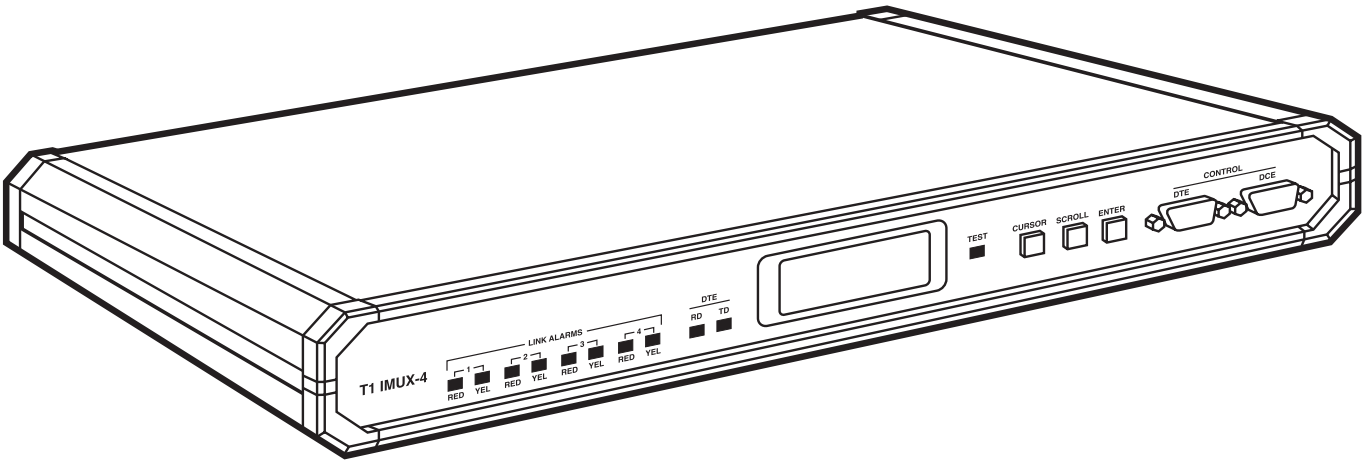
BLACK BOX®
NETWORK SERVICES

OCTOBER 1998
MT280A
MT280AE
MT285A
MT285AE
MT290A

T1 IMUX-2
T1 IMUX-4
2T1/E1 IMUX



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1. Specifications

Data Channels—MT280A, MT290A: 2; MT285A: 4

Speed—T1: 1.544 Mbps; Data: Any multiple of 1.472 Mbps, up to 5.888 Mbps; E1: Up to 2.048 Mbps

Interfaces—T1: CCITT Rec. G.703, G.704, AT&T TR-62411, PUB 54016; Data: V.35; MT290A: Only G.823 and G.703

Connectors—MT290A: (2) BNC, (4) RJ-45 (2 for T1, 1 for E1, 1 for external clock); Other models: (1) 34-pin female for V.35, (4) RJ-45 female

Indicators—Local and remote sync loss; Red and yellow alarm; Data port: TD, RD, TEST

Power—MT280A, MT285A: 115 VAC, 60 Hz; MT280AE, MT285AE: 230 VAC, 50 Hz; MT290A: 115/230 VAC (switch-selectable), 60–50 Hz, -48 VDC, 18.5 W

Size—1.7"H x 17"W x 9.5"D (4.3 x 43.2 x 24.1 cm)

Weight—5 lb. (2.3 kg)

2. Introduction

NOTE

This manual describes the T1 IMUX-4 (MT285A/AE). The other models work the same way, except for a few minor differences:

- **The T1 IMUX-2 can use only two T1 lines, whereas the T1 IMUX-4 can use up to 4.**
- **If you have a 2T1/E1 IMUX, read Chapter 7: It describes the differences you need to be aware of.**

2.1 Functional Description

2.1.1 Purpose and Main Features

The T1 IMUX-4 (MT285A) is an inverse multiplexor that allows transparent transmission of high-speed synchronous data at rates up to a maximum of 5.888 Mbps, using up to four standard lines.

The T1 IMUX-2 (MT280A) provides the same function, but uses up to two lines only.

The 2T1/E1 IMUX allows transparent transmission of E1 data over two standard T1 lines.

All three models provide a cost-effective, high-speed transmission medium for interconnecting bridges, routers, etc.

Figure 2-1 shows a basic application for the T1 IMUX-4, in which the IMUX is used to provide a high-speed data link for interconnecting two bridges or routers via standard T1 lines.

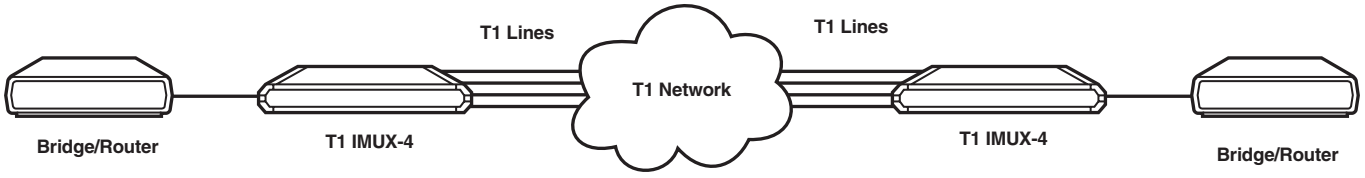

Figure 2-1. Basic T1 IMUX-4 Application.

Figure 2-2 shows another typical application for the IMUX-4. In this application, IMUX-4s give routers equipped with ATM-DXI interfaces access to the ATM network using fractional T3 services (for example, the Accunet® Fractional T45 [FT45] service offered by AT&T®). Using the FT45 service significantly increases the rate of transfer of inter-LAN traffic, and provides other advantages (such as a fallback feature or routing T1 lines over different paths*) of connecting routers via an ATM network.

*NOTE

If one of the T1 lines fails, the unit will fallback to a lower rate until the T1 line recovers. You can route T1 lines over different paths.

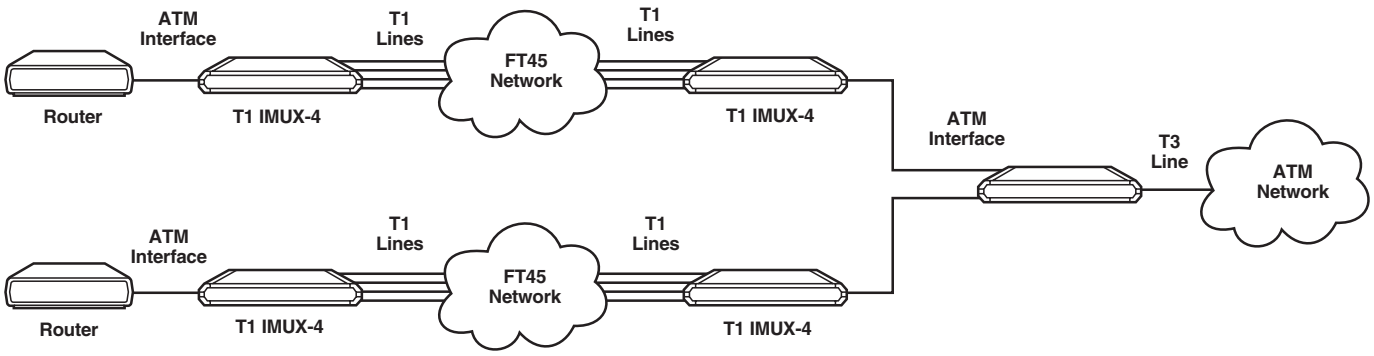

Figure 2-2. Typical T1 IMUX-4 Application for Fractional T3 Access to the ATM Network.

2.1.2 Inverse Multiplexing

Inverse multiplexing splits a high-speed data stream for parallel transmission over several lower-speed transmission lines. The T1 IMUX uses T1 lines for data transmission. The number of T1 link interfaces of the IMUX-4 is 4, so it can transmit data at rates that are multiples of 1.472 Mbps, including 2.944, 4.416, and 5.888 Mbps, depending on the number of T1 lines you are using. (For one line, you could transmit at rates up to 1.472, for two lines, up to 2.944, for three lines, up to 4.416, and for four lines, up to 5.888.) You select the number of lines, and when the number of T1 lines is less than four, you can also specify the link interfaces used.

The IMUX supports the fallback feature: If one of the T1 links fails, the IMUX will automatically select the next lower rate available and continue to provide service at the fallback rate. When the failed link recovers, the IMUX automatically returns to the original rate you selected.

NOTE

To use the fallback feature, your equipment must be able to tolerate changes in the data rate.

The data rates supported by the IMUX are similar to those offered by the AT&T Accunet Fractional T45 service; however, the IMUX can tolerate differential delays between any two lines up to 16 msec, and can also automatically detect interchanging of T1 lines. You can route the T1 lines used by a given IMUX over different paths or different facilities for greater flexibility and reliability.

NOTE

Although the IMUX can tolerate differential delays up to 16 msec, the actual latency of an IMUX-4 link is similar to the maximum differential delay encountered on the T1 lines you are using.

2.1.3 T1 Link Interface Characteristics

The IMUX-4 has four T1 link interfaces. Each link interface also has a built-in CSU.

The IMUX link interfaces are compatible with virtually all carrier-provided T1 services. The link interfaces support both the D4 (SF) and ESF framing formats, according to your selection. You can also select zero suppression over the line (transparent [AMI] coding, B7ZS or B8ZS).

The T1 line interfaces meet the requirements of AT&T TR-62411, ANSI T1.403, and CCITT Rec. G.703, G.704. Each interface has a 100-ohm balanced line interface, terminated in an RJ-45 connector. The nominal transmit level is ±3V, and the line signal is software-adjustable for line lengths of 0 to 655 feet (0 to 199.6 m) according to AT&T CB-119. The maximum line attenuation, without CSU, is up to 10 dB; when you use the integral CSU option, the maximum line attenuation is up to 34 dB. For shorter lines, you can set the CSU transmit level to -7.5, -15, or -22.5 dB.

2.1.4 User Data Channel Interface Characteristics

The IMUX has a synchronous DCE user interface. The electrical interface is V.35. The user data channel has a 34-pin female connector.

2.1.5 System Timing

The IMUX has several timing modes that give you maximum flexibility when integrating your system.

You can lock the IMUX system-timing reference to a set clock source that you select:

- The receive clock of each T1 link is always derived from the incoming line signal.
- The system clock, which also serves as the transmit clock source common to all the T1 links, is derived from a timing source that you select:

- An internal crystal oscillator that is accurate to ±32 ppm.

- An external (“station”) clock signal that has a nominal rate of 1.544 Mbps, connected to a separate RJ-45 connector via a balanced T1- type interface.

- The recovered receive clock signal of a T1 link that you select.

In addition to a main system clock source, you can specify a fallback source, which is automatically selected if the main source fails—for example, because of a red alarm (loss of signal) condition on the link selected as the main source.

2.1.6 User Data Channel Timing

The IMUX user data channel interface has two timing modes. In both modes, the clock signals are derived from the internal IMUX system-timing reference:

- *DCE mode*: The IMUX provides transmit and receive clock signals to your data terminal equipment. Your DTE must read the data sent by the IMUX at the rate of the receive clock signal, and the IMUX samples the transmit data arriving from your DTE according to the transmit signal provided to your DTE.
- *E-DCE mode*: This mode is similar to the DCE mode, except that the IMUX samples the transmit data arriving from your DTE according to an external transmit signal returned by your DTE. This clock signal must be derived from the transmit signal provided to your DTE.

2.1.7 Collecting Statistics

When operating with the ESF frame format, the IMUX stores T1 line statistics according to the ANSI T1.403-1989 requirements. The IMUX also provides local statistics support that meets the requirements of AT&T Pub. 54016.

2.1.8 Test and Diagnostics Capabilities

The IMUX can run comprehensive diagnostics that include local and remote loopbacks on the links and on your data channel, and bit error rate (BER) testing. The IMUX also supports the in-band code-activated network payload loopback, and the in-band code-activated network line loopback.

Advanced self-tests, and an automatic power-up self-test that provides circuit-level diagnostics data make the IMUX easy to maintain.

2.1.9 Alarms

The IMUX stores alarms it detects during its operation in a buffer that can hold up to 100 alarms. During regular operation, the front-panel LCD display notifies the local operator if there are any alarms in the alarm buffer. The local operator can then review the contents of the alarm buffer on the front-panel display, and can delete old alarms.

The front-panel LEDs display, in real time, the status of the IMUX links and the activity of the user's data channel, and alert you when test loops are present in the system.

2.1.10 Control of IMUX-4 Operation

The IMUX system is designed to operate unattended. The configuration of the IMUX (a complete collection of operating parameters) is determined by a database stored in non-volatile memory.

You can control the IMUX via a simple menu, operated by pushbuttons on the front panel. During setup, an LCD display guides you through the desired operations. The display gives you information about the current system configuration and operating mode, and the available values of each programmable parameter. If you make an error, the IMUX displays a message that explains the error and helps you correct it.

2.1.11 Remote Supervision and Monitoring

In addition to the front panel control, the IMUX also has an RS-232 supervisory port. This port gives you full control over IMUX operation, and lets you read alarm messages and monitor operation from a remote location via a standard ASCII data terminal, using either point-to-point or polling communications.

For polling, you can assign each IMUX an eight-bit address, up to a maximum of 255 nodes (the zero address is reserved).

Optionally, you can connect a Hayes® compatible dialup modem to the supervisory port so you can call in to your terminal from a remote location.

2.1.12 Physical Characteristics

The IMUX is a compact unit that you can install on a desktop or shelf. The unit is only 1U (1.75" [4.3 cm]) high.

2.1.13 Power Requirements

You can power the IMUX by either 115 or 230 VAC, depending on the power voltage available in your area.

2.2 Operating Environment

This section describes the T1 environment to give you the background information you will need to understand the IMUX configuration parameters.

The T1 line interfaces of the IMUX comply with AT&T Pub. 62411, and CCITT Rec. G.703, G.704, G.711, G.733, and G.824.

2.2.1 T1 Signal Structure

The T1 line operates at a nominal rate of 1.544 Mbps. The data transferred over the T1 line is organized in frames. Each T1 frame includes 193 bits, which consist of 24 time slots of eight bits each that carry the data payload. An additional time slot, including one bit (the F bit), carries framing and supervision information. As a result, the data rate supported by each payload time slot is 64 Kbps. The data rate of the framing slot is 8 Kbps. The T1 frame format is shown in **Figure 2-3**.

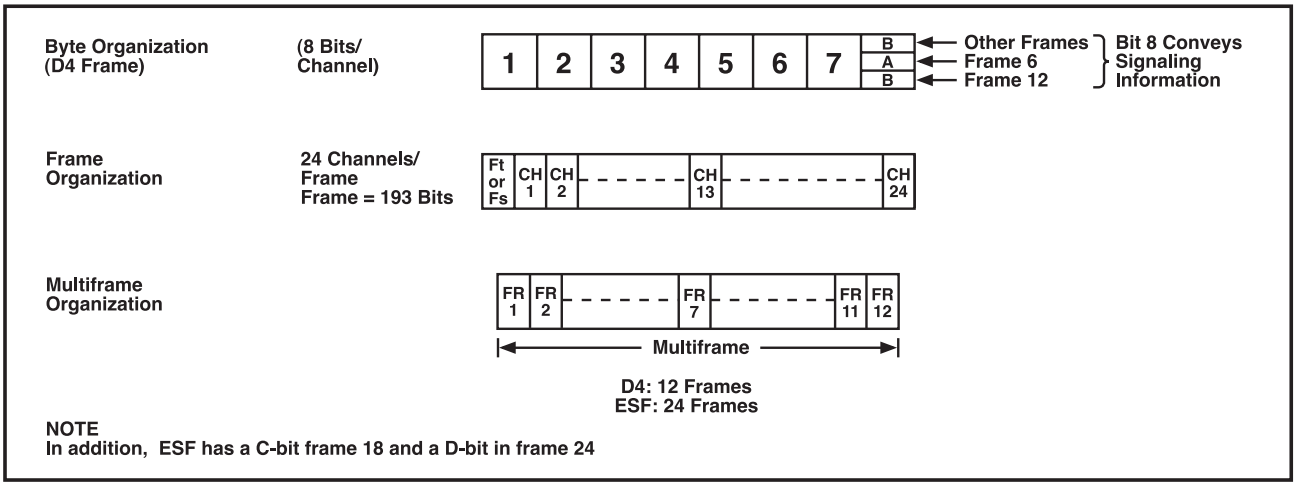

Figure 2-3. T1 Frame Format.

To enhance link/system supervision, the frames are organized in larger patterns, called super-frames. Two types of super-frames are used:

- SF (also called D4), consists of 12 T1 frames.
- Extended SF (ESF) consists of 24 T1 frames.

The SF format gives you limited supervision capabilities, such as end-to-end reporting of local loss-of-signal (yellow alarm).

The ESF format gives you much improved supervision capabilities, and allows better use of the 8-Kbps framing time slots. The major advantage of the ESF format is that it supports on-line link-performance monitoring (via a 2-Kbps Cyclic Redundancy Check [CRC] channel) and also provides a 4-Kbps end-to-end supervision and control data link.

The IMUX uses various F-bit patterns to implement the multiframing format. The F-bit pattern functions in three ways:

- Framing Pattern Sequence (FPS) defines frame and multiframe boundaries.
- Facility Data Link (FDL) allows transfer of supervisory data, for example, alarms, error performance, test loop commands, etc. to be passed through the T1 link.
- Cyclic Redundancy Check (CRC) lets the IMUX measure the bit error rate and makes the framing algorithm more reliable.

The F-bit pattern defines the structure of frames and multiframes. In the D4 (SF) frame format, the F-bit of consecutive frames is alternately interpreted as an F_t bit (terminal framing bit) or F_s bit (frame signaling bit).

- F_t pattern: alternating 0s and 1s, defines the frame boundaries.
- F_s pattern: fixed 001110 pattern, defines the multiframe boundaries, to distinguish one frame from another. The IMUX particularly needs the F_s pattern to identify frames 6 and 12 for recovering signaling bits.

In the ESF frame format, the multiframe structure is extended to 24 frames, but the frame and channel structure are the same as in the D4 (SF) format.

2.2.2 T1 Line Signal

The basic T1 line signal is coded using the alternate mark inversion (AMI) rules. In the AMI format, "ones" are alternately transmitted as positive and negative pulses, whereas "zeros" are transmitted as a zero voltage level. The AMI format cannot transmit long strings of "zeros," because such strings do not carry timing information. Therefore, the AMI signal source must generate a signal with guaranteed minimum "ones" density.

The minimum average "ones" density is 1:8, so when a T1 signal is transmitted over an AMI line, each frame time slot must include at least one "1" bit. In certain applications, this would effectively reduce the data rate available to you to only 56 Kbps per time slot, and would preclude the provision of clear-channel capability (CCC). To circumvent this problem, modified line codes, which perform zero suppression by substituting special codes for long strings of "zeros," are used.

A widely-used zero suppression method is B8ZS. This method provides clear-channel capability, and the "ones" density requirement no longer restricts user data characteristics, so each T1 frame time slot can support the full 64 Kbps.

2.2.3 T1 Alarm Conditions

The basic alarm conditions are the red alarm and the yellow alarm.

- A *Red Alarm* is generated when the local unit loses frame synchronization for more than 2.5 consecutive seconds. Loss of frame synchronization may be caused by F_s or F_t errors, by receiving an AIS signal, or by losing the input signal.

  In accordance with AT&T TR-62411, a system automatically recovers synchronization when there has been a period of 10 to 20 consecutive seconds free of the loss-of-sync condition. Since in many system applications this is an overly conservative specification, the IMUX lets you select a "fast" mode, which reduces the time needed to declare synchronization to approximately one second free of the loss-of-sync condition.

- A *Yellow Alarm* is sent from the remote unit to tell the local unit that a red alarm exists at the remote end.

- The *Alarm Indication Signal (AIS)* is an unframed "all-ones" signal that is used to maintain line signal synchronization when an alarm condition occurs in the equipment that supplies the line signal.
- *Excessive Bit Rate.* The bit error rate is measured on the framing bits. An excessive-error-rate condition is declared when the measured bit error rate exceeds 10^{-3}.

2.3 Application Considerations

This section presents typical IMUX applications and explains special application considerations.

2.3.1 Clock Waveforms

The IMUX distributes the incoming user's data bits among the active T1 links on a bit-by-bit basis. You select the number of active T1 links (up to the maximum of four available on a given IMUX-4.

The number of active T1 links determines the user's data rate: the IMUX-4 uses 23 time slots of each frame transmitted on a T1 link for the transmission of user's data, so the user's data rate is 1.472 Mbps times the number of active links. The remaining bits of each T1 frame (these are the eight bits of time slot 1 and the 193th bit of the frame) are used to transmit the overhead data. The overhead data includes the standard T1 frame synchronization and housekeeping data (see **Figure 2-3**), and information generated by the IMUX, which is used for the following main purposes:

- Identification of link numbers. This allows the receiving IMUX to detect connection errors, such as accidental interchange between links, and alert the operator.
- Determining the differential delays among the active T1 links.
- Reassembling the bits in the correct order, to restore the original user's data stream at the remote end of the IMUX link.

The receive path of the IMUX provides the original user's data stream and a clock signal that is synchronized with the individual data bits. As a result, the receive clock supplied to the user's DTE consists of bursts separated by gaps that appear during the transmission of overhead data. The basic frequency of the clock bursts is 1.544 Mbps, and gap duration depends on the number of active links, *n*.

The gap duration is an integer multiple of the bit interval at the 1.544 Mbps clock burst rate. The gap duration is *n* x 9 bits, followed by a clock burst of *n* x 184 bits. For example, at a user data rate of 5.888 Mbps (four active links), the gap has a duration of 36 bit intervals (4 x 9 bits) and appears after every group of 736 user data bits (4 x 184 bits).

2.3.2 System Timing Considerations

This section describes the timing modes offered by the IMUX. You can select two timing modes: one for the user's data channel and one for the system.

User-Data-Channel Timing Modes

The IMUX user-data-channel timing is always locked to the system clock. You can configure the flow of user's data channel timing signals to use either the DCE timing mode or the E-DCE timing mode.

The basic user-data-channel timing mode is called the DCE mode. In this mode, the user data channel interface operates as a DCE interface: The IMUX provides transmit and receive clock signals to the user's data terminal equipment. These signals are derived from the IMUX system clock. The user's DTE must read the data sent by the IMUX at the rate of the receive clock signal, and the IMUX samples the transmit data arriving from the user's DTE in accordance with the transmit signal provided to the user's DTE. The flow of timing signals in the user data channel interface, in the DCE mode, is shown in **Figure 2-4**.

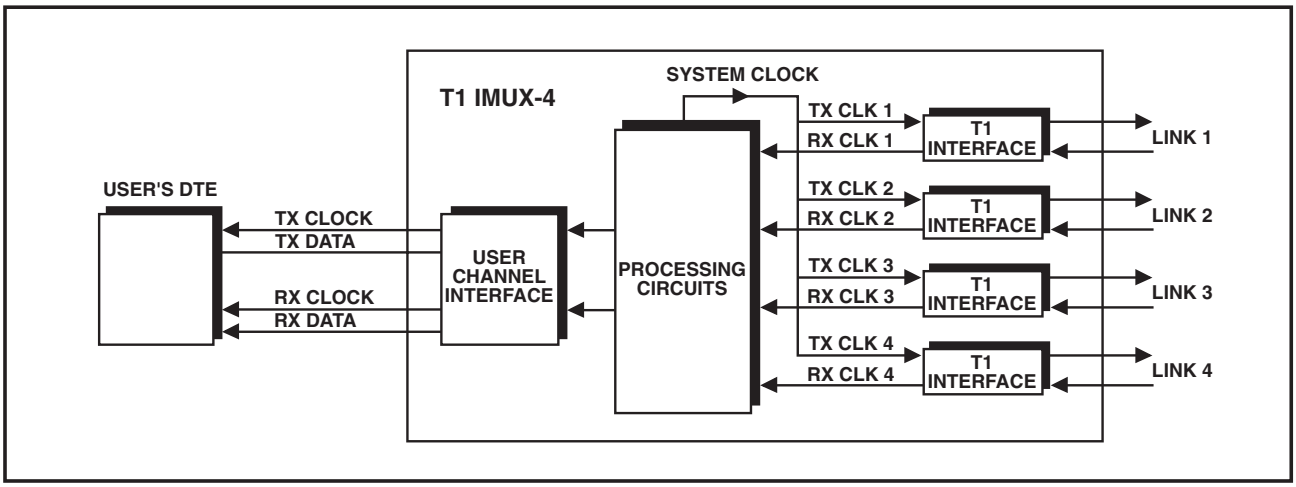

Figure 2-4. Flow of Timing Signals in User Data Channel Interface in the DCE Mode.

The second timing mode is the E-DCE mode: this mode is similar to the DCE mode, except that the IMUX samples the transmit data arriving from the user's DTE according to an external transmit signal returned by the user's DTE. This clock signal must be derived from the transmit signal provided to the user's DTE. The flow of timing signals in the user data channel interface, in the E-DCE mode, is shown in **Figure 2-5**.

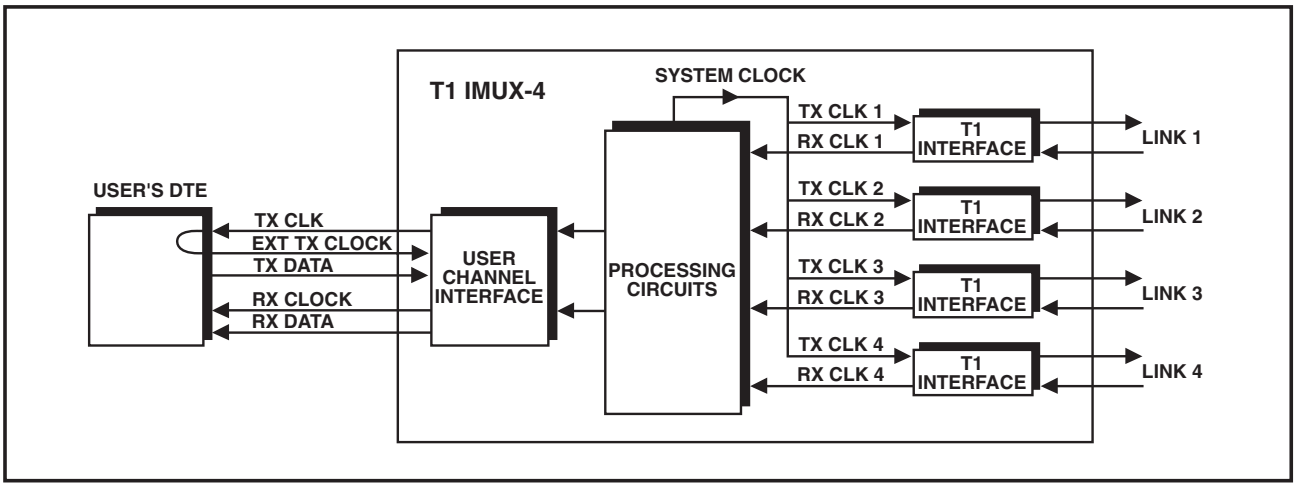

Figure 2-5. Flow of Timing Signals in User Data Channel Interface in the E-DCE Mode.

System Timing Modes

The IMUX system clock serves as the reference source for the transmit clocks of all the link interfaces, and for the user data channel interface clock signals. The IMUX has three system timing modes:

- Internal timing
- External timing
- Loopback timing

Internal Timing

With internal timing, the system clock of the IMUX is derived from a free-running internal crystal oscillator with an accuracy of ±32 ppm. Part A of **Figure 2-6** shows the flow of timing signals in an IMUX-4 using the internal timing mode. When an IMUX-4 uses internal clocking, the IMUX-4 at the remote end of the link must use loopback timing, as shown in Part B of **Figure 2-6**.

NOTE

The receive paths of the T1 link interfaces work with their own recovered clocks. These clock signals must be derived from the same source.

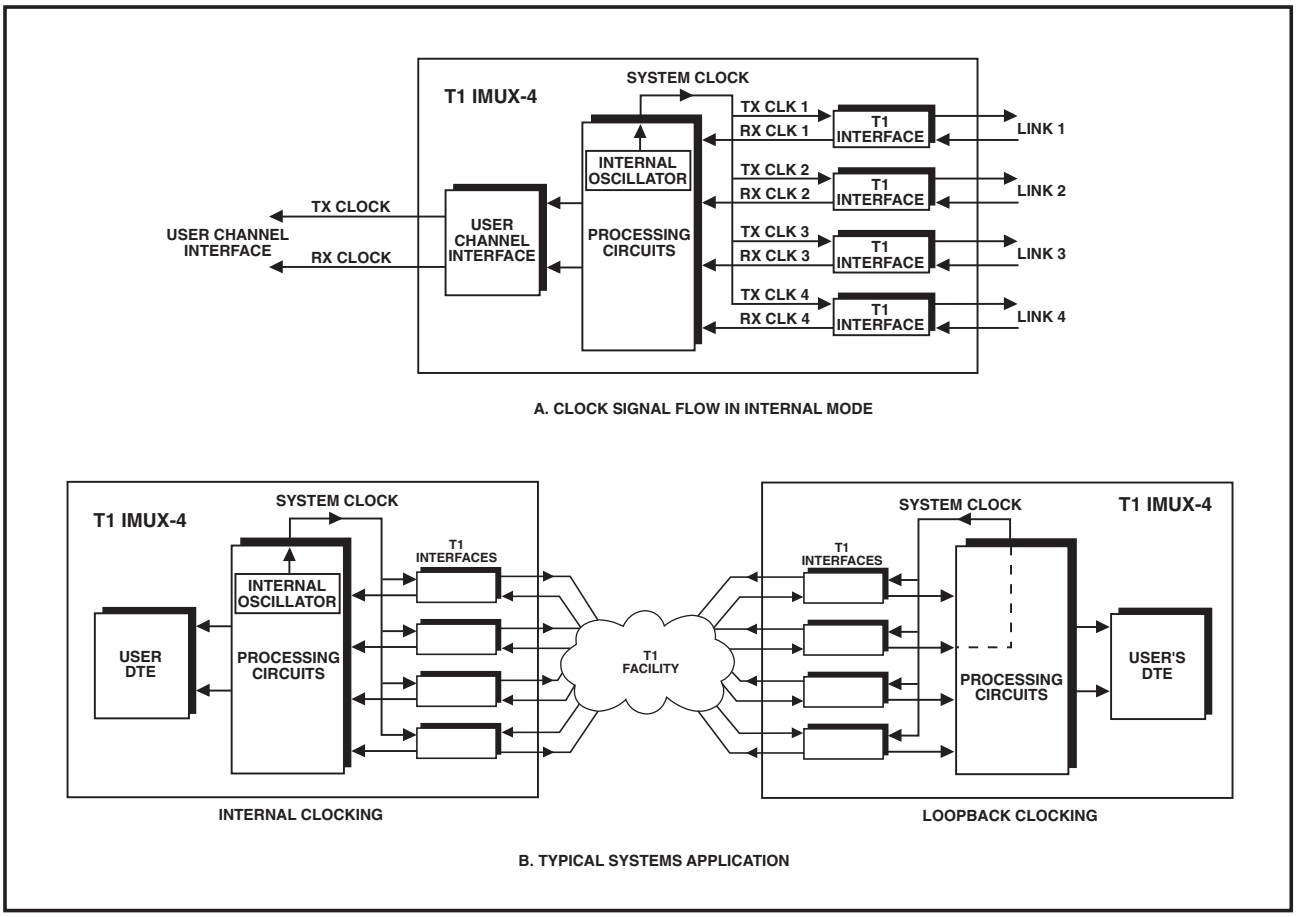

Figure 2-6. Flow of Timing Signals in Internal Timing Mode.

Loopback Timing

With loopback timing, the system clock is located to the recovered receive clock signal of a user-selectable T1 link. Part A of **Figure 2-7** shows the flow of timing signals in an IMUX using the loopback timing mode, when the timing source is the recovered clock signal of T1 link interface 2.

Since the network reference clock of most T1 carriers is locked to a master clock with very high accuracy and stability, the use of loopback timing at both ends of a link is a simple and effective means for locking the system clocks of the two IMUX units to the T1 network clock. This application is shown in Part B of **Figure 2-7**.

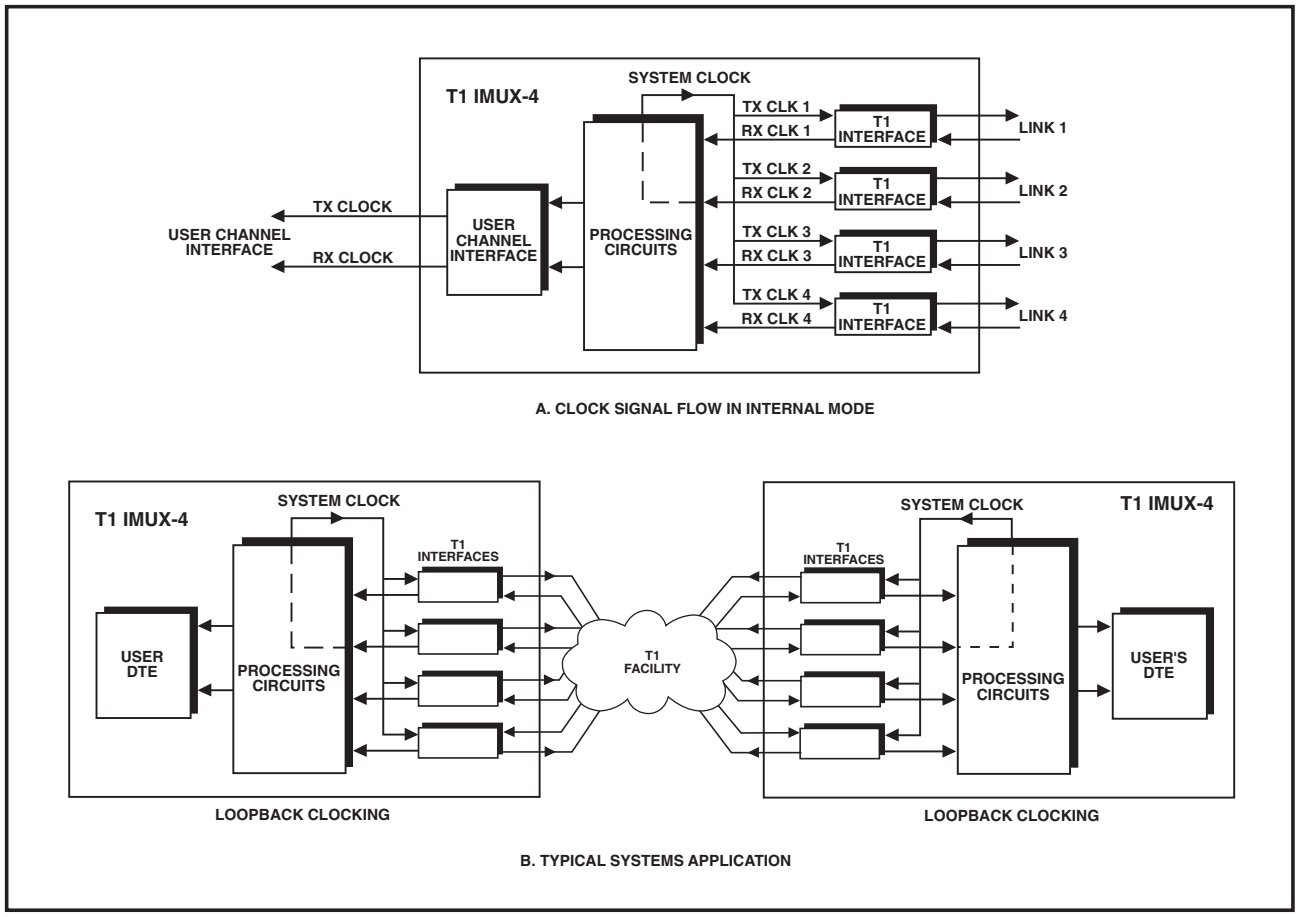

Figure 2-7. Flow of Timing Signals in Loopback Timing Mode.

External (Station) Timing

With external timing, the system clock is locked to an external ("station") clock signal. The external clock interface is available in a separate RJ-45 connector, designated STATION CLK. The external clock interface accepts a balanced unframed "all-ones" AMI or B8ZS signal having a nominal rate of 1.544 Mbps, and the maximum acceptable tolerance is ±130 ppm.

Part A of **Figure 2-8** shows the flow of timing signals in an IMUX using the external timing mode.

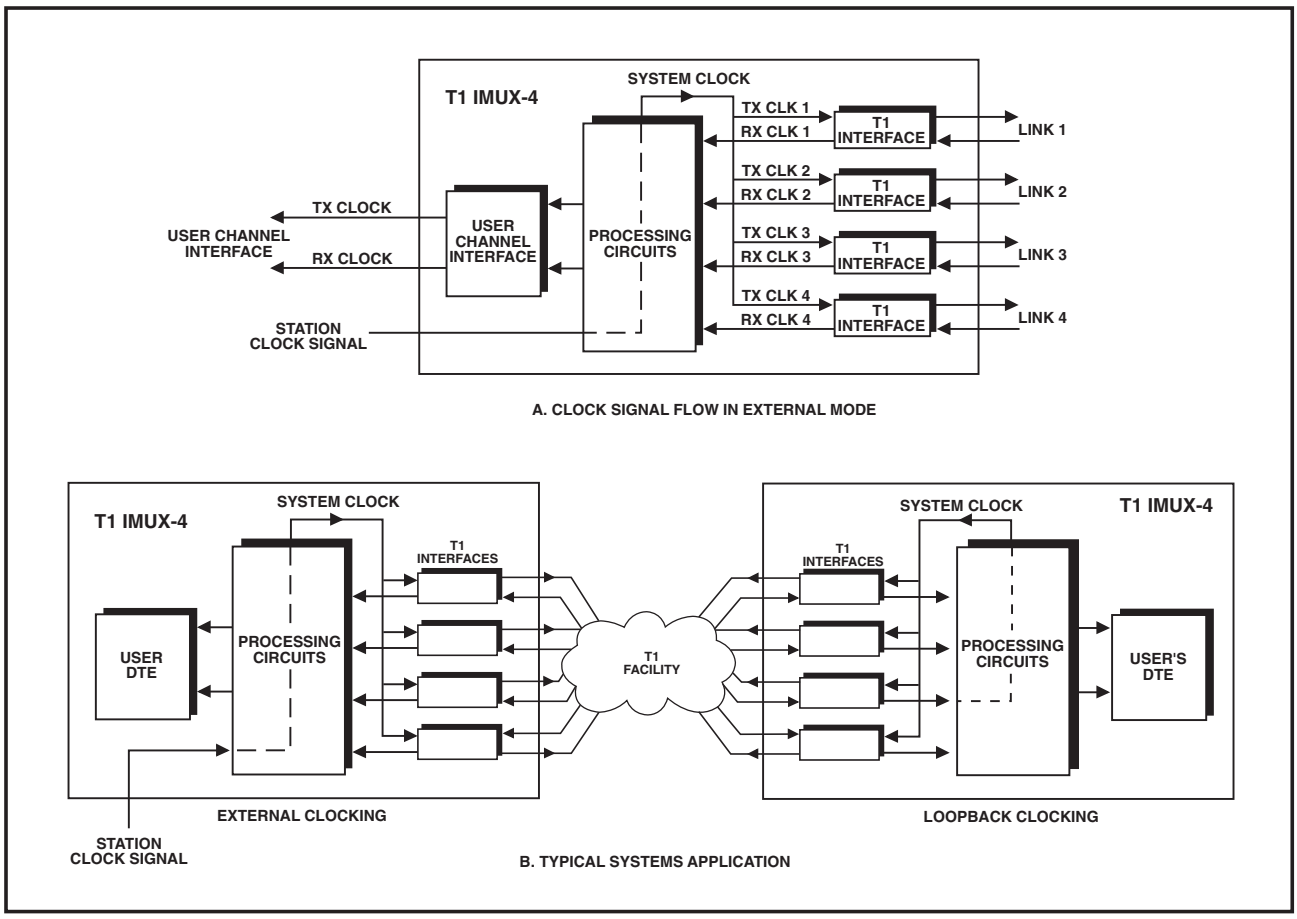

Figure 2-8. Flow of Timing Signals in External (Station) Timing Mode.

Main/Fallback Timing Sources

To prevent the loss of system timing if the selected source fails—for example, because of a red alarm (loss of signal) condition on the link selected as the main source—the IMUX-4 will automatically switch to internal timing.

To ensure that the system timing integrity is not lost if the main timing source fails, you can specify an additional timing source as a fallback source, and the IMUX will switch automatically to internal timing.

When the main timing source returns to normal operation, the IMUX will automatically switch back to the main source.

3. Installation

3.1 General

The IMUX is delivered completely assembled. It is designed for installation on a desktop or mounted in a 19" rack.

Mechanical and electrical installation procedures for the IMUX are provided in the following paragraphs.

After installing the unit, refer to **Chapter 4** for system configuration information and procedures using the front panel controls, or to **Chapter 5** for system configuration procedures using an ASCII terminal connected to the IMUX supervisory port.

If you encounter problems, refer to **Chapter 6** for test and diagnostics instructions.

3.2 Unpacking

Inspect the equipment container before unpacking. If you suspect damage, report it to your dealer immediately.

Unpack the equipment as follows:

- Place the container on a clean flat surface, cut all straps, and open or remove the top.
- Take out the IMUX carefully and place it securely on a clean surface.
- Inspect the product for damage. Report immediately any damage you find.

3.3 Site Requirements

3.3.1 Power

Install your IMUX within 5 feet (1.5 m) of an easily accessible grounded AC outlet supplying 115 VAC or 230 VAC.

3.3.2 Link and Station Clock Connections

The IMUX-4 has one RJ-45 connector for each link interface, and one for the external (station) clock interface. **Appendix A** shows the pinning for the RJ-45 connectors.

The maximum allowable line attenuation between the IMUX port and the network interface depends on the IMUX interface:

- For the station clock interface, and for link interfaces without CSU, the maximum range is 10 dB.
- For link interfaces with CSU, the maximum range is 34 dB.

3.3.3 User Data Channel Connections

The user data channel on the IMUX has a 34-pin female V.35 interface connector.

3.3.4 Front and Rear Panel Clearance

Allow at least 36 inches (90 cm) of frontal clearance for operator access. Allow at least 4 inches (10 cm) clearance at the rear of the unit for cable connections.

3.3.5 Ambient Requirements

The ambient operating temperature of the IMUX should be 32° to 113° F (0° to 45°C), at a relative humidity of up to 90%, non-condensing.

3.4 IMUX-4 Configuration Information

This paragraph provides information on the functions of the internal jumpers, to help you select the correct setting for your particular application, and gives you step-by-step instructions for setting these jumpers. The default settings for each jumper are also listed.

After you complete the installation, you can configure the unit from either the front panel or a supervision terminal. Information and instructions for these operations appear in **Chapters 4** and **5**, respectively.

Before installing the IMUX, check the positions of its internal jumpers and switches, and adjust them to fit your application.

WARNING

Dangerous high voltages are present inside the IMUX when it is connected to power and/or to the links. Disconnect the unit from the power line and from all the cables before removing the cover. Do not adjust, maintain, or repair the unit when the voltage is on unless you are aware of the hazard involved—YOU COULD BE SHOCKED! Even after the power is off, capacitators inside the unit may still be charged.

CAUTION

The IMUX contains components that are sensitive to electrostatic discharge (ESD). To prevent ESD damage, avoid touching the internal components, and before moving jumpers, touch the IMUX frame.

3.4.1 Opening IMUX Case

To reach the internal jumpers and switches of the IMUX, follow this procedure:

- Disconnect all the cables connected to the IMUX.
- Unscrew the large captive screw fastening the top cover to the rear panel.
- Remove the top cover.

3.4.2 Construction of the IMUX

Figure 3-1 shows the construction of the IMUX. The main components of the IMUX are the motherboard, four link interface boards, and a DCE interface board.

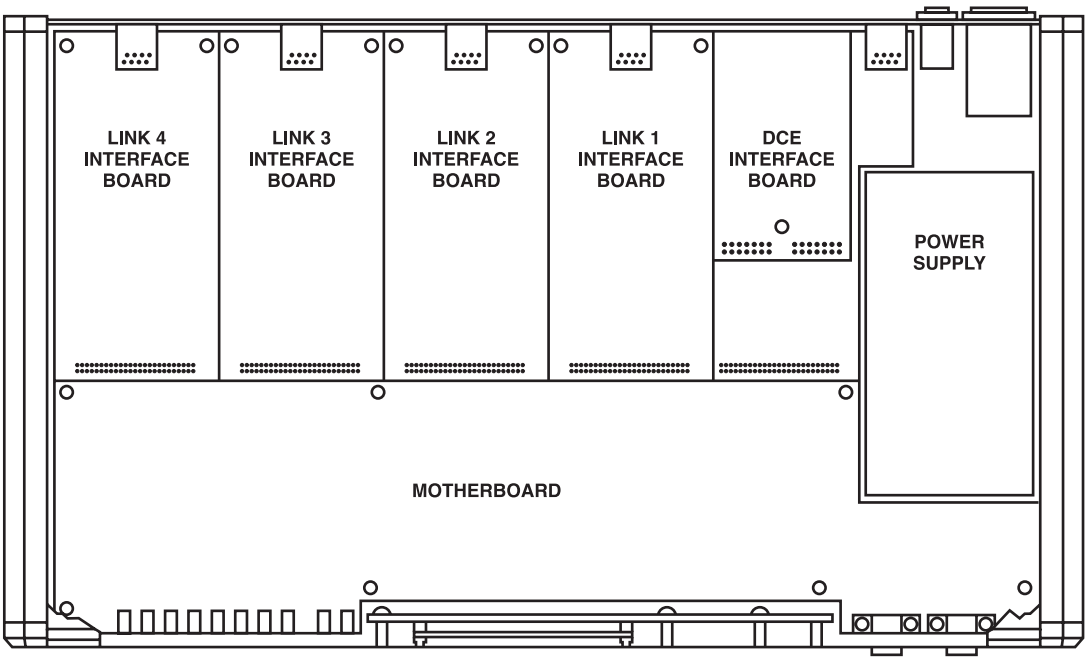

Figure 3-1. Construction of the IMUX-4.

3.4.3 Motherboard Jumpers and Switch, Location and Functions

In addition to the jumpers listed below, the IMUX-4 has other jumpers that are set by the manufacturer. Do not change the other jumper settings. The jumpers you *can* change are listed below.

WD Selection, Jumper JP5

- ON: watchdog enabled
- OFF: watchdog disabled

The IMUX-4 is shipped with jumper JP5 set to on.

FGND=SGND, Jumper JP22

- YES: signal ground is connected to the frame (chassis) ground
- NO: signal ground is not connected to the frame ground

The IMUX-4 is shipped with jumper JP22 set at YES (connected).

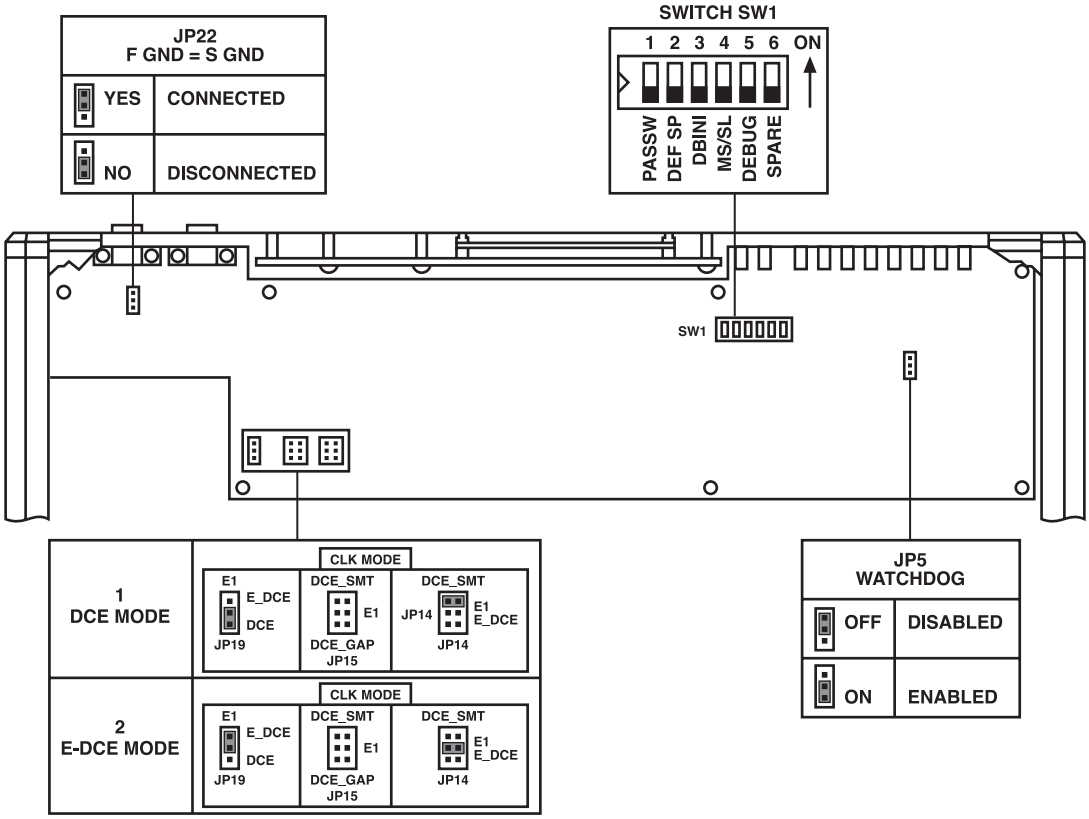

Figure 3-2. IMUX-4 Motherboard, Internal Settings.

Switch SW1

The IMUX-4 is delivered with a set of default parameters that allow you to start the configuration activities from a known state. These parameters are stored in its program EPROM, so you cannot modify them. By configuring the IMUX-4, you specify custom parameter values; these parameter values are stored in the IMUX-4 database (located in non-volatile memory), and are automatically loaded each time the IMUX is powered up.

NOTE

If the power-on self-test finds that your configuration has been corrupted, the IMUX will automatically reload the default parameters from its EPROM.

Switch SW1 lets you control the reloading of the desired group of default parameters. The switch has six sections, but you can set only sections 1, 2, and 3; you must not move the other sections from their OFF positions. The functions of the user-selectable sections are as follows:

- *Section 1—PASSW.* A password, consisting of four to eight alphanumeric characters, can be used to prevent unauthorized personnel from changing IMUX parameters from the front panel, and from using the IMUX supervision program.

NOTE

The personnel can read the configuration parameters on the IMUX front panel even when the password is used.

The IMUX is delivered with a default password, **IMX**, or you can select your own password.

Section 1 of SW1 is used to select between the default IMUX password (the ON position) and the password you select (the OFF position). The IMUX-4 address (node number) is also affected by section 1: with the jumper set to ON, the node number is set to 0.

When operating the unit for the first time, use the ON position to start the configuration. You can select this position again to restart with the default password and node address 0 in case the current user password is lost.

The IMUX-4 is shipped with section 1 set to OFF.

- *Section 2—DEFSP.* This section selects the source of the supervisory port parameters:

- ON—IMUX-4 uses the default parameters stored in its program EPROM. The default values are Autobaud, eight data bits, and no parity.

- OFF—IMUX-4 uses the user-selected parameters.

When you operate the unit for the first time, use the ON position to start the configuration. You can select this position again to restart with the default parameters in case the current values are not known, and it is not possible to communicate with the IMUX through its supervisory port.

The IMUX-4 is shipped with section 2 set to OFF.

- *Section 3—DBINI.* This section selects the source of the database configuration parameters:

- ON—IMUX-4 uses the default parameters stored in its program EPROM.

- OFF—IMUX-4 uses the user-selected parameters.

The IMUX-4 is delivered with the database loaded with the default parameters. You can select the ON position again to restart with the default parameters in case the current values are not known.

The IMUX-4 is shipped with section 3 set to OFF.

NOTE

User-selected parameter values are not erased by setting one or more of SW1 sections 1, 2, 3 to ON: This action merely causes the IMUX-4 to use the default values. However, if the IMUX-4 is powered off and then powered on again, the default values replace the user values.

Clock Mode Selection Jumpers

The jumpers designated JP14 and JP19 are used to determine the clocking mode. The two settings of these jumpers that are currently available to the user, shown in **Figure 3-2**, are as follows:

- *DCE*—the IMUX user's data channel operates in the DCE mode.
- *E-DCE*—the IMUX user's data channel operates in the E-DCE mode.

In both settings, the clock waveform is gapped.

The IMUX-4 is shipped with the jumpers set for the DCE mode.

T1 Link Interface Boards

The four T1 link interface boards do not include user-selectable jumpers.

NOTE

Each CSU interface board has protection fuses for the surge-protection circuits located on the line side of the line isolation transformers.

DCE Interface Boards

The DCE interface boards do not include user-selectable jumpers.

3.4.4 Internal Settings Procedure

Refer to **Figure 3-2**, and identify jumper and switch locations and settings. Change settings as required.

After completing the internal settings, reinstall the top cover of the IMUX-4 and fasten it to the rear panel by fully screwing in the large rear-panel screw.

3.5 Installation in 19" Racks

You can install the IMUX-4 in 19" racks. Unit height corresponds to 1U (1.75"). The following sections provide step-by-step instructions for rack installation.

WARNING

Disconnect all cables, including the power cables, from the units while performing the following procedure.

Installation Procedure

To prepare the IMUX for rack installation, attach two brackets (not included) to the side walls of the unit. Fasten each bracket via two screws (with flatwashers) that you insert into the front holes on the wide wall (if nuts are already in place on the inner side of the wall).

After attaching the brackets, the unit is ready for installation in the 19" rack. Fasten the brackets to the side rails of the 19" rack via four screws (not included), two each side.

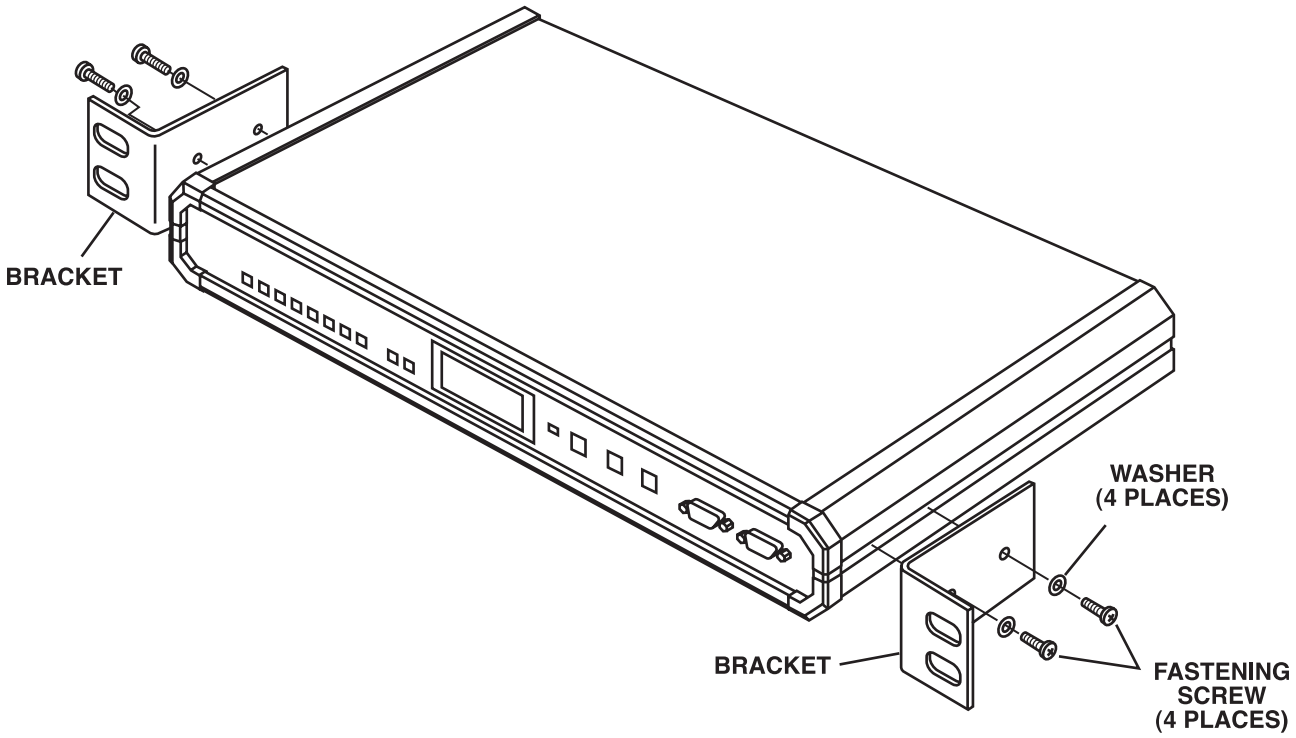

Figure 3-3. Installation of the IMUX-4 in a 19" Rack.

3.6 Connections

Figure 3-4 shows the rear panel of an AC-powered IMUX unit and identifies connector locations.

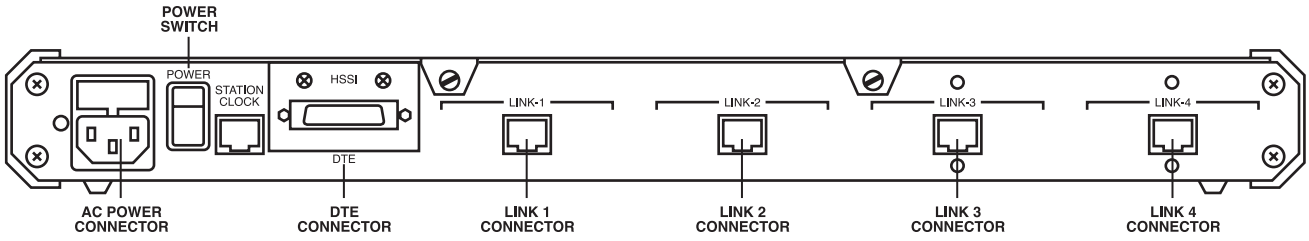

Figure 3-4. IMUX-4 Rear Panel.

3.6.1 Grounding

Any interruption of the protective (grounding) conductor (inside or outside the unit) or disconnecting the protective earth terminal can make this unit dangerous.

Before switching on the IMUX and before connecting any other cable, connect the protective earth terminals of the IMUX to the protective ground conductor of the (mains) power cord. Insert the mains plug only in a socket outlet that has a protective earth contact. Do not use an extension cord (power cable) without a protective conductor (grounding).

WARNING

Use only fuses with the required rated current, as marked on the IMUX-4 rear panel, for replacement. Avoid using repaired fuses and short-circuiting fuse holders.

If the protection offered by fuses is impaired, do not use the IMUX.

3.6.2 Power Connection

Supply AC power to the IMUX-4 through a 5-ft. (1.5-m) standard power cable terminated by a standard 3-prong plug.

- Check that the ON/OFF switch on the IMUX-4 rear panel is set to OFF.
- Connect the power cable first to the connector on the IMUX-4 rear panel, then to the mains outlet.

3.6.3 Link Connections

Connect each of the link cables to the connector corresponding to the link interface you will use: LINK-1, LINK-2, LINK-3, or LINK-4.

3.6.4 Station Clock Connection

If you will use an external clock signal, connect the external clock cable to the STATION CLK connector.

3.6.5 User's Data Terminal Connection

Connect the user's data terminal equipment to the rear panel connector marked DTE. The unit has a V.35 interface, with a 34-pin female connector, wired for direct connection to V.35 DTE devices.

3.6.6 Supervisory Port Connection

Connect a cable prepared according to **Appendix A** between the supervisory port connector marked DTE, located on the front panel of the IMUX, and the supervision terminal. If the supervision terminal is connected via modems, use a crossover cable.

To enable communication with the IMUX-4, set the supervisory terminal to the same data rate, data word format, and parity type as the IMUX-4, before you start operations.

4. Front-Panel Operating Instructions

4.1 Scope

In this chapter you will find detailed instructions for operating the IMUX-4 from the front panel. The information presented in this chapter includes:

- IMUX-4 front panel—**Section 4.2**
- General description of IMUX-4 control, display, and pushbutton functions, and menu organization—**Section 4.3**
- Configuration parameters—**Sections 4.4** through **4.7**
- Operating procedures (power-on, front-panel indications, performance monitoring, and power-off)—**Section 4.8**
- IMUX-4 local configuration setup—**Section 4.9**
- IMUX-4 configuration error messages—**Section 4.10**

Refer to **Chapter 5** for how to use a supervision terminal to remotely control and monitor IMUX-4 operation.

4.2 Front-Panel Controls, Connectors, and Indicators

Figure 4-1 shows the front panel of the IMUX-4. **Table 4-1** lists the functions of the IMUX-4 controls, connectors, and indicators located on the IMUX front panel. The index numbers in **Table 4-1** correspond to the item numbers in **Figure 4-1.**

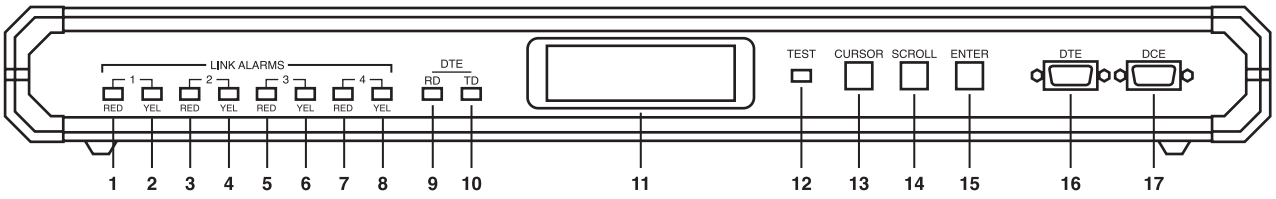

Figure 4-1. T1 IMUX-4 Front Panel.

Table 4-1. T1 IMUX-4 Controls, Connectors, and Indicators.

No.	Control or Indicator	Function
1	LINK 1 RED indicator	Lights when a red alarm is detected on link 1
2	LINK 1 YEL indicator	Lights when a yellow alarm is detected on link 1
3	LINK 2 RED indicator	Lights when a red alarm is detected on link 2
4	LINK 2 YEL indicator	Lights when a yellow alarm is detected on link 2
5	LINK 3 RED indicator	Lights when a red alarm is detected on link 3
6	LINK 3 YEL indicator	Lights when a yellow alarm is detected on link 3
7	LINK 4 RED indicator	Lights when a red alarm is detected on link 4
8	LINK 4 YEL indicator	Lights when a yellow alarm is detected on link 4
9	DTE RD indicator	Lights when data is present on the receive line of the user's interface
10	DTE TD indicator	Lights when data is present on the transmit line of the user's interface
11	Alphanumeric display	Liquid crystal display (LCD) used to display messages and status information. The display contains 2 rows of 16 characters each.
12	TEST indicator	Lights when a test is active
13	CURSOR pushbutton	Used to move among the information fields
14	SCROLL pushbutton	Used to scroll among the available options of the displayed functions
15	ENTER pushbutton	Used to enter the changes made in the IMUX-4 operation, and initiate operation under the new setup
16	DTE connector	Reserved for future use
17	DCE connector	Connection to supervision terminal

4.3 Control of T1 IMUX-4 Operation, General

4.3.1 General

T1 IMUX-4 operating mode is determined by a set of parameters stored in an internal non-volatile memory. You select these parameters, via either the IMUX front-panel pushbuttons or a supervision terminal.

After you load the operating parameters, the IMUX no longer requires an operator to attend to it.

The configuration stored in the IMUX-4 memory is not affected when the IMUX is powered off. When the IMUX is powered on, the IMUX checks the validity of the stored configuration data, and if everything is OK, it assumes the last selected configuration. If the configuration does not require modification, the IMUX is then ready for operation immediately after you power on the unit. However, if the configuration data is not valid, the IMUX lets you load a default configuration instead. The default configuration, prepared by the manufacturer, is stored in the program EPROM.

4.3.2 General Operating Instructions

All operations are performed using an interactive, menu-driven user-friendly interface. The interface is controlled via the display and three pushbuttons. The IMUX-4 guides you in executing the required task with simple and clear messages, presents the range of available parameter values, and checks your inputs.

The IMUX-4 will present to you only those parameter values available on your IMUX-4 in the selected operating mode.

If you make a configuration error—for example, you select a parameter value that conflicts with the current operating mode—the IMUX-4 rejects the erroneous selection and displays an error message that identifies the error.

You will find detailed instructions for operating the IMUX-4 in **Sections 4.8** and **4.9**. **Section 4.10** explains the configuration error messages, and presents instructions for correcting the problem.

4.3.3 Display Functions

The IMUX-4 display has four functions:

- Display of status messages
- Display of diagnostics performance data
- Display of test functions
- Display of configuration parameters

Status Messages

When the IMUX is not being configured and no test is active, its display shows status messages. The alarm buffer can store up to 100 alarms. The status messages appear under the header ALARM BUFFER, and are described in **Chapter 6**.

Diagnostics Functions

The IMUX-4 displays the traffic performance parameters gathered when operating with ESF framing. The IMUX-4 can also display BPV statistics when operating along with SF (D4) framing. The diagnostics data appears under the header DIAGNOSTICS. **Chapter 6** explains the diagnostics data displayed by the IMUX-4.

Test Functions

The test functions include:

- Local and remote loopbacks, to rapidly isolate faults.
- BER test.
- For T1 links with CSU interfaces, network line loopback and network payload loopback, controlled by the network. These loopbacks have the highest priority and will override any other loop request.

The test function messages appear under the header TEST OPTIONS. **Chapter 6** describes the available test functions.

Configuration Parameters

The IMUX-4 has four groups of configuration parameters:

- System parameters
- Link parameters
- Channel parameters

• Supervisory port parameters.

The configuration parameters are detailed in **Table 4-2**.

Table 4-2. Configuration Parameter Groups.

Display	Description	See...
SYSTEM PARAMETER	Display and selection of system parameters: • Master clock source • Fallback clock source	Section 4.4
LINK PARAMETERS	Display and selection of link parameters: • Framing • Synchronization time • Link interface function • Idle time slot fill-up code • Zero suppression coding • Transmit signal masking/attenuation • Link connection	Section 4.5
CHANNEL PARAMETERS	Display and selection of IMUX-4 links to be used	Section 4.6
SP PARAMETER	Display and selection of IMUX-4 supervisory port parameters: • Data rate • Number of data bits • Parity • Interface type	Section 4.7

In addition to the parameters configured from the front panel, there are parameters that you can control only from the supervision terminal. These are presented in **Chapter 5**.

After configuration, if alarm messages are stored in its ALARM BUFFER, the IMUX-4 automatically returns to the display of status messages.

4.3.4 Organization of IMUX-4 Display

The IMUX-4 display has two rows:

- *Upper row.* Shows the name of the displayed function, group of configuration parameters, or test option.
- *Lower row.* The lower row displays:

- Parameter name and value.
- Status messages.
- Loopback status.
- Error messages.
- Diagnostics messages.

4.3.5 Using Front-Panel Pushbuttons

You can control IMUX-4 operation via the display and the three pushbuttons called CURSOR, SCROLL, and ENTER. The same control actions are consistently used for all the activities.

- *CURSOR*—Use this pushbutton to indicate what you want to change. Pressing the CURSOR pushbutton moves the cursor among the fields in the current display. The cursor is a bar that underlines the selected field.
- *SCROLL*—Press repeatedly to display the alternatives for the current field/item indicated by the cursor. Holding the pushbutton depressed causes automatic scrolling of the available alternatives.
- *ENTER*—Press it once to select the value displayed in the field/item indicated by the cursor. If the selected value is valid, it replaces the old value and the change takes effect immediately. The ENTER key has two additional functions:

- When the alarm buffer is displayed, the ENTER key can be used to delete all the alarms in the buffer.
- When DIAGNOSTICS is displayed, the ENTER key can be used to reset the following error counters: ERROR EV, ERROR CRC, AV ERROR CRC, CURR ES, CURR SES, CURR BES, CURR UAS, CURR LOFC, CURR CSS, CURR SECS, BPV COUNT, L. TERM UAS, L. TERM LOFC, L. TERM CSS, L. TERM INT, CUR DEG MIN, BPV WORST, LST DEG MIN.

If you make an incorrect selection, it is not accepted. In this case, you will see a CONFIG ERROR message with a two-digit code in the second display row. The code indicates what is wrong. **Section 4.10** explains the codes and what to do to correct the error.

After a short time, the error message disappears, and you again see the original display. Now you can correct the error.

4.4 System Configuration Parameters

Table 4-3 lists the available system configuration parameters and their functions. The table also lists the parameter values included in the IMUX-4 default configuration.

Table 4-3. System Parameters.

Designation	Function	Values
CLK_MASTER	Selects the master timing reference	LNK1—Locked to the recovered receive clock of link 1 LNK2—Locked to the recovered receive clock of link 2 LNK3—Locked to the recovered receive clock of link 3 LNK4—Locked to the recovered receive clock of link 4 ST—External clock signal connected to the STATION CLK connector INT—Internal oscillator **Default: INT**
CLK_FBACK	Selects the alternate (fallback) timing reference for use in case the master reference fails	NONE—No fallback source is used LNK1—Locked to the recovered receive clock of link 1 LNK2—Locked to the recovered receive clock of link 2 LNK3—Locked to the recovered receive clock of link 3 LNK4—Locked to the recovered receive clock of link 4 ST—External clock signal connected to the STATION CLK connector **Default: NONE**

4.5 Link Configuration Parameters

Table 4-4 lists the available link configuration parameters and their functions. The table also lists the parameter values included in the IMUX-4 default configuration

Parameter values can be independently selected for each link.

Table 4-4. Link Parameters.

Designation	Function	Values
CON	Used to control the use of the selected link To actually use a given link, first it must be assigned to the data channel (**Section 4.6**)	NO—Link is not used YES—Link is used to carry user's data **Default: YES** (provided the link is installed)
FRAME	Selects the multiframing mode for the selected link	SF—12 frames per multiframe. ESF—24 frames per multiframe **Default: ESF**
SYNC	Permits you to reduce the time required for the selected link to return to normal operation after local loss of synchronization	62411—Complies with AT&T TR-62411 (after 10 seconds) FAST—After 1 second **Default: FAST**
FUNCTION	Indicates the type of interface installed on the selected link. The value appearing in the field is automatically displayed in accordance with the hardware installed on the selected link, and cannot be changed	CSU—The link interface includes a CSU DSU—The link interface does not include a CSU
I_TS_CODE	Selects the code transmitted to fill idle (unused) time slots in the frames transmitted on the selected link	The available selections are 00 to FF (hexa). **Default: 3F**

Table 4-4 (continued). Link Parameters.

Designation	Function	Values
CODE	Selects the line-coding method used for zero suppression	TRAN—Transparent (AMI) coding, no processing for zero suppression B7ZS—B7ZS coding B8ZS—B8ZS coding **NOTE** **Clear channel capability is available only with B8ZS coding.** **Default: B8ZS**
MASK	Controls the link transmit signal characteristics The displayed options depend on the link interface hardware When the link interface does not include a CSU, the transmit signal mask can be selected in accordance with the transmit line length, to meet DSX-1 requirements, as specified by AT&T CB-119, or operation in accordance with FCC Rules Part 68 When the link interface includes a CSU, the transmit signal can be attenuated by 7.5, 15. or 22.5 dB, to meet the requirements of FCC Rules Part 68	For links without CSU: 1. DSX-1 operation: The following selections, indicating the line length in feet (m), are available: Length in feet (m) — Display 0 to 133 ft (0 to 405 m) — 000- 133 to 266 ft (405 to 810 m) — 133- 266 to 399 ft (810 to 1216 m) — 266- 399 to 533 ft (1216 to 1624 m) — 399- 533 to 655 ft (1624 to 1996 m) — 533- 2. An additional selection, FCC68, provides compliance with the FCC Rule 68.308 Option A output pulse mask. **Default for links without CSU: 0-133** **For links with CSU:** 0 No attenuation 7.5 Attenuation of 7.5 dB relative to the nominal transmit level 15 Attenuation of 15 dB relative to the nominal transmit level 22.5 Attenuation of 22.5 dB relative to the nominal transmit level **Default for links with CSU: 0**

4.6 Channel Configuration Parameters

Table 4-5 lists the channel configuration parameters. The table also lists the parameter values included in the IMUX-4 default configuration.

Table 4-5 Channel Parameters.

Designation	Function	Values
LINK X	Controls the connection of each individual link to the user's data channel X designates the link number, 1 through 4	YES—Link can be used by the user's data channel NO—Link cannot be used to carry user data, even if it is installed on the IMUX-4 channel **Default: YES** (provided the link is installed on the IMUX)

4.7 Supervisory Port Configuration Parameters

Table 4-6 lists the available supervisory port configuration parameters and their functions. The table also lists the parameter values included in the IMUX-4 default configuration.

In addition to the parameters listed, the IMUX-4 supports additional parameters that can be modified only via the supervisory port. These parameters are explained in **Chapter 5**.

Table 4-6. Supervisory Port Parameters.

Designation	Function	Values
SPEED BPS	Selects supervisory port data rate	300, 1200, 2400, 4800, 9600 Supervisory port data rate (bps) AUTO Autobaud operation. The IMUX-4 automatically identifies the supervisory port data rate. To enable positive identification, the transmission must start with three consecutive Carriage Returns. **Default: AUTO**
DATA	Selects the number of data bits in the word format	7 or 8 data bits
PARITY	Controls the use of parity	ODD Odd parity EVEN Even parity NONE Parity disabled (available only with 8 data bits) **Default: NONE**
INTERFACE	Selects supervisory port interface	DCE The IMUX-4 appears as a DCE for the supervision terminal DTE The IMUX-4 operates as a DTE, for connection via modem to the supervision terminal (future option) **Default: DCE**

4.8 Operating Instructions

This section covers the following activities:

- Power-on
- Checking IMUX-4 configuration
- Normal IMUX-4 operating indications
- Monitoring IMUX-4 performance
- Power-off

4.8.1 Power-On

Set the Power switch to ON. Observe the front-panel indicators while the IMUX runs a self-test. During the self-test, the IMUX displays the software version in the format X.Y.

```
T1 IMUX-4          REV:  X.Y
SELF TEST
```

After successfully completing the self-test procedure, the IMUX-4 will switch to the default display—the ALARM BUFFER.

NOTES

1. If the IMUX-4 fails the self-test, you will see a description of the fault in the second row. In this case, the IMUX must be repaired before you use it again. Refer to Chapter 6 for instructions.

2. If the configuration data stored by the IMUX-4 is corrupted, the DATABASE CKS ERR alarm message is generated. In this case, you must initialize the database (after initialization, you can select the desired parameters again). To initialize the database, set section 3 of the internal switch SW1 to ON, power the IMUX on, and then power it off and return section 3 to OFF (refer to Chapter 3 for detailed procedures). The parameter values included in the default configuration are listed in Sections 4.4 through 4.7.

You can verify the IMUX-4 configuration as explained below. If you do not need to modify the configuration, the IMUX-4 is ready for operation immediately after it completes the self-test. To change the configuration, refer to **Section 4.9**.

4.8.2 Checking Current Operating Configuration

Review **Sections 4.4** through **4.7** for an explanation of the IMUX-4 configuration parameters.

NOTE

During the following procedure, do not press the ENTER button: This might accidentally change parameters.

1. Using the CURSOR key, bring the cursor under the top row (if it is not already there).
2. Using the SCROLL key, scroll to display SYSTEM PARAMETER in the top row. The second row will show the first system parameter, CLK MASTER, and its current selection.
3. Using the CURSOR key, bring the cursor under the left-hand field in the second row.
4. Using the SCROLL key, scroll to see the other system parameters. After each time you press the SCROLL key, the second display row shows the current value of the next system parameters. Continue until CLK MASTER appears again.
5. Using the CURSOR key, bring the cursor under the right-hand field in the top row.
6. Press the SCROLL key once to bring to display the next group of configuration parameters (the link parameters of link 1), LINK PARAM LNK1. The second row shows the first parameter of link 1, CON, and its current value.
7. Using the CURSOR key, bring the cursor under the left-hand field in the second row.
8. Using the SCROLL key, scroll to see the other parameters of link 1. After each time you press the SCROLL key, the second display row shows the current value of the next parameters. Continue until CON appears again.
9. Using the CURSOR key, bring the cursor under the right-hand field in the top row.
10. Using the SCROLL key, display LNK2 in the top row. The second row shows the first

parameter of link 2, CON, and its current value.

11. Using the CURSOR key, bring the cursor under the left-hand field in the second row.

12. Using the SCROLL key, scroll to see the other parameters of link 2. After each time you press the SCROLL key, the second display row shows the current value of the next parameters. Continue until CON appears again.

13. Repeat steps 9 through 12 for link 3.

14. Repeat steps 9 through 12 for link 4.

15. Bring the cursor under the left-hand field in the top row.

16. Bring to display the next group of configuration parameters, CH PARAMETER. The second row shows the first channel parameter, LINK 1, and its current selection.

17. Scroll to see the other channel parameters. After each time you press the SCROLL button, the second display row shows the next link. Continue until LINK 1 appears again.

18. Bring the cursor under the left-hand field in the top row.

19. Repeat steps 1 through 4 to display the supervisory port parameters—SP PARAMETER.

4.8.3 Normal Indications

Display

The normal message displayed in the top row is ALARM BUFFER. However, if no alarm is stored in the alarm buffer, the IMUX-4 will continue displaying the last user-selected display.

In addition, the IMUX-4 will automatically abort the current activity and will redisplay the ALARM BUFFER message if no front-panel button is pressed for one minute, thereby ensuring that it will not remain in an indeterminate state even if the operator does not complete a configuration activity. This does not apply to the DIAGNOSTICS display.

When the top row shows ALARM BUFFER, the second row displays the following information:

- During normal operation, the second row should show EMPTY (no alarm messages).
- If the alarm buffer contains alarms, you will see SCROLL in the left-hand field of the second row, and CLEAR in the right-hand field.

The alarms can be displayed by bringing the cursor under SCROLL, and then pressing ENTER: You can scroll between the alarms stored in the alarm buffer. To interpret the alarm messages displayed in the second row, refer to **Table 6-1**, in which you will find two types of alarms, designated as ON/OFF and ON.

- A message indicating an ON/OFF alarm is displayed only when the alarm condition is present, and is automatically removed when the condition is cleared (if the alarm is being displayed, it will disappear only when the display is refreshed by scrolling).
- A message indicating an ON alarm persists even after the event that caused the alarm condition is cleared.

If the IMUX-4 operates normally, but an alarm message of the ON type is displayed, you can clear the event alarm message from the display by the following procedure:

1. Move the cursor to the second row, under CLEAR.
2. Press ENTER to clear the event messages in the alarm buffer. If no state alarms are present, the second row should show EMPTY.

Normal Front-Panel Indications

During normal operation, all the IMUX-4 front-panel indicators located in the LINK ALARMS area, and the TEST indicator are off. Only the DTE RD and TD indicators should light to indicate data transmission on the user's data channel interface.

Fault Indications

If any of the LINK ALARMS indicators and/or the TEST indicator lights, data transfer is interrupted.

- The TEST indicator lights when a test is active. If the test is activated from the local IMUX-4, you can see the test type by entering the TEST OPTIONS (**Chapter 6**). You can disconnect a local or remote loop as explained in **Chapter 6**.

- The RED indicator of a link lights when a red alarm condition is present on the corresponding link.
- The YEL indicator of a link lights when a yellow alarm condition is present on the corresponding link.

4.8.4 Monitoring IMUX-4 Performance

The IMUX-4 continuously measures diagnostics performance data. The diagnostics data is available under DIAGNOSTICS. The measured parameters are explained in **Chapters 5** and **6**.

4.8.5 Power-Off

Set the IMUX-4 rear power switch to OFF.

4.9 Local Configuration Setup Procedure

Before starting any configuration action:

- Review the relevant configuration parameters given in **Sections 4.4** through **4.6**.
- Obtain a list of the required parameters from your network subscription data, and/or from your system administrator.

IMUX-4 configuration is set up by a simple three-step procedure:

1. Select the system parameters.
2. Select the link parameters.
3. Select the channel parameters.

When you will use a supervision terminal to control the IMUX-4, you should also select the parameters of the supervisory port.

The general configuration procedure is explained in **Section 4.9.2**.

The IMUX-4 presents only those parameters available in the selected mode, so you should perform the configuration according to the order specified above.

4.9.1 Password Protection

Configure the IMUX-4 via the supervision port, using a supervision terminal. If you cannot use a terminal to configure the IMUX, you must configure the unit from the front panel, but you must first disable the password. If the password is enabled, you can use the IMUX front panel to display the current parameter values, but you cannot modify them. If you try to modify a parameter or perform a test function when the password is enabled, you will see CONFIG ERROR 11.

When the IMUX-4 uses the default parameters values, the use of the password is disabled (to load the default parameters, use the DBINI section of the internal switch SW1, as explained in **Section 3.4**.) You can enable or disable the use of the password via the supervision terminal, by entering the DEF SP command (refer to **Chapter 5** for detailed instructions).

4.9.2 General Configuration Procedure

Follow these steps to perform any configuration activity:

NOTE

1. Before starting the configuration procedure, always disconnect all the user-initiated loopbacks (select OFF on TEST OPTIONS).

2. Refer to Section 4.10 for an explanation of the configuration error messages the IMUX-4 displays when you make an error.

1. Using the CURSOR key, bring the cursor under the top row (if it is not already there).
2. Scroll to display the desired group of parameters in the top row. The second row shows the first parameter in the selected group and its current value.

NOTE

When the desired group of parameters must be independently selected for each link, the top row indicates an additional field (at the rightmost side of the top row): This field is used to select the desired link number. In this case, use the CURSOR key to bring the cursor to the rightmost field, then SCROLL to show the desired link number.

3. When the second row has more than one field, bring the cursor under the left-hand field (parameter name) in the second row, and then scroll to display the desired parameter in the selected group. The second row shows the parameter name and its current value.

4. Bring the cursor under the right-hand field (the parameter value) in the second row.

5. Scroll to set the required value for the displayed parameter. The second row shows the available values.

6. When the desired parameter value is displayed, select the new parameter value. The cursor returns to the first field in the top row. The second row displays CONFIG ENTER momentarily, then returns to the normal display.

NOTE

You must press ENTER after changing parameters of a certain group—for example, SYSTEM, LINK, etc. If you change parameter values, but return the cursor to the first field and scroll to another group without pressing ENTER, the changes are discarded and you will see the message CONFIG LOST.

7. Repeat steps 3 through 6 until values are assigned to all the parameters in the group. The second row shows the current selection.

8. Repeat steps 1 through 7 until values are assigned to all the parameters in the desired groups. The second row shows the current selection.

9. After completing the configuration actions, you can use steps 1, 2 to return to the ALARM BUFFER. If alarm messages are stored in the ALARM BUFFER, ALARM BUFFER will be automatically displayed if no pushbutton is pressed for one minute.

4.9.3 Specific Configuration Guidelines

This section presents specific configuration guidelines for selecting parameter values. You may also wish to refer to **Section 2.2**, which provides a concise description of the IMUX-4 operating environment, including explanations for many of the relevant terms.

System Parameters

See parameter definition in **Section 4.4**.

- *CLK MASTER*—For connection to carrier lines, select any one of the connected links: LNK1, LNK2, LNK3, or LNK4. If a station clock is available, you may also select ST. For a point-to-point application with standalone equipment at both link ends, you can also select INT (or ST, if available) at one end and LNK1, LNK2, LNK3, or LNK4 at the other end.

- *CLK FBACK*—Select a source different from that selected as master. To disable switching to the fallback source, select NONE. In this case, the default fallback clock source is the IMUX-4 internal clock oscillator.

LINK PARAM

For each link, select the following parameters. See parameter definitions in **Section 4.5**.

- *CON*—For an active link, select YES. The number of active links determines the user's channel data rate (the user's channel data rate is *n* x 1.472 Mbps, where *n* is the total number of active links). Make sure you connect the required number of links using the CH PARAMETER function.

- *FRAME*—Select the framing mode specified for use in your network. In general, always select ESF unless the T1 equipment connected to the IMUX-4 does not support this mode.

- *SYNC*—Select FAST, unless your application requires exact conformance with AT&T TR-62411 requirements.

- *I_TS_CODE*—Select the value specified for your network.
- *CODE*—Select the framing mode specified for use in your network. For point-to-point applications, B8ZS should be used whenever supported by the carrier.
- *MASK*—Select in accordance with the required link operating mode, and the hardware installed on the link interface.

If the link interface does not include a CSU:

- For compliance with DSX-1 specifications per AT&T CB-119 and ANSI T1.102-1987, select the value corresponding to the length of the cable (in feet) connected between the T1 LINK connector and network entry point.
- For compliance with FCC Rules Part 68, select FCC68.

If the link interface includes a CSU, you must adjust the T1 output transmit level, for reliable operation of the network, and for compliance with FCC Rules Part 68. This adjustment minimizes the interference caused by your transmit signal to other users that transmit their signals on other pairs of the same cable.

The required setting depends mainly on the length of the cable that connects your IMUX-4 to the first repeater down the link. Repeaters are usually located every mile, and therefore, they are designed to optimally handle signals attenuated by a one-mile length (about 1.6 km) of cable. If your IMUX-4 is closer, the repeater would receive your signal at a higher level. This will not significantly improve the handling of your signal, but will certainly increase the interference coupled from your pair to repeaters that serve other pairs in the cable.

To prevent this, you can select an attenuation value that will bring your signal level closer to the expected repeater signal level. You can do this by connecting, as required, one, two, or three artificial line sections in series with your T1 transmit signal. Each line section introduces a nominal attenuation of 7.5 dB (equivalent to the attenuation of approximately 1000 feet of cable). Your system administrator or data carrier will tell you what is the proper setting for your IMUX-4.

CH PARAMETER

For each link, select YES if you want to enable its use. See parameter definitions in **Section 4.6**.

You must select YES for a total number equal to the number of links selected as active by means of the LINK PARAM function.

SP PARAMETERS

See parameter definitions in **Section 4.6**.

- *SPEED_BPS*—Select AUTO whenever feasible. In this case, start the communication with three Carriage Returns, to ensure positive identification of terminal data rate.

NOTE

Repeat the automatic baud-rate recognition procedure after you switch the DTR line in the DTE front-panel connector to OFF and then ON again.

- *DATA*—Select the required number of data bits (same as on the terminal).
- *PARITY*—Select the required parity (same as on the terminal).
- *INTERFACE*—Select DCE when directly connected to the supervision terminal. Select DTE when connected to a modem (future option).

NOTE

The INTERFACE parameter only changes the direction of the interface control (handshaking) signals, but not the functions of the interface pins. When connecting to a modem, you must use a crossover cable.

4.10 LCD Configuration Error Messages

The IMUX-4 detects configuration errors and displays a CONFIG ERROR XY message. The code XY identifies the error. You will find below the list of error messages and instructions that will help you correct the problem.

- CONFIG ERROR 1—You are trying to select the same source as both master and fallback clock source. Check and change as required.
- CONFIG ERROR 2—You are trying to select as clock source a link that is not connected to the IMUX-4. Check and change as required.
- CONFIG ERROR 3—Illegal combination of loopbacks: You are trying to activate simultaneously local and remote loopbacks on links and on the data channel, or a network-activated loopback may already be activated. Only one loopback can be connected at a time.
- CONFIG ERROR 4—Reserved.
- CONFIG ERROR 5—You are trying to map a link that is not active.
- CONFIG ERROR 6—You are trying to activate a link that is not connected to the IMUX-4. Check and change as required.
- CONFIG ERROR 7—You are trying to disconnect a link that has been selected as clock source, or a link that is mapped to the user's data channel. Check and change as required.
- CONFIG ERROR 8—You are trying to disconnect a loopback that is not active.
- CONFIG ERROR 11—You are trying to change a parameter from the front panel when the password is enabled.

5. Control of T1 IMUX-4 Operation from the Supervisory Port

5.1 General

This chapter provides instructions for the control of the T1 IMUX-4 operation from a supervision terminal connected to the IMUX-4 supervisory port. This chapter contains the following:

- Description of supervision terminal hardware requirements, communication, and handshaking—**Section 5.2**.
- Preparation for use of supervision terminal—**Section 5.3**.
- Description of supervision terminal set of commands and command syntax—**Section 5.4, 5.5**.
- General operating instructions, including start-up, routine operations, and stopping of remote control—**Section 5.6**.
- Configuration error messages—**Section 5.7**.

5.2 Hardware Requirements

5.2.1 Terminal Characteristics

Any standard ASCII terminal ("dumb" terminal or personal computer emulating an ASCII terminal) equipped with an RS-232 communication interface can be used to control IMUX-4 operation. The software you need to run the IMUX-4 supervision program is contained in the IMUX-4.

5.2.2 Communication Requirements

The supervision terminal can be connected either directly to the IMUX-4 supervisory port, or through a modem or any other type of full-duplex data link. The IMUX-4 supervisory port interface type must be set according to the connection method (see **Section 4.7**):

- DCE for direct connection
- DTE for connection through a modem or data link (cross cables must then be used at the IMUX-4 DTE front-panel connector)

The IMUX-4 can communicate with the supervision terminal at rates of 300, 1200, 2400, 4800, or 9600 bps. The word format consists of one stop bit and 7 or 8 data bits. Parity can be odd, even, or disabled.

The communication interface of the terminal and the IMUX-4 must be configured for operation with the same parameters.

The IMUX-4 supports two types of modems:

- Dial-up Hayes compatible modems. The IMUX-4 can accept external calls, but cannot initiate calls.
- Multidrop modems.

For multidrop operation, each IMUX-4 can be assigned a node address in the range of 1 through 255. Assigning address 0 to the IMUX-4 means that it will accept and answer any message: This is not permitted in multidrop operation. We recommend address 0 for use with both point-to-point and dialup modes.

Each IMUX-4 can be assigned a logical name of up to eight characters. The logical name is sent in each transmission of alarm messages. The name helps the operator to identify the source of messages that are received by the supervision terminal.

The relevant IMUX-4 configuration parameters are described in **Section 4.6** and **5.5**. Instructions for configuring the supervisory port appear in **Section 4.9**.

5.2.3 Handshaking Protocol

The handshaking between the IMUX-4 and the supervision terminal uses the control lines in the DTE connector located on the front panel of the IMUX-4.

The control lines being used in each mode and the direction of the control signals is detailed below.

Control Lines.

	Interface Type	DCE	DTE
Control Line	CTS	Out	Not used
	DCD	Out	Out
	DSR	Out	Out
	DTR	In	In
	RI	Not used	In
	RTS	In	In

Data Terminal Ready (DTR)

The terminal sets the DTR line ON (active) to gain control over the IMUX-4 and start a configuration/monitoring session.

When DTR is ON, the front-panel controls are disabled, and the LCD shows:
TERMINAL ON LINE.

The DTR line is OFF (inactive) when terminal control is not required. This ends the terminal-control connection, and returns the control to the IMUX-4 front panel. If password protection is used, the password must be entered again the next time the DTR line is set ON to start a new session.

Request to Send (RTS)

The RTS line is normally ON (active) when the supervision terminal is in session.

When the RTS line is OFF (inactive), the IMUX-4 interprets any data received from the terminal on the TD line as MARK.

Clear to Send (CTS)

The state of the CTS line is determined by the CTS parameter:

- *ON*—The CTS line is always ON (active).
- *=RTS*—The CTS line follows the RTS line.

Data Carrier Detect (DCD)

The state of the DCD line depends on the communication address (node number):

- When the node address is 0, the DCD line is always ON (active).
- When a non-zero mode address is used, the DCD line becomes ON (active) when data is detected on the RD line if the IMUX-4 recognizes its own address in the data stream.

To simulate DTE operation, you can set the delay between these events (via the DCD-DELAY parameter).

Ring Indication (RI)

The RI line is used only with dialup modems (INT=DTE). The RI line is normally OFF (inactive), and switches to the ON (active) state when the modem attached to the IMUX-4 front-panel DTE connector detects an incoming call. See also the DSR line.

Data Set Ready (DSR)

- Usually, the DSR line is configured to track the DTR line. In this case, if the supervisory port interface is DTE, the DSR line will be set to ON for 5 seconds when the RI line is ON while the DTR line is OFF.
- If the supervisory port interface is DCE, the DSR line can also be configured to be continuously ON. However, if the DTR line switches to OFF, the DSR line will also switch to OFF for 5 seconds.

In addition, the IMUX-4 always sets DSR OFF (inactive) for 5 seconds when the EXIT command is executed, or the disconnect timeout expires.

5.2.4 AUTOBAUD FUNCTION

When the AUTOBAUD function is enabled, the IMUX-4 can identify the operating data rate of the terminal by analyzing the timing of three consecutive Carriage Return + Line Feed characters (generated by pressing the carriage return key three times). The detected data rate is then used for the current communication session.

The automatic baud rate identification procedure is performed (or repeated) whenever three consecutive carriage returns are received after one of the following events occurs:

- The DTR line has been switched OFF.
- The EXIT command has been executed.
- The idle disconnect timeout expired because no data has been exchanged with the supervision terminal.

In case one of these events occurred, the IMUX-4 assumes that the current communication session has been terminated. Therefore, when the password protection is enabled, you must enter the password again before the supervision terminal can resume communication with the IMUX-4.

5.3 Preparing for Use of Supervision Terminal

5.3.1 T1 IMUX-4 Preparations

Internal Settings

See **Section 3.4** for detailed instructions.

NOTE

In general, you must enter a password when you start a control session. If the password is incorrect, the IMUX-4 will not respond. To correct this, set the PASSW section of SW1 as follows.

- *OFF*—In this position, you can define your own password and node address.
- *ON*—Set the switch section to ON to restore the default IMUX-4 password (**IMX**), and change the node address to the default value of 0. The change will be made after you turn the IMUX-4 off for a short time, and then turn it back on again.

Supervisory Port Configuration

Configure the IMUX-4 supervisory port as required. See **Section 4.7** through **4.9**.

If the supervisory port parameters are not correct, the IMUX-4 will not respond. To correct this, set the DEFSP section of SW1 as follows:

- *OFF*—In this position, you can define the desired supervisory port parameters.
- *ON*—Set the switch section to ON to restore the default supervisory port parameters. The change will be made after you turn the IMUX-4 off for a short time, and then turn it back on again.

5.3.2 Supervision Terminal

Configure the terminal for the same communication parameters you selected for the IMUX-4 supervisory port.

5.3.3 Connections

Connect the supervision cable (coming directly from the terminal, or from the modem used to connect the terminal) to the front-panel DTE connector of the IMUX-4. See **Appendix A** for cable wiring information.

Power the supervision terminal on and, when applicable, power on the modems and the other communication equipment used to connect the terminal to the IMUX-4.

5.4 IMUX-4 Supervision Language

This section presents the syntax, usage, and set of commands for the IMUX supervision language.

5.4.1 Command Language Syntax

- Commands can be entered only when the IMUX-4 supervisory port prompt is displayed. The prompt is **IMX-4T1**>, and it always appears at the beginning of a new line. The cursor appears to the right of the prompt.
- Commands are case-insensitive. For example, you can type commands in either lower-case or upper-case letters.
- To correct typing errors, backspace by pressing the BACKSPACE key until the error is cleared, and then type the correct command again.
- Use space as a separator between command fields and between parameters.
- Commands must end with a carriage return <CR>.
- To cancel the current command, press BREAK or type CTRL-C. You will again obtain the IMX-4T1 prompt.

5.4.2 Command Options

The types of options shown in **Table 5-1** are available with some commands. See details in the command set index, **Table 5-2**.

Table 5-1. General Types of Options Available With Some Commands.

Option	Meaning	Example of Usage
/A	All	CLR ALM /A Clears all the alarms stored by the alarm buffer.
/C	Clear	DSP ALM /C Displays all the alarms stored by the alarm buffer, and then clears all the alarms in the ON state stored by the alarm buffer.
/CA	Clear all	DSP ALM /CA Displays all the alarms stored by the alarm buffer, and then clears all the alarms stored by the alarm buffer.
/R	Repeat command execution automatically. Available only when node address is 0.	DSP ST LINK /R Enables you to monitor the status of link 1.

5.4.3 Command Protocol

- If AUTOBAUD is on, start any session by pressing the <CR> key three times in sequence. This will ensure identification of terminal data rate.
- When the IMUX-4 uses a non-zero node address, it expects an address before responding to the terminal commands. No response will occur until the node number is received and acknowledged by the addressed IMUX-4.

  Acknowledgment is indicated by the echoing of the node address part—for example, **Node<SP>nnn<SP>**, where <SP> stands for space.
- The address is in the range of 1 through 255 (0 indicates that the selective addressing function is disabled). The address is a prefix sent in the following format:
  Node<SP>nnn<SP>.
- When password protection is on, the addressed IMUX-4 waits for the password before continuing. After the correct password is received, the IMUX-4 sends the working prompt, **IMX-4T1>**.

  If password protection if off, this step is omitted and the working prompt appears after the node address conditions are fulfilled.
- After the working prompt is displayed, every character typed on the terminal keyboard is immediately evaluated by the IMUX-4 and echoed to the terminal screen. Full-duplex communication with the terminal is therefore necessary, to provide online feedback to the terminal operator.
- Command evaluation starts only when you press the <CR> key.

- In case an error is detected during command evaluation, the command is not executed. Instead, the IMUX-4 will send the erroneous command back to the terminal, and you will see **BAD COMMAND OR PARAMETER. TYPE 'H' FOR HELP** in the next row. You must then send the correct command again.
- The command is executed only after it is validated.
- You can interrupt command execution by pressing BREAK or CTRL-C. The IMX-4T1 prompt will be displayed, and you can enter a new command.

  Use the BREAK key (or CTRL-C) to stop the commands from automatically repeating (/R option).
- If an idle disconnect timeout is specified, the IMUX-4 will automatically disconnect the ongoing session if no command is received from the terminal for the specified timeout interval.

5.4.4 Index of Commands

Table 5-2 lists the IMUX-4 commands in alphabetical order.

Table 5-2. T1 IMUX-4 Command Set Index.

Command	Purpose	Options
BERT OFF	Deactivate the BER test on the IMUX-4.	
BERT ON	Activate the BER test on the IMUX-4.	
CLR ALM	Clear the alarms stored in the IMUX-4 alarm buffer.	/A
CLR LOOP L CH CLR LP L CH CLR LOOP R CH CLR LP R CH	Clear user-initiated loopbacks on the user's data channel.	
CLR LOOP L LINK CLR LP L LINK CLR LOOP R LINK CLR LP R LINK	Clear user-initiated loopbacks on the IMUX-4 links.	
CLR TST	Clear all the user-initiated tests and loopbacks.	
DATE	Set the date for the IMUX-4 internal clock.	
DEF CH	Define the link connections.	
DEF LINK X	Define the link parameters. The parameters can be defined for a specified link, or simultaneously for all the links. X stands for the link identification, 1 through 4.	/A
DEF NAME	Define the logical name of the IMUX-4.	
DEF NODE	Define the node number of the IMUX-4.	

Table 5-2. T1 IMUX-4 Command Set Index.

Command	Purpose	Options
DEF PWD	Define new password.	
DEF SP	Define supervisory port parameters.	
DEF SYS	Define system parameters.	
DSP ALM	Display the contents of the alarm buffer and optionally clear the buffer.	/C /CA
DSP BERT	Display the last results (errored seconds) of the on-going BER test.	/R /C
DSP CH	Displays the current IMUX-4 link use, the user-data-channel interface type, and the state of the loops on the user's data channel.	
DSP HDR TST	Display hardware faults (detected during the power-on self-test, and during normal operation).	
DSP PM X	Display the contents of the performance monitoring registers, and optionally clear these registers. X stands for the link identification, L1 through L4.	/C /CA
DSP ST LINK X	Display status information on the selected link (link interface type and function, and link error events counters), and optionally clear the link error events counters. X stands for the link identification, 1 through 4.	/R /C
DSP ST LINK X	Display status information on the selected link (link interface type and function, and link error events counters), and optionally clear the link error events counters. X stands for the link identification, 1 through 4.	/R /C
DSP ST SYS	Display system status information (node name and number, software and hardware versions, and clock source).	
EXIT	End the current control session.	
F	Select the codes for the "clear the screen," "cursor right," and "cursor home" commands sent to the supervisory terminal.	
HELP	Displays a concise index of commands and option switches.	
INIT DB	Load the default configuration instead of the user configuration. **Table 5-4** lists default parameter values.	

Table 5-2. T1 IMUX-4 Command Set Index.

Command	Purpose	Options
INIT F	Reset the codes for “clear the screen,” “cursor right,” and “cursor home” to 0.	
LOOP L LINK LP L LINK LOOP R LINK LP R LINK	Activate a specified user-controlled loopback on the IMUX-4 links.	
LOOP L CH LP L CH LOOP R CH LP R CH	Activate a specified user-controlled loopback on the user’s data channel.	
NODE	Send the node address to the IMUX-4, followed by the node address itself.	
RESET	Reset the IMUX-4 system.	
TIME	Set the time of the IMUX-4 internal clock.	

5.5 IMUX-4 Command Set Description

This section describes the IMUX-4 commands. The commands are listed in alphabetical order. The description includes command format, use, and options.

The following notation conventions are used:

[ ] square brackets indicate optional entry/parameter

‘ ’ single quotes delimit user entry

<CR> indicates the pressing of the carriage return key

X identifies the link (1 for link 1, 2 for link 2, 3 for link 3, 4 for link 4)

BERT OFF

- *Purpose*—Deactivate (stop) the BER test.
- *Format*—BERT OFF
- *Use*—

1. To deactivate the BER test, type:

   BERT OFF<CR>

2. You will see the time and date, followed by the IMX-4T1 prompt.

BERT ON

- *Purpose*—Activate the BER test. To perform the BER test, you must activate a loopback at the appropriate location along the signal paths, or to activate the BER test at both ends of the link.
- *Format*—BERT ON
- *Use*—

1. To activate the BER test, type:

   BERT ON<CR>

2. You will see the time and date, following by the IMX-4T1 prompt.

CLR ALM

- *Purpose*—Clear the alarm buffer.
- *Format*—CLR ALM [/A]
- *Use*—

1. To clear only alarms of the ON type stored in the alarm buffer (see **Table 5-2**):

   CLR ALM<CR>

2. To clear all the alarms stored in the alarm buffer (including ON/OFF alarms):

   CLR ALM /A<CR>

3. You will see the time and date, followed by the IMX-4T1 prompt.

CLR LOOP CH

- *Purpose*—Deactivate the specified user-initiated loopback on the user’s data channel.
- *Format*—CLR LOOP [looptype] CH or CLR LP [looptype] CH
- *Use*—

1. To deactivate a local (L) or a remote (R) loopback on the IMUX-4 user’s data channel:

   CLR LOOP L CH<CR>

   CLR LOOP R CH<CR>

2. You will see the time and date, followed by the IMUX-4 prompt.

3. If no loopback of the specified type is now activated, you will receive ERROR 8.

CLR LOOP LINK

- *Purpose*—Deactivate the specified user-initiated loopback on the IMUX-4 links.
- *Format*—CLR LOOP [looptype] LINK or CLR LP [looptype] LINK
- *Use*—

1. To deactivate a local (L) or a remote (R) loopback on the IMUX-4 links, type:

   CLR LOOP L LINK<CR>

   CLR LOOP R LINK<CR>

2. You will see the time and date, followed by the IMUX prompt.

3. If no loopback of the specified type is now activated, you will receive ERROR 8.

CLR TST

- *Purpose*—Deactivate all the user-initiated tests and loopbacks on the IMUX-4.
- *Format*—CLR TST
- *Use*—

1. To deactivate all the user-initiated tests and loopbacks, type:

   CLR TST<CR>

2. You will see the time and date, followed by the IMUX-4 prompt.

3. If no test or loopback is now activated, you will receive ERROR 8.

DATE

- *Purpose*—Set the date for the IMUX-4 internal real-time clock.
- *Format*—DATE
- *Use*—

1. Type

   DATE<CR>

2. The IMUX-4 sends the date entry form:

   Date
   Day=06
   Month=09
   Year=1994

3. Bring the cursor to the first field to be changed by pressing <CR>.

4. To change the selected field, press F to increase and B to decrease the displayed values. When done, press <CR> to move to the next field.

5. To end, press <CR> after the YEAR field. The IMUX-4 will display the TIME and DATE fields (note that DATE has changed), followed by the IMUX-4 prompt.

DEF CH

- *Purpose*—Define the IMUX-4 link connections. See **Section 4.9** for practical selection recommendations.
- *Format*—DEF CH
- *Use*—

1. To define the link connectivity data form, type:

   DEF CH<CR>

2. You will see the link connectivity data form. A typical display is shown below.

LNK-1	LNK-2	LNK-3	LNK-4
YES	YES	YES	YES

3. The data form includes one field for each link. The field shows the current connection status:

- NO—link is not used.
- YES—link is used.

4. To change the link status, use the following procedure:

- Bring the cursor to the beginning of the desired field by pressing the space bar.
- Select between NO and YES by pressing F or B.

5. After updating the link status, press <CR> to end. The IMUX-4 will display the TIME and DATE fields, followed by the IMUX-4 prompt.

DEF LINK

- *Purpose*—Assign values to the link parameters for a selected IMUX-4 link.

  See **Section 4.5** for parameter description and allowable ranges, and **Section 4.8** for practical selection recommendations.

- *Format*—DEF LINK [link]
- *Use*—

1. To define the parameters of link 1, type:

   DEF LINK 1<CR> or DEF LINK<CR>

   To define the parameters of another link, type:

   DEF LINK X<CR>

   where X stands for the link identification (2, 3, or 4).

2. To define the parameters of all the installed links, type:

   DEF LINK /A<CR>

3. The link parameters data form for the selected link is displayed. A typical display is shown below.

```
CON  FRAME  CODE  MASK  SYNC  IDLE_TS_CODE
YES  ESF    B8ZS  000   FAST  3F
```

4. Change the parameter values as follows:

- Bring the cursor to the beginning of the first field to be changed by pressing the space bar.
- To change the selected field, press F or B to scroll among the available selections. When the desired selection is displayed, press the space bar to move to the next field.

5. After the desired parameter values are selected, press <CR> to display the second page of the link parameters data form. Change the parameter values as explained above.

6. After the desired parameter values are selected, press <CR> to end. The IMUX-4 will display the TIME and DATE fields, followed by the IMUX-4 prompt.

DEF NAME

- *Purpose*—Define the node name (up to eight alphanumeric characters).
- *Format*—DEF NAME
- *Use*—

1. To define the IMUX-4 node name, type:

   DEF NAME<CR>

2. The IMUX-4 displays the node name entry form:

   ENTER NODE NAME (MAX 8 CHARACTERS)

   CURRENT NODE NAME='name'

   where 'name' is the node name the IMUX-4 is currently assigned.

3. Type the desired name, and then press <CR>. The IMUX-4 will display the TIME and DATE fields, followed by the IMUX-4 prompt.

NOTE

Before entering a node name, make sure that section 1, PASSW, of the IMUX-4 internal switch SW1 is not set to ON, because in such a case the default name (blank) is enforced.

DEF NODE

- *Purpose*—Define the node number, or address, of the IMUX-4. The allowed range is 0 to 255.
- *Format*—DEF NODE
- *Use*—

1. To define the IMUX-4 node number, type:

   DEF NODE<CR>

2. The IMUX-4 displays the node entry form:

   NODE (0 to 255)=0

3. Type the desired number in the range of 0 to 255, and then press <CR>. The IMUX-4 will display the TIME and DATE fields, followed by the IMUX-4 prompt.

NOTE

Before entering a node number, make sure that section 1, PASSW, of the IMUX-4 internal switch SW1 is not set to ON, because in such a case the default number (0) is enforced.

DEF PWD

- *Purpose*—Define a new user password for the IMUX-4. The password must have 4 to 8 characters.
- *Format*—DEF PWD
- *Use*—

1. Type

   DEF PWD<CR>

2. The password entry screen appears:

   NEW PASSWORD (4 to 8 CHARS)=
   CURRENT PASSWORD='password'

   where 'password' is the current password.

3. Type the required password. Carefully check that the specified password has been indeed typed in, and then press <CR>. The IMUX-4 will display the TIME and DATE fields, followed by the IMUX-4 prompt.

NOTE

Before entering a new password, make sure that section 1, PASSW, of the IMUX-4 internal switch SW1 is not set to ON, because in such a case the default password (IMX) is enforced.

DEF SP

- *Purpose*—Assign values to supervisory port parameters. See **Section 4.7** for parameter description and allowable ranges, and **Section 4.9** for practical selection recommendations.
- *Format*—DEF SP
- *Use*—

1. Type

   DEF SP<CR>

2. The first page of the supervisory port parameters data form is displayed. A typical form is shown below. The form presents the current parameter values as defaults.

SPEED	DATA	PARITY	INTERFACE	CTS	DCD_DEL	DSR
AUTO	8	NO	DCE	=RTS	0_MSEC	ON

3. Change the parameter values as follows:

- Bring the cursor to the beginning of the first field to be changed by pressing the space bar.
- To change the selected field, press F or B to scroll among the available selections.
- When the desired selection is displayed, press the space bar to move to the next field.

4. When done, press <CR> to display the next page of supervisory port parameters. A typical form is shown below.

POP_ALM	PWD	LOG_OFF
NO	NO	NO

5. Repeat the procedure given in step 3 above to select new parameter values.

NOTES

In addition to the parameters listed in Section 4.6, the following parameters can be programmed only from the terminal:

PWD—Password protection: select YES or NO

LOG_OFF—Idle disconnect time:
NO: automatic session disconnection disabled.
10_MIN: automatic disconnection after ten minutes if no input data is received by the IMUX-4.

CTS—Determines CTS state:
ON: The CTS line is always ON (active).
=RTS: The CTS line follows the RTS line.

DCD_DEL—With IMUX-4 supervisory port defined as DTE, indicates delay (in msec) between DCD=ON and the sending of data. Values: 0, 10, 50, 100, 200, 300 msec.

POP_ALM—Controls the automatic display of alarms in the terminal.
YES: The terminal automatically displays every 10 minutes the alarm status (or whenever an alarm changes state to ON)
NO: The automatic display feature is disabled.

DSR—Determines the DSR state:
ON: The DSR line is continuously on. It will switch to OFF for five seconds after the DTR line is switched OFF.
DTR: The DSR line tracks the DTR line. When INTERFACE=DTE, the DSR line will switch to ON for five seconds when the RI line is ON while the DTR line is OFF.

6. After the desired parameter values are selected, press <CR> to end. The IMUX-4 will display the TIME and DATE fields, followed by the IMUX-4 prompt.

DEF SYS

- *Purpose*—Assign values to system parameters. See **Section 4.4** for parameter description and allowable ranges, and **Section 4.9** for practical selection recommendations.
- *Format*—DEF SYS
- *Use*—

1. Type

   DEF SYS<CR>

2. The system parameters data form is displayed. A typical form is shown below. The form presents the current parameter values as defaults.

CLK_MASTER	CLK_FBACK
INT	NONE

3. Change the parameter values as follows:

- Bring the cursor to the beginning of the first field to be changed by pressing the space bar.
- To change the selected field, press F or B to scroll among the available selections.
- When the desired selection is displayed, press the space bar to move to the next field.

4. After the desired parameter values are selected, press <CR> to end. The IMUX-4 will display the TIME and DATE fields, followed by the IMUX-4 prompt.

DSP ALM

- *Purpose*—Display the contents of the alarm buffer. This buffer can contain up to 100 alarms.
- *Format*—DSP ALM [Option]
- *Use*—

1. To display the complete contents of the buffer, type:

   DSP ALM<CR>

2. To display the complete buffer contents and then clear the type-ON alarms, type:

   DSP ALM /C<CR>

3. To display the complete buffer and then clear all the stored alarms, type:

   DSP ALM /CA<CR>

- *Display Format*—The contents of the alarm buffer are displayed as a table with four columns: the alarm record number, the alarm number and alarm syntax (description), the alarm status, and the time of occurrence. Each block of alarms received from a IMUX-4 is preceded by a header. The header lists the assigned node name and the node number of the IMUX-4 unit that sent the alarm block, and thus it serves as an easily-identified separator between alarms transmitted by different IMUX-4 units.

  Table 5-3 lists all the alarm messages that can be displayed by the terminal. "X" stands for the link identification, 1, 2, 3, or 4.

Table 5-3. Supervision Terminal Alarm Messages.

Alarm No.	Alarm Syntax	Meaning	Status	Time
01	SIGNAL LOSS, LNK:X	Loss of input signal on link X.	[ON]	hh:mm:ss
02	BPV ERROR, LNK:X	A bipolar violation error has been detected on linkX.	[ON]	hh:mm:ss
03	FRAME SLIP, LNK:X	A frame slip occurred on link X.	[ON]	hh:mm:ss
04	NETWORK LLB, LNK:X	A network-activated line loopback is currently activated on link X.	[ON][OFF]	hh:mm:ss
05	NETWORK PLB, LNK:X	A network-activated payload loopback is currently activated on link X.	[ON][OFF]	hh:mm:ss
06	EXCESSIVE BPV, LNK:X	The rate of bipolar violation errors on link X is too high.	[ON][OFF]	hh:mm:ss
07, 08	Reserved for future use			
09	AIS OCCURRED, LNK:X	AIS is being detected on link X.	[ON][OFF]	hh:mm:ss
10	AIS RED ALARM, LNK:X	AIS and loss of frame alignment on link X.	[ON][OFF]	hh:mm:ss
11	RED ALARM, LNK:X	Local loss of frame alignment on link X.	[ON][OFF]	hh:mm:ss
12	DB CHECKSUM ERROR	The database currently stored in the non-volatile memory of IMUX-4 is corrupted. Message can appear only upon power-on.	[ON]	hh:mm:ss
13	ALARM BUFFER OVERFLOW	The IMUX-4 alarm buffer is full, and new alarms overwrite the older alarms.	[ON][OFF]	hh:mm:ss
14	CLOCK WAS CHANGED TO FALLBACK	The main clock source of the IMUX-4 failed, and the IMUX-4 switched to the clock source selected as fallback	[ON]	hh:mm:ss

Table 5-3. Supervision Terminal Alarm Messages.

Alarm No.	Alarm Syntax	Meaning	Status	Time
15	CLOCK WAS CHANGED TO INTERNAL	The current clock source of the IMUX-4 failed, and the IMUX-4 switched to the internal oscillator.	[ON]	hh:mm:ss
16	SELF TEST ERROR	A fault has been detected during the power-on self-test.	[ON]	hh:mm:ss
17	HARDWARE FAILURE	A hardware fault has been detected.	[ON]	hh:mm:ss
18	PSWRD SWITCH IS ON	Section 1, PASSW, of switch SW1 is set to ON.	[ON]	hh:mm:ss
19	SP-PAR SWITCH IS ON	Section 2, DEFSP, of switch SW1 is set to ON.	[ON]	hh:mm:ss
20	DB-INIT SWITCH IS ON	Section 3, DBINI, of switch SW1 is set to ON.	[ON]	hh:mm:ss
21	REAL TIME CLOCK BATTERY FAILURE	The battery that powers the IMUX-4 internal real-time clock is not powered or has failed.	[ON]	hh:mm:ss
22	YELLOW ALARM, LNK:X	The remote unit connected to the other end of link X reports loss of frame alignment.	[ON][OFF]	hh:mm:ss
23	LINK1 RECEIVES LINK2 LINK1 RECEIVES LINK3 LINK 1 RECEIVES LINK4 LINK2 RECEIVES LINK1 LINK2 RECEIVES LINK3 LINK2 RECEIVES LINK4 LINK3 RECEIVES LINK1 LINK3 RECEIVES LINK2 LINK3 RECEIVES LINK4 LINK4 RECEIVES LINK1 LINK4 RECEIVES LINK2 LINK4 RECEIVES LINK3	The IMUX-4 detected incorrect link connections (interchange between the specified links connected to its interfaces).	[ON]	hh:mm:ss

DSP BERT

- *Purpose*—Display the BER test results while a BER test is being performed.

  The BER test results are given as the number of errored seconds detected since the BER test has been started, or since the results have been last cleared (the latter of the two events).

  The errored seconds counter range is 0 through 63555. If the count exceeds the maximum count, the counter continues showing 65535 (an overflow message will be displayed).

- *Format*—DSP BERT [Option]

- *Use*—

1. To display the current BER test results, type:

   DSP BERT<CR>

2. To monitor continuously the BER test results, type:

   DSP BERT /R<CR>

   The display will be continuously updated. To stop the monitoring, press the BREAK key (or CTRL+C).

4. To display the current BER test results and then clear the counter, type:

   DSP BERT /C<CR>

DSP CH

- *Purpose*—Display the current IMUX-4 link connections, the data channel interface type, and the state of the loops on the user's data channel.

- *Format*—DSP CH

- *Use*—

1. To display the link connectivity data form, type:

   DSP CH<CR>

2. You will see the link connectivity data form. A typical display is shown below.

```
STATUS OF CHANNEL
LNK-1  LNK-2  LNK-3  LNK-4  INTERFACE
YES    YES    YES    YES    V.35

CH LOOPS:  LOCAL      REMOTE
             NO         NO
```

3. The data form includes one field for each link. The field shows the current connection status:

- NO—link is not used.

- YES—link is used.

4. For the user's data channel, the form lists the data channel interface type, and the state of the loops:

- NO—loop not connected.

- YES—loop connected.

DSP HDR TST

- *Purpose*—Display the results of the last hardware test (made during power-on self-test and during regular operation).

- *Format*—DSP HDR TST

- *Display Format*—The display has one field that shows NO HARDWARE FAILURE if everything checks good, or lists the detected problem:

- DATABASE FAILURE

- EPROM FAILURE

- I/O EXPANDER ERROR

- COUNTER ERROR

DSP PM

- *Purpose*—Display the contents of the performance-monitoring registers specified by AT&T Pub. 54016. This option is available only on T1 links with ESF framing. For an explanation of the performance-monitoring registers, refer to **Section 6.3**.

- *Format*—DSP PM X[Option]

- *Use*—

1. To display the performance-monitoring registers of link 1, type:

DSP PM L1<CR> or DSP PM<CR>

To display the performance-monitoring registers of link 1, and clear only the event register of link 1, type:

DSP PM L1 /C<CR> or DSP PM /C<CR>

To display the performance-monitoring registers of link 1, clear all the performance monitoring registers of link 1, and restart the count intervals, type

DSP PM L1 /CA<CR> or DSP PM /CA<CR>

2. To display the performance-monitoring registers of another link, type:

DSP PM X<CR>

where X stands for the link identification, L2, L3, or L4.

To display the performance-monitoring registers of another link, and clear only the event register of another link, type:

DSP PM X /C<CR>

where X stands for the link identification, L2, L3, or L4.

To display the performance-monitoring register of another link, clear all the performance monitoring registers of another link, and restart the count intervals, type

DSP PM X /CA<CR>

where X stands for the link identification, L2, L3, or L4.

3. If the current framing mode is SF (D4), you will receive an error message (illegal command for current link mode).

- *Display Format*—The performance monitoring registers displayed for a T1 link with ESF framing are listed in the following order:

ESF ERROR EVENTS	=	[0].....[65535]
CURRENT ES	=	[0].....[900]
CURRENT UAS	=	[0].....[900]
CURRENT SES	=	[0].....[900]
CURRENT BES	=	[0].....[900]
CURRENT LOFC	=	[0].....[255]
CURRENT CSS	=	[0].....[255]
CURRENT TIMER	=	[0].....[900]

INTERVAL mm ES=nnn UAS=nnn BES=nnn SES=nnn LOFC=nnn CS=nnn

24 HOUR ES	=	[0].....[65535]
24 HOUR UAS	=	[0].....[65535]
24 HOUR SES	=	[0].....[65535]
24 HOUR BES	=	[0].....[65535]
24 HOUR LOFC	=	[0].....[255]
24 HOUR CSS	=	[0].....[255]
LAST 24 DEGRADE MIN=		[0].....[1440]
24 HOUR INTERVAL	=	[0].....[96]

The numbers in brackets indicate the range of values for each register.

DSP ST LINK

- *Purpose*—Display status information on a selected link, and optionally clear the event registers.
- *Format*—DSP ST LINK X [Option]
- *Use*—

1. To display the current status information for link 1, type:

   DSP ST LINK 1<CR> or DSP ST LINK<CR>

   To display status information for link 1, and then clear all the event registers of link1, type

   DSP ST LINK 1 /C<CR> or DSP ST LINK /C<CR>

   To monitor continuously the status information of link 1, type:

   DSP ST LINK 1 /R<CR> or DSP ST LINK /R<CR>

   The display will automatically be updated. To stop the monitoring, press BREAK (or CTRL+C).

2. To display status information for another link, type:

DSP ST LINK X<CR>

where X stands for the link identification, 2, 3, or 4.

To monitor continuously the status information of another link, type:

DSP ST LINK X /R<CR>

where X stands for the link identification, 2, 3, or 4.

The display is automatically updated. To stop the monitoring, press BREAK (or CTRL+C).

- *Display Format*—A typical link status display for a T1 link is shown below. X stands for the link identification: 1 for link1, 2 for link2, 3 for link3, 4 for link4.

```
STATUS OF LINK X
TYPE              =T1
FUNCTION          =CSU
ALARM             =RED      YELLOW
                    NO        NO
LNK LOOPS         =LOCAL    REMOTE    PLB    LLB
                     NO
BPV LAST MINUT    =0
BPV WORST MINUT=1
```

The fields included in the status information display are listed below:

TYPE—Displays the type of the selected link, T1.

FUNCTION—Displays the type of interface hardware installed on the selected link: CSU or DSU.

ALARM—Indicates the status of the link alarms.

BPV LAST MINUT—Displays the number of BPV events detected in the worst minute. This counter is displayed only when the link framing mode is SF (D4).

LNK LOOPS—Displays the state of each type of loopback, including network-initiated loopbacks, that can be activated on the selected link.

BPV WORST MINUT—Displays the number of BPV events detected during the worst minute since the last time the counters were cleared. This counter is displayed only when the link framing mode is SF (D4).

DSP ST SYS

- *Purpose*—Display system status information.
- *Format*—DSP ST SYS
- *Use*—To view the current system status, type:

  DSP ST SYS<CR>

- *Display Format*—A typical status information display is shown below.

```
NODE              =0
NAME              -'IMUX-4 name'
NODAL CLOCK       =INT
BERT STATE        =OFF
SOFTWARE REV      =X.Y
HARDWARE REV      =X.Y
```

The system status fields are described below (from top to bottom).

NODE—The node number of the IMUX-4.

NAME—The node name of the IMUX-4.

NODAL CLOCK—Indicates the current source for the IMUX-4 system clock: INT, ST, LNK-1, LNK-2, LNK-3, LNK-4 (see **Section 4.4**).

BERT STATE—Indicates the current state of the BER test: ON or OFF.

SOFTWARE REV—IMUX-4 software version.

HARDWARE REV—IMUX-4 hardware version.

EXIT

- *Purpose*—End the current session and return control to the IMUX-4 front panel.
- *Format*—EXIT
- *Use*—Type:

  EXIT<CR>

F

- *Purpose*—Define the codes used to be sent to the supervision terminal to perform the following terminal control functions:

- Clear screen.

- Move cursor to screen home position.

- Move cursor to the right by one position.

The codes used by typical terminals are listed in **Table 5-4**.

Table 5-4. Codes Used by Typical Terminals.

Function	Terminal Type TV920	VT52	VT100	Freedom 100/110	Freedom 220
Clear Screen	1B2A0000	N/A	1B5B324A	1B2A0000	1B5B324A
Cursor Home	1E000000	1B480000	1B5B4800	1E000000	1B5B4800
Cursor Right	0C000000	1B430000	1B5B3143	0C000000	1B5B0143

- *Format*—F

- *Use*—

1. To display the current codes, type:

   F<CR>

2. The terminal function entry screen is displayed. The screen includes three separate lines, displayed one after the other. A typical screen, showing all the three lines, is shown below:

CLEAR SCREEN=hhhhhhhh (clear screen code)

CURSOR HOME=hhhhhhhh (cursor home code)

CURSOR RIGHT=hhhhhhhh (cursor right code)

   where h indicates hexadecimal digits.

3. To change a code, press <CR> to bring the cursor under the first digit of the code you wish to change, then enter the appropriate hexadecimal digit.

4. Repeat the procedure until all codes are changed.

HELP

- *Purpose*—Display an index of the supervisory port commands and the options available for each command.

- *Format and Use*—H<CR>

  You will see the first HELP page. Press any key to see the next page.

INIT DB

- *Purpose*—Load a specified set of default parameters values instead of the user configuration (**Table 5-5**).

- *Format*—INIT DB

- *Use*—

1. Type

   INIT DB<CR>

2. The IMUX-4 will display the TIME and DATE fields followed by the IMUX-4 prompt.

Table 5-5. IMUX-4 Default Configuration used with Supervision Terminal.

Parameter Type	Parameter Designation	Default Value
General	PASSWORD	IMX
	NODE (node number)	0
	CLEAR SCREEN	00000000
	CURSOR HOME	00000000
	CURSOR RIGHT	00000000
System	CLK_MASTER	INT
	CLK_FBACK	NONE
Channel	LNK-1	YES
	LNK-2	YES
	LNK-3	YES
	LNK-4	YES
Link	CON	YES
	FRAME	ESF
	SYNC	FAST
	IDLE_TS_CODE	3F
	CODE	B8ZS
	MASK	000
SP (Supervisory Port)	SPEED	AUTO
	DATA	8
	PARITY	NONE
	INT	DCE
	PWD	NO
	LOG_OFF	NO
	CTS	=RTS
	DSR	ON
	DCD_DEL	0_MSEC
	POP_ALM	NO

INIT F

- *Purpose*—Reset the terminal control codes used to clear the terminal screen, to move the cursor to the right, and to return the cursor to the home position to 0.
- *Format and Use*—INIT F<CR>

LOOP CH

- *Purpose*—Activate a user-controlled loopback on the IMUX-4 user's data channel (see **Section 6.3** for loopback description).
- *Format*—LOOP [looptype] CH or LP [looptype] CH
- *Use*—

1. To activate a local (L) or remote (R) loopback on the user's data channel, type:

   LOOP L CH<CR> or LP L CH<CR>

   LOOP R CH<CR> or LP R CH<CR>

2. You will see the time and date, followed by the IMUX-4 prompt.

   At any time, you can activate only one loopback on the IMUX-4 user's data channel. If you try to activate a second loopback on the user's data channel, you will see an error message (illegal link loop combination). You must deactivate the other loopback before you can activate the new one.

LOOP LINK

- *Purpose*—Activate a user-controlled loopback on the IMUX-4 links (see **Section 6.3** for loopback description).
- *Format*—LOOP [looptype] LINK or LP [looptype] LINK
- *Use*—

1. To activate a local (L) or remote (R) loopback on the IMUX-4 links, type:

   LOOP L LINK<CR> or LP L LINK<CR>

   LOOP R LINK<CR> or LP R LINK<CR>

2. You will see the time and date, followed by the IMUX-4 prompt.

   At any time, you can activate only one loopback on the IMUX-4 links. If you try to activate a second loopback on the IMUX-4 links, you will see an error message (illegal link loop combination). You must deactivate the other loopback before you can activate the new one.

NODE

- *Purpose*—Select an IMUX-4 for establishing a control session.
- *Format*—NODE 'node number'
- *Use*—

1. To connect to the desired IMUX-4, type:

   NODE 'node number' <CR>

   where 'node number' is the three-digit node number, in the range of 1 through 255.

2. When the addressed IMUX-4 is on-line, it will echo the complete string: NODE<SP>nnn<SP>. After you see the echo, type the desired command.

PASSWORD

- *Purpose*—Enter the password when prompted to type the password upon the start of a control session.
- *Format*—PWD<SP>'password'
- *Use*—

1. When you see the prompt

   PASSWORD>

   type:

   'password'<CR>

   where 'password' is the string of four to eight alphanumeric characters that has been defined by the user (or the default, IMX, as appropriate).

2. The IMUX-4 sends the current time and date, and then the prompt **IMX-4T1>** is displayed on the next line.

RESET

- *Purpose*—Reset the IMUX-4. This will cause the IMUX-4 to initialize, therefore the traffic through the IMUX-4 will be disrupted until the IMUX-4 returns to normal operation.
- *Format*—RESET
- *Use*—To reset the IMUX-4, type:

  RESET<CR>

TIME

- *Purpose*—Set the time for the IMUX-4 internal real-time clock.
- *Format*—TIME
- *Use*—

1. Type

   TIME<CR>

2. The IMUX-4 sends the time entry form:

   Time
   Hour=12
   Minute=25
   Second=16

3. If necessary, change the time as follows:

- Bring the cursor to the beginning of the first field to be changed by pressing the space bar.
- To change the selected field, press F or B to scroll among the available selections.
- When the desired selection is displayed, press the space bar to move to the next field.

4. Set the time about one minute beyond the current time, and then press <CR> at the correct instant. The IMUX-4 will display the TIME and DATE fields (note that TIME has changed), followed by the IMUX-4 prompt.

5.6 Supervision Terminal Operating Instructions

Before using the supervision terminal, make sure you complete the preparations listed in **Section 5.3** and all the relevant equipment has been turned on.

5.6.1 Starting a Session—Single IMUX-4

When the terminal is used to control a single IMUX-4, always assign node address 0 to the IMUX-4. Use the following start-up sequence to connect to an IMUX-4 that has been assigned node number 0.

1. If you use the AUTO (Autobaud) mode, press the <CR> key three times. This allows the IMUX-4 to identify the terminal data rate.

2. Assuming that the IMUX-4 successfully identified the data rate of the supervision terminal, you will be notified if the IMUX-4 failed the power-on self-test:

- If you see IMUX-4 SELFTEST FAILED, the IMUX-4 must be repaired before you can continue using it.
- If IMUX-4 successfully passed the power-on self-test (IMUX-4 SELF TEST OK), it sends the following message:

  IMX SUPERVISORY PORT ON LINE. TYPE "H" FOR HELP

3. By now, the IMUX-4 prompt should already be displayed on the terminal screen, after the ON-LINE announcement.

   If you see

   PASSWORD>

   this indicates that password protection is enabled. In this case, type the password:

   'password'<CR>

   where 'password' stands for the current password (four to eight characters). For each password character you type, the terminal displays an asterisk (*). If your password is accepted, you will see the prompt **IMX-4T1>**.

4. The IMUX-4 is now in session, under your control:

- On your terminal, you will see the prompt:

  IMX-4T1>

- On the IMUX-4 front panel, you will see the message:

TERMINAL ON LINE

The front-panel controls are disabled as long as the IMUX-4 is under remote control.

NOTE

While the supervision terminal is in session with the IMUX-4, the IMUX-4 local operator can regain control by disconnecting the cable from the IMUX-4 front panel DTE connector, or by sending the EXIT command from the supervision terminal.

The IMUX-4 will automatically return to front-panel control if no commands are received for a certain period of time (controlled by the LOG_OFF parameter). You can disable this timeout.

5.6.2 Starting a Session—Multiple IMUX-4s

When one terminal is used to control several IMUX-4s connected via modems, non-zero node addresses are assigned to each IMUX-4. The nodes addresses, in the range of 1 through 255, are assigned during the first session, by means of the command DEF NODE. Use the following procedure to establish a session with a specific IMUX-4.

NOTE

If you are using a multidrop configuration, do not assign address 0 to any of the IMUX-4s connected to a given terminal. Make sure the interface type is set as DTE, and select the appropriate DCD_DEL parameter.

1. Press the <CR> key three times.
2. Type NODE, space, the desired IMUX-4 node address and another space, and then type the desired command and press <CR>. For example, with node address 234, type:

   NODE<SP>234<SP> ‘command’ <CR>

3. If the addresses IMUX-4 does not use password protection, you will see the prompt:

   PASSWORD>

   Type the node address and then the password again. For example, for node address 234, type:

   NODE<SP>234<SP>‘password’<CR>

5. If the password is correct, the IMUX-4 will execute the command. Otherwise, you will see ENTER PASSWORD>.

5.6.3 Control Session

1. During the control session, type the desired commands at the terminal keyboard. You must see the IMUX-4 echo character by character.

   If a bad command appears, backspace to clear the error, and then type the correct character again.

- When you see the correct and complete command in the echo line, press <CR> to execute the command. The IMUX-4 will process the command and display the appropriate response. After the command executes, the IMUX-4 displays the current time and date, and then provides a new prompt for the next command line.
- If you changed your mind, and want to abort the command, press BREAK or CTRL-C. You will again receive the prompt, so you can enter another command.

NOTE

You can also use BREAK or CTRL-C to stop automatic repetition of commands sent with the /R option.

2. If your command is not correct, the IMUX-4 will not execute it, but will echo the command again, with a bad command message in the following line. Type the correct command again.
3. If the terminal screen fills up during the exchange with the IMUX-4, you will see the message:

   HIT ANY KEY TO CONTINUE

   After pressing any key except BREAK, the terminal scrolls to the next page.

5.6.4 Ending a Control Session

1. To end the control session, type:

   EXIT

2. The IMUX-4 prompt will disappear. Now you can control the IMUX-4 from its front panel.

NOTE

A control session may also be terminated by the IMUX-4 if the idle disconnect timeout is enabled, or when the DTR line switched to the inactive (OFF) state.

5.7 Configuration Error Messages

The IMUX-4 provides configuration error messages for the supervision terminal user. The configuration messages have the format ERROR, followed by a two-digit code. The IMUX-4 will display a short description of the error message after the ERROR code.

The error messages are explained below.

ERROR 01 MASTER AND FALLBACK CLOCKS ARE SAME

You are trying to select the same source as both master and fallback clock source. Check and change as required.

ERROR 02 CLOCK SOURCE FROM NOT VALID LINK

You are trying to select as clock source a link that is not connected to the IMUX-4. Check and change as required.

ERROR 03 ILLEGAL LOOP COMBINATION

Illegal combination of loopbacks: you are trying to activate simultaneously local and remote loopbacks on links and on the data channel, or a network-activated loopback may already be activated. Only one loopback can be connected at a time.

ERROR 04 LINK3 AND LINK4 ARE NOT AVAILABLE ON E1—>2T1 CONFIGURATION

You are trying to display the status of a link that is not available on the IMUX-2.

ERROR 05 MAPPING UNCONNECTED LINK

You are trying to map a link that is not active.

ERROR 06 CONNECTING TO UNEXISTING LINK

You are trying to activate a link that is not connected to the IMUX-4. Check and change as required.

ERROR 07 UNCONNECTING LINK THAT SUPPLIES CLOCK OR MAPPED TO CHANNEL

You are trying to disconnect a link that has been selected as clock source, or a link that is mapped to the user's data channel. Check and change as required.

ERROR 08 LOOP IS NOT ACTIVE

You are trying to disconnect a loopback that is not active.

ERROR 09 LINK IS NOT ACTIVE

You are trying to display the status of a link that is not active. Check and change as required.

ERROR 10 ILLEGAL COMMAND FOR CURRENT LINK MODE

You are trying to select a parameter value that is not supported under the current link framing mode. Check and change as required.

6. Diagnostics

6.1 General

The IMUX-4 diagnostics functions include:

- Status indications and messages—**Section 6.2**.
- Performance diagnostics—**Section 6.3**.
- Test functions—**Section 6.4**.
- Power-on self-test—**Section 6.5**.
- Troubleshooting—**Section 6.6**.

6.2 Status Indications and Messages

6.2.1 Indicators

IMUX-4 status is indicated by the RED and YEL alarm indicators of its links, and by the DTE RD and TD indicators of the user's data channel. Indicator functions are listed in **Table 4-1**.

6.2.2 Display

The IMUX-4 maintains an alarm buffer. The buffer can store one alarm event of each type, and a maximum of 100 alarms can be displayed on the supervision terminal.

The IMUX-4 operator can view the contents of the alarm buffer on the front panel LCD display, and can delete the event alarms from the buffer when no longer needed. This procedure is explained in **Section 4.8**.

Table 6-1 presents the alarm messages displayed on the IMUX-4 display in alphabetical order, and lists the actions required to correct the alarm condition (the messages displayed on the supervision terminal have a similar syntax). In these messages, "X" identifies the link, 1, 2, 3, or 4.

To correct the reported problem, perform the corrective actions in the given order, until the problem is corrected. If the problem cannot be corrected by carrying out the listed actions, call for Technical Support.

Table 6-1. IMUX-4 Alarm Buffer Messages.

Message	Description	Corrective Actions	Alarm Type
ALARM BUFFER OVERFLOW	More than 100 alarms entries have been written in the alarm buffer since the last clear command.	Read the messages. If you are using the front panel, delete all the event alarms by selecting CLEAR. From the supervision terminal, send the CLR ALM command.	ON/OFF
AIS OCCURRED, LNK:X	Unframed “all ones” sequence is received in the link data stream.	Problem at the remote equipment.	ON/OFF
AIS RED ALM, LNK:X	Local loss of frame synchronization alarm on the specified link caused by AIS condition.	Problem at the remote equipment.	ON/OFF
BPV ERROR, LNK:X	Bipolar variations in the link receive signal. Updated once per second.	Have the link checked.	ON
CLOCK WAS CHANGED TO FALLBACK	The IMUX-4 switched to the fallback clock source, because the master clock source failed.	Check the link providing the master clock source. The IMUX-4 replaces a recovered link clock when the corresponding link loses frame synchronization or its input signal is missing.	ON/OFF
CLOCK WAS CHANGED TO INTERNAL	The IMUX-4 switched to the internal clock source, because both the master and the fallback clock sources failed.	Check the link providing the clock source. The IMUX-4 replaces a recovered link clock when the corresponding link loses frame synchronization or its input signal is missing.	ON/OFF
DATABASE CKS ERR	IMUX-4 technical failure (internal database error).	1. Load the default configuration in the place of the current database (from the supervision terminal, enter the INIT DB command). 2. Replace the IMUX-4.	ON/OFF
DB-INIT SW IS ON	Section 3, DBINI, of switch SW1 is set to ON.	If it is no longer necessary to enforce the default database parameter value, change setting to OFF.	ON

Table 6-1 (continued). IMUX-4 Alarm Buffer Messages.

Message	Description	Corrective Actions	Alarm Type
EXCESSIVE BPV, LNK:X	The rate of bipolar violations in the link receive signal exceeds 1 x 10^{-6} during a measurement interval of 1000 seconds.	Problem in network facilities.	ON/OFF
FRAME SLIP, LNK:X	Frame slips are detected (not displayed during local loss of frame synchronization). Updated once per second.	1. Incorrect selection of clock source. 2. Problem at far end (unstable clock source). 3. Replace the IMUX-4 only if no problem has been detected in steps 1 and 2.	ON
HARDWARE FAILURE	IMUX-4 technical failure (one of the internal programmable components).	Replace the IMUX-4.	ON/OFF
LINKX RECEIVES LINKY	The IMUX-4 detected incorrect link connections (link X is connected to the interface of linkY).	Check and correct the connections.	ON
NETWORK LLB, LINK:X	Line loopback command received from the network.	Wait until the loopback condition is removed.	ON/OFF
NETWORK PLB, LNK:X	Payload loopback command received from the network.	Wait until the loopback condition is removed.	ON/OFF
PSWRD SW IS ON	Section 1,PASSW, of switch SW1 is set to ON.	If it is no longer necessary to enforce the default password and node number, change setting to OFF.	ON
RED ALARM, LNK:X	Local loss of time synchronization alarm on the specified link.	1. Check cable connections to the link connector. 2. Check line and/pr other communication equipment providing the link to the remote IMUX-4. 3. Replace the IMUX-4.	ON/OFF
REAL TIME CLOCK BATTERY FAILURE	The battery that powers the IMUX-4 internal real-time clock when IMUX-4 is not powered has failed.	Have the IMUX-4 repaired.	ON

Table 6-1 (continued). IMUX-4 Alarm Buffer Messages.

Message	Description	Corrective Actions	Alarm Type
SELF TEST ERROR	A problem has been detected during IMUX-4 self-test.		ON
SIGNAL LOSS, LNK:X	Loss of link receive signal.	1. Check cable connections to the link connector. 2. Check line and/or other communication equipment providing the link to the remote IMUX-4.	ON/OFF
SP-PAR SW IS ON	Section 2, DEFSP, of switch SW1 is set to ON.	If it is no longer necessary to enforce the default supervisory port parameters, change setting to OFF.	ON
YELLOW ALARM, LNK:X	Remote loss of frame synchronization alarm on the specified link (only on T1 links).	Problem at the remote equipment.	ON/OFF

6.3 Performance Diagnostics Data

This section describes the performance evaluation and monitoring functions provided by the IMUX-4. The functions actually available depend on the framing in use, ESF or SF (D4).

- *ESF Framing*—When ESF framing is used, you can monitor end-to-end data transmission performance. With this type of framing (see **Section 2.2**), the data stream transmitted end-to-end includes supervision and error-detection information.

  The error-detection information is derived from the data payload included in each extended super-frame, by performing a cyclic redundancy check (CRC). The resulting CRC checksum is transmitted in addition to the raw data bits.

  The receiving end recalculates the checksum and compares the results with the received checksum: Any difference between the two checksums indicates that one or more bit errors are contained in the current data block (ESF) being evaluated.

- *SF Framing*—The SF-framed signal does not support the capabilities listed above. However, the IMUX-4 is capable of gathering the number of bipolar violations measured during the last minute.

ANSI T1.403-1989 ESF Statistics

When using ESF framing, the IMUX-4 stores T1 line statistics for each T1 link interface in compliance with the ANSI T1.403-1989 requirements. The statistic data is gathered once per second. The statistics are collected over the last four seconds, and then transmitted via the 4-Kbps control and supervision data link (FDL) of the ESF frames. This permits real-time monitoring of data transmission performance.

The performance parameters defined for AT&T Pub. 54016 statistics are listed below:

- *Current ESF error events (ERROR EV).* An ESF error event is any extended super-frame containing a CRC error and/or OOF event. The number of events is collected in a current ESF error events register.

NOTE

Register contents can be displayed at any time. When the ESF error events are displayed on the front-panel LCD, the register can be reset by pressing ENTER.

- *Current seconds (SECS).* The number of seconds in the current measurement interval. A measurement interval has 900 seconds (15 minutes).
- *Current errored seconds (ES).* An errored second is any second containing one or more CRC error events, or one or more OOF events, or one or more controlled slip events. The data is collected for the current 15-minute interval.
- *Current unavailable seconds (UAS).* An unavailable second is any second in which a failed signal state exists. A failed signal state is declared when 10 consecutive severely errored seconds (SES) occur, and is cleared after 10 consecutive seconds of data are processed without an SES.
- *Current severely errored seconds (SES).* A SES is a second with 320 or more CRC error events, or one or more OOF events. The data is collected for the current 15-minute interval.
- *Current bursty errored seconds (BES).* A BES is a second with 2 to 319 CRC error events. The data is collected for the current 15-minute interval.
- *Current loss of frame counter (LOFC).* The loss of frame (LOF) counter counts the loss of frame alignment events. The data is collected for the current 15-minute interval.
- *Current slip second counter (CSS).* A CSS is a second with one or more controlled slip events. The data is collected for the current 15-minute interval.

The IMUX-4 also provides local statistics

support that meets the requirements of AT&T Pub. 54106. These are long-term statistics gathered over the long-term interval (96 15-minute intervals, that is, a total of 24 hours) for each T1 link interface. The additional parameters included in this class are:

- *Long-term errored seconds (ES).* The total number of ES in the current 24-hour period.
- *Long-term fail seconds (UAS).* The total number of UAS in the current 24-hour interval.
- *Long-term severely errored seconds (SES).* The total number of SES in the current 24-hour interval.
- *Long-term loss of frame counter (LOFC).* The total number of LOF events in the current 24-hour interval.
- *Long-term slip second counter (CSS).* The total number of CSS in the current 24-hour interval.
- *Long-term (BES).* The total number of BES in the current 24-hour interval.
- *Long-term interval.* The number of valid 15-minute intervals in the previous 24-hour period.
- *Current degraded minutes.* The total number of degraded minutes in the current 24-hour interval. A degraded minute is a minute in which the bit error rate (BER) exceeded 1 x 10^{-6}. This number is updated every minute.
- *Last degraded minutes.* The total number of degraded minutes in the last 24-hour interval. This number is updated every 24 hours.

SF Statistics

The performance evaluation and monitoring parameters collected by the IMUX-4 for SF framing are listed below:

- *Bipolar violations (BPV) count (BPV last minute).* The total number of bipolar violations counted in the last minute. This number is updated every minute.
- *Bipolar violations worst count.* The number of bipolar violations counted in the worst minute since the last resetting of the BPV count. This number is updated every minute.

6.3.1 Summary of Performance Monitoring from the Front Panel

A summary of the performance diagnostics data displayed on the IMUX-4 front panel, under DIAGNOSTICS, is given in **Table 6-2**.

The IMUX-4 lets you reset the performance diagnostics by pressing the ENTER button.

Table 6-2. Summary of Performance Monitoring from the Front Panel.

Display	Description	Range
CURR ES	Number of ES measured during the current 15-minute interval. The display is updated every second.	0-900
CURR UAS	Number of UAS measured during the current 15-minute interval. The display is updated every second.	0-900
CURR SECS	The time in seconds that expired from the start of the current 15-minute interval. The display is updated every second.	0-900
CURR SES	Number of SES measured during the current 15-minute interval. The display is updated every second.	0-900
CURR BES	Number of BES measured during the current 15-minute interval. The display is updated every second.	0-900
CURR LOFC	Number of loss of frame synchronization events measured during the current 15-minute interval. The display is updated every second.	0-255
CURR CSS	Number of CSS measured during the current 15-minute interval. The display is updated every second.	0-255
L. TERM ES	Number of ES measured during the current 24-hour interval. The display is updated every 15 minutes.	0-900
L. TERM UAS	Number of UAS measured during the current 24-hour interval. The display is updated every 15 minutes.	0-65535
L. TERM SES	Number of SES measured during the current 24-hour interval. The display is updated every 15 minutes.	0-65535
L. TERM BES	Number of BES measured during the current 24-hour interval. The display is updated every 15 minutes.	0-65535
L. TERM LOFC	Number of loss of frame synchronization events measured during the current 24-hour interval. The display is updated every 15 minutes.	0-255
L. TERM CSS	Number of CSS measured during the current 24-hour interval. The display is updated every 15 minutes.	0-255
L. TERM INT	The number of 15-minute intervals that expired from the start of the current 24-hour interval. The display is updated every 15 minutes.	0-96

Table 6-2 (continued). Summary of Performance Monitoring from the Front Panel.

Display	Description	Range
ERROR EV	The number of ESF error events recorded since the last time the register was cleared. The display is updated every second.	0-65535
BPV COUNT	The total number of BPV errors during the last minute. The display is updated every minute.	0-9999
CUR DEG MIN	The number of degraded minutes measured during the last 24 hours. The display is updated every minute.	0-1440
BPV WORST	The number of BPV errors measured during the worst minute. The display is updated every minute.	0-9999
LST DEG MIN	Last 24-hour count of degraded minutes. The display is updated every 24 hours.	0-1440

6.3.2 Displaying the Performance Data on the Front Panel

Use the following procedure to display the performance diagnostics data on the IMUX-4 front-panel LCD.

1. Bring the cursor under the left-hand field of the top row (if it is not already there).
2. Scroll to display DIAGNOSTICS in the top row. The right-hand field of the top row indicates LNK1, meaning that the displayed diagnostics data pertains to link 1. The second row shows the first performance item for link 1, and its current value. The displayed item depends on the framing mode used on this link.
3. Bring the cursor under the left-hand field in the second row.
4. Scroll to see the other statistics. After each time you press SCROLL, the second row shows the current value of the next item. Continue until the first item appears again.
5. Bring the cursor under the right-hand field of the top row (if it is not already there).
6. Scroll to display LNK2. The second row shows the first performance item for link 2, and its current value. The displayed item depends on the link type and framing mode.
7. Repeat steps 3, 4 above to see the other statistics of link 2. After each time you press SCROLL, the second row shows the current value of the next item. Continue until the first item appears again.
8. Repeat steps 6, 7 above to see the statistics of link 3, and then for those of link 4.

Resetting the Performance Data Registers

The registers storing diagnostics data can be reset. To reset a register, bring the register to display and press ENTER.

To ensure that the collected data remains meaningful and correlated after a specific register is reset, the IMUX-4 will automatically perform the following actions:

- Since the data collected on a given link for the current interval and for the current 24-hour interval is correlated, pressing ENTER while any of the following CURR of L. TERM data items is displayed clears all the performance diagnostics registers, not only that appearing on the display: ES, UAS, SES, BES, LOFC, CSS, and the registers for CURR SECS, CURR DEG MIN, LST DEG MIN, and L. TERM INT.
- In case the BPV COUNT register of a given link is reset, the BPV WORST register of that link is also reset, and vice versa.

The only register that can be reset independently of the other registers is the ERROR EV register (available for T1 links using ESF framing).

6.3.3 Displaying the Performance Data on a Supervision Terminal

The performance data can be displayed on the supervision terminal by means of the DSP PM command, as explained in **Chapter 5**. By adding the /CA switch to the command, you can reset all the performance diagnostics registers.

6.4 Test Functions

6.4.1 User-Controlled Test Functions

The IMUX-4 supports five types of user-controlled test functions.

- Local channel loopback (LOOP L CH)
- Remote channel loopback (LOOP R CH)
- Local link loopback (LOOP L LINK)
- Remote link loopback (LOOP R LINK)
- BER testing on the data channel

The user-controlled test functions are accessed from the TEST OPTIONS menu.

The available test functions are described in the following paragraphs. The test functions are identified by the designation displayed by the IMUX-4.

LOOP L CH

When activated, the local channel loopback returns the signal received from the user's DTE, after passing through the user channel interface of the IMUX-4. The local loopback is obtained by connecting the transmit signal to the input of the receive path of the user channel interface. The test signal is provided by the DTE connected to the IMUX-4, which must receive its own transmission without errors while the loopback is activated. During the loopback, the local IMUX-4 continues sending the user's data to the link.

Figure 6-1 shows a typical local channel loopback.

This test is generally used to check the connections to the DTE to the IMUX-4.

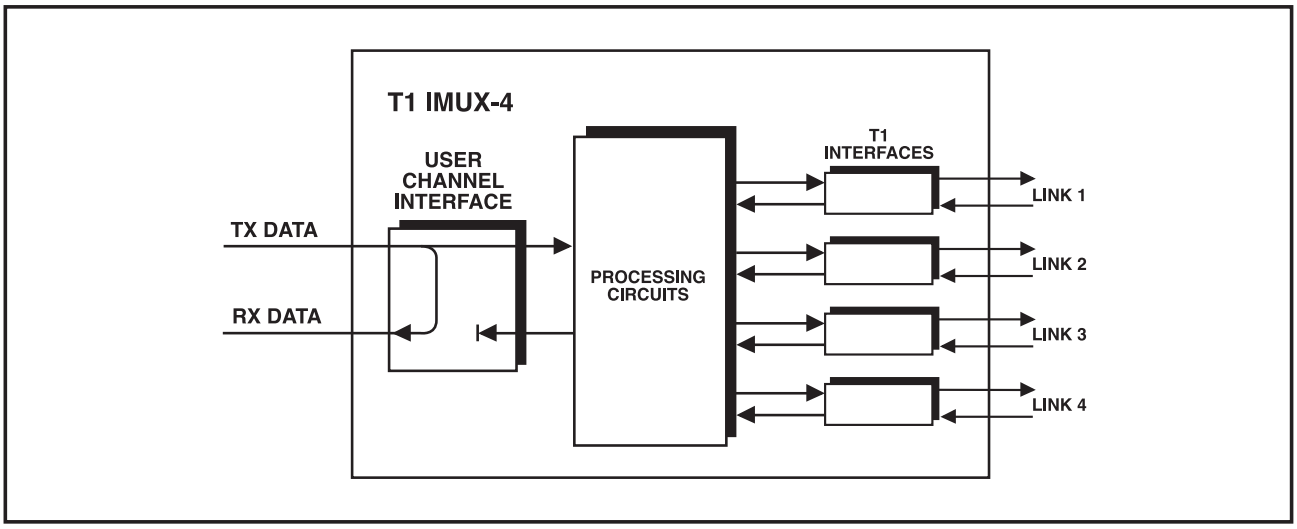

Figure 6-1. LOOP L CH Loopback.

LOOP R CH

When activated, the remote channel loopback returns the received data channel signal toward the remote user DTE. The remote loopback is performed by internally connecting the data channel receive signal to the input of the transmit path. The received data channel signal remains connected to the local user's DTE. The test signal is provided by the user DTE connected to the remote end of the link, which must receive its own transmission without errors while the loopback is activated.

Figure 6-2 shows a typical remote channel loopback.

This test fully checks the data link, including the cables connecting the two IMUX-4s to the links, the transmission plant connecting the two IMUX-4s, and the cable connecting the remote user DTE to the remote IMUX-4.

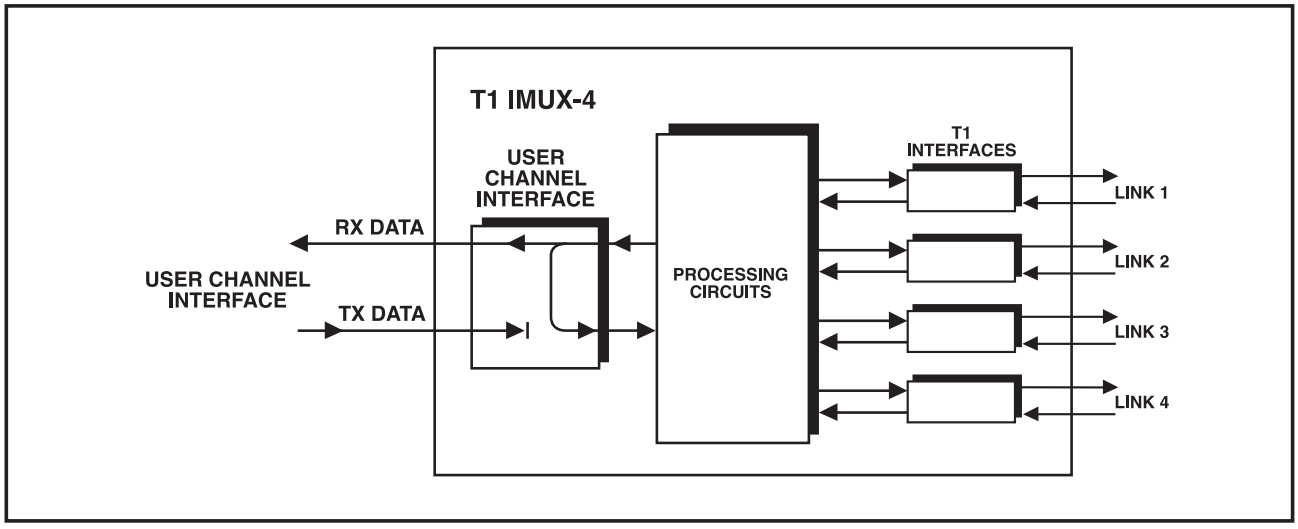

Figure 6-2. LOOP R CH Loopback.

LOOP L LINK

When activated, the local link loopback returns the signals transmitted by each T1 link interface of the local IMUX-4 to the receive input of the same interface. Therefore, this loop tests all the local IMUX-4 circuits.

The local loop is obtained by connecting the link transmit signal to the input of the receive path. The test signal is provided by the local DTE, which must receive its own transmission without errors while the loopback is activated. During the loopback, the local IMUX-4 sends an unframed "all-ones" signal to the links.

Figure 6-3 shows a typical local link loopback.

This test fully checks local IMUX-4 operation, and the connections to the local user's DTE.

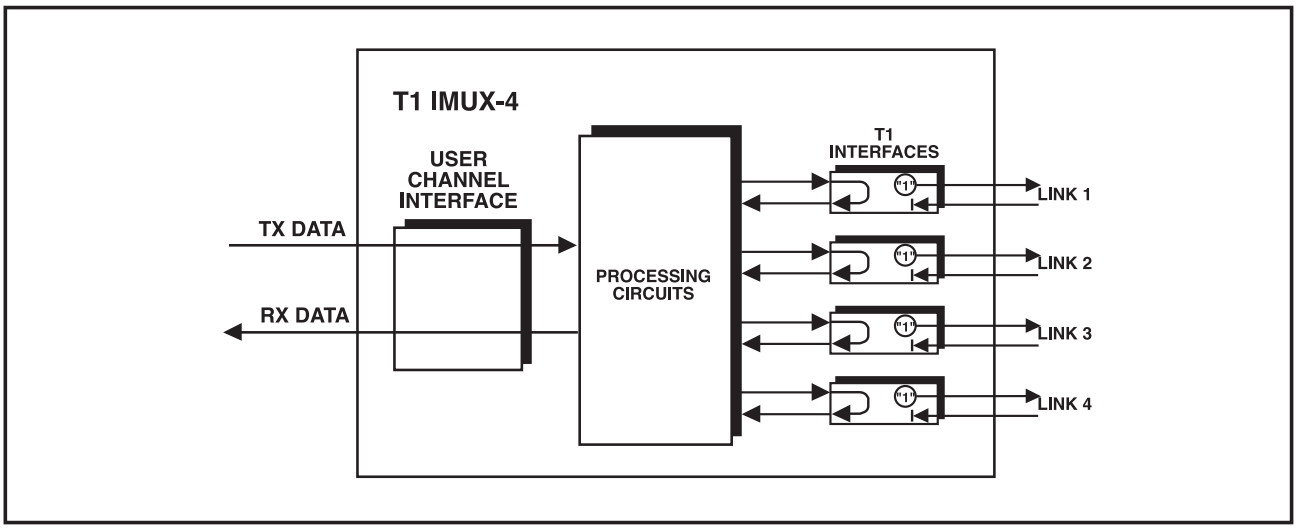

Figure 6-3. LOOP L LINK Loopback.

LOOP R LINK

When activated, the remote link loopback returns the signals received by each IMUX-4 link interface toward the remote user DTE, on the same link. The loopback is performed by connecting the link receive signal, after regeneration, to the input of the transmit path. The test signal is provided by the user DTE connected to the remote end of the link, which must receive its own transmission.

Figure 6-4 shows a typical remote link loopback.

This test fully checks the data link, including the cables connecting the two IMUX-4s to the links, the transmission plant connecting the two IMUX-4s, and the cable connecting the remote user DTE to the remote IMUX-4.

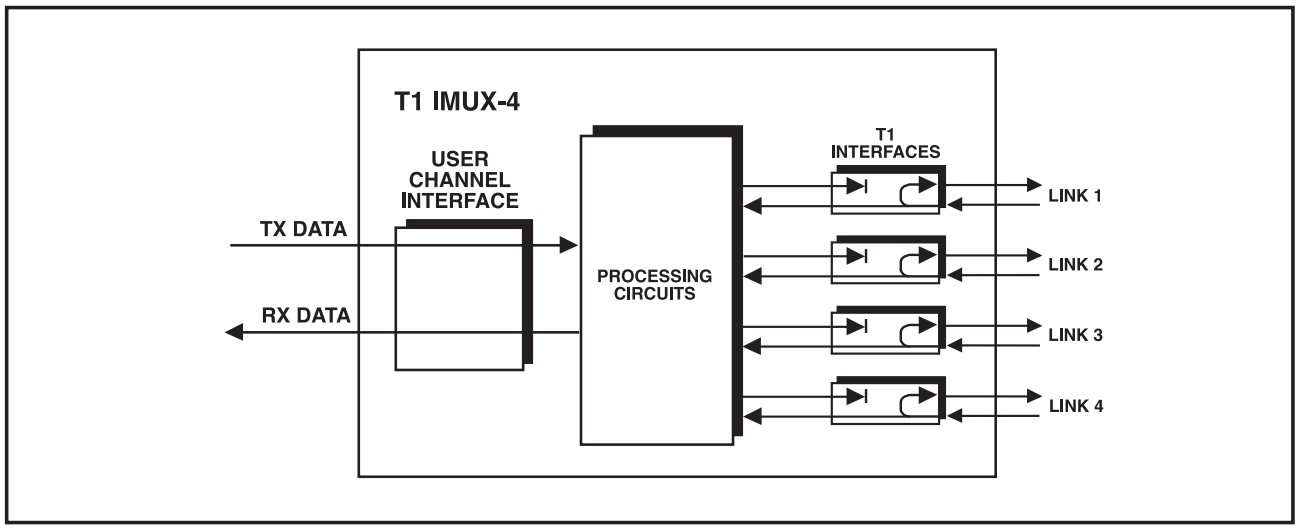

Figure 6-4. LOOP R LINK Loopback.

BER Testing

The BER testing is performed by replacing the transmit user's data with a pseudorandom sequence provided by a test-sequence generator. The test sequence is returned to an error detector by means of a loopback connection, at the desired location along the signal path: For example, for testing the local IMUX-4, a local link loopback should be used.

The error detector compares the received sequence with a copy of the transmitted sequence, and counts the errored seconds detected during the test.

6.4.2 TEST OPTIONS Operating Instructions

NOTE

In general, before starting a test, you should activate only one loopback at a time. However, the IMUX-4 will allow you to activate a remote loopback on one link, and a local loopback on the other link.

To activate or deactivate a specific test, use the following procedure:

1. Bring the cursor under the left-hand field in the top row (if not already there).
2. Scroll to display TEST OPTIONS in the top row. The right-hand field of the top row indicates OFF, since no test is active. The second row is empty.
3. To select the type of test, bring the cursor under the right-hand field in the top row, and scroll to display the desired type. The right-hand field of the top row indicates LNKS when the test is to be activated on the links, or CH when the test is to be activated on the data channel.
4. After the desired type is selected, bring the cursor under the left-hand field in the second row, and scroll to display the desired type of loopback, LOCAL LOOP or REMOTE LOOP. The second tow shows the current state of the selected test, OFF or ON.
5. To change the test state, bring the cursor under the right-hand field in the second row, and scroll to display the desired state. The second row shows the new state of the selected test (for example, OFF).
6. Press ENTER to activate the displayed test. The TEST indicator turns on if the test is activated, or turns off if no test is activated.

6.4.3 Network-Controlled T1 Loopback Functions

The IMUX-4 supports two types of network-controlled loopbacks, network latching loopback and network payload loopback.

The available network-controlled loopback functions are described in the following paragraphs. The loopbacks are identified by the designation displayed by the IMUX-4.

Network LLB

The latching network line loopback is connected when it receives the appropriate code from the network. The loopback connections are shown in **Figure 6-5**.

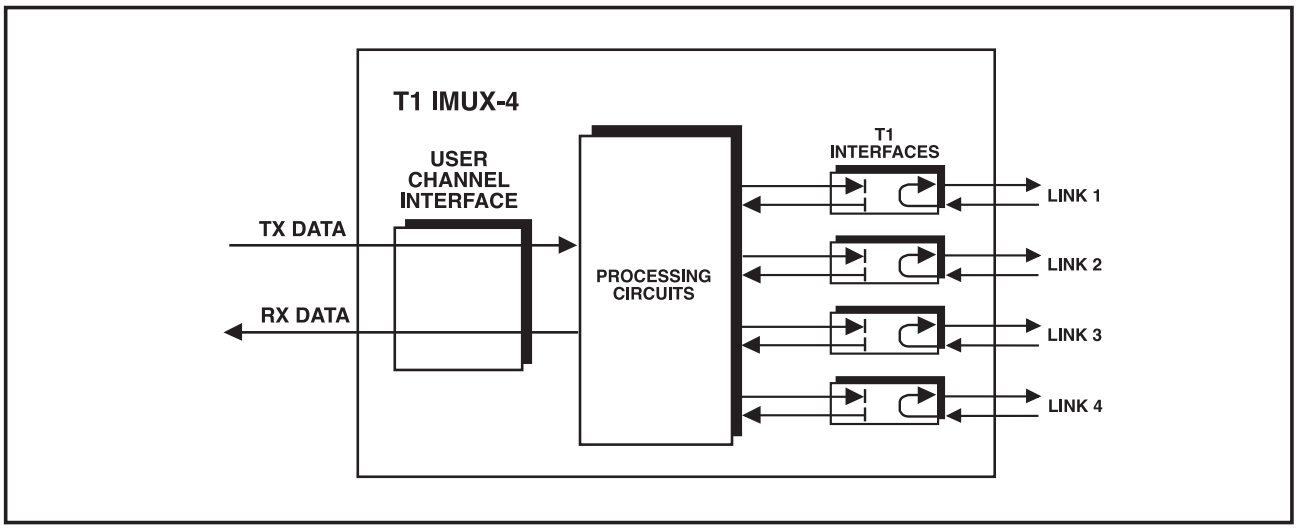

Figure 6-5. Latching Network Line Loopback.

The activation/deactivation code depends on the main link framing mode:

- *SF (D4)*—The network line loopback is activated when the IMUX-4 detects the continuous transmission of the repeating sequence 10000.... for at least 5 seconds, and is deactivated by the transmission of the sequence 100..... for at least 5 seconds.
- *ESF*—The network line loopback is activated when the IMUX-4 detects the pattern 00001110 11111111 on the FDL, and is disconnected by the reception of the pattern 00111000 11111111 (rightmost bit transmitted first). Alternately, the network line loopback is also activated by the pattern listed above for SF (D4) framing.

The latching network line loopback has priority over all the user-controlled loopbacks; therefore, when a network loopback command is received, the user-controlled loopbacks are disconnected. They are automatically reconnected when the network loopback disconnection command is received.

While the network line loopback is connected, the IMUX-4 displays NETWORKLLB.

Network PLB

The latching network payload loopback is connected when it receives the appropriate code from the network. Loopback connections are shown in **Figure 6-6**.

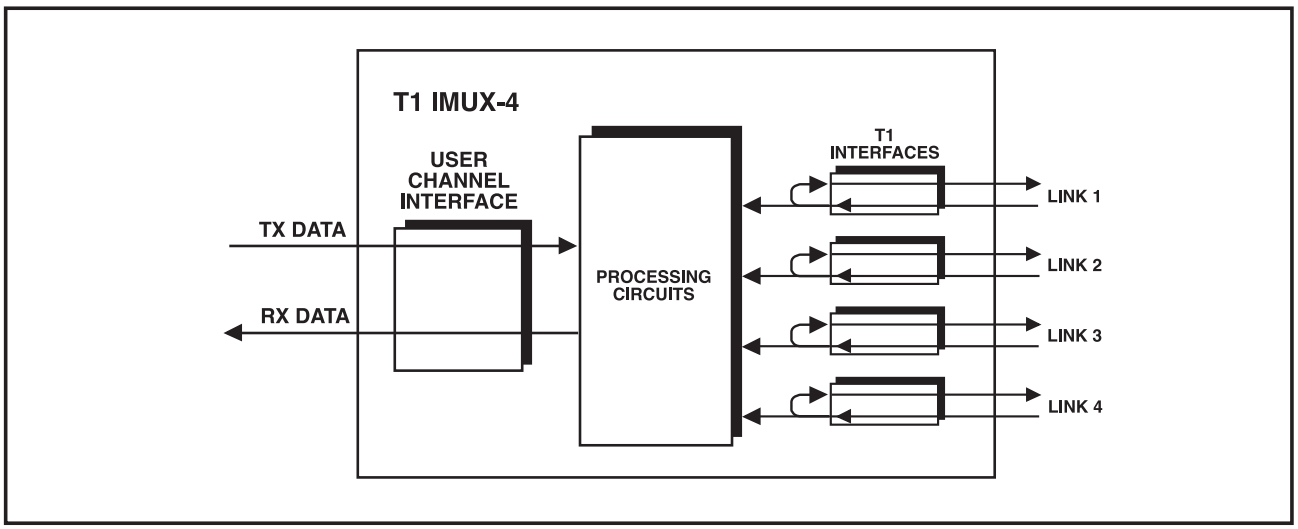

Figure 6-6. Latching Network Line Loopback.

The loopback can only be connected when ESF main link framing is used. The connection is performed by means of commands transmitted through the FDL link.

- The network payload loopback is activated when the IMUX-4 detects the pattern 00010100 11111111 on the FDL.
- The network payload loopback is disconnected when it receives the pattern 00110010 11111111 (rightmost bit transmitted first).

The latching network payload loopback has priority over all the user-controlled loopbacks. Therefore, when a network loopback command is received, the user-controlled loopbacks are disconnected; they are automatically reconnected when the network loopback disconnection command is received.

While the network line loopback is connected, the IMUX-4 displays NETWORK PLB.

6.5 Power-On Self Test

The IMUX-4 performs a self-test upon power-on. The self-test sequence, described in **Section 4.7**, tests the critical circuit functions and the display.

In case of failure, the IMUX-4 displays an alarm messages in the second row.

6.6 Troubleshooting Instructions

In case a problem occurs, check the displayed alarm messages and refer to **Section 6.2** and **Table 6-1** for their interpretation. If you cannot correct the trouble by performing the actions listed in **Table 6-1**, use **Table 6-2**: identify the trouble symptoms and perform the actions listed under "Corrective Measures" in the order given in **Table 6-3**, until the problem is corrected. If you need help, call for Technical Support.

Table 6-3. Troubleshooting Chart.

No	Trouble Symptoms	Probable Cause	Corrective Measures
1	The IMUX-4 is “dead”	1. No power	1. Check that both ends of the power cable are properly connected.
		2. Blown fuse	Disconnect power cable from both ends and replace the fuse with another fuse of proper rating.
		3. Defective IMUX-4	Replace the IMUX-4.
2	IMUX-4 reports red alarm	1. External problem	Activate the local link loopback. Check that the previously lit RED indicator turns OFF. If the indicator turns OFF, the problem is external.
		2. Defective IMUX-4	Perform power-on self-test and replace the IMUX-4 if it is defective.
3	IMUX-4 reports yellow alarm	1. Problem at remote end	Activate the local link loopback on the remote IMUX-4. Check that all the RED indicators turn OFF. If a RED indicator remains ON, replace the remote IMUX-4.
		2. Defective IMUX-4	Perform power-on self-test and replace the IMUX-4 if it is defective.
4	Local user’s DTE does not receive data	1. Cable problem	1. Activate the local data channel loopback. If the local DTE does not receive its own transmission, check the cable connecting it to the IMUX-4 DTE connector.
		2. Defective DTE	2. Perform self-test on the DTE.
		3. Defective IMUX-4	3. Perform power-on self-test and replace the IMUX-4 if it is defective.

7. 2T1/E1 IMUX Operation

The 2T1/E1 IMUX is a version of the T1 IMUX-4 inverse multiplexor that has an E1 data port and two T1 line interfaces. Since many of the characteristics of the 2T1/E1 IMUX are similar to those of the IMUX-4, this chapter covers only the differences between the two. For characteristics common to both versions, refer to the corresponding chapter of this manual.

NOTE

When interpreting information appearing in the other chapters of this manual for use with the IMUX-2, please remember that the term "user's data channel" indicates the E1 port of the IMUX-2.

7.1 Introduction

7.1.1 Functional Description

Purpose and Main Features

The 2T1/E1 IMUX allows transparent transmission of E1 data (2.048 Mbps) over two standard T1 (1.544 Mbps) lines, enabling E1 equipment to use T1 transmission facilities. The 2T1/E1 IMUX is completely transparent to the E1 framing pattern (it does not even synchronize to the E1 frame), so it can transmit E1 data streams using 256N or 256S, with or without CRC-4, and using any proprietary framing methods, as well as unframed data streams.

The 2T1/E1 IMUX can tolerate a differential delay of up to 16 msec between the two T1 lines, and it can automatically detect interchanging of T1 lines. You can route T1 lines used by a given 2T1/E1 IMUX over different paths or different facilities.

NOTE

Although the IMUX can tolerate differential delays up to 16 msec, the actual latency of an IMUX T1 link is similar to the maximum differential delay encountered on the T1 lines you are using.

Figure 7-1 shows a typical application for the 2T1/E1 IMUX, in which the 2T1/E1 IMUX is used to interconnect two E1 multiplexors via standard T1 lines.

Figure 7-1. Typical Application.

T1 Link Interface Characteristics

The 2T1/E1 IMUX link interfaces are similar to the link interfaces of the IMUX-4 (**Chapter 2**).

Each link interface has a built-in CSU.

E1 Port Interface Characteristics

The 2T1/E1 IMUX E1 port interface meets the requirements of CCITT Rec. G.703. The E1 port has a 120-ohm balanced line interface (one RJ-45 connector) and an unbalanced line interface (two BNC connectors).

Line coding is HDB3. The nominal balanced interface transmit level is ±3V, and the unbalanced interface transmit level is ±2.37V. The maximum line attenuation is up to 10 dB. Jitter performance complies with the requirements of CCITT Rec. G.823.

System Timing

The 2T1/E1 IMUX have five timing modes for maximum flexibility in system integration.

- *Transparent timing*—the T1 transmit clocks of both T1 links are locked to the E1 receive clock, and the E1 transmit clock is locked to the receive clock of T1 link 1 or link2.
- *External E1 timing*—the T1 transmit clocks of both T1 links and the E1 transmit clock are locked to the E1 receive clock.
- *Loopback timing*—the transmit clocks of both T1 links and the E1 transmit clock are derived from the receive clock of T1 link 1 or link 2.
- *Internal timing*—an internal oscillator with an accuracy of ±32 ppm is the source for all the E1 and T1 transmit clocks.
- *External station timing*—the source for both the E1 and T1 transmit clocks is an external clock signal. The 2T1/E1 IMUX requires a framed or unframed "all ones" 1.544 Mbps AMI- or B8ZS-coded signal.

The receive timing is always recovered from the receive data, on both the T1 and E1 sides.

Proprietary circuits on each side provide the jitter attenuation needed to meet the requirements of AT&TTR-62411 on the T1 side, and those of the CCITT Rec. G.823 on the E1 side.

In addition to a main system clock source, you can specify a fallback source, which is automatically selected in case the main source fails—for example, because of a loss of signal on the link selected as the main source.

Time Slot Mapping

The 32 time slots of the E1 frame are transparently transferred over the 2T1/E1 IMUX link. The time slots of the two T1 links are used as follows:

- The E1 time slots are inserted into the following 16 time slots of each T1 link: 2, 3, 5, 6, 8, 9, 11, 12, 14, 15, 17, 18, 20, 21, 23, 24.
- T1 time slots 4, 7, 10, 13, 16, 19, and 22 of each T1 link carry the idle code (7F hex).
- T1 time slot 1 carries 2T1/E1 IMUX management and link supervision data.

7.1.2 Operating Environment

This section describes the E1 environment, to provide the background for information required for the understanding of the 2T1/E1 IMUX configuration parameters. For a description of the T1 environment, see **Section 2.1.2**.

The E1 port interface of the 2T1/E1 IMUX complies with the applicable requirements of CCITT Rec. G.703 and G.823.

E1 (CEPT) Signal Structure

The E1 line operates at a nominal rate of 2.048 Mbps. The data transferred over the E1 line is organized in frames. Each E1 frame includes 256 bits. The E1 frame format is shown in **Figure 7-2**.

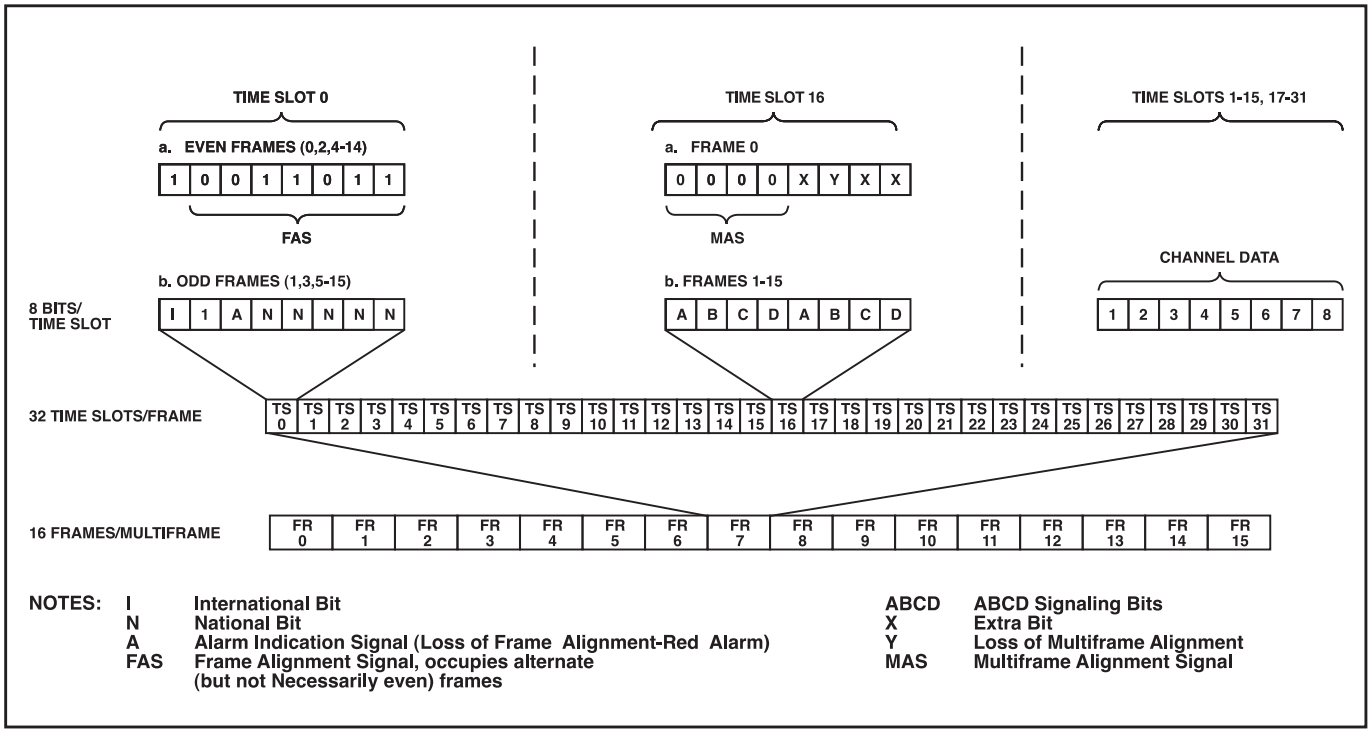

Figure 7-2. E1 (CEPT) Frame Format.

The 256 bits consist of 32 time slots of eight bits each, which carry the data payload. The frame repetition rate is 8,000 per second, so the data rate supported by each time slot is 64 kbps. The number of time slots available for user data is a maximum of 31, because time slot 0 is always used for E1 frame synchronization.

The frames are organized in larger patterns, called multiframes. Two types of multiframes are generally used: G.732N, which includes 2 frames, and G.732S, which includes 16 frames.

- The G.732N multiframe is generally used when time slot 16 is available to the user, or serves for the transmission of end-to-end signaling using common-channel signaling (CCS).
- The G.732S multiframe is generally used when time slot 16 serves for the transmission of end-to-end signaling using channel-associated signaling (CAS). CAS is typically used on links that transfer voice channels.

  Since the 2T1/E1 IMUX transfers the E1 frames transparently, it is not sensitive to the framing method used, and can even transfer unframed data.

E1 (CEPT) Line Signal

The E1 line signal is coded using the High-Density Bipolar 3 (HDB3) coding rules. The HDB3 coding format is an improvement of the alternate mark inversion (AMI) code.

In the AMI format, "ones" are alternately transmitted as positive and negative pulses, whereas "zeros" are transmitted as a zero voltage level. The AMI format cannot transmit long strings of "zeros," because such strings do not carry timing information.

The HDB3 coding rules restrict the maximum length of a "zero" string to 3 pulse intervals. Longer strings are encoded at the transmit end to introduce non-zero pulses. To allow the receiving end to detect these artificially-introduced pulses and to enable their removal to restore the original data string, the encoding introduces intentional bipolar violations in the data sequence. The receiving end detects these violations, and when they appear to be part of an encoded "zero" string, it removes them. Other bipolar violations are probably caused by line errors, and can be counted separately, to obtain information on the quality of the transmission link.

E1 (CEPT) Line Alarm Conditions

- *Alarm indication signal (AIS).* The AIS signal is an unframed "all-ones" signal, and is used to maintain line signal synchronization in case of loss of input signal, for example, because an alarm condition occurred in the equipment that supplies the line signal. The equipment receiving an AIS signal loses frame synchronization.
- *Loss of frame alignment* (also called loss of synchronization). This condition is declared when too many errors are detected in the frame alignment signal (FAS). Since the 2T1/E1 IMUX transfers the E1 frame transparently, irrespective of its structure, it need not retrieve the frame alignment signal, and therefore this alarm is not relevant and not supported.
- *Excessive bit error rate.* The bit error rate is measured on the frame alignment signal. Since the 2T1/E1 IMUX does not retrieve the frame

alignment signal, this alarm is not supported.

7.1.3 2T1/E1 IMUX System Application Considerations

This section explains application considerations specific to the 2T1/E1 IMUX. For general application considerations, see **Section 2.3**.

System Timing Considerations

This section describes the timing modes offered by the 2T1/E1 IMUX. The 2T1/E1 IMUX has five system timing modes:

- Internal timing.
- External (station) timing.
- Loopback timing.
- External E1 timing.
- Transparent timing.

Internal Timing

With internal timing, the system clock of the 2T1/E1 IMUX (which determines the T1 transmit clock signals and the E1 outgoing clock signal) is derived from a free-running internal crystal oscillator with an accuracy of ±32 ppm. **Figure 7-3** shows the flow of timing signals in the internal timing mode.

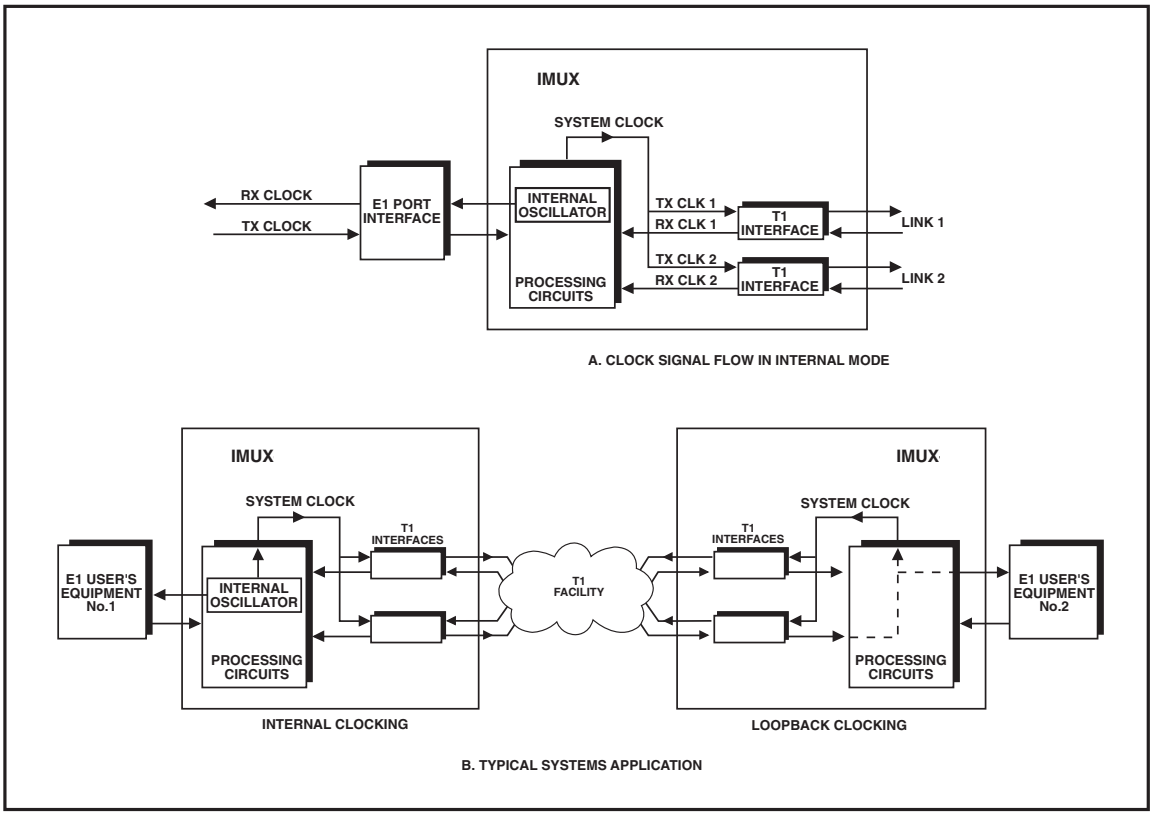

Figure 7-3. Flow of Timing Signals in Internal Timing Mode.

Part A of **Figure 7-3** shows the flow of timing signals in the 2T1/E1 IMUX using the internal timing mode. When internal clocking is used by an 2T1/E1 IMUX, the 2T1/E1 IMUX at the remote end of the link must use loopback timing, as shown in **Part B** of **Figure 7-3**.

NOTE

The receive paths of the T1 link interfaces work with their own recovered clocks. These clock signals must be derived from the same source.

Loopback Timing

With loopback timing, the system clock (which determines the T1 transmit clock signals and the E1 outgoing clock signal) is locked to the recovered receive clock signal of a user-selectable T1 link. **Part A** of **Figure 7-4** shows the flow of timing signals in an 2T1/E1 IMUX using the loopback timing mode, when the timing source is the recovered clock signal of T1 link interface 2.

Since the network reference clock of most T1 carriers is locked to a master clock with high accuracy and stability, the use of loopback timing at both ends of a link is a simple and effective means for locking the system clocks of the two 2T1/E1 IMUX units to the T1 network clock. This application is illustrated in **Part B** of **Figure 7-4**.

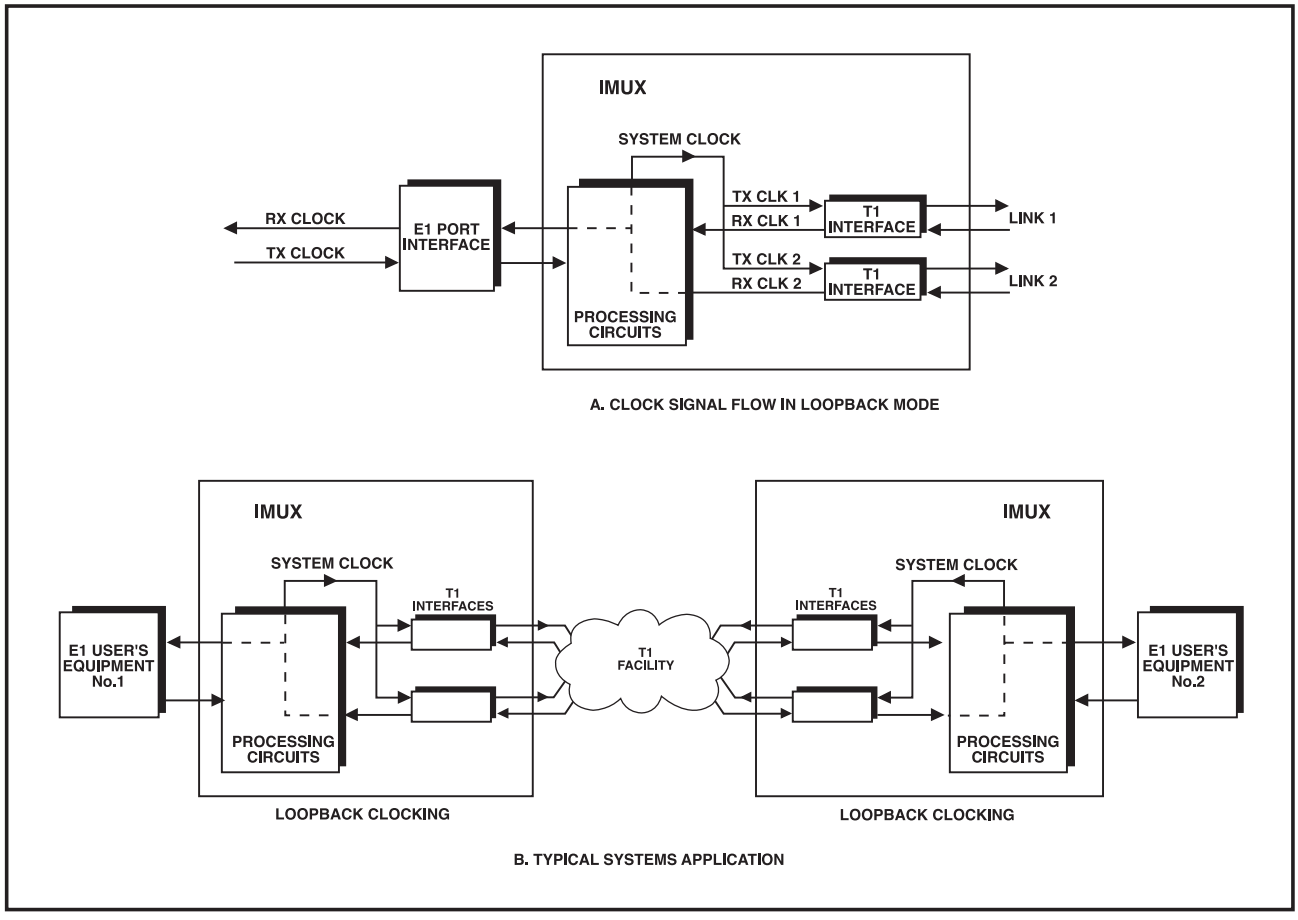

Figure 7-4. Flow of Timing Signals in Loopback Timing Mode.

External (Station) Timing

With external timing, the system clock (which determines the T1 transmit clock signals and the E1 outgoing clock signal) is locked to an external ("station") clock signal. The external clock interface is available in a separate RJ-45 connector, designated STATION CLK. The external clock interface accepts a balanced unframed "all-ones" AMI or B8ZS signal having a nominal rate of 1.544 Mbps, and the maximum acceptable tolerance is ±130 ppm.

Part A of **Figure 7-5** shows the flow of timing signals in an 2T1/E1 IMUX using the station timing mode.

NOTE

The receive paths of the T1 link interfaces work with their own recovered clocks. These clock signals must be derived from the same source.

When external clocking is used by an 2T1/E1 IMUX, the 2T1/E1 IMUX at the remote end of the link must use either loopback timing, or external timing derived from the same timing source that provides the timing signal for the other 2T1/E1 IMUX. An external (station) clock signal is usually available in locations that include higher-level multiplexors—for example, T3 multiplexors. **Part B** of **Figure 7-5** shows the flow of timing signals in a system that uses station timing at one end of the link, and loopback timing at the other end of the link.

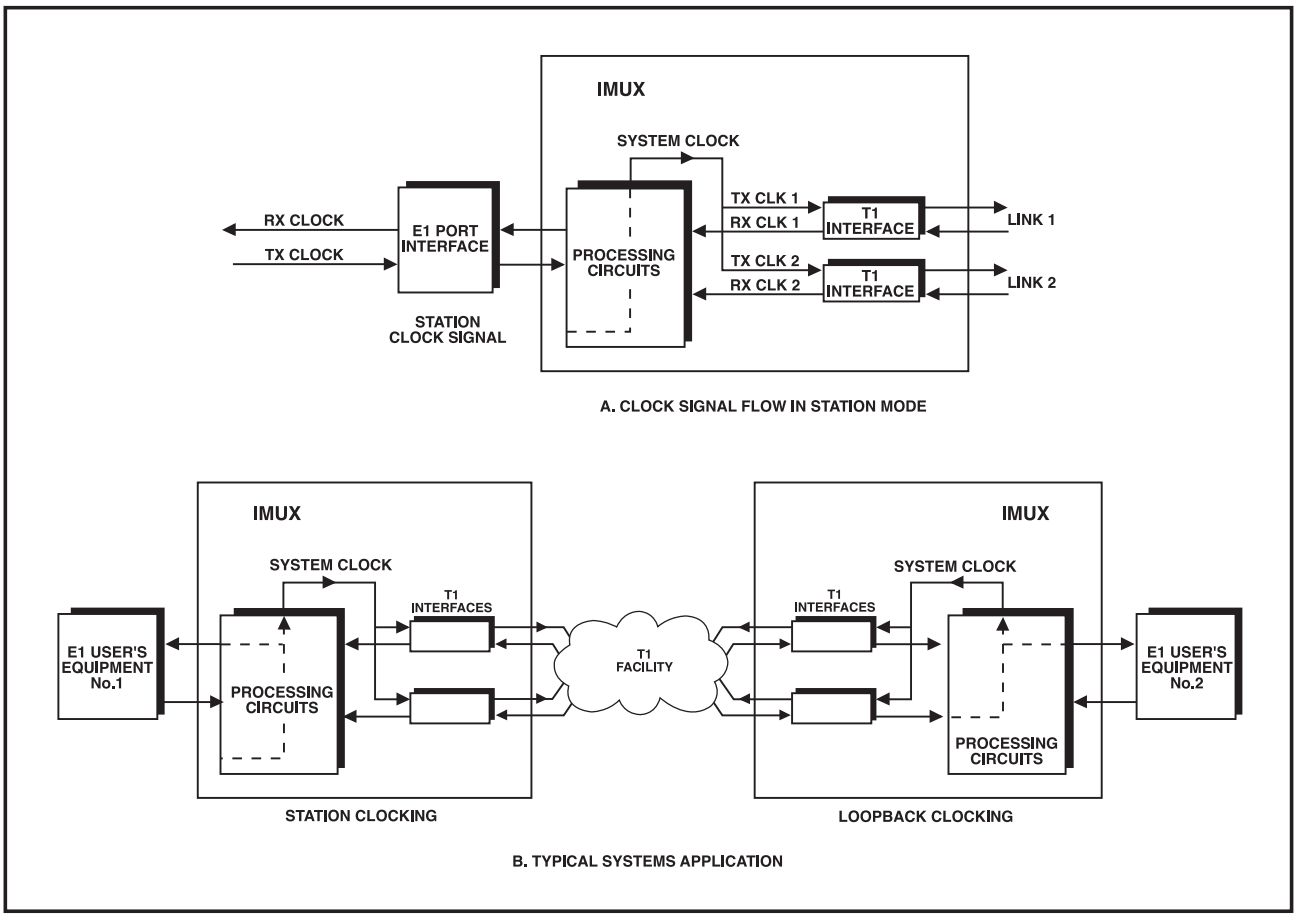

Figure 7-5. Flow of Timing Signals in Station Timing Mode.

External E1 Timing

With external E1 timing, the system clock (which determines the T1 transmit clock signals and the E1 outgoing clock signal) is locked to the E1 incoming signal, provided by the E1 equipment connected to the E1 port of the 2T1/E1 IMUX.

Part A of **Figure 7-6** shows the flow of timing signals in an 2T1/E1 IMUX using the external E1 timing mode.

NOTE

The receive paths of the T1 link interfaces work with their own recovered clocks. These clock signals must be derived from the same source as the source of the E1 clock.

When external E1 clocking is used by an 2T1/E1 IMUX, the 2T1/E1 IMUX at the remote end of the link must use either loopback timing, or external timing derived from the same timing source that provides the timing signal for the other 2T1/E1 IMUX. **Part B** of **Figure 7-6** shows the flow of timing signals in a system that uses external E1 timing at one end of the link, and loopback timing at the other end of the link.

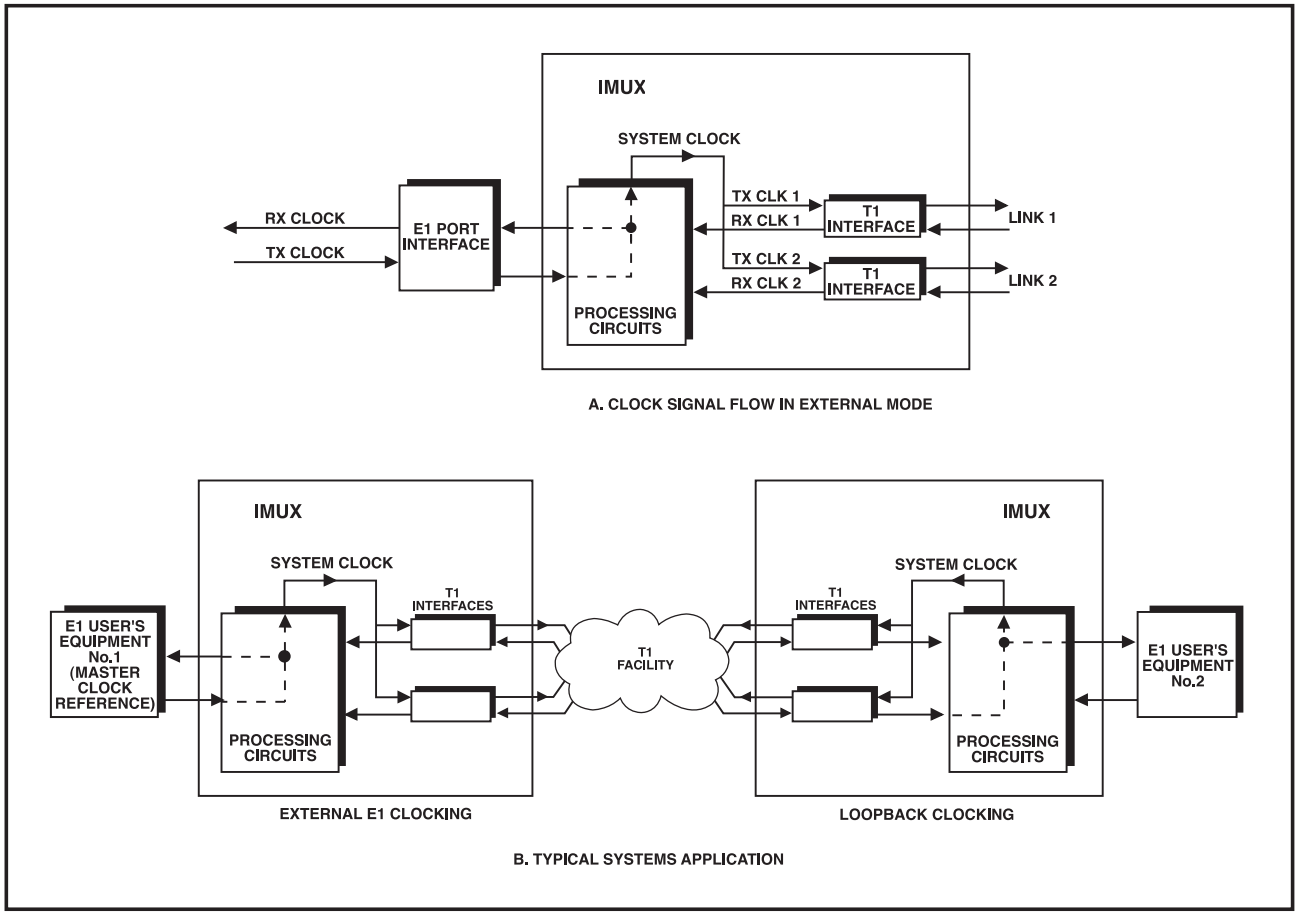

Figure 7-6. Flow of Timing Signals in External E1 Timing Mode.

Transparent Timing

With transparent timing, the system clock and the transmit clock signals for the T1 links are locked to the E1 incoming signal, provided by the E1 equipment connected to the E1 port of the 2T1/E1 IMUX, whereas the E1 outgoing clock is locked to the receive clock of a user-selected T1 link. **Part A** of **Figure 7-7** shows the flow of timing signals in an 2T1/E1 IMUX using the transparent timing mode.

NOTE

With transparent timing, the timing is transparently transferred through the link. Therefore, when transparent timing is used at the two ends of the link, it is possible to lock the timing of the equipment connected in the link either to the timing provided by the E1 equipment, as shown in Part B of Figure 7-7, or to the T1 network timing, as shown in Part C of Figure 7-7.

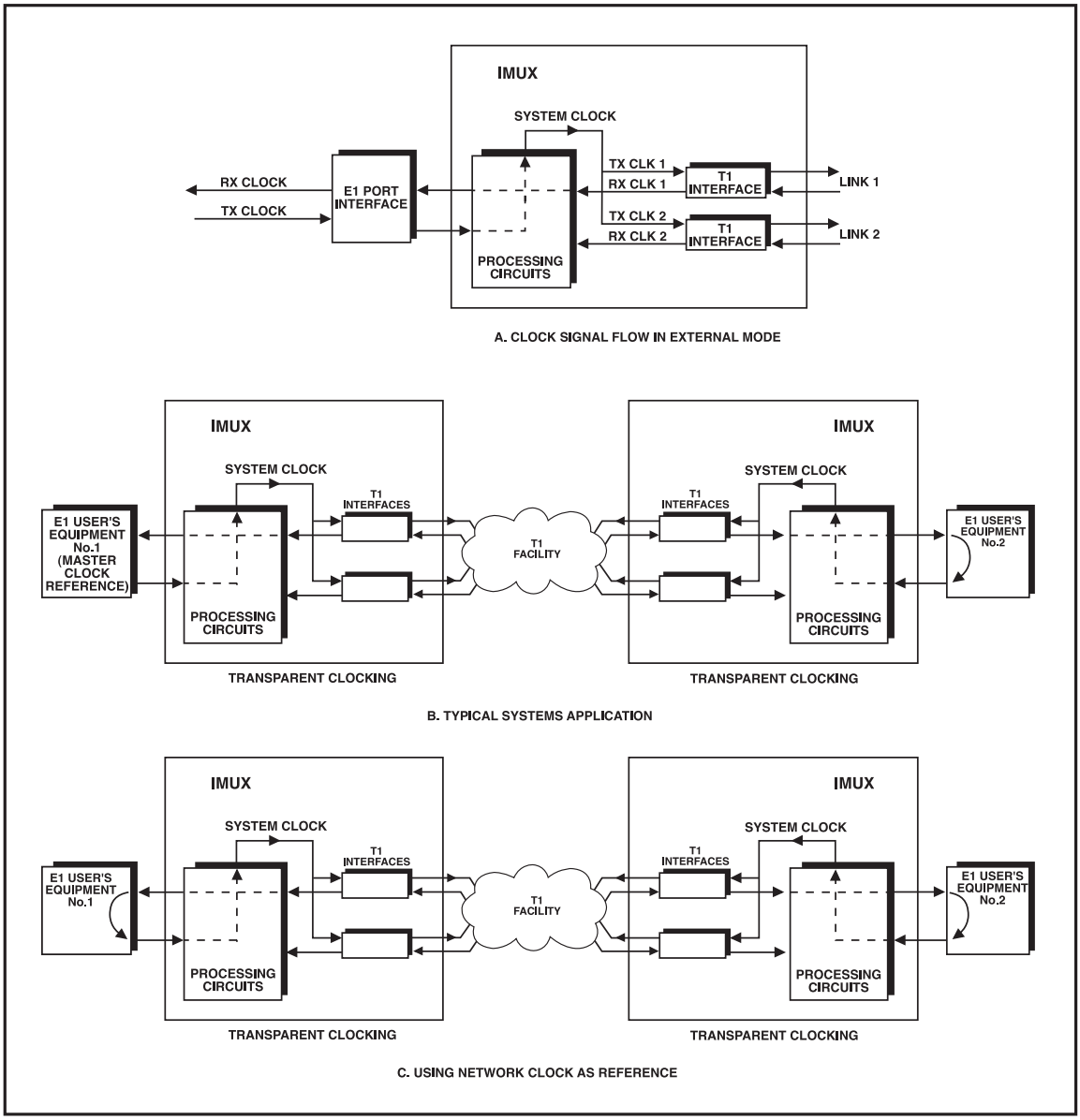

Figure 7-7. Flow of Timing Signals in Transparent Timing Mode.

Main/Fallback Timing Sources

To prevent the loss of system timing in case the selected timing source fails, the 2T1/E1 IMUX will automatically switch to internal timing, for example, because of a loss of signal condition on the link selected as the main source.

To ensure that the system timing integrity is not lost in case the main timing source fails, you can specify an additional timing source as a fallback source. The source you select as a fallback source is automatically selected in case the main source fails (if the fallback source fails, the 2T1/E1 IMUX will automatically switch back to the main source).

Interaction Between E1 and T1 Links

In case of a problem on the T1 side, the 2T1/E1 IMUX will send an AIS signal on the E1 side. The AIS signal is sent in the following cases:

- Loss of either T1 input signal.
- Loss of local frame synchronization on either T1 link.
- Reception of the AIS signal on either T1 link.

7.2 Installing the 2T1/E1 IMUX

7.2.1 Site Requirements

Refer to **Section 3.3**.

7.2.2 Configuration Information

General

This section provides information on the functions of the internal jumpers specific to the 2T1/E1 IMUX.

Before installing the 2T1/E1 IMUX, check the positions of its internal jumpers and switches. If necessary, change the settings according to the specific requirements of your application.

WARNING

HIGH VOLTAGES! Disconnect the unit from the power line and from all the cables before removing the cover. Dangerous high voltages are present inside the IMUX when it is connected to power or to the links.

If possible, avoid adjusting, maintaining, or repairing the unit when it is open and under voltage. Only a skilled person who is aware of the hazard involved should attempt to adjust, maintain, or repair the unit. Capacitors inside the unit may still be charged even after the unit is disconnected from its power source.

CAUTION

The IMUX contains components sensitive to electrostatic discharge (ESD). To prevent ESD damage, avoid touching the internal components, and before moving jumpers, touch the IMUX frame.

Opening the Case

Refer to **Section 3.4**.

Construction

Figure 7-8 shows the construction of the 2T1/E1 IMUX. The main components for the 2T1/E1 IMUX are the motherboard, two T1 link interface boards, and the E1 port interface board.

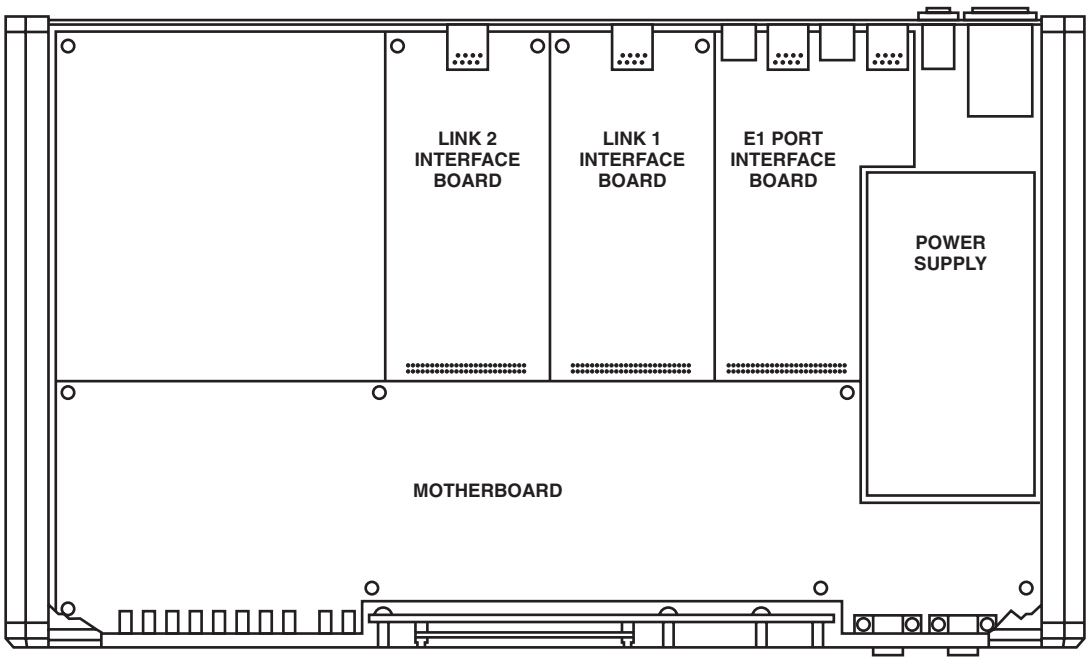

Figure 7-8. Construction of the IMUX.

Motherboard Jumpers and Switch, Location and Functions

The jumpers and switches located on the motherboard are identified in **Figure 7-9**. Their functions are described in **Figure 3-4**.

In addition to the jumpers listed below, the IMUX has additional jumpers that are set by the manufacturer and must not be changed by you.

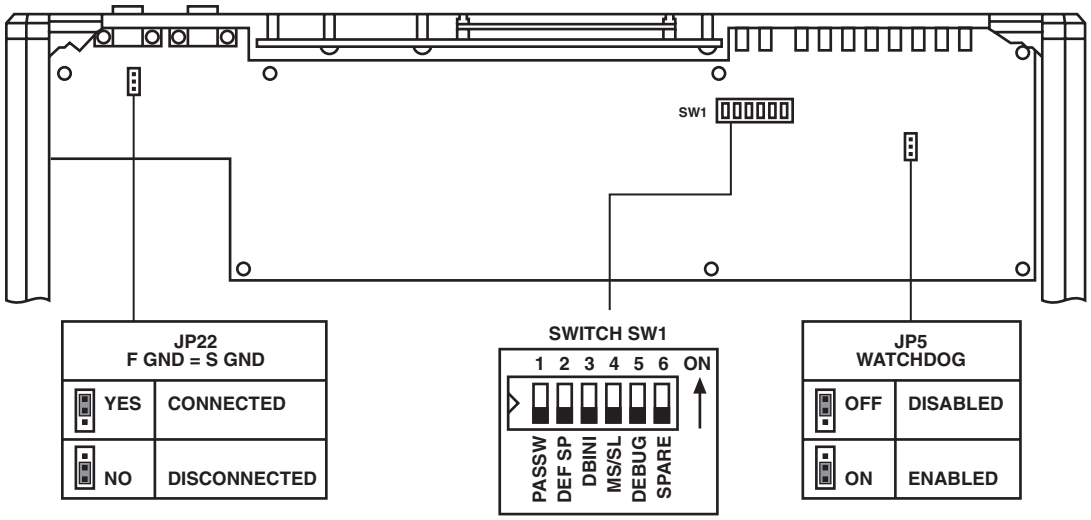

Figure 7-9. IMUX Motherboard, Internal Settings.

T1 Link Interface Boards

Refer to **Section 3.4**.

E1 Port Interface Board

The E1 port interface board includes several user-selectable jumpers. These jumpers are identified in **Figure 7-10**.

Termination Selection Jumpers

The jumpers JP3, JP4, JP5, JP6, and JP7 are used to select the E1 port interface. **The jumpers must always be set to the same position.**

- **B**—for operation with the balanced interface.
- **U**—for operation with the unbalanced interface.

The IMUX is shipped with all the jumpers set at B.

Transmit Side Frame Ground Reference, Jumper TFGND JP8

The TFGND jumper is used to connect the outer contact of the E1 RX OUT BNC connector to the frame ground reference of the E1 port output when the unbalanced interface is used.

In accordance with CCITT recommendations, the jumper is installed when the unbalanced interface is used.

The IMUX is shipped with the jumper not installed (operation with balanced interface).

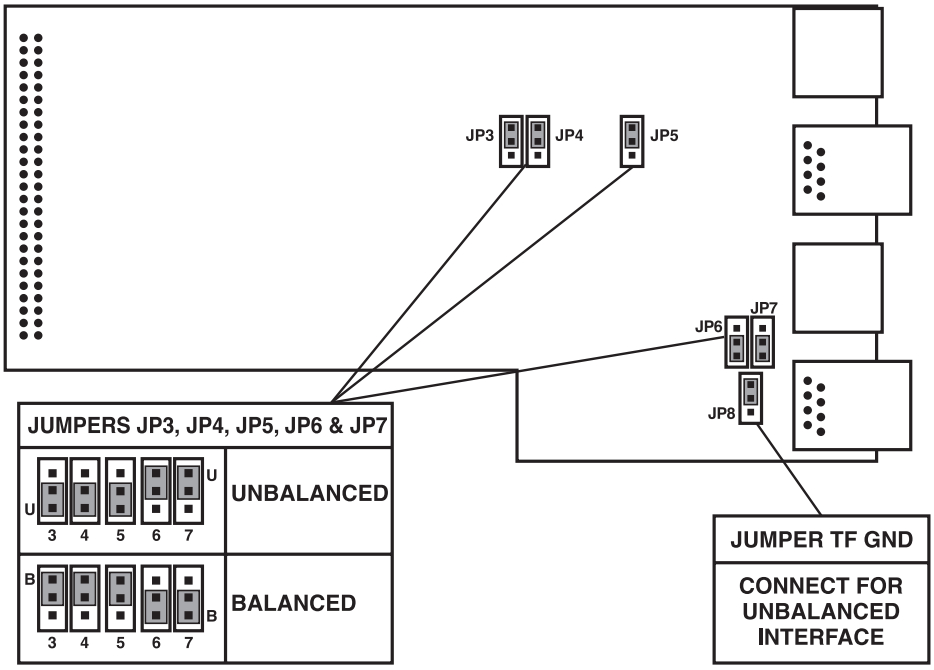

Figure 7-10. E1 Port Interface Board, Internal Settings.

Internal Settings Procedure

Refer to **Figures 7-9** and **7-10**, and identify jumper and switch locations and settings. Change settings as required.

After completing the internal settings, reinstall the top cover of the IMUX and fasten it to the rear panel via the large rear-panel screw.

7.2.3 Installation in 19" Racks

Refer to **Section 3.5**.

7.2.4 IMUX Connections

Connector Locations

Figure 7-11 shows the rear panel of an AC-powered IMUX and identifies connector locations.

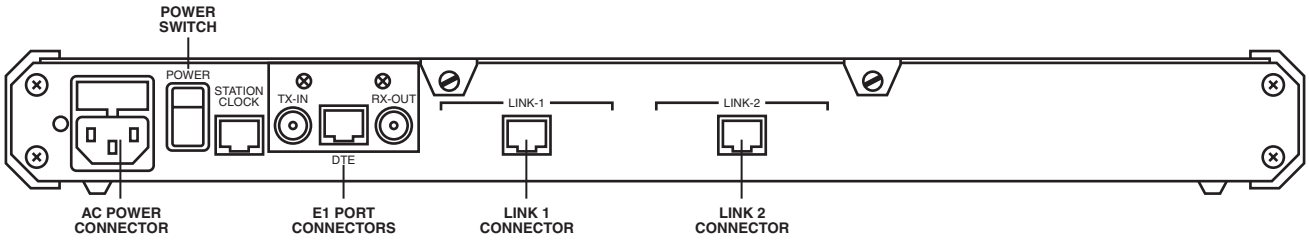

Figure 7-11. Rear Panel.

Grounding

Any interruption of the protective (grounding) conductor (inside or outside the unit) or disconnecting the protective earth terminal can make this instrument dangerous. Do not intentionally interrupt the grounding.

Before switching on the 2T1/E1 IMUX and before connecting any other cable, connect the protective earth terminals of the 2T1/E1 IMUX to the protective ground conductor of the (mains) power cord. The mains plug must only be inserted in a socket outlet provided with a protective earth contact. The protective action must not be negated by using an extension cord (power cable) without a protective conductor (grounding).

WARNING

Make sure that only fuses with the required rated current, as marked on the rear panel, are used as replacements. Avoid using repaired fuses and short-circuiting fuse holders.

Whenever it is likely that the protection offered by fuses has been impaired, make the IMUX inoperative and secure it against unintended operation.

Power Connection

Refer to **Section 3.6**.

Link Connections

Refer to **Section 3.6**.

Station Clock Connection

Refer to **Section 3.6**.

E1 Port Connection

Connect the E1 port cable(s) to the connector(s) corresponding to the interface you are using. **Do not connect to both the balanced and unbalanced connectors of the E1 port.**

- When using the balanced interface, connect to the RJ-45 connector.
- When using the unbalanced interface, connect to the two BNC connectors designated RX-OUT and TX-IN.
  - Make sure you connect the cable from the transmit (outgoing signal) connector of the E1 equipment to the incoming signal connector, TX-IN, of the E1 port.
  - Make sure you connect the cable from the receive (incoming signal) connector of the E1 equipment to the outgoing signal connector, RX-OUT, of the E1 port.

Supervisory Port Connection

Refer to **Section 3.6**.

7.3 Front-Panel Operating Instructions

7.3.1 Front Panel

The 2T1/E1 IMUX front panel is identical to the IMUX-4 front panel, shown in **Figure 4-1**.

NOTE

The DTE RD and TD indicators show activity on the E1 port receive output and transmit input, respectively.

The functions of the other controls, connectors, and indicators are identical to the functions of the corresponding IMUX-4 items, explained in **Table 4-1**, except the LINK ALARM indicators for links 3 and 4 are not used. Refer to **Section 4.2**.

7.3.2 Front Panel Operating Instructions

The operating instructions for the 2T1/E1 IMUX are similar to the operating instructions for the IMUX-4, which are covered in **Sections 4.3** through **4.10**. These are the differences:

- The IMUX will display its name (2T1/E1 IMUX) and software revision during power-on self-test.
- The 2T1/E1 IMUX has only two links, so if you try to display parameters for link 3 or 4, the 2T1/E1 IMUX will display ERROR 4.
- The clock source selections for the master and fallback timing references are as follows:
  - **LNK1—**Locked to the recovered receive clock of link 1.
  - **LNK2—**Locked to the recovered receive clock of link 2.
  - **TRAN—**Transparent timing.
  - **EXT—**Locked to the recovered incoming clock of the E1 port.
  - **ST—**External clock signal connected to STATION CLK connector.
  - **INT—**Internal oscillator (available only for master reference).

7.4 Control of IMUX Operation from Supervisory Port

The supervisory terminal operating instructions for the 2T1/E1 IMUX are similar to the operating instructions for the IMUX-4, which are covered in **Chapter 5**. These are the differences:

- The prompt displayed by the 2T1/E1 IMUX is **2T1/E1 IMUX>**.
- The 2T1/E1 IMUX has only two links, so the commands that list the available links show N/A for links 3 and 4. If you try to display parameters for link 3 or 4, the 2T1/E1 IMUX will display CONFIG ERROR 4.
- Commands referring to the user's data channel (CH) apply to the E1 port.

- The clock source selections for the master and fallback timing references are as listed in **Section 7.10**.
- The list of alarm messages includes the additional three messages shown in **Table 7-1**, specific to the 2T1/E1 IMUX.

Table 7-1. List of Alarm Messages.

Alarm No.	Alarm Syntax	Meaning	Status	Time
35	CH BPV ERROR	A bipolar error has been detected on the E1 port interface. This message usually indicates a problem on the link to the equipment connected to the E1 port.	[ON]	hh:mm:ss
36	CH AIS RED ALARM	An unframed “all-ones” signal is received at the E1 port interface. This message usually indicates a problem in the equipment connected to the E1 port.	[ON][OFF]	hh:mm:ss
37	CH SIGNAL LOSS	Loss of signal on the E1 port interface. This problem could be caused by improper connection of cables between the E1 port and the E1 equipment, or by defective cables. If the connection between the E1 port and the E1 equipment is made via additional communication equipment, check this equipment as well.	[ON][OFF]	hh:mm:ss

7.5 IMUX Diagnostics

The diagnostic functions for the 2T1/E1 IMUX are similar to the diagnostic functions for the 2T1/E1 IMUX, which are covered in **Chapter 6**, except that the 2T1/E1 IMUX has only two links, so all the commands related to links 3 and 4 are disregarded.

NOTE

The loop commands referring to the user's data channel (CH) now apply to the E1 port.

7.6 2T1/E1 IMUX Connectors

T1 Link Connectors

The wiring of the T1 link connectors of the 2T1/E1 IMUX is given in **Table A-1**.

E1 Port Connectors

The E1 port has two BNC connectors, designated RX-OUT and TX-IN, for the unbalanced interface, and one RJ-45 connector for the balanced interface. The connectors are wired as shown in **Table 7-2**.

Table 7-2. E1 Port Connector Wiring.

Function	RJ-45 Pin	BNC Connector
Receive Data Output (A wire)	1	RX-OUT center contact
Receive Data Output (B wire)	2	RX-OUT outer contact
Frame Ground	3	
Transmit Data Input (A wire)	4	TX-IN center contact
Transmit Data Input (B wire)	5	TX-IN outer contact
Frame Ground	6	

Appendix A: Connector Wiring

A.1 T1 Link Connectors

The T1 LINK connectors have 8-pin RJ-45 connectors, wired according to **Table A-1**.

Table A-1. LINK Connectors, Pin Allocation.

Pin	Line Connector Pin Function
1	Receive Data (A wire)
2	Receive Data (B wire)
3	Frame Ground
4	Transmit Data (A wire)
5	Transmit Data (B wire)
6	Frame Ground
7, 8	Not Connected

A.2 V.35 User Data Channel Connector

The IMUX-4 has a 34-pin female connector wired according to **Table A-2**.

Table A-2. V.35 User Data Channel Connector Pinout.

Pin	Direction	Designation	Function
A	PG	<—>	Protective Ground
B	SG	<—>	Signal Ground
C	RTS	To IMUX-4	Request to Send
D	CTS	From IMUX-4	Clear to Send
E	DSR	From IMUX-4	Data Set Ready
F	DCD	From IMUX-4	Data Carrier Detect
P	TDA	To IMUX-4	Transmit Data (A wire)
R	RDA	From IMUX-4	Receive Data (A wire)
S	TDB	To IMUX-4	Transmit Data (B wire)
T	RDB	From IMUX-4	Receive Data (B wire)
U	ETCA	To IMUX-4	External Transmit Clock (A wire)
V	RCA	From IMUX-4	Receive Clock (A wire)
W	ETCB	To IMUX-4	External Transmit Clock (B wire)
X	RCB	From IMUX-4	Receive Clock (B wire)
Y	TCA	From IMUX-4	Transmit Clock (A wire)
Z	ERCB	To IMUX-4	External Receive Clock (B wire)
AA	TCB	From IMUX-4	Transmit Clock (B wire)
BB	ERCA	To IMUX-4	External Receive Clock (A wire)

A.3 RS-232 (V.24) Supervisory Port Connector

The IMUX-4 supervisory port has a standard RS-232 interface. The physical interface is a 9-pin female connected wired according to **Table A-3**.

Table A-3. Supervisory Port Interface Signals (CCITT V.24/EIA RS-232 Interface).

Pin	Line	Notes	Connected to Terminal	Connected to Dial-Out Modem
1	Data Carrier Detect (DCD)	From IMUX-4	8	4
2	Receive Data (RD)	From IMUX-4	3	2
3	Transmit Data (TD)	To IMUX-4	2	3
4	Data Terminal Ready (DTR)	To IMUX-4	20	6
5	Signal Ground (SG)	Common reference. Can be isolated from chassis ground (AA) (strap-selectable)	7	7
6	Data Set Ready	From IMUX-4	6	20
7	Request to Send (RTS)	To IMUX-4	4	8
8	Clear to Send (CTS)	From IMUX-4	5	—
9	Ring Indicator (RI)	To IMUX-4	—	22

A.4 Station Clock Connector

The station clock port physical interface is an RJ-45 connector, wired according to **Table A-4**.

Table A-4. V.35 User Data Channel Connector Pinout.

Pin	Designation	Function	Direction
1	CLK (T)	Station clock (tip)	To IMUX-4
2	CLK (R)	Station clock (ring)	To IMUX-4
3	N/A	N/A	N/A
4	N/A	N/A	N/A
5	N/A	N/A	N/A
6	N/A	N/A	N/A
7	N/A	N/A	N/A
8	N/A	N/A	N/A

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