state of the message waiting indicator is not retained when the board is reset.

The voltage applied for a message waiting indication is dependent on the parameter profile of the port and the voltages applied. For more details see the section on “Power Supply Considerations.”

### **7.4.9 Hook-Flash Detection**

Many station sets are equipped with a button that can be used to generate a short on-hook signal to get the attention of the controlling software for purposes such as initiating a transfer or answering a waiting call. This



button is typically labeled “Flash” or “Pause.” Alternately, the user can briefly depress the hook switch for the same purpose. When this is done on ports that are of type “phone” a message of the form “**SQxx**” where xx is the port number is generated. The application can then take appropriate action. It should be noted that when a hook flash is detected, the board takes no other action other than sending the message.

The timing of the flash or pause signal may vary with switch type and country. In North America the “flash” signal is normally between 350 and 1000 msec. In Europe the “pause” signal is shorter, between 50 and 100 msec. To allow for these variations, the hook-flash timing can be changed on a port by port basis. This is done with a command of the form “**SHxxaabb**” where xx is the port number, aa is the minimum time and bb is the maximum time for the hook flash in 10 msec. increments. On-hook signals of less than the minimum time will be ignored, those that are greater than the maximum will be treated as a disconnect. Note that this only affects ports set to type “phone”. For example, the message “**SH00284B**” would set the minimum time for port 00 to 400 msec. and the maximum time to 750 msec. The hook flash timing parameters may be saved in EEROM.

#### **7.4.10 Battery Polarity**

There may be occasions where the battery polarity must be reversed as a signal to a piece of terminal equipment attached to a station port. This can be done with a command of the form **PRxx** where xx is the port number. The polarity may be restored by a command of the form **PNxx**. The polarity may only be reversed for ports that are not in the idle or ringing states. The polarity will automatically return to normal when a port is disconnected or goes on-hook.

#### **7.4.11 Call Waiting Tone**

A tone can be issued to a port that is already in the connect state to indicate that another call is waiting. This tone consists of a 440 Hz. signal in one of several patterns. The command to send this tone takes the form

“CWxxpe” where xx is the port number, p is the pattern, and e is an optional E if DTMF detection is to be enabled. The pattern codes are:

- 0 - a single tone for 300 msec.
- 1 - two tone bursts of 100 msec. each with 100 msec. between
- 2 - three tone bursts of 300 msec. each with 100 msec. between
- 3 - 100 msec. tone, 300 msec., and 100 msec. tones
- 4 - no tone

To respond to this tone, the user sends a hook-flash signal. The application can then put the first call on hold and connect the user to the second caller.

### **7.4.12 Caller Identity**

The H.110 Station Board is capable of sending Caller Identity information to appropriately equipped station sets. This information includes the time and date of the call and the calling party number. The calling party name may also be included. For new calls, the information is normally sent between the first and second ring. The information may also be sent after a call waiting tone if another call is already in progress.

To send caller identity information, the time, date, and number must be set up before the ringing or call waiting command is issued. This is done with a message of the form “**DDxxmddhhmm/#**” where xx is the port number, mdd is the month and date, hhmm is the hour and minute, and # is the calling party number. The date and time are in decimal using a 24 hour format. The calling party number should be between 4 and 10 digits. Longer numbers may not display properly. In some cases, it may be desired not to display the number either because it is not available or restricted. In this case, the number may be replaced with with an “O” for out of area if not available, or with a “P” for private.

The calling party name may be added to the information with a command of the form “**DNxxname**” where xx is the port and name is the calling party name. The board will accept up to 28 characters in the name field, but current devices are limited to either 15 or 21 characters. In the case

where the name is not available or private, the name may either be omitted or replaced with a “?O” if not available or “?P” if private. The “DN” command must be sent after the “DD” command.

Custom Caller ID information may be created using a command of the form **DCxxaabb...cc**, where xx is the port number and aa, bb, etc. are the hexadecimal value of the octets of the message. Commands of the form **DAxxaabb...cc** may be sent to add octets to the messages up to a maximum of 128 octets.

As an example of sending caller identity information:

<u>command</u>	<u>description</u>
DD0004030201/6085551234	April 3, 2:01 AM, 608-555-1234
DN00John Smith	calling party name “John Smith”
CR001	standard ringing

If the caller identity information is to be sent using the call waiting tone, the port must be in the connect state. If the call waiting message is set with the “E” option set, then DTMF digits will be detected and reported. As an example:

<u>command</u>	<u>description</u>
DD0004030201/6085551212	April 3, 2:01 AM 608-555-1212
DN00Jane Doe	calling party name “Jane Doe”
CW001E	call waiting tone 1, DTMF detection on

Caller Identity information is sent using the Multiple Date Message Format (MDMF) format.

### **7.4.13 Visual Message Waiting Indicator**

Some station sets equipped with Caller Identity capabilities also have a feature known as a “Visual Message Waiting Indicator” to allow the set to display whether or not there are messages waiting. This feature is distinct

from the message waiting indication described in section 7.4.7 in that it uses the same mechanism as the Caller Identity feature rather than voltage levels across the tip and ring conductors.

The Visual Message Waiting Indicator is controlled using a command of the form “**DVxxa**” where xx is the port and a is the action, either “F” to turn the indicator on or “N” to turn the indicator off. This command can only be issued when the port is in the on-hook idle condition.

### **7.4.14 Metering Pulses**

Metering pulses are used in Europe to indicate the charge for a call. Each pulse represents a unit of charge. The more pulses during a call, the higher the toll. The rate at which pulses are issued depends on the toll for a particular call, pulses will be issued more often on high toll routes than on routes where a lower rate is charged.

Different countries use different pulse formats. The H.110 Station is capable of generating three of these, battery reversal, 12 kHz. and 16 kHz. pulses with a pulse length of 100 msec. The command to issue a pulse takes the form **PMxxf** where xx is the port number and f is the format. A format of “0” is for battery reversal, “1” is for a 12 kHz. pulse and “2” is for a 16 kHz. pulse. Note that the port profile must match the pulse format.

## **7.5 Examples**

This section gives detailed example of various situations typical of the operation of the board.

### **7.5.1 An Example of a Station Originating a Call**

The following is an example of the steps involved in a station set originating a call. Both the “C” commands and state change messages will be shown. The dialed digits will be detected, ringback played, and finally a connection

made and broken when the phone hangs up.

<u>commands</u>	<u>responses</u>	<u>description</u>
	SF06	off-hook message
CL06		set up DTMF detection, play dial tone
	SX06	detection confirmation
	ST061	the digit “1” detected
	ST062	the digit “2” detected
	ST063	the digit “3” detected
CP063		play audible ringback
	SL06	tone played to port
CC0601020304		connect the port
	SC00	connection confirmation
	SN06	on-hook message
CD06		disconnect the port
	SI06	port returned to idle state

### **7.5.2 An Example of a Station Receiving a Call**

This example shows the steps involved in a station set receiving a call. First, ringing will be generated, then the port will be connected, and finally disconnected when a far end disconnect is detected.

<u>commands</u>	<u>responses</u>	<u>description</u>
CR001		ringing message, cadence 1
	SF06	off-hook message
CC0601020304		connect audio to the port
	SC06	connection confirmation
CD06		disconnect the port
	SI06	port in idle state

### **7.5.3 An Example of a Hook-Flash**

This example shows what might happen if a station set used a hook flash to get the attention of the application to perform some action such as transferring a call. The hook flash will be received, digits will be detected and then processed.

<u>commands</u>	<u>responses</u>	<u>description</u>
CR001		ringing to station
	SF00	station goes off-hook
CC0001000200		station connected to caller
	SC00	connection confirmation
	SQ00	hook-flash detected
CL00		Set up DTMF detection, play dial tone
	SX00	detection confirmation
	ST001	digit "1" detected, dial tone removed
	ST002	digit "2" detected
	ST003	digit "3" detected
CH00		hold command to end detection
	SH00	hold confirmation
	SN00	on-hook detected
CD00		disconnect command
	SI00	disconnect confirmation, port idle

## 8.0 Diagnostics & Error Messages

### 8.1 Diagnostic Commands

Several diagnostic commands are available:

- VA** Used to request the checksum of the firmware in the alternate segment of the board. This is returned in a message of the form `VAxxxx` where `xxxx` is the checksum of the firmware in the alternate segment of ROM.
- VC** Used to request the version of the firmware on the board. A message of the form `VCxxxxyyyyHS` is returned, where `xxxx` is the checksum of the firmware stored in the main segment of ROM, `yyyy` is a four-digit version number, `HS` indicates the board type (cPCI Station Board). This message takes the same form with all Infinity Series boards, and can be used to determine the configuration of the system.
- VD** Used to request the version of the DSP software. This is returned in a message of the form `VDxxxx`, where `xxxx` is the version number. All DSP's on the board use the same software version.
- QHcrrrr** Queries the contents of the CT812 chip `c`, for register `rrrr`. The contents are returned as the 24 bit value `dddddd` values in the message `QHcrrrrdddddd`. This command refers to the details of the internal switching circuitry, and is ordinarily of limited use to the application.

**QL** This message queries the geographic shelf and slot address information. The information is returned in a message of the form QLaa**bb** where aa is the hexadecimal value of the shelf address bits and bb is the value of the slot address bits.

## 8.2 Error Messages

The board will detect a number of error conditions and respond with appropriate error messages. These messages are:

**ECxx** A clock error bit event **xx** has occurred. The value **xx** is a hexadecimal number where the bits are (a bit value of 1 is an error)

<u>bit</u>	<u>description</u>
0	CT bus clock A
1	CT bus clock B
2	SCbus clocks
3	MVIP bus clocks
4	Master PLL error
5	Frame Boundary

**SM0** An EEPROM operation has failed. This indicates that either a read or write to the EEPROM was unsuccessful.

**SM1** An EEPROM operation successfully completed.

**U[*cmd*]** If the board does not recognize a command message, or if it does not have the appropriate number of arguments, the same message will be returned by the board preceded by a **U** to indicate an undefined message.



## **8.3 Auxiliary LED**

**SLm** This messages sets the mode for AUX LED on the front panel. The default mode is for the LED to be under control of the on board processor. When under control of the on board processor, the LED normally blinks green. During a restart it will be solid green, and it will be yellow during a reset using the “RA” command. The LED can be controlled by the application by sending a message of the form SLm where m is:

- 0 LED off
- 1 LED solid green
- 2 LED solid yellow
- 3 LED blinks green
- 4 LED blinks yellow
- X LED controlled by the processor

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# Appendix A: Environmental Specifications

The Infinity Series H.110 Station Board meets the following environmental specifications:

## TEMPERATURE EXTREMES:

Operating: 0EC (+32EF) to +50EC (+122EF).

Storage: -40EC (-40EF) to +70EC (+158EF).

## AMBIENT HUMIDITY:

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

## MECHANICAL:

All Infinity Series H.110 boards conform to the PCI-SIG mechanical specifications for full-length PCI cards.

## MTBF:

50,000 hours.

## ELECTRICAL REQUIREMENTS:

+5 volts  $\pm 5\%$  @ 1.5 amps maximum.

-5 volts, +3 volts, and  $\pm 12$  volts are not required.

Primary Battery (-24 or -48 volts) maximum current per port 30 mA.

Auxiliary Battery typically less than 15 mA per port

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## **Appendix B: User Programmable Profiles**

The firmware includes five fixed or “hard coded” parameter profiles which should meet the needs of most situations. However, there may be configurations where due to line impedance, supply voltages, or telephone instrument design, the standard profiles do not provide a good match. For use in these cases, four user programmable profiles are provided. These profiles are designated 6-9.

The line interface on the H.110 Station board is provided by a Siemens DuSLIC (Dual Subscriber Line Interface Circuit). This chip is designed to meet a wide variety of circuit configurations. This flexibility is achieved by using a number of programmable coefficients that are used to determine the behavior of the circuit. Each profile consists of 156 coefficients as well as 22 gain coefficient sets. The calculation of the values is beyond the scope of this Appendix. Siemens provides a set of tools that may be used to determine appropriate values.

The coefficients are set in blocks of 8. The command to set the coefficients takes the form:

**SPVprrv1v2v3v4v5v6v7v8**

where p is the profile number (6-9), rr is a register number (the address of the 1st coefficient in the block) and v1 ... v8 is a set of eight byte values expressed in hexadecimal notation. For example the following command would set the coefficients that control ringing for profile 6:

**SPV6704A0C2324C4922403**

In this case, the register address is 70.

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*Appendix B: User Programmable Profiles*

Each profile must also have 22 sets of transmit and receive gain coefficients set corresponding to the levels -10 to + 10 dBm (there are separate entries for +0 and -0 dBm). Each set of coefficients includes 3 byte values. The command to set gain coefficients takes the form:

**SPGpd(+/-)ggaabbcc**

where p is the profile number, d is the direction (either “R” or “T” for receive or transmit), (+/-)gg is the gain step, and aa, bb, and cc are the coefficients. For example the command to set the transmit coefficients for +3 dbm would be:

**SPG6T+03A50006**

Note that upper nibble of the last coefficient value is always 0.

In many cases, only a few coefficient values will be different than one of the fixed profiles. In this case, the fixed profile can serve as a template for the user profile. This is done with a command of the form:

**SPTtu**

where s is the template profile and u is the user profile. This command will cause all of the values from the template to be entered into the user profile. The values that are different can then be modified.

While testing or establishing values, it may be desirable to examine the current settings on the board. This can be done with a command of the form:

**SPQpr**

where p is the profile and rr is the register number. The results will be returned in a message of the form:

**SPQprrv1v2v3v4v5v6v7v8**

where v1 ... v8 are the programmed values.

The profile coefficients can be saved in the onboard EEPROM using the “SMS” command. If this is done, the coefficients will be loaded upon a board restart eliminating the need of setting the user profile each time the host is booted.

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# Appendix C: Custom Tones

The DSP firmware provides a wide variety of dialed and information tones that should cover the majority of situations. However, for those cases when the standard set of tones is not sufficient, it is possible to modify these tones to provide custom capabilities.

The standard set of informational or call progress tones consist of the 12 tones listed in the table below. These tones can be played to a station using the **CP** command. Any one of these twelve tones may be modified by using the **SI** command to create a custom call progress tone. However, if this is done, the original tone will no longer be available.

**Standard Call Progress Tones**

tone	description	tone	description
00h	dial tone	06h	ETSI dial tone
01h	reorder	07h	congestion tone
02h	busy tone	08h	ETSI busy tone
03h	ringback	09h	ETSI ringback
04h	digital milliwatt	0Ah	U.K. ringback
05h	silence	0Bh	Japanese ringback

The command to create a custom call progress tone takes the form

**SI***ttffffllffffllnnffnnff*

where *tt* is the number of the tone, *ffff* are the first and second frequencies used to make the tone, *ll* is the level of the first and second frequencies in

-dBm, and nn and ff are the on and off times of the tone in 50 msec. increments. To create complex cadences, a second on and off time may be specified. The frequency range is from 0000-0CFFh or 0 to 3327 Hz. The levels ll of the two frequency components is given in -dBm and has a range of 00-3Eh or 0 dBm to -62 dBm. A value of 3Fh will disable the frequency allowing a single frequency tone to be created. The on and off times are specified in 50 msec. increments and has a range of 00-FEh or 50-12700 msec. A duration of value of 0FFh will cause a continuous tone.

As an example, the command **SD04028A1001A41005050000** will change the digital milliwatt (tone 04) to a tone composed of the frequencies 650 and 420 Hz. each at -10 dBm with a cadence of 250 msec. on and 250 msec. off.

Custom tones can also be created for use with the **CT** command. The standard set of tones consists of 27 tones plus 4 tones that are reserved for custom programming as given in the following table. The first 16 tones are the standard DTMF tones. The next four tones are used to provide a lower and upper single frequency tone and a short and long pause. The next seven tones are used for the Call Waiting and Caller ID functions. The four remaining tones are reserved for user programming.

Any of these 31 tones may be customized using the **SD** command, however if one of the standard tones is modified, it is no longer available. It is therefore not recommended that the standard tones (00-1Ah) be modified if it can be avoided. The form of the command to modify a tone is:

**SDttffffllffffllnnff**

where tt is the tone, ffff is the first and second frequencies used to make the tone, ll is the level of the first and second frequencies, and nn and ff are the on and off durations of the tone. The ranges for these arguments are the same as for the **SI** command.

As an example, to modify the first user programmable tone, the command **SD1B028A1001A4100505** would create a tone composed of the

frequencies 650 and 420 Hz. at -10 dBm with an on and off duration of 250 msec. To send this tone to a port, the command would be **CT00f**.

**Standard Dialed Digit Tones**

Tone	Char.	Description	Tone	Char.	Description
00	0	DTMF 0	10	L	697 Hz.
01	1	DTMF 1	11	U	941 Hz.
02	2	DTMF 2	12	X	.2 sec pause
03	3	DTMF 3	13	P	2 sec. pause
04	4	DTMF 4	14	N	dial tone
05	5	DTMF 5	15	E	ETSI dial tone
06	6	DTMF 6	16	a	440 Hz. .1/.1
07	7	DTMF 7	17	b	440 Hz. .1/.03
08	8	DTMF 8	18	c	440 Hz. .3/.1
09	9	DTMF 9	19	d	440 Hz. .3/.03
0A	A	DTMF A	1A	e	2130/3750 Hz. .08
0B	B	DTMF B	1B	f	user tone 1
0C	C	DTMF C	1C	g	user tone 2
0D	D	DTMF D	1D	h	user tone 3
0E	*	DTMF *	1E	i	user tone 4
0F	#	DTMF #	1F		unavailable

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