Addendum: 2531/2531A T1 Echo Canceller Modules

1. General

1.01 This addendum to practice section 812531/2531A, revision B (dated 2 December 1986) identifies the difference between the 2531/A and the 2531IS and 2531AIS. In addition, this addendum clarifies the following:

- Information concerning the 62 X system option.
- Nonvolatile memory updating.
- A&B signaling interpretation.
- Non-signaling modes.

Reconditioned 812531IS and 812531AIS Modules

1.02 The 812531IS and 812531AIS modules are reconditioned units. All specifications are identical to the 81.2531/A. The standard 2 year warranty for the 81.2531/A also applies to the 81.2531IS and the 81.2531AIS.

Framing Bit Error Control (System Mode 62.X)

1.03 the 62.X system option operates in the reverse manner as described in the Technical Manual. That is, the 62.0 parameter causes F-bit errors to be corrected, and the 62.1 parameter causes F-bit errors to be regenerated.

Nonvolatile Memory

1.04 the nonvolatile memory in the 2531/A receives updated only after the three-digit System Mode display has been advanced to the next system option. For example, if system option 40.X is changed from 40.1 to 40.2, the nonvolatile memory is not updated until the channel display is advanced to the 5.32 system option. The last three-digit option, 89.X, is updated at the blank display. To ensure that all system options are stored, always advance the channel window to the blank display after configuring the 2531/A.

2. Application

A&B Signaling Interpretation

2.01 The 2531/A monitors A&B signaling to determine when a channel is busy or idle. correct interpretation of the A&B signaling is essential for proper activation of both the self-test routine and the echo cancellation. When a channel is busy (either A or B = 1 for E&M signaling), the self-test routine is inhibited, and cancellation is activated.

2.02 When a channel is idle (A=B=0 for E&M signaling), the channel is placed in clear channel operation. In clear channel operation, cancellation is deactivated, and the self-test routine is performed. Transmission is maintained through the echo canceller, although the far-end is no longer protected from echo.

Non-Signaling Modes

2.03 The force active mode activates cancellation and inhibits the self-test routine regardless of the state of the A&B signaling bits. Single or multiple channels of the 2531/A can be forced active from the front-panel or the RS-232-C remote control port. Channels that are forced active can be disabled by the presence of a 2100Hz disabling tone.

2.04 The clear channel mode deactivated cancellation regardless of the state of the A&B signaling bits Single or multiple channels can be placed into clear channel operation from the front-panel or the RS-232-C remote control port. The self test routine is activated, and transmission is maintained throughout the echo canceller. However, the far-end is no longer protected from echo.

2.05 Although signaling detection is over-ridden in both force active clear channel operation, the A&B signaling bit stream is passed unaltered through the 2531/A when it is optioned for CAS signaling.

2531 and 2531A T1 Echo Canceller Modules

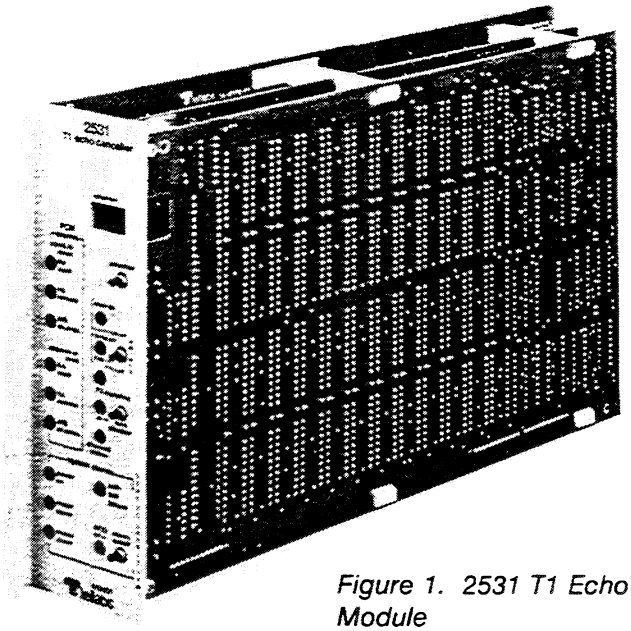

Figure 1. 2531 T1 Echo Canceller Module

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1. General Description

1.01 The 2531 and 2531A T1 Echo Canceller Modules (figure 1) are adaptive, split-type echo-control systems that directly interface 1.544 Mb/s T1 digital carrier facilities at the DS1 level. A single module provides individual echo control for all 24 channels of a T1 facility. The only difference between the 2531 and 2531A Modules (referred to collectively as 2531/2531A) is that the 2531 operates with an end-path delay of up to 32ms, whereas the 2531A operates with an end-path delay of up to 64ms. (Keep in mind that this is the delay between the 2531/2531A and the **near**-end station — the amount of delay between near-end and far-end stations has no effect on the canceller.)

1.02 The 2531 2531A monitors the busy idle status of each channel and performs comprehensive self tests on idle channels. If a channel fails self-test, the module bypasses that channel around all echo-cancellation circuitry, ensuring that service is maintained, albeit with possible echo.

1.03 If power is interrupted or if the module's internal power supply fails, metallic T1 bypass relays in the 2531 2531A route the send and receive PCM streams around the canceller. This bypass can also be effected manually via the RS-232-C remote control interface. In the event of a power loss, all programmed system and channel parameters are retained in nonvolatile memory (EEROM). When power is reapplied, the 2531 2531A runs power-up diagnostics, and commences operation as configured prior to the power interruption.

2531/2531A Module Features

- The 2531 operates with an end path of up to 32ms of delay
- The 2531A includes all the features of the 2531, with the added capability of operating with an end path having a delay of up to 64ms
- T1 interfacing at DSX-1 level
- Choice of standard or extended superframe format
- AMI with bit-7 stuffing to suppress all zero code or B8ZS line coding
- Channel and System operating modes can be programmed and monitored via either the front panel or the RS-232-C link
- Can operate as a stand-alone system; microprocessor control monitors the signaling for channel idle/busy status
- All front-panel programmed configurations stored in nonvolatile memory
- Choice of E&M or FX signaling on each channel
- Front-panel red alarm (RA), yellow alarm (YA) and alarm indication signal (AIS) LED's
- Switch-selectable T1 receive out and send out CO equalizers
- Echo cancellation in each channel can be individually disabled via 2100Hz tone
- Routine automatic testing of idle channels
- Nonlinear processor removes residual echo (which is less than -40dBm0) after cancellation
- The 2531 can be physically removed from its mounting without affecting T1 transmission

2531/2531A Module Accessories

- 253A prewired mounting assembly; for 253A accessories see the 8X.0253A practice
- 95 5003 prewired bay; includes eight 253A prewired mounting assemblies (Contact Tellabs for custom prewired bays)

2. Application

Note: *The 2531/2531A modules are not intended for use with SF Bypass.*

2.01 The 2531/2531A is intended for use on T1 circuits with an echo return loss (ERL) of at least 6dB. During singletalk (one-party speaking), the system provides a virtually infinite ERL. During doubletalk (two parties speaking simultaneously), an effective ERL of 36dB or greater is provided. One 2531/2531A module protects the opposite end of the circuit from echoes.

2.02 The 2531/2531A constructs a mathematical model of the near-end-path and uses this model to compute echo estimates, which are subtracted from the send-path signal. An adaptive digital filter continuously updates the model during singletalk, ensuring accurate echo cancellation regardless of any change in circuit-path characteristics.

Echo Cancellation

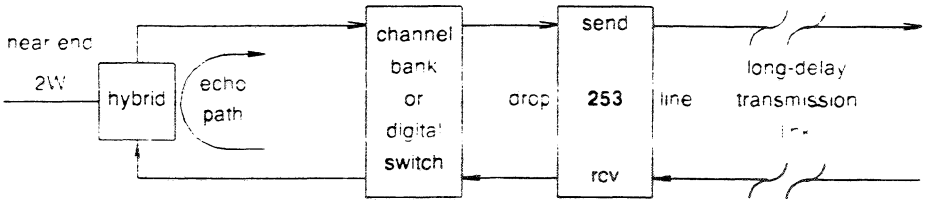

Figure 2. Simplified 2531/2531A Application

2.03 A typical 2531/2531A application is shown in figure 2 where the primary source of echoes received at the far end is an impedance mismatch at the hybrid. Signal reflections at the hybrid, were it not for the 2531/2531A, would cause the party at the far end to hear echoes of their own voice. With the 2531/2531A in place, echoes received at the send-in port are cancelled and the remaining (desired) signal is transmitted at the send-out port to the far end, thus eliminating the echo. A canceller at the far end likewise protects the near-end receive channels from echo.

2.04 This split-type configuration provides effective echo control regardless of the total delay on the long-delay transmission link. Thus, the 2531/2531A System is well suited for a broad range of digital-network applications, including single-hop and double-hop satellite circuits (whose round-trip delays are approximately 600 and 1200ms, respectively) and terrestrial circuits where the transmission characteristics of echo suppressors or via-net-loss (VNL) designs may be undesirable.

2.05 **Convergence**. Upon establishment of the voice path, the 2531/2531A begins an initial adaptation process where a mathematical model of the end-path is generated. This process is completed within 250 milliseconds. When the speaker begins to talk at the beginning of a call, he or she may initially hear some echo, but this disappears upon convergence (typically within two or three syllables of speech). Following convergence, full-duplex speech is possible without the usual choppiness and lockout characteristic of circuits served by conventional echo suppressors

Remote Control/Status Monitoring Interface

2.06 The 2531/2531A can be controlled from a remote location via a serial data interface compatible with EIA standard RS-232-C. The 2531/A is configured as data communications equipment (DCE) allowing direct connection to data terminal equipment (DTE). Up to 32 2531/A's can be daisy-chained on a single RS-232-C link.

2.07 The remote control interface accommodates all control and status-monitoring functions that are available from the front panel, plus additional commands. See section 5 of this practice for details.

End Office 2W/4W Terminating Set Balance

2.08 When a 2531/2531A is used to treat echo on a circuit caused by an unbalanced terminating set, maintaining precise balance at that term set no longer becomes necessary. The low per-line cost of the 2531/2531A provides a viable economic alternative to the costly manpower needed for this maintenance function. The 2531/2531A thus becomes an advantageous addition to T1 facilities whether or not substantial line delays are present to make the excessive echo noticeable.

T1 Network Interface

2.09 **Formats.** The 2531/2531A directly interfaces the digital network at the T1 (DS1) level and thus eliminates the need for per-channel echo control devices on associated VF circuits. At this interface level, both the send and receive paths accommodate multiplexed input signals in a serial stream at 1.544 Mbits/s with segmented μ255 companded PCM coding. Either standard AMI or B8ZS line coding can be accommodated. When AMI operation is selected, any all-zero channel received at the send-in port is transmitted with bit 7 set high to insure a minimum ones density at the send-out port. This process is referred to as *bit-7 stuffing for zero code suppression*. Since B8ZS insures a minimum ones density, no bit-7 stuffing is performed when this mode is selected. Also accommodated are standard superframe or extended superframe, as specified by AT&T Compatibility Bulletin CB142. All of the above formats can be optioned from the front panel or via the RS-232-C interface.

2.10 **Connection**. The 2531/2531A typically operates in conjunction with a D-type channel bank or a digital toll switch. In such applications, the canceller is normally located between two DSX-1 cross-connect frames as shown in figure 3. With 22-gauge cable, maximum permissible distance between the DSX-1 cross-connect frame and the 2531/2531A (including intraframe cabling in the DSX-1 frame) is 650 feet (198 meters).

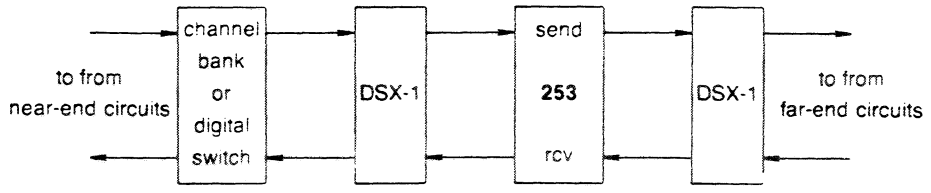

Figure 3. Location of 2531/2531A in a CO Circuit Path

2.11 **Channel Numbering.** The 2531/2531A can be programmed to select channel numbering of the D1D, D2 and D3/D4 formats. Thus, in all cases, the channel number displayed in the front-panel *channel* window is the actual channel being optioned.

2.12 **Framing-Bit Error Correction.** The default operation of the 2531 A modules is to generate a bit error in the outgoing F(T) bits on the send-out port when an error is detected in the received F(T) bits. The 2531 A modules provide optional framing bit error correction on the send path.

End-Path Delay Limits

2.13 Maximum round-trip delay of the end-path served by a 2531 2531A must fall within the signal-processing window (less than 32 milliseconds for the 2531 and 64 milliseconds for the 2531A). The total end-path delay is made up of propagation delay over transmission lines, fixed delays through transmission and switching equipment, plus dispersion through channel banks and loaded VF cable. Refer to the following formula, table 1 and table 2, and the example in figure 4 when calculating end-path delay.

$$d_{total} = d_1 - d_2 - \ldots d_n$$

$$d_n = \frac{2l}{v}$$

where:

d_n propagation delay of individual facility

l length of facility (one way)

v propagation velocity of the facility

Medium	Wavespeed	Propagation Delay
Microwave Radio	140,000 miles sec	.007 msec mile
'L' Carrier Coax	100,000 to 125,000 miles sec	.008 to .01 msec mile
Fiber Optic Cable	100,000 miles sec	.01 msec mile
T1 Carrier	94,000 to 125,000 miles sec	.008 to .0106
Non-loaded VF Cable	50,000 miles sec	.02 msec mile
Load VF Cable	3,000 to 20,000 miles sec	.05 to .33 msec mile

Table 1. Approximate Propagation Delays of Transmission Facilities

2.14 All transmission and switching equipment exhibits some fixed delay. For accurate information, the manufacturer's practice should be consulted, but the following table can serve as a starting point.

Transmission Equipment	Fixed Delay - One-Way
PCM Channel Bank	0.125 to 0.5 msec + dispersion
Digital Switch	up to 1.2 msec
Trans Mux	1.8 to 6 msec (each conversion)
M13 MXU	0.5 msec
Digital Cross Connect	0.25 msec

Table 2. Typical Fixed Delays of Common Transmission Facilities

2.15 Spreading of energy over time, or dispersion, is a form of delay encountered due to bandwidth limitations of channel banks and VF-loaded cable. This delay must be taken into consideration when calculating total end-path delay. Unlike propagation delay and fixed delay, dispersion is not additive and typically falls within 4-7 milliseconds, regardless of the number of channel banks present in the end path.

2.16 The **2531A** can be programmed for either a 32ms or 64ms processing window. If the maximum end-path delay exceeds 32ms, the 64ms processing window must be selected. Otherwise, the 32ms window should be selected since it offers slightly enhanced performance

For this example, let's assume that our end path consists of a digital switch, then a 500-mile T1 line, a channel bank, and finally 5 miles of loaded cable to the subscriber.

round-trip delay of T1 line
= 500 mi X 2 (for round trip) X 1 sec / 94,000 mi
= 0.0106 sec = **10.6ms**

fixed delay of switching equipment
= .125 msec x 2 = **.250 msec**

round-trip delay of loaded cable
= 5 mi X 2 X 1 sec / 10,000 mi
= 0.001 sec = **1 ms**

round-trip dispersion of channel banks and loaded cable
= **7 ms** (estimated)

total end-path round-trip delay
= 10.6ms + 1ms + 7ms
= **18.85msec**

Figure 4. Example of End-Path Delay Calculation

End-Path Signal Linearity

2.17 The 2531/2531A must be located at a point in an end path where signals are nominally linear (e.g., not compressed). The performance of the 2531/2531A will be somewhat degraded if it is located at a point in a circuit where it must process nonlinear signals. This is because the 2531/2531A always creates a linear end-path model.

CCS and CAS Signaling Modes

2.18 **CAS (Channel Associated Signaling)** This more commonly used mode robs the 8th voice-data bit of every signaling frame and uses it for signaling status identification. The 2531/2531A recognizes two types of CAS: E&M or foreign exchange. Since the 2531/2531A relies upon A/B signaling to determine busy/idle status for self-test operation, correct interpretation of signaling is essential. (See table 3 for A&B interpretation for idle state.)

drop side channel card	send-in		receive-in	
	A	B	A	B
E&M	0	0	0	0
FXO: GS	1*	1	0	1*
FXS; GS	0	1*	1*	1
FXO: LS	0*	1	0	1*
FXS; LS	0	1*	0*	1
* These bits are inverted in the D2 channel bank format.				

Table 3. A & B Bit Interpretation for Idle State

2.19 **CCS (Common-Channel Signaling)**. This mode does not allow for any signaling information to be transmitted on the voice facility; no voice-data bits are robbed. Signaling must be transmitted on a separate facility and communicated to the 2531/2531A via RS-232-C link. This application is typical in the use of a processor-controlled toll switch.

Tone Disabler

2.20 Upon detection of 2100Hz tone greater than -32dBm0, the 2531/2531A disables cancellation (and the nonlinear processor) of the channel in which this tone was detected. A guard band prevents false disabler activation by speech signals. Once disabled, the channel becomes completely transparent to all transmission and remains so until normal operation is restored, which can occur in one of two optioned manners:

hold band: the canceller remains disabled as long as a continuous speech signal is present

end of call: the canceller remains disabled as long as the channel is found to be busy

2.21 The tone disabler feature can be optioned on or off for individual channels of a digroup either via the front panel or remote RS-232-C control. The hold-band or end-of-call options apply to the entire digroup, and can also be controlled by either the front panel or the data link.

3. 2531 and 2531A Module Installation

Inspection

3.01 Immediately after unpacking, inspect the 2531/2531A Module for shipping damage. If any damage is found, file a claim with the carrier as soon as possible. If stored, inspect the unit again prior to installation.

Note: *The 2531/A module is static-sensitive and therefore shipped in a protective plastic bag. Whenever you remove the module from the bag, be sure to wear a grounded wrist strap to protect the module from damage due to static discharge.*

253A Mounting Assembly

3.02 The 2531 2531A is intended for mounting in a Tellabs 253A Mounting Assembly, however, it can be mounted in any Tellabs Type 16 or equivalent shelf equipped with 56-pin (0.156" centers) card-edge connectors. It is recommended for applications requiring a multi-system RS-232-C link that the 253A Mounting Assembly be used since it provides an integral daisy chain and automatic RS-232-C module addressing.

CO Equalizer Optioning

3.03 The 2531/2531A has two switch-selectable equalizers: one at the send-out port and one at the receive-out port. Each equalizer has a 3-position switch located on the printed circuit board that must be optioned for the distance between its respective output and the associated DSX-1 cross-connect frame as shown in Figure 5. This is the only switch option for the module.

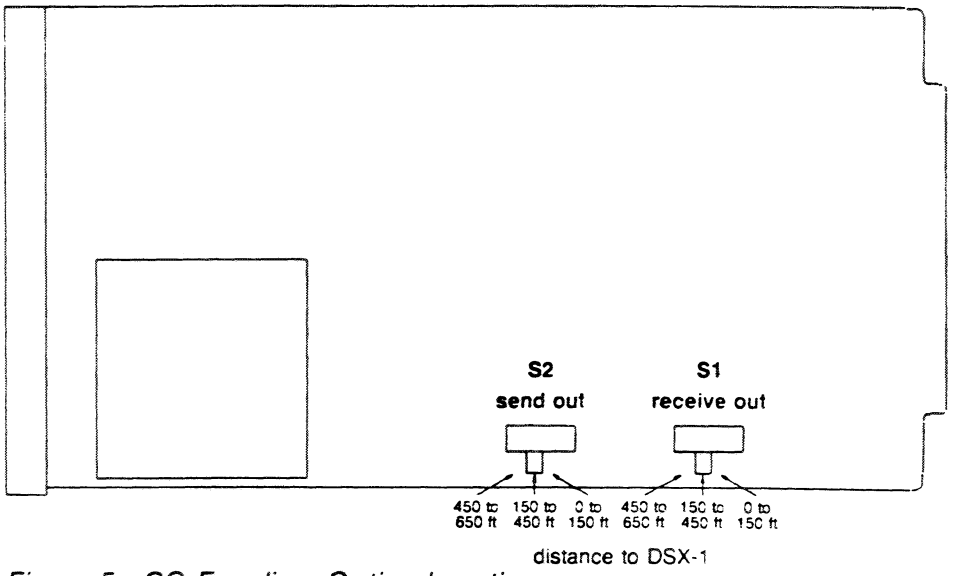

Figure 5. CO Equalizer Option Locations

Note: *The switch setting given above are nominal distances for 22 AWG shielded, twisted-pair ABAM cable. Actual switch settings should be selected to achieve the correct DSX-1 pulse mask for the specific installation and cabling.*

Initial Power-On Sequence

1. Insert the module into the front of the shelf. Ensure that it is firmly seated in its edge connector.
2. Observe the front panel for the following:
   - the *power on* LED goes on
   - the display starts at 8.8.8 and counts down to 7 7 7, 6 6 6, etc., until it reaches 1 0 0, then goes blank. This power-up diagnostic routine starts up automatically and runs for up to 15 seconds.
3. If no T-carrier has been applied to the module, then both the *SEND IN* and *RECEIVE IN RA local alarm* LEDS, as well as, the *major alarm* LED should be lit.
4. If T-carrier is applied to both sides of the canceller, only the green *power on* LED should be on.

If Problems Are Encountered

3.04 If the display stops during the initial power-on sequence and displays a number in the range 8.8.8. to 1.0.0., perform the following:

1. Remove and reinsert the module.
2. Observe the display again.
3. If the display stops again, consider the module defective. See "Repair and Return" in Section 10.

Module Configuration

1. Verify that the LINE side has been connected to RECEIVE IN and SEND OUT ports and that the DROP side has been connected to SEND IN and RECEIVE OUT (See figure 2, section 2).

2. Check continuity of wiring from the DSX-1 cross-connect to the echo canceller bay. Place echo canceller in **clear channel** mode. At the cross-connect, insert a framed T1 signal with a 1004Hz tone present on channel one, into the SEND IN port of the echo canceller. Loop the SEND OUT port to the RECEIVE IN port and monitor for the tone at the RECEIVE OUT port.

3. Program the 2531/A for the desired application. Refer to section 4 for front-panel controls.

4. Verify proper module operation by performing Operational Tests listed in section 10.

Edge Connector Pin Assignments

3.05 Table 4 shows the pin assignments for the 2531 2531A's card-edge connector.

Component Side		Solder Side	
signal	pin #	pin #	signal
SS0	56	55	SUN0
GND	54	53	SUN1
SS1	52	51	SUN2
unassigned	50	49	*unassigned*
DCD	48	47	DTR
RXD	46	45	TXD
CTS	44	43	RTS
test point	42	41	test point
MAJ NO1	40	39	MAJ NO2
MAJ C1	38	37	MAJ C2
MAJ NC1	36	35	MAJ NC2
MIN NO3	34	33	MIN NO4
MIN C3	32	31	MIN C4
MIN NC3	30	29	MIN NC4
unassigned	28	27	*unassigned*
RCV OUT – RING	26	25	RCV IN – RING
unassigned	24	23	*unassigned*
RCV OUT – TIP	22	21	RCV IN – TIP
unassigned	20	19	test point
SHIELD	18	17	SHIELD
unassigned	16	15	*unassigned*
SHIELD	14	13	SHIELD
unassigned	12	11	*test point*
SEND OUT – RING	10	9	SEND IN – RING
unassigned	8	7	*unassigned*
SEND OUT – TIP	6	5	SEND IN – TIP
unassigned	4	3	*unassigned*
-48Vdc	2	1	GND

Table 4. 2531/2531A Pinouts

Note: *Under no circumstances should connections be made to test points.*

4. Front Panel Control

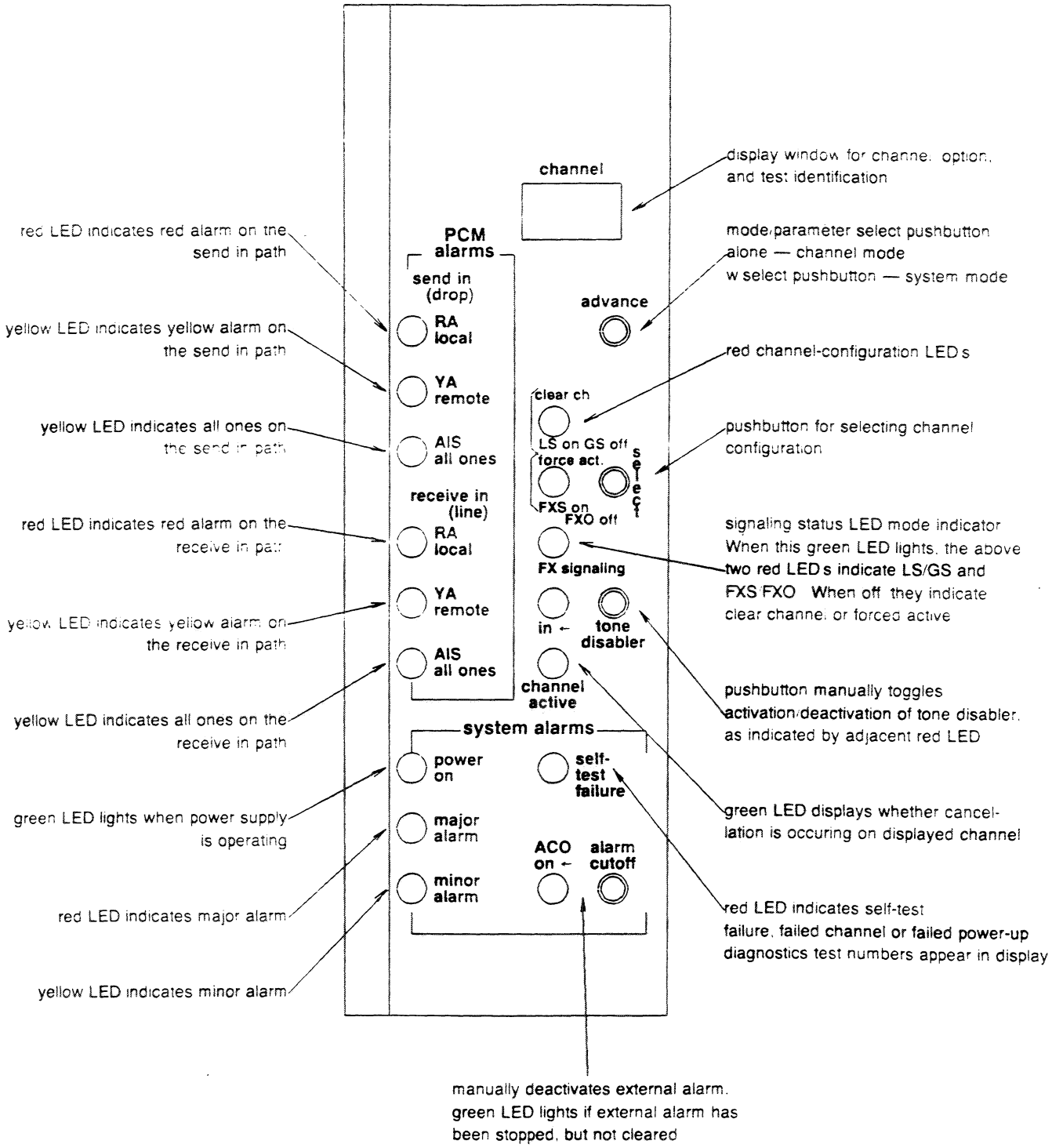

Figure 6. 2531/2531A Front Panel

4.01 Pushbuttons and LED's on the 2531/2531A's front panel provide the means for programming and monitoring both system and individual channel operating parameters. Figure 6 provides a quick-reference information source for the front panel.

Front Panel Modes

4.02 There are two modes that the front panel can be placed in — the **system** mode, and the **channel** mode. Within each mode, the various parameters can be accessed as shown in figure 7 and table 5.

Mode	Parameter	Selection	Options or Indications
Channel	channel configuration	see table 6	• E&M signaling • clear channel • **force active** • FXO-GS signaling • FXO-LS signaling • FXS-GS signaling • FXS-LS signaling
	canceller active indicator	*channel active* LED	• on • off
	tone disabler	push-button	• **on** • off
	last self test result	*self-test failure* LED	• passed • failed
System	channel number assignment	20.1 20.2 **20.3**	• D1D • D2 • **D3 D4**
	line coding	**60.0** 60.1	• **AMI with bit 7 stuffing** • B8ZS
	framing format	**61.0** 61.1	• **standard** • **extended superframe**
	framing bit error control	**62.0** 62.1	• **regenerate F bit errors** • correct F bit errors
	signaling mode	**63.0** 63.1	• **channel associated signaling (CAS)** • common channel signaling (CCS)
	end-path delay	**5.32** 5.64	• **32 milliseconds** • 64 milliseconds (2531A only)
	nonlinear processor (NLP) configuration	40.0 40.1 **40.2**	• canceller only • CCITT mode — NLP off during DT • **normal — NLP on**
	nonlinear processor (NLP) loss	41.0 **41.1**	• hard • **soft**
	tone disabler release	**71.0** 71.1	• **hold band** • end of call
	RS-232-C module address	3.XX	01 - 32
	baud rate	00.3 00.6 **01.2** 02.4 04.8 09.6 19.2	• 300 baud • 600 baud • **1200 baud** • 2400 baud • 4800 baud • 9600 baud • 19.2 Kbaud
	front panel control access	**89.0** 89.1	• **control mode** • view mode

*Table 5. Front Panel Modes (***Default in Bold***)*

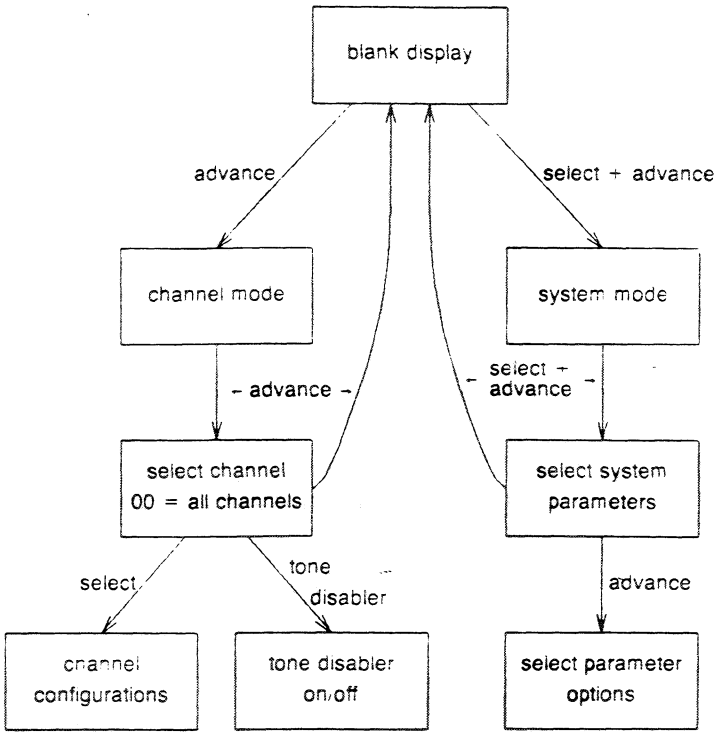

Figure 7. Front Panel-Mode State Diagram

Getting to the Blank Display

4.03 The starting point for controlling the 2531/2531A from its front panel is when the digital display window is blank. Either the channel mode or system mode can be reached from this point. If the display is not blank, see below:

1. If **three digits, each separated by a period** is displayed, the module has failed power-up diagnostics. See section 3 of this practice
2. If the display is **flashing**, this signifies that a self-test routine has failed. The channel and system modes can be accessed from this point, and therefore this condition can be treated the same way as a blank display condition.
3. If **three digits with one period** are displayed, the front panel is in the system mode. Press the *select* pushbutton, and while holding it down, press the *advance* pushbutton. Repeat until the display clears.
4. If **two digits** are displayed, the front panel is in the channel mode. Press and hold the *advance* pushbutton until the display clears.

The Channel Mode

- To enter the channel mode:

1. Ensure that the front panel is in the **blank display** mode.
2. Press *advance*. *00* should appear in the display. With *00* in the display, channel-configuration information is programmed into all 24 channels.
3. To access individual channels press, *advance* until the desired channel number appears in the display.

Note: *If certain LED's flash when the display shows 00, this denotes that their corresponding parameters are configured differently for different channels.*

- To exit the channel mode:

1. Press and hold *advance* until the display clears.

Channel Configuration

1. Enter channel mode.
2. Press *advance* to select channel number (or *00* for all channels)
3. While watching the three LED's in table 6, press *select* to step through channel configurations.

signaling		E&M	ignored	ignored	FXO GS	FXO LS	FXS GS	FXS LS
canceller operation		on during call	forced off	forced on	on during call	on during call	on during call	on during call
LED	**clear ch. LS on/GS off**	off	**on**	off	off	**on**	off	**on**
	force act. FXS on/FXO off	off	off	**on**	off	off	**on**	**on**
	FX signaling	off	off	off	**on**	**on**	**on**	**on**

Table 6. Channel Configuration Options

Canceller Active Monitor

4.04 The echo cancellation circuitry normally becomes active when a call is initiated. To determine whether or not a given channel's canceller is currently active:

1. Enter the channel mode.
2. Select the channel.
3. Observe the *channel active* LED to determine if the canceller is active for the displayed channel number.

Tone Disabler Use

4.05 The *tone disabler* pushbutton toggles between whether or not an incoming 2100Hz tone disables cancellation.

1. Enter channel mode.
2. Select channel number.
3. Press *tone disabler* to toggle the tone disabler use status. When the *in* ← LED is on, a tone will disable the echo canceller for the displayed channel number (or for all channels if *00* is displayed).

Last Self-Test Result

1. Enter channel mode.
2. Select channel number.
3. Observe the *self-test failure* LED. If it is on, the displayed channel has failed the last time self-test was run on it.

The System Mode

- To enter the system mode:

1. Ensure that the front panel is in the **blank display** mode.
2. Press *select*, and while holding *select*, press *advance*. *01.2* or the current baud rate code should appear in the display.
3. To step through the parameters, hold *select* and press *advance* once for each parameter.

- To exit the system mode:

1. Press and hold *select*, then repeatedly press *advance* until the display clears.

Channel Number Assignment Scheme

1. Enter the system mode. *01.2* or the current baud rate code should be displayed.
2. Hold *select* and press *advance* until *20.X* is displayed.
3. Release *select* and press *advance* to select the option from those shown below.

displayed code	number scheme
20.1	D1D
20.2	D2
20.3	**D3**

Line Coding

1. Enter the system mode. *01.2* or the current baud rate code should be displayed.
2. Hold *select* and press *advance* until *60.X* is displayed.
3. Release *select* and press *advance* to select the option from those shown below.

displayed code	line code
60.0	**AMI with B7 stuffing**
60.1	B8ZS

Framing Format

1. Enter the system mode. *01.2* or the current baud rate code should be displayed.
2. Hold *select* and press *advance* until *61.X* is displayed.
3. Release *select* and press *advance* to select the option from those shown below.

displayed code	format
61.0	**standard**
61.1	extended

Framing Bit Error Control

1. Enter the system mode. *01.2* or the current baud rate code should be displayed.
2. Hold *select* and press *advance* until *62.X* is displayed.
3. Release *select* and press *advance* to select the option from those shown below.

displayed code	F-bit error treatment
62.0	**regenerate F-bit errors**
62.1	correct F-bit errors

Signaling Mode

1. Enter the system mode. *01.2* or the current baud rate code should be displayed.
2. Hold *select* and press *advance* until *63.X* is displayed.
3. Release *select* and press *advance* to select the option from those shown below.

displayed code	signaling mode
63.0	**channel associated signaling (CAS)**
63.1	common channel signaling (CCS)

End-Path Delay (2531A)

1. Enter the system mode. *01.2* or the current baud rate code should be displayed.
2. Hold *select* and press *advance* until *5.32* is displayed for the 2531 or *5.64* for the 2531A.
3. Release *select* and press *advance* to select the option from those shown below. This will only work for the 2531A.

displayed code	maximum delay
5.32	32 milliseconds
5.64	64 milliseconds

Nonlinear Processor (NLP) Configuration

4.06 The nonlinear processor can be allowed to operate fully in conjunction with the canceller, it can be forced off, or it can be forced to operate only during singletalk (off during doubletalk, per CCITT recommendations).

1. Enter the system mode. *01.2* or the current baud rate code should be displayed.
2. Hold *select* and press *advance* until *40.X* is displayed.
3. Release *select* and press *advance* to select the option from those shown below.

displayed code	NLP configuration
40.0	off — canceller only
40.1	off during doubletalk — CCITT
40.2	**on**

Nonlinear Processor (NLP) Loss

4.07 The nonlinear processor attenuates in two different manners — hard and soft. With the hard option, signals below the NLP threshold are virtually turned off. In soft operation, these signals are attenuated, but not infinitely. The difference between hard and soft operation is subtle, but can be noticeable on circuits where noise is introduced in the end path, where the soft option reduces the degree of noise "pumping".

1. Enter the system mode. *01.2* or the current baud rate code should be displayed.
2. Hold *select* and press *advance* until *41.X* is displayed.
3. Release *select* and press *advance* to select the option from those shown below.

displayed code	NLP loss
41.0	hard
41.1	**soft**

Tone Disabler Release

4.08 If the tone disabler option is used, it can operate in two manners:

hold band When 2100Hz tone is detected, the 253 assumes an unbroken stream of data and will disable the canceller only until a pause or silence in the signal is detected.

end of call When 2100Hz tone is detected, the 253 will disable the canceller until it detects that the call has ended.

1. Enter the system mode. *01.2* or the current baud rate code should be displayed.
2. Hold *select* and press *advance* until *71.X* is displayed.
3. Release *select* and press *advance* to select the option from those shown below.

displayed code	disabler control
71.0	**hold band**
71.1	end of call

Displaying the RS-232-C Module Address

4.09 When used with the 253A Mounting Assembly, the RS-232-C address is automatically assigned. To display the module's RS-232-C address:

1. Enter the system mode. *01.2* or the current baud rate code should be displayed.
2. Hold *select* and press *advance* until *3.XX* is displayed. The *XX* is the RS-232-C Module Address.

Setting the Data Link Baud Rate (RS-232-C)

1. Enter the system mode. *01.2* or the current baud rate code should be displayed.
2. Release *select* and press *advance* to select the option from those shown below.

displayed code	RS-232-C baud rate
00.3	300 baud
00.6	600 baud
01.2	**1200 baud**
02.4	2400 baud
04.8	4800 baud
09.6	9600 baud
19.2	19,200 baud

Front-Panel Lockout

4.10 The front-panel pushbuttons can be placed in either **control** or **view** mode. In the **control** mode, all options may be accessed and programmed. In **view** mode, all options may be displayed, but the pushbutton that changes each option is disabled.

1. Enter the system mode. *01.2* or the current baud rate code should be displayed.
2. Hold *select* and press *advance* until *89.X* is displayed.
3. Release *select* and press *advance* to select the option from those shown below.

displayed code	front panel control access
89.0	**control mode** - options may be changed
89.1	**view mode** - options may be viewed only

5. Remote Control

5.01 The 253 can be controlled from a remote location via a remote control status RS-232-C interface. The remote interface provides a superset of the status and control functions available with the 2531/2531A's front panel. This full duplex, asynchronous serial link uses seven bit ASCII characters with one start bit, one stop bit, and one even parity bit. Serial link speed can be 300, 600, 1200, 2400, 4800, 9600, or 19,200bps and the selected speed must be programmed into the 2531/2531A module via the front panel. The 253 echoes all characters received; therefore, configure the controlling terminal or computer for remote echoplex operation.

Input Command Format

5.02 All commands consist of a sequence of four ASCII characters. They take the form shown in figure 8.

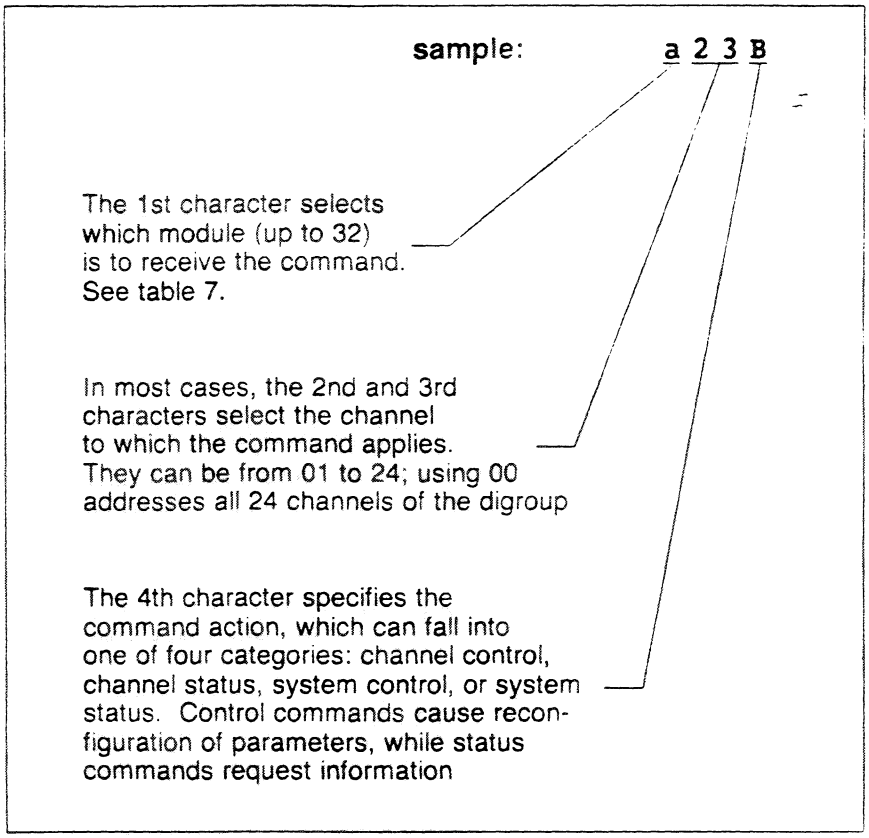

Figure 8. Input Command Format

RS-232-C Addressing (1st Character)

5.03 Table 7 lists each character needed to address a specific one of 32 possible 2531/2531A Modules in one daisy chain.

Canceller Unit No.	ASCII Character	Hex Code	Canceller Unit No.	ASCII Character	Hex Code
1	a	61	17	q	71
2	b	62	18	r	72
3	c	63	19	s	73
4	d	64	20	t	74
5	e	65	21	u	75
6	f	66	22	v	76
7	g	67	23	w	77
8	h	68	24	x	78
9	i	69	25	y	79
10	j	6A	26	z	7A
11	k	6B	27	{	7B
12	l	6C	28	|	7C
13	m	6D	29	}	7D
14	n	6E	30	~	7E
15	o	6F	31	DEL	7F
16	p	70	32	'	60

Table 7. Module Address Characters

Commands and Command Families

5.04 There are four types of command families, which are:

1. **Channel Status Query**. These commands request information concerning individual channels of the digroup, but do not change any configurations; hence, they are "read only" commands.

2. **Channel Control**. These commands change parameter options of individual channels of the digroup.

3. **System Status Query**. These commands request information concerning the configuration of the addressed 2531/2531A, but do not change them; hence, like the channel status query commands, they are "read only". These commands require that the channel number be entered as 00.

4. **System Control**. These commands affect all channels of the digroup and can not be set on an individual channel basis.

5.05 Table 8 provides a summary of all parameters that can be queried or changed, and the characters that can be used in the fourth position of the command character set.

Command Family	Command	ASCII	Hex
Channel Status	single channel status	S	53
	channel signaling status	<	3C
	clear channel status	E	45
	busy/idle status	J	4A
	CCS busy idle status	Y	59
	forced active status	K	4B
	tone disabler use	+	2B
	tone disabler active	_	5F
	self test result	T	54
Channel control	clear channel on	B	42
	force active	**N**	**4E**
	E&M signaling on	/	2F
	FXS-LS signaling on	:	3A
	FXO-LS signaling on	;	3B
	FXS-GS signaling on	>	3E
	FXO-GS signaling on	?	3F
	CCS busy*	U	55
	CCS idle*	W	57
	CAS restore*	**V**	**56**
	H reset on*	R	52
	H reset off*	**Q**	**51**
	H hold on*	H	48
	H hold off*	**I**	**49**
	tone disabler use on	**(**	**28**
	tone disabler use off	)	29
System Status	module configuration status	Z	5A
	alarm status	M	4D
	software revision level	=	3D
System control	**set default values**	**!**	**21**
	channel number assignment (default **D3/D4**)	A	41
	line coding (default **B7**) F-bit error control	X	**58**
	(default **no correct**) framing format (default **standard**)		
	CAS CCS select (default **CAS**)	[	5B
	End-path delay (default **32ms**)	L	4C
	nonlinear processor (NLP) off	C	43
	nonlinear processor (NLP) on	**D**	**44**
	nonlinear processor (NLP) operation during doubletalk (default **on**)	\	5C
	nonlinear processor (NLP) loss (default **soft**)	@	**40**
	bypass relay on*	F	46
	bypass relay off*	**G**	**47**
	tone disabler release (default **hold band**)	]	5D
	alarm cut off (ACO)*	O	4F
	re-run power-up diagnostics*	P	50

* These commands are not stored in non-volatile (EEROM) memory

Table 8. Remote Control Command Summary
*(**default control parameters shown in bold**)*

Output Responses

5.06 When a control command is sent, the targeted 2531 2531A returns an *ACK* character (06 hexadecimal) if the command is legal, or a *NAK* character (15 hex) if the command is illegal. Neither an *ACK* nor a *NAK* is returned in response to status query commands; only the status information is returned.

5.07 A *NAK* response could occur for one of two reasons:

1. The channel number entered is illegal (not 00 to 24).
2. The command is not recognizable.

Channel Status Query Commands

The All-Channel Status Reply

5.08 Certain channel status query commands will produce the response:

a00XXXXXX

where **a** is the 2531/2531A address and **XXXXXX** is a string of six hexadecimal characters. These hex characters, when translated into binary, produce 24 bits, each of which designates a "yes" or "no" status for one of the 24 channels. Table 9 shows how this six-character string translates into channel numbers and their status.

Hex Character X	1st	2nd	3rd	4th	5th	6th
Binary Position Breakdown	8 4 2 1	8 4 2 1	8 4 2 1	8 4 2 1	8 4 2 1	8 4 2 1
Channel Represented	4 3 2 1	8 7 6 5	12 11 10 9	16 15 14 13	20 19 18 17	24 23 22 21
logic 1 — affirmative logic 0 — negative						

Table 9. All-Channel-Status Reply Bit Map

Single Channel Status

- To request a list of all parameter values for a designated channel, enter:

  axxS

  where **a** is the 2531/2531A address and **xx** is the channel number.

  Response:

  axxXXX

  where **XXX** is a string of three hexadecimal characters. When translated to binary, the bits indicate the following:

Hex character	Bit Position	Status
1st	12th (MSB)	tone disabler enabled
	11th	H reset
	10th	canceller forced active
	9th	clear channel (canceller bypassed) via front panel
2nd	8th	busy
	7th	self-test failed
	6th	H hold
	5th	canceller bypassed
3rd	4th	canceller only (no NLP)
	3rd	E&M (See Table below)
	2nd	FXS (See Table below)
	1st (LSB)	loop start (See Table below)
Logic 1 — active	Logic 0 — inactive	

E&M bit	FXS bit	loop start bit	signaling type
0	0	0	FXO-GS
0	0	1	FXO-LS
0	1	0	FXS-GS
0	1	1	FXS-LS
1	0	0	E&M
1	1	1	no signaling

Table 10. Single-Channel Status Bit Map

Example response:

h17894

indicates that 2531/2531A #8, channel 17 is using E&M signaling and the tone disabler is enabled and is currently busy. H reset, H hold, clear channel and forced active are all inactive, and at this moment, the canceller is not active.

Channel Signalling Status

- To query the signaling type of a designated channel, enter:

  axx<

  where **a** is the 2531/2531A address and **xx** is the channel number from 01 to 24.

  Responses:

  axx0 clear channel or forced active
  axx1 E & M
  axx2 FXO-GS
  axx3 FXO-LS
  axx4 FXS-GS
  axx5 FXS-LS

Clear Channel Status

- To request a list of channels bypassing echo cancellation, enter:

  a00E

  where **a** is the 2531/2531A address.

  Response:

  a00XXXXXX

  which is the all-channel-status reply (see table 9). Logic "1's" indicate that the channel is bypassing cancellation.

Busy/Idle Status

- To request a list of all channels identifying those which are idle and those which are busy, enter:

  a00J

  where **a** is the 2531/2531A address.

  Response:

  a00XXXXXX

  which is the all-channel-status reply (see table 9). Logic "1's" indicate that the channel is busy, and logic "0's" show the channel to be idle.

CCS Busy/Idle Status

- To query whether or not echo cancellation in the specified channel is CCS busy or CCS idle, enter:

  axxY

  where **a** is the 2531/2531A address and **xx** is the channel number.

  Response:

  axxL indicates that echo cancellation has been CCS forced off

  axxM indicates that echo cancellation has been forced on

  axxE indicates that normal busy/idle detection is in effect, where echo cancellation is turned on during busy and off during idle

Forced Active Status

- To request a list of all channels identifying those with echo cancellation forced active, enter.

  a00K

  where **a** is the 2531/2531A address.

  Response:

  a00XXXXXX

  which is the all-channel-status reply (see table 9) Logic "1 s" indicate that the channel's canceller is forced active.

Tone Disabler Option Status

- To query which channels are optioned so that 2100Hz tone temporarily disables the canceller, enter:

  a00+

  where **a** is the 2531/2531A address.

  Response:

  a00XXXXXX

  which is the all-channel-status reply (see table 9). Logic "1's" indicate that the channel's tone disabler is in use, i.e. that a 2100Hz tone will disable cancellation if detected.

- **disabling tone detected.** To request a list of channels whose tone disablers are currently activated due to the presence of a disabling tone. enter:

  a00_

  where **a** is the 2531/2531A address.

  Response:

  a00XXXXXX

  which is the all-channel-status reply (see table 9). Logic "1's" indicate that the channel's tone disabler is in use, and that tone has been detected and cancellation is currently being disabled.

Self-Test Result

- To request the result of the last self-test performed on the specified channel, enter:

  axxT

  where **a** is the 2531/2531A address and **xx** is the channel number.

  Response:

  axxP indicates that the channel had passed

  axxF indicates that the channel had failed

  a00XXXXXX an all-channel-status reply; see table 9

Channel Control Commands

Canceller Operation

- **Clear Channel.** To force echo cancellation to be off at all times for the specified channel and render that channel transparent, enter:

  axxB

  where **a** is the 2531/2531A address and **xx** is the channel number.

- **Force Active.** To force echo cancellation to be on at all times for the specified channel, enter:

  axxN

  where **a** is the 2531/2531A address and **xx** is the channel number.

Signaling

*• **E & M signaling.** To change the signaling of the specified channel from whatever it previously was to E & M (which is the system default), enter:

axx/

where **a** is the 2531/2531A address and **xx** is the channel number.

*• **FXS-LS signaling.** To change the signaling of the specified channel from whatever it previously was to foreign exchange station-end with loop start operation, as it faces the facility, enter:

axx:

where **a** is the 2531/2531A address and **xx** is the channel number.

*• **FXO-LS signaling.** To change the signaling of the specified channel from whatever it previously was to foreign exchange office-end with loop start operation, as it faces the facility, enter:

axx;

where **a** is the 2531/2531A address and **xx** is the channel number.

*• **FXS-GS signaling.** To change the signaling of the specified channel from whatever it previously was to foreign exchange station-end with ground start operation, as it faces the facility, enter:

axx>

where **a** is the 2531/2531A address and **xx** is the channel number.

*• **FXO-GS signaling.** To change the signaling of the specified channel from whatever it previously was to foreign exchange office-end with loop start operation, as it faces the facility, enter:

axx?

where **a** is the 2531/2531A address and **xx** is the channel number.

* *This command will not be accepted while the system is in the transparent (CCS) mode. Entering the command will cause a NAK response.*

Tone Disabler Activation Option

- **Tone Disable Option ON.** To condition a channel such that a nominal 2100Hz tone disables its canceller, enter:

  axx(

  where **a** is the 2531/2531A address and **xx** is the channel number.

- **Tone Disable Option OFF.** To remove tone disabler capability from channel xx, enter:

  axx)

CCS Control Commands

- **CCS Busy.** This command tells the 2531/2531A that the specified channel is busy, thus inhibiting self-test in that channel. This also performs a 30ms H reset, then allows the canceller to converge (reconstruct the end-path model). Enter:

  axxU

  where **a** is the 2531/2531A address and **xx** is the channel number.

- **CCS Idle.** This command tells the 2531/2531A that the specified channel is idle, thus allowing self-test to be performed on this channel. If the channel is already busy the call is not dropped, but cancellation is removed. This command also performs the 30ms H reset. Enter:

  axxW

  where **a** is the 2531/2531A address and **xx** is the channel number.

- **CAS restore.** This command negates a force busy ON or force idle ON command and restores normal operation. Enter:

  axxV

H Reset

- **H reset ON.** This command initializes the specified channel's convolution-processor H register. The H register is held in the reset state until an H-reset OFF command is issued. To reset the H register, enter:

  axxR

  where **a** is the 2531/2531A address and **xx** is the channel number.

- **H Reset OFF.** To return the convolution processor to normal operation, enter:

  axxQ

H Hold

- **H hold ON.** This command 'freezes' the model of the near-end circuit path of all channels in the digroup by disabling updates to their convolution processors. To disable updates to the convolution processors, enter:

  a00H

  where **a** is the 2531/2531A address and **0** is the all channel. If H hold is already on, entering **a00H** again will enable cancellation for 250ms, then restore H hold.

- **H Hold OFF.** To restore updating, enter:

  a00I

System Status Commands

Module Configuration Status

- To request a summary of the T1 interface attributes of a specific 2531/2531A, enter:

  a00Z

  where **a** is the 2531/2531A address.

  Response:

  axxXXX

  where **XXX** is a string of three hexadecimal characters. When translated to binary, the bits indicate the following:

Character	Bit Position	Status
1st	12th (MSB)	bypass relay (1 = bypassed)
	11th	signaling mode (1 = CCS)
	10th & 9th	timeslot-channel numbering 11 = D3, 10 = D2, 01 = D1D
2nd	8th	*unassigned*
	7th	framing format (0 = standard, 1 = extended superframe)
	6th	F-bit control (0 = regenerate, 1 = B8ZS)
	5th	line coding (0 = AMI with bit 7 stuffing, 1 = B8ZS)
3rd	4th	*unassigned*
	3rd	tone disabler release (0 = hold, 1 = end call)
	2nd	end path (0 = 32ms, 1 = 64ms)
	1st (LSB)	*unassigned*
Logic 1 — active	Logic 0 — inactive	

Table 11. Module-Configuration-Status Bit Map

Alarm Status

- To request a summary of the alarm conditions of a specific 2531 2531A, enter:

a00M

where **a** is the 2531/2531A address.

Response:

a00XXXXX

where **XXXXX** is a string of five hexadecimal characters. When translated to binary, the bits indicate the following:

Alarm Type	Hex character	Bit Position	Status
send path	1st	20th (MSB)	red alarm
		19th	yellow alarm
		18th	*unassigned*
		17th	*unassigned*
	2nd	16th	*unassigned*
		15th	AIS
		14th	framing error
		13th	carrier alarm
receive path	3rd	12th	red alarm
		11th	yellow alarm
		10th	*unassigned*
		9th	*unassigned*
	4th	8th	*unassigned*
		7th	AIS
		6th	framing error
		5th	carrier alarm
system	5th	4th	ACO
		3rd	test signal*
		2nd	minor alarm
		1st (LSB)	major alarm
Logic 1 — active Logic 0 — inactive * Tellabs test purposes only.			

Table 12. Alarm-Status Bit Map

Software Revision Level

- To query the identification of the software load of a specific 2531/2531A, enter:

a00=

where **a** is the 2531/2531A address.

Response:

81-253 REV x

where **x** is the revision level.

System Control Commands

Set Default Values

- To initialize the system EEPROM to default values, enter:

  a00!

  where **a** is the 2531/2531A address.

  This command also reinitializes system software and reruns power-up diagnostics. All default values are shown in table 8.

Channel Number Assignment

- To select which timeslot-to-channel cross reference numbering scheme is to be used on a specific 2531/2531A, enter:

  ayyA

  where **a** is the 2531/2531A address and **yy** can be:

yy	Timeslot Assignment
D1	D1D numbering scheme
D2	D2 numbering scheme
D3	D3/D4 numbering scheme

Note: *This command does not use the 2nd and 3rd characters as channel specifiers.*

Line Coding/ F-Bit Error Control/ Framing Format

- To select a DS1 format for a specific 2531/2531A, enter:

  ayyX

  where **a** is the 2531/2531A address and **yy** can be:

yy	line coding	F bit error control	framing format
#1	B7	regenerate F bit errors	standard
#2	B8ZS	regenerate F bit errors	standard
#3	B7	correct F bit errors	standard
#4	B8ZS	correct F bit errors	standard
#5	B7	regenerate F bit errors	extended
#6	B8ZS	regenerate F bit errors	extended
#7	B7	correct F bit errors	extended
#8	B8ZS	correct F bit errors	extended

Note: *This command does not use the 2nd and 3rd characters as channel specifiers.*

CAS CCS Select

- To select whether robbed-bit signaling (CAS, channel associated signaling) or transparent signaling (CCS, common channel signaling) is to be used, enter:

  `ayy[`

  where **a** is the 2531/2531A address and **yy** can be:

yy	signaling mode
#0	CAS — robbed bit
#1	CCS — transparent

Note: *This command does not use the 2nd and 3rd characters as channel specifiers.*

End-Path Delay (2531A only)

- **32ms**. To configure a specific 2531A to operate with an end path whose delay is less than 32ms, enter:

  `a32L`

  where **a** is the 2531/2531A address.

- **64ms**. To configure a specific 2531A to operate with an end path whose delay is between 32ms and 64ms, enter:

  `a64L`

  where **a** is the 2531/2531A address.

Note: *This command does not use the 2nd and 3rd characters as channel specifiers.*

Nonlinear Processor (NLP) ON or OFF

- **canceller only.** This command determines whether or not the nonlinear is to be active in conjunction with echo cancellation for the specified channel. To turn the nonlinear processor **off**, enter:

  `a00C`

  where **a** is the 2531/2531A address.

- **NLP ON**. To turn the nonlinear processor **on**, enter:

  `a00D`

Nonlinear Processor (NLP) Operation During Doubletalk

- To select whether the nonlinear processor is to operate during all echo cancellation, or only during singletalk (i.e., off during doubletalk, which is the CCITT recommendation), enter:

  `ayy\`

  where **a** is the 2531/2531A address and **yy** can be:

yy	NLP operation
#1	off during doubletalk (per CCITT)
#2	on (normal)

Note: *This command does not use the 2nd and 3rd characters as channel specifiers.*

Nonlinear Processor (NLP) Loss

- To select whether the muting of the NLP provides infinite attenuation (hard) or partial attenuation (soft), enter:

  `ayy@`

  where **a** is the 2531/2531A address and `yy` can be:

yy	NLP loss
#1	hard
#2	soft

Note: *This command does not use the 2nd and 3rd characters as channel specifiers.*

Bypass Relay

- **ON.** To bypass the DS1 signal directly through a specific 2531/2531A, enter:

  `a00F`

  where **a** is the 2531/2531A address.

- **OFF.** To turn the T1 bypass relay off, thus allowing echo cancellation to take place on a selected 2531/2531A (where the DS1 signal has previously been bypassed), enter:

  `a00G`

  where **a** is the 2531/2531A address.

Tone Disabler Release

- To select whether the tone disabler operates in hold band or end-of-call mode, enter:

  `ayy]`

  where **a** is the 2531/2531A address and `yy` can be:

yy	disabler release
#1	hold band
#2	end of call

Note: *This command does not use the 2nd and 3rd characters as channel specifiers.*

Alarm Cutoff

- To cut off external alarm indicators, enter:

  `a00O`

  where **a** is the 2531/2531A address.

Rerun Power-UP Diagnostics

- To initialize a specific 2531/2531A as if it were first being powered up, enter:

  `a00P`

  where **a** is the 2531/2531A address.

6. Automatic Self-Test and Alarms

Automatic Self-Test

6.01 The 2531/2531A's self-test subsystem scans each channel at regular intervals for on-hook off-hook status. On-hook channels are subjected to the self-test routine, which automatically verifies proper operation of each channel's echo-control circuitry. The testing sequence is halted for any channel that goes off hook, while on-hook channels remain under test until the end of the sequence. Any channel that repeatedly fails a self-test activates a minor alarm, causes the *self-test failure* LED to go on, and automatically displays the failed channel's number.

PCM Alarms

6.02 PCM alarms are indicated by LED's on the front panel of the 2531 2531A. They are grouped into two categories - *send in (drop)* and *receive in (line)*. Figure 10 and table 13 provide explanations of the origins of these alarm conditions.

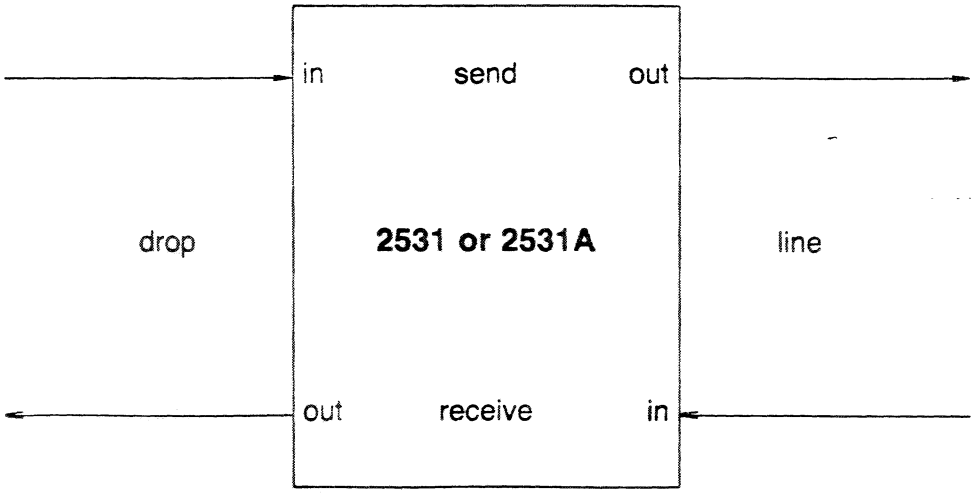

Figure 10. 2531/2531A-to-Facility Orientation

Alarm LED		Alarm Type	Indicated Problem
send in (drop)	RA local	red alarm	loss of local T1 line synchronization at the 2531/2531A's send input
	YA remote	yellow alarm	loss of synchronization at near-end channel bank or switch detected at send input
	AIS all ones	alarm indication signal	2531/2531A send input has detected upstream equipment failure
receive in (line)	RA local	red alarm	loss of synchronization at 2531/2531A
	YA remote	yellow alarm	loss of synchronization at far-end channel bank or switch
	AIS all ones	alarm indication signal	2531/2531A receive input has detected upstream equipment failure

Table 13. PCM Alarms

Major and Minor Alarms

6.03 When fault conditions are detected by the 2531/2531A, they are automatically classified as either minor or major. Both classes of alarms are indicated by front-panel LED's. In addition, each of the two alarm classes has two dedicated pairs of form-C relay contacts, both of which provide a change of state for an external indication (audible, visible, or both) when an alarm occurs.

6.04 Minor alarms can be caused by any of the following:

- failure of the self-test routine on an individual-channel basis
- a yellow alarm (*YA remote*)
- an alarm indication signal (*AIS all ones*)

6.05 In addition to initiating LED indications and minor alarm relay contact operation, self-test failure of a single channel causes the 2531/2531A to bypass that channel so that transmission can still take place over the channel, albeit with possible echo.

6.06 Major alarms can be the result of loss of local frame synchronization in the transmit or receive path. If frame synchronization cannot be regained in the amount of time alloted, the output of the problem path begins transmission of the AIS "all ones" signal. Loss of power will also cause a major alarm.

Alarm Timings and Interaction

6.07 As per Bellcore Technical Advisory TA-TSY-000191, the 2531/2531A follows the timing sequence for alarm indication as shown in figure 11 and as explained below. This example uses a fault condition originating on the upstream send path, but can also apply to the receive path.

6.08 In figure 11, when a 2531/2531A (in this case, that in the first intermediate maintence span) loses synchronization at either PCM input, a red alarm (RA local) is generated immediately, and an alarm indication signal (AIS) is transmitted at the respective output. Two seconds later, a major alarm is generated. When synchronization is restored, both the red alarm and AIS transmission immediately cease. Ten seconds after restoration, the major alarm is retired. Successive intermittent synchronization losses of less than two seconds duration may be integrated resulting in a major alarm. The integration algorithm uses a 5:1 attack/decay time ratio until two seconds have accumulated.

6.09 The 2531/2531A in the successive intermediate maintenance span is receiving an AIS transmission from the upstream equipment. Immediately upon detection of AIS at the PCM input, a red alarm is flagged and AIS is transmitted at the send output. At 1.5 seconds after this initial detection, the red alarm is inhibited, the *AIS* LED goes on, and a minor alarm is generated. In this situation, the *RA local* LED goes on at initial detection, and goes off 1.5 seconds later. At the moment that normal transmission is restored, the send output ceases AIS transmission and begins normal operation, and the red alarm detector resets. The minor alarm then ceases 1.5 seconds after restoration of normal operation.

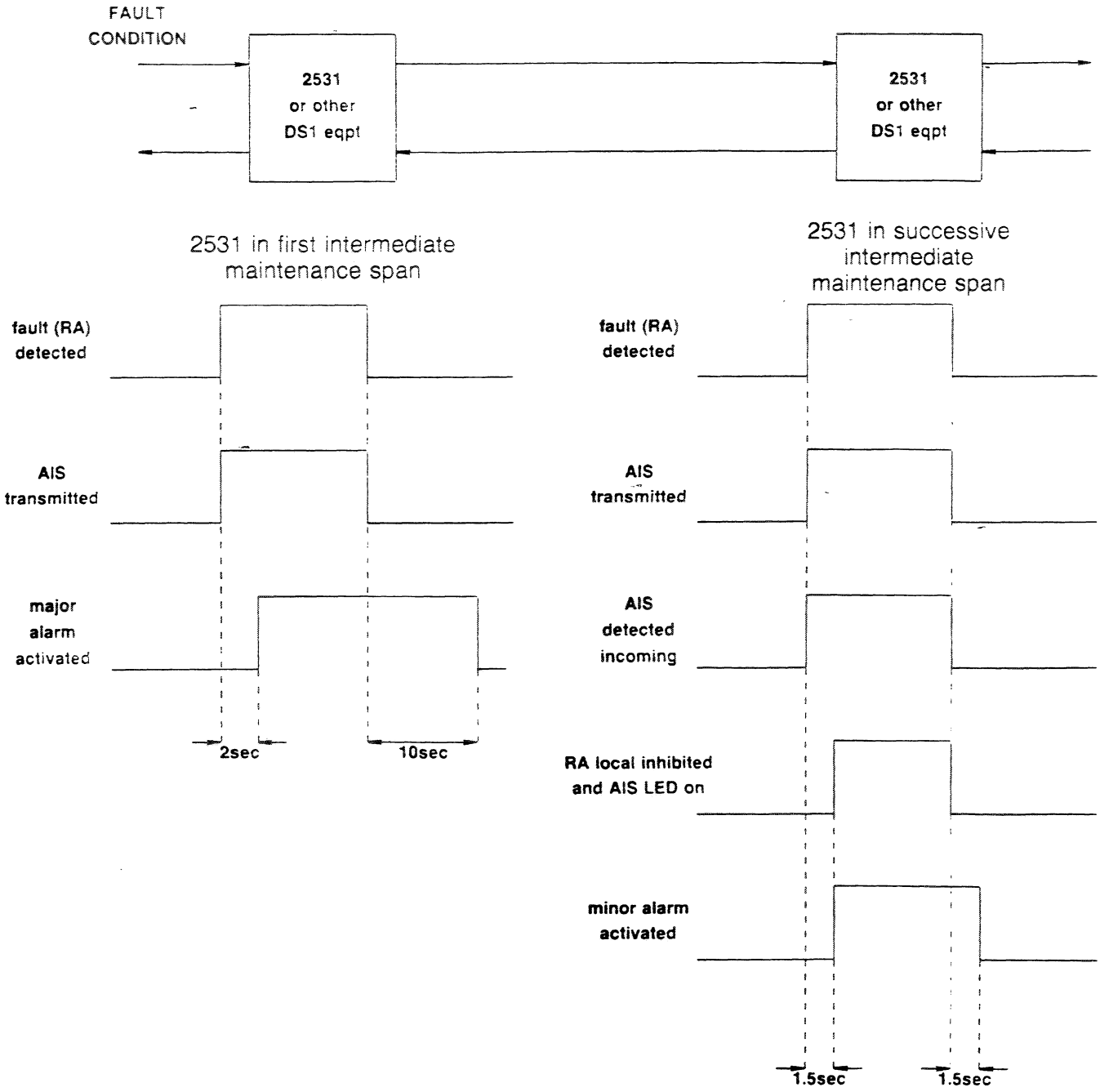

Figure 11. 2531/2531A Alarm Response Timing

Alarm Cutoff and Lamp Test

6.10 Momentarily depressing the front-panel *alarm cutoff* pushbutton restores the corresponding alarm relay to its normal state, thereby causing the external alarm indications to cease. Although this clears all external alarm indications, local alarm indications remain until the fault is cleared.

6.11 Holding down the *alarm cutoff* pushbutton for more than one second places the module in a lamp test mode, where the following should occur:

- 8.8.8. appears in the display.
- All LED's light.

7. Circuit Description and Operation

7.01 This circuit description is intended to familiarize you with the 2531/2531A module for application and engineering purposes only. Attempts to troubleshoot any portion of the system internally are not recommended and may void your Tellabs warranty. Please refer to the 2531/2531A block diagram while reading this description.

Receive Path

7.02 The *T1 metallic bypass* relays cause both send and receive paths to be completely routed around all active circuitry in the event of a power loss. A manual metallic bypass can be achieved while the module is powered up via the RS-232-C remote control port.

7.03 The *T1 RECEIVER* derives clock and recovers data from the *RCV IN* port. The *FRAMING* circuit, using the clock derived from the receive line, demultiplexes the recovered data into 24 channels. The *CHANNEL ALIGNMENT ELASTIC STORE* compensates for differences in send and receive line rates, insuring that the echo cancellation circuitry processes the corresponding receive and send channels at the same time. The aligned receive data (x) from the *CHANNEL ALIGNMENT ELASTIC STORE* is used by the echo cancellation circuitry to generate the echo estimate (r). The *CHANNEL ALIGNMENT ELASTIC STORE* also extracts signaling from the receive data, allowing the *MICROPROCESSOR* to determine the busy-idle status of each channel.

7.04 The *T1 TRANSMITTER* takes the same clock and data used by the *FRAMING* circuit and converts it into bipolar AMI suitable for transmission at the *RCV OUT* port. The receive side is essentially a repeater, since the received data is re-transmitted at the *RCV OUT* port.

Send Path

7.05 The send-path *T1 RECEIVER* and *FRAMING* circuits operate in the same manner as the receive-side circuitry. The *CLEAR CHANNEL CONTROL* makes it possible to bypass individual channels around all echo control circuitry.

7.06 The 2531 contains 24 individual *ECHO ESTIMATORS* (48 on the 2531A), each of which adapts to the end path of the call in progress. At the beginning of a call a channel's *ECHO ESTIMATOR* begins a process known as convergence. During convergence the *ECHO ESTIMATOR* computes the impulse response of the end path; an accurate model of the end-path usually requires about 250ms to construct. The impulse response is then convolved with the (x) signal from the *CHANNEL ALIGNMENT ELASTIC STORE*, resulting in the echo estimate (r). This estimate is subtracted from the send path (x) by the *SUBTRACTER*. After the subtraction process, residual echo (e) may still be present due to small errors in the echo estimate.

7.07 To insure that the send-out signal is completely free from echo, the *NONLINEAR PROCESSOR (NLP)* replaces residual echo with a digital null signal. The *NLP* is level sensitive in that send path signals above a threshold determined by the strength of the *RCV-IN* (x) signal are passed unaffected. Thus speech signals are left intact and only residual echo is removed.

7.08 The *T1 TRANSMITTER* converts the echo-free signal into DS1 format for transmission at the *SEND OUT* port.

Tone Disabler

7.09 A built-in *TONE DISABLER* serves all 24 channels independently. Upon reception of a 2100Hz disabling tone in either the send or receive paths, all echo cancellation and nonlinear processing stops, and the channel is rendered completely transparent. The *TONE DISABLER* can be optioned on a channel-by-channel basis from the front panel or via the RS-232-C remote control port. Self-test is run on all channels that have been tone-disabled.

Control and Alarms

7.10 Control and "thinking" functions are performed by the *MICROPROCESSOR* and its associated interfacing. Among the many responsibilities of this circuit, it receives on-hook off-hook data from each channel, and initiates self-test on all channels found idle. External communication is achieved via the RS-232-C port, and internal and front-panel communications via the *DATA ADDRESS BUS*.

7.11 Carrier group alarms are extracted by the receivers, and then sorted by the *MICROPROCESSOR* for major and minor alarm indications. The alarms are flagged to the user through front-panel LED's and form-C relay contacts.

7.12 Alarm indication signal (AIS, all ones) is detected by the *T1 RECEIVERS* and reported to the *MICROPROCESSOR*. The 2531/2531A is also able to send this signal by tapping off the *AIS GENERATOR* and injecting into either of the transmitter circuits.

Power

7.13 The module derives regulated power for all logic circuits from filtered, positive ground referenced nominal -48Vdc input. A *DC-DC CONVERTER* produces +5Vdc for all logic circuits. If the power converter fails, the *power on* LED goes off.

8. Block Diagram

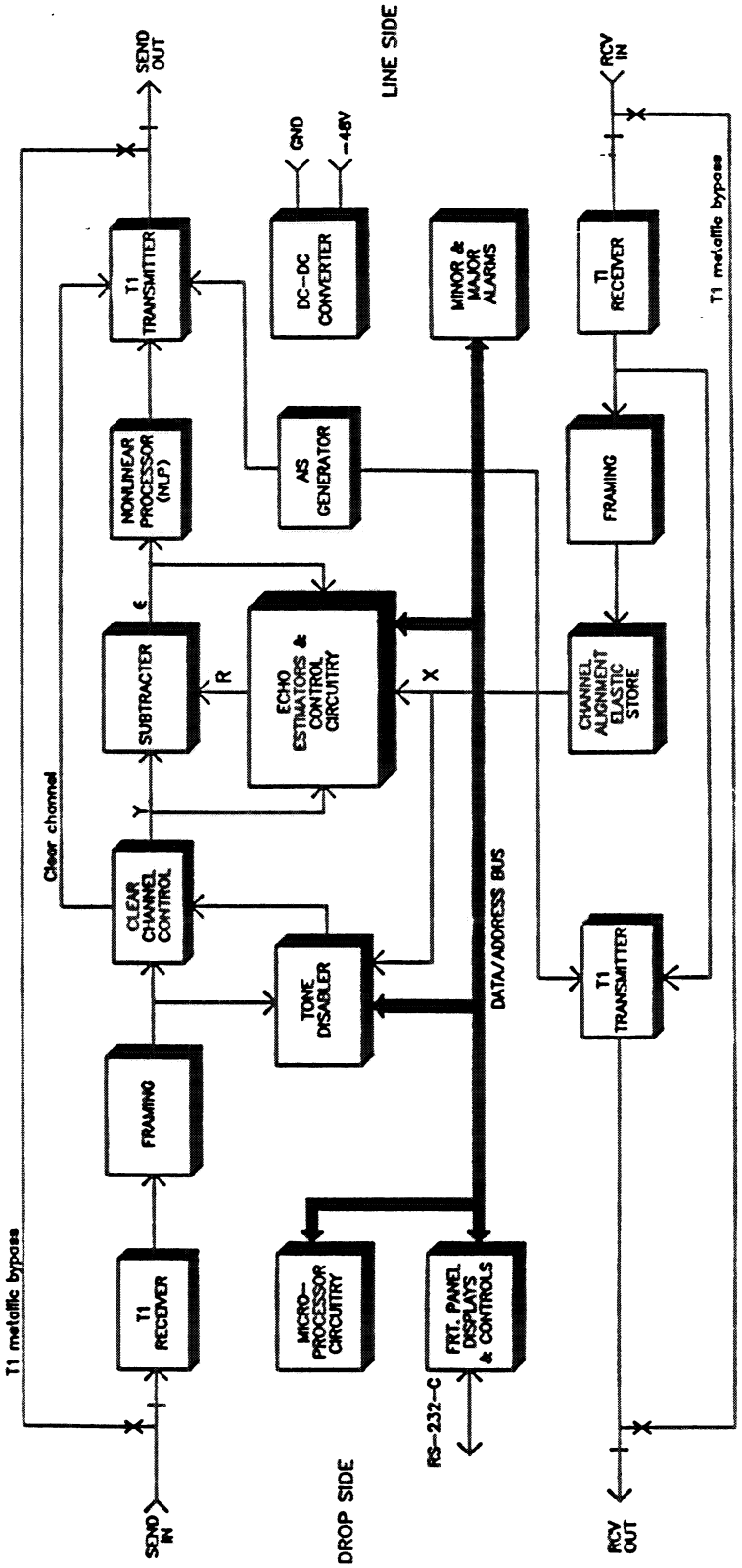

Figure 12. 2531/A Module Block Diagram

9. Specifications

Network Interface

line rate	1.544Mb s
line code	selectable bipolar B8ZS or AMI (in the AMI mode the all zeros code PCM is suppressed by bit-7 stuffing on the send-side only)
message signal encoding	• per CCITT recommendation G.711 • segmented μ-255 companded
minimum ones density	zero code suppression via forced bit 7 or via B8ZS, selectable
message signal levels	• send and receive inputs: 0.75 to 3.7V, base to peak • send and receive outputs: 3 to 6V, base to peak, adjustable to 6V maximum peak level by choice of switch-selectable CO Equalizers
clock frequency change between input and output	none
AIS transmission frequency	• 1.544 MHz ±75Hz under loss of carrier • same as recovered clock frequency under loss of framing conditions
signal processing delay	• send channel: less than 0.200ms, input to output • receive channel: none
clock recovery circuitry	introduced timing jitter: less than 25 degrees peak (loaded Q is 80 to 120 per DS1 rate system specification)
framing format	• meets CCITT recommendation G.733 and D3 D4 channel-bank specifications • Extended superframe (per AT&T compatibility bulletin CB142), programmable option.
frame synchronization	achieved in less than 50ms
quantizing noise	meets D3 channel-bank specifications during signal processing
port impedances	100 ohms nominal, balanced, at all four ports
remote control/status interface	• signal format: serial, compatible with EIA standard RS-232-C • control command transmission: seven-bit ASCII code • data-transfer rate: 300, 600, 1200, 2400, 4800, 9600, or 19,200 b/s, selectable
tone disabler circuit (meets CCITT recommendation G.164)	• operate time: 300 +/-100ms for continuously applied tone between -31 and 0dBm0 • conditioning band: 2010 to 2240Hz • conditioning-band sensitivity: -31dBm0 nominal sensing of both send and receive paths • guard band: 500 to 1775Hz and 2465 to 3000Hz • guard signal ratio: white-noise level to inhibit disabling is no greater than conditioning-band-signal level and not less than 5dB below conditioning-band-signal level • hold band release threshold: -36dBm0, 500 to 3000Hz
alarm outputs	major and minor: 2 pairs form-C, 1Amp contacts for each

Cancellation Circuits

Note: *The cancellation performance of the 2531/2531A meets CCITT recommendation G.165.*

convolution processor 2531	• number of coefficients (2531): 254 • maximum end path delay: 32ms • echo-return loss enhancement (ERLE): greater than 30dB with a minimum 10dB of echo return loss at an equivalent receive-input level of —10dBm0 • convergence: >20dB ERLE in 250ms >23dB ERLE in 500ms
convolution processor 2531A	• number of coefficients: 508 • maximum end path delay: 64ms • echo return loss enhancement (ERLE): greater than 27dB with a minimum of 10dB of echo return loss at an equivalent receive-input level of —10dBm0 • convergence: >17dB ERLE in 250ms >20dB ERLE in 500ms
near-end speech detector (double talk)	• detection threshold: 6dB below receive level • threshold timing: after detection, update processing enters HOLD mode until absence of speech is detected for an interval of 75ms
nonlinear processor	• threshold level: send-input samples (32ms interval) more than 27dB below maximum receive-input level are suppressed • timing: no insertion or removal timing (zero delay)
end-path delay	300 microseconds minimum

Power Requirements

input voltage	-44 to -56Vdc, positive ground referenced
maximum AC ripple	300mV peak-to-peak at 120Hz
typical power consumption — one module (nominal -48Vdc and 25°C)	• 2531: 12 watts • 2531A: 15 watts **Note:** *The above figures include power required for the tone disabler circuit, which is a standard feature.*

Physical

dimensions (2531 or 2531A)	• height: 6.71 inches (17.0cm) • width: 2.13 inches (5.4cm) • depth: 12.94 inches (32.9cm)
weights	• 2531: 2 lbs 9 oz (1.16 kg) • 2531A: 2 lbs 11 oz (1.24 kg)
environment (2531 or 2531A)	• operating temperature. −5 to −43°C. normal. -10 to −50 C (14 to 122 F) short term* • shipping and storage temperature: -58 to −185°F (-50 to −85°C) • operating altitude. up to 11,500 feet (3500 meters) • relative humidity: 20% to 60% (no condensation), normal; 2% to 98% (no condensation), short term* * short term is defined as a duration of up to 72 consecutive hours, not to exceed 15 days per year
reliability — MTBF (mean time before failure)	• 2531: greater than 20 years • 2531A: greater than 16 years

10. Testing and Troubleshooting

10.01 The troubleshooting guide below can assist in the installation, testing, or troubleshooting of the 2531/2531A Module. The guide is intended as an aid in the localization of trouble to a specific module If a module is suspected of being defective, substitute a new one and conduct the test again. If the substitute operates correctly, return the original module to Tellabs for repair or replacement. We strongly recommend that no internal (component-level) testing or repairs be attempted. Unauthorized testing or repairs may void the module's warranty; in addition, if the equipment is part of a registered system, unauthorized repairs will void the FCC registration.

Operational Tests

Signalling Mode Test. To insure that the proper signalling mode has been selected, proceed as follows:

1. Push the *advance* pushbutton until **01** appears in the **channel** window.

2. Toggle both the A and B signaling bits. In the **E&M Signalling Mode**, the *channel active* LED should light whenever A or B is equal to one. Refer to Table 3 for Foreign Exchange Signalling busy-idle status.

Tone Disabler Test. To test the tone disabler for proper operation, perform the following steps:

1. Activate cancellation on channel 1 via the A&B Signalling bits. (see Section 4 for front-panel optioning). The green *channel active* LED should light.

2. Advance the channel display to 01 by depressing the advance pushbutton. Turn on the tone disabler by depressing the *tone disabler* pushbutton. The red *tone disabler* LED should light.

3. Apply a framed T1 signal with a 2100Hz disabling tone present on channel 1 to the SEND IN port of the canceller. The *channel active* LED should go dark.

4. Repeat procedure at the RECEIVE IN port.

Echo Cancellation Test. To insure the 2531 A has been installed in the network properly, perform the following test. With the 2531 A connected as shown in Table 4, 30dB of echo cancellation should be obtained with the canceller optioned for the **canceller only** mode.

1. Option the 2531/A for **canceller only** (40.0) mode.

2. Idle channel 1 via the A&B signalling bits.

3. Set the attenuator for 10dB of loss.

4. Set the noise generator for 5KHz bandwidth and 2σ clipping level.

5. Verify that all TLP shifts have been taken into account.

6. Adjust the noise generator for a 80 dBrnC0 output level, the transmission test set should now read 70dBrnC0.

7 Activate cancellation via the A&B signalling bits or after allowing time for full convergence the transmission test set should read less than or equal to 40dBrnC0.

For proper test results, it is essential that white noise be used for this test. Pseudo-random noises or tones will give different test results For more information on echo canceller testing, refer to CCITT recommendation G.165.

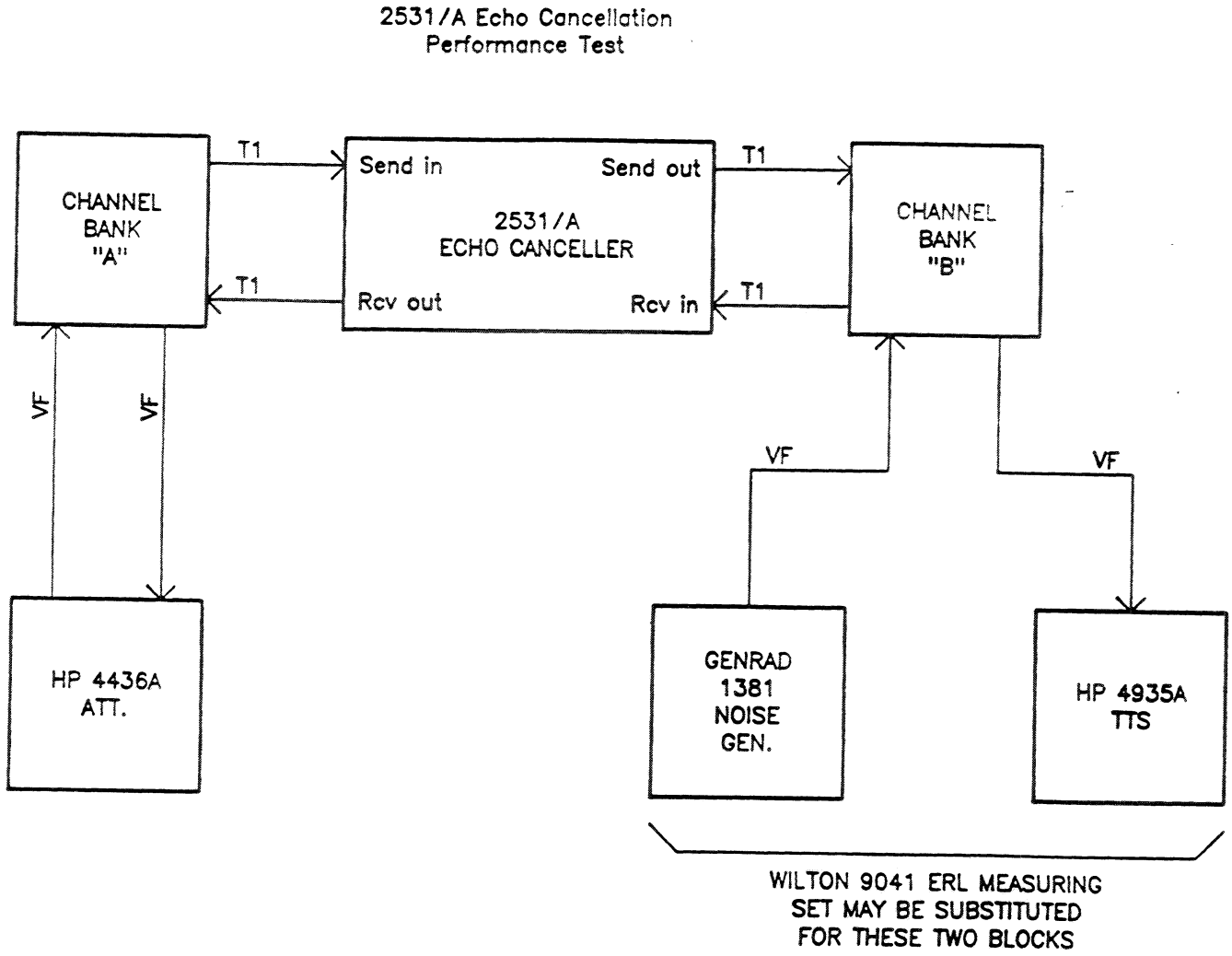

Figure 13. 2531A Echo Cancellation Performance Test

Troubleshooting Guide

Symptom	Possible Source of Problem
Power on indicator extinguished	• improper ground or battery connection • blown fuse • module not properly seated • failed power converter; module defective
8.88 through 1.0.0 shown in display *self-test failure* LED on	• module has failed power-up diagnostics module defective if second attempt at power up also fails
0.1 through 2.4 shown in display and *self-test failure* LED on LED on	• channel self-test failure; module is defective
self-test failure LED on	• channel self-test failure, advance to blank display to view failed channel number; module is defective
channel configuration and/or *tone disabler in* LED's flashing	• all channels not configured in same manner; module not defective
channel display flashes 4.0.0	• timing recovery out of alignment; module is defective
display fails to advance when *advance* or *select* pushbuttons depressed; tone disabler and *ACO* pushbuttons fail to respond	• front-panel access control is in view mode; module not defective
canceller fails to cancel, although all PCM alarms extinguished and *channel active* LED illuminates	• check network connections; line and drop connections to canceller may be reversed
canceller fails to respond to signalling	• improper signalling mode selected or canceller in *clear channel*, *common* *channel signalling*, or *force active* mode
poor cancellation	• maximum end-path delay has been exceeded; recalculate end-path delay (use 2531A for end-path delays greater than 32ms
RA local flickers	• wrong framing format selected, check optioning
canceller will not respond to disabling tone	• tone disabler not selected, disabling tone at a detection band or low in level
canceller responds to a disabling tone but a pause in transmission activaties cancellation	• hold band option selected, option tone disabler for end-of-call operaton

Telephone Assistance

10.02 If a situation arises that is not covered in the troubleshooting guide, contact Tellabs Customer Service as follows:

USA customers:

Atlantic region: (203) 798-0506
Capital region: (703) 478-0468
Central region: (312) 357-7400
Southeast region: (305) 645-5888
Southwest region: (214) 869-4114
Western region: (714) 850-1300

Canada customers.

(416) 624-0052

International customers:

Contact your Tellabs distributor

Replacement

10.03 If a module is diagnosed as defective and a critical service outage exists with no spares available, the module must be replaced. To obtain a replacement module, notify Tellabs via letter, telephone, or TWX. Be sure to provide all relevant information, including the 8X2531(A) part number (the X indicates the issue of the module in question). Upon notification, we shall ship a replacement module to you. If the module in question is in warranty, the replacement will be shipped at no charge. Pack the defective module in the replacement module's carton, sign the packing slip included with the replacement, and enclose it with the defective module (this is your return authorization). Affix the preaddressed label provided with the replacement module to the carton being returned, and ship the module prepaid to Tellabs.

Repair and Return

10.04 If a module is diagnosed as defective and the situation is not critical (no service outage), return the defective module, shipment prepaid, to Tellabs (attn: repair and return).

In the USA:

Tellabs, Inc.
4951 Indiana Avenue
Lisle, Illinois 60532
telephone (312) 969-8800
twx: 910-695-3530

In Canada:

Tellabs Communications Canada, Ltd.
1200 Aerowood Drive, Unit 39
Mississauga, Ontario, Canada L4W 2S7
telephone (416) 624-0052
twx: 610-492-4387

10.05 Enclose an explanation of the malfunction. Follow your company's standard procedure with regard to administrative paperwork. Tellabs will repair the module and ship it back to you. If the module is in warranty, no invoice will be issued.

Note: *Warranty service does not include removal of permanent customer markings on the front panels of Tellabs modules, although an attempt will be made to do so. If a module must be marked defective, we recommend that it be done on a piece of tape or on a removable stick-on label.*