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practice section 826168/826168B/826168C

6168, 6168B, and 6168C 4Wire-to-4Wire or 4Wire-to-2Wire DX-to-E&M Terminal Repeaters

CLEI™ codes: NCC4T562AA, NCC4T552AA, and NCC43902AA, respectively

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1. general description

1.01 The 6168, 6168B, and 6168C 4Wire-to-4Wire or 4Wire-to-2Wire DX-to-E&M Terminal Repeater modules (figure 1) each provide 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 6168, 6168B, and 6168C contain circuitry that eliminates the need for a conventional resistive and capacitive DX balance network. In addition, the 6168B and 6168C contain transmission and signaling loopback circuitry to facilitate local or remote testing of the module and the facility. As members of Tellabs' 262 Network Channel Terminating Equipment/Data Station Termination (NCTE/DST) System of modules and enclosures, the 6168, 6168B, and 6168C each fulfill 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. Table 1 lists the distinguishing features of each of the three modules.

module	receive (post-) equalization	transmit (pre-) equalization	loopback
6168	yes	no	no
6168B	yes	no	yes
6168C	yes	yes	yes

table 1. Distinguishing features of 6168, 6168B, and 6168C modules

1.02 This practice section is reissued to cover the Issue 2 version of the 6168 module (Tellabs part number **826168**) and also to cover the Issue 2 6168B and 6168C modules (Tellabs part numbers **826168B** and **826168C,** respectively). The Issue 2 6168 differs from its Issue 1 predecessor primarily through the deletion of a 900-ohm terminal-side terminating-impedance option in 4wire-to-2wire operation and through simplified switch optioning resulting from a reduction in the number of DIP switches on the module. Because the 6168B and 6168C are based upon the Issue 2 6168, these newer modules also carry Issue 2 part numbers even though they have no Issue 1 counterparts.

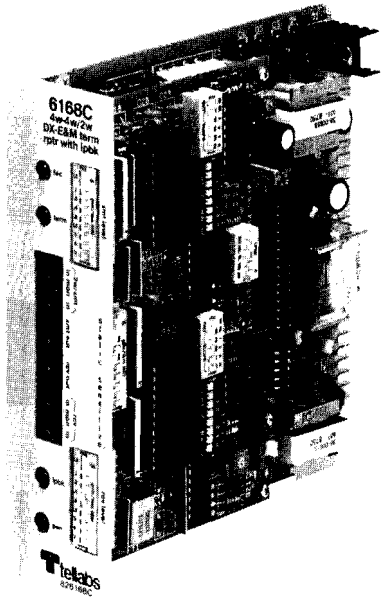

figure 1. 6168C 4Wire-to-4Wire or 4Wire-to-2Wire DX-to-E&M Terminal Repeater module with Loopback

Note: *In those parts of this practice that apply equally to the 6168, 6168B, and 6168C, all three modules are, for convenience, referred to collectively as the* **6168/X.**

1.03 The 6168/X 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 the receive channel of the 6168 and 6168B and in both channels of the 6168C.

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- Equalizer-bypass option switch for the receive channel of the 6168 and 6168B and for each channel of the 6168C.
- Transformer coupling at all transmission 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).
- Switch-selectable 1200, 600, or 150-ohm terminating impedance at both facility-side ports. side ports.
- Fixed, balanced 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 600-ohm impedance 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.
- 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 typical busy current requirements (at −52Vdc) of 80mA for the 6168, 90mA for the 6168B, and 95mA for the 6168C.
- 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 6168/X 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.
- 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 6168B and 6168C modules 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 6168/X 4Wire-to-4Wire or 4Wire-to-2Wire DX-to-E&M Terminal Repeater module is used to terminate a DX signaling facility to an E&M tie trunk. The 6168/X 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 6168/X 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. Integral transmission and signaling loopback circuitry in the 6168B and 6168C permits testing of both the module and the facility from a local or remote location.

2.02 The 6168/X 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 6168/X.

2wire terminal interface and balance network

2.03 When optioned for 2wire terminal interface, the 6168/X interfaces the local 2wire E&M trunk or line via its integral electronic hybrid terminating set. This hybrid provides fixed, balanced 600-ohm terminating impedance (in series with 2.15μF) at the 2wire port for interface primarily 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 600-ohm impedance in series with 2.15μF of capacitance.

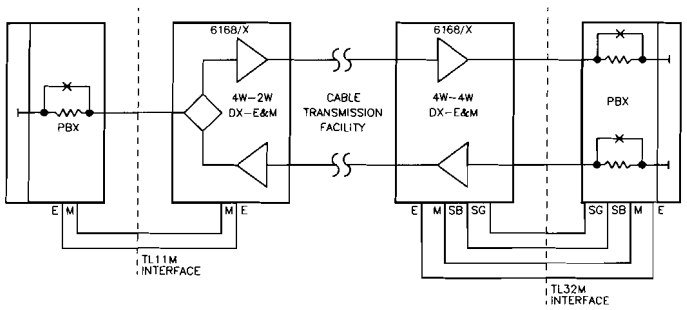


figure 2. Typical short-haul tie-trunk circuit using 6168/X module

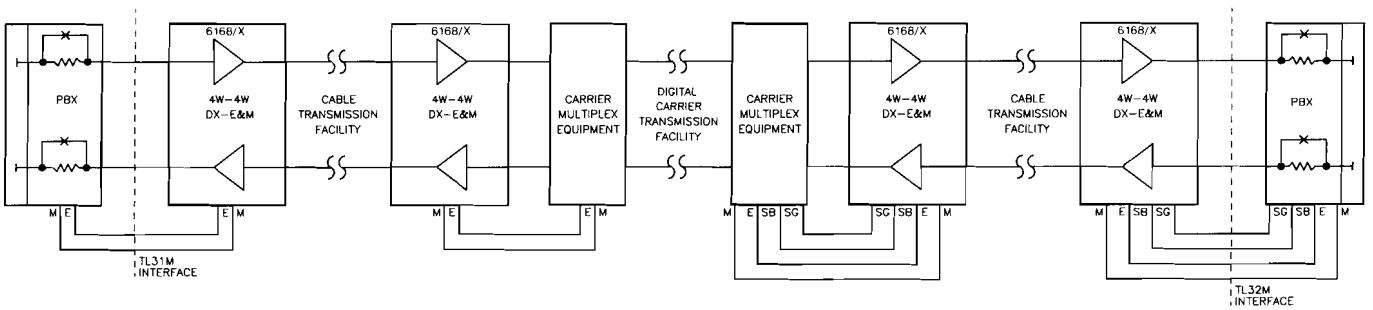


figure 3. Typical long-haul tie-trunk circuit using 6168/X module

4wire terminal interface

2.05 When optioned for 4wire terminal interface, the 6168/X 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 for interface primarily with nonloaded cable or 600-ohm equipment (e.g., a PBX).

facility (4wire) interface

2.06 On its facility side, the 6168/X interfaces the 4wire DX signaling facility via transformers at the 4wire transmit output and 4wire receive input ports and via prescription amplifiers in the transmit and receive paths (see paragraph 2.08). These transformers provide balanced, switch-selectable 1200, 600, or 150-ohm terminating impedances. 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 nonloaded cable through the deliberate impedance mismatch.

2.07 Both facility-side transformers are center-tapped to derive balanced 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 6168/X block diagram, section 5 of this practice). In the normal arrangement, the signaling lead of the 6168/X'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 6168/X 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 6168/X'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 6168/X 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*.

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 channel of the 6168, 6168B, and 6168C for post-equalization of the facility-side receive pair. This same type of equalization is also available in the transmit channel of the 6168C for pre-equalization of the facility-side transmit pair. These equalizers provide low-end slope equaliza-

tion 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.

2.10 Figures 4 and 5 show typical response curves for the 309B-equivalent equalizers 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 2.

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

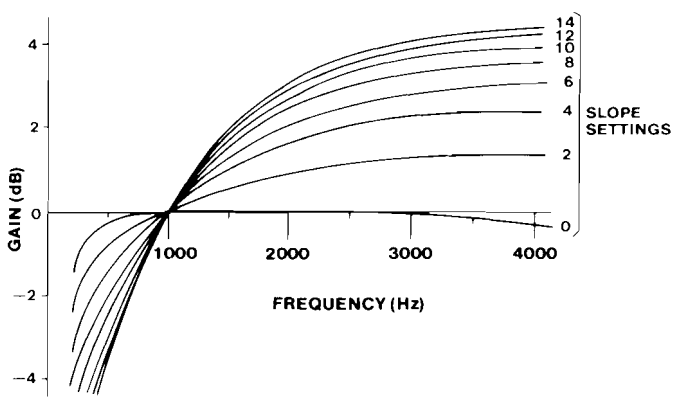


figure 4. Typical response curves for receive equalizer in slope mode, nonloaded cable

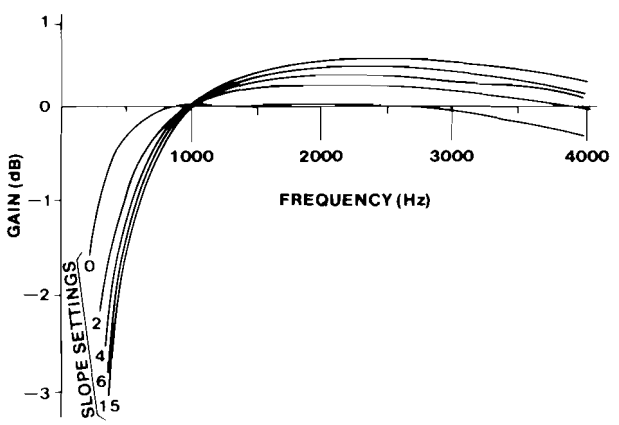


figure 5. Typical response curves for receive equalizer in slope mode, loaded cable

2.11 Figures 6 and 7 show typical response curves for the 309B-equivalent equalizers 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 *HT* and *BW* switch settings selected. These amounts are listed in table 3.

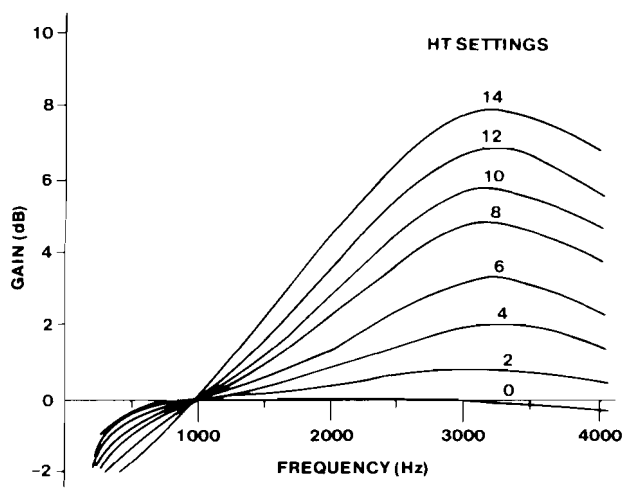


figure 6. Typical response curves for receive equalizer in bump mode, BW switch = 14

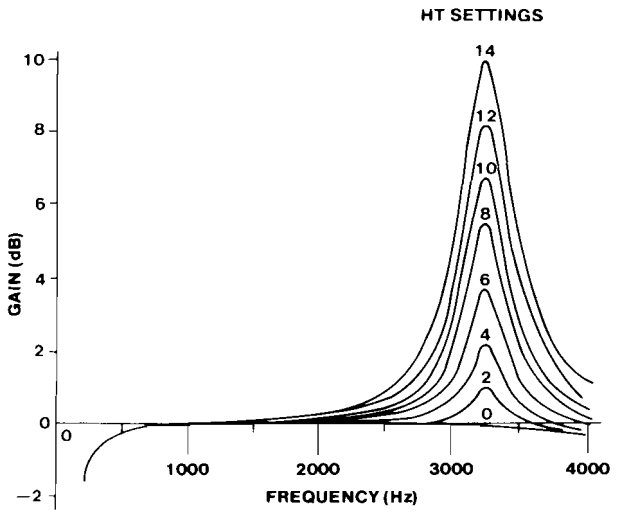


figure 7. Typical response curves for receive equalizer in bump mode, BW switch = 3

DX signaling loop limits

2.12 For proper DX signaling operation, total resistance of the DX signaling loop between the 6168/X 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 6168/X 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 6168/X 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 6168/X is optioned for DX1 operation. If the terminal equipment provides E-lead outputs and receives M-lead inputs, the 6168/X is optioned for DX2 operation.

E&M signaling interfaces

2.15 The 6168/X 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 4 summarizes these codes and the DX1/DX2 signaling and E&M interface options required for each.

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

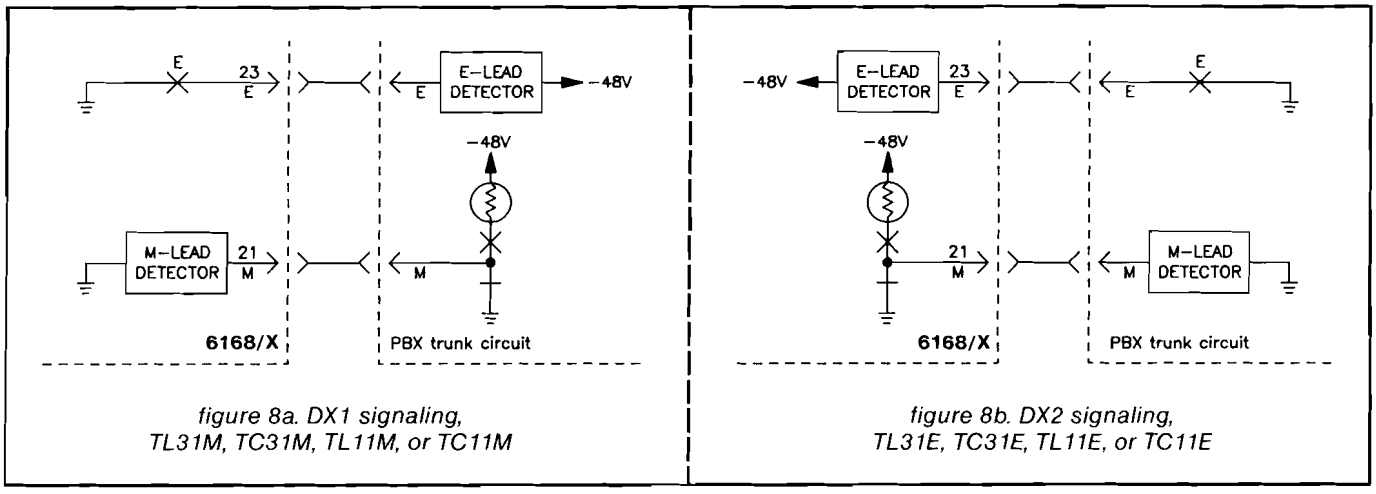


figure 8a. DX1 signaling, TL31M, TC31M, TL11M, or TC11M

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

figure 8. Type I E&M interface arrangements

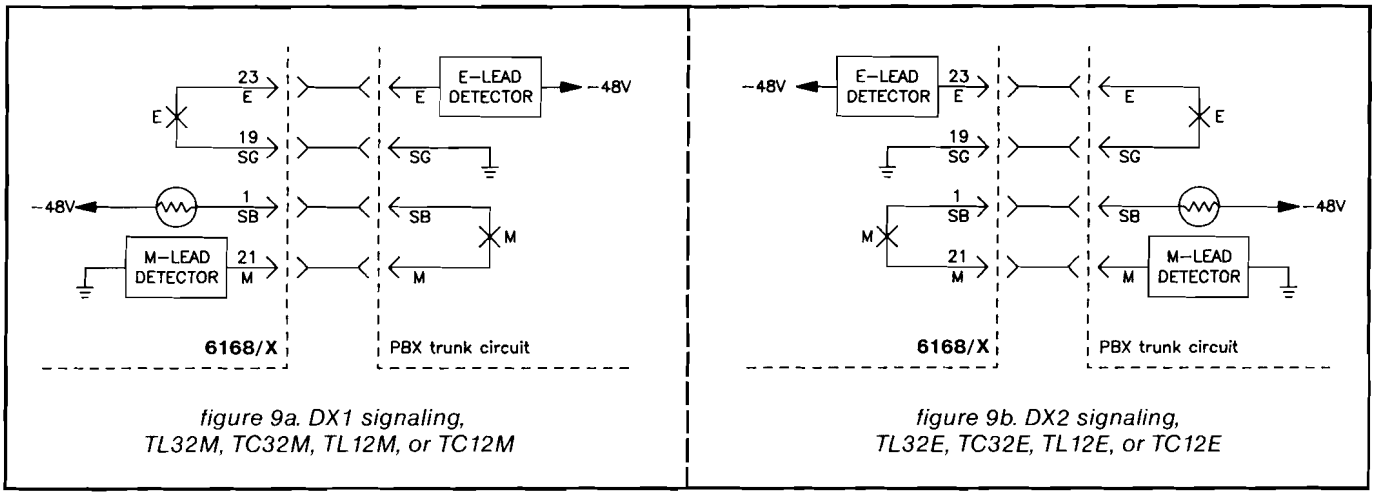


figure 9a. DX1 signaling, TL32M, TC32M, TL12M, or TC12M

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

figure 9. Type II E&M interface arrangements

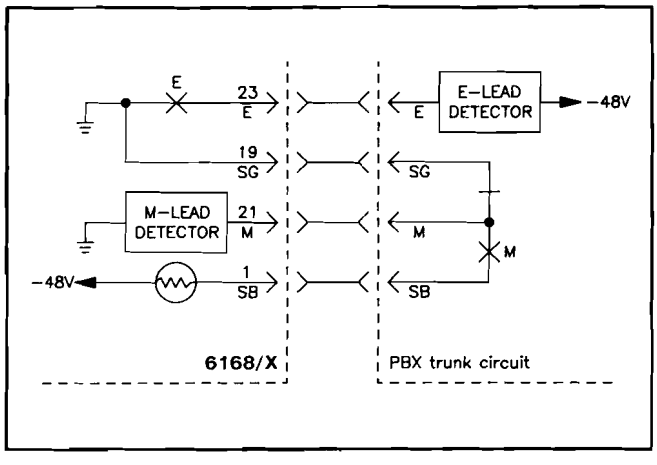


figure 10. DX1 signaling, Type III E&M interface arrangement

Registered Facility Interface Code	E&M interface	DX signaling arrangement*	6168/X 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 4. E&M interface and signaling options for Registered Facility Interface Codes fulfilled by 6168/X

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 6168/X 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.

power

2.18 The 6168/X 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. Typical busy current required (at −52Vdc) is 80mA for the 6168, 90mA for the 6168B, and 95mA for the 6168C. If the 6168B's or 6168C's loopback option is activated, an additional 30mA is required.

loopback (6168B and 6168C only)

2.19 **Overview.** Integral facility-side transmission and signaling loopback circuitry in the 6168B and 6168C 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 6168B or 6168C to busy out its terminal side during loopback (see paragraph 2.23). Figure 11 shows, in simplified form, the transmission and signaling loopback paths through the 6168B and 6168C modules. A front-panel *lpbk* LED lights whenever either module is in the loopback mode.

2.20 Transmission loopback in the 6168B or 6168C 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

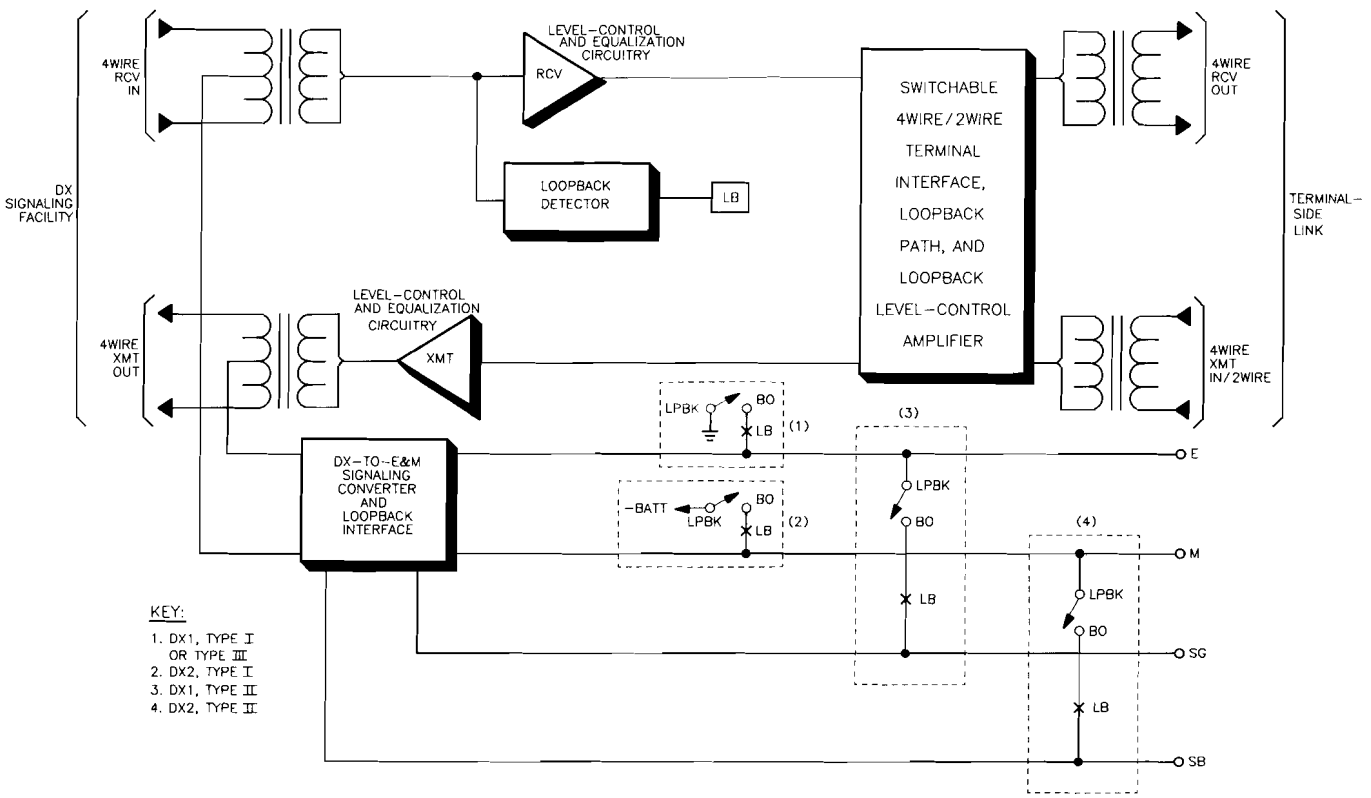


figure 11. Loopback route through 6168B and 6168C modules

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.

2.21 Signaling loopback allows the 6168B's or 6168C's DX-to-E&M signaling converter circuitry and E-lead/M-lead 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.

2.22 If the 6168B's or 6168C'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 signaling-state change toward the distant DX unit.

2.23 The terminal-side busy-out switch option on the 6168B or 6168C, 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.

2.24 **Local (Manual) Loopback Activation and Deactivation.** Two methods of local loopback activation are available for the 6168B and 6168C:

- Setting the *ML* position of each module's loopback DIP switch (*S23*) toward *ML*.
- Connecting each 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.

2.25 **Remote (Two-Tone) Loopback Activation and Deactivation.** Remote (two-tone) loopback in the 6168B and 6168C is enabled via switch option and activated by placing a 2713Hz tone on the 4wire receive input pair (pins 7 and 13) 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 6168B and 6168C 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 6168/X 4Wire-to-4Wire or 4Wire-to-2Wire DX-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 6168/X 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 6168/X 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 6168/X 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 6168/X 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 5 lists external connections to the 6168/X 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	23
M lead	21
SB (signal battery)**	1
SG (signal ground)**	19
EXT MNLB (external manual loopback, 6168B and 6168C only)	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 5. External connections to 6168/X

option selection

3.06 Several option switches must be set before the 6168/X 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 6 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 6, and set each option switch on the 6168/X as required.

Note: *The three signaling switches (***S49, S50,** *and* **S41***) on the module's main board should be set as required* **before** *power is applied to the module.*

alignment overview

3.07 Alignment of the 6168/X 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 (6168C only).
E. Adjusting the loopback-path level (6168B and 6168C only).

prescription alignment

3.08 Prescription alignment of the 6168/X 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 7 in this practice summarizes all alignment switches on the 6168/X 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 6168/X by setting each switch as indicated in the table (or on the CLR, if preferred).

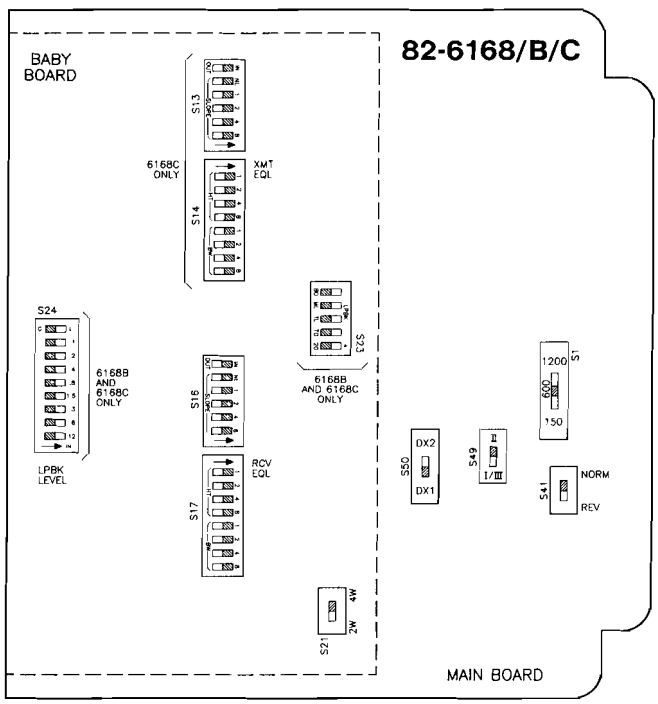


figure 12. 6168/X option switch locations

equipment required for non-prescription alignment

3.09 In applications where prescription alignment settings are unavailable, non-prescription alignment of the 6168/X 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 6), especially those that select terminating impedances and 4wire or 2wire terminal interface, are properly set. For the 6168B or 6168C, 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.

option	switch	selection	setting	checklist
terminating impedance, 4wire receive input and transmit output ports (facility side)	*S1* on main board	1200 ohms (for loaded cable)		
		600 ohms (for nonloaded cable or carrier)		
		150 ohms (extra equalization for nonloaded cable)		
2wire or 4wire terminal-side interface*	*S21* on baby board	2wire interface		
		4wire interface		
Note: *The next three switches (***S49, S50,** *and* **S41***) 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	*S49* 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**	*S50* on main board	DX1 operation	DX1	
		DX2 operation	DX2	
normal or reverse facility-side simplex leads***	*S41* on main board	normal SX leads	NORM	
		reverse SX leads	REV	
Note: *The following five* **loopback** *switch options are available on the 6168B and 6168C modules only.*				
busying out of module's terminal side (E&M leads) during loopback †	*BO* position of *S23* (*LPBK* DIP switch) on baby board	busy out	toward BO	
		no busy out	away from BO	
manual loopback activate/deactivate	*ML* position of *S23* (*LPBK* DIP switch) on baby board	manual loopback activated	toward ML	
		manual loopback deactivated	away from ML	
tone loopback enable/disable † †	*TL* position of *S23* (*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 *S23* (*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 *S23* (*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 600 ohms in series with 2.15μF.

** In DX1 operation, the 6168/X receives M-lead signals and sends E-lead signals on the terminal side. In DX2 operation, the 6168/X 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 *S41*.

† 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 *S23* (*LPBK* DIP switch) are nonfunctional. With tone loopback enabled but tone-loopback timeout disabled, the *4/20* position of *S23* is nonfunctional.

table 6. Summary and checklist of 6168/X switch options

C. Set to *OUT* the *IN/OUT* position of the baby-board receive and (on 6168C only) transmit *SLOPE* equalization switches (*S16* and *S13*, respectively) for no equalization.
D. On the 6168B or 6168C, set the baby-board loopback-level-control DIP switch (*S24*) for no gain or loss.

non-prescription alignment

3.11 Align the 6168/X 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.*

alignment function	switch	selection	setting	checklist
selection of receive-channel flat gain or loss	*GN/LS* position of front-panel *rcv level* DIP switch	gain	GN	
		loss	LS	
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 *S16* on baby board	equalizer included in circuit	IN	
		equalizer bypassed (excluded)	OUT	
introduction of receive-channel 309B-equivalent equalization	*SLOPE NL* position of DIP switch *S16* on baby board	nonloaded cable	toward NL	
		loaded cable	away from NL	
	SLOPE 1, 2, 4, 8 positions of DIP switch *S16* 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 *S17* 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 *S17* 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* position of front-panel *xmt level* DIP switch	gain	GN	
		loss	LS	
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	

table 7 continued on next page

alignment function	switch	selection	setting	checklist
Note: *The following two* **transmit-channel equalization** *alignment functions are available on the 6168C module only.*				
inclusion or bypass (exclusion) of transmit-channel equalizer	*IN/OUT* position of DIP switch *S13* 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 *S13* on baby board	nonloaded cable	toward NL	
		loaded cable	away from NL	
	SLOPE 1, 2, 4, 8 positions of DIP switch *S13* 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 *S14* 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 *S14* on baby board**	affected bandwidth	BW 1 to 1	
			BW 2 to 2	
			BW 4 to 4	
			BW 8 to 8	
Note: *The following two* **loopback** *alignment functions are available on the 6168B and 6168C modules only.*				
selection of loopback-path gain or loss	*GN/LS* position of DIP switch *S24* on baby board	gain	GN	
		loss	LS	
amount of loopback-path gain or loss, as selected above*	dB-value positions of DIP switch *S24* 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 all eight dB-value positions of the loopback-level *gain/loss (dB)* DIP switch (*S24*) on the baby board of the 6168B and 6168C. 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 (for 6168C only) transmit equalization DIP switches on the baby board are cumulative. These switch positions may be set in any combination as required.

table 7. Summary and checklist of 6168/X alignment switches

4. circuit description

4.01 This circuit description is intended to familiarize you with the 6168/X 4Wire-to-4Wire or 4Wire-to-2Wire DX-to-E&M Terminal Repeater module 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 6168/X block diagram (section 5 of this practice) will aid in understanding the circuit description.

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

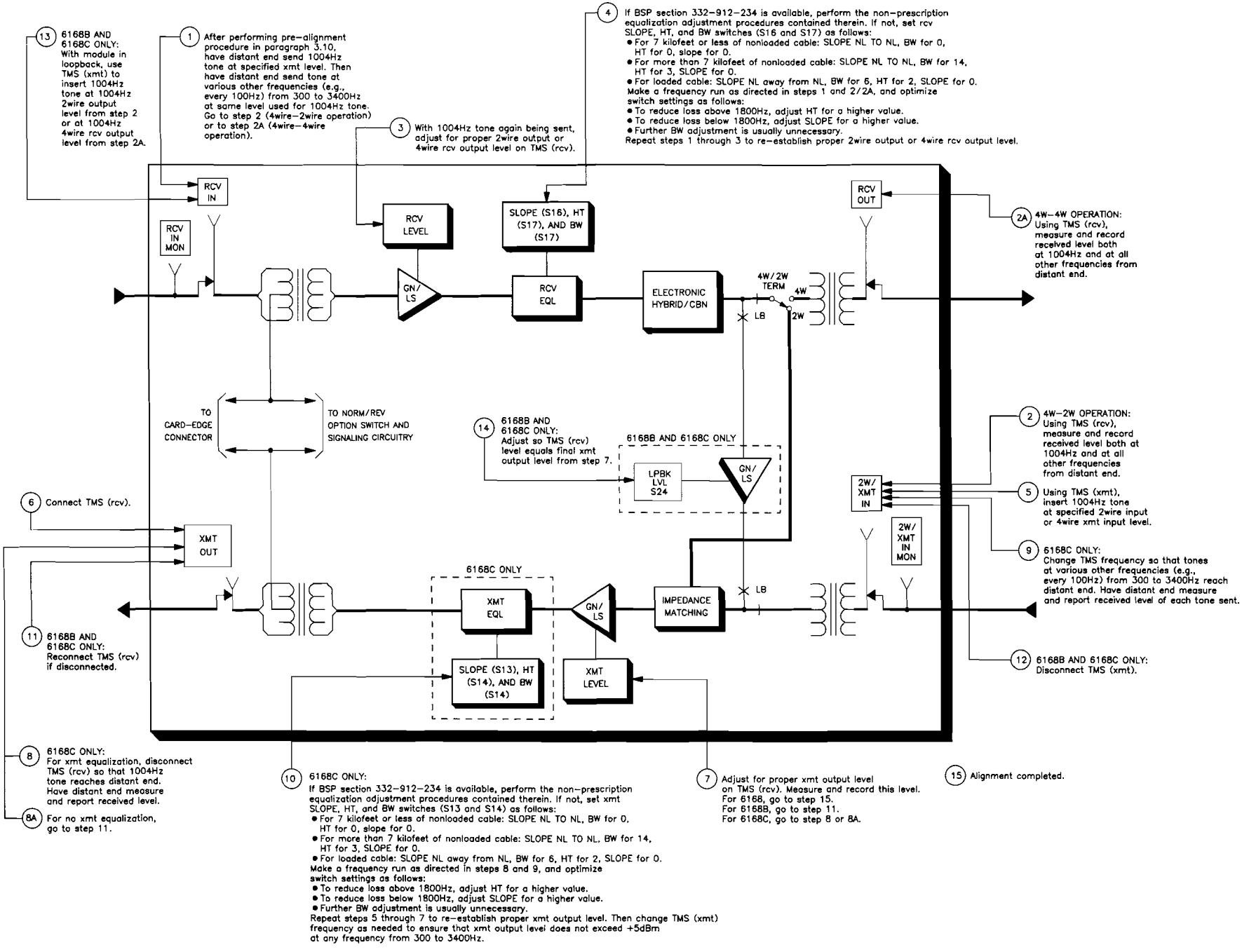


figure 13. Non-prescription alignment procedure for 6168/X

level coordination and then, for the 6168C only, to a 309B-equivalent prescription amplitude *equalizer.* This transmit *equalizer* 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 6168/X provides a switch-selectable 2wire or 4wire terminal-side interface. With 2wire interface selected, terminating impedance at the 2wire port is fixed at 600 ohms, balanced, in series with 2.15μF. With 4wire interface selected, terminating impedance at each 4wire port is likewise fixed at 600 ohms, balanced. 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 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 6168/X, 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 6168/X 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 6168/X'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.

loopback (6168B and 6168C only)

4.09 Both transmission loopback and signaling loopback in the 6168B and 6168C 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 (*S23*) 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 (*S23*) is closed, it must be opened again to deactivate loopback.

4.10 When the 6168B or 6168C is in loopback, the *LB relay* contacts disconnect the *hybrid* or the 4wire terminal-side ports from the module's internal circuitry and connect the output of the receive path to the input of the transmit path. Signaling loopback operates 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

4.11 The *power supply* in the 6168/X 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 is applied.

6. specifications

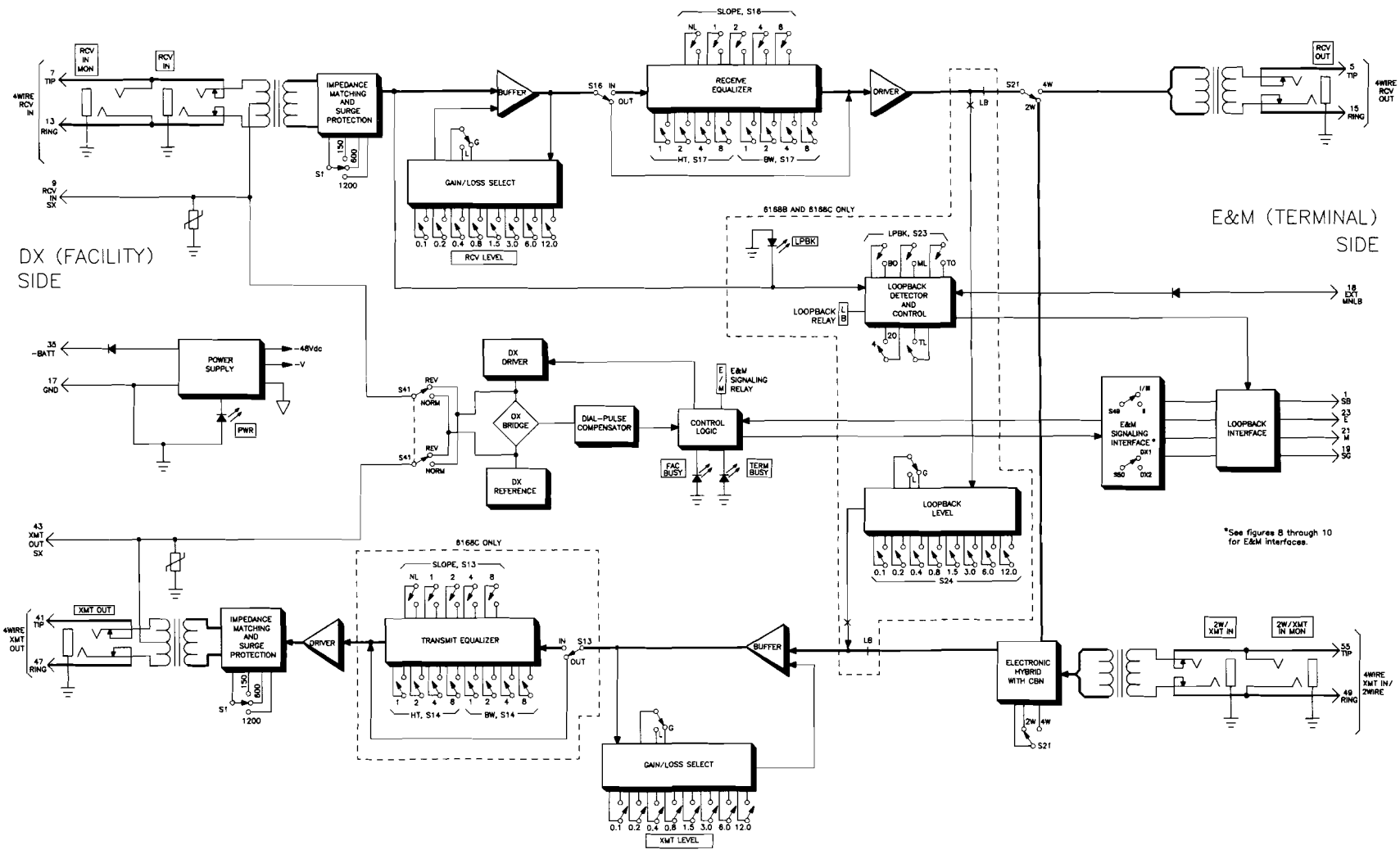
transmission

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

specifications continued on page 16



6168, 6168B, and 6168C 4Wire-to-4Wire or 4Wire-to-2Wire DX-to-E&M Terminal Repeaters **826168/826168B/826168C**

5. block diagram

amplitude equalization, rcv and (for 6168C only) xmt 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, switch-selectable

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

2wire terminal interface: 600 ohms, fixed, balanced, in series with 2.15μF

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
600 ohms in series with 2.15μF

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 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, 6168B and 6168C only

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

tone-loopback activation/deactivation
−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 ±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 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, 6168 (at −52Vdc): 75mA maximum at idle, 110mA maximum when busy
current, 6168B (at −52Vdc): 80mA maximum at idle, 117mA maximum when busy, with an additional 30mA required during loopback
current, 6168C (at −52Vdc): 85mA maximum at idle, 120mA maximum when busy, 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
6168: 11.3 ounces (287 grams)
6168B: 12.9 ounces (328 grams)
6168C: 13.6 ounces (345 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 to assist in the installation, testing, or troubleshooting of the 6168/X 4Wire-to-4Wire or 4Wire-to-2Wire DX-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 Northeast	(203)798-0506	Danbury, CT
US Capital	(703)359-9166	Washington, D
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)858-2058.

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 60532-1698
telephone (312)969-8800

in Canada:
Tellabs Communications Canada, Ltd.
2433 Meadowvale Boulevard
Mississauga, Ontario, Canada L5N 5S2
telephone (416)858-2058

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

text continued on page 18; troubleshooting guide on page 19

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. The defective equipment must be received within 30 days of the replacement's ship date. When we receive the defective equipment, a credit will be issued, leaving a balance due on the replacement's invoice that reflects only the express service and/or out-of-warranty charges, if any. Returns received more than 30 days after the replacement's ship date **will not be accepted for credit** but instead will be returned to you, thereby rendering the replacement's invoice due and payable. Please note that OEM, modified, and manufacture-discontinued equipment is not available via overnight express service.

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-side interface switch (*S21*) improperly set. 2) Front-panel *rcv level* DIP switch improperly set. 3) Main-board facility-side impedance switch (*S1*) improperly set. 4) Baby-board receive equalization DIP switches (*S16* and/or *S17*) 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-side interface switch (*S21*) improperly set. 2) Front-panel *xmt level* DIP switch improperly set. 3) Main-board facility-side impedance switch (*S1*) improperly set. 4) For 6168C only, baby-board transmit equalization DIP switches (*S13* and/or *S14*) 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 (*S41*) improperly set. 3) Main-board *I(III)/II* E&M signaling interface switch (*S49*) improperly set. 4) Main-board *DX1/DX2* signaling switch (*S50*) improperly set. 5) Excessive cable leakage. 6) Excessive longitudinal voltage on facility.
cannot deactivate manual loopback via option switch (6168B and 6168C only)	1) Ground on EXT MNLB (external manual loopback) lead (pin 18).
Cannot activate or deactivate manual loopback via EXT MNLB-lead ground (6168B and 6168C only)	1) EXT MNLB (external manual loopback) lead (pin 18) improperly wired. 2) Source of ground defective.
cannot activate or deactivate 2713Hz tone loopback (6168B and 6168C only)	1) Loopback options improperly set; check baby-board *LPBK* DIP switch (*S23*). 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 (6168B and 6168C only)	1) Module not in loopback (*lpbk* LED unlit).
cannot derive proper loopback transmission level (6168B and 6168C only)	1) Loopback level improperly set; check baby-board *loopback-level* DIP switch (*S24*). 2) Module not in loopback (*lpbk* LED unlit).
cannot derive signaling loopback (6168B and 6168C only)	1) Module not in loopback (*lpbk* LED unlit).