



ES2000 Users Manual

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IPBridges LLC

ES2000 User's Manual

IPBridges LLC

1 Batterymarch Park / Suite 100

Quincy, MA 02269

(617) 689-0444

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Chapter 1 – ES2000 Overview

The ES2000 (ES2K) is an Enhanced Digital Switch used in T1 and E1 communication environments. The ES2K has the T1 / E1 capability to accommodate up to 28 T1 / E1 Spans (DS1's), or 672 channels (DS0's). The Spans may be allocated in any desired ratio allowing channels to be cross-connected in any combination demanded by one or more applications. The ES2K provides for a seamless call transition to and from multiple carrier networks, multiple Voice Processor Units (VPU) or Speech Recognition Servers (SRS), multiple Private Branch Exchanges (PBX), and optionally, IP based network integration. Internal Voice and Advanced DSP Resources round out the feature rich command set of the ES2000.

Designed for scalability, the QuadSpan T1/E1 Card is fundamental to all ES2K configurations. The ES2K will have from one to seven QuadSpan T1/E1 Cards, where seven cards provide the capacity for a full 28 T1 or E1 spans. Inbound ANI/DNIS characters are automatically detected and transmitted to the application host on a per channel basis. Channel Associated Signaling is embedded within the QuadSpan Card, speeding call delivery and completion rates. The ES2K has a precise tone plant for generation of DTMF (TT) / MF tones, various standard telephony operation tones, and continuity testing tones.

The ES2000 offers Integrated Voice Resources on the baseboard. Stored prompts are played on command to any channel at any time during a call. Included with the ES2K is a flash PC-Card that is used to store up to 1 hour of any customer specific vocabulary. Voice Resources can play on as many as 126 channels simultaneously.

The ES2000 also has high speed Advanced DSP Resources integrated to the baseboard. These DSP Resources can be used for touch-tone or noise detection during a call, dial progress reporting, character or pattern recognition, and conference bridging applications. Standard in the ES2K are 128 Advanced DSP Resources that may be assigned to any channel at any time.

T1 Switching Applications

Each span enabled within the ES2000 can be independently configured to support various T1 or E1 signaling protocols, thereby providing tremendous flexibility when using the ES2K in multi-protocol, multi-switched telephony environment. There is no restriction to the ratio of inbound to outbound ports, so that all 28 T1/E1 spans can be allocated in any desired ratio. Seamless call control is given to any host application processor(s) commanding the ES2K. In the event the application host should fail, the ES2K can be configured to cross-connect any span to any span, or leave existing cross connections intact until respective calls complete.

Protocol support

The ES2K can support all North American T1 signaling protocols for both the CO and CPE:

- Feature Group A
- Feature Group B
- Feature Group D
- International Feature Group D (Three stage outdial)
- Reverse Feature Group A
- Rockwell D2
- Rockwell D3
- Loop start
- Ground start

Several E1 protocols are available, as are custom signaling sequences. Please contact IPBridges LLC for more protocol support information.

T1 Call Monitoring Applications

The ES2K can support full duplex monitoring, summing, and recording of T1 audio channels. In this mode, the ES2K is connected in parallel to T1/E1 lines being monitored. The connections are made to both the inbound and outbound sides of the channels, isolated by a non-intrusive DSX tap. Special line interface build-outs are set present no load to the T1 line, and will not interfere with normal function of the line. The ES2K adds together both sides of the call and presents the output for monitoring and/or recording.

The ES2K used in a monitor mode may be controlled by an application processor or run a standalone mode. The selection is made at the baseboard switch module, the ES2K will run standalone when switch 4 is closed. While running standalone the correspondence between monitored lines and recorder channels must pre-determined.

Call Monitor configurations

The ES2K uses 16 T1 framers to monitor 8 full-duplex T1 spans. Advanced DSP Resources are allocated to sum the audio from both sides of a conversation and present it to output channels. The state of all monitored lines is continuously examined. When a call seizure occurs, a corresponding recording line is seized, and the summed audio is routed to the recorder. When the monitored line hangs up, the recorder line is released.

Call monitoring applications require a special version of ES2K firmware. Please contact IPBridges LLC for more information on Call Monitoring applications.

Call Conferencing Applications

The Advanced DSP Resources available on the ES2000 can provide conferencing bridges available to any of the individual channels. Up to 48 Conference Resources can provide up to 24 independent conference bridges, and as many as 12 callers may be bridged into a single conference. Various tones are available at request of the application to supply conference “entrance” or “exit” indication to the bridged callers.

Call Conferencing applications require specialized DSP software. Please contact IPBridges LLC for more information on Call Conferencing applications using the ES2000.

IP Media Gateway Option and Applications

The ES2000 may be equipped with the IP Media Gateway Option. This mode allows for complete channel pass through an IP network. Applications include connectivity to advanced voice processing equipment such IP based Speech Recognition / Text To Speech Servers. Database integration, PSTN to IP conversion, Toll Bypass, and existing platform extensions are easily accomplished. The ES2K combined with the IP Media Gateway Option, is the ultimate solution for multi platform cross integration.

The design of the ES2000 with the IP Media Gateway Option, allows users to build a larger switching matrix, with a single ES2K as the basic building block. Multiple ES2K's are easily be “aggregated” on the IP Network side. The density of the switch matrix is completely scaleable to meet any need or solution. Please contact IPBridges LLC for more information on this powerful new option for the ES2000.

Chapter 2 - ES2000 Theory of Operation

The ES2K is an event-driven state machine. It continuously checks for events based on internal states and reports them to the host application processor. Events may be external, such as line seizure, or internal, such as dial sequence completion. The host application processor controls the progress of the transaction by sending commands to the ES2K. The ES2K executes the commands immediately as it sequentially receives them from the host processor. The application processor uses the ES2K responses to command the next phase of the transaction.

Resource control

Various resources are available to the ES2000. Internal Voice Resources, Advanced DSP Resources, Baseboard Resources, or one or more external VPU's may be connected to the ES2K. The VPU's allocate channels for call processing, giving the ES2K extended functionality such as; large vocabularies, recording connections, speech recognition services or speech synthesis services. The application processor performs the coordination of VPU resources and ES2K operation. Many applications are handled by the ES2K with its integral Voice and DSP Resources without the need for additional VPU's.

Call processing

In a example call, the ES2K receives the incoming call, collects DNIS information, and reports it to the application processor. The ES2K handles the call according to the instructions from the application processor, plays the caller a message, then generates an outgoing seizure, dials DTMF digits, and reports dial progress status. Table 2-1 is a simplified description of the stages in performing call processing in conjunction with an application processor and a VPU.

Table 2-1: ES2K Call Processing

Stage	Description
1	ES2K detects a line seizure and notifies the host processor. It also automatically receives incoming DNIS and sends the data to the host processor.
2	The host processor analyzes the data and commands the ES2K to answer the inbound line, speak a prompt, and collect a DTMF digit.

3	The caller enters a DTMF “2”, requesting a connection transfer option.
4	Based on the data received, the host processor commands the ES2K to seize an outbound line and dial a DNIS sequence.
5	The ES2K notifies the host processor that the out dial is complete, and reports the status of the out dial progress.
6	The host processor commands the ES2K to connect the inbound line to the outbound line.
7	The ES2K notifies the host processor when one of the subscribers has hung up.
8	The host processor commands the ES2K to hang up toward both subscribers.

System control

The host application processor controls the operational status, resource availability, and alarm report status for all the resources in the ES2K. The application sends the commands to the ES2K, the ES2K returns responses to the application processor as event occurs. Communications between the host processor and the ES2K consist of messages that are sent over a standard serial interface. With the use of additional device, the ES2K is easily controller over the TCP/IP network. Messages sent from the host processor to the ES2K are called *commands* and messages sent from the ES2K to the host processor are called *responses*.

ES2K operating states

The ES2K has three operating states: cold start, warm start, and run. On power-up, the ES2K checks for valid firmware and enters the warm start state. If the firmware is invalid or missing, the ES2K enters the cold start state, which requires the firmware to be loaded into the Baseboard Flash device. In the warm start state the ES2K is waiting for initialization. The host processor can set up various operating parameters and request diagnostic information before commanding the run state. The host processor can command the ES2K to enter the warm start or the cold start states.

A cold start is not a normal field requirement, since the ES2K is shipped preloaded with all required system software. A cold start is typically performed for development purposes under the direction of IPBridges LLC

Host processor message structure

In the warm start state, there are two types of messages: commands and responses. These are *non-alphanumeric* ASCII characters. The initialization string sets byte values for the operating parameters, consisting of an ASCII alpha character byte identifier, followed by ASCII-coded 2 hex digits that set the byte value, and terminated with carriage return.

In the run state, all commands and responses are messages with a header byte and a trailer byte. The header byte is ASCII-coded alpha character and the trailer byte is always carriage return.

Run state resource address structure

All run state commands and responses are messages that begin with an alpha character and end with a return. Most run state messages refer to a resource address. Every resource in the ES2K can be addressed with four address values, designated as *prnn*, where

- The *p* value is the PCM slot where the resource resides; it ranges from 1 – 9, A – G. Number 8 is reserved for the ES2K baseboard.
- The *r* value is the Resource to be accessed. Every *r* value has four resources ranging from 1 to 4.
- The *nn* value is a 2-digit number identifying the channel number within the resource. It ranges from 01 to 32. Not all spans have 32 channels. For example, a T1 span has only 24 and an E1 span has only 30

Chapter 3 - Hardware Components

System architecture

The ES2000 consists of an open architecture that provides the user with computer-controlled processes within the telephony environment. The ES2K enables a host device (application processor) to control all aspects of call operations, in a transparent manner.

Sixteen PCM highways provide the communications link among the ES2K component modules. Each PCM Slot consists of an 8-MHz PCM highway with the capacity for 128 bi-directional channels. The sixteen PCM highways are configured in the following manner:

- Seven PCM Slots interface with the configurable QuadSpan T1/E1 Card(s).
- One PCM highway interfaces with the integrated Advanced DSP Resources.
- One PCM highway interfaces with the integrated Voice Resources.
- One PCM highway interfaces with the system resources on the ES2K baseboard.
- Seven PCM highways interface with the IP Switching backbone.

Note: The Integrated Voice Resources share a PCM highway with PCM Slot 7. This is an either/or situation and both cannot be used at the same time. The standard configuration has the integrated Voice Resources enabled and six QuadSpan T1/E1 Cards installed.

Component Modules

The component modules of the ES2K provide flexibility in handling analog and various digital signaling protocols efficiently.

The ES2K is composed of the following major modules:

- ES2K Baseboard
- One to seven QuadSpan T1/E1 Card(s)
- Music On Hold / Monitor option

ES2K baseboard

The Baseboard is the hardware platform upon which the ES2K is built, and allows the ES2K to perform its various tasks while providing communication with various resources available. The

Baseboard has seven PCM Slot connectors for access to the QuadSpan T1/E1 Cards. Integrated into the baseboard additionally are Voice Resources and Advanced DSP Resources.

Baseboard Components

The ES2K Baseboard incorporates each of the following components:

Microprocessor

The microprocessor controls all the baseboard devices and their corresponding functions, including the dual cross point switches and T1/E1 framers. The microprocessor is responsible for interpreting signaling events on the T1/E1 spans and for providing maintenance access to the other devices.

DLSAC

The DLAC coder/decoder converts analog signals to digital format and digital signals to analog. It is used in music-on-hold applications where the music source is an external analog signal and in audio monitor. Any T1/E1 audio channel can be selected for the audio monitor and all channels can receive music-on-hold.

Baseboard DSP Resources

The digital signal processor (DSP) is responsible for tone generation and incoming DNIS/ANI detection. The DSP is incorporated into the baseboard to allow for a more flexible and powerful application structure. It is a shared resource and is automatically assigned to any channel that might require DNIS/ANI detection.

MTSXL Switch

The Memory Time Switch Extended Large (MTSXL) is used to connect full-duplex audio paths between the T1/E1 channels and all other resources in the ES2K. The MTSXL is fully non-blocking on all 16 PCM highways. The MTSXL is controlled by the microprocessor.

Flash PROMs

All the software resident in the ES2K is loaded in two, 2-megabit Flash PROMs. One is used strictly for boot code and the other for all other run-time code. This includes all the DSP software downloaded to the DSPs at system initialization.

Baseboard switches



The Baseboard switches are contained in a four-position switch pack with the following options:

Switch Option 1	TEST (Internal Use Only)
Switch Option 2	Host port Baud rate; o=38400 c=9600
Switch Option 3	N/A
Switch Option 4	Spare (may be customized)

Note: These switches are used for special test conditions and configurations. Under normal operation all switches are open.

Operational status LEDs

The front panel has three LEDs. One will blink, indicating the operational status of the ES2K. When the ES2K is in the warm start state, the LED is illuminated. When the ES2K is in the run state, the LED blinks approximately two times per second. The other two LEDs indicate the status of the power supply, one for 5v and the other for 12v.

Host1 port

This port connects to a host device (application processor) that controls the functions of the ES2K.

Host2 port

This port connects to an alternate host device. (Not currently supported.)

Microprocessor and DSP port

The Microprocessor and DSP ports are for use solely by IPBridges LLC and are not used under normal conditions.

Tap1 & Tap2 ports

These ports may be configured for Music on Hold (MOH) or Audio Monitor.

Audio monitor

An optional audio monitor is used for listening or playing Music On Hold to the voice channels. The output of any voice channel can be sent to an external speaker without interrupting service.

Alarm port

This port may be used for customer defined, factory configured applications.

Power connector



The power connector is the industry standard PC ATX connector that supplies the ES2K with +5VDC, +12VDC, +3.3VDC and Ground.

Cooling fans

Several cooling fans are integral to the ES2K and are automatically activated when the ES2K is powered on.

QuadSpan T1/E1 Card

The QuadSpan T1/E1 Card interfaces four T1 spans or four E1 spans to the ES2K Baseboard, used by the unit to perform the desired functions. The QuadSpan T1/E1 Card must be positioned starting in PCM Slot One of the base unit. . The span interface is a T1 long- and short-haul transceiver for DSI/DSX-1/CSU or NTU/ISDN for a PRI application. Frame synchronization and data generation are performed by the integral T1 primary rate framer.

When configured in the T1 mode, the four T1 spans on the Card provide 96 individual channels (DS0's) that are available for switching or protocol conversion. Spans may be configured to handle virtually any line protocol. When configured in the E1 mode, the four E1 spans provide 120 individual channels that are available for switching or protocol conversion. Support for R1 and R2 protocols is available. Please contact IPBridges LLC for support of E1 protocols.

Integrated Advanced DSP Resources

The Integrated Advanced DSP Resources provide various tone detection services or call progress reporting to the call transaction. The resources consist of ultra fast DSP devices. A total of 128 independent DSP resources may be assigned to any channel. The DSP program code is stored in the baseboard Flash and is downloaded to the Advanced DSP Resources at initialization. The Services from these Resources include; DTMF tone detection, dial progress reporting to determine status of an outbound call, loopback functions, and continuity test tone detection.

Integrated Voice Resources

The Integrated Voice Resources include a Flash PC Card, which stores digitized speech. The data is stored on the Flash Card while the ES2K is offline, and are available for playback to any channel on host processor command. The data controller is a high performance DSP that supports

simultaneous speech output on 126 channels. The DSP program code is stored on the baseboard and is downloaded to the Voice Resources at initialization

IP Interface

The optional IP interface connects up to 7 PCM highways to an external PCI interface. This interface is used in the IP Media Gateway Option and IP Switching configurations.



Chapter 4 - Software Components

Resident Software

The software resident in the ES2K is loaded in two 2-Mbit Flash PROMs. This design provides quick program updates without removal of the PROMs.

Firmware

The ES2K baseboard consists of up to four volumes of firmware:

- Microprocessor code
- DSP code for the baseboard DSP Resource
- DSP code for integrated Advanced DSP Resources
- DSP code for the integrated Voice Resources

Versions

Various versions of ES2K code are available depending on the customer application. The standard programs supported by IPBridges LLC are the following:

- Standard Telephony, VPU and T1 Switching
- Custom Full duplex, multi-span T1 monitoring
- Custom Telephony, VPU and E1 switching
- Custom E1-T1 Protocol Conversion
- Custom Conferencing
- Custom IP Media Gateway Option

ES2K Toolbox

The ES2K Toolbox Software is a windows based program used to communicate to the ES2K for the following functionality:

- Download Code – Used to download/update the code that runs in the ES2K.
- Download Vocabulary – Used to download/update the vocabulary on the ES2K.
- Production Test – Sanity test to check basic ES2K functionality.
- Create Initialization Strings – Utility to generate Init strings for the ES2K.
- Monitor – Monitor program to probe the ES2K for testing.
- Future enhancements available on customer request.

Chapter 5 - System Initialization

On power-up, the ES2K performs a diagnostic check of its internal hardware and any errors found are reported to the host processor.

Initialization occurs in the warm start state. The ES2K sends the host processor a + when it enters the warm start state. The host processor can request the warm start state at any time by sending a + to the ES2K. In this state, the host processor can request diagnostic information, set certain operating parameters, and command the ES2K to enter the run state.

Diagnostic responses

Error Reporting

Purpose: To report hardware errors. Here the `xx` is a 2-digit ASCII numeric digit that identifies the faulted device.

Syntax: `Exx`

Where `xx` is as following Table 5-1:

Table 5-1: Diagnostic responses

<code>xx</code> variable	indicates...
<code>t1, t2, t3, t4</code>	faults in T1 framers and DSP units on PCM highway resource 1 to 4
<code>81</code>	baseboard DSP phase 0, 1, or 2 faults
<code>82</code>	DSLAC fault
<code>83</code>	MTSXL switch fault

Diagnostic commands and responses in initialization

The host processor receives information about the status and configuration of the ES2K by sending commands to the ES2K and analyzing the responses.

+ command and - response

Purpose: To enter the ES2K into the cold start state and to reload the Flash PROM with new firmware.

Command Syntax: -

Response Syntax: -

+ command and + response

Purpose: To enter the ES2K into the warm start state.

Command Syntax: +

Response Syntax: +

!! command

Purpose: To initiate new vocabulary reload into the Voice Resource Flash PROM. The ES2K will enter the Voice Resource load process. This process is documented along with the Windows program ES2K TOOLBOX that performs this host function.

Command Syntax: !!

Response Syntax: !!

@ command

Purpose: To place the ES2K into the run state.

Command Syntax: @

Response Syntax: @

*command

Purpose: To verify the Card configurations in each of the ten Card slots. The response will be a 2 digit ASCII coded hex value for each of the 10 ES2K Cards in sequence. The first digit identifies the Card Type and the second digit identifies the Card revision level. See Tables 5-2 and 5-3.

Command Syntax: *

Response Syntax: *abababababababababab

Table 5-2: ES2K Card Revisions

Card Revision	b hex value
A	A
B	B
C	C
D	D
E	E
F	F
G	0
H	1
I	2
J	3

Table 5-3: ES2K Card Types

CARD Types	a hex value
Advanced DSP Resources	3
Voice Resources	4
Empty slot	e
QuadSpan T1/E1	2

Baseboard	1
-----------	---

#t command

Purpose: Reserved for future vocabulary indexing.

Command Syntax: = #t

Response Syntax: To be determined

Initialization parameters

All processing parameters in the ES2K are set to a default value during initialization. The host processor can change certain parameter values if required for the application. Each parameter value sets one byte. There are two types of parameters: global and span-specific. The global parameters are set by sending a parameter identifier followed by two ASCII coded hex digits that represent the binary byte value. The span specific parameters are of the same form but the first of the two hex digits identifies the span to which the value will apply and the second digit sets a 4-bit value. The entire initialization string can be sent as one message. The ES2K sends the string back to the host processor for verification to ensure that the parameters have been set in accordance with the application. Parameter identifiers are ASCII characters G through Z and the hex digits are ASCII 0 through 9 and A through F.

Global Parameters

Flash Hook on hook duration time

Purpose: On hook time duration during Flash Hook in a dial sequence in units of 60 ms.

Gab The default value is 0C, decimal 12, or 720 ms.

Maximum number of DNIS/ANI characters

Purpose: Inbound direct inward dialing (DID) terminates on either number of received characters or on timeout. This value sets the number of characters or optionally, number of # characters (MF Stops) to terminate DID. If the number of characters is variable or unknown, set this value to the largest expected number.

Hab The default value is 04 characters.

Feature Group wink duration

Purpose: Duration of a Wink (off hook–on hook) when performing a Feature Group protocol. This value is in units of 60 ms.

Iab The default is 04 or 240 ms.

Host Watchdog timeout

Purpose: If the host watchdog is enabled and no message is received from the host in this timeout period, the ES2K will go into host down state. This value is in units of 250 ms.

Jab The default is F0, decimal 240, or 60 seconds.

DID Interdigit timeout

Purpose: When receiving inbound DID, if the time between data exceeds this value, DID is considered complete and is terminated. This value is in units of 60 ms.

Kab The default is 07 or 420 ms.

DID start timeout

Purpose: When receiving inbound DID, the ES2K will wait this long for the first data. If no data is received in this period, DID will terminate. This value is in units of 60 ms.

Lab The default is 32 or 3 seconds.

Feature Group D answer time

Purpose: For Feature Group D, the time between the acknowledge wink and off hook initiation. This value is in units of 60 ms.

Mab The default is 08 or 480 ms.

Waiting on Far End warning time

Purpose: The ES2K will warn the host processor that it is waiting on the far end to complete its protocol activity. This time is the rate at which this warning will be issued, the value is in units of 60 ms.

Nab The default is FF, decimal 255 or about 15 seconds.

Pause time in dial

Purpose: This is the pause duration in the dial sequence when a pause command is inserted in the dial string. This value is in units of 60 ms.

Oab The default is 11, decimal 17, or about 1 second.

Dial Pulse time

Purpose: The duration of the on-time or the off-time of the dial pulse. This value is in units of 3 ms.

Pab The default is 11, decimal 17, or 51 ms.

Secondary Frequency reference

Purpose: The ES2K has a primary and a secondary frequency reference that control the clocking of all the T1 spans. This value designates one of the 28 T1 spans as a secondary reference. The secondary reference is automatically selected when the primary reference fails. The 28 spans are numbered sequentially as hexadecimal 00 to 1B.

Rab The default is 01, meaning the second T1 span.

Primary Frequency reference

Purpose: The ES2K has a primary and a secondary frequency reference that control the clocking of all the T1 spans. This value designates one of the 28 T1 spans as a primary reference. This

reference is initially selected to clock the T1 spans. The 28 spans are numbered sequentially as hexadecimal 00 to 1B.

Sab The default is 00, meaning the first T1 span.

Long character detection time

Purpose: The host processor can designate a data character for long duration detection. When the character is detected to be pulsed on for a time greater than this value, the host processor is notified. This value is in units of 60 ms.

Tab The default is 17, decimal 23, or about 1.3 seconds.

Long character detect

Purpose: This is the character to be monitored for long on-time duration detection. The value is the 2 hex digits that equate in binary to the ASCII code for the character.

Uab The default is 23, which is ASCII code for #.

Option Selection 1

The 2 hex digits describe the binary value of the option selection byte. The bits in this byte select various options. See Table 5-4 .

Yab The default FF, all bits set.

Table 5-4: Option Selection Binary Values

Bit position	Bit set (default)	Bit reset (option)
0	Host Watchdog disabled	Host Watchdog enabled
1	Standard disconnect supervision	Detect Flash Hook in disconnect supervision

2	DID terminates on number of # (MF stop) characters or timeout	DID terminates on number of characters or timeout
3	Inbound DID is DTMF	Inbound DID is MF
4	Standard host down activity selection	Hot start on host down (special option)
5	Send each DID character when detected	Queue up all DID characters and send them in one message
6	Send the 'O' response on protocol warning	Do not send the 'O' response message

Option Selection 2

The 2 hex digits describe the binary value of the option selection byte. The bits in this byte select various options. See Table 5-5.

zab The default FF, all bits set.

Table 5-5: Option Selection Bit values

Bit position	Bit set (default)	Bit reset (option)
0	Reserved	Reserved
1	No bipolar violation monitor	Perform bipolar violation performance monitor

Span Specific parameters

Tandem paired span specification 1

Purpose: These values are used to specify the paired spans that are connected in tandem on a host down condition, when the host down action value is 5 or 13 (see parameters). The value is the delta distance between the paired spans. For example, if span 2 is to be connected to span 10 the value set for those spans is 8. This parameter specifies the pairing for the first 14 spans. Note that *a* is the span number, 0-13 (0-9,A-D), and *b* is the delta distance from this span to its paired span. The range of values is 1-15, A-F.

qab The default is 00

Tandem paired span specification 2

Purpose: These values are used to specify the paired spans that are connected in tandem on host down when the host down action value is 5 or 13 (see parameter *t*). The value is the delta distance between the paired spans. For example, if span 11 is to be connected to span 12 the value set for those spans is 1. This parameter specifies the pairing for the second 14 spans. Note that *a* is the span number, 0-13 (0-9,A-D), and *b* is the delta distance from this span to its paired span. The range of values is 1-15, A-F.

rab The default is 00

Action on Host down and OOT option selection 1

Purpose: The first three bits selects the activity for the first 14 T1 spans to be performed when the host down event is detected. The fourth bit sets the Open On TT (OOT) option. When OOT is set, detection of entered TT data on the marked span will cause the audio to be terminated. Specifically, if that line was switched to another line, the audio to the other line will be silenced so that the line will not hear any audio until the host makes a connection to it. Note that *a* is the span number, 0-13 (0-9,A-D), and *b* is the option value in the Table 5-6 . When option 5 or 13 is selected, the corresponding value specifying the paired span must be entered in parameter *q*.

sab The default is 01.

Table 5-6: Host Down Action Values

b value	action on host down	OOT option
0	do nothing	clear
1	send yellow alarm	clear
2	on hook for all lines in span	clear
3	on hook when lines go idle	clear
4	off hook for all lines in span	clear
5	tandem connect to another span	clear
8	do nothing	set
9	send yellow alarm	set
A	on hook for all lines in span	set

B	on hook when lines go idle	set
C	off hook for all lines in span	set
D	tandem connect to another span	set

Action on Host down and OOT option selection 2

Purpose: Selects the activity for the second 14 T1 spans to be performed when the host down event is detected and then controls the OOT option. Note that *a* is the span number, 0-13 (0-9,A-D), and *b* is the option value in Table 5-6. When option 5 or 13 is selected, the corresponding value specifying the paired span must be entered in parameter *r*.

tab The default is 01.

Line Mode selection 1

Purpose: Selects the mode for the first 14 T1 spans. Note that *a* is the span number, 0-13 (0-9,A-D), and *b* is the option value in Table 5-7. OOB/SS7 (*b* values 5 and 6) refers to Out-Of-Band processing mode such as MCI SS7. In this mode, most of the line control is performed by the host processor on an external link. The ES2K, however will accept off/on commands and will respond with off/on status as these transitions are detected. It will support line assignment (X command), clear channel (C command), TT detections and all audio generation (M command).

uab The default is 01.

Table 5-7: Line Mode Options

b value	mode
0	do not service span
1	standard T1 Super Frame
2	ISDN clear Channel
3	Extended Super Frame with B8ZS
4	Extended Super Frame without B8ZS
5	OOB/SS7 ESF with B8ZS
6	OOB/SS7 SF

ES2KLine Mode selection 2

Purpose: Selects the mode for the second 14 T1 spans. Note that *a* is the span number, 0-13 (0-9,A-D), and *b* is the option value in Table 5-7.

vab The default is 01.

Signaling selection 1

Purpose: Selects the signaling for the first 14 T1 spans. Note that *a* is the span number, 0-13 (0-9,A-D), and *b* is the option value in Table 5-8.

wab The default is 04.

Table 5-8: Signaling Option Values

b value	Signaling Protocol
0	Rockwell D3 (as CO)
1	Ground start (as CO)
2	Loop start (as CO)
3	Rockwell D2 (as CO)
4	Feature Group A
5	Feature Group B
6	Feature Group D
7	Loop start/ Rockwell D3 (as CPE)
8	Ground start (as CPE)
9	Rockwell D2 (as CPE)
A	Reverse FGA

Signaling selection 2

Purpose: Selects the signaling for the second 14 T1 spans. Note that *a* is the span number, 0-13 (0-9,A-D), and *b* is the option value in Table 5-8.

xab The default is 04.

Line Build-out selection 1

Purpose: Selects the line build-out for the first 14 T1 spans. Note that *a* is the span number, 0-13 (0-9,A-D), and *b* is the value in Table 5-9.

yab The default is 0B.

Table 5-9: Line Build-out Values

b hex value	Build-out
B	DSX-1 0-133 FT / 0.6 DB
C	DSX-1 133-266 FT / 1.2 DB
D	DSX-1 266-399 FT / 1.8 DB
E	DSX-1 399-533 FT / 2.4 DB
F	DSX-1 533-655 FT / 3.0 DB

Line Build-out selection 2

Purpose: Selects the build-out for the second 14 T1 spans. Note that *a* is the span number, 0-13 (0-9,A-D), and *b* is the value in Table 5-9.

zab The default is 0B.

Chapter 6 - ES2K Commands

After the ES2K has received an initialization string, it waits for the application processor to command it to run. Once the ES2K receives the command to run, it completes the initialization process of loading and initializing all the resources, and enters the run state. The host processor can command the ES2K to exit the run state by sending the command to enter the warm start state. In the run state, the host processor controls the operation of the ES2K by sending commands to it. All commands are messages that begin with an alpha character and end with a CARRIAGE RETURN. There are two categories of commands, transaction commands and diagnostic commands.

Table 6-1: Summary of transaction commands

Summary of Transaction Commands	
A	Answer or seize a line.
B	Take line out of service is used in fractional T1 spans.
C	Enable the line for outbound audio while remaining on hook.
D	Dial on the line.
H	Hang up or disconnect the line.
M	Play a sound to the line.
N	Reject the call. This is only valid during inbound DID.
S	Connect audio path from source to destination.
X	Make a resource assignment such as DSP, voice or T1 to T1 tandem connection.

Table 6-2: Summary of diagnostic commands

Summary of Diagnostic Commands	
F	Select a new clock frequency reference.
I	Request Card configuration.
J	Re-enable a span after it has been disabled by the host.
K	Disable a span.
O	Request status of all the lines for a span.
P	Poll request.
V	ES2K version request.
Y	DSP code version request.
\	Baseboard version request.

Command Format

Most commands include an address of resources referred to as *prnn*. This address is defined as follows:

Table 6-3: Command Format

Parameter	Function
P	PCM Highway identifier 1-9, A-G
R	Resource number 1-4
Nn	in resource r channel number 01-32 Not all Cards support 32 channels per resource. For example: E1 has 30 channels per resource (span).

Answer or seize line

Purpose: This command is valid only for a T1 or E1 line. It is used to answer a line after a ring response has been received by the host processor on an inbound call, or to seize a line for an outbound call. This command is not required for an outbound dial because a dial command will automatically follow a seizure procedure.

Syntax: *Aprnn*

Deservice a line

Purpose: This command is valid only for a T1 or E1 line. It is used to take a line out of service for any reason, but it was specifically designed for the case of fractional T1 span where only some of the 24 lines are active or a fractional E1 span where only some of the 30 lines are active. When a line is taken out of service, it is left on hook and is not serviced. The line cannot be put back in service without reinitializing the ES2K.

Syntax: *Bprnn*

Enable outbound audio while on hook

Purpose: This command is only valid for a T1 or E1 line that is idle. It opens an outbound audio path to the line without seizing it. The line can then be commanded to play various supervision tones such as busy. This condition can be terminated with an answer or hang-up command. This command is only used in special situations.

Syntax: *Cprnn*

Dial line

Purpose: This command is valid for any T1 or E1 line. If the command is given to a line that is idle, the ES2K seizes the line in accordance with the protocol specified for the line. If the line is already off hook, the ES2K performs the function of the command arguments. Table 6-4 lists the dial string arguments *d* and their functions that can be used in the dial command. The maximum number of arguments in the command string is 30. It is recommended that no other commands be sent to this line until the dial ended response is received.

When / is included in the data, the ES2K completes the dial and waits for a wink from the far end before initiating the next command in support of extended Feature Group D. The host processor should send the next dial command as soon as it receives the dial-completed response from this command.

When the ES2K looks for dial tone and fails to detect it, a glare response is sent to the host processor and the dial string is terminated.

Syntax: *Dprnnd...d*

Table 6-4: Dialing arguments for *d* variable

Dialing String Argument, <i>d</i>	Function
\$	First character for MF tones, omit for DTMF
0-9 * #	Dial digits For MF KP is * ST is #
: ; < =	Dial A B C D for DTMF For MF ST3 is : STP is ; ST2 is <
.	Pause
?	Wait for dial tone
!	Do flash hook
/	Look for inbound wink before the next dial command in support of Extended Feature Group D
>	Monitor dial progress at the end of dialing. Must be last character in the data string

&n	Transmit the following EIB coin sent paid command 0 Coin Collect 1 Coin Return 2 Ringback 3 Operator Attach 4 Operator Release 5 Coin Collect and Operator Release
----	--

Frequency reference select

Purpose: This command is valid only for a T1 or E1 span. The ES2K will use the recovered clock from the reference span to clock the other T1 or E1 spans. This command overrides the default primary and secondary frequency reference selections that were made at initialization. This command would typically be used if both the primary and secondary references have failed.

Syntax: *Fpr*

Hang up or disconnect the line

Purpose: This command is valid only for a T1 or E1 line. It is used to disconnect, idle, and reset a line.

Syntax: *Hprnn*

Configuration request

Purpose: This command is used to request the ES2K configuration. The ES2K will respond to this command with a list of the type and revision level of each Card attached to the 10 PCM highways.

Syntax: *I*

Re-enable span

This command is valid only for a T1 or E1 span. It re-enables a span if it has been disabled by a host processor command to unframe it.

Syntax: *Jpr*

Disable span

Purpose: This command is valid only for a T1 or E1 span. It disables the span by transmitting an unframed signal and terminating all inbound processing on this span.

Syntax: *Kpr*

Line sounds supervision

Purpose: This command is valid for a T1 or E1 line only. It is used to transmit various supervision sounds to the line based on the value of *d* as defined in Table 6-5. This command should only be issued when the line is in an answered supervision, i.e. the line is answered (a response was received) or outbound audio has been enabled while on hook (*C* command). The sound can be terminated with a command for quiet or line hang up.

Syntax: *Mprnd*

Table 6-5: Line sound variables for *d* variable

Data Variable <i>d</i>	Supervision Sound
0	Busy tone
1	Ring back
2	Reorder (fast busy)
3	Dial tone
4	Quiet
5	Signaling System 7 tone test ON
6	Signaling System 7 tone test OFF
7	Music-on-hold from channel 1
8	Auto-trunk routing tone 1004hz
9	Line loop back with 6 dB attenuation

Reject the call in DID

Purpose: This command is valid only for T1 or E1 lines and only during the inbound DID period. This period is defined as the time between when the host receives the *R* response and when it sends the *A* command for protocols that receive DNIS/ANI. The host processor can examine the DNIS/ANI data and either accepts the call by sending the *A* command or reject it by sending the *R* command. This command will cause the line to go idle and wait for the far end to disconnect.

Syntax: *Nprnn*

Status request for span

Purpose: This command is valid only for a T1 or E1 span. It requests the status of all the lines in the span. The response informs the host processor if the line is in idle, active, disabled, or alarmed.

Syntax: *Opr*

Poll request

Purpose: This command is used to poll the ES2K for a known response. It may be used to validate communications between the host processor and the ES2K when no other communications apply.

Syntax: *P*

Table 6-6: Switch Command Variable

Command Variable	Function and Range
<i>d</i>	Half Duplex no <i>d</i> or <i>d</i> =1 Full Duplex <i>d</i> =2

Switch audio path

Purpose: This command is valid for any resource address in the ES2K. It switches the audio, one way only, from the source to the destination. The first *prnn* address is the source and the second is the destination. For a full duplex connection, you must reissue with the source and destination reversed. You can connect a source to many destinations (broadcast) but a destination can receive

from only one source. Therefore, the command removes a previous connection to this destination but maintains the path between this source and its previous destination. Refer to Table 6-6.

Syntax: *Sprnnprnn[d]*

ES2K version request

Purpose: This command requests the ES2K version. The response is the ES2K type and version.

Syntax: *v*

Talk Command

Purpose: Talk command on voice channel. Here *prnn* is the voice source channel (i.e. *p*=voice board PCM highway *rnn* is the timeslot on the highway. Please note that *rnn*= 431 and *rnn*=432 are not available. An audio connection (*X* command) should have been made prior to issuing the talk command. The *aaaaa* is the start address in ASCII hex and the *dddddd* is the duration in ASCII hex.

Syntax *Wprnnaaaaaddddd*

Assign resource to destination

Purpose: This assigns and connects any resource to a destination. The first address, *prnn*, is the source address and the second is the destination. The assignment is sticky and is maintained until it is change by the host processor or a reset. There are three cases to be considered: DSP Resources, Voice Resources, and T1-to-T1 assignment.

To assign a DSP Resource to a T1 or E1 line, the source is the T1 or E1 line address and the destination is the DSP Resource address. There are 96 DSP Resources total. Only one DSP resource can be assigned to a channel. Thus, this command removes any previous assignment. Once assigned, DSP detection responses reference the T1 or E1 channel assigned to the DSP Resource. You can un-assign a DSP Resource by making both the source and the destination addresses the DSP resource.

You can assign a T1 line to another T1 line, or an E1 line. In this case, the two lines will operate in tandem. This means that any signaling condition on one line immediately transfers to the signaling on the other line. This assignment is half duplex, unless you use the *d* suffix See Table 6-6. The host will be notified of any change in the off hook and on hook condition. An answer (*A*) or a hang up (*H*) command removes this assignment.

Syntax: *Xprnnprnn[d]*

DSP firmware & Advanced DSP resources code revision request

Purpose: This command requests the DSP code revision level. The response is the code versions for the baseboard DSP Resources, Advanced DSP Resources, and Voice DSP Resources.

Syntax Y

Stop Talking Request

Purpose: This command requests the Voice resource to stop talking on voice channel prnn (kill Voice)

Syntax Zprnn

Chapter 7 - ES2K Responses

This section describes the responses sent from the ES2K to the application processor in the run state. The responses notify the host processor of an event that has occurred. All responses are messages that begin with an alpha character and end with a Carriage Return. There are two categories of responses, transaction responses and diagnostic responses.

Table 7-1: Summary of transaction responses

Response	Indicates...
A	Line has answered or gone off hook
C	Outbound dial (DOD) has completed or inbound dial (DID) has completed
D	Data detected
G	Dial sequence aborted or glare
H	Line disconnected or hung up
R	Line is ringing or seizing
W	Inbound flash hook was detected
Z	Dial progress status
z	Channel stopped talking

Table 7-2: Summary of diagnostic responses

Response	Indicates...
C	Signaling System 7 tone test passed
E	Hardware fault detected
F	Line protocol error detected
f	Signaling System 7 tone test failed
I	Configuration response
J	Local alarm has occurred on the T1 span
K	Local alarm has cleared on the T1 span
L	Remote alarm was detected on the T1 span
M	Remote alarm has cleared on the T1 span
N	Syntax error in host processor message

O	Waiting on line protocol event caution
o	Line status response for lines in span
P	Attention for a T1 span is recovering from an alarm condition
Q	Response to a poll
S	Dial command rejected because no dialers are available
V	Response to ES2K version request
X	Warning host watchdog timer is about to expire
Y	Response to DSP code revision request
?	ES2K is out of service and in host down state
?	ES2K is out of service and in host down state and all lines are idle
!	ES2K is out of service and in host down state but some lines are still active

Response format

Most responses include an address of resources referred to as *prnn*. This address is defined as follows:

Table 7-3: Response Format

Parameter	Function
p	PCM Highway identifier 1-16
r	Resource number 1-4
nn	Channel in resource r number 01-32 Not all Resources support 32 channels per resource (span). For example: A T1 span will have 24 lines.

Line answered or off hook

Purpose: This response is sent when a T1 line has transitioned to the answered state and is seized by the other end. This is not intended to indicate that the ES2K has gone off hook toward the far end but rather that the far end has answered toward the ES2K.

Syntax: *Aprnn*

Bipolar violation report option

Purpose: This response is sent to report bipolar violations (BPV) on a T1 span when this option is enabled by parameter Z.pr is the span identifier and xx is a decimal count (01-99) of the number of 0.25 second periods that exhibited BPV in one minute. For guidance, when xx exceeds 32, it indicates that the span needs attention as soon as practical. If xx exceeds 64, it indicates that the span needs immediate attention. This message is not sent when a span is alarmed or if no BPV have been detected on that span.

Syntax: *aprxx*

Dialing is complete

Purpose: This response is sent when an outbound dial completed or inbound DID (DNIS/ANI) has completed.

Syntax: *Cprnn*

Signaling system 7 test passed

Purpose: This response is sent after the host processor requests a test tone loop test using the M command. If the test passes, this response is sent indicating that Signaling System 7-tone test passed. This terminates the test.

Syntax: *cprnn*

Tone data detection

Purpose: This response is sent when tone data is detected. This data may be DNIS/ANI data during inbound DID or data received during answered supervision. If the buffer data option is selected, all the DID data will be send in one response. The argument *d* is defined in Table 7-4.

Syntax: *Dprnnd* or *Dprnnd...d*

Table 7-4: d argument

Argument, d	Function
>	Long character detected
0-9 * #	Dial digits For MF KP is * ST is #
: ; < =	Dial A B C D for DTMF For MF ST3 is : STP is ; ST2 is <

Hardware error

Purpose: This response is sent when a hardware fault or error has been detected. The *xxx* arguments are defined in Table 7-5.

Syntax: *E_{xxx}*

Table 7-5: xx values

<i>xxx</i> variable	indicates...
t1, t2, t3, t4	faults in T1 framers and DSP units in slot t, spans 1 to 4
t5, t6, t7, t8	faults in T1 Line Interface Units in slot t, spans 1 to 4
80, 81, 82	baseboard DSP phase 0, 1, or 2 faults
83	primary switch fault
84	secondary switch fault
85	conferencing unit fault

Line protocol error

Purpose: This response is sent when a protocol violation on the inbound side of a line has been detected. These violations include hang up during DID, wink duration infraction, and failure to ring trip. When this event occurs, an attempt is made to clear and idle the line.

Syntax: *Fprnn*

Signaling system 7 test failed

Purpose: This response is sent after the host processor requests a tone loop test using the M command. If the test fails, this response is sent indicating that Signaling System 7-tone test failed. This terminates the test.

Syntax: *fprnn*

Glare or dial sequence aborted

Purpose: This response is sent when wait for dial tone is executed in the dial command and no dial tone is detected. The dial sequence is aborted and line processing continues for that line.

Syntax: *Gprnn*

Line hung up or on hook

Purpose: This response is sent when a T1 line has transitioned to the on hook state and is idled by the other end. This is not intended to indicate that the ES2K has gone on hook toward the far end but rather that the far end is hung toward the ES2K.

Syntax: *Hprnn*

Configuration response

Purpose: This message is in response to the host processor command I, request for configuration. The response arguments are a 2-digit ASCII coded hex value for each of the 10 PCM highways in sequence. The first digit identifies the Type and the second digit identifies the Revision level as shown in the Table 5-2 and Table 5-3.

Syntax: *Iabababababababababab*

Local alarm set

Purpose: This response is sent when local alarm condition is observed on a T1 span. This condition occurs when a loss of signal or signal out of frame is detected. All lines in the span are reset and the lines are not serviced until the alarm condition clears. A yellow alarm is sent on the outbound side to notify the other end that communications on this span are disrupted.

Syntax: *Jpr*

Local alarm clear

Purpose: This response is sent when local alarm condition is has cleared on a T1 span. This means that the signal is recovered and the span is. Service of the lines in the span will be initiated from an idle state and the outbound yellow alarm is terminated.

Syntax: Kpr

Remote alarm set

Purpose: This response is sent when remote alarm condition is observed on a T1 span. This condition occurs when an alarm indication signal or a yellow alarm is detected on the inbound signal. All lines in the span are reset and the lines are not returned to service until the alarm condition clears.

Syntax: Lpr

Remote alarm clear

Purpose: This response is sent when remote alarm condition has cleared on a T1 span. This means that the other end is no longer sending an alarm indication. Service of the lines in the span will be initiated from an idle state.

Syntax: Mpr

Host message syntax error

Purpose: This response informs the host that a syntax error has been detected in a command received from the host. The string *abc...* is the command message itself up to the point that the syntax error was observed and any further parsing of the command was abandoned.

Syntax: Nabc...

Waiting on line protocol caution

Purpose: This response is a caution message to the host processor that the line process continues waiting on a protocol event from the far end. Certain protocol procedures do not have timing specifications. When the line process reaches such a situation, it waits on the far end to perform a protocol step, and starts a timer. If the timer elapses before the protocol event occurs, this response

is sent to the host processor and the timer is restarted. The line process remains in this condition until the protocol advances or the host processor terminates the process by sending a hang up command.

Syntax: *Oprnn*

Line status in span

Purpose: This message is sent in response to a line status command request from the host processor. The status of the 24 lines in the referenced span are sent sequentially as arguments in the message. The value of the argument *a* is specified in Table 7-6.

Syntax: *opraaaaaaaaaaaaaaaaaaaaaa*

Table 7-6: a arguments

Argument a	Line status
0	Idle
1	Active
2	Alarmed
3	Out of service

Red alarm clearing advisory

Purpose: This response is an advisory that a span that has been in a local alarm state is about to clear the alarm. This response is sent as soon as the span regains the signal but prior to confirmation that the span is fully operational.

Syntax: *Ppr*

Poll response

Purpose: This is a response to a poll request from the host processor.

Syntax: *Q*

Line ringing

Purpose: This response is sent when ringing or an attempted seizure is detected on an idle line. If the line protocol includes inbound DID it will automatically be initiated. The host must respond with an answer command or, if in DID, a possible reject command. This response will be sent periodically until the host responds with the required command.

Syntax: *Rprnn*

No dialers available

Purpose: This response is sent when the host processor sends a dial command and no dialers are available because they are all active. It indicates to the host processor that the dial command on the referenced line was rejected. To avoid this situation, the host processor should keep track of the number of active dialers and not command more than the available number.

Syntax: *Sprnn*

ES2K version response

Purpose: This message is in response to a host processor request for the ES2K version. The arguments *aaa* are alphanumeric ASCII coded characters that identify the ES2K version.

Syntax: *Vaaa*

Flash hook detected

Purpose: This message is sent when the option for flash hook in disconnect supervision is enabled and an inbound flash hook is detected.

Syntax: *Wprnn*

Host watchdog timer warning

Purpose: If the host watchdog is enabled, a timer is initiated to monitor host communications. If no host messages are received in half the timer elapsed time, the warning message is sent. The host processor must immediately respond with a poll or some other message to avoid changing the state to host down.

Syntax: *X*

DSP code revision level response

Purpose: This message is in response to the host processor request for DSP code revision level. The arguments are triplets of alphanumeric ASCII coded characters that identify the DSP code revision level. The arguments *aaa* identify the Baseboard DSP code, the arguments *bbb* identify the Advanced DSP Resources code, and the arguments *ccc* identify the DSP Voice code.

Syntax: *Yaaabbbccc*

Dial progress report

Purpose: This response informs the host processor on the status of dial progress. The ring back report is informational only and does not terminate the dial progress. All other reports terminate the dial progress. Dial progress processing is coincident with answered supervision. The argument *d* is defined in Table 7-7.

Syntax: *Zprnnd*

Table 7-7: d arguments

Argument <i>d</i>	Dial progress status
0	Ring back (progress continues)
1	SIT undefined
2	SIT VC
3	SIT NC-BOC
4	SIT INTR
5	SIT REO-BOC
6	SIT REO-CAR
7	SIT NC-CAR
8	Busy
9	Reorder (fast busy)
:	Voice answered
;	Answer machine

Talk complete

Purpose: This response when a channel has completed talking on channel *prnn*.

Syntax: *zprnn*

Host down (out of service) lines are idle

Purpose: This response is sent periodically when the ES2K is in the host down state waiting to be initialized and all lines are idle. It enters this state if the host watchdog option was enabled and no communication was received from the host processor for a set amount of time. In this state, the ES2K responds to a poll request with this response.

Syntax: ?

Host down (out of service) lines are active

Purpose: This response is sent periodically when the ES2K is in the host down state and lines are active. The ES2K enters host down state if the host watchdog option was enabled and no communication was received from the host processor for a set amount of time. In this state, the ES2K responds to a poll request with this response.

Syntax: !



Chapter 8 - Installing the ES2K

The ES2000 is housed in a 1U Rack Mount chassis, and may be mounted in a standard 19" rack. To install the ES2K in a 19" rack, (4) clip nuts and (4) 10-32 screws are required.

Power requirements are 120VAC - 200Watts.

Spans are located on the back of the ES2000. Spans are numbered 1 through 16 on the top row (left to right) and 17 through 28 on the lower row of connectors.

