Tellabs
technical manual
76-844001C
rev A

practice section 844001C

4001C Prescription Line Amplifier

contents

1. general description

1.01 The 4001C Prescription Line Amplifier module (figure 1) provides active prescription level control, active prescription amplitude equalization, and impedance matching for the transmit and receive channels of a 4wire voice-frequency transmission facility. The 4001C also contains two independent sealing-current sources, one on the facility side and the other on the terminal side of the module.

Note: *Because the 4001C has identical equalizers in both channels, identical impedance-matching capabilities at all four ports, and identical sealing-current sources on the facility and terminal sides, it can be used either at an intermediate point or near an end point of a 4wire facility. Although the terms "facility side" and "terminal side" do not strictly apply in intermediate applications, these terms will, for convenience, be used throughout this practice as follows:* **Facility side** *will refer to the receive input, transmit-output side of the 4001C, and* **terminal side** *will refer to the transmit-input, receive-output side as shown on the block diagram in section 5 of this practice.*

1.02 This practice section is reissued to cover the Issue 4 version of the 4001C module (Tellabs part number **844001C**). The Issue 4 module is identical to its Issue 3 predecessor except for the addition of a front-panel power-on indicator LED.

1.03 The 4001C's transmit and receive amplifiers can be independently prescription-set to provide from 0 to 24dB of loss or 0 to 24dB of gain in their respective channels. For each channel, gain or loss is selected via a front-panel slide switch. The desired amount of gain or loss is then introduced into each channel in precise 0.1dB increments via a front-panel DIP switch. The maximum output level of each channel is +10dBm, with distortion at maximum output less than 1 percent.

1.04 All four ports of the 4001C module can be switch-optioned for balanced 1200, 600, or 150-ohm terminating impedance. The impedance of the two facility-side ports is selected independently from that of the two terminal-side ports. The transformers at all four ports of the module are center-tapped to derive balanced simplex leads.

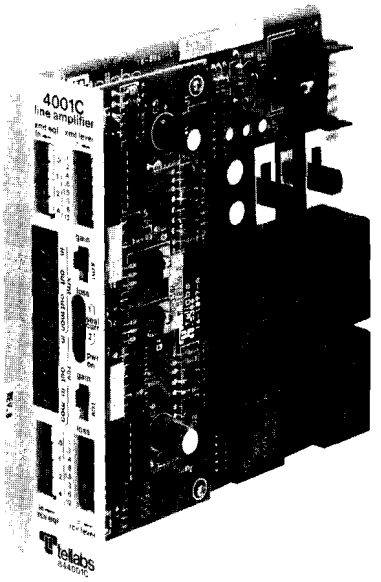


figure 1. 4001C Prescription Line Amplifier

1.05 In addition to active prescription level-control circuitry, the 4001C contains active prescription slope-type amplitude-equalization circuitry in both channels. The transmit and receive equalizers are identical, each providing from 0 to 7.5dB of gain at 2804Hz (re 1004Hz). Equalization is introduced into each channel independently, in 0.5dB increments, via DIP switches on the module's front panel.

1.06 The 4001C can be optioned to provide 25mA of internally generated sealing current to metallic facilities on the facility and terminal sides of the module, to accept externally generated sealing current from the far ends of the facilities on both sides of the module, to derive normal simplex leads on both sides of the module, or to provide bypassed (straight-through) simplex-lead signaling via a path separate from the transmit and receive transmission paths. Each of the 4001C's two internal sealing-current sources has a "ZAP" feature by which a greater amount of sealing current is provided for a few seconds when power is initially applied to the module.

1.07 The front panel of the 4001C is designed so that all level and equalization adjustments can be made while the module is mounted in place. Six front-panel bantam-type test jacks facilitate alignment and maintenance. Both bridging and opening jacks are provided at the facility-side ports; opening jacks alone are provided at the terminal side ports. Front-panel *seal curr 1* and *seal curr 2* LED's light when the module's internal facility-side and terminal-side sealing-current options, respectively, are activated and sealing current is flowing. Also located on the front-panel is a *pwr on* LED that lights when power is applied to the module.

1.08 An internally regulated power supply permits the module to operate on filtered, ground-referenced −22 to −56Vdc input. **If the internal-sealing current option is selected, input power must be from −42 to −56Vdc.** Maximum current requirements (at −48Vdc input) are as follows:

- With both sealing-current sources inactive, 30mA at idle and 65mA at maximum transmit and receive output levels.
- With one sealing-current source active, 57mA at idle and 92mA at maximum output levels.
- With both sealing-current sources active, 84mA at idle and 132mA at maximum output levels.

1.09 Surge protection is provided for the input and output of the transmit and receive amplifiers. Reverse-battery protection and transient limiting are provided for the module's internal power-supply circuitry.

1.10 A Type 10 module, the 4001C mounts in one position of a Tellabs Type 10 Mounting Shelf, versions of which are available for relay-rack or apparatus-case installation. In relay-rack applications, up to 12 modules can be mounted across a 19-inch rack, while up to 14 modules can be mounted across a 23-inch rack. The 4001C can also be used in the Tellabs 246 Resistive Data Bridge System, in which case the module mounts in one position of the Tellabs 246 Mounting Assembly. The 246 Assembly, basically a prewired Type 10 Shelf equipped with a connectorized printed-circuit backplane, houses up to 12 modules and mounts in a 19-inch relay rack. The 246 Assembly and all rack-configured Type 10 Shelves each occupy 6 inches of vertical rack space.

2. application

2.01 The 4001C Prescription Line Amplifier with sealing current is designed for use on 4wire voice-frequency transmission facilities, where it provides active prescription level control, active prescription amplitude equalization, and impedance matching in both the transmit and receive channels. The module also contributes longitudinal isolation and surge protection for the facility. In itself, the 4001C module is equivalent to a 4wire-to-4wire (44V4) voice-frequency repeater. When used with a Tellabs 420X Terminating Set (or equivalent), a 2wire-to-4wire (24V4) repeater results.

2.02 Because equalization is available in both channels (instead of in the receive channel only), the 4001C can be used not only as a terminal repeater but also as an intermediate repeater. Figure 2 shows a typical off-premises-station (OPS) circuit in which the 4001C is used in a variety of applications.

2.03 The 4001C can also be used in the Tellabs 246 Resistive Data Bridge System, where each module provides an active interface between an external 4wire facility and the passive fixed-loss data bridge. Figure 3 shows a typical configuration for two 4wire 6way fixed-loss data bridges.

level control

2.04 Prescription level-control circuitry allows from 0 to 24dB of gain or loss to be introduced into each channel of the 4001C independently. For each channel, either flat gain or flat loss is selected via a front-panel slide switch. The precise amount of gain or loss required in the channel is then selected in 0.1dB increments, via an eight-position front-panel DIP switch.

amplitude equalization

2.05 The 4001C's active slope-type amplitude equalizers allow from 0 to 7.5dB of prescription-set gain at 2804Hz (re 1004Hz) to be introduced into the module's receive and transmit channels individually. Adjustable in 0.5dB increments via front-panel DIP switches, this type of equalization is ideal for nonloaded cable and can also be used effectively in many loaded-cable applications to compensate for the frequency-response characteristics of metallic facilities interfacing the module.

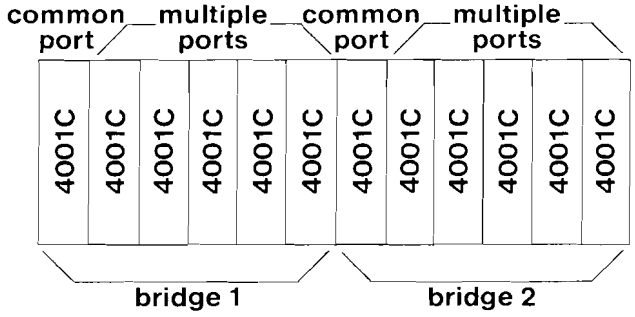


figure 3. Module arrangement for two 4wire 6way resistive data bridges in a Tellabs 246 Mounting Assembly

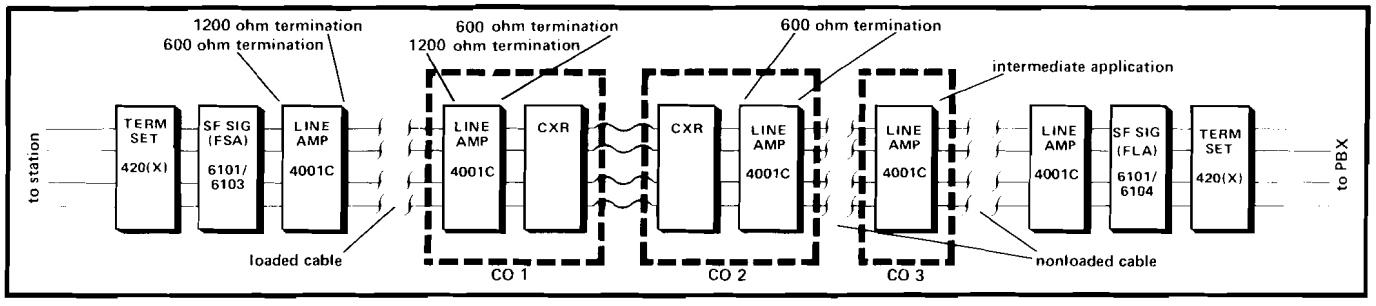


figure 2. Typical off-premises-station (OPS) circuit using 4001C Line Amplifiers

The equalized gain response of each module is **not affected** by flat gain or loss adjustments, which are used to provide precise transmission alignment. The frequency response of the equalizers is shown graphically in figure 4 and in tabular format in table 1.

Note: *Because introduction of equalization into either channel of the 4001C* **does not affect** *1004Hz levels, equalization can be introduced not only before but* **after** *transmission levels are set.*

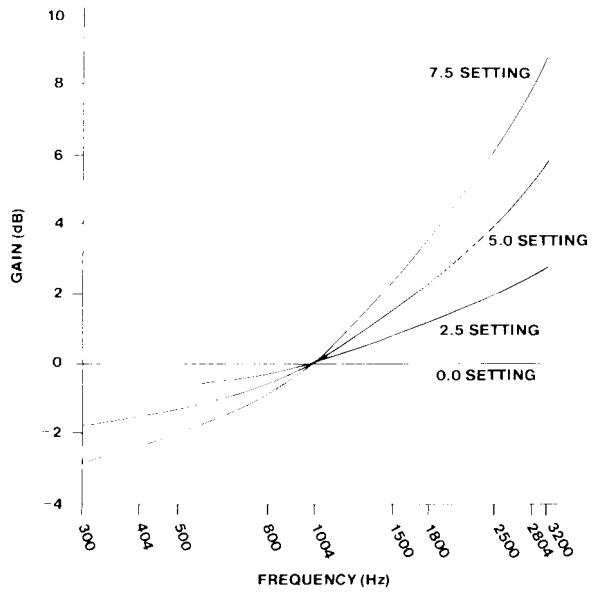


figure 4. Typical transmit and receive equalizer response curves

2.06 Whether one or both channels' equalizers are used depends upon the 4001C's position in the circuit. Use of the module as an amplifier at an intermediate point in a 4wire circuit, for example, often requires the use of the transmit equalizer as well as the receive equalizer. In any case, equalizing at the receive end of a circuit (post-equalization) is generally preferable to equalizing at the transmit end (pre-equalization). Pre-equalization tends to amplify high-frequency signals to a level that is conducive to crosstalk. Post-equalization not only eliminates this problem but also expedites the equalization process because the circuit is easier to equalize at the receive end. In some applications, however, pre-equalization may be necessary because post-equalization at the receive end is unavailable.

impedance matching

2.07 Impedance-matching transformers at all four ports of the 4001C can be switch-optioned for balanced 1200, 600, or 150-ohm terminating impedance. A single option switch selects the desired impedance for both facility-side ports (receive input and transmit output); a second option switch performs this function for both terminal-side ports (receive output and transmit input). Thus, on both the facility and terminal sides, the 4001C can interface a variety of facilities and equipment, as listed in table 2. The 150-ohm options provide a small amount of slope equalization for long sections of nonloaded cable through the deliberate impedance mismatch.

impedance	facility or equipment interfaced
1200 ohms	loaded cable
600 ohms	nonloaded cable, carrier, SF and DX signaling units, terminating sets, station apparatus
150 ohms	small amount of slope-type amplitude equalization for long sections of non-loaded cable through the deliberate impedance mismatch

table 2. Terminating impedance selection guidelines

receive equalizer switch setting (dB)	equalized gain (dB) introduced at various frequencies								
	300Hz	400Hz	500Hz	800Hz	1004Hz	1500Hz	1800Hz	2500Hz	2804Hz
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.5	-0.23	-0.19	-0.15	-0.06	0.0	+0.15	+0.24	+0.43	+0.50
1.0	-0.52	-0.42	-0.33	-0.13	0.0	+0.32	+0.52	+0.93	+1.07
1.5	-0.75	-0.60	-0.49	-0.18	0.0	+0.46	+0.74	+1.33	+1.54
2.0	-1.00	-0.80	-0.64	-0.24	0.0	+0.61	+0.98	+1.76	+2.04
2.5	-1.22	-0.98	-0.78	-0.29	0.0	+0.75	+1.20	+2.15	+2.49
3.0	-1.50	-1.20	-0.95	-0.36	0.0	+0.90	+1.45	+2.60	+3.01
3.5	-1.71	-1.37	-1.09	-0.41	0.0	+1.03	+1.65	+2.97	+3.45
4.0	-2.02	-1.63	-1.29	-0.49	0.0	+1.22	+1.95	+3.54	+4.12
4.5	-2.25	-1.79	-1.42	-0.53	0.0	+1.33	+2.14	+3.90	+4.56
5.0	-2.49	-1.98	-1.57	-0.59	0.0	+1.47	+2.36	+4.32	+5.08
5.5	-2.68	-2.14	-1.69	-0.63	0.0	+1.58	+2.53	+4.67	+5.51
6.0	-2.89	-2.30	-1.81	-0.68	0.0	+1.69	+2.72	+5.05	+5.99
6.5	-3.07	-2.44	-1.93	-0.72	0.0	+1.79	+2.87	+5.38	+6.41
7.0	-3.29	-2.61	-2.05	-0.76	0.0	+1.89	+3.05	+5.76	+6.90
7.5	-3.45	-2.74	-2.15	-0.78	0.0	+1.98	+3.19	+6.06	+7.30

table 1. Typical transmit and receive equalization frequency response

sealing current and simplex leads

2.08 The 4001C contains two separate and independent 25mA sealing-current sources, one on the facility side and one on the terminal side of the module. In addition, all four impedance-matching transformers on the 4001C are center-tapped to derive balanced simplex (SX) leads. Option switches on the facility and terminal sides of the module afford a choice of four sealing-current and simplex-lead options, as follows:

- When the 4001C's internal sealing-current option on the facility side is selected, 25mA of sealing current flows from the transmit output port (pins 41 and 47) and returns via the receive input port (pins 7 and 13). When the 4001C's internal sealing-current option on the terminal side is selected, 25mA of sealing current flows from the transmit input port (pins 55 and 49) and returns via the receive output port (pins 5 and 15). Both sealing-current sources have a ZAP feature that provides a greater amount of current for a few seconds when power is initially applied to the module. Each of the two front-panel *seal curr* LEDs lights when its respective source is active and current is flowing.
- A second sealing-current/simplex-lead option available independently on the facility and terminal sides of the 4001C excludes the module's sealing-current sources from the circuit and provides return paths for sealing current applied at the distant end of the facilities.
- A third option is the derivation of normal simplex leads on either or both sides of the module. This allows the 4001C to be used on circuits employing DX, loopback, or other dc signaling schemes (see figure 5). Normal simplex leads can also be used to apply sealing current to a metallic facility from a local source external to the module.
- The fourth sealing-current/simplex-lead option is bypassed simplex-lead signaling. This option provides a straight-through simplex-lead signaling path between the module's facility and terminal sides that is completely separate from the module's transmit and receive transmission paths. A switch option available when bypassed simplex-lead signaling is selected provides either a normal straight-through signaling path (RCV IN SX to RCV OUT SX and XMT IN SX to XMT OUT SX) or a reversed straight-through signaling path (RCV IN SX to XMT IN SX and RCV OUT SX to XMT OUT SX). The reversed signaling-path option is used to compensate for polarity reversals in duplex- (DX-) signaling and ground-start applications.

3. installation

inspection

3.01 The 4001C Prescription Line Amplifier module should be visually inspected upon arrival to find possible damage incurred during shipment. If damage is noted, a claim should immediately be filed with the carrier. If stored, the module should be visually inspected again prior to installation.

mounting

3.02 The 4001C module mounts in one position of a Tellabs Type 10 Mounting Shelf, which is available in configurations for relay-rack and apparatus-case installation, or in one position of a Tellabs 246 Resistive Data Bridge Mounting Assembly. The module plugs physically and electrically into a 56-pin connector at the rear of its shelf or assembly position.

installer connections

3.03 Before making any connections to the mounting shelf or assembly, ensure that power is **off** and modules are **removed.** Modules should be put into place only **after** they are properly optioned and **after** wiring is completed. When installing 4001C modules in 246 Assemblies, refer to the Tellabs practice on the 246 Resistive Data Bridge System for cabling instructions and module pinout assignments.

3.04 Table 3 lists external connections to the 4001C module. All connections are made via wire-wrapping to the 56-pin connector at the rear of the module's mounting shelf position. Pin numbers are found on the body of the connector.

strap options

3.05 As shipped from Tellabs, connector pin 43 is the 4001C's XMT OUT SX lead and connector pin 3 is the RCV OUT SX lead. If an additional (or alternative) connector-pin appearance for the XMT OUT SX lead is desired on pin 45, install option strap *ST9*

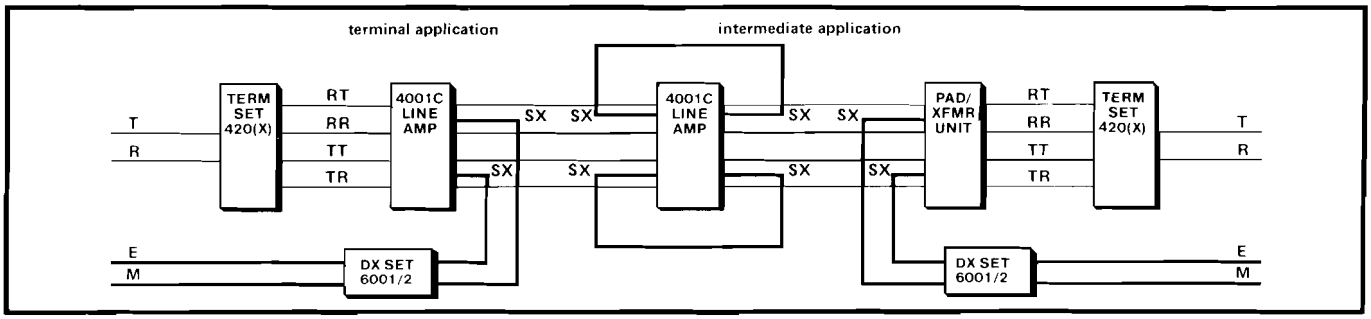


figure 5. Typical 4wire DX signaling application using 4001C Line Amplifiers

connect:	to pin:
XMT OUT TIP	41
XMT OUT RING	47
XMT OUT SIMPLEX	43 and 45
RCV IN TIP	7
RCV IN RING	13
RCV IN SIMPLEX	9 and 11
XMT IN TIP	55
XMT IN RING	49
XMT IN SIMPLEX	51 and 53
RCV OUT TIP	5
RCV OUT RING	15
RCV OUT SIMPLEX	1 and 3
−BATT (filtered −22 to −56Vdc in)*	35
GND (ground)	17

* If one or both internal sealing-current sources are to be used, input power must be between −42 and −56Vdc.

table 3. External connections to 4001C

where indicated on the module's printed circuit board, as shown in figure 6. If an additional (or alternative) connector-pin appearance for the RCV OUT SX lead is desired on pin 3, install option strap *ST10* where indicated on the module's printed circuit board (also shown in figure 6). Before installing *ST9* or *ST10*, be sure to observe the caution below.

Caution: *Extreme care must be taken when soldering on printed circuit boards to prevent damage to the delicate foil. Use a soldering iron with a tip temperature or 800°F or less, use only 60/40 or 63/37 tin/lead rosin-core solder, and do not hold the tip of a hot iron on a solder connection for longer than 2 seconds.*

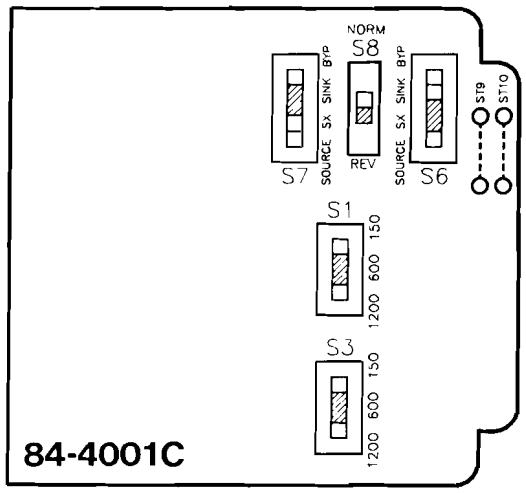


figure 6. 4001C option switch and strap locations

switch options

3.06 Five option switches must be set before the 4001C can be placed into service. Locations of these switches on the module's printed circuit board are shown in figure 6, and instructions for setting the switches are given in paragraphs 3.07 and 3.08.

Note: *All switches on the front panel of the 4001C are used for alignment and are covered in paragraphs* 3.09 *through* 3.14.

3.07 **Terminating Impedances.** Switch *S1* selects the terminating impedances at the 4001C's facility-side ports (rcv in and xmt out). Switch *S3* performs the same function for the 4001C's terminal-side ports (rcv out and xmt in). Set each switch to the *1200, 600,* or *150* position as required. In general, 1200-ohm impedance is used to interface nonloaded cable, 600-ohm impedance is used to interface nonloaded cable, carrier, SF or DX signaling units, terminating sets, or station apparatus, and 150-ohm impedance is used to provide a small amount of slope equalization through the deliberate impedance mismatch when the module interfaces long sections of nonloaded cable (see paragraph 2.07).

3.08 **Facility-Side Sealing-Current / SX-Lead Options.** Switch *S6* conditions the 4001C to supply internally generated 25mA sealing current, to accept externally supplied sealing current from the distant end of the facility, or to derive normal simplex leads on the facility side. Select the desired facility-side sealing current/SX-lead arrangement as follows:

- For normal SX-lead derivation on the facility-side, set *S6* to *SX*.
- For internally generated 25mA sealing current on the facility side, set *S6* to *SOURCE*.
- To provide a return path for sealing current applied from the far end on the facility side, set *S6* to *SINK*.

Note 1: *For instructions on setting* S6 *for a bypassed signaling arrangement, see paragraph 3.10.*

Note 2: *When switch* S6 *is set to either* SX, SINK, *or* SOURCE, *switch* S8 *is nonfunctional and can therefore be left in either the* REV *or* NORM *position.*

3.09 **Terminal-Side Sealing-Current/SX-Lead Options.** Switch *S7* conditions the 4001C to supply internally generated 25mA sealing current, to accept externally supplied sealing current from the far end of the facility, or to derive normal simplex leads on the terminal side. Select the desired terminal-side or sealing-current/SX-lead arrangement as follows:

- For internally generated 25mA sealing current on the facility side, set *S7* to *SOURCE*.
- To provide a return path for sealing current applied from the far end on the facility side, set *S7* to *SINK*.
- For normal SX-lead derivation on the terminal side, set *S7* to *SX*.

Note 1: *For instructions on setting* S7 *for a bypassed signaling arrangement, see paragraph 3.10.*

Note 2: *When* S7 *is set to either* SX, SINK, *or* SOURCE, *switch* S8 *is nonfunctional and can therefore be left in either the* REV *or* NORM *position.*

3.10 **Bypassed Signaling.** For bypassed signaling, i.e., to provide a straight-through SX-lead signaling path separate from the 4001C's transmission paths, set switches *S6, S7,* and *S8* as follows:

- For a normal straight-through signaling path (RCV IN SX to RCV OUT SX and XMT IN SX to XMT OUT SX), set *S6* and *S7* to *BYP* and *S8* to *NORM.*
- For a reversed straight-through signaling path (RCV IN SX to XMT IN SX and RCV OUT SX to XMT OUT SX), as required to compensate for polarity reversals in DX-signaling and ground-start applications, set *S6* and *S7* to *BYP* and *S8* to *REV.*

alignment

3.11 This alignment procedure is divided into three parts: gain adjustment, output level adjustment, and equalization. The **gain adjustment** procedure (paragraph 3.12) covers local prescription alignment for applications where the circuit-layout-record (CLR) transmission requirement is expressed in terms of **expected measured gain** (EMG). If the CLR transmission requirement is expressed in terms of **transmission level points** (TLP's), the **output level adjustment** procedure (paragraph 3.13), which covers composite prescription alignment of the circuit in which the module is used, should be performed instead. If equalizer settings are not given on the CLR or if the given settings do not adequately equalize the facility, frequency response measurements should be taken and the module's equalizer set as described in paragraphs 3.14 through 3.17. Because the equalizers do not affect 1004Hz transmission levels, equalization may be introduced after transmission levels are set.

gain adjustment (for levels expressed as EMG)

3.12 If the CLR transmission requirement is expressed as EMG, proceed as directed below. If the transmission requirement is expressed as TLP's, proceed instead to paragraph 3.13.

Note: *When the CLR transmission requirement is expressed as EMG, both the transmit and receive portions of the transmission measuring set (TMS) used for alignment must be optioned for 600 ohms.*

receive channel:

A. Determine from the CLR whether gain or loss is required in the receive channel, and set the front-panel *rcv gain/loss* switch to *gain* or *loss* as appropriate.
B. Set all front-panel *rcv level* DIP switches for zero gain or loss, i.e., to the *out* position.
C. If you have not already done so, insert the module into its mounting and apply power.
D. Determine from the CLR the amount of receive-channel gain or loss (in dB) required. Call this amount *G rcv.*
E. Arrange the transmit portion of a TMS for 1004Hz tone output at a $-G$ *rcv* dBm level and for 600-ohm impedance and connect it to the module's *rcv in* jack.
F. Arrange the receive portion of the TMS for 600-ohm terminated measurement and connect it to the module's *rcv out* jack.
G. Set to *in* that combination of front-panel *rcv level* DIP switches which adds up to the required amount of gain or loss, as verified by a 0dBm reading on the TMS.

transmit channel:

H. Determine from the CLR whether gain or loss is required in the transmit channel, and set the front-panel *xmt gain/loss* switch to gain or loss as appropriate.
E. Set all front-panel *xmt level* DIP switches for zero gain or loss, i.e., to the out position.
J. Determine from the CLR the amount of transmit-channel gain or loss (in dB) required. Call this amount *G xmt.*
K. Arrange the transmit portion of the TMS for a 1004Hz output at a $-G$ *xmt* dBm level and for 600-ohm impedance, and connect it to the module's *xmt in* jack.
L. Arrange the receive portion of the TMS for 600-ohm terminated measurement, and connect it to the module's *xmt out* jack.
M. Set to *in* that combination of front-panel *xmt level* DIP switches which adds up to the required amount of gain or loss, as verified by a 0dBm reading on the TMS.

output level adjustment (for levels expressed as TLP's)

3.13 If the CLR transmission requirement is expressed as TLP's, proceed as directed below. Please be aware that this procedure requires end-to-end measurements.

Note: *If the CLR transmission requirement is expressed as TLP's, both the transmit and receive portions of the local transmission measuring set (TMS) must be optioned to match the impedance of the module ports to which they are connected. If this is not possible due to the type of TMS available, reoption the module to match the impedance of the TMS while alignment is performed, and be certain to reoption the module appropriately after alignment is completed.*

receive channel:

A. Set all front-panel *rcv level* DIP switches for zero gain or loss, i.e., to the *out* position.
B. If you have not already done so, insert the module into its mounting and apply power.
C. Arrange the receive portion of a TMS for terminated measurement at the terminal-side impedance selected on the module (see note above), and connect it to the module's *rcv out* jack.
D. Request personnel at the distant (facility-side) end of the circuit circuit to send 1004Hz tone at the CLR-specified level. Record the level observed on the local TMS; this level is the receive input level because the module is now optioned for zero gain or loss and no equalization.
E. Refer to the CLR to obtain the required receive output level. Determine the difference between the measured receive input level and the required receive output level.
F. Depending upon whether gain or loss is required (as determined in the preceding step),

set the module's front-panel *rcv gain/loss* switch to *gain* or *loss* as appropriate.

G. Then set to *in* that combination of front-panel *rcv level* DIP switches which adds up to the difference determined in step E, as verified by a proper receive output level reading on the local TMS.

transmit channel:

H. Set all front-panel *xmt level* DIP switches for zero gain or loss, i.e., to the *out* position.

I. Arrange the transmit portion of the TMS for 1004Hz tone output at the CLR-specified transmit input level and for the terminal side impedance selected on the module (see note above), and connect it to the module's *xmt in* jack.

J. Request personnel at the distant (facility-side) end of the circuit to measure and report the level of the received 1004Hz tone.

K. Determine the difference between the actual received level at the distant end and the desired level at that end.

L. Depending upon whether gain or loss is required to achieve the desired level at the distant end (as determined in the preceding step), set the module's front-panel *xmt gain/loss* switch to *gain* or *loss* as appropriate.

M. Set to *in* that combination of front-panel *xmt level* DIP switches which adds up to the difference determined in step K, as verified by a proper receive input level at the distant end of the circuit.

equalization adjustment

3.14 To adjust the 4001C's receive and transmit active slope equalizers when prescription equalization settings (i.e., the amount of equalized gain at 2804Hz re 1004Hz required for each channel) are given in the CLR, simply set the module's front-panel *rcv eql* and *xmt eql* DIP switches appropriately, as directed in paragraph 3.15. If, however, prescription equalization settings are not given in the CLR or if the given settings do not provide adequate results, it is necessary to perform equalization adjustment as directed in paragraphs 3.16 through 3.18.

3.15 **Prescription Receive and Transmit Equalization.** Equalization is introduced via the front-panel *rcv eql* and *xmt eql* DIP switches. The specific amount of equalized gain at 2804Hz (re 1004Hz) introduced via each individual DIP-switch position is indicated on the front panel adjacent to the switch. These switch positions are cumulative; the total amount of equalized gain (0 to 7.5dB) introduced into a channel is the sum of that channel's DIP-switch positions set to in. Because the amounts of required equalization given in the CLR may be specified to the nearest 0.1dB (while the *rcv eql* and *xmt eql* DIP switches are arranged in 0.5dB increments), use the following guidelines for rounding up or down when setting the switches: If, for example, 0.3 to 0.7dB of equalized gain is required, set the switches to introduce 0.5dB. If 0.8 to 1.2dB of equalized gain is required, set the switches to introduce 1dB. Similarly, if 1.3 to 1.7dB of equalized gain is required, set the switches to introduce 1.5dB, and so on upward through the switches' range. If no equalization is required for a channel, ensure that all of that channel's equal DIP-switch positions are set to *out*.

3.16 **Non-Prescription Receive-Channel Post-Equalization Adjustment.** To determine the need for receive-channel post-equalization at the local end of the facility, and to adjust the module's receive equalizer when prescription settings are not given in the CLR, proceed as follows:

A. Ensure that all front-panel *rcv eql* DIP-switch positions are set to *out* for no equalization. Then remove the module from its mounting position, ensure that both terminating-impedance switches (*S1* and *S3*) are correctly set, and reinsert the module into its mounting position.

B. Arrange the receive portion of a transmission measuring set (TMS) for terminated measurement at the terminal-side interface impedance selected on the module. Connect the receive portion of the TMS to the module's *rcv out* jack. (The transmit portion of the TMS must remain disconnected from the module at this time.)

Note: *If the TMS does not provide an impedance setting that matches the impedance selected on the module, reoption the module as necessary for a proper impedance match during this procedure. Then, when this procedure is completed, reset the module's impedance as required.*

C. Have the distant facility-side end send 1004Hz test tone at the CLR-specified level. Verify that the TMS reading equals the CLR-specified receive level; then measure and record the level.

D. Now have the distant facility-side end send 2804Hz test tone at the CLR-specified level. Measure and record the received 2804Hz tone level. Subtract this 2804Hz level from the 1004Hz level measured in step C.

E. Set to *in* the proper combination of *rcv eql* DIP switches that approximates as closely as possible the measured difference, i.e., the amount of equalized gain required, as specified in table 4.

3.17 **Non-Prescripion Transmit-Channel Post-Equalization for Intermediate Applications.** In intermediate-repeater applications, transmit-channel equalization is often used to post-equalize the input to the module's transmit channel in the same manner as the module's receive equalizer. In such applications, to determine the need for transmit-channel post-equalization at the local end of the facility interfacing the module's "terminal" side, and to adjust the module's transmit equalizer when prescription settings are not given in the CLR, proceed as follows:

A. Ensure that all front-panel *xmt eql* DIP-switch positions are set to *out* for no equalization. Then remove the module from its mounting position, ensure that both terminating-impedance

1004Hz-2804Hz difference	amount of equalized gain required
0.0 to 0.2dB	0.0dB
0.3 to 0.7dB	0.5dB
0.8 to 1.2dB	1.0dB
1.3 to 1.7dB	1.5dB
1.8 to 2.2dB	2.0dB
2.3 to 2.7dB	2.5dB
2.8 to 3.2dB	3.0dB
3.3 to 3.7dB	3.5dB
3.8 to 4.2dB	4.0dB
4.3 to 4.7dB	4.5dB
4.8 to 5.2dB	5.0dB
5.3 to 5.7dB	5.5dB
5.8 to 6.2dB	6.0dB
6.3 to 6.7dB	6.5dB
6.8 to 7.2dB	7.0dB
7.3 to 7.7dB	7.5dB

table 4. Equalized gain settings from cable loss data

switches (*S1* and *S3*) are correctly set, and reinsert the module into its mounting position.

B. Arrange the receive portion of a transmission measuring set (TMS) for terminated measurement at the facility-side interface impedance selected on the module. Connect the receive portion of the TMS to the module's *xmt out* jack. (The transmit portion of the TMS must remain disconnected from the module at this time.)

Note: *If the TMS does not provide an impedance setting that matches the impedance selected on the module, reoption the module as necessary for a proper impedance match during this procedure. Then, when this procedure is completed, reset the module's impedance as required.*

C. Have the distant terminal-side end send 1004Hz test tone at the CLR-specified level. Verify that the TMS reading equals the CLR-specified receive level; then measure and record the level.

D. Now have the distant terminal-side end send 2804Hz test tone at the CLR-specified level. Measure and record the received 2804Hz tone level. Subtract this 2804Hz level from the 1004Hz level mesured in step C.

E. Set to *in* the proper conbination of *rcv eql* DIP switches that approximates as closely as possible the measured difference, i.e., the amount of equalized gain required, as specified in table 4.

3.18 **Non-Prescription Transmit-Channel Pre-Equalization for Terminal or Intermediate Applications.** In both terminal and intermediate repeater applications, transmit-channel equalization (i.e., pre-equalization) at the local end of the facility is normally left flat (no equalization) in favor of receive-channel post-equalization at the distant end of the facility. In such applications, to determine the need for transmit-channel pre-equalization, and to adjust the module's transmit equalizer when prescription settings are not given in the CLR, proceed as follows:

A. Ensure that all front-panel *xmt eql* DIP switches are set to *out* for no equalization. If you have not already done so, remove the module from its mounting position, ensure that both terminating-impedance switches (*S1* and *S3*) are correctly set, and reinsert the module into its mounting position.

B. Connect the transmit portion of the TMS, arranged for the terminal-side interface impedance selected on the module, to the module's *xmt in* jack.

Note: *If the TMS does not provide an impedance setting that matches impedance selected on the module, reoption the module as necessary for a proper impedance match during this procedure. Then, when this procedure is completed, reset the module's impedance as required.*

C. Send test tone at 1004Hz and 2804Hz at the CLR-specified transmit input level toward the distant facility-side end. Have personnel at that end measure the received levels, subtract the 2804Hz level from 1004Hz level, and report the result.

D. Set to *in* the proper combination of *xmt eql* DIP switches that approximates as closely as possible the reported difference, i.e., the amount of equalized gain required, as specified in table 4.

4. circuit description

4.01 This circuit description is intended to familiarize you with the 4001C Prescription Line Amplifier for engineering and application purposes only. Attempts to troubleshoot the unit internally are not recommended and may void your warranty. Troubleshooting procedures should be limited to those prescribed in section 7 of this practice. Refer to the 4001C block diagram, section 5 of this practice, as an aid in following this circuit description.

Note: *The transmit and receive channels of the 4001C module are virtually identical. Therefore, the description in paragraphs 4.02 and 4.03 applies to both channels.*

4.02 A transformer is used at each port (input and output) of each channel to interface external circuits. Switch-selectable taps on the external-circuit side of each transformer afford a choice of 1200, 600, or 150-ohm balanced terminating impedance on both sides (facility and terminal) of the module. The internal-circuit side of each transformer is protected by a silicon voltage-transient suppressor that limits transient voltages to a safe level and provides surge protection. In addition, both transformers are center-tapped to derive balanced simplex leads.

4.03 Signals entering each channel's input port are coupled across the input transformer and applied to the *level adjust* circuit and *gain amp*. The *level adjust* circuit is controlled by the channel's front-panel *gain/loss* and *level* switches. These switches allow selection of 0 to 24dB of gain or loss in 0.1dB increments. Signals at the output of the *gain amp* are applied to an active slope-type

amplitude equalizer consisting of the *equalization adjust* circuit and *eql amp.* The *equalization adjust* circuit is controlled by the channel's front-panel *eql* switches. These switches allow selection of 0 to 7.5dB of gain at 2804Hz (re 1004Hz) in 0.5dB increments. Signals at the output of the *eql amp* are applied to the *power amp,* which drives the output transformer.

4.04 The 4001C can be optioned to provide 25mA of internally generated sealing current to metallic facilities on the facility and/or terminal sides of the module, to accept externally generated sealing current from the far ends of the facilities on both sides of the module, to derive normal simplex leads on both sides of the module, or to provide bypassed (straight-through) simplex-lead signaling via a path separate from the transmit and receive transmission paths. Each of the 4001C's two internal sealing-current sources has a "ZAP" feature by which a greater amount of sealing current is provided for a few seconds when power is initially applied to the module.

4.05 When the internal sealing-current source on the 4001C's facility side is selected, sealing current is fed to the external 4wire facility through the transmit output port (pins 41 and 47) and is returned to the module through the receive input port (pins 7 and 13). When the internal sealing-current source on the 4001C's terminal side is selected on either side of the module, sealing current is fed to the external 4wire facility through the transmit input port (pins 49 and 55) and is returned to the module through the receive output port (pins 5 and 15). When the externally supplied sealing current option is selected on either side of the module, the center-tapped leads of the receive and transmit transformers are connected together. This creates a return path that allows the module to accept sealing current from an external source at the distant end of the external facility. The third option setting provides normal simplex-lead derivation at the module's facility-side and/or terminal-side ports. When optioned for bypassed (i.e., straight-through SX-lead signaling, an additional switch option selects either normal (RCV IN SX to RCV OUT SX and XMT IN SX to XMT OUT SX) or reversed (RCV IN SX to XMT IN SX and RCV OUT SX to XMT OUT SX) straight-through signaling.

4.06 The 4001C's facility-side (receive input and transmit output) transformers are connected to both bridging and opening bantam-type test jacks, while the terminal side (receive output and transmit input) transformers are connected to opening bantam-type test jacks only.

4.07 The *power supply* on the 4001C is a simple series voltage regulator that uses a zener diode as reference source. A series diode in the negative input battery lead protects the circuit against reversed input-power connections, and a metal-oxide varistor between input battery and ground limits high-level supply transients to a safe level.

6. specifications

Note: *Transmit-channel and receive-channel specifications of the 4001C are identical.*

terminating impedances (all four ports)
1200, 600 or 150 ohms, balanced, switch-selectable

flat gain or loss
0 to 24dB of gain or 0 to 24dB of loss, in switch-selectable 0.1dB increments, with gain or loss selected via switch option increments, prescription-set

deviation from gain or loss setting indicated by front-panel switches
± 0.25dB maximum, re 1000Hz

maximum output level
+10dBm

total harmonic distortion
less than 1% at +10dBm output level

longitudinal balance (each port)
55dB minimum, 150 to 3000Hz

frequency response (unequalized)
± 0.5dB, 300 to 3000Hz, re 1000Hz
± 0.3dB, 500 to 3000Hz, re 1000Hz

amplitude equalization
active prescription slope-type providing from 0 to 7.5dB of gain at 2804Hz, re 1004Hz, in switch-selectable 0.5dB increments

noise
15dBrnC maximum at maximum gain

delay distortion
less than 100μs, 300 to 3000Hz, re 1800Hz (measured worst-case with equalization)

crosstalk loss between channels
85dB minimum at 1000Hz
75dB minimum at 3000Hz

crosstalk loss between units in adjacent, above, or below shelf slots
90dB minimum at 1000Hz
85dB minimum at 3000Hz

simplex (SX) current
120mA maximum, with 5mA maximum unbalance

internal sealing-current sources (facility and terminal sides)
25mA, balanced (with higher ZAP current for a few seconds upon initial application of power to module)

input power requirements when neither sealing-current source is used
voltage: −22 to −56Vdc filtered, ground referenced
current (at −48Vdc): 75mA maximum, 30mA at idle

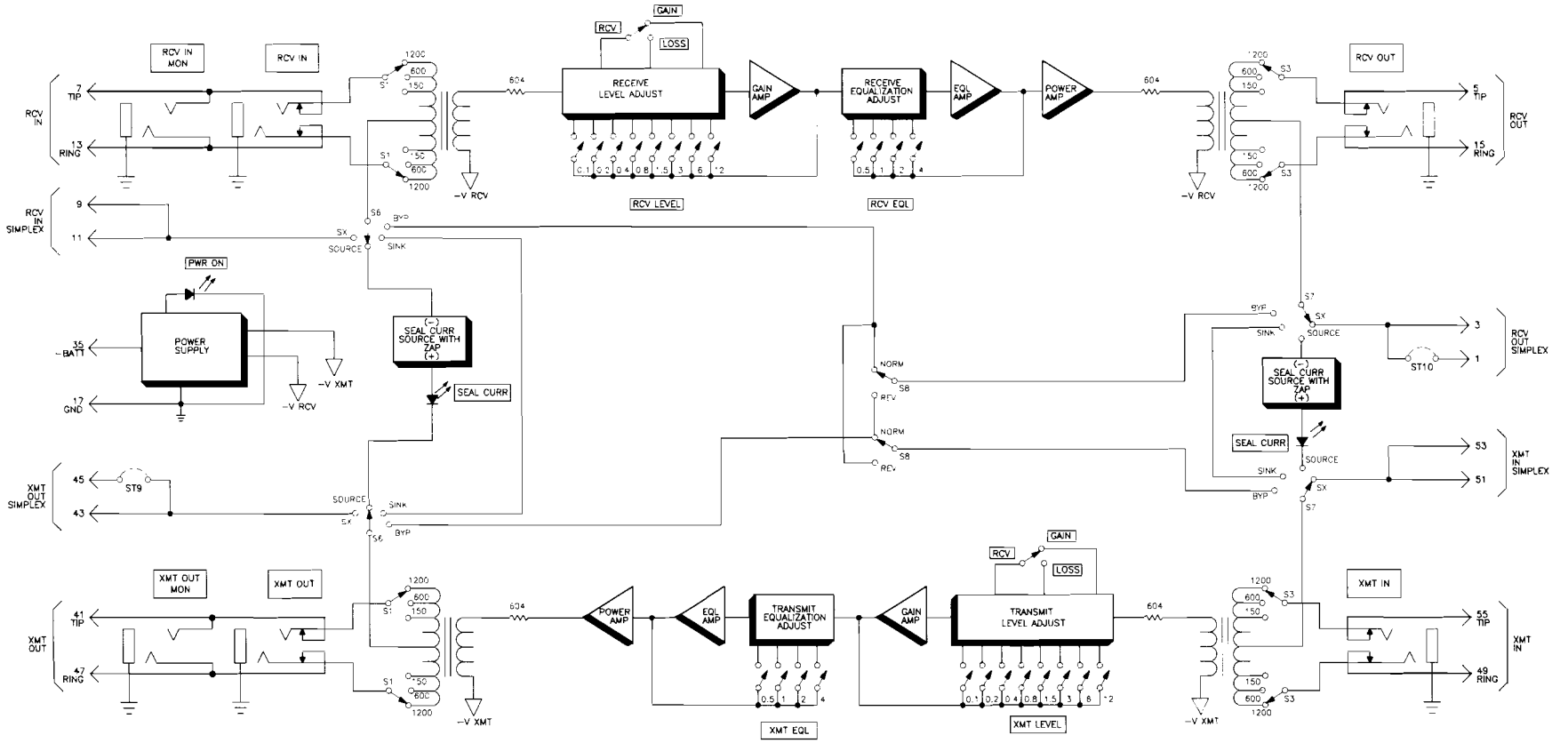
input power requirements when internal sealing-current sources are used
voltage: −42 to −56 Vdc filtered, ground referenced
current (at −48Vdc): 57mA at idle, 92mA maximum with one sealing-current source active; 84mA at idle, 132mA maximum with both sealing-current sources active

operating environment
20° to 130°F (−7 to 54°C), humidity to 95% (no condensation)

dimensions
5.58 inches (14.17cm) high
1.42 inches (3.61cm) wide
5.96 inches (15.14cm) deep

weight
13 ounces (369 grams)

mounting
relay rack or apparatus case via one position of a Tellabs Type 10 Mounting Shelf or one position of a Tellabs 246 Resistive Data Bridge Mounting Assembly



4001C Prescription Line Amplifier **844001C**

5. block diagram

7. testing and troubleshooting

7.01 The *testing guide checklist* in this section may be used to assist in the installation, testing, or troubleshooting of the 4001C Prescription Line Amplifier. The checklist is intended as an aid in the localization of trouble to a specific module. If a module is suspected of being defective, a new one should be substituted and the test conducted again. If the substitute module operates correctly, the original module should be considered defective and returned to Tellabs for repair or replacement as directed below. We strongly recommend that no internal (component-level) testing or repairs be attempted on the module. Unauthorized testing or repairs may void the module's warranty. Also, if the module is part of a registered system, unauthorized repairs will result in noncompliance with Part 68 of the FCC Rules and Regulations.

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.*

7.02 If a situation arises that is not covered in the checklist, contact Tellabs Customer Service as follows (telephone numbers are given below):

USA customers: Contact Tellabs Customer Service at your Tellabs Regional Office.

Canadian customers: Contact Tellabs Customer Service at our Canadian headquarters in Mississauga, Ontario.

International customers: Contact your Tellabs distributor.

US Atlantic Region: (203) 798-0506
US Capital Region: (703) 478-0468
US Central Region: (312) 357-7400
US Southeast Region: (305) 834-8311
US Southwest Region: (214) 869-4114
US Western Region: (714) 850-1300
Canada: (416) 624-0052

7.03 If a module is diagnosed as defective, follow the *replacement* procedure in paragraph 7.04 when a critical service outage exists (e.g., when a system or a critical circuit is down and no spares are available). If the situation is not critical, follow the *repair and return* procedure in paragraph 7.05.

replacement

7.04 To obtain a replacement module, notify Tellabs via letter or telephone (see addresses and numbers below) or via TWX (910-695-3530 in the USA, 610-492-4387 in Canada). Be sure to provide all relevant information, including the 8X4001C part number that 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

7.05 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

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

Enclose an explanation of the module's 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.

checklist on next page

testing guide checklist

test	test procedure	normal result	if normal conditions are not met, verify:
receive level	Arrange transmit portion of transmission measuring set (TMS) for 1004Hz tone output at −20dBm if module's rcv channel is optioned for gain or at 0dBm if module's rcv channel is optioned for loss. Also set transmit portion of TMS for facility-side interface impedance selected on module. Connect 1004Hz signal to *rcv in* jack. Arrange receive portion of TMS for terminated measurement at terminal-side inter-face impedance selected on module, and connect it to *rcv out* jack.	Signal level indicated on TMS corresponds to receive gain or loss setting on module ☐.	Power ☐. Wiring ☐. Proper impedance terminations (check for double terminations) ☐. Impedance switches (*S1* and *S3*) properly set ☐. Level switches (*rcv gain/loss* and *rcv level*) properly set ☐. Replace module and retest ☐.
receive equalization	Maintain connections as above. Adjust *rcv eql* switches for no equalization (all switches set to *out*). Adjust module's receive output level for 0dBm at 1004Hz. Change input frequency to 2804Hz and add equalization (up to maximum) by setting *rcv eql* switches to *in* one by one.	Receive output level at 2804Hz increases to +7.5dBm as equalization is added ☐.	Input level at 2804Hz same as at 1004Hz ☐. Terminating impedance correct ☐.
transmit level	Arrange transmit portion of TMS for 1004Hz tone output at −20 dBm if module's xmt channel is optioned for gain or at 0dBm if module's xmt channel is op-tioned for loss. Also set transmit portion of TMS for terminal-side interface impedance selected on module. Connect 1004Hz signal to *xmt in* jack. Arrange receive portion of TMS for terminated measurement at facility-side interface impedance selected on module, and connect it to *xmt out* jack.	Signal level indicated on TMS corresponds to transmit gain or loss setting on module ☐.	Power ☐. Wiring ☐. Proper impedance terminations (check for double terminations) ☐. Impedance switches (*S1* and *S3*) properly set ☐. Level switches (*xmt gain/loss* and *xmt level*) properly set ☐. Replace module and retest ☐.
transmit equalization	Maintain connections as above. Adjust *xmt eql* switches for no equalization (all switches set to *out*). Adjust module's transmit output level for 0dBm at 1004Hz. Change input frequency to 2804Hz and add equalization (up to maximum) by setting *xmt eql* switches to *in* one by one.	Transmit output level at 2804Hz increases to +7.5dBm as equalization is added ☐.	Input level at 2804Hz same as at 1004Hz ☐. Terminating impedance correct ☐.
sealing current, facility	Option module for internally supplied sealing current on facility side by setting switch *S6* to *SOURCE*. Using bantam-type plugs inserted into *xmt out* and *rcv in* jacks, connect VOM set for mA measurement across facility-side xmt and rcv tip leads (pins 7 and 41), with positive VOM lead on xmt out tip (pin 7).	VOM reads approximately 25mA ☐. Front-panel *seal curr 1* LED lights ☐.	Input battery at least −42Vdc ☐. Replace module and retest ☐.
sealing current, terminal	Option module for internally supplied sealing current on terminal side by setting switch S7 to source. Using bantam-type plugs inserted into *xmt in* and *rcv out* jacks, connect VOM set for mA measurement across terminal-side xmt and rcv tip leads (pins 5 and 55), with positive VOM lead on xmt in tip (pin 55).	VOM reads approximately 25mA ☐. Front-panel *seal curr 2* LED lights ☐.	Input battery at least −42Vdc ☐. Replace module and retest ☐.