amtelco

Infinity Series H.100 Station Board

TECHNICAL MANUAL

This manual applies to the H.100 PCI and PCI Express Station Interfaces with ARM processor and Zarlink ZL50031 telephony switch. Earlier versions of this board are described in the manual 257M003.

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Infinity Series H.100 Station Board Technical Manual
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FCC Part 15 Notice

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

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.

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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-Systems, Inc.
800-356-9148
4800 Curtin Drive
McFarland, WI 53558

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

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

Product Safety

The telephony 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 telephony 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.

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.

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European Approvals

CE Approval

C E

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.100 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.

1.0 Introduction

The Infinity Series H.100 Station Board is designed to provide twenty-four Station Set interfaces connected to the H.100 bus on a board with the PCI 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 the generation of Caller ID information. Thirty two channels of voice record and playback capability are also available. Each port can be programmed to conform to various national standards and practices.

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

The H.100 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 PCI or PCI Express form factor. A wide variety of H.100 compatible boards are available from a number of different vendors.

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.100 boards.

1.1   Features and Capabilities

This section presents an overview of the features and capabilities of the Infinity Series H.100 Station Board.

1.1.1   The Station Interface

Twenty-four 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.

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.100 Station Board is equipped with a DSP that performs 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. In addition, the DSP has voice record and playback capabilities which are beyond the scope of this document.

1.1.4   The H.100 Bus

The H.100 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 computer telephony.

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.100 bus, each frame consists of 128 channels or timeslots. The bit rate of the H.100 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.100 bus consists of a 68 conductor ribbon cable that is used to interconnect the boards in the system. This cable connects to a header at the upper right hand edge on each board.

1.1.5   Clock Modes

The H.100 Station Board can operate in a variety of clock modes. Modes are available so that the master clock can either be derived from the H.100 bus or be provided by an internal source on the H.100 Station Board. The clock redundancy and clock fallback functions of the H.100 bus are also supported so that the H.100 Station Board can be set to provide a clock to the H.100 bus if the master clock on the bus should fail.

1.1.6   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 or PCI Express board, the address and interrupt of the board is assigned at boot time. The message passing scheme used by the Infinity Series H.100 Station Board is identical to that of the other Infinity Series H.100 boards, allowing for the easy combination of a variety of Infinity Series H.100 boards in a single system.

The message passing scheme and message syntax of Infinity Series H.100 boards is similar to that of the older XDS series of MVIP and SCbus boards.

1.1.7   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.

1.1.8   EEPROM for Configuration Information

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.100 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 (Communicating with the PC) for an overview of how to communicate with the H.100 Station Board. Section 5.0 includes a summary of the commands for constructing your application and details concerning system interrupts.

Before you develop your application, read sections 6.0 (The H.100 Bus & Clock Modes) and 7.0 Using the Station Board). These sections explain, with practical examples, how the H.100 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 Appendices contain information on power requirements and interfacing that will be helpful when installing your H.100 Station Board.

2.0 Quick Start

This section describes the first steps you should perform to determine if your Infinity Series H.100 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. Make sure the PC power is off, then insert the board into a PCI or PCI Express slot as appropriate.

2. Turn on your PC.

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.100 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 motherboard. There may also be a problem with a memory or interrupt conflict. Power down the PC 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 PC is unable to find the board, contact Amtelco for technical assistance.

6. Run the program "xdsutil" supplied with the driver. Send the message **IN** to the H.100 Station Board. The board should respond with the message **IA**.

7. Send the message **VC** to the board. Verify that the Receive Message reads: **VCxxxxvvvvPSD** (where **xxxxvvvv** is a variable indicating the firmware version).

8. If the Communications screen shows the correct command responses, your H.100 Station Board is communicating with the PC. 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.100 Station Board into your PC 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).
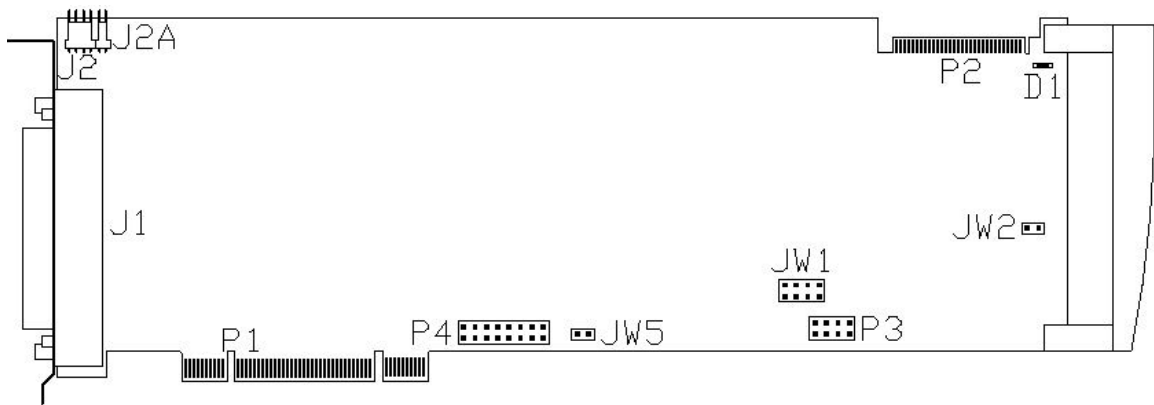
Figure 1: Location of jumpers, headers, and connectors for PCI boards
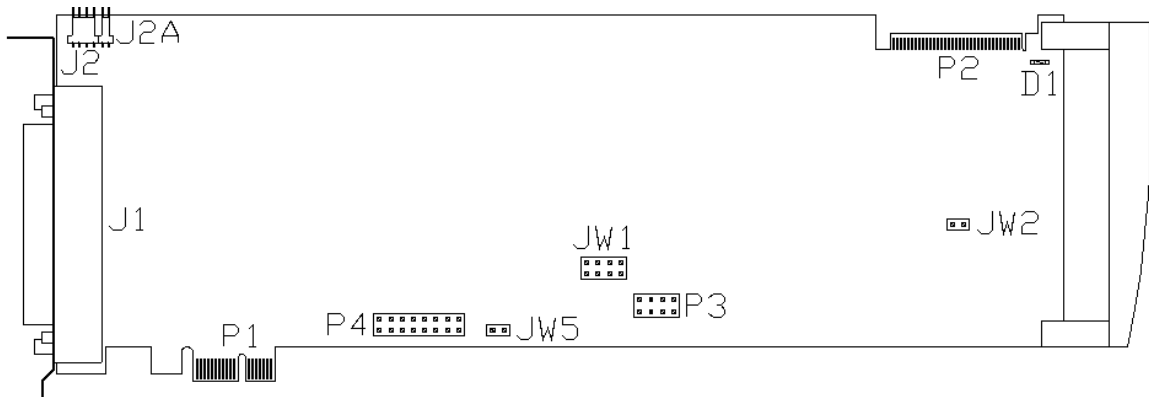
Figure 2: Location of jumpers, headers, and connectors for PCI Express boards

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3.1   PCI Configuration

As Infinity Series boards conform to the PCI and PCI Express standards, there are no switches to set to configure the H.100 Station Board's memory address, I/O addresses, or interrupt. The PC's bios will automatically configure the board at boot time to avoid conflicts with other boards in the system.

3.2   Jumpers & Headers

The following is a complete list of all jumpers for the H.100 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   Undefined, reserved for future use.

JW1-3   Undefined, reserved for future use.

JW1-4   Undefined, reserved for future use.

JW2   DSP Firmware Select. If JW2 is installed, the factory DSP firmware is executed after reset. Otherwise, the downloaded firmware is executed if present.

JW5   For factory use only. Never install jumpers here.

P3   Diagnostic port. Never install jumpers here.

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

3.3   Connectors: P2, J1, J2 and J2A

P2   H.100 bus. The H.100 bus connector is a standard H.100 bus
              header. Use an H.100 bus ribbon cable to connect the H.100
              Station Board to other H.100 boards within the same PC chassis.

J1   Analog telephone connections. This connector is a standard RJ21
              type 50 pin connector. It contains the audio pairs for the board.
              Each port occupies one pair in order. See Figure 3.
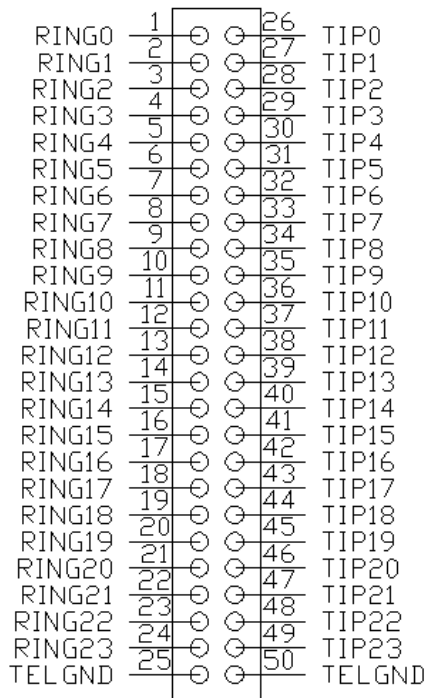
Figure 3: J1 RJ21 Pin Assignments

J2   Power connector. This connector is used to supply power for the
              talk battery and external ringing The pins on this connector are:

              pin 1   primary battery (-24 or - 48 Volts)
              pin 2   telephony ground
              pin 3   ring voltage (not used)
              pin 4   telephony ground

J2A   Secondary power connector. This connector is used for connecting the additional DC voltages for use in generating ringing and the message waiting indication.

pin 1   auxiliary battery
pin 2   telephony ground

3.4   Installation

To install the H.100 Station Board in your system:

1.   Do not connect the board to the PSTN. Follow the quick check procedures described in section 2.0 to verify the operation of the board.

2.   If the quick check is successful, turn off the PC power and remove the board from the chassis.

3.   Install any necessary board jumpers. See section 3.2 for jumper configurations.

4.   Reinsert the board into the chassis. Seat it properly in a PCI or PCI Express slot as appropriate and tighten the screw in the back of the board to secure it. Do not connect the telephony cable to the board.

5.   Connect the H.100 cable to P2. If needed, connect the telephony power supply cable to connector J2 and J2A. Do not connect the telephony power supply to the PC.

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

7.   Connect the telephony cable to J1. The telephony cable terminates in an RJ-21 male connector. Secure with mounting screws.

If it is subsequently desired to open the host equipment chassis for any reason, the telephony cable and telephony power supply 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.100 Station Board can operate with a variety of power supply configurations. Primary battery is applied through the J2 connector. For internal ring generation and message waiting indication, an additional DC voltage between -72 and -140 V 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 off hook (very little heat is dissipated by on hook 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' (-80 V) – '5' (-120 V).

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 is set to a greater magnitude than the auxiliary power supply voltage the output 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.

In cases where DID operation using profile 6 will be selected, the primary voltage must be -48 V ± 5%. As DID ports are active at all times, if this

voltage is selected, the user must ensure that the board receives adequate cooling to avoid excessive heat buildup.

4.0 Initialization

This section describes the procedures necessary to initialize the system and enable the PC to communicate with the Infinity Series H.100 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.100 boards have the same vendor and device IDs. The vendor ID is 14E3h. For the PCI version of the board the device ID is 0101h while for the PCI Express version the device ID is 0301h. 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.100 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.100 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.100 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.100 Station Board using these commands

Command   Purpose

SCmsabb(c)   Sets the clock mode for the board. The parameter **m** is the clock-mode. The parameter **s** is the clock sub-mode. The parameters **a**, **bb**, and **c** are used to specify additional clock control information such as local network and CT_NETREF settings. The default mode on power-up or restart is mode 0. See section 6.0 for details of clock mode arguments.

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.

SP(xx…xx)   Set the port parameter profile for each port on the board. The profile must be included for each of the ports on the board. In general the parameter should not be left at the default setting (0).

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   North American DID (Direct Inward Dialing)
7   User profile 1
8   User profile 2
9   User profile 3

SPxxabc   Set the DID protocol for port **xx**. If the port is to use a signaling protocol for address signaling it must be set using this command. This command is only used with ports set to the DID type. Supported protocols are 'I' - Immediate Start and 'W' - Wink Start. The address digits can be received as dial pulses, DTMF digits or MF-R1 tones. The arguments **a**-**c** are used to specify the protocol parameters:

a   start protocol (I or W)
b   format (M, P, or T)
c   number of address digits

Note that if the format is set to 'M' for MF-R1 and the **c** parameter is set to 'X' each received digit will be reported in an individual message.

ST(xx...xx)   Set the port type for each port on the board. An '*' may
                         be used to indicate no change. The port type parameter
                         must be included for each of the ports on the board. The
                         battery feed types are used to interface to headsets. The
                         several phone types are used to interface to station sets or
                         other equipment that requires ringing. The differences
                         between the phone types are due to what state the line is
                         in when disconnected. The valid port types are:

                         B   phone, with linebreak on disconnect
                         D   Direct Inward Dialing
                         F   battery feed, interface to headsets
                         M   phone, interface to modems
                         N   no type defined
                         O   battery feed with open on disconnect
                         P   phone, interface to station sets
                         U   undefined/unused

STab   Controls termination. Parameters **a** and **b** control
                         termination for the H.100 and MVIP bus respectively.
                         When set to 'E', termination is enabled and when set to
                         'D', termination is disabled. Boards on the end of the
                         H.100 cable should have termination enabled. The MVIP
                         termination parameter is non-functional and is only
                         present for compatibility with existing software.

SWa   Sets the duration of the wink signal for DID calls. The
                         parameter **a** may be 'A' for ANSI (200 ms) or 'N' for
                         NENA (250 ms) standards.

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:

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.100 Station Board. It includes the definitions for the H.100 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 null-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.100 Station Board are:

1. Build a command. Broadly speaking, a command is a string of ASCII characters with a null (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 null 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:

Type of Information	Offset Address
Board ID	1F00-1F03
Firmware Version	1F04-1F07

Switch Chip Identifier	1F0E
Processor Identifier	1F0F
Number of transmit timeslots	1F10-1F11
Base timeslot	1F12-1F13
Clock mode settings	1F18-1F1B
Board configuration	1F1C-1F1E
Clock status bits	1F1F
ID Code (serial number)	1F30-1F3F

Note: The switch and processor identifiers will be set to 'Z' and 'A', respectively, on this board. The number of reserved transmit timeslots, and base timeslot value were used only in the SCbus compatibility mode on earlier versions of this board and are not supported.

The board stores its identity upon power up or a hardware restart. The phrase **Restart PSD (c) Amtelco 2012** appears in the receive mailbox. The receive flag is not set and no interrupt is generated.

5.2   Interrupts

The H.100 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, 2, and 3 of PCI Base Address 0 + 4Dh. Clear bits 1 and 3 and set bits 0 and 6 of PCI Base Address 0 + 4Ch. Do not modify any other bits in these registers. These registers are byte-wide memory mapped registers.

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.100 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	00-17h
sstt	H.100 bus stream & timeslot number, **ss** = stream, **tt** = timeslot on stream	**ss** = 00-1Fh **tt** = 00-7Fh
aabb	H.100 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.100 Station Board

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

Port Commands
CAxxsstt   Set port **xx** to listen to stream **ss** timeslot **tt**
CBxx   Set port to hold if not busy, else return SBxx
CCxxssttaabb(B) Connect port **xx** to stream **ss** timeslot **tt** and from stream **aa** timeslot **bb**, **B**- optional alerting tone
CDxx   Disconnect port **xx**

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CExxdd	Enable energy detection for port **xx**, look for energy of duration **dd**
CExxF	Disable energy detection for port **xx**
CFxx	Generate a wink signal on port **xx**
CHxx	Put port **xx** on hold
CIxx	Disable output to CT bus
CKxx(ds)	Send dial string **(ds)** to port **xx** in MF-R1 format
CLxx	Set port **xx** to detect DTMF & Pulse digits, play dial tone
CLxxo	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

CMxx	Enable audio for port **xx**, no switching or control
CPxxy	Give Port **xx** call progress tone **y** where **y** values are

North American Tones	ETSI Tones
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

CRxxc	Ring port **xx** with cadence **c**, **c** = 1-A
CSxxsstt	Play call progress tone to stream **ss** timeslot **tt**, **xx** values 20-2Bh correspond to progress tones 0-B
CTxx(ds)	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
CVxxffffllffffllnnffrr	Generate custom tone on port **xx**

> **ffff** = freq. 1st & 2nd tone, **ll** = level 1st & 2nd tone, **nn** = on duration, **ff** = off duration, **rr** = repetitions

CWxxt	Generate call waiting tone **t** on port **xx**
CXxxsstt(B)	Set Port **xx** to transmit on stream **ss** timeslot **tt**, **B** - optional alerting tone

CZxxo   Set echo suppression for port **xx**, **o** = D - disable, E - enable, X - external

Caller Id Commands

DAxx(aabb..zz)   Add octets **aa**-**zz** to caller ID message for port **xx**

DCxx(aabb..zz)   Create caller ID message for **xx** with octets **aa**-**zz**

DDxxdate/#   Set caller ID date/time, calling party #

DFa   Set caller ID format, N - North America, E - Europe

DNxx(name)   Set caller ID name field (must be after date & time)

DSxxdate#   Set SDMF Caller ID date/time, calling party #

DVxxF   Turn VMWI off for port **xx**

DVxxN   Turn VMWI on for port **xx**

Interrupt Control Commands

IN   Enable transmit interrupts and messages

IF   Disable transmit interrupts and messages

MVIP Compatibility Commands

MBxxD   Disable alerting tone, port **xx**

MBxxE   Enable alerting tone, port **xx**

MDhhD   Disable DTMF detector **hh** (MVIP) (00-1F)

MDhhE   Enable DTMF detector **hh** (MVIP) (00-1F)

MEhhdd   Enable Energy detector **hh** (MVIP) (00-1F) duration **dd**

MEhhF   Disable Energy detector **hh** (MVIP) (00-1F)

MGhh(ds)   Generate the dial string **(ds)** with generator **hh** (MVIP) (00-1F)

MObssttD   Set_output disable mode, **bsstt** - output terminus

MObssttEbsstt   Set_output enable mode, **bsstt** - output terminus, **bsstt** - input terminus

MObssttPpp   Set_output pattern mode, **bsstt** - output terminus, **pp** - pattern value

MPxxD   Disable Dial Pulse detection for port **xx**

MPxxE   Enable Dial Pulse detection for port **xx**

MTD   Disable output to the CT Bus (tristate)

MTE   Enable output to the CT Bus

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Polarity Commands

PMxxf	Send a metering pulse on port **xx**, pulse format **f**
PNxx	Normal polarity on port **xx**
PRxx	Reverse polarity on port **xx**

Query Commands

QHHsstt	Query ZL50031, **sstt** = H.100 stream and timeslot
QHLsstt	Query ZL50031, **sstt** = local bus stream and timeslot
QHR00rr	Query ZL50031, **rr** = control register address
QLa	Query level metering for source **a**, A - IO3, B - IO4
QObsstt	Query Output for terminus **bsstt**
QPdx(msg)	Send **(msg)** to DSP **d**, send only bits 0-4 of **x**

Reset Commands

RA	Reset all (resets ports, DSP functions, H.100 bus)
RD	Reset DSP (resets DSP chip only)
RPxx	Reset port **xx**

Setup Commands

SBabcd	Set bit rate for streams 0-3, 4-7, 8-11, and 12-15 2 - 8.192 MHz
SCmsabb(c)	Set clock mode **m** submode **s**, arguments **a**, **bb**, & **c**
SDttffffllffffllnnff	Set custom dialed digit tone **tt** **ffff** = freq. 1st & 2nd tone, **ll** = level 1st & 2nd tone **nn** = on duration, **ff** = off duration
SEa	Set Encoding mode **a**, M = Mu-Law, A = A-Law
SGxxpttprr	Set gain for port **xx**, **ptt** - xmit gain, **prr** - rcv gain
SHxxaabb	Set hookflash detect times for port **xx** **aa** = minimum time, **bb** = maximum time
SIttffffllffffllnnffnnff	Set custom information tone **ii** **ffff** = freq. 1st & 2nd tone, **ll** = level 1st & 2nd tone **nn** = 1st & 2nd on duration, **ff** = 1st & 2nd off dur.
SLxxbb	Set line break duration for port **xx** to **bb**. Only valid for ports set to type 'B'. "00" uses default value of 2 s. Specified in 100 ms units. (Firmware version 020c and later)

SMC	Clear the EEPROM configuration contents
SML	Load the EEPROM contents onto the board
SMS	Save the configuration in EEPROM
SP(pp..p)	Set port parameter profiles to **p**
SPxxabc	Set port **xx** to DID address signaling protocol
	a - incoming protocol (I = immediate, W = wink)
	b - digit format (M=MF-R1, P=pulse, T=DTMF)
	c - number of address digits (X if each MF digit)
SPGpdggaabbcc	Set coefficients for gain **dgg** of profile **p** to **aabbcc**
SPQprr	Query coefficients of profile **pp**, register **rr**
SPTab	Use profile **a** as a template for profile **b**
SPVprr(vv...v)	Set parameter profile values for profile **p**, register **rr**,
	values **(vv...v)**
ST(xx...xx)	Set port types for each port where **x** values are:
	B - Phone type with linebreak on disconnect
	D - Direct Inward Dialing (DID)
	F - Battery Feed, normal operation
	M - modem line type
	N - No type defined
	O - Battery Feed with open disconnect
	P - Phone or Station Set
	U - Undefined/unused
	* - No change to port type
STab	Set bus termination, **a** = H.100 bus, **b** = MVIP bus, E –
	enable, D – disable. Option **b** is ignored
SVab	Set Vbat 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)

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SWa   Set the wink duration to **a**, A = ANSI (200) ms, N = NENA (250 ms)

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**
WVvvv...vvv   Set Message Waiting voltages for each port 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 to segment **s**

5.3.4 Responses from the H.100 Station Board

Acknowledgments
IA   Acknowledge interrupts enabled
RA   Reset all acknowledged
RPxx   Reset port **xx** acknowledged
SMx   EEPROM operation **x**, 0 = failure, 1 = success

Error Messages

ECxx Clock error bit **xx**

ETxx DID timeout on port **xx**

Query Responses

QHHssttcsttdd Reply to ZL50031 H.100 bus query, **cstt** - stream & timeslot, control bits, **dd** - data memory contents

QHLssttcsttdd Reply to ZL50031 local bus query, **cstt** - source stream, timeslot, control, **dd** - data memory contents

QHR00rrdddd Reply to ZL50031 register query, **rr** - reg., **dddd** - data

QObssttm(bsstt) Query_output reply, **bsstt** - output terminus, **m** - mode, **(bsstt)** input terminus

QPd(text) DSP diagnostic responses from DSP **d**

SPQprr(vv...v) Response to profile parameter query

Port State Change Messages

SBxx Port **xx** is busy (response to CBxx message)

SCxx Connect on port **xx** acknowledged

SDxxd Dial pulse digit **d** detected on port **xx**

SDxxdd...d DID digits **dd...d** received on port **xx**

SExx Tone string on port **xx** completed

SEXhh Tone string from generator **hh** ended

SFxx Port **xx** off-hook

SHxx Hold on port **xx** acknowledged

SIxx Disconnect on port **xx** acknowledged

SLxx Listen on port **xx** acknowledged

SMxx Audio enable on port **xx** acknowledged

SNxx Port **xx** on-hook

SPxxr Energy detection on port **xx**, **r** = 1 energy detected, **r** = 0 energy ended

SPXhhr Energy detector **hh** results **r**

SQxx Hook flash detected on port **xx**

STxxd DTMF digit **d** detected on port **xx**

STXhhd DTMF digit **d** detected by detector **hh** (MVIP)

SXxx Transmit on port **xx** acknowledged

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Diagnostic Responses

VAxxxx	Checksum of the alternate segmen
VCxxxxyyyyPSD	Version response, **xxxx** = checksum of main segment, **yyyy** = version number, **PSD** = board type
VDxxxx	DSP version **xxxx**
U(msg)	An undefined or unparseable message response

6.0 The H.100 Bus & Clock Modes

The Infinity Series H.100 Station Board provides a means of connecting analog Station ports to the digital H.100 computer telephony bus. Through this bus, the Station ports can be connected to other H.100 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.100 operation.

6.1 The H.100 Bus

The H.100 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.100 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.100 bus is a 68 conductor ribbon cable that connects the various boards in the system. As in any such bus, termination is important for its proper operation. The board at each end of the H.100 cable must have the proper termination installed or enabled, while any board between the ends must not terminate the bus. For the H.100 Station Board, termination is enabled using a command of the form **STab** where **a** controls the H.100 termination and **b** the MVIP bus termination (non-functional, provided for software compatibility). Termination is enabled if **a** is 'E' and disabled if **a** is 'D'.

6.2   Clock Modes

The H.100 bus specification defines a variety of clock signals. Two clock signals CT bus A and CT bus B are provided for redundancy. In addition, a signal called CT_NETREF is defined which may be referenced to an external clock source such as a T1 or E1 span. This signal exists 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. The default clock mode on a power up is to provide a local clock, but to neither source clock signals to the bus nor 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.100 bus clock. The other boards in the system must slave their internal clocks to the master. If the H.100 Station Board is to use the H.100 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.100 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
2 - reserved
3 - reserved
4 - reserved
5 - reserved
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

As the H.100 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. Note that CT_NETREF_2 is defined only for the H.110 bus and not the H.100 bus. It is included for upward compatibility.

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.100 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

For submode 1, argument **bb** will select the frequency of the CT_NETREF signal. The choice is:

00 - 8 kHz (frame rate)

Note that on earlier boards other CT_NETREF rates were supported, but that this is not possible with the current switching chip.

Submode 0 should only be chosen if there are no other boards in the system that can derive clocks from an external digital network.

For all modes, argument **a** should be set to 0. This value was used on earlier versions of the board for setting clocks signals for legacy buses and has been retained for software compatibility.

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 the board will automatically fall back on that source if the primary clock source 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, the arguments **s**, **a**, and **bb** are the same as when operating as a primary master.

6.2.4   Clock Fallback

The H.100 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, 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.100 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:

bit	Error Description
0	CT bus clock A
1	CT bus clock B
2	reserved - always 1
3	reserved - always 1
4	reserved - always 1
5	reserved - always 1

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 with bits 0-1 containing the value for streams 0-3, bits 2-3 for streams 4-7, and so on. Bits 0 and 1 of the sixth byte indicate the state of the H.100 and MVIP

termination, respectively, with a value of 1 being the enabled state. The seventh byte will always be 0 for the H.100 Station Board as the board cannot derive clocks from an external network. The eighth byte contains the clock error status bits. These are in the same order as in the **EC** clock error message (section 6.2.5).

7.0 Using the Station Board

This section describes the process used for controlling the ports on the Infinity Series H.100 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 commands described in this section are called '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 17h.

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.100 bus and these range from 00 to 1F. The last two digits are used to indicate the timeslot. H.100 streams have 128 timeslots ranging from 00-7Fh. As an example, the argument **712** would refer to stream 7, timeslot 12h (18 decimal).

7.2   MVIP-95 Driver Compatibility Commands

Several commands exist for compatibility with the MVIP-95 driver specification. These commands are also useful for controlling the switching resources outside of the "state-machine" model described in section 7.4. 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.100 CT bus, and 'L' for the local bus. The local bus provides connections to the analog ports and DSP resources as shown in the following table:

Local Stream	Input	Output
0	ports 00-17h	ports 00-17h
1	voice ports 00-1Fh	voice ports 00-1Fh
2	none	call progress tones 00-0Bh
3	DTMF & Energy detectors 00-1Fh	DTMF generators 00-1Fh

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.100 timeslot 23h, stream 1. Connections can be made between the H.100 bus and the local bus, or between timeslots on the local bus. Under some circumstances, it may be necessary to issue a **CMxx** command to enable audio if the port is not set to type 'P' or 'F'.

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 **MDhhm** 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 **STXhhd** where **hh** is the detector number and **d** is the digit. The Energy detectors are controlled with a command of the form **MEhhdd** where **hh** is the detector number and **dd** is the minimum duration of the signal to be detected in 100 ms increments. To disable an energy detector, the command takes the form **MEhhF**. To generate DTMF digits the command takes the form

MGhh(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 **SEXhh** where **hh** is the generator
number. To access the DSP resources, an **MO** (Set Output) command must be
issued to connect the resource to the desired port or H.100 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:

commands	responses	description
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 **QObsstt** is also available to query the state of the output
terminus **bsstt**. This command corresponds to the Query_Output
command in the MVIP-95 specification. The response takes the form
QObssttm(bsstt) where **bsstt** is the output terminus, **m** is the mode,
and if the mode is 'E' (enable), the second **bsstt** 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 those ports
should be the source of the master clock. (See section 6.2 for clock mode
details.)

Several other steps may be necessary to configure individual ports for the type of equipment that is to be connected to them and for the line characteristics necessary to make that equipment function.

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

7.3.1   Setting the Port Type

A port can be configured as unused or undefined, or to tailor it for different types of behavior depending on the particular applications. For applications where the connected equipment, such as a telephone instrument, requires the application of ring voltage the port should be configured as a "phone" type. Where the connected equipment is a headset or other device that does not require ringing, the port should be set as a "battery feed" type. For Direct Inward Dialing or DID applications the port type should be "DID."

Due to differing requirements, both the phone and battery feed types have several variants. The phone type may be set to generate a linebreak upon a disconnect where the connected equipment requires this for disconnect supervision. In addition, some modems may require that the line remains in the active state between calls in order for the modem to dial out. Battery feed ports may be set to either go into a low power or a high impedance state when disconnected. The latter may be useful when connected to headsets to limit the pickup from the headset microphone when not connected to a call.

The **ST** command is used to configure the ports. It consists of characters, one for each port, representing the port type. Valid line types are:

> B Phone - linebreak upon disconnect
> D Direct Inward Dialing (DID)
> F Battery Feed, normal operation
> M Phone - interface to a modem
> N No type defined
> O Battery Feed, high impedance when disconnected
> P Phone - normal operation

U Undefined/unused
* no change to port type

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 of the ports are unused, then the **ST** message to be sent would be:

```
STFFFFFFPPPPPPUUUUUUUUUUUU
```

7.3.2 Setting Line Characteristics

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 profile number of each of the 24 ports. 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 North American DID (Direct Inward Dialing)
7 User profile 1
8 User profile 2
9 User profile 3

Note that profile 6 requires a -48 V ± 5% battery voltage. Setting the parameters for the user profiles requires a detailed knowledge of the DuSLIC interface chip and is beyond the scope of this document.

7.3.3 Setting Port Gains

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

SGxxpttprr 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 '+' or '-'. 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.

7.3.4   Setting Line Break Timing

For ports set to type 'B' (Phone - linebreak upon disconnect), the line break timing can be adjusted with a command of the form **SLxxbb**, where **xx** is the port number and **bb** is the line break duration in 100 ms units. The default value is 2 s. If **bb** is set to "00", the default value is used. For example, the command **SL040A** would set the line break duration for port 4 to 1 s. (This command is only available on firmware versions 020c and later.)

7.4   Using the 'C' Commands

The analog ports on the H.100 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 **aabb** 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. 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.100 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.100 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.100 bus, a silence pattern will be output to the H.100 bus. This pattern can be disabled by a **CIxx** 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 (200 ms or 2 s). 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" to port 3.

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.

The H.100 Station Board is also capable of sending MF-R1 digits. This is done with a command of the form **CKxxdd...d** where **xx** is the port number and **dd...d** is the digit string to be sent. The MF-R1 format defines several tone pairs in addition to the digits 0-9 that are used to indicate the beginning and end of the address digit string. These tone pairs are called KP, ST, and STP which are represented by 'K', 'S', and 'P' respectively. KP is used to indicate the start of the digit string and the STP the end of the number. In an alternate format where both the calling and called numbers are sent, the ST is used to separate the two number strings and to indicate the end of the address digits. Typically, an MF string begins with a KP and ends with an STP, though there are variations on this format. As an example, to send the string of digits 1, 2, 3 framed by a KP and STP on port 04, the command would be **CK04K123P**.

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.100 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.

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 ms. The range is from 100 ms to 22.3 s or from

01 to DFh. 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 s on, 4 s off
    2   North American PBX (as per RS-464), 1 s on, 3 s off
    3   Split ringing, .8 s on, .4 s off, .8 s on, 4 s 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 s on, .2 s off, .4 s on, 2 s off
    6   European Ringing, 1 s on, 4 s off
    7   European Ringing, .6 s on, .2 s off, .2 s on, 4 s 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 s on, 2 s off
    A   Special, .2 s on, 4 s off

Ringing will begin as soon as the command is processed, i.e. 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 section 3.5 (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 section 3.5 (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 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 ms. In Europe the "pause" signal is shorter, between 50 and 100 ms. 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 ms 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 ms and the maximum time to 750 ms. The hook flash timing parameters may be saved in EEPROM.

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 **CWxxp** where **xx** is the port number and **p** is the pattern. The pattern codes are:

    0   a single tone for 300 ms
    1   two tone bursts of 100 ms each with 100 ms between
    2   three tone bursts of 300 ms each with 100 ms between
    3   100 ms tone, 300 ms, and 100 ms 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.100 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 **DDxxmmddhhmm/#** where **xx** is the port number, **mmdd** 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 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.

As an example of sending caller identity information:

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

Caller Identity information is normally sent using the Multiple Data Message Format (MDMF) format. However, it can be sent using the Single Data Message Format (SDMF) by using a message of the form **DSxxmmddhhmm#** where the arguments are the same as for the **DD** command. Note that in the SDMF format, no name information may be included in the message.

To allow for custom Caller ID formats, two additional commands are included. These commands allow the application to specify each octet of the message using a pair of hexadecimal digits. To initiate a message, a command of the form **DCxxaabb...zz** where **xx** is the port number and **aa**, **bb**, etc. are digit pairs specifying the hex value of each octet in the message. The board will add the header and checksum to the message. To create messages longer than will fit in the 32 character mailbox, additional octets may be appended to the message with a command of the form **DAxxaabb...zz** where **xx** is the port number. As many append commands as needed may be used as long as the total number of octets including the header and checksum is less than 128.

As an example of sending a message using these commands:

```
DC00010830313032303330334    date & time, Jan. 2, 3:04 AM
DA00020735353531323132       calling number, 5551212
DA0007084A4F484E20444F45     calling name, JOHN DOE
```

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 7.4.8 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 'N' to turn the indicator on or 'F' 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.100 Station is capable of generating three of these, battery reversal, 12 kHz and 16 kHz pulses with a pulse length of 100 ms. 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.

7.4.15 DID Protocols

Direct Inward Dialing or DID is a scheme by which a central office (CO) or PBX can send address information (usually the called party number) to a suitable receiver prior to establishing a call. Typically, a DID circuit is used to terminate a block of phone numbers, and the address digits indicate which number the call is for. Usually, only the last few digits are sent to speed call processing. Several DID circuits may be combined in a group, thus allowing multiple calls to the same number at the same time.

Unlike the case for a standard loop circuit, it is the receiver and not the central office that supplies the -48V talk battery, and battery polarity reversals by the receiver are used to indicate a connect. To initiate a call, the CO seizes the line. The receiver then gets ready to accept the address digits. If the Wink Start protocol is used, the receiver will send a brief polarity reversal to indicate that it is ready. After all the digits have been received, the receiver plays a suitable call progress tone such as audible ringback or busy. When ready to establish two way audio, the battery polarity is reversed. A return to normal battery polarity by the receiver, or an opening of the loop by the CO will disconnect the call and return the circuit to the idle state.

The address digits may be sent as a string of dial pulses, as DTMF digits or as MF-R1 tone pairs. To configure a port the start protocol, address digit format, and number of digits expected must be specified. This is done with a command of the form **SPxxabc** where **xx** is the port number, **a** specifies the start protocol, either 'I' for immediate start or 'W' for wink start, **b** specifies the digit format, 'P' for dial pulse, 'T' for DTMF tones and 'M' for

MF-R1 tones. The **c** specifies the expected number of digits. The port must also be set to type DID. Note that setting the parameters to "IP0" will disable the receiver.

To meet the specifications typical for DID operation, profile '6' should also be selected to ensure appropriate loop characteristics. Profile 6 requires -48 V ± 5% primary battery voltage. Other profiles may be used if the connected equipment will operate reliably with lower loop voltages and currents. In those cases it may be possible to use a -24 V primary battery supply.

When all the expected digits have been received, a message of the form **SDxxdd...d** will be sent by the board where **xx** is the port number and **dd...d** are the received address digits. An example would be **SD001212** where "00" is the port number and "1212" is the last four digits of the called number 555-1212.

The MF-R1 format defines several tone pairs in addition to the digits 0-9 that are used to indicate the beginning and end of the address digit string. These tone pairs are called KP, ST, and STP which are represented by 'K', 'S', and 'P', respectively. KP is used to indicate the start of the digit string and STP the end of the number. In an alternate format where both the calling and called numbers are sent, ST is used to separate the two number strings and to indicate the end of the address digits. The board will not include the KP, ST or STP in the **SD** message, and will separate the two numbers, if present, with a '/' character.

As there are a number of different variations of the MF-R1 format, an option has been included which causes the board to send a message for each digit as received. This allows the application to interpret the address digit string. To set this option, the argument for the number of digits in the **SP** command should be set to 'X'.

ANSI standard *EIA/TIA-464-A* requires a wink signal duration of between 140 and 290 ms. The default duration of the wink generated by the Station Board is 200 ms which conforms to this standard. However, there are other standards which may be applicable. The National Emergency Number Association standards for E9-1-1 equipment (*NENA-03-002*) requires a wink

duration of 200 to 300 ms. To accommodate this requirement, the wink duration generated by the board can be adjusted to 250 ms by using a command of the form **SWx** where **x** can take the values of either 'A' for the ANSI standard value of 200 ms or 'N' for the NENA standard of 250 ms.

7.4.16 Recording Alert Tone

Many jurisdictions require that a periodic tone be played when a telephone conversation is being recorded to alert the parties of this fact. The H.100 Station Board provides a mechanism which will add such a tone to the audio stream from a station towards the H.100 bus so that a party on the far end of the connection will hear the tone. The tone consists of a .5 s 1400 Hz tone repeated every 15 seconds.

To add a tone to a connection a 'B' is appended to either the **CC** or **CX** messages. For example, the command **CC0301000200B** would introduce an alerting tone on the audio stream between port 03 and H.100 timeslot 0100. The alerting tone will be disabled by any subsequent command or by a change of state such as going on hook.

If connections are made using the **MO** command, the alerting tone may be inserted using a command of the form **MBxxE** where **xx** is the port number. A command of the form **MBxxD** will disable the tone.

If an alerting tone other than the default is desired, the tone may be customized using the **SI** command for tone generator 12h (see Appendix C for details). For example, the command **SI1202581000003F05190000** would create a 600 Hz tone of .5 s duration and with 2.5 s between tones. Note that for generator 12h the values for the on and off duration is in increments of 100 ms not 50 ms as it is for all other generators.

7.4.17 Echo Suppression

There may be instances where, because of excessive transmission delays, echo may be introduced into the audio signal. The on board DSP can be used to suppress this echo. This feature is controlled by a command of the form **CZxxm** where **xx** is the port number and **m** is the mode. Valid modes values

are 'D' to disable suppression, 'E' to enable suppression, and 'X' to enable suppression in the external inbound direction.

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.

commands	responses	description
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.

commands	responses	description
CR001		ringing message, cadence 1

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	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.

commands	responses	description
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 **VCxxxxyyyyPSD** is returned, where **xxxx** is the checksum of the firmware stored in the main segment of ROM, **yyyy** is a four-digit version number, and **PSD** indicates the board type (H.100 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.

QHbsstt Queries the ZL50031 switching chip, for bus **b**, stream and timeslot **sstt**. The bus value **b** can be either 'H' for the H.100 bus, 'L' for the local bus, or 'R' for control registers. For the H.100 and local buses, the contents are returned in a message of the form **QHHssttcsttdd**, where **cstt** are the control bits and source stream and timeslot, and **dd** is the contents of data memory. If the timeslot is not found, only a location value of 01FF is returned. The register results are returned as a 16 bit value in a message of the form **QHR00rrdddd** where **rr** is the register address and **dddd** is the data. This command refers to the details

of the internal switching circuitry, and is ordinarily of limited use to an application.

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)

bit	description
0	CT bus clock A
1	CT bus clock B
2	reserved - always 1
3	reserved - always 1
4	reserved - always 1
5	reserved - always 1

ETxx   Address digits were not received on port **xx** within 10 seconds on an incoming call using a DID address protocol.

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[cmnd] 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.

Appendix A   Environmental Specifications

The Infinity Series H.100 Station Board meets the following environmental specifications:

TEMPERATURE EXTREMES:

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

AMBIENT HUMIDITY:

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

MECHANICAL:

All Infinity Series H.100 boards conform to the PCI-SIG mechanical specifications for full-length PCI or PCI Express cards.

ELECTRICAL REQUIREMENTS:

PCI Boards:
+5 volts @ 1.5 amps maximum.
-5 volts, +3 volts, and ±12 volts are not required.

PCI Express Boards:
+3.3 volts @ 2.0 amps maximum
+12 volts @ 100 mA maximum

For all Boards:
Primary Battery (-24 or -48 volts) maximum current per port 30 mA.
Auxiliary Battery typically less than 15 mA per port

MTBF:

50,000 hours.

Appendix B   User Programmable Profiles

The firmware includes six 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, three user programmable profiles are provided. These profiles are designated 7-9.

The line interface on the H.100 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 (7-9), **`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 (register address 70h) for profile 7:

`SPV7704A0C2324C4922403`

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:

`SPG7T+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 `t` 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:

`SPQprr`

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

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restart eliminating the need of setting the user profile each time the host is booted.

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

```
SIttffffllffffllnnffnnff
```

where **tt** is the number of the tone, **ffff** are the first and second frequencies used to make the tone, **ll** are the levels of the first and second frequencies in -dBm, and **nn** and **ff** are the on and off times of the tone in 50 ms 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 frequencies 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 ms increments and has a range of 00-FEh or 50-12700 ms. A duration of value of 0FFh will cause a continuous tone.

As an example, the command **SI04028A1001A41005050000** will change the digital milliwatt (tone 04) to a tone composed of the frequencies 650 and 420 Hz each at -16 dBm with a cadence of 250 ms on and 250 ms off.

Custom tones can also be created for use with the **CT** command. The standard set of tones consists of 29 tones plus 2 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 nine tones are used for the Call Waiting and Caller ID functions. The two 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 (00-1Ch) be modified if it can be avoided. The form of the command to modify a tone is:

SDttffffllffffllnnff

where **tt** is the tone, **ffff** are the first and second frequencies used to make the tone, **ll** are the levels of the frequencies, and **nn** and **ff** are the on and off durations of the tone. The ranges are the same as for the **SI** command, except the duration is in 10 ms increments.

As an example, to modify the first user programmable tone, the command **SD1D028A1001A4100505** would create a tone composed of the frequencies 650 and 420 Hz at -16 dBm with an on and off duration of 50 ms. To send this tone to a port, the command would be **CT00h**.

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	200 ms pause
03	3	DTMF 3	13	P	2 s 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	2130/3750 .1/.05
0C	C	DTMF C	1C	g	DTMF D .06 on
0D	D	DTMF D	1D	h	user tone 1
0E	*	DTMF *	1E	i	user tone 2
0F	#	DTMF #	1F		unavailable

A single instance of a custom tones may also be generated with a command of the form:

CVxxffffllffffllnnffrr

where **xx** is the port number, **ffff** is the first and second frequency, **ll** is the level of the first and second frequency, **nn** is the on duration, **ff** is the off duration in 50 ms increments, and **rr** is the number of repetitions of the tone.

As an example, the command **CV04028A0A01A40A050507** would send a tone consisting of 640 and 420 Hz at -10 dBm, on and off durations of 250 ms and repeating a total of seven times to port 4.