tellabs
technical manual
76-814001F
rev A

practice section 814001F/814002F

4001F and 4002F 4Wire-to-4Wire Terminal Repeaters with Sealing Current

contents

1. general description

1.01 The 4001F and 4002F 4Wire-to-4Wire Terminal Repeater modules with Sealing Current (figure 1) provide prescription level control (gain or loss) and impedance matching in both the transmit and receive channel of a 4wire voice-frequency transmission facility. Both modules also provide, in the receive channel only, active prescription amplitude equalization equivalent to that provided by the Western Electric 309B Prescription Equalizer. Each module can be switch-optioned to supply 20mA of sealing current from a source internal to the module, to accommodate externally generated sealing current, or to derive normal simplex leads at the facility-side ports. Simplex-lead routing and polarity are also controlled by switch options on each module. The 4001F and 4002F are component modules of the Tellabs 246 Resistive Data Bridge System and are identical in all respects but one: the 4001F contains front-panel bantam-type test jacks while the 4002F does not.

1.02 In the event that this practice section is reissued, the reason for reissue will be stated in this paragraph. Except where noted, the 4001F and 4002F will, for convenience, be referred to collectively as the *4001F/02F* in the remainder of this practice.

1.03 Independently adjustable transmit and receive amplifiers in the 4001F/02F provide from −24 to +24dB of flat gain in switch-selectable 0.1dB increments. The maximum output level of each channel is +10dBm, with less than 1% distortion.

1.04 An active amplitude equalizer in the receive channel of the 4001F/02F provides prescription post-equalization for either loaded or nonloaded cable facilities. Functionally equivalent to the Western Electric 309B Prescription Equalizer, the 4001F/02F's equalizer offers both low-end slope-type and high-end bump-type equalization, with switch-selectable degree of slope, height of bump, and affected bandwidth.

1.05 The 4001F/02F can be switch-optioned for balanced 1200, 600, or 150-ohm terminating impedance at both facility-side ports (receive input and transmit output). Fixed, balanced 600-ohm terminating impedance is provided at the terminal-side ports (receive output and transmit input). Transformers associated with each of the four ports are center-tapped to derive balanced simplex leads, which are required for DX, loopback, and other dc signaling schemes or for sealing current (see paragraph 1.06).

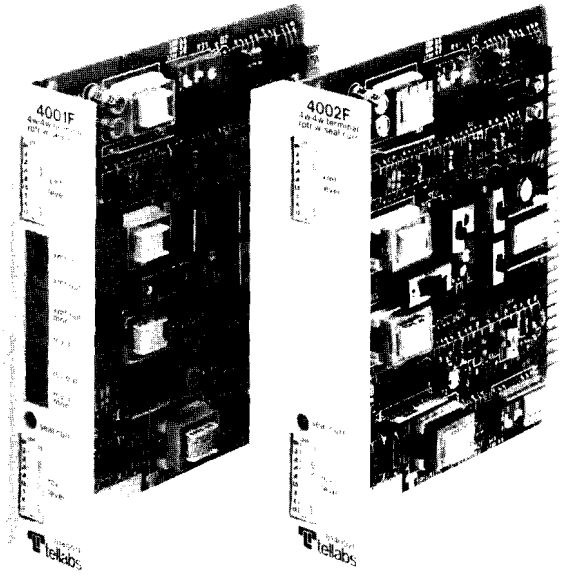


figure 1. 4001F and 4002F 4Wire-to-4Wire Terminal Repeaters with Sealing Current

1.06 The 4001F/02F's facility-side ports can be switch-optioned to provide 20mA of internally generated sealing current to the facility, to accept externally generated sealing current, or to derive normal simplex leads. The module's internal sealing current source has a "ZAP" feature by which a greater amount of sealing current (approximately 34mA on a 1000-ohm loop) is provided for approximately 1 second when power is initially applied to the module. With either the internal or external sealing current option selected, the 4001F/02F can be further switch-optioned for normal or reversed simplex-lead polarity. With normal simplex-lead derivation selected, the 4001F/02F can be further switch-optioned for normal, reversed, or cut-through simplex-lead routing.

1.07 The front panel of the 4001F/02F is designed so that all level adjustments can be made while the module is mounted in place. The 4001F alone features a complement of six front-panel bantam-type test jacks to facilitate alignment and maintenance. Both opening jacks (facing the module) and bridging (monitoring) jacks are provided at the facility-side ports, while opening jacks (facing the module) are provided at the terminal-side ports. Where test-jack access is available

elsewhere, the 4002F provides all the functions and features of the 4001F at a lower cost. A front-panel *seal curr* LED lights when the 4001F/02F's internal sealing-current option is activated and sealing current is flowing.

1.08 An internally regulated power supply permits the 4001F/02F to operate on filtered, ground-referenced −22 to −56Vdc input. Current requirements (at −48Vdc input with the internal sealing-current source inactive) range from 28mA when idle to 58mA with both the transmit and receive amplifiers at maximum output levels. If the internal sealing-current option is selected, input power to the module must be from −42 to −56Vdc. Current requirements when the module's internal sealing-current source is active (at -48Vdc input with a 1000-ohm loop) are 49mA when idle and 79mA at maximum transmit and receive output levels, with an additional 14mA required upon initial sealing-current activation (ZAP operation).

1.09 A Type 10 module, the 4001F/02F 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. As a component module of the Tellabs 246 Resistive Data Bridge System, the 4001F/02F also mounts in one position of a 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 or 23-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 4001F/02F 4Wire-to-4Wire Terminal Repeater with Sealing Current is primarily designed for use near the end points of 4wire voice-frequency transmission facilities, where it provides bidirectional level control, receive-channel amplitude equalization, and impedance matching. The module also contributes longitudinal isolation and surge protection for the facility in both the transmit and receive channels. While the 4001F/02F is, in itself, a 4wire-to-4wire device, it can be paired with a Tellabs 420X Terminating Set (or equivalent), in which case a 4wire-to-2wire repeater results.

2.02 The primary application of the 4001F/02F is in the Tellabs 246 Resistive Data Bridge System, where it provides an active interface between the external 4wire facility and the passive fixed-loss data bridge. Figure 2 shows a typical configuration for two 4wire 6way fixed-loss data bridges. See the Tellabs practice on the 246 System for complete information.

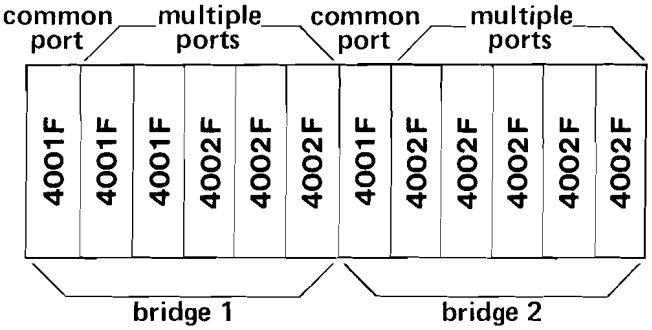


figure 2. Module arrangement for 2 resistive data bridges

2.03 Additional applications of the 4001F/02F include data-channel interface applications of the type shown in figure 3 and voice-paging networks of the type shown in figure 4. In voice-paging applications, the Tellabs 265A Mounting Assembly can be used to house both the 4001F/02F and an associated Tellabs 4406 4Wire Station Termination module if desired. See the Tellabs 265A Voice Signaling System practice for details.

levels

2.04 Levels in both channels of the 4001F/02F are individually prescription-set to provide up to 24dB of flat gain or flat loss in 0.1dB increments.

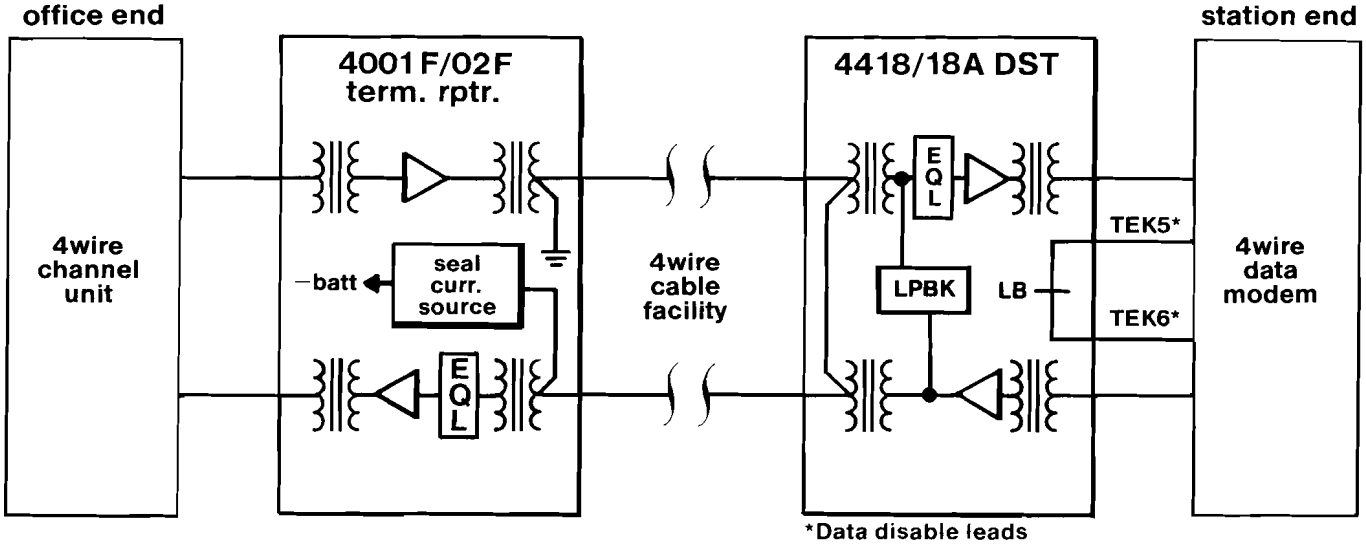


figure 3. Typical data-channel-interface application of 4001F/02F

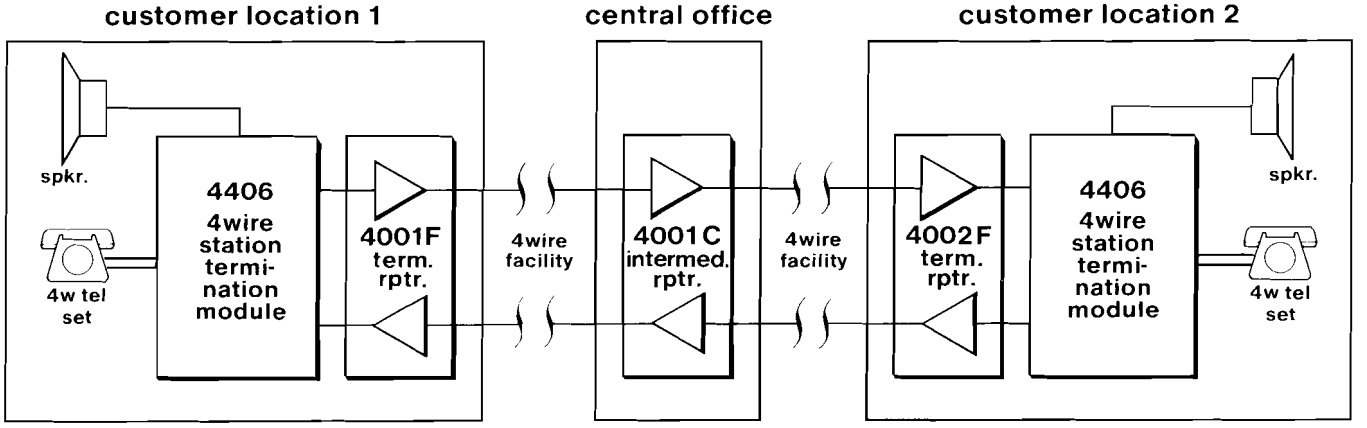


figure 4. Typical voice-paging-network application of 4001F/02F

DIP switches on the module's front panel allow flat gain or loss to be selected for each channel individually; additional front-panel DIP switches are then used to provide precise transmission alignment. Maximum output level of each channel is +10dBm, with less than 1 percent distortion.

amplitude equalization

2.05 The 400F1/02F provides active prescription post-equalization of loaded or nonloaded cable facilities in its receive channel. The 4001F/02F's equalizer is functionally equivalent to the Western Electric 309B Prescription Equalizer, providing low-end slope equalization down to 404Hz and high-end bump equalization centered at 3250Hz. Degree of slope, height of bump, and affected bandwidth are controlled by option switches on the module's printed circuit board.

2.06 Figures 5 and 6 show typical response curves for the 4001F/02F's equalizer in the slope mode. Figure 5 shows the curves for nonloaded cable, while figure 6 shows the curves for loaded cable. For comparison purposes, all frequency-response curves in figures 5 and 6 are drawn with the same 0dB-gain reference point (1004Hz). In reality, all of these curves except those for a 0 (zero) *SLOPE* switch setting are raised above the 0dB level at 1004Hz by as much as 11.4dB. The exact amount by which a particular curve is raised depends upon the *SLOPE* and *L/NL* (loaded/nonloaded) switch settings selected. These amounts are listed in table 1.

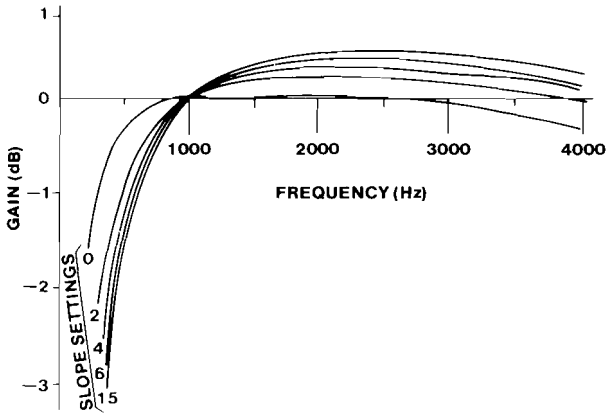


figure 5. Typical response curves for receive-channel equalizer in slope mode, loaded cable

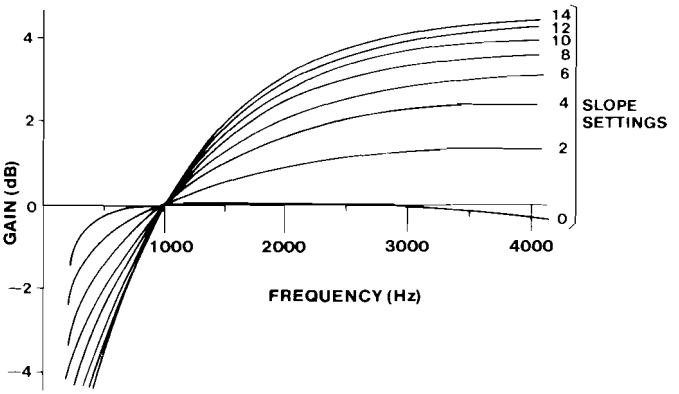


figure 6. Typical response curves for receive-channel equalizer in slope mode, nonloaded cable

SLOPE switch setting	L/NL (loaded/nonloaded) switch setting	
	L	NL
0 (slope disabled)	0.0dB	0.0dB
1	1.4	0.4
2	2.6	0.9
3	3.7	1.4
4	4.7	1.8
5	5.5	2.3
6	6.3	2.8
7	7.2	3.4
8	7.8	3.7
9	8.4	4.2
10	9.0	4.6
11	9.5	5.0
12	10.0	5.4
13	10.5	5.8
14	11.0	6.2
15	11.4	6.6

table 1. Equalized gain (in dB) at 1004Hz in slope mode

2.07 Figures 7 and 8 show typical response curves for the 4001F/02F's equalizer in the bump mode. Figure 7 shows the curves representing various height settings versus a wide bandwidth setting, while figure 8 shows the curves representing various height settings versus a narrow bandwidth setting. For comparison purposes, all frequency response curves in figures 7 and 8 are

drawn with the same 0dB-gain reference point (1004Hz). In reality, all of these curves except those with an *HT* switch setting of 1 or 0 and/or with a *BW* switch setting of 5 or less are raised above the 0dB level by as much as 3.9dB. The exact amount by which a particular curve is raised depends upon the *HT* and *BW* switch settings selected. These amounts are listed in table 2.

impedance matching, simplex leads, and sealing current

2.08 Impedance-matching transformers at the facility-side (receive input and transmit output) ports of the 4001F/02F can be individually switch-optioned for balanced 1200, 600, or 150-ohm terminating impedance. The 1200-ohm option is used to interface loaded cable, while the 600-ohm option is used to interface nonloaded cable or carrier. The 150-ohm option provides approximately 2dB of slope equalization (in the receive channel, this is in addition to any provided by the module's integral equalizer) for long sections of nonloaded cable through the deliberate impedance mismatch. Fixed, balanced 600-ohm terminating impedance is provided at the module's terminal-side (receive output and transmit input) ports to interface a terminating set or terminal-side station equipment.

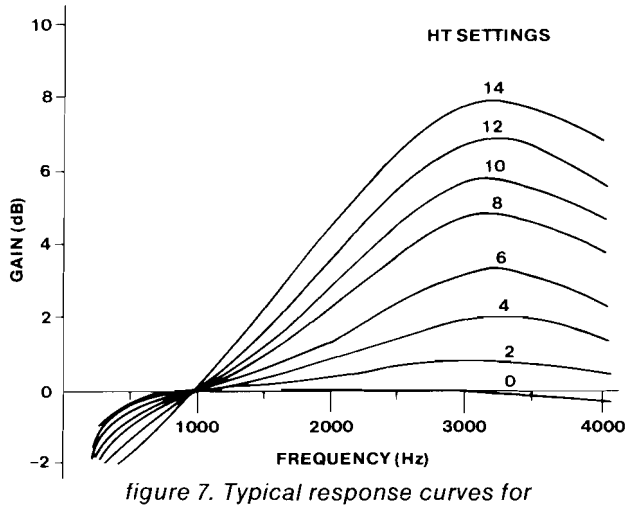


figure 7. Typical response curves for receive-channel equalizer in bump mode, BW switch = 14

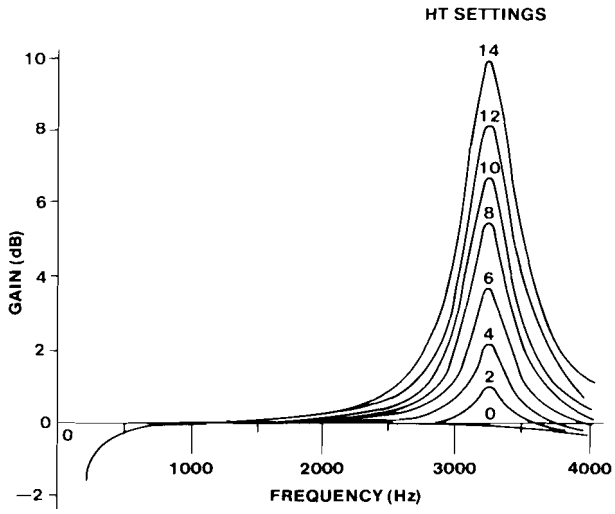


figure 8. Typical response curves for receive-channel equalizer in bump mode, BW switch = 3

2.09 All four impedance-matching transformers on the 4001F/02F are center-tapped to derive balanced simplex leads, thus allowing the module to be used on circuits employing DX, loopback, or other dc signaling schemes. In addition, a three-position option switch on the 4001F/02F affords a choice of either internally supplied sealing current, accommodation of externally generated sealing current, or normal simplex-lead derivation on the module's facility side.

2.10 When the internal sealing current option is selected, 20mA of sealing current is provided by a source integral to the module. This option provides a greater amount of sealing current for approximately 1 second when power is initially applied to the module (this is the ZAP feature) to retard oxidation at cable splices and at metallic connections between terminations. The external sealing-current option is selected when sealing current is supplied

HT switch setting*	BW switch setting**									
	6	7	8	9	10	11	12	13	14	15
2	0.0dB	0.0dB	0.0dB	0.0dB	0.0dB	0.0dB	0.0dB	0.1dB	0.1dB	0.2dB
3	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.3
4	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.4
5	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.3	0.5
6	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.4	0.7
7	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.5	0.9
8	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.7	1.2
9	0.0	0.1	0.1	0.2	0.2	0.3	0.4	0.5	0.8	1.5
10	0.0	0.1	0.2	0.2	0.2	0.3	0.4	0.6	1.0	1.7
11	0.1	0.1	0.2	0.2	0.3	0.4	0.5	0.7	1.2	2.0
12	0.1	0.1	0.2	0.3	0.3	0.4	0.6	0.9	1.4	2.4
13	0.1	0.2	0.3	0.3	0.4	0.6	0.8	1.1	1.7	2.8
14	0.1	0.2	0.3	0.4	0.5	0.7	0.9	1.3	2.0	3.3
15	0.2	0.3	0.4	0.5	0.7	0.9	1.2	1.7	2.5	3.9

*HT switch position 0 disables bump function. HT switch position 1 introduces 0.1dB of gain or less at 1004Hz.
**BW switch positions 0 through 5 introduce 0.1dB of gain or less at 1004Hz for all HT settings.

table 2. Equalized gain (in dB) re 1004Hz in bump mode

from an external source at the distant end of the facility. A switch option allows for polarity reversal of either internally or externally generated sealing current. The front-panel *seal curr* LED lights when either the external or internal sealing current option is selected and sealing current is flowing. If neither of these options is selected, the option switch is set for normal simplex-lead derivation, thereby allowing dc signaling or sealing current to be applied from a local source external to the module. When normal simplex-lead derivation is selected, three additional option switches can be set to route each pair of simplex leads to either side of the module or to connect the facility-side simplex leads to the terminal-side simplex leads for cut-through operation (see paragraph 3.03).

3. installation

inspection

3.01 The 4001F/02F 4Wire-to-4Wire Terminal Repeater with Sealing Current 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 4001F/02F module mounts in one position of a Tellabs Type 10 Mounting Shelf, which is available in configurations for both relay-rack and apparatus-case installation, or in one position of a Tellabs 246 Resistive Data Bridge System 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, make sure 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 4001F/02F modules in prewired, connectorized 246 Mounting Assemblies, no connections to individual module positions in the assembly are required. In this case, 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 4001F/02F module. All connections to non-prewired shelves are made via wire-wrapping at the 56-pin connector at the rear of the module's mounting shelf position. Pin numbers are found on the body of the connector.

option selection

3.05 Six option switches must be set before the 4001F/02F can be placed into service. These switches and their functions are described in paragraphs 3.06 through 3.08. Locations of these switches on the module's printed circuit board and front panel are shown in figure 9.

impedance matching

3.06 Switches *S1* and *S2* are two-position DIP switches that select the terminating impedance at the receive input port and the transmit output port, respectively, on the module's facility side. Set each switch to the *1200, 600,* or *150* position as required. In general, the 1200-ohm option is used to interface loaded cable, while the 600-ohm option is used to interface nonloaded cable or carrier. The 150-ohm option provides approximately 2dB of slope equalization (in the receive channel, this is in addition to any provided by the module's integral equalizer) for long sections of nonloaded cable through the intentional impedance mismatch.

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

* If the internal sealing current source is to be used, input power must be between −42 and −56Vdc.

table 3. External connections to 4001F/02F

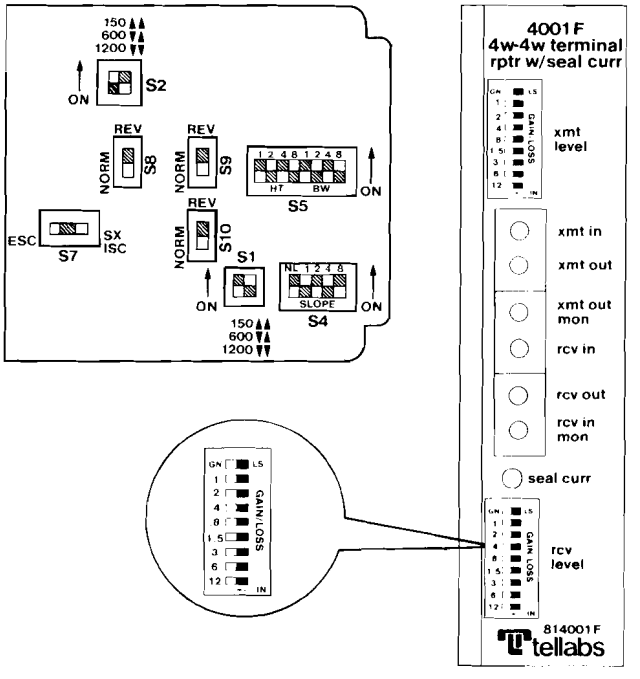


figure 9. Option and alignment switch locations

sealing-current options

3.07 Switch *S7* selects any one of three facility-side sealing current options on the 4001F/02F. If sealing current is to be supplied externally from the distant end of the facility, set switch *S7* to the *ESC* (external sealing current) position to provide a return path for this current. If the module's internal sealing-current source is to be used, set *S7* to the *ISC* (internal sealing-current) position. The direction of sealing-current flow is normally out of the center tap of the receive input transformer and into the center tap of the transmit output transformer

(with switch *S8* set to *NORM*). Set switch *S8* to the *REV* position to reverse this sealing-current polarity. For normal simplex-lead derivation on the module's facility side, set *S7* to the *SX* (simplex) position.

Note: *With* S7 *set to either* ISC *or* ESC, *simplex-lead-routing option switches* S9 and S10 *are nonfunctional.*

simplex routing

3.08 With normal simplex-lead derivation selected (*S7* set to *SX*), switches *S8, S9,* and *S10* are used in combination to provide either a normal, reversed, or cut-through (bypass) simplex-lead arrangement. (Cut-through renders the module transparent to simplex information.) These functions and their corresponding switch settings are shown in figure 10 and listed in table 4.

alignment

3.09 Alignment of the 4001F/02F consists of setting the transmit and receive transmission levels and introducing receive equalization. Two methods of alignment are available: prescription or direct measurement (non-prescription). With the prescription method, the module's *rcv level, xmt level, SLOPE, BW* (bandwidth), and *HT* (height) switches are set as specified on the circuit layout record (CLR). Procedures for prescription alignment are given in paragraphs 3.10 through 3.12. In cases where the information supplied by the CLR is inadequate or unavailable, it is necessary to perform the direct measurement (non-prescription) alignment procedure. The non-prescription procedure, which consists of making measurements at the unit's station-side ports and at the far end of the facility to determine the required settings of the alignment switches, is given in paragraphs 3.13 through 3.15.

Note: *Because the 4002F module has no test jacks, the use of a Tellabs 9801 Card Extender (or equivalent) or an external jackfield is strongly recommended to simplify alignment of this module. The 4002F can be aligned without using a card extender if measurements are made at the numbered pins at the rear of the module's shelf position and care is taken to avoid double terminations. In some instances, it may be necessary to disconnect the module from the connector at the rear of the shelf before tone can be applied or measured.*

prescription level adjustment, transmit and receive

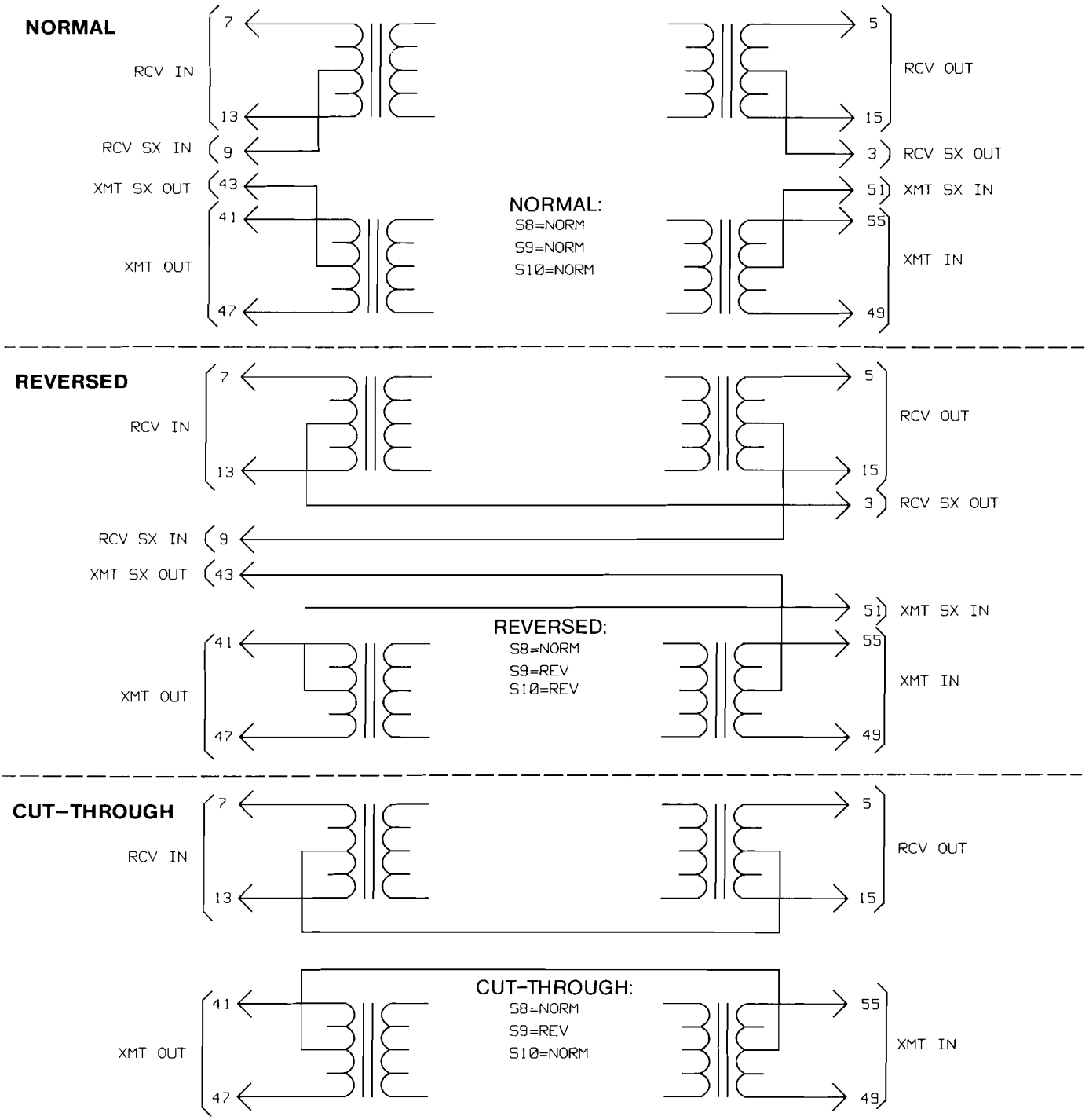
3.10 To adjust the transmit and receive levels on the 4001F/02F, proceed as follows: From the *CLR*, determine whether gain or loss is required in each channel and set the corresponding front-panel *GN/LS* DIP switch to the appropriate setting (*GN* for gain or *LS* for loss). Next, determine (from the CLR) the amount of gain or loss required in each channel. Finally, to achieve the required levels, set the appropriate combinations of *xmt level* and *rcv level* DIP switches to the *IN* position. The specific amount of gain or loss (in dB) introduced by each DIP-switch position is indicated on the switch body adjacent to that switch position. These switch positions are cumulative; the total amount of flat gain or loss introduced into a channel is the sum of that channel's DIP-switch positions set to *IN*.

prescription receive equalization

3.11 Adjusting the receive-channel equalization on the 4001F/02F consists of setting the *SLOPE, BW* and *HT* DIP switches on the module's printed circuit board. These switches are functionally identical to those on the Western Electric 309B Prescription Equalizer. Refer to the CLR for the required

NORMAL	**S8**	**S9**	**S10**
Facility-side simplex information routed to RCV IN SIMPLEX and XMT OUT SIMPLEX leads (normal polarity); terminal-side simplex information routed to RCV OUT SIMPLEX and XMT IN SIMPLEX leads.	NORM	NORM	NORM
Facility-side simplex information routed to RCV IN SIMPLEX and XMT OUT SIMPLEX leads (reversed polarity); terminal-side simplex information routed to RCV SIMPLEX OUT and XMT SIMPLEX IN leads.	REV	NORM	NORM
REVERSED	**S8**	**S9**	**S10**
Facility-side simplex information routed to RCV OUT SIMPLEX and XMT IN SIMPLEX leads (normal polarity); terminal-side simplex information routed to RCV SIMPLEX IN and XMT SIMPLEX OUT leads.	NORM	REV	REV
Facility-side simplex information routed to RCV SIMPLEX OUT and XMT SIMPLEX IN leads (reversed polarity); terminal-side simplex information routed to RCV IN SIMPLEX and XMT OUT SIMPLEX leads.	REV	REV	REV
CUT–THROUGH (BYPASS)	**S8**	**S9**	**S10**
SX cut-through (normal polarity)	NORM	REV	NORM
SX cut-through (reversed polarity)	REV	REV	NORM

table 4. Simplex-lead routing and polarity arrangements and switch settings (with S7 *set to* SX *for normal simplex-lead derivation)*



Note: *Setting S8 to the REV position reverses the RCV SX IN and XMT SX OUT leads.*

figure 10. Simplex-lead routing arrangements

combination of *SLOPE, BW* and *HT* DIP-switch settings and set each position of each switch to *IN or OUT* as indicated. Prescription settings for the receive equalizer can be found in Tellabs addendum section 819908B or in BSP 332-912-232.

post-alignment testing

3.12 After the transmission levels and receive equalization are set, it may be desirable to confirm the results via end-to-end tests. Where computer-controlled test equipment is used, a subsequent printout will verify the alignment results. Any deviation from the required levels can then be adjusted via the appropriate switches. If computer-controlled test equipment is not available, the alignment results can be confirmed by performing the measurements in the non-prescription alignment procedures below.

non-prescription receive-level adjustment

3.13 To adjust the receive level of the 4001F/02F when prescription level settings are not given in

the CLR or when the given settings do not produce adequate results, proceed as follows (jack designations are those on the 4001F):

A. Ensure that no *rcv level* DIP-switch positions are set to *IN.* Also ensure that switch S1 is correctly set to provide proper impedance matching at the receive input port.
B. Arrange the receive portion of a transmission measurement (TMS) for 600-ohm terminated measurement and connect it to the *rcv out* jack (or to pins 5 and 15).
C. Have personnel at the distant facility-side end send 1004Hz tone at the CLR-specified level. If the receive level is the same as that specified on the CLR, no receive-level adjustment is necessary. If the measured level is lower than the specified level, set the front-panel receive *GN/LS* (gain/loss) switch to *GN.* (This switch is the topmost position of the nine-position front-panel *rcv level* DIP switch). If the measured level is greater than the specified level, set the *GN/LS* switch to *LS.* Then set to *IN* that combination of *rcv level* DIP-switch positions which equals the required amount of gain or loss (i.e., the difference between the measured level and the specified level).

Note: *The amount of gain or loss introduced by each position of the* rcv level *DIP-switch is indicated on the switch body. These switch positions are cumulative; the total amount of gain or loss introduced is the sum of those switch positions set to the* IN *position.*

non-prescription receive equalization adjustment

3.14 The receive-channel equalizer of the 4001F/02F is functionally identical to Western Electric model 309B Prescription Equalizer. Non-prescription alignment procedures for the equalizer can be found in BSP 332-912-234.

non-prescription transmit level adjustment

3.15 To adjust the transmit level of the 4001F/02F when prescription level settings are not given in the CLR or when the given settings do not produce adequate results, proceed as follows:

A. Ensure that no *xmt level* DIP-switch positions are set to *IN* position. Also ensure that switch *S2* is set correctly to provide proper impedance matching at the transmit output port.
B. Arrange the transmit portion of a transmission measuring set (TMS), terminated at 600 ohms, to output 1004 Hz tone at the CLR-specified level, and connect it to the *xmt in* jack, (or to pins 55 and 49).
C. Have personnel at the distant facility-side end measure and report the incoming level. If the level measured at the distant end is the same as that specified in the CLR, no transmit-level adjustment is necessary. If the measured level is lower than the specified level, set the front-panel transmit *GN/LS* switch to *GN.* (This switch is the topmost switch of the nine-position front-panel *xmt level* DIP switch.) If the measured level is greater than the specified level, set the switch to *LS.* Then set to *IN* that combination of *xmt level* DIP-switch positions which equals the required amount of gain or loss (i.e., the difference between the measured level and the specified level).

Note: *The amounts of gain or loss introduced by each position of the* xmt level *DIP-switch are indicated on the switch body. These switch positions are cumulative; the total amount of gain or loss introduced is the sum of those switch positions set to* IN.

4. circuit description

4.01 This circuit description is intended to familiarize you with the 4001F/02 4Wire-to-4Wire Terminal Repeater with Sealing Current for engineering and application purposes only. Attempts to troubleshoot these units 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 4001F/02F block diagram, section 5 of this practice, while reading this circuit description.

4.02 The *power supply* of the 4001F/02F is a simple 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 high-voltage varistor between input battery and ground limits high-voltage supply transients to a safe level.

4.03 Input and output transformers in each channel are used to interface external circuits. The module is protected by a varistor to limit transient potentials and to provide surge protection at the input and output ports. The primary winding of each transformer is center-tapped to derive a simplex lead at each of the module's four ports. The secondary winding of each transformer is connected to the channel amplifier and impedance-matching circuitry. The impedance of the transmit input and receive output ports is fixed at 600 ohms, while switch-selectable 1200, 600, or 150-ohm terminating impedance is provided at the module's transmit output and receive input ports.

4.04 Each *amplifier* section is controlled by a front-panel *GN/LS* (gain loss) switch that introduces controlled feedback to provide either that gain or that loss. The precise amount of gain or loss is selected via the front-panel *xmt level and rcv level* DIP switches, which provide from −24 to +24dB of gain in discrete 0.1dB increments.

4.05 The output of the *receive-channel amplifier (rcv amp)* also feeds a series-connected *receive equalizer* that is functionally identical to the Western Electric 309B Prescription Equalizer. The amount of equalization introduced into the receive channel is controlled by the *SLOPE, HT* (height), and *BW* (bandwidth) switches. An option switch conditions the *equalizer* for loaded or nonloaded cable.

4.06 A nominal 20mA *sealing-current source* with a ZAP feature higher current for about 1 second upon initialization) provides sealing current in applications where the facility-side pairs are metallic. This source is a two-transistor series current limiter that uses resistive bias to set the limiting current. The *sealing-current source* can be activated or deactivated via switch option. Another switch option provides polarity reversal of the sealing current. When the *sealing-current source* is activated and current is flowing, the front-panel *seal curr* LED lights.

4.07 When the internal *sealing-current source* is not required, the same three-position option switch that activates the *sealing-current source* can be set to connect the facility-side simplex leads together to provide a return path for sealing current supplied from the distant end of the facility, or to derive normal simplex leads at all four ports. With the facility-side simplex leads connected together, just as with internal sealing current selected, the module can be further optioned for sealing-current polarity reversal. With normal simplex leads selected, the module can be further optioned for normal, reversed, or cut-through (bypassed) simplex-lead routing.

4.08 On the 4001F only, opening jacks facing the module are provided at all four ports, and monitoring jacks bridging the facility are provided at the facility-side ports. All six test jacks on the 4001F are bantam-type.

6. specifications

Note: *Transmit-channel and receive-channel specifications are identical except where noted.*

terminating impedance at facility-side ports (receive input and transmit output)
150 ohms ± 15%, 600 ohms ± 10%, or 1200 ohms ± 10%, balanced, 300 to 4000Hz

terminating impedance at terminal-side ports (receive output and transmit input)
fixed 600 ohms ± 10% balanced, 300 to 4000Hz

flat gain or loss
−24 to +24dB in 0.1dB increments, prescription-set via front-panel DIP switches (gain or loss selected via switch option)

maximum output level
+10dBm

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

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

longitudinal balance (each port)
60dB minimum, 200 to 3000Hz

receive-channel frequency response
0 ± 0.5dB, 400 to 4000Hz, re 1004Hz
−0.8 ± 0.5dB at 300Hz, re 1004Hz
−1.5 ± 0.5dB at 200Hz, re 1004Hz

transmit-channel frequency response
0± 0.5dB, 200 to 4000Hz, re 1004Hz

equalization (receive channel only)
prescription equalizer functionally identical to Western Electric Equalizer 309B

internal sealing-current source
current output: 20mA, balanced, with initial ZAP feature (see below)
ZAP current (upon initial activation of internal sealing-current source): 51mA on 500-ohm loop, 34mA on 1004-ohm loop
ZAP current duration: approximately 1 second on 1000-ohm loop

noise
13dBrnC maximum at maximum gain with maximum equalization
peak-to-average ratio (P/AR): ≥98

crosstalk coupling loss (between channels)
75dB minimum, 200 to 3400Hz

input power requirements (without internal sealing-current option selected)
voltage: −22 to −56Vdc filtered, ground referenced
current (at −48Vdc input): 28mA idle, 58mA maximum

input power requirements (with internal sealing-current option selected and active)
voltage: −42 to −56 Vdc filtered, ground referenced
current (at −48Vdc input, 1000 ohm loop): 49mA idle, 79mA maximum, with an additional 14mA required upon initial sealing-current activation (ZAP current)

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

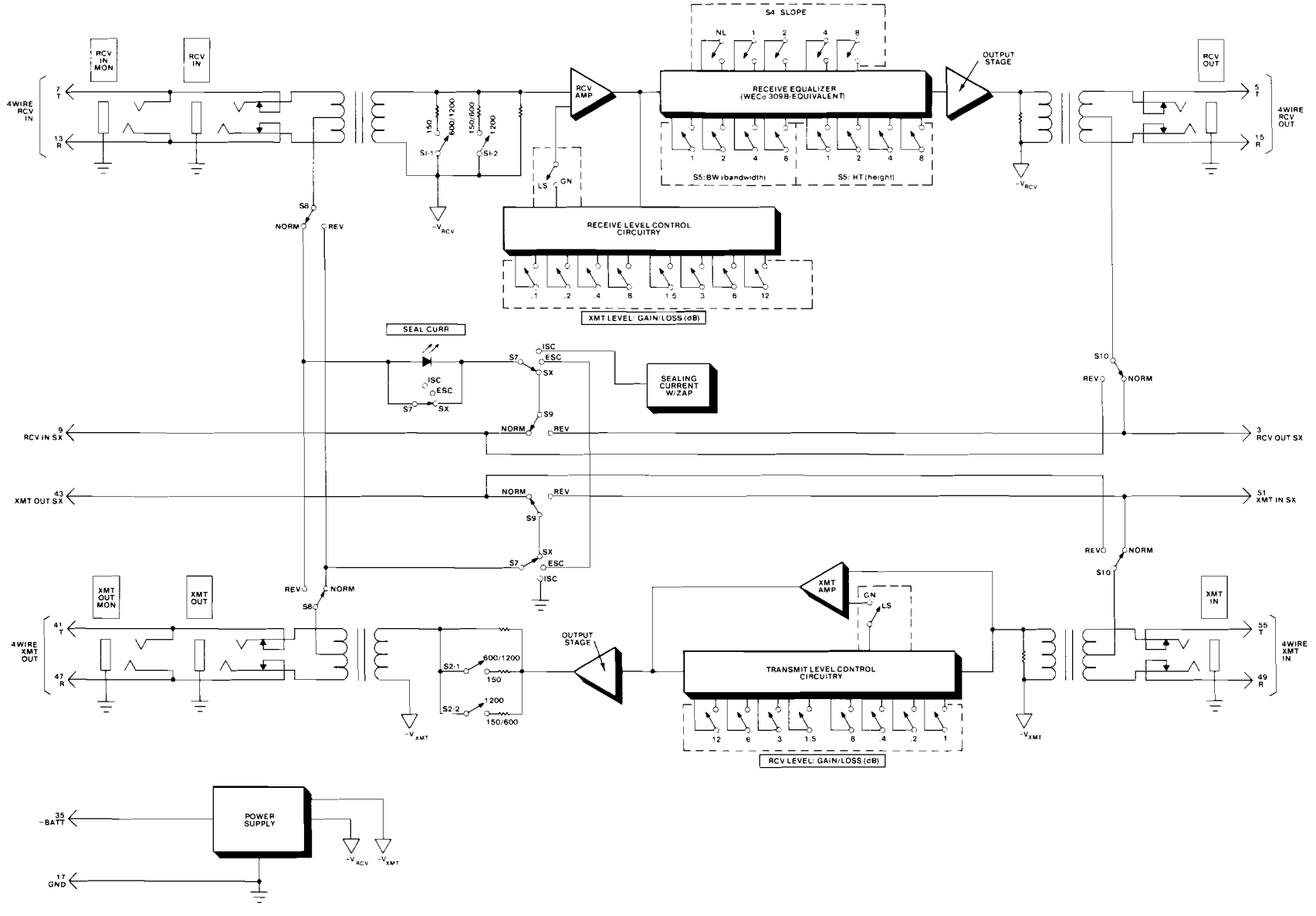
dimensions
5.58 inches (14.17cm) high
1.42 inches (3.61cm) wide
5.96 inches (15.14cm) deep

weight
4001F: 6.5 ounces (184 grams)
4002F: 7.0 ounces (198 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

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 4001F/02F 4Wire-to-4Wire Terminal Repeater with Sealing Current. 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. We strongly recommend that no internal (component-level) testing or repairs be attempted on the module. Instead, a malfunctioning module should be returned to Tellabs for repair or replacement as directed below.



4001F and 4002F 4Wire-to-4Wire Terminal Repeaters with Sealing Current **814001F/814002F**

5. block diagram

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 non-compliance 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 central region: (312) 969-8800
US northeast region: (412) 787-7860
US Atlantic region: (203) 798-0506
US southeast region: (305) 645-5888
US western region: (702) 827-3400
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 8X4001F/02F 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.

testing guide checklist on next page

testing guide checklist

test	test procedure	normal result	if normal conditions are not met, verify:
receive level	Arrange xmt portion of properly terminated* transmission measuring set (TMS) for 1004Hz tone output at CLR-specified level. Connect this signal to *rcv in* jack (4001F) or to pins 7 and 13 (4002F). Arrange rcv portion of TMS for 600-ohm terminated measurement, and connect it to *rcv out* jack (4001F) or to pins 5 and 15 (4002F). Vary *rcv GN/LS* and *level* DIP-switch settings over their entire ranges.	Signal level corresponds to gain and loss settings ☐.	Power ☐. Wiring ☐. Proper impedance terminations (check for double terminations) ☐. Rcv input impedance switch (*S1*) properly set ☐. Front-panel *rcv GN/LS* and *level* switches properly set ☐. Replace module and retest ☐.
transmit level	Arrange xmt portion of TMS, terminated at 600 ohms, for 1004Hz tone output at CLR-specified xmt input level. Connect this signal to *xmt in* jack (4001F) or to pins 55 and 49 (4002F). Arrange rcv portion of TMS for terminated measurement at same impedance selected for xmt output port*, and connect it to *xmt out* jack (4001F) or to pins 41 and 47 (4002F). Vary *xmt GN/LS* and *level* DIP-switch settings over their entire ranges.	Signal level corresponds to gain and loss settings ☐.	Power ☐. Wiring ☐. Proper impedance terminations (check for double terminations) ☐. Xmt output impedance switch (*S2*) properly set ☐. Front-panel *xmt GN/LS* and *level* switches properly set ☐. Replace module and retest ☐.
receive equalization, *HT* and *BW*	Maintains TMS connections as above. Set all *BW* switches to *ON* position. Set all *SLOPE* and *HT* switches to OFF. Arrange TMS for 3250Hz tone output, and set *HT* switches to *ON* one at a time.	Level at *rcv out* jack or at pins 5 and 15 increases as equalization is added ☐.	Input level at 3250Hz same as at 1004Hz ☐. Terminating impedances correct ☐. Switch *S1* set correctly ☐. Replace module and retest ☐.
receive equalization, *SLOPE*	Maintains TMS connections as above. Set all *BW* and *HT* switches to *OFF*. Arrange TMS for 404Hz tone output, *SLOPE* switches to on one at a time.	Level at *rcv out* jack or at pins 5 and 15 increases as equalization is added ☐.	Input level at 404Hz same as at 1004Hz ☐. Terminating impedances correct ☐. Switch *S1* set correctly ☐. Replace module and retest ☐.
sealing current	With module optioned for internal sealing current (*S7* set to *ISC*), connect VOM between *xmt out mon* jack and *rcv in mon* jack.	VOM indicates approximately 20mA after higher initial ZAP current for about 1 second ☐. Front-panel *seal curr* LED lights ☐.	Switch *S7* set to *ISC* ☐. Input battery feed at least −42Vdc ☐. Replace module and retest ☐.

* If TMS has 135-ohm setting instead of 150 ohms, use 135-ohm setting; the slight impedance mismatch will not affect level measurements. If TMS has no 1200-ohm setting, reoption module for 600-ohm facility-side impedance in channel being tested and use 600-ohm TMS setting. Then, upon completion of testing, reset impedance switches for 1200 ohms as required.

Tellabs Incorporated
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