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practice section 836048/836048A

6048 and 6048A 4Wire-to-4Wire or 4Wire-to-2Wire SF-to-E&M Terminal Repeaters

contents

1. general description

1.01 The 6048 and 6048A 4Wire-to-4Wire or 4Wire-to-2Wire SF-to-E&M Terminal Repeater modules (figure 1) each provide both active transmission interface and bidirectional signaling conversion between a 4wire facility that uses 2600Hz single-frequency (SF) signaling and a 4wire or 2wire trunk or line that uses E&M signaling. Unlike the 6048, the 6048A contains transmission and signaling loopback circuitry to facilitate local or remote testing of the module and the facility. As members of Tellabs' 262 Network Terminating Equipment/Data Station Termination (NCTE/DST) System of modules and enclosures, the 6048 and 6048A each fulfill Registered Facility Interface Codes TC11E, TC11M, TC12E, TC12M, TL11E, TL11M, TL12E, and TL12M when optioned for 4wire-to-2wire operation and Registered Facility Interface Codes TC31E, TC31M, TC32E, TC32M, TL31E, TL31M, TL32E, and TL32M when optioned for 4wire-to-4wire operation in applications where the serving telephone company uses facility-side SF signaling.

1.02 This practice section covers the Issue 3 versions of the 6048 and 6048A modules (Tellabs part numbers **836048** and **836048A**, respectively). The practice is revised to highlight certain mandatory alignment-procedure steps. The Issue 3 modules differ from their Issue 1 (6048) and Issue 2 (6048A) predecessors as follows:

- The facility-side level-control circuitry offers a choice of gain or loss (instead of gain only) in both the transmit and receive channels.
- All printed-circuit-board option and alignment switches are moved to card-edge locations for easier visibility and accessibility.
- The receive-channel equalizer now offers a choice of compromise bump-type or active prescription slope-type amplitude equalization instead of slope equalization only.
- The transmit channel now offers active prescription slope-type amplitude equalization identical to the slope equalization available in the receive channel.
- Both modules now operate on −42 to −56Vdc input power only.
- The facility-side simplex-lead pinouts are changed so that the 4wire receive input simplex (RCV IN SX) lead now appears on pin 9 in addition to pin 11 and the 4wire transmit output simplex (XMT OUT SX) lead now appears on pin 43 instead of pin 45.
- An internal sealing-current source is no longer provided.
- Transformer coupling is provided at all ports.
- The front-panel E&M-lead access jack is eliminated.
- A *power* LED is added to the front panel.
- The external manual loopback (EXT MNLB) lead is changed from pin 9 to pin 18.
- The 6048A now offers an automatic terminal-side busy-out option in all loopback modes.
- The 6048A's switch-selectable tone-loopback timeout intervals are changed to 4 minutes and 20 minutes instead of the previous 2.6 and 20.8 minutes.
- The 6048A's loopback-level control circuit is changed to provide 1.0dB gain/loss increments.
- The module's signaling relay is no longer a mercury-wetted type.

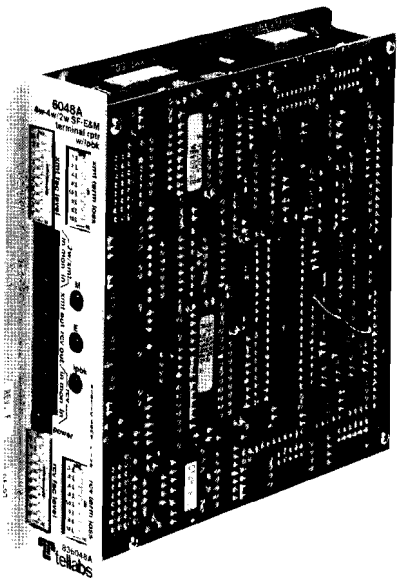


figure 1. 6048A 4Wire-to-4Wire or 4Wire-to-2Wire SF-to-E&M Terminal Repeater module

1.03 Features and options common to both the 6048 and 6048A modules include the following:

- Switch-selectable 4wire or 2wire terminal-side interface, with an integral electronic hybrid providing the 4wire-to-2wire conversion when 2wire terminal interface is selected.
- From 0 to 24dB of prescription-set gain or loss, in switch-selectable 0.1dB increments, in both the transmit and receive channels at the facility-side 4wire ports (receive input and transmit output).

- From 0 to 24dB of prescription-set loss, in switch-selectable 0.1dB increments, in both the transmit and receive channels at the terminal-side ports (receive output and transmit input). When 2wire terminal interface is selected, this loss is actually introduced on the 4wire side of the hybrid.
- Integral receive-channel amplitude equalizer with a choice of two switch-selectable equalization modes:
  - ★ Compromise bump-type equalization for loaded cable. The bump equalizer introduces a 3dB bump at 3200Hz (re 1004Hz) and provides 1.5dB of roll-off at 404Hz (re 1004Hz).
  - ★ Active prescription slope-type equalization for nonloaded cable. The slope equalizer introduces from 0 to 7.5dB of gain at 2804Hz (re 1004Hz) in switch-selectable 0.5dB increments.
- Integral transmit-channel amplitude equalizer that is functionally identical to the receive-channel active prescription slope equalizer described above.
- Transformer coupling at all ports in either the 4wire-to-4wire or 4wire-to-2wire mode.
- Isolation transformers that are center-tapped to derive balanced simplex (SX) leads at both facility-side 4wire ports (receive input and transmit output).
- Independently switch-selectable 1200, 600, or 150-ohm terminating impedance at each facility-side 4wire port.
- Independently switch-selectable 900 or 600-ohm terminating impedance in series with 2.15μF at the 2wire terminal-side port when 2wire interface is selected.
- Integral compromise balance network (CBN) when 2wire terminal interface is selected. This CBN provides either 900 or 600-ohm impedance (depending upon 2wire-port optioning) in series with 2.15μF.
- Fixed, balanced 600-ohm terminating impedance at both terminal-side 4wire ports (transmit input and receive output) when 4wire interface is selected.
- Integral 2600Hz SF tone oscillator.
- Minimum-break transmit pulse correction.
- Full precision receive pulse correction.
- Switch-selectable Type I, II, or III E&M interface.
- Switch-selectable A-side or B-side E&M signaling.
- Front-panel LED's that light to indicate local E-lead and M-lead busy and power on.
- Six front-panel bantam-type test jacks: both opening and monitoring (bridging) jacks at the two input ports and opening jacks at the two output ports.
- Lightning surge protection at both facility-side transmission ports.
- Reverse-battery protection, transient-limiting circuitry, and RC (resistance-capacitance) filtering and decoupling networks to minimize crosstalk coupling and the effects of noise on the input power leads.
- Operation on filtered, ground-referenced −42 to −56Vdc input power with current requirements of 60mA typical at idle (at −48Vdc), with an additional 10mA required for the 6048A when the module is in loopback.
- Type 10 module for mounting in a variety of Tellabs Type 10 Mounting Shelves, which are available in versions for relay-rack (occupying 6 inches of vertical rack space) and apparatus-case installation. The module can also be mounted in one position of a Tellabs 262-series NCTE/DST Mounting Assembly.

1.04 Loopback features and functions of the 6048A module include the following:

- Ability to perform transmission testing on the module and facility from a local or remote location.
- Ability to test the module's SF-to-E&M signaling converter circuitry and E-lead (A-side)/M-lead (B-side) signaling relay from a local or remote location.
- Manual (local) loopback activation via either of two methods: switch option or a connection between the external manual loopback lead and the input power ground lead.
- Two-tone (remote) loopback with 2713Hz tone activation and a choice of deactivation methods: a second 2713Hz tone or automatic deactivation after a switch-selectable 4-minute or 20-minute interval.
- From 0 to 23dB of loopback-path loss or from 0 to 24dB of loopback-path gain, in switch-selectable 1.0dB increments, for true equal-level loopback.
- Switch-selectable automatic terminal-side busy-out during loopback.
- Front-panel LED that lights when loopback is in effect.

Note: *In those parts of this practice that apply equally to the 6048 and the 6048A, both modules are, for convenience, referred to collectively as the* **6048/A.**

2. application

2.01 The 6048/A 4Wire-to-4Wire or 4Wire-to-2Wire SF-to-E&M Terminal Repeater module is typically used to interface a 4wire SF transmission facility with a 4wire or 2wire E&M trunk or line associated with a two-way dial/supervisory telephone circuit. The 6048/A module combines the functions of a 4wire line amplifier, an SF transceiver, an SF-to-E&M signaling converter, and either a 4wire-to-2wire hybrid terminating set or a 4wire pad/transformer module. No external interface circuitry is required because the 6048/A is a complete SF signaling and terminating circuit, less power, on a single Type 10 card. Thus, the module provides not only bidirectional signaling conversion but also active transmission interface (impedance matching, level control, amplitude equalization, and optional 4wire-to-2wire conversion) between the 4wire SF facility and the 4wire or 2wire E&M trunk or line. Unlike the 6048, the 6048A contains integral transmission and signaling loopback circuitry that

permits testing of both the module and the facility from a local or remote location.

2.02 The 6048/A is well suited to a variety of 4wire-to-4wire and 4wire-to-2wire SF-to-E&M applications, both network-terminating and otherwise. Figures 2 through 4 show three typical network-terminating tie-trunk applications of the 6048/A.

2wire terminal interface and balance network

2.03 When optioned for 2wire terminal interface, the 6048/A interfaces the local 2wire E&M trunk or line via prescription attenuators in the transmit and receive paths on the 4wire side of the integral electronic hybrid (see paragraph 2.07) and via the hybrid itself. This hybrid provides switch-selectable 900 or 600-ohm terminating impedance (in series with 2.15μF) at the 2wire port. The 900-ohm option is selected for interface with loaded cable (or with a switched network involving both loaded and non-loaded cable). The 600-ohm option is selected for interface with nonloaded cable or station equipment.

2.04 To ensure that adequate hybrid balance (i.e., enough transhybrid loss) is provided, an integral compromise balance network (CBN) is connected to the hybrid's balance port (opposite the hybrid's 2wire port) whenever the module is optioned for 2wire terminal interface. This CBN provides either 900 or 600-ohm impedance (depending upon the terminal impedance selected at the 2wire port) in series with 2.15μF of capacitance.

4wire terminal interface

2.05 When optioned for 4wire terminal interface, the 6048/A interfaces the local 4wire E&M trunk or

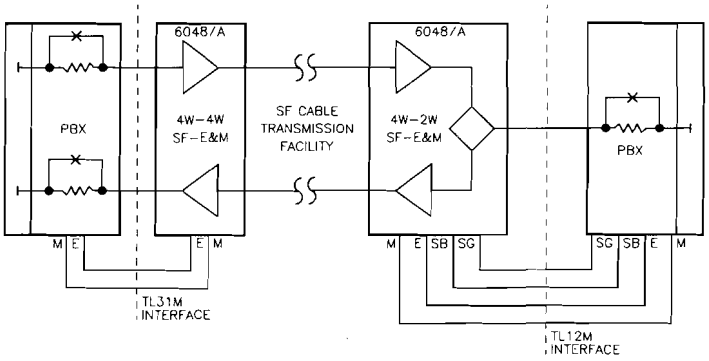


figure 2. Typical short-haul tie-trunk circuit using 6048/A modules

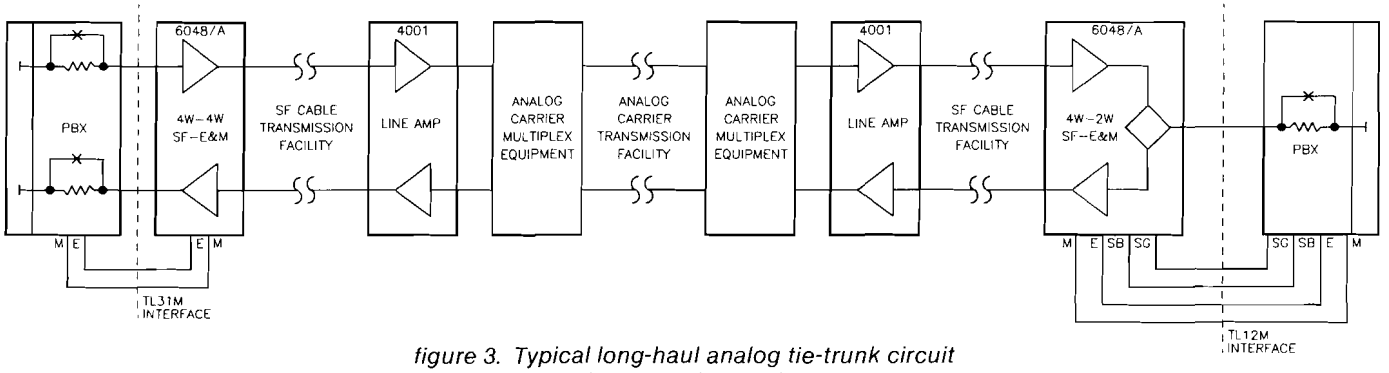


figure 3. Typical long-haul analog tie-trunk circuit using 6048/A modules

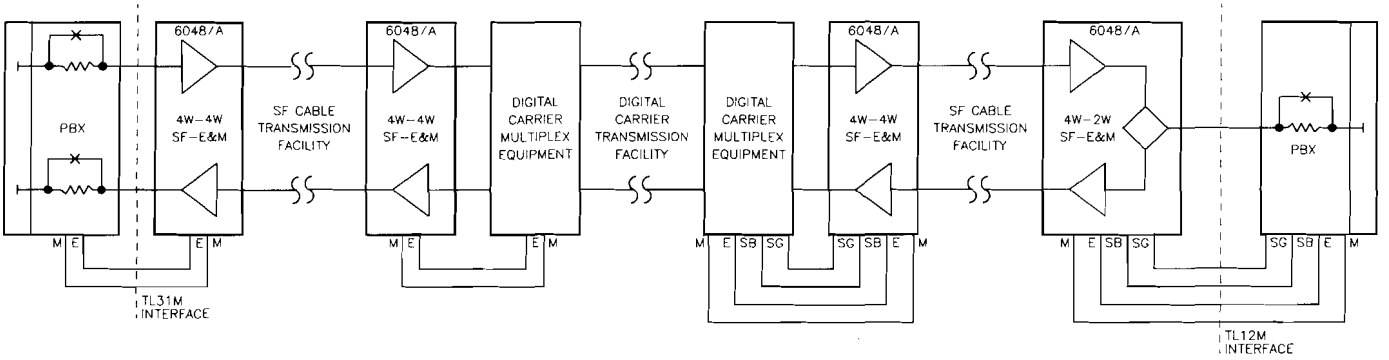


figure 4. Typical long-haul digital tie-trunk circuit using 6048/A modules

line via prescription attenuators in the transmit and receive paths (see paragraph 2.07) and via transformers that provide fixed, balanced 600-ohm terminating impedance at the 4wire transmit input and the 4wire receive output ports. (The module must be optioned for 600 ohms when 4wire terminal interface is selected; the 900-ohm option is not available.)

facility (4wire) interface

2.06 On its facility side, the 6048/A interfaces the 4wire SF signaling facility via transformers at the 4wire transmit output and the 4wire receive input ports and via prescription amplifiers in the transmit and receive paths (see paragraph 2.07). Each facility-side transformer provides balanced, switch-selectable 1200, 600, or 150-ohm terminating impedance. The 1200-ohm option is used for interface with loaded cable; the 600-ohm option, for interface with nonloaded cable or carrier; and the 150-ohm option, to provide a small amount of slope-type amplitude equalization for long sections of nonloaded cable through the deliberate impedance mismatch. Both facility-side transformers are center-tapped to derive simplex (SX) leads, which can be used to provide sealing current to a metallic facility from a local source external to the module or which can be strapped together to establish a return path for sealing current applied at the distant end of the facility.

level control

2.07 Prescription-set transmit and receive amplifiers on the facility side of the 6048/A allow the module to interface the 4wire SF signaling facility directly, i.e., without a separate facility-side line amplifier. These amplifiers, in conjunction with the prescription-set transmit and receive attenuators on the module's terminal side, provide for full coordination between facility-side (4wire) and terminal-side (2wire or 4wire) levels (see figure 5). In the receive channel, the facility-side amplifier is set to provide the gain or loss necessary to derive a +7 transmission level point (TLP) within the module. This internal TLP is then used as a reference as the module's terminal-side receive attenuator is set to provide the loss necessary to derive the required terminal-side 2wire output or 4wire receive output level. In the transmit channel, the terminal-side attenuator is set to provide the loss necessary to derive a −16TLP within the module. This internal TLP is then used as a reference as the module's facility-side transmit amplifier is set to provide the gain or loss necessary to derive the required facility-side 4wire transmit output level. Both facility-side amplifiers in the 6048/A provide from 0 to 24dB of gain or from 0 to 24dB of loss in switch-selectable 0.1dB increments. Both terminal-side attenuators provide from 0 to 24dB of loss in switch-selectable 0.1dB increments. Thus, 4wire receive input TLP's from −17 to +7 can be accommodated and 2wire output or 4wire receive output TLP's from +7 to −17 can be derived. In a similar manner, 2wire input or 4wire transmit input TLP's from −16 to +8 can be accommodated and 4wire transmit output TLP's from +8 to −16 can be derived. Total facility-side gain or loss and total terminal-side loss introduced into a channel are the respective sums of that channel's front-panel *fac level* and *term loss* switches set to *IN*. The overload point for the 4wire receive input port, and for the 2wire port output or the 4wire receive output

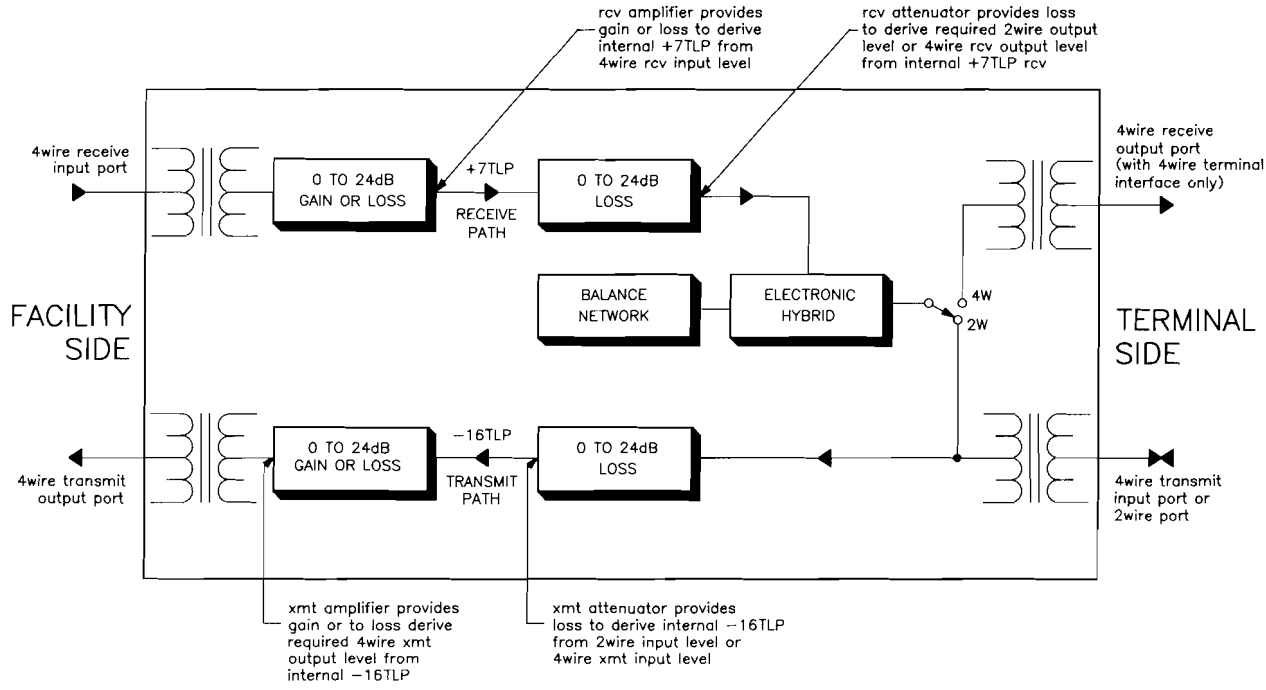


figure 5. Level coordination in 6048/A module

port, is 0dBm0. The overload point for the 2wire port input or the 4wire transmit input port, and for the 4wire transmit output port, is +3dBm0.

receive-channel amplitude equalization

2.08 Two modes of amplitude equalization are available on the 6048/A for post equalization of the facility-side 4wire receive input pair. The first is prescription active slope equalization for nonloaded cable. When this mode is selected, from 0 to 7.5dB of gain at 2804Hz (re 1004Hz) can be introduced into the receive path in switch-selectable 0.5dB increments. Typical frequency response of the slope equalizer is shown in graphic form in figure 6 and in tabular form in table 1.

2.09 The second mode of receive-channel equalization available on the 6048/A is compromise bump-type equalization for loaded cable. The bump equalizer inserts a 3dB bump at 3200Hz (re 1004Hz) and provides 1.5dB of roll-off at 404Hz (re 1004Hz). Typical frequency response of the compromise bump equalizer is shown in graphic form in figure 7 and in tabular form in table 2.

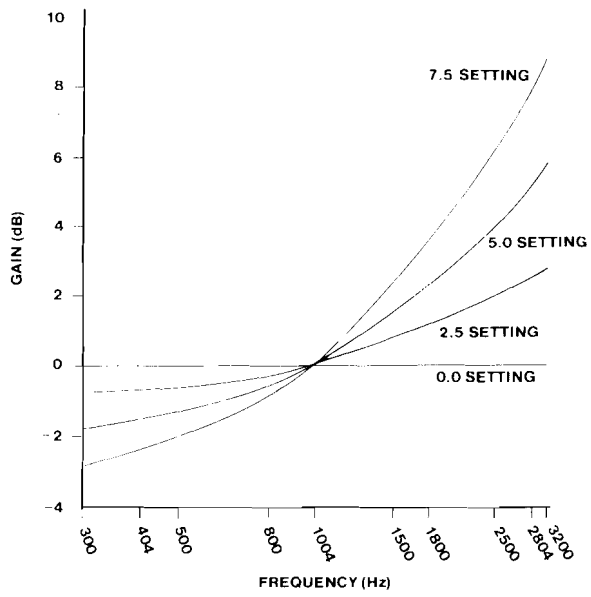


figure 6. Typical slope equalization response curves

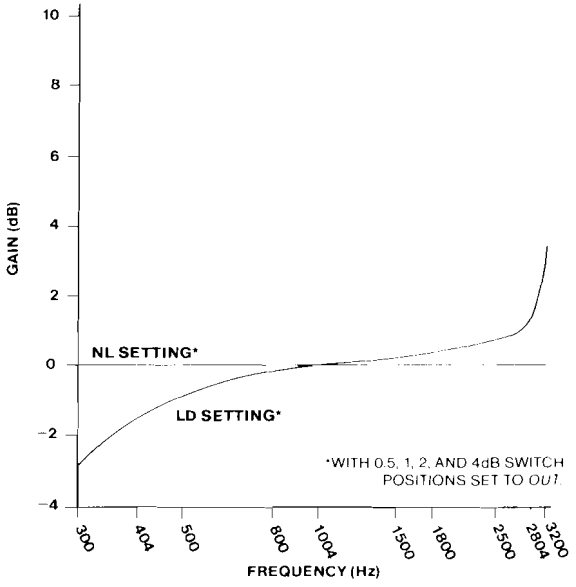


figure 7. Typical compromise bump equalization response curves

slope equalizer switch setting (dB)	equalized gain (in dB) introduced at various frequencies									
	300Hz	404Hz	500Hz	800Hz	1004Hz	1500Hz	1800Hz	2500Hz	2804Hz	3200Hz
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.5	−0.2	−0.2	−0.1	−0.1	0.0	+0.2	+0.3	+0.4	+0.5	+0.5
1.0	−0.3	−0.3	−0.3	−0.1	0.0	+0.4	+0.5	+0.9	+1.0	+1.1
1.5	−0.5	−0.5	−0.4	−0.2	0.0	+0.5	+0.8	+1.3	+1.5	+1.6
2.0	−0.7	−0.6	−0.5	−0.2	0.0	+0.7	+1.1	+1.8	+2.0	+2.2
2.5	−0.9	−0.8	−0.7	−0.3	0.0	+0.9	+1.4	+2.2	+2.5	+2.7
3.0	−1.1	−0.9	−0.8	−0.3	0.0	+1.1	+1.6	+2.7	+3.0	+3.3
3.5	−1.2	−1.1	−0.9	−0.4	0.0	+1.3	+1.9	+3.1	+3.5	+3.9
4.0	−1.5	−1.3	−1.2	−0.5	0.0	+1.3	+2.0	+3.4	+3.9	+4.4
4.5	−1.6	−1.5	−1.3	−0.5	0.0	+1.5	+2.3	+3.9	+4.4	+5.0
5.0	−1.8	−1.6	−1.4	−0.6	0.0	+1.6	+2.5	+4.3	+4.9	+5.6
5.5	−2.0	−1.8	−1.5	−0.6	0.0	+1.8	+2.8	+4.8	+5.5	+6.2
6.0	−2.2	−2.0	−1.7	−0.7	0.0	+1.9	+3.0	+5.2	+6.0	+6.9
6.5	−2.4	−2.1	−1.8	−0.8	0.0	+2.1	+3.2	+5.6	+6.5	+7.5
7.0	−2.6	−2.3	−2.0	−0.8	0.0	+2.2	+3.4	+6.0	+7.0	+8.2
7.5	−2.7	−2.5	−2.1	−0.9	0.0	+2.3	+3.6	+6.4	+7.5	+8.9

table 1. Typical slope equalization frequency response

LD/NL switch setting	equalized gain (in dB) introduced at various frequencies (with 0.5, 1, 2, and 4dB switch positions set to OUT)									
	300Hz	404Hz	500Hz	800Hz	1004Hz	1500Hz	1800Hz	2500Hz	2804Hz	3200Hz
NL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LD	−2.5	−1.5	−0.9	−0.2	0.0	+0.2	+0.3	+0.6	+1.1	+3.1

table 2. Typical compromise bump equalization frequency response

2.10 The response curves of both the slope equalizer and the bump equalizer "pivot" at 1004Hz, as shown in figures 6 and 7. Thus, neither equalizer has any effect on 1004Hz levels. As a result, equalization can be introduced into the receive channel of the 6048/A not only before but also **after** receive levels are set, with no interference between level and equalization adjustments.

2.11 It is possible to introduce both modes of equalization into the receive channel simultaneously. If this is done, the resulting equalized gain at any frequency is the sum of the gain introduced by each equalizer at that frequency, as listed in tables 1 and 2. For example, if both equalizers are used and the slope equalizer is set for 3.5dB of gain at 2804Hz (re 1004Hz), the total amount of equalized gain at 800Hz is −0.6dB, which is the sum of −0.4dB (from table 1) and −0.2dB (from table 2). As a second example, with the same slope equalizer setting, the amount of gain introduced by both equalizers at 1800Hz is +2.2dB, which is the sum of +1.9dB (from table 1) and +0.3dB (from table 2). Please note that even if both equalizers are used, there is no effect upon 1004Hz levels, as explained in paragraph 2.10.

transmit-channel amplitude equalization

2.12 Prescription active slope-type amplitude equalization is available on the 6048/A for pre-equalization of a facility-side 4wire transmit output pair consisting of nonloaded cable. The transmit equalizer is essentially identical to the receive-channel slope equalizer, providing from 0 to 7.5dB of gain at 2804Hz (re 1004Hz) in switch-selectable 0.5dB increments. Typical achievable flatness and typical frequency response of the transmit equalizer are the same as those of the receive-channel slope equalizer (see paragraph 2.08, figure 6 and table 1). Like the receive equalizers, the transmit equalizer does not affect 1004Hz levels. Thus, transmit equalization can be introduced not only before but also **after** transmit levels are set.

E&M signaling interfaces

2.13 The 6048/A can be switch-optioned to derive either a Type I (single-lead) or a Type II or III (looped-signaling-lead) E&M interface. The Type I and Type II interfaces can be used with either A-side or B-side E&M signaling (see paragraphs 2.14 through 2.18). The Type III interface can be used with A-side signaling only. Figures 8 through 12 show the connections required for Type I, II, and III E&M interfaces with A-side signaling and for Type I and II interfaces with B-side signaling.

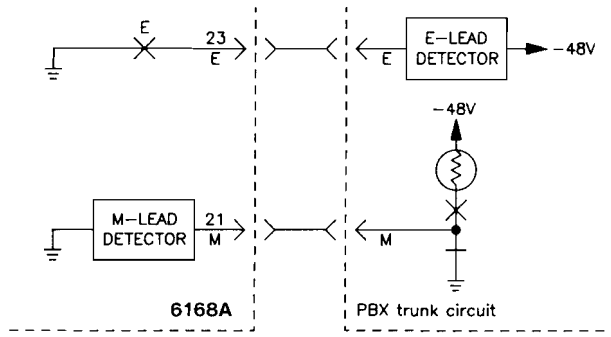


figure 8. Type I E&M interface (TC11M, TL11M, TC31M, or TL31M), A side

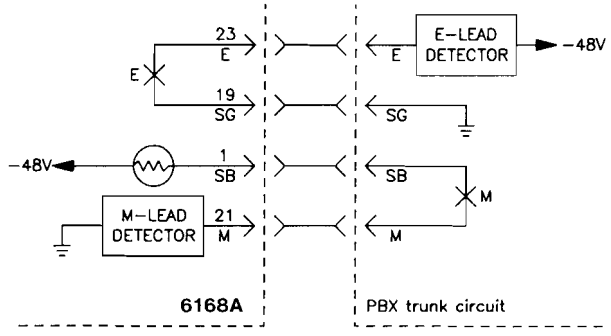


figure 9. Type II E&M interface (TC12M, TL12M, TC32M, or TL32M), A side

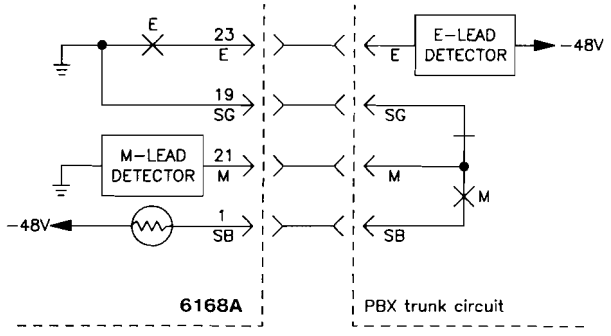


figure 10. Type III E&M interface, A side

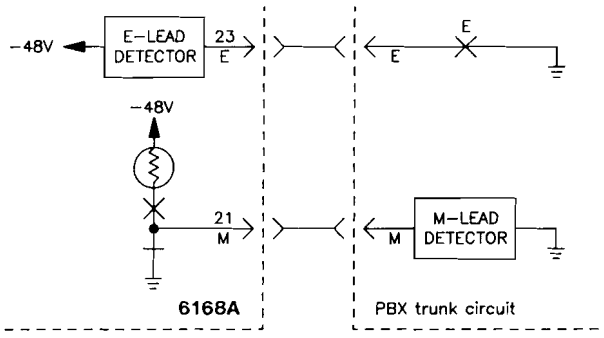


figure 11. Type I E&M interface (TC11E, TL11E, TC31E, or TL31E), B side

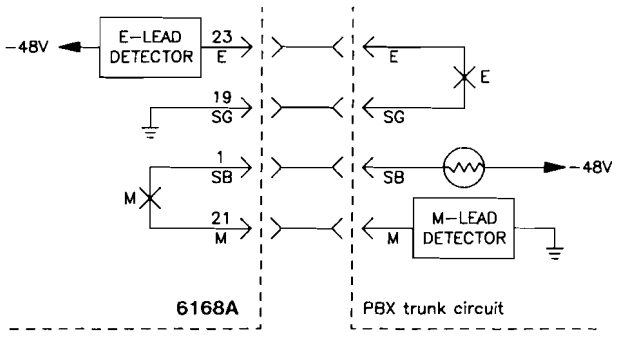


figure 12. Type II E&M interface (TC12E, TL12E, TC32E, or TL32E), B side

registered facility interface code	E&M interface	E&M signaling mode*	6048/A signaling directions	
			E lead	M lead
TL31M or TC31M (4wire) TL11M or TC11M (2wire)	Type I	A side	out	in
TL31E or TC31E (4wire) TL11E or TC11E (2wire)	Type I	B side	in	out
TL32M or TC32M (4wire) TL12M or TC12M (2wire)	Type II	A side	out	in
TL32E or TC32E (4wire) TL12E or TC12E (2wire)	Type II	B side	in	out
not applicable	Type III	A side	out	in

*A-side signaling is used when the associated E&M terminal equipment provides M-lead outputs and receives E-lead inputs. B-side signaling is used when the associated E&M terminal equipment provides E-lead outputs and receives M-lead inputs.

table 3. E&M interface and signaling options for Registered Facility Interface Codes fulfilled by 6048/A

E&M signaling modes

2.14 The 6048/A can be switch-optioned for either A-side or B-side E&M signaling. A-side signaling is selected when the associated terminal equipment provides M-lead outputs and receives E-lead inputs. B-side signaling is selected when the associated terminal equipment provides E-lead outputs and receives M-lead inputs. Each of these E&M signaling modes is described in detail below. Table 3 summarizes E&M interface and signaling options for Registered Facility Interface codes that the 6048/A fulfills. Please note that in this table, A-side and B-side are the E&M signaling modes of the port that the 6048/A interfaces.

2.15 **A-Side E&M Signaling.** In typical A-side SF-to-E&M signaling applications (with a Type I interface), the 6048/A provides an E-lead output that is open when SF tone is detected at the 4wire receive input port and that is at circuit ground when no tone is detected. In the transmit channel, SF tone is transmitted when the M lead is at ground potential (or open), and tone transmission ceases when the M lead is at negative battery potential.

2.16 The E-lead output from the 6048/A is derived via a relay with a normally open contact. This contact can accommodate a Type I, II, or III E-lead interface. The relay is energized when the module detects no SF tone at the receive input port and is de-energized when SF tone is detected. The module's full precision **receive** pulse corrector is arranged to control the pulsing relay such that, following tone recognition, the relay is de-energized for 58 ±4 percent of the pulsing cycle. After the input break interval, the relay energizes upon absence of tone. The minimum-break **transmit** pulse corrector ensures that the minimum duration of any outgoing SF tone pulse is 50ms and that the minimum duration of any silent (no tone) interval is 25ms.

2.17 **B-Side E&M Signaling.** In typical B-side SF-to-E&M signaling applications (with a Type I interface), the 6048/A provides an M-lead output that is at ground potential when SF tone is detected at the 4wire receive input port and that is at negative battery potential when no tone is detected. In the transmit channel, SF tone is transmitted when

the E lead is open, and tone transmission ceases when the E lead is at ground potential.

2.18 The M-lead output from the 6048/A is derived via a relay with a normally open contact. This contact accommodates either a Type I or Type II M-lead interface (Type III cannot be used with B-side signaling). The relay is energized when the module detects no SF tone at the 4wire receive input port and is de-energized when SF tone is detected. The full precision **receive** pulse corrector is arranged to control the pulsing relay such that, following tone recognition, the relay is de-energized for 58 ±4 percent of the pulsing cycle. After this input break interval, the relay energizes upon absence of tone. The minimum-break **transmit** pulse corrector ensures that the minimum duration of any outgoing SF tone pulse is 50ms and that the minimum duration of any silent (no tone) interval is 25ms.

incoming SF tone detection

2.19 The 6048/A is designed to interface the receive path on the facility (4wire) side at any TLP from −17 to +7. Idle-state SF tone is received at a level of −20dBm0. A higher level of −8dBm0 is received during break portions of dial pulses and for about 400ms at the beginning of each tone interval. The SF tone detector in the module reliably detects tone levels as low as −27dBm0, provided that the SF tone energy is approximately 12dB above the level of all other signals simultaneously present at the 4wire receive input port. The SF tone detector is actually a signal-to-guard ratio comparator that compares energy in a narrow band of frequencies centered at the SF tone frequency with energy in the entire voice band. This detection arrangement aids significantly in prevention of talk-off, but it places an upper bound on allowable circuit noise. In general, received noise in excess of 51dBrnC0 may interfere with detection of low-level signaling tones.

2.20 The 6048/A's SF tone detector is designed to ignore momentary losses of SF tone during periods of otherwise continuous receipt of tone and to ignore momentary tone bursts to prevent false signaling. Within approximately 13ms of detection of incoming SF tone, a band-elimination filter (BEF) is inserted into the receive transmission path to prevent propagation of SF tone beyond the module. An internal timing circuit ensures that the BEF remains inserted during dial pulsing and during momentary losses of tone continuity. See tables 4 and 5 for details concerning BEF insertion.

receive pulse correction

2.21 To ensure optimum pulsing toward the local termination, the 6048/A's full precision receive pulse corrector corrects incoming pulsing (tone bursts) at 8 to 12 pulses per second to provide outgoing pulsing at 58 ±4 percent break (i.e., the module's E-lead [for A-side] or M-lead [for B-side] signaling relay is de-energized for 58 ±4 percent of the pulsing cycle). The module recognizes signaling-state changes in the receive path regardless of the local M-lead state (in A-side signaling) or the local E-lead state (in B-side signaling).

outgoing SF tone transmission

2.22 The 6048/A is designed to interface the transmit path on the facility (4wire) side at any TLP from +8 to −16. During the idle state, the module transmits SF tone at −20dBm0. During dial pulsing and also for the first 400ms each time it applies tone to the facility, the module transmits SF tone at a higher level of −8dBm0. This momentarily increased tone level aids in distant-end detection of supervisory-state changes and incoming dial pulsing.

delay circuit and transmit pulse correction

2.23 A symmetrical delay of approximately 18ms is provided between the M-lead input (A-side signaling) or the E-lead input (B-side signaling) and the tone transmission gate. This delay prevents inadvertent transmission or interruption of SF tone in response to momentary transitions of the signaling-lead inputs. This delay is also instrumental in prevention of transient interference with SF tone transmission, as noted in paragraph 2.26.

2.24 A minimum-break pulse corrector and a 25ms minimum make in the transmit path ensures a 50ms minimum break duration during dialing. This type of pulse correction does not interfere with supervisory winks and momentary signaling-state changes and helps to ensure that recognizable pulses are transmitted. The pulse corrector does not alter the duration of tone intervals resulting from M-lead (in A-side signaling) or E-lead (in B-side signaling) state changes longer than 50ms.

transmit path cut

2.25 The transmit voice path through the 6048/A is cut (opened) during idle circuit conditions and is restored when the M lead (A-side signaling) or the E lead (B-side signaling) is in the busy condition. The path is also cut during dialing in either direction and is momentarily cut in response to any transition of the M lead while the E lead is in the off-hook state (A-side signaling) or in response to any transition of the E lead while the M lead is in the off-hook state (B-side signaling). These path cuts prevent transmission of noise, transients, speech, and other interfering signals during critical signaling intervals.

2.26 The transmit path cut is inserted within 5ms of an M-lead (A-side signaling) or E-lead (B-side signaling) state change. Tone transmissions in response to M-lead (A-side signaling) or E-lead (B-side signaling) state changes are delayed 18 ±5ms, resulting in a pre-cut interval of 8 to 22ms. This ensures that any transients associated with signaling-state changes in the local trunk circuit or line circuit do not affect SF tone transmission. Details concerning insertion and removal of the transmit path cut are provided in tables 4 and 5.

SF tone source

2.27 The 6048/A is equipped with an integral 2600Hz SF tone oscillator and therefore does not require an external SF tone supply.

text continued on page 10

circuit condition	SF tone states		local condition of xmt path cut			local rcv-path band-elimination-filter (BEF) insertion
	xmt	*rcv*	*before*	*change*	*after*	
idle	on	on	cut	none	cut	inserted
seizure	on/off transition	on	cut	stays cut 125±50ms after seizure	not cut	inserted
distant end returns *delay-dial* signal	off	on/off transition	not cut	none	not cut	removed 50±5ms after cessation of SF tone
distant end sends *start-dial* signal	off	off/on transition	not cut	none	not cut	inserted 13±7ms after receipt of SF tone
local-end dialing	off/on and on/off transitions, ending with on/off transition	on	not cut	precut 15±7ms; remains cut as long as M-lead make/break transitions are less than 125±25ms apart; remains cut 125±50ms after last break/make transition*	not cut	inserted
distant end answers (free call	off	on	not cut	none	not cut	inserted
distant end answers (toll call)	off	on/off transition	not cut	none	not cut	removed 50±5ms after cessation of SF tone
talking	off	off	not cut	none	not cut	out of circuit
disconnect, local end first	off/on transition	off	not cut	precut 15±7ms; cut 625±125ms after M-lead transition from battery to ground*	not cut	out of circuit
disconnect, distant end	on	off/on transition	not cut	cut within 35ms	cut	inserted 13±7ms after receipt of SF tone
idle	on	on	cut	none	cut	inserted

*E-lead transition for B-side signaling.

table 4. SF tone states and status of transmit path cut and receive BEF for local call origination

circuit condition	SF tone states		local condition of xmt path cut			local rcv-path band-elimination-filter (BEF) insertion
	xmt	*rcv*	*before*	*change*	*after*	
idle	on	on	cut	none	cut	inserted
seizure, distant end	on	on/off transition	cut	remains cut 625± 125ms after cessation of SF tone	not cut	removed 50±5ms after cessation of SF tone
distant end returns *delay-dial* signal	on/off transition	off	not cut	cut 125±50ms after M-lead transition from ground to battery*	not cut	out of circuit
local end returns *start-dial* signal	off/on transition	off	not cut	precut 15±7ms; remains cut 625±125ms after M-lead transition from battery to ground*	not cut	out of circuit
distant end transmits dial pulses	on	off/on and on/off transitions, ending with on/off transition	not cut	cut within 7ms of receipt of first tone pulse; remains cut as long as incoming break/make transitions are less than 625±125ms after last incoming on/off transition	not cut	inserted 13±7ms after receipt of first tone pulse; remains in circuit until 50± 5ms after last incoming on/off transition or 225±50ms, whichever is longer
local-end answers (free call)	on	off	not cut	none	not cut	out of circuit
local end answers (toll call)	on/off transition	off	not cut	cut 125±50ms after M-lead transition from ground to battery*	not cut	out of circuit
talking	off	off	not cut	none	not cut	out of circuit
disconnect, distant end	off	off/on transition	not cut	none	not cut	inserted 13±7ms after receipt of SF tone
disconnect, local end	off/on transition	on	not cut	precut 15±7ms; then continuously cut	cut	inserted
idle	on	on	cut	none	cut	inserted

*E-lead transition for B-side signaling.

table 5. SF tone states and status of transmit path cut and receive BEF for distant-location call origination

power

2.28 The 6048/A operates on filtered, ground-referenced input potentials between −42 and −56Vdc. The positive side of the dc power supply should be connected to earth ground. Maximum current required (at −56Vdc) is 100mA, with an additional 10mA required for the 6048A when loopback is in effect.

loopback (6048A only)

2.29 **Overview.** Integral facility-side transmission and signaling loopback circuitry in the 6048A allows local or remote testing of both the module and the facility. This loopback circuitry can be activated either manually (locally) or via 2713Hz tone (remote two-tone loopback). A prescription loopback-level-control circuit introduces from 0 to 23dB of loss or from 0 to 24dB of gain into the loopback path in switch-selectable 1dB increments to provide true equal-level transmission loopback. In addition, a switch option conditions the 6048A to automatically busy out its terminal side during loopback (see paragraph 2.33). Figure 13 shows, in simplified form, the transmission and signaling loopback paths through the module. A front-panel *lpbk* LED lights whenever the module is in the loopback mode.

2.30 Transmission loopback in the 6048A module establishes a transmission path from the 4wire receive input port to a point on the receive path after the level-control and equalization circuitry (see the block diagram later in this practice), thence through the loopback-level-control stage to a point on the transmit path before the level-control and equalization circuitry, and finally to the 4wire transmit output port. The loopback level control stage (**LOOPBACK LEVEL** block on the block diagram) provides for true equal-level loopback, if desired.

2.31 Signaling loopback allows the 6048A's SF-to-E&M signaling converter circuitry and E-lead (A-side)/M-lead (B-side) signaling relay to be tested in any of the five possible E&M operating modes: Type I, II, or III interface with A-side signaling or Type I or II interface with B-side signaling.

2.32 If the 6048A's signaling converter circuitry and E-lead/M-lead signaling relay are operational, the module repeats all signaling states that it receives. For example, if an on-hook (incoming SF tone on) is sent to a 6048A under test and in loopback, the module responds by transmitting an on-hook (outgoing SF tone on). If an off-hook (removal of incoming SF tone) is sent to the 6048A, it responds by transmitting an off-hook (removal of outgoing SF tone).

2.33 The 6048A's terminal-side busy-out switch option, when selected, busies out the customer's E&M trunk circuit or line circuit whenever loopback is activated. This prevents inadvertent seizure of the trunk circuit or line circuit during loopback. Without this option, calls could be lost if, for example, a trunk in a hunt group were placed into loopback.

2.34 **Local (Manual) Loopback Activation and Deactivation.** Two methods of local loopback activation are available:

- Setting the *ML* position of the module's *LPBK* (loopback) DIP switch (*S17*) toward *ML*.
- Connecting the module's EXT MNLB (external manual loopback) lead (pin 18) to input power ground (pin 17).

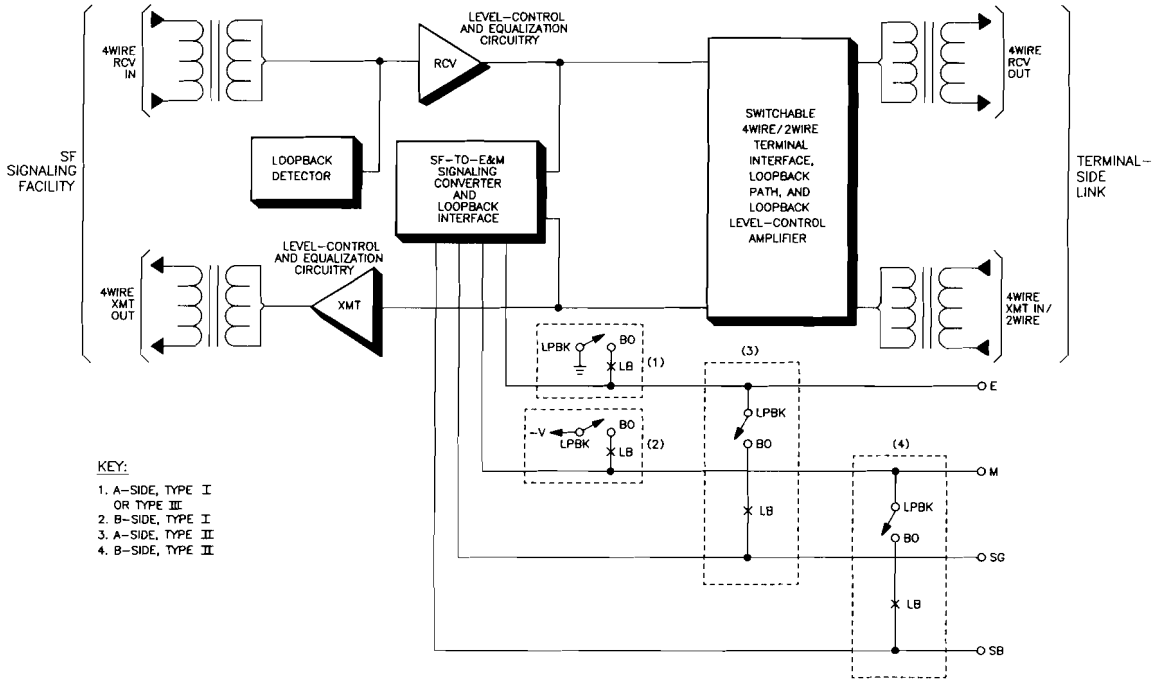


figure 13. Loopback route through 6048A module

With either of these methods of activation, loopback is maintained until the *ML* switch is set away from *ML* or until the EXT MNLB-ground connection is removed.

2.35 **Remote (Two-Tone) Loopback Activation and Deactivation.** Remote (two-tone) loopback is enabled via switch option and activated by placing a 2713Hz tone on the 4wire receive input pair (pins 7 and 13) of the 6048A for at least 2.5 seconds and then removing the tone. Because loopback is activated only upon removal of the tone, the accidental looping of other than the intended module is prevented. The threshold of the loopback tone-detection circuit is −30dBm as measured at the module's 4wire receive input port. The loopback tone detector's center frequency is 2713Hz, and its maximum bandwidth is ±37Hz. A 12dB signal-to-guard ratio prevents either raw data signals or harmonics of those signals from initiating loopback, thus allowing the 6048A to operate in circuits where similar units might be prone to false loopback. Remote loopback is deactivated when the unit detects a second 2713Hz tone at least 1.2 seconds in duration; removal of this tone is not necessary to deactivate loopback. With remote (two-tone) loopback enabled, another switch option either enables automatic loopback deactivation after a selected timeout interval or disables automatic deactivation for second-tone deactivation only. With automatic deactivation enabled, an additional switch option selects the desired timeout interval: 4 minutes or 20 minutes. With either timeout interval selected, tone-activated loopback can be deactivated prior to expiration of the interval by transmitting a second 2713Hz tone.

3. installation

inspection

3.01 The 6048/A 4Wire-to-4Wire or 4Wire-to-2Wire SF-to-E&M Terminal Repeater module should be visually inspected upon arrival to find any damage incurred during shipment. If damage is noted, a claim should be filed immediately with the carrier. If stored, the module should be visually inspected again prior to installation.

mounting

3.02 The 6048/A mounts in one position of a Tellabs Type 10 Mounting Shelf or in one position of a Tellabs 262-series NCTE/DST Mounting Assembly. Type 10 Shelves are available in versions for relay-rack and apparatus-case installation, while 262 Assemblies are available in versions for relay-rack, wall or desktop, and floor mounting. The 6048/A module plugs physically and electrically into a 56-pin connector at the rear of its shelf or assembly position.

3.03 In applications where a 6048/A module is to be installed in a 262 Assembly, no external connections to the module need be made. This is because all of the assembly's internal connections are factory-prewired and because external wiring is simplified through the use of 25-pair connector-ended cables arranged in accordance with Universal Service Order Code (USOC) RJ2HX. If the customer's terminal equipment is cabled in accordance with USOC RJ2HX, direct connection between the assembly and the customer's equipment is possible. If not, cross-connections between the assembly and the local terminal equipment must be made at an intermediate connectorized terminal block or by means of a special adapter cable available as a list number for selected assemblies.

installer connections

3.04 When a 6048/A module is to be installed in a conventional Type 10 Shelf or in an unwired apparatus case or mounting assembly, external connections to the module must be made. Before making any connections to the shelf, case, 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.

3.05 Table 6 lists external connections to the 6048/A module. All connections to non-prewired mountings are made via wire-wrapping to the 56-pin connector at the rear of the module's shelf, case, or assembly position. Pin numbers are found on the body of the connector.

connect:	to pin:
4WIRE RCV IN TIP	7
4WIRE RCV IN RING	13
4WIRE XMT OUT TIP	41
4WIRE XMT OUT RING	47
4WIRE RCV OUT TIP*	5
4WIRE RCV OUT RING*	15
4WIRE XMT IN TIP or 2WIRE TIP	55
4WIRE XMT IN RING or 2WIRE RING	49
4WIRE RCV IN SX (simplex, facility side)	9 and 11
4WIRE XMT OUT SX (simplex, facility side)	43
E lead	23
M lead	21
SB (signal battery)**	1
SG (signal ground)**	19
EXT MNLB (external manual loopback, 6048A only)	18
−BATT (−42 to −56Vdc filtered input)	35
GND (ground)	17

*Not used when module is optioned for 2wire terminal interface.
**Mandatory for Type II and III E&M interfaces only.

table 6. External connections to 6048/A

option selection

3.06 Several option switches must be set before the 6048/A can be placed into service. Locations of these switches and of certain alignment switches on the module's printed circuit board are shown in figure 14. Table 7 summarizes all switch options and provides a convenient **checklist** that can be filled out either prior to installation for prescription optioning or during installation to serve as a record for later reference. Refer to figure 14 and table 7, and set each option switch on the 6048/A as required.

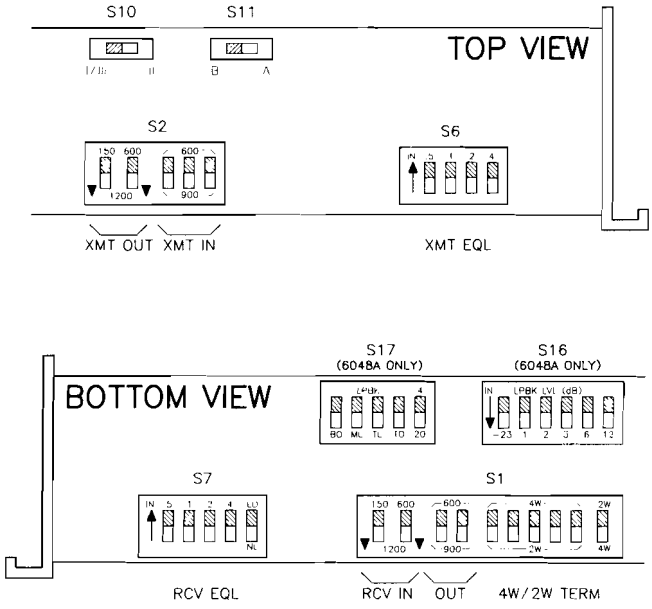


figure 14. 6048/A option switch locations

alignment overview

3.07 Alignment of the 6048/A comprises the following procedures (all option switches should already be properly set as described above):

A. Setting the receive-channel facility-side and terminal-side levels.
B. Introducing receive-channel equalization, if necessary.
C. Setting the transmit-channel terminal-side and facility-side levels.
D. Introducing transmit-channel equalization, if necessary.
E. For the 6048A only, adjusting the loopback-path level.

prescription alignment

3.08 Prescription alignment of the 6048/A module involves setting all level-control, equalization, and loopback-level (6048A only) switches in accordance with specifications on the circuit layout record (CLR) before plugging the module into its shelf or assembly position. Table 8 in this practice summarizes all alignment switches on the 6048/A and provides a convenient **checklist** for prescription alignment. To use this table, simply indicate all required alignment-switch settings in the **checklist** column. Then, at installation time, align the 6048/A by setting each switch as indicated in the table (or on the CLR, if preferred).

equipment required for non-prescription alignment

3.09 In applications where prescription alignment settings are unavailable, non-prescription alignment of the 6048/A is necessary. Access to the appropriate ports of the module is conveniently provided via six front-panel bantam jacks. Equipment required for non-prescription alignment consists of a transmission measuring set (TMS), preferably one with independent transmit and receive impedance settings. If the module's equalizers and/or loopback-level circuitry (6048A only) are to be used, a Tellabs 9801 or 9802 Card Extender (or equivalent) will facilitate alignment by allowing access to the switches on the module's printed circuit board while the module is in place and operating.

mandatory pre-alignment procedure for non-prescription alignment

3.10 Before beginning non-prescription alignment, do the following:

A. Ensure that all option switches (see table 7), especially those that select terminating impedances and appropriate 4wire or 2wire terminal interface, are properly set. For the 6048A only, also ensure that the module is not in loopback (*lpbk* LED unlit).
B. Set all front-panel receive and transmit level-control switches for no gain or loss.
C. Set all receive and transmit equalization switches for no equalization.

Note: *On the receive equalizer DIP switch (S7), the* LD/NL *position must be set to* NL. *Otherwise, bump equalization will be introduced even though no dB-value positions are set to* IN.

D. For the 6048A only, set the loopback-level DIP switch (*LPBK LVL, S16*) for no loopback-path loss or gain.

non-prescription alignment

3.11 Align the 6048/A as directed in the **non-prescription alignment procedure**, figure 15 of this practice.

Note 1: *The procedure in figure 15 is based on the assumption that certain required local input and output levels are available from circuit records. If this is not the case, some steps may have to be modified to include end-to-end measurements.*

Note 2: During alignment, always ensure that the receive portion of the TMS is arranged for properly terminated measurement where appropriate. If the TMS has independent transmit and receive impedance settings, also ensure that the proper TMS transmit impedance is selected when inserting test tone. Please observe the following when aligning the module by the non-prescription method: Most TMS's provide 900, 600, and 135-ohm settings but not the 1200 and 150-ohm settings available at the module's 4wire facility-side ports. Therefore, to obtain the most accurate level readings and settings possible, do the following: If the module is optioned for 1200 or 150 ohms on the 4wire facility side, reoption it for 600 ohms and use the 600-ohm setting on the TMS. Then, when alignment is completed, reoption the module for 1200 or 150 ohms as required.

4. circuit description

4.01 To provide the clearest possible understanding of the operation of the 6048/A 4Wire-to-4Wire or 4Wire-to-2Wire SF-to-E&M Terminal Repeater module, function sequence flowcharts (figures 16, 17, and 18) that illustrate operation of the module

text continued on page 15

option	switch	selection	setting	checklist
terminating impedance, 4wire receive input port (facility side)	*RCV IN* positions of *S1* on main board	1200 ohms (for loaded cable)	150 toward 1200, 600 toward 1200	
		600 ohms (for nonloaded cable or carrier)	150 toward 1200, 600 toward 600	
		150 ohms (extra equalization for nonloaded cable)	150 toward 150, 600 toward 1200	
terminating impedance, 4wire transmit output port (facility side)	*XMT OUT* positions of *S2* on main board	1200 ohms (for loaded cable)	150 toward 1200, 600 toward 1200	
		600 ohms (for nonloaded cable or carrier)	150 toward 1200, 600 toward 600	
		150 ohms (extra equalization for nonloaded cable)	150 toward 150, 600 toward 1200	
2wire or 4wire terminal-side interface*	*4W/2W TERM* positions of *S1* on main board	2wire interface	all six 4W/2W TERM positions toward 2W	
		4wire interface	all six 4W/2W TERM positions toward 4W	
terminating impedance, 2wire port (with 2wire terminal interface)	*RCV OUT* positions of *S1* on main board **AND:**	900 ohms plus 2.15μF	both positions toward 900	
		600 ohms plus 2.15μF	both positions toward 600	
	XMT IN positions of *S2* on main board	900 ohms plus 2.15μF	all three positions toward 900	
		600 ohms plus 2.15μF	all three positions toward 600	
terminating impedance, 4wire receive output port (with 4wire terminal interface)	*RCV OUT* positions of *S1* on main board	600 ohms only (900-ohm option cannot be used with 4wire terminal interface)	both positions toward 600	
terminating impedance, 4wire transmit input port (with 4wire terminal interface)	*XMT IN* positions of *S2* on main board	600 ohms only (900-ohm option cannot be used with 4wire terminal interface)	all three positions toward 600	
Type I, Type II, or Type III E&M interface	*S10* on baby board	Type I interface	I/III	
		Type II interface	II	
		Type III interface (available with A-side signaling only)	I/III	
A-side or B-side E&M signaling**	*S11* on baby board	A-side signaling	A	
		B-side signaling	B	
Note: *The following loopback options are available on the 6048A only.*				
busying out of module's terminal side (E&M leads) during loopback***	*BO* position of *S17* (*LPBK* DIP switch) on baby board	busy out	toward BO	
		no busy out	away from BO	
manual loopback activate/deactivate	*ML* position of *S17* (*LPBK* DIP switch) on baby board	manual loopback activated	toward ML	
		manual loopback deactivated	away from ML	
tone loopback enable/disable****	*TL* position of *S17* (*LPBK* DIP switch) on baby board	tone loopback enabled	toward TL	
		tone loopback disabled (for manual loopback only)	away from TL	

table 7 continued on next page

option	switch	selection	setting	checklist
tone-loopback timeout enable/disable (with tone loopback enabled)****	*TO* position of *S17* (*LPBK* DIP switch) on baby board	tone-loopback timeout enabled (see below for duration selection)	toward TO	
		tone-loopback timeout disabled (for second-tone deactivation only)	away from TO	
tone-loopback timeout duration (with tone-loopback timeout enabled)****	*4/20* position of *S17* (*LPBK* DIP switch) on baby board	4 minutes	toward 4	
		20 minutes	toward 20	

* The module's integral CBN is inserted into the circuit whenever 2wire terminal interface is selected. This CBN provides either 900 or 600 ohms (in series with 2.15μF), depending upon 2wire-port impedance optioning.
** Select A-side signaling when the associated terminal-side equipment provides M-lead outputs and receives E-lead inputs. Select B-side signaling when the associated terminal-side equipment provides E-lead outputs and receives M-lead inputs.
*** Busying out the module's terminal side (E&M leads) during loopback prevents inadvertent seizure of the associated trunk circuit or line circuit.
**** With tone loopback disabled, both the *TO* and *4/20* positions of *S17* are nonfunctional. With tone loopback enabled but tone-loopback timeout disabled, the *4/20* position of *S17* is nonfunctional.

table 7. Summary and checklist of 6048/A switch options

alignment function	switch	selection	setting	checklist
selection of receive-channel facility-side flat gain or loss	*GN* and *LS* positions of front-panel *rcv fac level* DIP switch	gain	GN to IN LS to OUT	
		loss	GN to OUT LS to IN	
amount of receive-channel facility-side gain or loss, as selected above*	dB-value positions of front-panel *rcv fac level* DIP switch*	0.1dB	0.1 to IN	
		0.2dB	0.2 to IN	
		0.4dB	0.4 to IN	
		0.8dB	0.8 to IN	
		1.5dB	1.5 to IN	
		3.0dB	3.0 to IN	
		6.0dB	6.0 to IN	
		12.0dB	12.0 to IN	
receive-channel terminal-side flat loss*	front-panel *rcv term loss* DIP switch*	0.1dB	0.1 to IN	
		0.2dB	0.2 to IN	
		0.4dB	0.4 to IN	
		0.8dB	0.8 to IN	
		1.5dB	1.5 to IN	
		3.0dB	3.0 to IN	
		6.0dB	6.0 to IN	
		12.0dB	12.0 to IN	
receive-channel equalizer selection	*LD/NL* position of *RCV EQL* switch (*S7*) on main board	compromise bump equalizer (for loaded cable) inserted	LD	
		compromise bump equalizer excluded (for no equalization or use of slope equalizer)	NL	
receive-channel slope equalization for nonloaded cable (gain at 2804Hz re 1004Hz)**	dB-value positions of *RCV EQL* switch (*S7*) on main board**	0.5dB	.5 to IN	
		1dB	1 to IN	
		2dB	2 to IN	
		4dB	4 to IN	
transmit-channel terminal-side flat loss*	front-panel *xmt term loss* DIP switch*	0.1dB	0.1 to IN	
		0.2dB	0.2 to IN	
		0.4dB	0.4 to IN	
		0.8dB	0.8 to IN	
		1.5dB	1.5 to IN	
		3.0dB	3.0 to IN	
		6.0dB	6.0 to IN	
		12.0dB	12.0 to IN	

Important: During alignment, set these switches to achieve a +7dBm level (see figure 15) before setting *rcv term loss* switches to obtain final rcv output level.

Important: During alignment, set these switches to achieve a −16dBm level (see figure 15) before setting *xmt fac level* switches to obtain final xmt output level.

table 8 continued on next page

alignment function	switch	selection	setting	checklist
selection of transmit-channel facility-side flat gain or loss	*GN* and *LS* positions of front-panel *xmt fac level* DIP switch	gain	GN to IN LS to OUT	
		loss	GN to IN LS to OUT	
amount of transmit-channel facility-side gain or loss, as selected above*	dB-value positions of front-panel *xmt fac level* DIP switch*	0.1dB	0.1 to IN	
		0.2dB	0.2 to IN	
		0.4dB	0.4 to IN	
		0.8dB	0.8 to IN	
		1.5dB	1.5 to IN	
		3.0dB	3.0 to IN	
		6.0dB	6.0 to IN	
		12.0dB	12.0 to IN	
transmit-channel slope-equalization for nonloaded cable (gain at 2804Hz re 1004Hz)**	*XMT EQL* switch (*S6*) on main board**	0.5dB	.5 to IN	
		1dB	1 to IN	
		2dB	2 to IN	
		4dB	4 to IN	
loopback-path loss or gain (6048A only)***	*LPBK LVL* switch (*S16*) on baby board***	23dB loss	−23 to IN	
		1dB gain	1 to IN	
		2dB gain	2 to IN	
		3dB gain	3 to IN	
		6dB gain	6 to IN	
		12dB gain	12 to IN	

* The eight dB-value positions of the front-panel *rcv fac level* and *xmt fac level* DIP switches are cumulative, as are all eight posiitons of the *rcv term loss* and *xmt term loss* DIP switches. Total facility-side gain or loss and total terminal-side loss introduced into a channel are the sums of that channel's *fac level* dB-value and *term loss* switch positions set to *IN*.

** The dB-value positions (*.5, 1, 2,* and *4*) of the *RCV EQL* switch (*S7*) and all four positions of the *XMT EQL* switch (*S6*) are cumulative. Total gain introduced at 2804Hz (re 1004Hz) is the sum of those dB-value positions set to *IN*. For no receive equalization set the *LD/NL* position of *S7* to *NL* and the four dB-value positions of *S7* to *OUT*. For no transmit equalization, set all four positions of *S6* to *OUT*.

*** The six positions of the *LPBK LVL* switch (*S16*) on the 6048A are cumulative. Total loss or gain, in dB, introduced into the module's loopback path is the sum of those *LPBK LVL* switch positions set to *IN*.

table 8. Summary and checklist of 6048/A alignment switches

on incoming and outgoing calls are presented in lieu of a more conventional circuit description. Horizontal paths identify events occurring simultaneously, and vertical paths denote sequential events. Dotted lines indicate elapsed time. These flowcharts can be used to determine normal operation by observing the module's response and comparing it to that shown in the flowcharts. Reference to the 6048/A block diagram (section 5 of this practice) will aid in understanding the flowcharts.

4.02 The flowcharts are intended to familiarize you with the operation of the 6048/A for engineering, application, and troubleshooting purposes only. Attempts to test or troubleshoot this module internally are not recommended and may void its Tellabs warranty. Procedures for recommended testing and troubleshooting in the field should be limited to those prescribed in section 7 of this practice.

6. specifications

transmission

alignment level ranges, facility-side ports
4wire rcv input port: −17 to +7TLP
4wire xmt output port: −16 to +8TLP

alignment level ranges, terminal-side ports
2wire output port or 4wire rcv output port: +7 to −17TLP
2wire input port or 4wire xmt input port: +8 to −16TLP

overload points
4wire rcv input port: 0dBm0
4wire xmt output port: +3dBm0
2wire output port or 4wire rcv output port: 0dBm0
2wire input port or 4wire xmt input port: +3dBm0

facility-side gain or loss (xmt and rcv)
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

terminal-side loss (xmt and rcv)
0 to 24dB of loss in switch-selectable 0.1dB increments

insertion loss, xmt and rcv channels (600-ohm termination at all ports)
0 ± 0.2dB at 1004Hz with all level-control switches set for no gain or loss

receive-channel amplitude equalization
active prescription slope-type: 0 to 7.5dB of gain at 2804Hz, re 1004Hz, in switch-selectable 0.5dB increments
compromise bump-type: 3.0dB bump at 3200Hz, re 1004Hz, and 1.5dB loss at 404Hz, re 1004Hz
additive mode: if both equalizers are used simultaneously, the results are additive

specifications continued on page 21

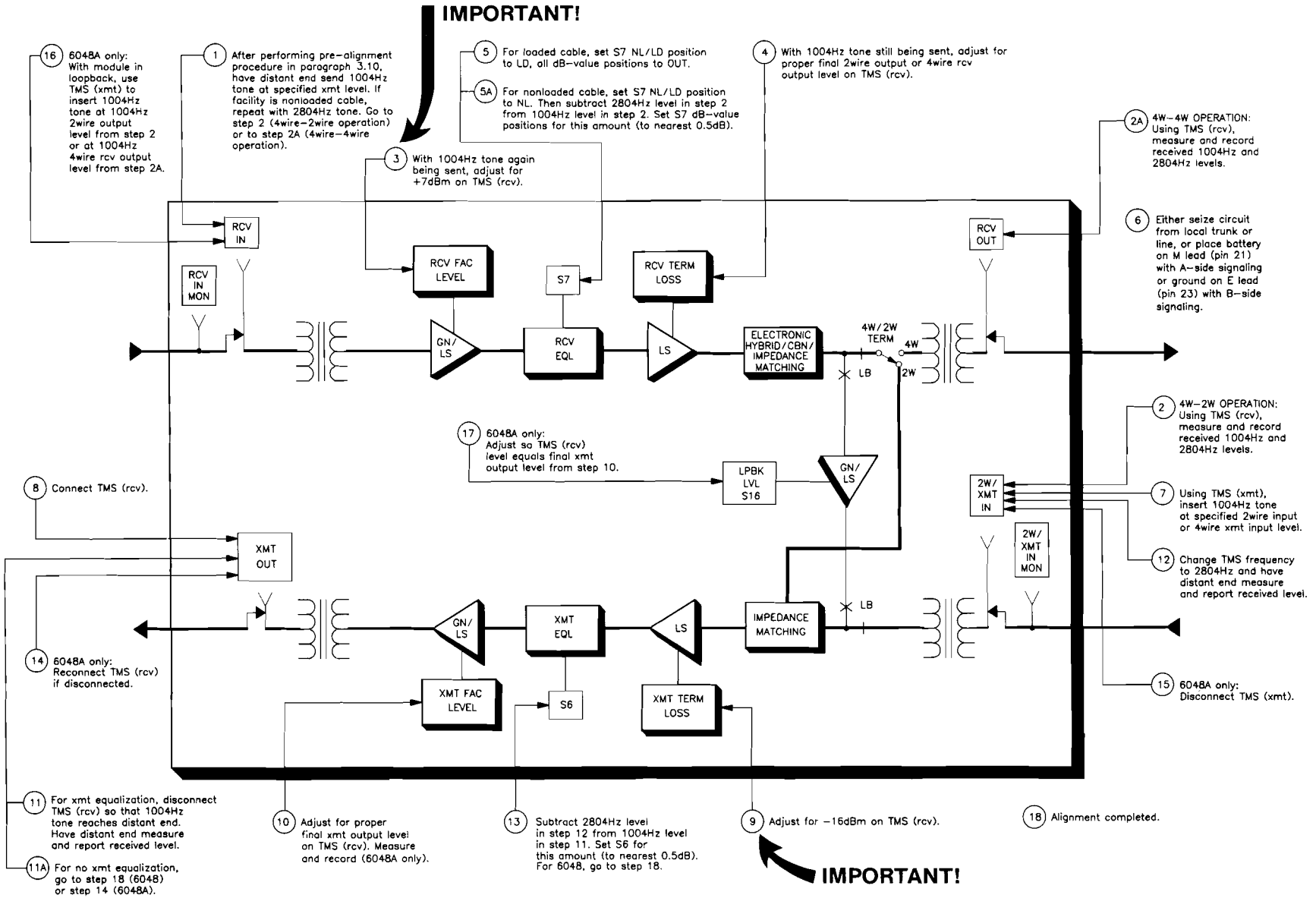


figure 15. Non-prescription alignment procedure for 6048/A

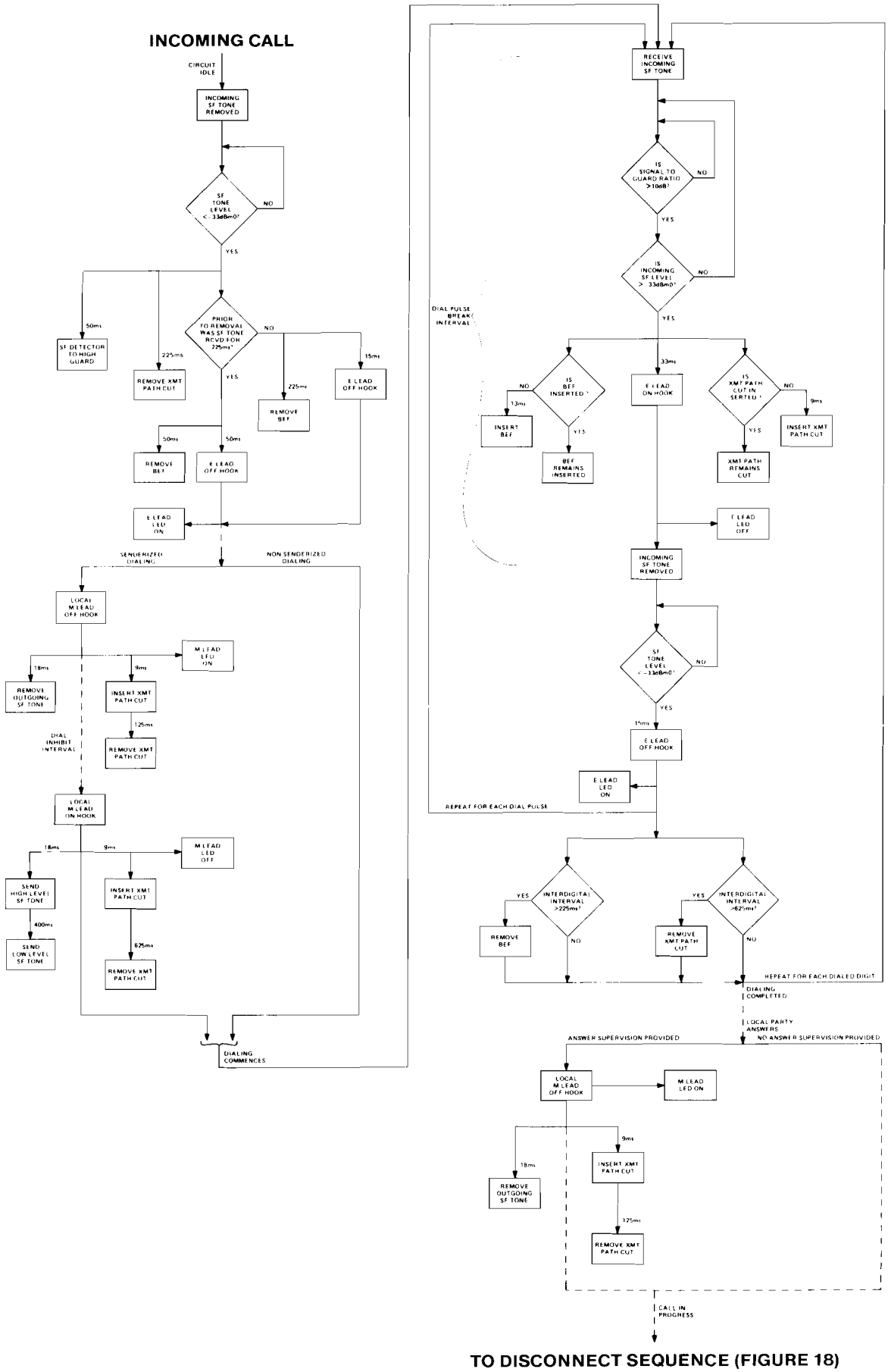


figure 16. Function sequence flowchart, incoming call

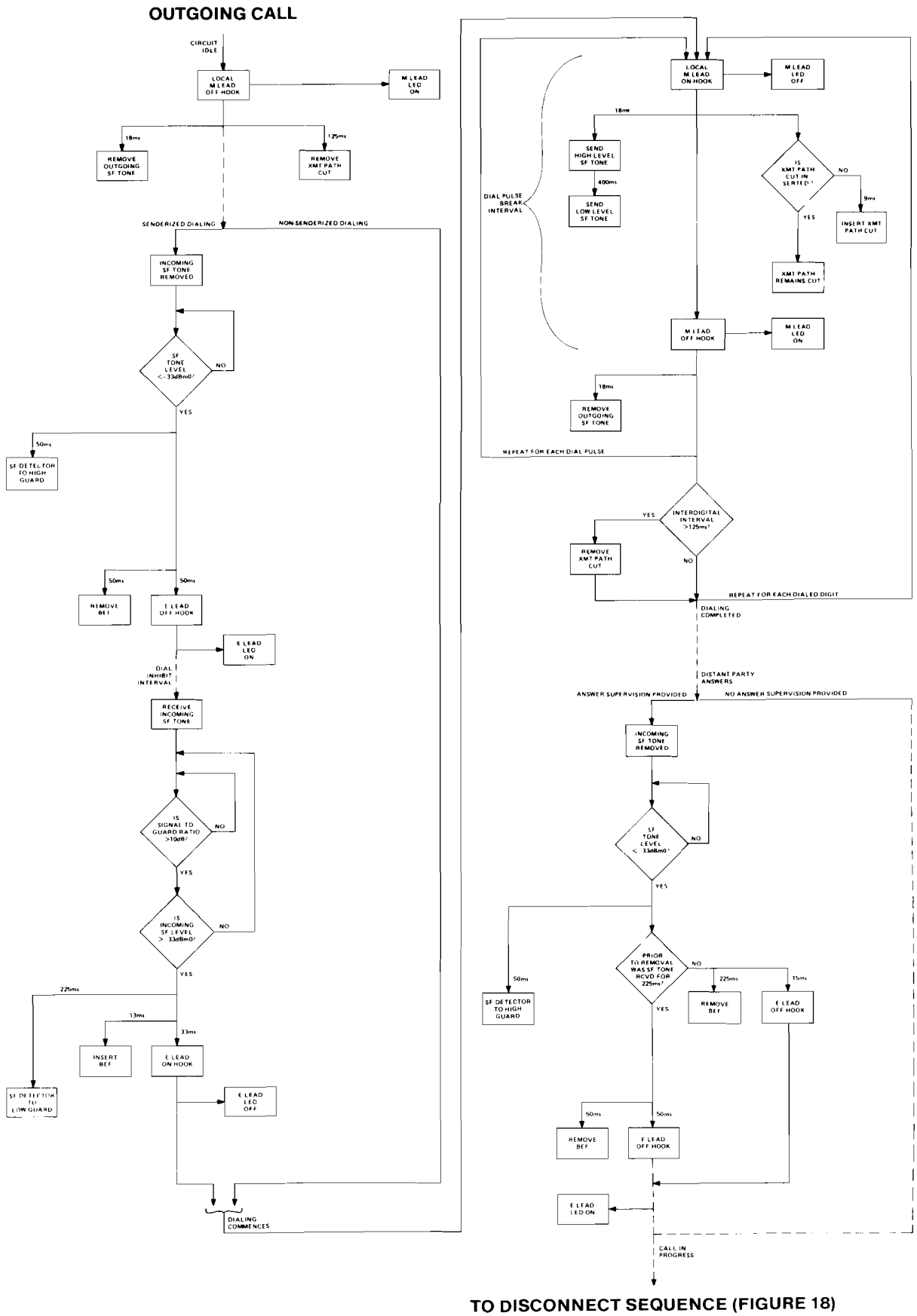


figure 17. Function sequence flowchart, outgoing call

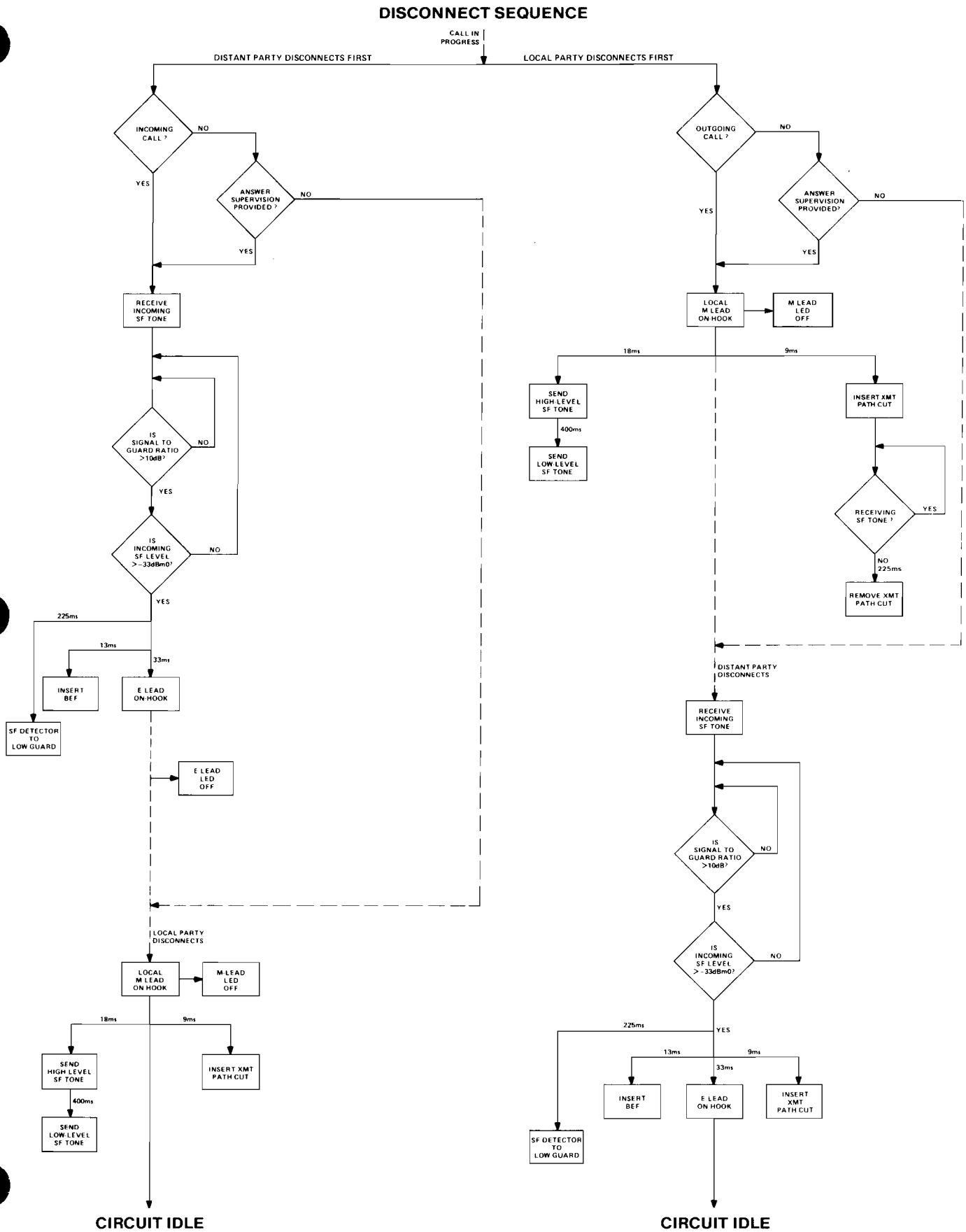
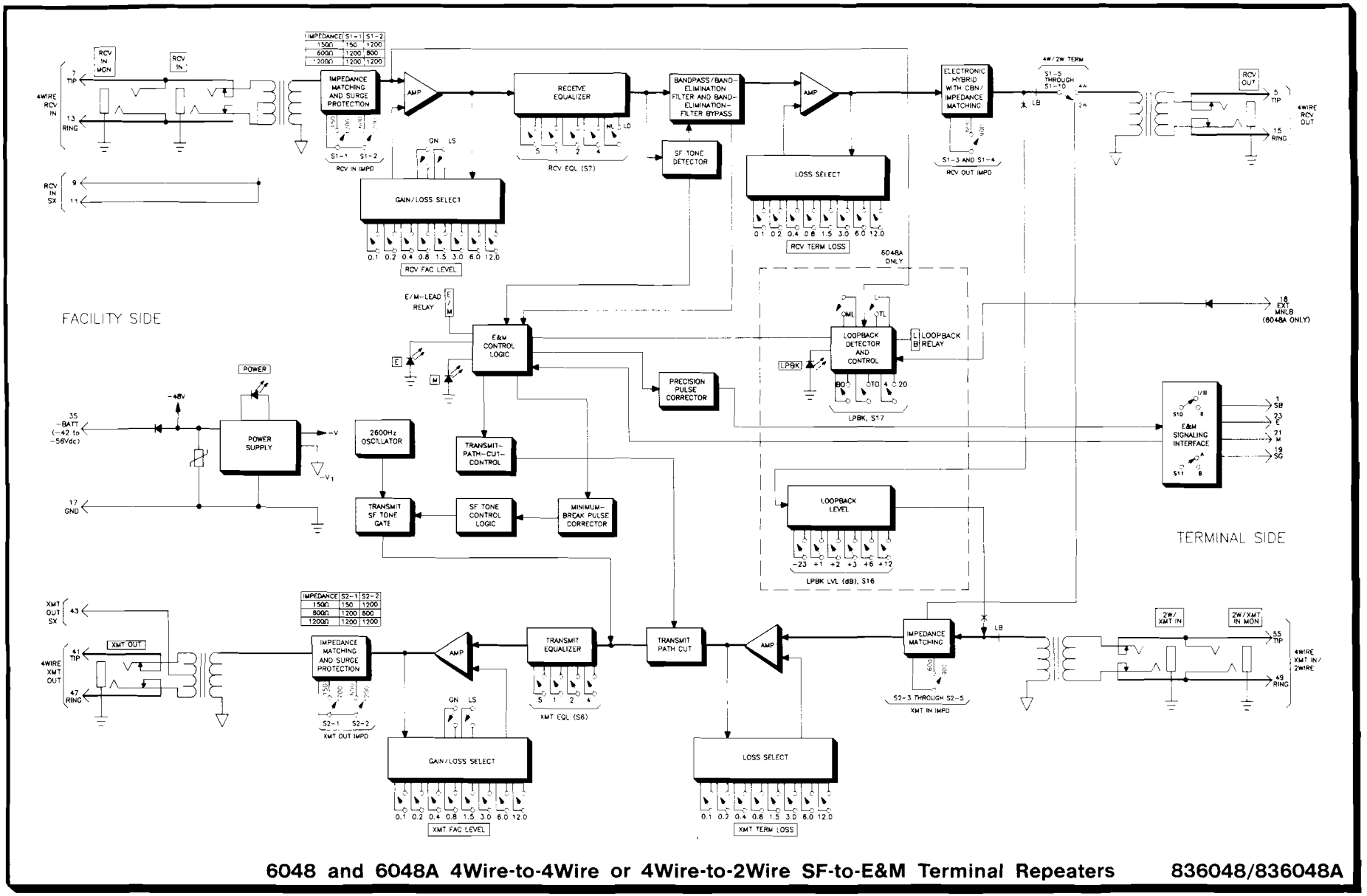


figure 18. Function sequence flowchart, disconnect sequence for incoming and outgoing calls



3. block diagram

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

terminating impedances, facility-side ports (4wire rcv in, 4wire xmt out)
1200, 600, or 150 ohms, balanced, individually switch-selectable at each port

terminating impedances, terminal-side port(s) (4wire xmt in and 4wire rcv out, or 2wire)
4wire terminal interface: 600 ohms, fixed, balanced at each port (900-ohm option not available with 4wire terminal interface)
2wire terminal interface: 900 or 600 ohms in series with 2.15μF, balanced, switch-selectable

frequency response, 4wire rcv input to 4wire rcv output, with no equalization and with receive-channel BEF removed
+0.0, −1.7dB, 300 to 500Hz, re 1004Hz
± 0.7dB, 500 to 3400Hz, re 1004Hz

frequency response, 4wire xmt input to 4wire xmt output, with no equalization
± 0.8dB, 300 to 500Hz, re 1004Hz
± 0.5dB, 500 to 3400Hz, re 1004Hz

frequency response, 4wire rcv input to 2wire output, with no equalization and with receive-channel BEF removed
+0.0, −1.7dB, 300 to 500Hz, re 1004Hz
± 0.7dB, 500 to 3400Hz, re 1004Hz

frequency response, 2wire input to 4wire xmt output, with no equalization
± 1.0dB, 300 to 500Hz, re 1004Hz
± 0.8dB, 500 to 3400Hz, re 1004Hz

integral compromise balance network (CBN), with 2wire terminal interface
900 or 600 ohms in series with 2.15μF, depending upon the terminating impedance selected at the 2wire port

total harmonic distortion, all ports
less than 1% at overload point

internal noise, xmt and rcv channels
17dBrnC0 maximum at maximum gain

4wire longitudinal balance
greater than 58dB, 200 to 3000Hz

2wire longitudinal balance
greater than 55dB, 200 to 3000Hz

4wire echo return loss
greater than 23dB vs. 600 or 1200 ohms

2wire echo return loss
greater than 23dB vs. 600 or 900 ohms in series with 2.15μF

intrinsic transhybrid loss
greater than 35dB

peak-to-average ratio (P/AR), receive-channel BEF removed
98 minimum, without equalization

crosstalk loss between xmt and rcv channels (4wire mode)
75dB minimum, 200 to 3400Hz

crosstalk loss between adjacent modules in shelf
80dB minimum, 200 to 3400Hz

SF transmit section

internal SF tone oscillator frequency and stability
2600 ± 5Hz for life of unit

SF tone levels
low level: −20dBm0 ± 1dB
high level: −8dBm0 ± 1dB

outgoing SF tone states
see table 4 (local call origination) and table 5 (distant call origination) in section 2 of this practice

high-level timing
high-level tone is transmitted for 400 ± 100ms following each off-hook-to-on-hook transition of M lead (A-side signaling) or E lead (B-side signaling)

M-lead delay (A-side signaling) or E-lead delay (B-side signaling)
18 ± 5ms delay between M-lead or E-lead state change and SF-tone state change

pulsing characteristics (M lead to SF for A-side, E lead to SF for B-side)

- **input breaks and makes shorter than M-lead or E-lead delay are not recognized**
- **input breaks of a duration between that of M-lead or E-lead delay and 50ms are transmitted as 50 ± 2ms tone bursts**
- **input makes of a duration between that of M-lead or E-lead delay and 25ms are repeated as 25 ± 2ms silent (no tone) intervals**
- **input breaks longer than 50ms are transmitted as tone bursts equal in duration to the input break duration ± 2ms**
- **input makes longer than 25ms are repeated as silent (no tone) intervals equal in duration to the input make duration ± 2ms**

transmit-path-cut insertion
transmit speech path is cut (opened) 18 ± 5ms before transmission of SF tone

transmit-path-cut removal
transmit speech path cut is removed 125 ± 50ms after detection of an off-hook condition if SF tone is being received

SF receive section

SF tone detection
frequency: 2600 ± 15Hz
level range: 0 to −27dBm0

SF tone rejection threshold
−37dBm0

signal-to-guard ratio for signal detection
6 to 12dB

incoming SF tone states
see table 4 (local call origination) and table 5 (distant call origination) in section 2 of this practice

maximum line noise
51dBrnC0

guard-circuit transition timing
high-to-low: 225 ± 60ms
low-to-high: 50 ± 10ms

band-elimination-filter timing

- **insertion time: 13 ± 7ms**
- **insertion duration for SF tones shorter than 175 ± 60ms: 225 ± 50ms (with BEF insertion duration longer than tone duration in all cases)**
- **insertion duration for SF tones longer than 175 ± 60ms: duration of SF tone plus 50 ± 10ms**

minimum SF pulse duration accepted
33 ± 3ms

dial pulse characteristics, SF to E lead (A side) or SF to M lead (B side) for pulse rates of 8, 10, and 12pps
input break: 50% to 75%
output break: 58% ± 4%

signaling relay (A-side E-lead, B-side M-lead) contact rating
maximum current: 1 ampere
maximum voltage: 200Vdc
contact resistance: 50 milliohms maximum
contact protection: internal transient protection is provided

E&M signaling, A side

E-lead current rating
500mA maximum (resistor-capacitor contact protection provided)

E-lead resistance
less than 0.5 ohm

M-lead sensitivity
−20Vdc minimum threshold; 500 ohms minimum external M-lead resistance from −48Vdc, will not detect external M-lead resistance of 20 kilohms or greater

E&M signaling, B side

M-lead current rating
500mA maximum (resistor-capacitor contact protection provided)

M-lead current from battery (Type I interface only)
100mA with less than 5-volt drop; current limiting above 200mA

E-lead sensitivity
500 ohms minimum external E-lead resistance to ground, will not detect external E-lead resistance of 20 kilohms or greater

loopback specifications (6048A only)

tone-loopback frequency
module will loop back at 2713 ± 7Hz; module will not loop back outside of 2713 ± 37Hz

tone-loopback activation/deactivation level
−30 to −3dBm

tone-loopback signal-to-guard ratio
12 ± 6dB

tone-loopback operating times
initiate: must initiate after 2.5-second or longer application of tone, with loopback after removal of tone; must not initiate for tone application of less than 1.5 seconds
tone release: must release after second application of tone for 1.2 seconds or longer, with release during tone; must not release for second tone application of less than 0.6 second
automatic release: 20 minutes ± 60 seconds or 4 minutes +45, −15 seconds, as selected via switch option

local (manual) loopback
activation: option switch on module or connection between EXT MNLB lead (pin 18) and input power ground (pin 17)
deactivation: option switch on module or removal of EXT MNLB-ground connection

loopback-path gain or loss
0 to 24dB of gain or 0 to 23dB of loss in switch-selectable 1dB increments

common specifications

input power requirements
voltage: −42 to −56Vdc, filtered, positive-ground referenced
current: 60mA at idle (at −48Vdc), 100mA maximum (at −56Vdc), with an additional 10mA required for the 6048A when in loopback

operating environment
32° to 122°F (0° to 50°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
12.5 ounces (354 grams)

mounting
relay rack or apparatus case via one position of a Tellabs Type 10 Mounting Shelf. Can also be mounted in one position of a Tellabs 262-series NCTE/DST Mounting Assembly.

7. testing and troubleshooting

7.01 The **troubleshooting guide** in this section may be used in conjunction with the function sequence flowcharts (figures 16 through 18) to assist in the installation, testing, or troubleshooting of the 6048/A 4Wire-to-4Wire or 4Wire-to-2Wire SF-to-E&M Terminal Repeater module. The guide is intended as an aid in the localization of trouble to this specific equipment. If the equipment is suspected of being defective, substitute new equipment (if possible) and conduct the test again. If the substitute operates correctly, the original 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 equipment. Unauthorized testing or repairs may void its warranty. Also, if the equipment is part of a registered system, unauthorized repairs will result in noncompliance with Parts 15 and/or 68 of the FCC Rules and Regulations.

Note: *Although repair service always includes an attempt to remove any permanent markings made by customers on Tellabs equipment, the success of such attempts cannot be guaranteed. Therefore, if*

equipment must be marked **defective** *or* **bad**, *we recommend that it be done on a piece of tape or on a removable stick-on label.*

technical assistance via telephone

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

USA customers: Contact your Tellabs Regional Office listed below.

region	telephone	office location
US Atlantic	(203)798-0506	Danbury, CT
US Capital	(703)359-9166	Washington, DC
US Central	(312)357-7400	Chicago, IL
US Southeast	(305)834-8311	Orlando, FL
US Southwest	(214)869-4114	Dallas, TX
US Western	(714)850-1300	Orange County, CA

Canadian customers: Contact our Canadian headquarters in Mississauga, Ontario. Telephone (416)624-0052.

International customers: Contact your Tellabs distributor.

selecting correct product service procedure

7.03 If equipment is diagnosed as defective or if in-service equipment needs repair, follow the **product return procedure** in paragraph 7.04 in all cases except those where a critical service outage exists (e.g., where a system or a critical circuit is down and no spares are available). In critical situations, or if you wish to return equipment for reasons other than repair, follow the **product replacement procedure** in paragraph 7.05.

product return procedure (for repair)

7.04 To return equipment for repair, first contact Tellabs Product Services (see addresses and numbers below) to obtain a Material Return Authorization (MRA). A service representative will request key data (your company's name and address, the equipment's model and issue numbers and warranty date code, and the purchase order number for the repair transaction). The service representative will then give you an MRA number that identifies your particular transaction. After you obtain the MRA number, send the equipment prepaid to Tellabs (attn: Product Services).

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 malfunction, your company's name and address, the name of a person to contact for further information, and the purchase order number for the transaction. Be sure to write the MRA number clearly on the outside of the carton being returned. Tellabs will inspect, repair, and retest the equipment so that it meets its original performance specifications and then ship the equipment back to you. If the equipment is in warranty, no invoice will be issued. Should you need to contact Tellabs regarding the status of a repair, call or write the Product Services department at our Lisle or Mississauga headquarters as directed above.

product replacement procedure

7.05 For critical service outages, Tellabs offers a choice of two replacement services (if the product is in replacement stock) in lieu of the 15-day repair and return service described above. These are **overnight express service** (at extra cost) anywhere in the USA and **five-day expedited delivery** (at no extra cost) anywhere in the USA and Canada. To obtain replacement equipment via either of these services, contact your Tellabs Regional Office in the USA or our Canadian headquarters in Mississauga, Ontario, for details, costs (if applicable), and instructions. Telephone numbers are given in paragraph 7.02. A service representative will request key data (your company's name and address, the equipment's model and issue numbers and warranty date code, and the purchase order number for the replacement transaction). Tellabs will then ship the replacement to you in accordance with the replacement service you request. An invoice in the amount of the replacement's current price plus any applicable service charges will be issued after the replacement is shipped. When you receive the replacement, pack the equipment to be returned in the replacement's carton, sign and enclose the packing list, affix to the carton the preaddressed label provided, and ship the carton prepaid to Tellabs at our USA or Canadian headquarters. When we receive the defective equipment (within 30 days of our issuing the replacement), the invoice will be adjusted to reflect only service charges (if applicable). Please note that OEM, modified, and manufacture-discontinued equipment is not available via overnight express service.

troubleshooting guide on next page

troubleshooting guide

trouble condition	possible causes (check before assuming module is defective)
module completely inoperative	1) No input power. 2) Improper wiring.
cannot derive proper receive-channel (4wire-to-4wire or 4wire-to-2wire) transmission levels	1) Main-board 4wire or 2wire terminal interface switches (*4W/2W TERM* positions of DIP switch *S1*) improperly set. 2) Front-panel *rcv fac level* and/or *rcv term loss* DIP switches improperly set. 3) Main-board receive impedance switches (*RCV IN/OUT* positions of DIP switches *S1*) improperly set. 4) Main-board receive equalization DIP switch (*S7*) improperly set. 5) Circuit not seized. 6) Test-equipment impedance improperly set or test equipment not terminated.
cannot derive proper transmit-channel (4wire-to-4wire or 4wire-to-2wire) transmission levels	1) Main-board 4wire or 2wire terminal interface switches (*4W/2W TERM* positions of DIP switch *S1*) improperly set. 2) Front-panel *xmt fac level* and/or *xmt term loss* DIP switches improperly set. 3) Main-board transmit impedance switches (*XMT OUT/XMT IN* positions of DIP switch *S2*) improperly set. 4) Main-board transmit equalization DIP switch (*S6*) improperly set. 5) Circuit not seized. 6) Test-equipment impedance improperly set or test equipment not terminated.
improper signaling	1) Incorrect transmission level setting (see preceding trouble condition and possible causes). 2) Baby-board *I(III)/II* E&M interface switch (*S10*) improperly set. 3) Baby-board E&M signaling mode (A-side/B-side) switch (*S11*) improperly set. 4) Internal receive and/or transmit TLP's improperly derived. 5) Excessive noise in circuit. 6) Excessive SF tone leak at receive input port. 7) Incorrect incoming SF tone level.
cannot activate or deactivate manual loopback via option switch (6048A only)	1) Ground on EXT MNLB (external manual loopback) lead (pin 18).
cannot activate or deactivate manual loopback via EXT MNLB-lead ground (6048A only)	1) EXT MNLB (external manual loopback) lead (pin 18) improperly wired. 2) Source of ground defective.
cannot activate or deactivate 2713Hz tone loopback (6048A only)	1) Loopback options improperly set; check baby-board *LPBK* DIP switch (*S17*). 2) Tone not applied for proper duration and, for activation only, then removed. 3) Tone at improper frequency or below −30dBm detection threshold. 4) Ground on EXT MNLB (external manual loopback) lead (pin 18).
cannot derive transmission loopback (6048A only)	1) Module not in loopback (*lpbk* LED unlit).
nnot derive proper loopback smission level (6048A only)	1) Loopback level improperly set; check baby-board *LPBK LVL* DIP switch (*S16*). 2) Module not in loopback (*lpbk* LED unlit).