tellabs
technical manual
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rev A

practice section 816168A

6168A 4Wire-to-4Wire or 4Wire-to-2Wire DX-to-E&M Terminal Repeater with Loopback

contents

1. general description

1.01 The 6168A 4Wire-to-4Wire or 4Wire-to-2Wire DX-to-E&M Terminal Repeater module with Loopback (figure 1) provides both active transmission interface and bidirectional signaling conversion between a 4wire facility that uses duplex (DX) signaling, which is extended-range E&M signaling via DX signaling leads, and a 4wire or 2wire trunk or line that uses conventional E&M signaling. Unlike ordinary DX modules, the 6168A contains circuitry that eliminates the need for a conventional resistive and capacitive DX balance network. In addition, the 6168A contains transmission and signaling loopback circuitry to facilitate local or remote testing of the module and the facility. A switch option on the 6168A excludes its DX-to-E&M signaling-conversion circuitry from the circuit, thereby allowing the 6168A to function as a data station termination (DST) module rather than as a signaling unit. As a member of Tellabs' 262 Network Channel Terminating Equipment/Data Station Termination (NCTE/DST) System of modules and enclosures, the 6168A fulfills Registered Facility Interface Codes TC11E, TC11M, TC12E, TC12M, TL11E, TL11M, TL12E, 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 DX signaling.

1.02 In the event that this practice section is revised or reissued, the reason for revision or reissue will be stated in this paragraph.

1.03 The 6168A module offers the following transmission features and options:

- Switch-selectable 4wire or 2wire terminal-side interface, with an integral electronic hybrid providing 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.
- Active prescription slope-type or bump-type amplitude equalization, equivalent to that provided by the Western Electric (WECo) 309B Prescription Equalizer, in both the transmit and receive channels.
- Equalizer-bypass option switches for both channels.
- 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 ports (receive input and transmit output).
- Independently switch-selectable 1200, 600, or 150-ohm terminating impedance at both facility-side ports.
- 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 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 ports (receive output and transmit input) when 4wire interface is selected.
- 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.

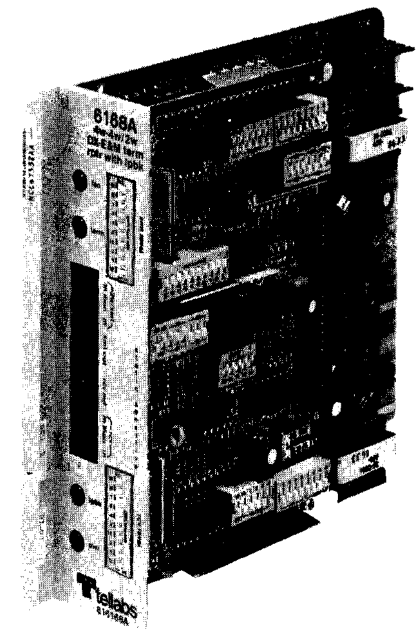


figure 1. 6168A 4Wire-to-4Wire or 4Wire-to-2Wire DX-to-E&M Terminal Repeater module with Loopback

- Lightning surge protection at both facility-side transmission ports.
- Reverse-battery and power-cross 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 −45 to −52Vdc input power with current requirements of 85mA typical at idle (at −52Vdc).
- 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 The 6168A module offers the following signaling features and options:

- Maximum DX signaling range of 5000 ohms.
- No DX balance network to align; optimum DX signaling performance is provided in any application up to the unit's maximum signaling range.
- Facility-side simplex-lead reversal switch.
- Switch-selectable DX1 or DX2 operation.
- Switch-selectable Type I, II, or III (Type III with DX1 only) E&M interface.
- M-lead current limiting.
- Switch-selectable exclusion of DX-to-E&M signaling circuitry for use of module as a 4wire-to-4wire or 4wire-to-2wire DST unit.
- Front-panel LED's that light to indicate DX-to-E&M busy (*fac busy*), E&M-to-DX busy (*term busy*), power on, and loopback.

1.05 Loopback features and options of the 6168A 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 DX-to-E&M signaling converter circuitry and E-lead/M-lead 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 24dB of loopback-path loss or from 0 to 24dB of loopback-path gain, in switch-selectable 0.1dB increments, for true equal-level loopback.
- Switch-selectable terminal-side busy-out during loopback.

2. application

2.01 The 6168A 4Wire-to-4Wire or 4Wire-to-2Wire DX-to-E&M Terminal Repeater module with Loopback is used to terminate a DX signaling facility to an E&M tie trunk. The 6168A module combines the functions of a 4wire line amplifier, a DX-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 6168A is a complete DX 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 DX facility and the 4wire or 2wire E&M trunk or line. As an alternative to DX-to-E&M signaling-unit operation, the 6168A can be switch-optioned to function as a data station termination (DST) module, in which case the module's signaling circuitry is excluded from the circuit (see paragraph 2.18). Integral transmission and signaling loopback circuitry permits testing of both the 6168A and the facility from a local or remote location.

2.02 The 6168A is well suited to a variety of 4wire-to-4wire and 4wire-to-2wire DX-to-E&M applications, both network-terminating and otherwise. Figures 2 and 3 show two typical network-terminating tie-trunk applications of the 6168A.

2wire terminal interface and balance network

2.03 When optioned for 2wire terminal interface, the 6168A interfaces the local 2wire E&M trunk or line via its integral electronic hybrid terminating set. This hybrid provides balanced, 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 nonloaded 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 terminating 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 6168A interfaces the local 4wire E&M trunk or line via transformers that provide fixed, balanced 600-ohm terminating impedance at the 4wire transmit input and the 4wire receive output ports.

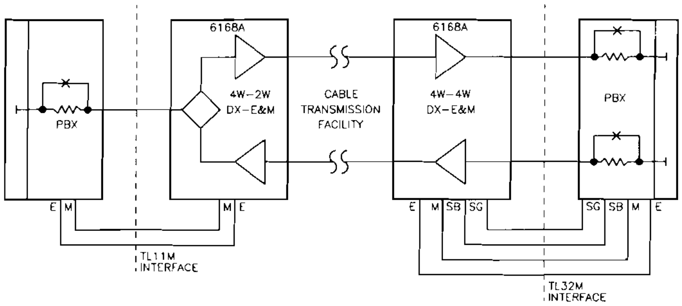


figure 2. Typical short-haul tie-trunk circuit using 6168A module

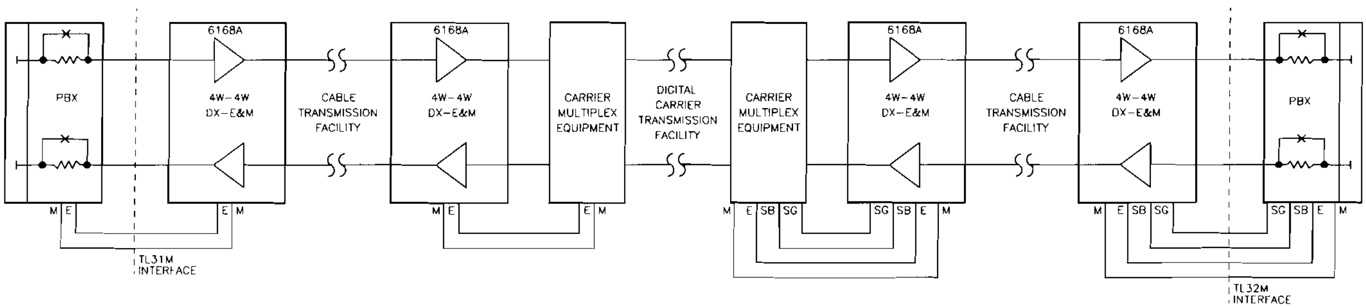


figure 3. Typical long-haul tie-trunk circuit using 6168A module

(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 6168A interfaces the 4wire DX 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 2.08). 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.

2.07 Both facility-side transformers are center-tapped to derive simplex (SX) leads, by which the DX signaling path is extended toward the facility. Connection of these SX leads to the module's integral DX unit is controlled by an option switch that selects either a normal or reverse arrangement (see the 6168A block diagram, section 5 of this practice). In the normal arrangement, the signaling lead of the 6168A's DX unit is connected to the transmit output SX pinout (pin 43), and the reference lead of the DX unit is connected to the receive input SX pinout (pin 9). In the reverse arrangement, the DX unit's signaling lead is connected to the receive input SX pinout, and the DX unit's reference lead is connected to the transmit output SX pinout. The normal/reverse option is provided to accommodate signaling-lead reversals at other points in the circuit. Please be aware that these normal and reverse designations are not consistent throughout the industry. What is "normal" on the 6168A may be "reverse" on another DX module. Therefore, to ensure proper end-to-end DX signaling operation, the modules at the two ends of a DX circuit must be optioned so that the signaling drivers of both modules are on one SX (dc) pair and so that the reference drivers of both modules are on the other SX (dc) pair. This means that, if two 6168A's are used on a circuit, one would be optioned for normal and the other for reverse.

level control

2.08 Prescription-set transmit and receive amplifiers allow the 6168A to interface the DX signaling facility directly, i.e., without a separate line amplifier. Both amplifiers provide from 0 to 24dB of gain or 0 to 24dB of loss in switch-selectable 0.1dB increments. Total gain or loss introduced into a channel is the sum of that channel's front-panel level switches set to IN.

receive- and transmit-channel amplitude equalization

2.09 Active prescription amplitude equalization functionally equivalent to that provided by the Western Electric 309B Prescription Equalizer is available in the receive and transmit channels of the 6168A for post- (receive) and pre- (transmit) equalization of the 4wire facility-side pairs. These equalizers provide low-end slope equalization down to 404Hz and high-end bump equalization centered at 3250Hz for loaded or nonloaded cable, as selected via switch option. Degree of slope, height of bump, and affected bandwidth are also controlled by option switches on the module. If no equalization is required, the equalizers can be electrically bypassed by means of additional switch options.

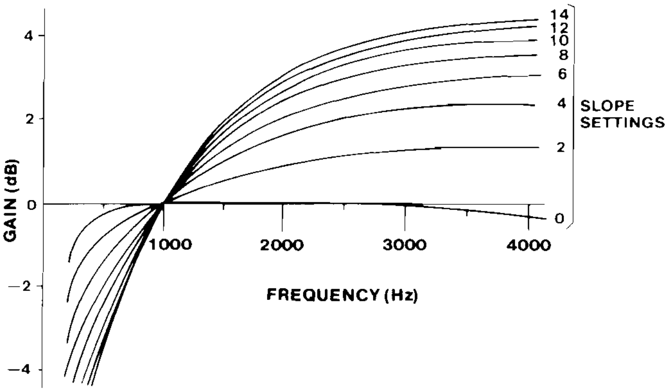


figure 4. Typical response curves for receive and transmit equalizers in slope mode, nonloaded cable

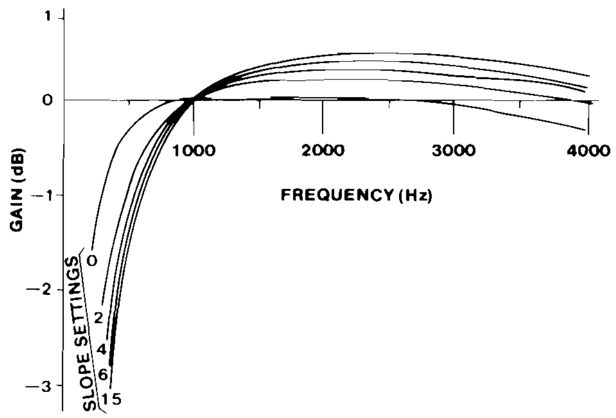


figure 5. Typical response curves for receive and transmit equalizers in slope mode, loaded cable

SLOPE switch setting	NL switch setting	
	OUT (loaded)	NL (nonloaded)
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

2.10 Figures 4 and 5 show typical response curves for the 309B-equivalent equalizer in the slope mode. Figure 4 shows the curves for nonloaded cable, while figure 5 shows the curves for loaded cable. For comparison purposes, all frequency-response curves in both figures are drawn with the same 0dB-gain reference point (1004Hz). Actually, all of these curves except those for a *SLOPE* switch setting of *0* 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 *NL* (nonloaded/loaded) switch settings selected. These amounts are listed in table 1.

2.11 Figures 6 and 7 show typical response curves for the 309B-equivalent equalizer in the bump mode. Figure 6 shows the curves representing various height settings versus a wide bandwidth setting, while figure 7 shows the curves representing various height settings versus a narrow bandwidth setting. For comparison purposes, all frequency-response curves in both figures are drawn with the same 0dB-gain reference point (1004Hz). Actually, all of these curves except those for a height (*HT*) switch setting of *1* or *0* and/or for a bandwidth (*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

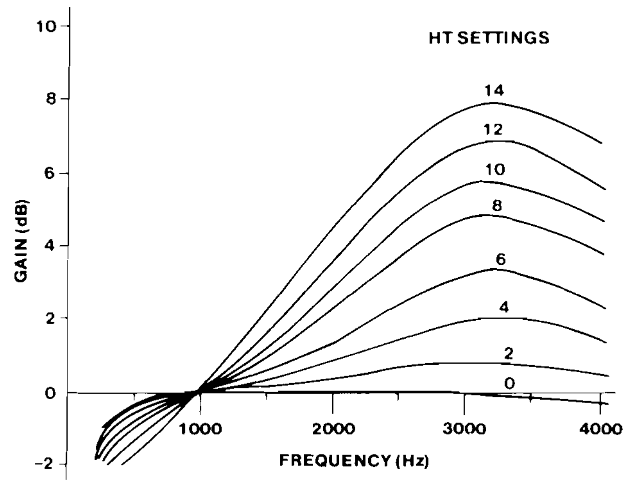


figure 6. Typical response curves for receive and transmit equalizers in bump mode, BW switch = 14

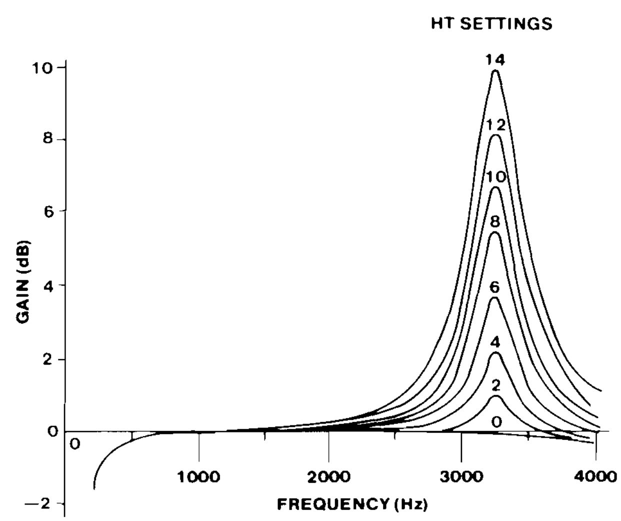


figure 7. Typical response curves for receive and transmit equalizers in bump mode, BW switch = 3

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	0.1	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

* An *HT* switch setting of *0* disables the bump function. An *HT* switch setting of *1* introduces 0.1dB of gain or less at 1004Hz.
** A *BW* switch setting of *0* through *5* introduces 0.1dB of gain or less for all *HT* switch settings.

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

HT and *BW* switch settings selected. These amounts are listed in table 2.

DX signaling loop limits

2.12 For proper DX signaling operation, total resistance of the DX signaling loop between the 6168A and the DX unit at the distant facility-side location must not exceed 5000 ohms. Total DX signaling loop resistance in 4wire DX applications equals one-half of the loop resistance of the receive input pair plus one-half of the loop resistance of the transmit output pair. Total DX signaling loop resistance in 2wire DX applications equals one-half of the sum of the resistance of the 2wire DX pair and the resistance of the distant-end DX unit (when properly aligned).

DX balance

2.13 The 6168A contains circuitry that eliminates the need for the typical resistive and capacitive balance network of conventional DX modules. The module's DX unit provides optimum signaling performance in any application up to its 5000-ohm limit without the need for balance-network alignment.

DX1/DX2 signaling

2.14 The 6168A can be switch-optioned for a DX1 or DX2 signaling arrangement. This option eliminates the need for a pulse-link repeater in tandem applications of DX units and in applications where the module interfaces a carrier channel. In DX1 operation, M-lead signals are incoming to and E-lead signals are outgoing from the module on the terminal (E&M) side. In DX2 operation, E-lead signals are incoming to and M-lead signals are outgoing from the module on the terminal (E&M) side. Selection of DX1 or DX2 operation therefore depends upon the E&M signaling arrangement of the associated terminal equipment. If the terminal equipment provides M-lead outputs and receives E-lead inputs, the 6168A is optioned for DX1 operation. If the terminal equipment provides E-lead outputs and receives M-lead inputs, the 6168A is optioned for DX2 operation.

E&M signaling interfaces

2.15 The 6168A 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 DX1 or DX2 signaling. The Type III interface can be used with DX1 signaling only. Figures 8 through 10 show the connections required for Type I, II, and III E&M interfaces with DX1 and DX2 signaling and indicate the Registered Facility Interface Codes (if applicable) that each signaling arrangement fulfills. Table 3 summarizes these codes and the DX1/DX2 signaling and E&M interface options required for each.

2.16 With Type I interface, incoming and outgoing signaling each consist of the presence of either ground, battery, or an open condition on the E&M leads. With Type II interface, incoming and outgoing signaling consist of contact closures between the M lead and the MB/SB (M-lead-battery or signal-battery) lead and the E lead and the EG/SG (E-lead-ground or signal-ground) lead. The Type III interface is a compromise: a partially looped format essentially identical to the Type I interface except that battery and ground for M-lead signaling are supplied via the SB and SG leads. Type II E&M-lead interfacing permits direct interconnection of trunk circuits or signaling units without intermediate signaling-lead conversion (which is required with Type I and Type III E&M-lead interfacing).

2.17 The 6168A uses relay contacts to derive E-lead and M-lead signaling, thereby allowing interface with nonstandard E-lead and M-lead voltage levels and polarities. When the module is used to derive a Type II interface, terminal-side equipment can use any convenient voltage or polarity.

optional DST operation

2.18 As an alternative to DX-to-E&M signaling operation, the 6168A can be switch-optioned to function as a DST module. In this mode of operation, the module's DX-to-E&M signaling circuitry is electrically excluded from the circuit, leaving only

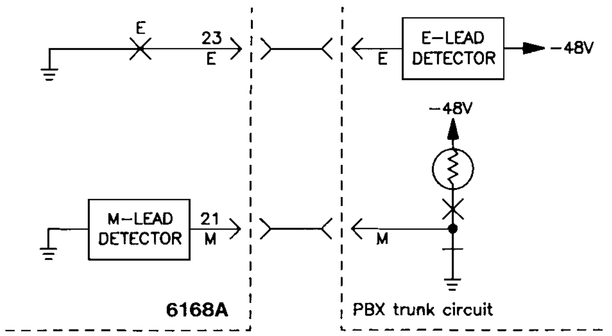


figure 8a. DX1 signaling, TL31M, TC31M, TL11M, or TC11M

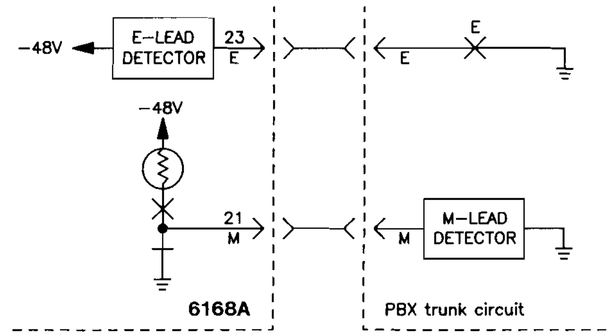


figure 8b. DX2 signaling, TL31E, TC31E, TL11E, or TC11E

figure 8. Type I E&M interface arrangements

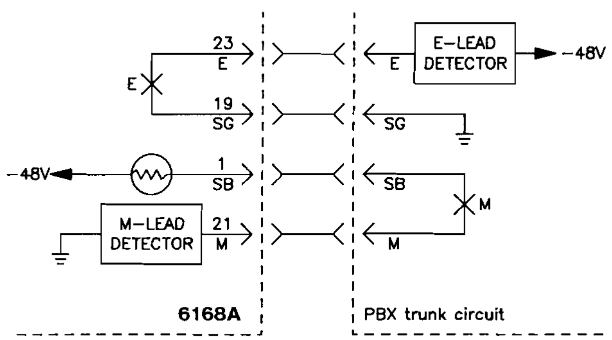


figure 9a. DX1 signaling, TL32M, TC32M, TL12M, or TC12M

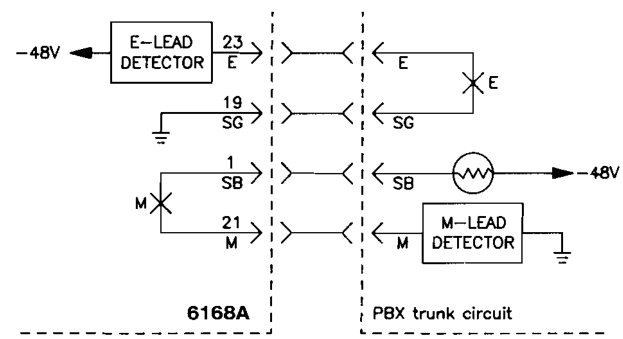


figure 9b. DX2 signaling, TL32E, TC32E, TL12E, or TC12E

figure 9. Type II E&M interface arrangements

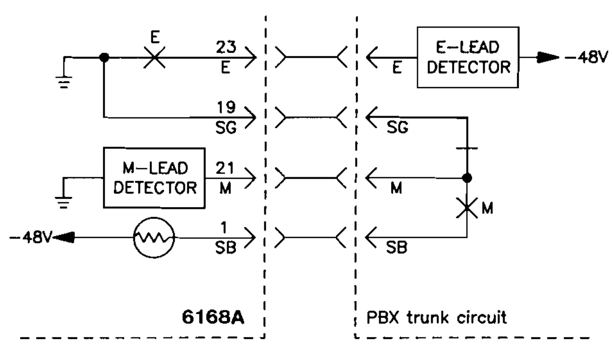


figure 10. DX1 signaling, Type III E&M interface arrangement

Registered Facility Interface Code	**E&M inter-face**	**DX signaling arrange-ment***	**6168A signaling directions**	
			E lead	**M lead**
TL31M or TC31M (4W) TL11M or TC11M (2W)	Type I	DX1	out	in
TL31E or TC31E (4W) TL11E or TC11E (2W)	Type I	DX2	in	out
TL32M or TC32M (4W) TL12M or TC12M (2W)	Type II	DX1	out	in
TL32E or TC32E (4W) TL12E or TC12E (2W)	Type II	DX2	in	out
not applicable	Type III	DX1	out	in

* DX1 signaling is used when the associated E&M terminal equipment provides M-lead outputs and receives E-lead inputs. DX2 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 6168A

the level-control, amplitude-equalization, impedance-matching, and loopback circuitry operational. Also, the facility-side SX leads are connected together (except during loopback) to serve as a return path for sealing current applied from the distant end of the facility. The DST-operation option can be selected with either 4wire or 2wire terminal interface in effect.

power

2.19 The 6168A operates on filtered, ground-referenced input potentials between −45 and −52Vdc. The positive side of the dc power supply should be connected to earth ground. Maximum current required (at −52Vdc) is 120mA unless the 6168A's loopback option is activated, in which case an additional 30mA is required.

loopback

2.20 **Overview.** Integral facility-side transmission and signaling loopback circuitry in the 6168A 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 24dB of loss or from 0 to 24dB of gain into the loopback path in switch-selectable 0.1dB increments to provide true equal-level transmission loopback. In addition, a switch option conditions the 6168A to busy out its terminal side during loopback (see paragraph 2.24). Figure 11 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.

2.21 Transmission loopback in the 6168A 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.

2.22 Signaling loopback allows the 6168A's DX-to-E&M signaling converter circuitry and the E&M signaling relay to be tested in any of the five possible E&M operating modes: Type I, II, or III interface with DX1 signaling or Type I or II interface with DX2 signaling. With the DST option selected, the SX path and the TEK5 and TEK6 leads are opened during loopback.

2.23 If the 6168A's signaling converter circuitry and E-lead/M-lead signaling relay are operational, the module repeats all signaling states that it receives by responding with the appropriate DX loop-current changes.

2.24 The 6168A'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.

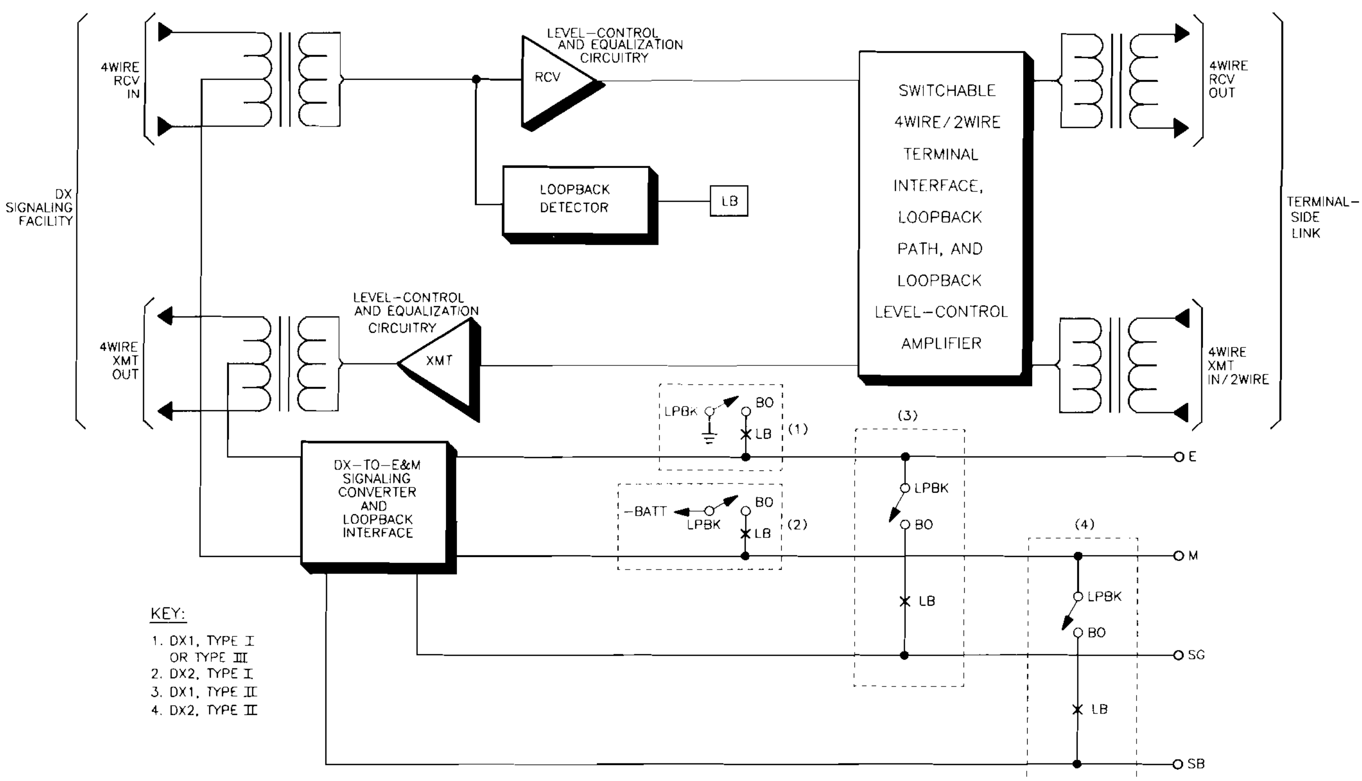


figure 11. Loopback route through 6168A module

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

- Setting the *ML* position of the module's loopback DIP switch (*S100*) toward *ML*.
- Connecting the module's EXT MNLB (external manual loopback) lead (pin 18) to input power ground (pin 17).

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.

2.26 **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 6168A 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 6168A 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 6168A 4Wire-to-4Wire or 4Wire-to-2Wire DX-to-E&M Terminal Repeater module with Loopback 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 6168A 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 6168A 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 6168A 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 6168A 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 mounting 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 4 lists external connections to the 6168A 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
4WIRE XMT OUT SX (simplex, facility side)	43
E lead/TEK 6	23
M lead/TEK 5	21
SB (signal battery)**	1
SG (signal ground)**	19
EXT MNLB (external manual loopback)	18
−BATT (−45 to −52Vdc filtered input)	35
GND (ground)	17

* Not used when module is optioned for 2wire terminal interface.

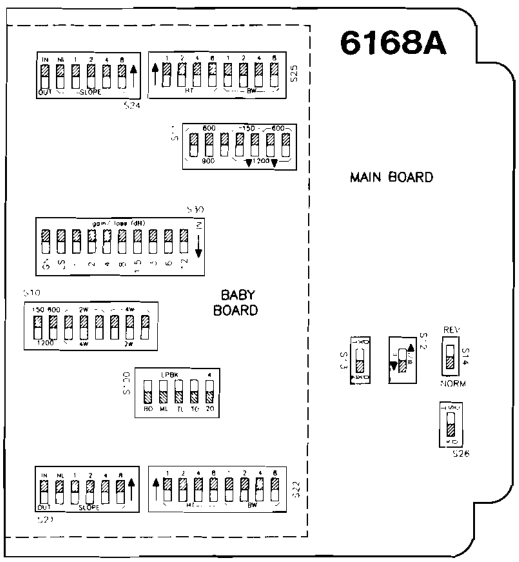
** Mandatory for Type II and III E&M interfaces only.

table 4. External connections to 6168A

option selection

3.06 Several option switches must be set before the 6168A 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 12. Table 5 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 12 and table 5, and set each option switch on the 6168A as required.

Note: *The four signaling switches (***S12, S13, S14,** *and* **S26***) on the module's main board should be set as required* **before** *power is applied to the module.*



Note: *Switch numbers on baby board may not be visible.*

figure 12. 6168A option switch locations

alignment overview

3.07 Alignment of the 6168A comprises the following procedures (all option switches should already be properly set as described above):

A. Setting the receive-channel level.
B. Introducing receive-channel equalization, if necessary.
C. Setting the transmit-channel level.
D. Introducing transmit-channel equalization, if necessary.
E. Adjusting the loopback-path level.

prescription alignment

3.08 Prescription alignment of the 6168A module involves setting all level-control and equalization switches in accordance with specifications on the circuit layout record (CLR) before plugging the module into its position. Table 6 in this practice summarizes all alignment switches on the 6168A 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 6168A 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 6168A 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.

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 5), especially those that select terminating impedances and 4wire or 2wire terminal interface, are properly set. Also ensure that the module is not in loopback.
B. Set the front-panel receive and transmit level-control DIP switches for no gain or loss.
C. Set to *OUT* the *IN/OUT* position of the baby-board receive and transmit *SLOPE* equalization switches (*S21* and *S24*, respectively) for no equalization.
D. Set the baby-board loopback-level-control DIP switch (*S30*) for no gain or loss.

non-prescription alignment

3.11 Align the 6168A as directed in the non-prescription alignment procedure, figure 13 of this practice.

Note 1: *The procedure in figure 13 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.*

4. circuit description

4.01 This circuit description is intended to familiarize you with the 6168A 4Wire-to-4Wire or 4Wire-to-2Wire DX-to-E&M Terminal Repeater module with Loopback for engineering and application purposes only. Attempts to test or troubleshoot this module internally are not recommended and may void its Tellabs warranty. Procedures for recommended testing or troubleshooting in the field should be limited to those prescribed in section 7 of this practice. Reference to the 6168A block diagram (section 5 of this practice) will aid in understanding the circuit description.

option	switch	selection	setting	check-list
terminating impedance, 4wire receive input port (facility side)	*150/1200* and *600/1200* positions of *S10* on baby board	1200 ohms (for loaded cable)	150/1200 switch toward 1200, 600/1200 switch toward 1200	
		600 ohms (for nonloaded cable or carrier)	150/1200 switch toward 1200, 600/1200 switch toward 600	
		150 ohms (extra equalization for nonloaded cable)	150/1200 switch toward 150, 600/1200 switch toward 1200	
terminating impedance, 4wire transmit output port (facility side)	*150/1200* and *600/1200* positions of *S11* on baby board	1200 ohms (for loaded cable)	both 150/1200 switches toward 1200, both 600/1200 switches toward 1200	
		600 ohms (for nonloaded cable or carrier)	both 150/1200 switches toward 1200, both 600/1200 switches toward 600	
		150 ohms (extra equalization for nonloaded cable)	both 150/1200 switches toward 150, both 600/1200 switches toward 1200	
2wire or 4wire terminal-side interface*	*2W/4W* and *4W/2W* positions of *S10* on baby board	2wire interface	all positions toward 2W	
		4wire interface	all positions toward 4W	
terminating impedance, 2wire port (with 2wire terminal-side interface selected)	*600/900* positions of *S11* on baby board	900 ohms plus 2.15μF	all 600/900 positions toward 900	
		600 ohms plus 2.15μF	all 600/900 positions toward 600	
terminating impedance, 4wire rcv out and 4wire xmt in ports (with 4wire terminal-side interface selected)	*600/900* positions of *S11* on baby board	600 ohms **only** (900-ohm option **cannot** be used with 4wire terminal interface)	all 600/900 positions toward 600	
Note: *The next four switches* **(S12, S13, S14,** *and* **S26)** *select the module's signaling options and should be set as required* **before** *power is applied to the module.*				
Type I, Type II, or Type III E&M interface	*S12* on main board	Type I interface	I/III	
		Type II interface	II	
		Type III interface (available **only** with DX1 operation)	I/III	
DX1 or DX2 operation**	*S13* on main board	DX1 operation	DX1	
		DX2 operation	DX2	
normal or reverse facility-side simplex leads***	*S14* on main board	normal SX leads	NORM	
		reverse SX leads	REV	
operation as DX-to-E&M signaling unit or as data station termination (DST) unit	*S26* on main board	DX-to-E&M operation	DX	
		DST operation (DX-to-E&M signaling circuitry excluded, and facility-side SX leads connected together)	DST	

table 5 continued on next page

option	switch	selection	setting	check-list
busying out of module's terminal side (E&M leads) during loopback†	*BO* position of *S100* (*LPBK* DIP switch) on baby board	busy out	toward BO	
		no busy out	away from BO	
manual loopback activate/deactivate	*ML* position of *S100* (*LPBK* DIP switch) on baby board	manual loopback activated	toward ML	
		manual loopback deactivated	away from ML	
tone loopback enable/ disable††	*TL* position of *S100* (*LPBK* DIP switch) on baby board	tone loopback enabled	toward TL	
		tone loopback disabled (for manual loopback only)	away from TL	
tone-loopback timeout enable/disable (with tone loopback enabled)††	*TO* position of *S100* (*LPBK* DIP switch) on baby board	tone-loopback timeout enabled (see selection below for duration)	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 *S100* (*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 interface is selected. This CBN provides either 900 or 600 ohms (in series with 2.15μF), depending upon 2wire-port optioning.

** In DX1 operation, the 6168A receives M-lead signals and sends E-lead signals on the terminal side. In DX2 operation, the 6168A receives E-lead signals and sends M-lead signals on the terminal side.

*** Continuity of the DX leads must be maintained between the local and distant DX units, i.e., the signaling and reference (balancing) leads of one DX unit must be connected to the respective leads of the other DX unit. See paragraph 2.07 and the block diagram in this practice for complete information on setting switch *S14.*

† 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 *S100* (*LPBK* DIP switch) are nonfunctional. With tone loopback enabled but tone-loopback timeout disabled, the *4/20* position of *S100* is nonfunctional.

table 5. Summary and checklist of 6168A switch options

alignment function	switch	selection	setting	checklist
selection of receive-channel flat gain or loss	*GN* and *LS* positions of front-panel *rcv level* DIP switch	gain	GN to IN, LS to OUT	
		loss	GN to OUT, LS to IN	
amount of receive-channel gain or loss, as selected above*	dB-value positions of front-panel *rcv level* DIP switch*	0.1dB	.1 to IN	
		0.2dB	.2 to IN	
		0.4dB	.4 to IN	
		0.8dB	.8 to IN	
		1.5dB	1.5 to IN	
		3.0dB	3 to IN	
		6.0dB	6 to IN	
		12.0dB	12 to IN	
inclusion or bypass (exclusion) of receive-channel equalizer	*IN/OUT* position of DIP switch *S21* on baby board	equalizer included in circuit	IN	
		equalizer bypassed (excluded)	OUT	
introduction of receive-channel 309B-equivalent equalization (continued on next page)	*SLOPE NL* position of DIP switch *S21* on baby board	nonloaded cable	toward NL	
		loaded cable	away from NL	
	SLOPE 1, 2, 4, 8 positions of DIP switch *S21* on baby board**	degree of slope	SLOPE 1 to 1	
			SLOPE 2 to 2	
			SLOPE 4 to 4	
			SLOPE 8 to 8	

table 6 continued on next page

alignment function	switch	selection	setting	checklist
introduction of receive-channel 309B-equivalent equalization (continued)	*HT 1, 2, 4, 8* positions of DIP switch *S22* on baby board**	height of bump	HT 1 to 1	
			HT 2 to 2	
			HT 4 to 4	
			HT 8 to 8	
	BW 1, 2, 4, 8 positions of DIP switch *S22* on baby board**	affected bandwidth	BW 1 to 1	
			BW 2 to 2	
			BW 4 to 4	
			BW 8 to 8	
selection of transmit-channel flat gain or loss	*GN* and *LS* positions of front-panel *xmt level* DIP switch	gain	GN to IN, LS to OUT	
		loss	GN to OUT, LS to IN	
amount of transmit-channel gain or loss, as selected above*	dB-value positions of front-panel *xmt level* DIP switch*	0.1dB	.1 to IN	
		0.2dB	.2 to IN	
		0.4dB	.4 to IN	
		0.8dB	.8 to IN	
		1.5dB	1.5 to IN	
		3.0dB	3 to IN	
		6.0dB	6 to IN	
		12.0dB	12 to IN	
inclusion or bypass (exclusion) of transmit-channel equalizer	*IN/OUT* position of DIP switch *S24* on baby board	equalizer included in circuit	IN	
		equalizer bypassed (excluded)	OUT	
introduction of transmit-channel 309B-equivalent equalization	*SLOPE NL* position of DIP switch *S24* on baby board	nonloaded cable	toward NL	
		loaded cable	away from NL	
	SLOPE 1, 2, 4, 8 positions of DIP switch *S24* on baby board**	degree of slope	SLOPE 1 to 1	
			SLOPE 2 to 2	
			SLOPE 4 to 4	
			SLOPE 8 to 8	
	HT 1, 2, 4, 8 positions of DIP switch *S25* on baby board**	height of bump	HT 1 to 1	
			HT 2 to 2	
			HT 4 to 4	
			HT 8 to 8	
	BW 1, 2, 4, 8 positions of DIP switch *S25* on baby board**	affected bandwidth	BW 1 to 1	
			BW 2 to 2	
			BW 4 to 4	
			BW 8 to 8	
selection of loopback-path gain or loss	*GN* and *LS* positions of *gain/loss (dB)* DIP switch (*S30*) on baby board	gain	GN to IN, LS to OUT	
		loss	GN to OUT, LS to IN	
amount of loopback-path gain or loss, as selected above*	dB-value positions of *gain/loss (dB)* DIP switch (*S30*) on baby board*	0.1dB	.1 to IN	
		0.2dB	.2 to IN	
		0.4dB	.4 to IN	
		0.8dB	.8 to IN	
		1.5dB	1.5 to IN	
		3.0dB	3 to IN	
		6.0dB	6 to IN	
		12.0dB	12 to IN	

* The eight dB-value positions of the front-panel *rcv level* and *xmt level* DIP switches are cumulative, as are the eight dB-value positions of the loopback-level *gain/loss (dB)* DIP switch (*S30*) on the baby board. Total gain or loss introduced is the sum of those dB-value positions set to *IN*.

** The *1, 2, 4,* and *8* positions of the *SLOPE, HT,* and *BW* receive and transmit equalization DIP switches on the baby board are cumulative. These switch positions may be set in any combination as required.

table 6. Summary and checklist of 6168A alignment switches

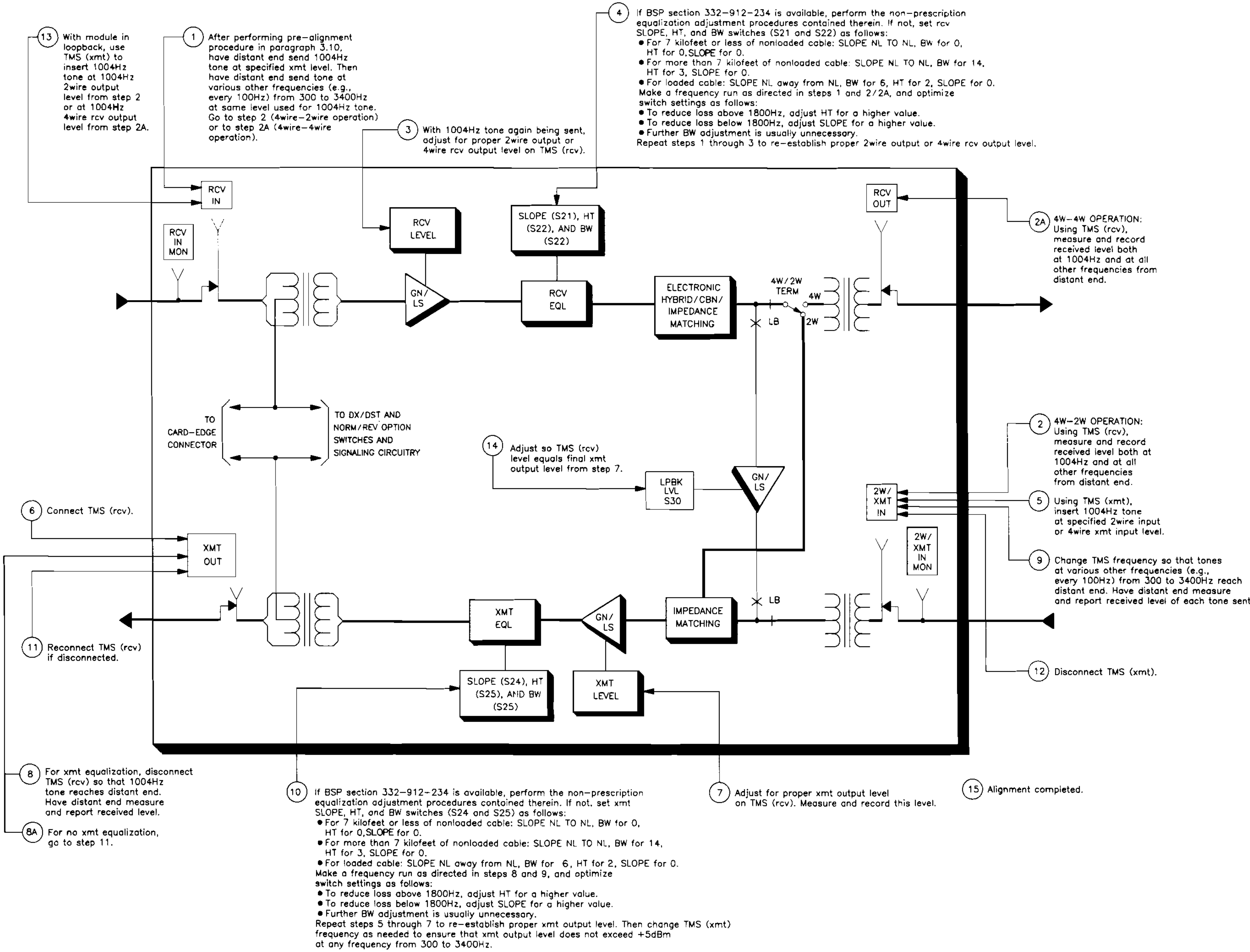


figure 13. Non-prescription alignment procedure for 6168A

4wire receive section
4.02 A transformer at the 4wire receive input port interfaces the transmission facility and derives tip, ring, and simplex leads. The transformer's secondary windings are coupled to a switch-selectable 1200, 600, or 150-ohm *impedance matching* circuit.

4.03 Lightning protection is provided at both facility-side ports. Prescription *receive level* circuitry for level coordination is connected to a *slope/bump-type equalizer* that is functionally equivalent to the Western Electric 309B Prescription Equalizer and that can be electrically bypassed via switch option. The output of the *equalizer* is connected to a driver that drives either the transformer-coupled 4wire receive output port or the integral electronic *hybrid*.

4wire transmit section
4.04 Signals from either the integral electronic *hybrid* or the secondary windings of the transformer interfacing the 4wire transmit input port are coupled to prescription *transmit level* circuitry for level coordination and then to a 309B-equivalent prescription amplitude *equalizer,* which is identical to the receive *equalizer* and can likewise be electrically bypassed via switch option. Switch-selectable 1200, 600, or 150-ohm *impedance matching* circuitry is provided at the 4wire transmit output port. A transformer at the 4wire transmit output port interfaces the transmission facility and derives the tip, ring, and simplex leads.

2wire/4wire section
4.05 The 6168A provides a switch-selectable 2wire or 4wire terminal-side interface. With 2wire interface selected, a switch-selectable 900 or 600-ohm *impedance matching* circuit in series with 2.15μF is available. With 4wire interface selected, however, only the 600-ohm option is available. An electronic *hybrid* provides the 4wire-to-2wire (facility to terminal) conversion. An integral *compromise balance network* (*CBN*) connected to the *hybrid* maximizes transhybrid loss by simulating the 900 or 600-ohm terminal-side (2wire) terminating impedance in series with 2.15μF.

DX signaling
4.06 Both ends of a DX signaling circuit are balanced symmetrical circuits connected by two metallic conductors. One lead in the DX signaling path carries supervisory and pulsing signals consisting of combinations of local ground and battery. Differences in ground or battery potentials between each end of the DX signaling circuit create nonsupervisory currents in this signaling lead. The second lead in the DX circuit acts as a reference for these differences in end-office potentials. The DX signaling unit is arranged so that the unbalance created in the second lead is equal and opposite to that created in the first lead. The current in the second lead cancels the effect of these unwanted potential differences in the first lead, thus compensating for ground-potential or battery-supply variations. Additionally, the circuit is balanced against longitudinal ac line voltages and currents.

4.07 The 6168A, deriving local signaling from currents transmitted over derived metallic simplex leads, connects the signaling to the *DX bridge* circuit, a balanced bridge-type detector that senses differential voltage changes. The input signal is then passed to associated circuitry that eliminates the need for a conventional resistive and capacitive DX balance network. This input signal is directly coupled to an integral *dial-pulse compensator.* The *compensator* introduces a slight delay so that the 6168A ignores spurious signals. Also, to minimize dial-pulse distortion, the *compensator* adjusts for nonsymmetrical switching of the *E&M signaling relay*, which provides the local E-lead output (in the DX1 mode) or the local M-lead output (in the DX2 mode). The *E&M signaling relay* is operated during busy and not operated during idle. Resistor-capacitor contact protection is provided for the relay contacts. Front-panel *fac busy* and *term busy* LED's provide a visible indication of the status of the 6168A's E&M signaling interface.

4.08 At the local end of the DX signaling path, the *E&M signaling interface* circuit determines the state of the local M lead (DX1 mode) or E lead (DX2 mode). These local signals are converted to outgoing DX signals via the *DX driver* circuitry.

4.09 With either 4wire-to-4wire or 4wire-to-2wire operation, the 6168A can, by switch option, function as a DST (transmission-only) module instead of as a DX-to-E&M signaling converter.

loopback
4.10 Both transmission loopback (with either the *DX* or *DST* switch option) and signaling loopback (with only the *DX* switch option) are activated when the *LB relay* operates. This *relay* is controlled by the *loopback detector and control* circuit, which operates the *relay* when any of the following happens:

A. A 2713Hz tone of correct level and duration is detected in the receive path.
B. The external manual loopback lead (pin 18) is grounded.
C. The *ML* position of the *LPBK* switch (*S100*) is closed.

In case A (tone loopback), loopback can be deactivated by either a 2713Hz tone or by automatic timeout circuitry. In case B, if the external manual loopback lead is grounded, the ground must be removed to deactivate loopback. In case C, if the *ML* position of the *LPBK* switch (*S100*) is closed, it must be opened again to deactivate loopback.

4.11 When the module is in loopback, the LB relay contacts disconnect the *hybrid* or the 4wire terminal-side ports from the 6168A circuitry and connect the output of the receive path to the input of the transmit path. Signaling loopback is such that DX signals received at the module are echoed back onto the facility. A front-panel *lpbk* LED lights to indicate that loopback is in effect.

power supply

4.12 The *power supply* in the 6168A is a series-regulated bipolar supply that uses a zener diode to derive a reference source. A diode in series with the negative input lead protects against reversed voltage connections. A front-panel *pwr* LED lights to indicate that power has been applied.

6. specifications

transmission

overload points
transmit path: +8.0dBm
receive path: +8.0dBm

transmission gain or loss, xmt and rcv channels
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

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

amplitude equalization, xmt and rcv channels
active prescription slope or bump-type equalization for nonloaded or loaded cable, functionally equivalent to that provided by the WECo 309B Prescription Equalizer. Each channel's equalizer can be electrically bypassed (excluded) via switch option.

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, with 4wire terminal interface and no equalization (xmt and rcv)
−0.5, +0.2dB, 200 to 300Hz, re 1004Hz
−0.4, +0.3dB, 300 to 3400Hz, re 1004Hz

frequency response, with 2wire terminal interface and no equalization (xmt and rcv)
−2.0, +0.0dB, 200 to 300Hz, re 1004Hz
−0.5, +0.25dB, 300 to 3000Hz, re 1004Hz
−1.25, +0.0dB, 3000 to 3400Hz, re 1004Hz

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

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

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

longitudinal balance (facility side)
greater than 60dB, 200 to 3400Hz

longitudinal balance (terminal side)
greater than 60dB, 200 to 4000Hz

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 30dB

peak-to-average ratio (P/AR)
98 minimum, without equalization

crosstalk loss between xmt and rcv channels (4wire mode)
75dB minimum, 300 to 3200Hz

crosstalk loss between adjacent modules in shelf
75dB minimum, 300 to 3200Hz

DX signaling

DX loop resistance
5000 ohms maximum

dial-pulsing rate accepted
7.5 to 12.0pps

dial-pulse distortion
4 percent maximum

E&M signaling, DX1 mode

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

E-lead resistance
less than 0.5 ohm

M-lead sensitivity
will detect 500 ohms external M-lead resistance from −48Vdc; will not detect −BATT through 20 kilohms

E&M signaling, DX2 mode

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

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

E-lead sensitivity
will detect 500 ohms external E-lead resistance to ground; will not detect GND through 20 kilohms

loopback specifications

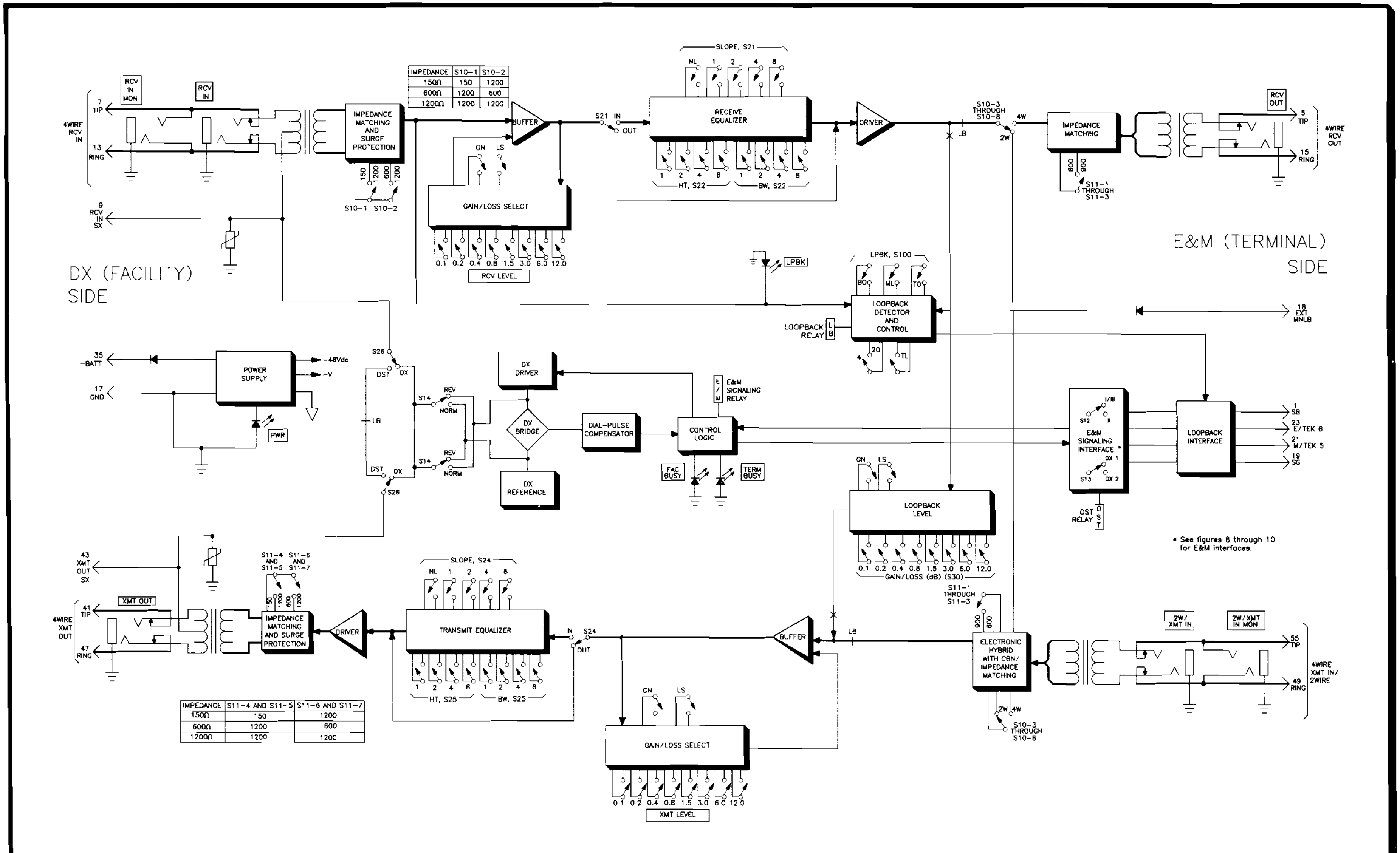
tone-loopback frequency
module will loop back at 2713 ± 7Hz; module will not loop back outside of 2713 ± 37Hz

tone-loopback activation/deactivation level range
−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

specifications continued on page 17



6168A 4Wire-to-4Wire/2Wire DX-to-E&M Terminal Repeater with Loopback **816168A**

5. block diagram

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 24dB of loss in switch-selectable 0.1dB increments, with gain or loss selected via switch option

loopback-path insertion loss
± 0.4dB maximum

power requirements

input power requirements
voltage: −45 to −52Vdc, filtered, positive-ground-referenced
current: 85mA at idle (at −52Vdc), 120mA at busy (at −52Vdc), with an additional 30mA required during loopback

dc earth potential difference
greater than ± 45Vdc

ac induction
greater than 35Vrms

physical

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
13.5 ounces (383 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 NCTE/DST Mounting Assembly.

7. testing and troubleshooting

7.01 The *troubleshooting guide* in this section may be used to assist in the installation, testing, or troubleshooting of the 6168A 4Wire-to-4Wire or 4Wire-to-2Wire DX-to-E&M Terminal Repeater module with Loopback. The guide 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. Unauthorized testing or repairs may void the module's warranty. Also, if the module is part of a registered system, unauthorized repairs will result in noncompliance with Part 68 of the FCC Rules and Regulations.

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

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

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

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

International customers: Contact your Tellabs distributor.

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

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

replacement
7.04 To obtain a replacement module, notify Tellabs via letter or telephone (see addresses and numbers below) or via TWX (910-695-3530 in the USA, 610-492-4387 in Canada). Be sure to provide all relevant information, including the 8X6168A part number that indicates the issue of the module in question. Upon notification, we shall ship a replacement 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'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 carton prepaid to Tellabs.

repair and return
7.05 Return the defective 6168A 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.

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 level	1) Baby-board 4wire or 2wire terminal interface switches (*2W/4W* and *4W/2W* positions of DIP switch *S10*) improperly set. 2) Front-panel *rcv level* DIP switch improperly set. 3) Baby-board receive impedance switches (*150/1200* and *600/1200* positions of DIP switch *S10* and/or *600/900* positions of DIP switch *S11*) improperly set. 4) Baby-board receive equalization DIP switches (*S21* and/or *S22*) 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 2wire-to-4wire) transmission level	1) Baby-board 4wire or 2wire terminal interface switches (*2W/4W* and *4W/2W* positions of DIP switch *S10*) improperly set. 2) Front-panel *xmt level* DIP switch improperly set. 3) Baby-board transmit impedance switches (*600/900, 150/1200,* and *600/1200* positions of DIP switch *S11*) improperly set. 4) Baby-board transmit equalization DIP switches (*S24* and/or *S25*) improperly set. 5) Circuit not seized. 6) Test-equipment impedance improperly set or test equipment not terminated.
improper signaling	1) Incorrect transmission level settings (see preceding trouble condition and possible causes). 2) Main-board *NORM/REV* switch (*S14*) improperly set. 3) Main-board *I(III)/II* E&M signaling interface switch (*S12*) improperly set. 4) Main-board *DX1/DX2* signaling switch (*S13*) improperly set. 5) Main-board *DX/DST* operation switch (*S26*) improperly set. 6) Excessive cable leakage. 7) Excessive longitudinal voltage on facility.
cannot activate or deactivate manual loopback via option switch	1) Ground on EXT MNLB (external manual loopback) lead (pin 18).
cannot activate or deactivate manual loopback via EXT MNLB-lead ground	1) EXT MNLB (external manual loopback) lead (pin 18) improperly wired. 2) Source of ground defective.
cannot activate or deactivate 2713Hz tone loopback	1) Loopback options improperly set; check baby-board *LBK* DIP switch (*S100*). 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	1) Module not in loopback (*lpbk* LED unlit).
cannot derive proper loopback transmission level	1) Loopback level improperly set; check baby-board *gain/loss (dB)* DIP switch (*S30*). 2) Module not in loopback (*lpbk* LED unlit).
cannot derive signaling loopback	1) Module not in loopback (*lpbk* LED unlit). 2) Main-board *DX/DST* operation switch (*S26*) improperly set.