tellabs
technical manual
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rev A

practice section 826044A

6044A 4W-4W DX Network Terminating Module w/Loopback

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1. general description

1.01 The Tellabs 6044A 4W-4W DX Network Terminating Module with Loopback (figure 1) provides transmission interface and signaling conversion between a 4wire PBX tie trunk or a carrier channel and a 4wire metallic facility. This module provides level control (loss and gain) in the transmit and receive channels, active slope equalization for loaded or nonloaded cable in the receive channel, and extended-range E&M (DX) signaling. Specifically, the 6044A provides DX signaling over simplex leads derived from the 4wire facility, conversion between that DX signaling and terminal-side E&M signaling, and extension of this E&M signaling toward the 4wire termination. The 6044A provides switch-selectable DX1 or DX2 operation with a choice of either Type I, Type II, or Type III E&M-lead interfacing (see paragraph 1.07). The loopback feature of the 6044A provides both transmission-lead and signaling-lead loopback for remote testing of the module as well as the associated transmission facility. A member of Tellabs' 262U Universal Network Terminating System of modules and enclosures, the 6044A fulfills Registered Facility Interface Codes TC31E, TC31M, TC32E, TC32M, TL31E, TL31M, TL32E, and TL32M for applications where the serving telephone company uses facility-side DX signaling.

1.02 In the event that this Practice section is reissued, the reason for reissue will be stated in this paragraph.

1.03 The 6044A's transmit and receive amplifiers each provide from −18 to +16dB of continuously adjustable gain. Maximum output level of each channel is +12dBm, with no more than 1% distortion.

1.04 Active slope equalization is available in the module's receive channel to compensate for the frequency response characteristics of loaded or nonloaded cable. The module's equalizer can be continuously adjusted from essentially flat (±0.5dB, 300 to 4000Hz, re 1000Hz) to 7.5dB (at 2804Hz, re 1000Hz) via a front-panel control.

1.05 Impedance-matching transformers facing the 4wire facility can be independently switch-optioned for balanced 1200-, 600-, or 150-ohm terminating impedances. These transformers are center-tapped to derive simplex leads required for DX signaling; a switch option permits normal or reversed operation of these leads. Fixed, balanced 600-ohm terminating impedance is provided at the module's terminal-side ports; balanced simplex leads are also derived at these ports.

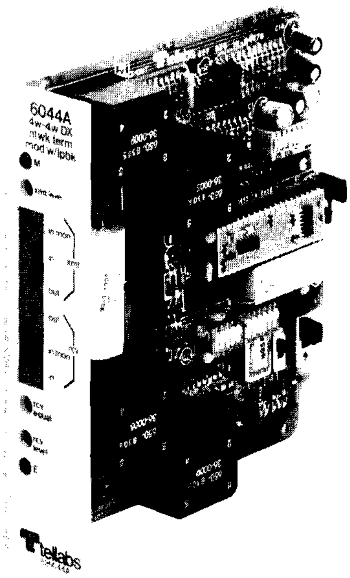


figure 1. 6044A 4W-4W DX Network Terminating Module with Loopback

1.06 The 6044A contains a low-power electronic DX set designed for end-to-end use with conventional relay-type DX sets or other electronic units. Signaling range of the 6044A is 5000 ohms of external loop resistance.

1.07 The 6044A can be switch optioned for DX1 or DX2 operation. With DX1 operation, M-lead signals are input to and E-lead signals are output from the module. With DX2, E-lead signals are input to and M-lead signals are output from the module. Either Type I, II, or III E&M lead interfacing (see figures 3 through 5 in section 2 of this Practice) can also be switch-selected. Please note that while the Type I and II interfaces can be used with either DX1 or DX2 operation, the Type III interface can **only** be used with DX1.

1.08 The 6044A incorporates a resistive and capacitive DX balance network. This network can be switch-optioned to provide up to 6750 ohms of balancing resistance (in 250-ohm increments) and up to approximately 7μF of capacitive balance (4μF of fixed capacitance, plus an additional 3μF in switch-selectable 1μF increments).

1.09 The 6044A contains integral loopback circuitry that loops 4wire receive input signals back to the 4wire transmit output port for testing of signaling and transmission within the module and also on the associated transmission facility. A prescription loopback-level-control circuit introduces from 0 to 23dB of loss or gain into the loopback path in switch-selectable increments (23dB loss; 0.5, 1.5, 3, 6, and 12dB gain) to provide true equal-level loopback. Loopback can be activated and deactivated manually via a DIP switch on the 6044A's loopback subassembly. Loopback can also be activated remotely by applying nominal 2713Hz tone to the facility-side 4-wire receive input pair. With tone-activated loopback, switch options provide a choice of three different methods of loopback deactivation: application of a second 2713Hz tone, automatic deactivation after a 2.6-minute timeout, or automatic deactivation after a 20.8-minute timeout. In either of the timeout deactivation modes, loopback can also be deactivated prior to timeout by applying 2713Hz tone. Another loopback-related switch option conditions the 6044A to busy out the associated terminal equipment (with DX1 signaling and Type I E&M interface only) during loopback to prevent the trunk circuit or line circuit from being inadvertently seized.

1.10 The front panel of the 6044A is designed so that all level and equalization adjustments can be made while the module is mounted in place. Continuously adjustable level and equalization controls are complemented by a complete set of bantam-type test jacks. Opening jacks at all four ports (transmit and receive input and output) face the module, while bridging jacks are provided at the transmit and receive input ports. Front-panel LED's light to indicate seizure in either direction, i.e., to indicate local E-lead and M-lead status.

1.11 A dial-pulse trimming control allows receive dial-pulse make-break ratios to be adjusted for optimum performance. The 6044A accommodates dial pulsing speeds from 8 to 14 pulses per second (pps).

1.12 The 6044A operates on filtered, ground-referenced −44 to −56Vdc input. At idle, maximum current requirement is 40mA (during DX1 operation) or 45mA (during DX2 operation); busy-state maximum current requirement is 85mA.

1.13 A Type 10 module, the 6044A mounts in one position of a Tellabs Type 10 Mounting Shelf, versions of which are available for relay-rack or apparatus-case installation. In relay-rack applications, up to 12 modules can be mounted across a 19-inch rack, while up to 14 modules can be mounted across a 23-inch rack. In either case, 6 inches of vertical rack space is used.

1.14 A member of Tellabs' 262U Universal Network Terminating System of modules and enclosures the 6044A can also be mounted in any of Tellabs' prewired 262U System Assemblies, vertions of which are available for both relay-rack and apparatus-case installation.

2. application

2.01 The 6044A 4W-4W DX Network Terminating Module with Loopback provides transmission interface and signaling conversion between a 4wire metallic facility using DX signaling and a 4wire PBX tie trunk using E&M signaling or a carrier channel (figure 2). This module combines the functions of a 4wire line amplifier and an E&M-to-DX signaling converter. In applications where the serving telephone company uses DX signaling, the 6044A fulfills Registered Facility Interface Codes TC31E, TC31M, TC32E, TC32M, TL31E, TL31M, TL32E, and TL32M.

2.02 Gain or loss in the transmit and receive channels of the 6044A is continuously adjustable from −18 to +16dB via front-panel controls. Maximum output level of each channel is +12dBm, with no more than 1% distortion.

2.03 Up to 7.5dB of slope equalization at 2804Hz (re 1000Hz) is available in the receive channel of the 6044A to compensate for the frequency-response characteristics of loaded or nonloaded cable. Because the transmit channel is generally used to coordinate levels rather than to reduce facility loss, no transmit equalization capability is provided.

2.04 A switch-selectable choice of 1200, 600, or 150-ohm terminating impedance at both facility-side ports (transmit output and receive input) allows the 6044A to interface loaded cable (1200

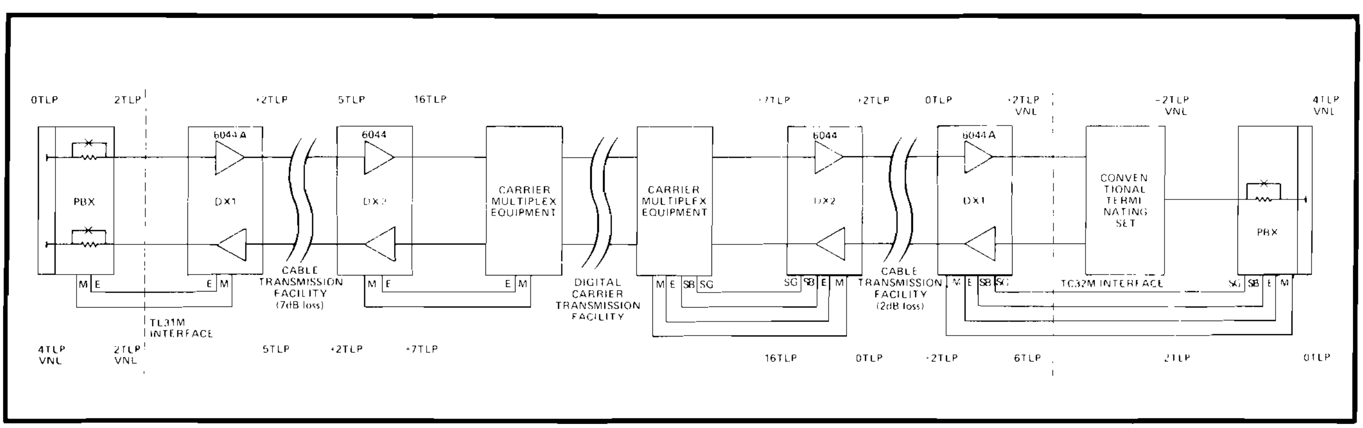


figure 2. Typical long-haul tie-trunk circuit using 6044 and 6044A Network Terminating Modules

ohms) or non-loaded cable (600 or 150 ohms) at these ports. *The 150-ohm option presents a deliberate impedance mismatch that yields a small amount of slope equalization for nonloaded cable.* Fixed, balanced 600-ohm impedance is provided at the module's terminal-side ports (transmit input and receive output).

2.05 Impedance-matching transformers at the 6044A's facility-side ports are center-tapped to derive simplex leads required for DX signaling. A reverse/normal option switch can be used to reverse the reference and signal assignments applied, respectively, to the B lead (receive pair) and the A lead (transmit pair). This reversal option is used in tandem applications of DX sets. The DX module at one end of the circuit is optioned for *REV* and the DX module at the other end is optioned for *NORM.* It does not matter at which end of the circuit the reversal takes place.

2.06 Balanced simplex leads are also derived at the module's terminal-side ports, thereby allowing the 6044A to be used with any of Tellabs' 610X Loop-to-E&M Signaling Converter modules to derive a two-module FXO, FXS, or ringdown circuit.

2.07 The 6044A operates in either the DX1 mode (M-lead input, E-lead output) or the DX2 mode (E-lead input, M-lead output). The DX2 mode is generally used in tandem applications of DX sets, in applications where the 6044A interfaces carrier or other signaling sets, or in other applications where a terminal-side E&M interface must be provided. Both DX1 and DX2 operation eliminate the need for a pulse-link repeater in applications where the 6044A interfaces carrier or in tandem DX-set applications. Type I, II, or III E&M-lead interfacing can be switch-selected (see figures 3 through 5). The Type I and II interfaces can be used with either DX1 or DX2 operation; the Type III interface is **only** used with DX1. In general, Type I is used with elec-

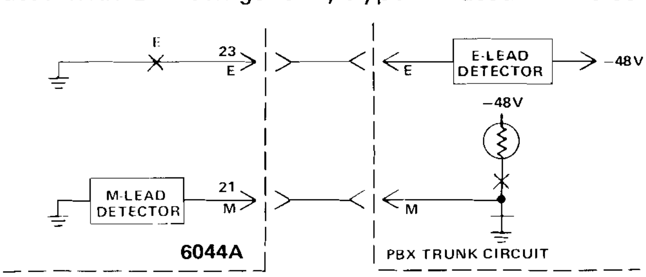


figure 3. Type I E&M interface

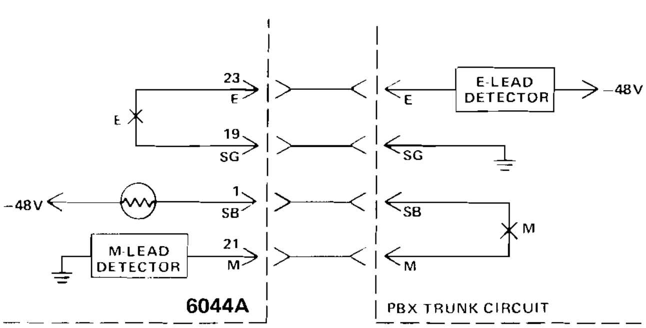


figure 4. Type II E&M interface

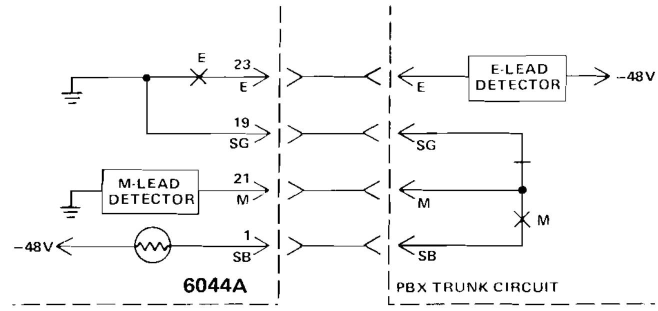


figure 5. Type III E&M interface

tromechanical switching systems while Type II and III are used in electronic switching environments.

2.08 With Type I interfacing, incoming and outgoing signaling each consists of the presence of either ground, battery, or an open condition on the E and M leads. With Type II operation, incoming signaling consists of a contact closure between the M lead and the MB/SB (M-lead-battery/signal-battery) lead, while outgoing signaling consists of a contact closure between the E lead and the EG/SG (E-lead ground/signal-ground) lead. The Type III interface is a compromise: a partially looped format, essentially identical to the Type I interface with the exception that battery and ground for M-lead signaling are supplied via the SB and SG leads, respectively. 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).

2.09 The 6044A uses relay contacts to derive E-lead and M-lead signaling, thereby facilitating interfacing with nonstandard E-lead and M-lead voltage levels and polarities. When the 6044A is used to derive a Type II interface, terminal-side equipment can use any convenient voltage or polarity.

2.10 As with loop-signaling equipment, current requirements for DX sets depend upon loop length. In addition, these requirements depend upon the differences of voltage and ground between DX sets. A DX set draws its maximum current when it is busy and the distant-end DX set is idle. Under these conditions, the 6044A draws 70mA (85mA maximum) on a 0-ohm loop. As loop length increases current requirements drop. On a 1000-ohm loop, the 6044A draws 55mA (70mA maximum); on a 5000-ohm loop, current requirement is 35mA (55mA maximum).

2.11 In general, a DX unit must be resistively balanced against the resistance of the signaling loop plus 1250 ohms. This is *not* the case with the 6044A, however, because this module incorporates 1250 ohms of internal balance-network resistance. Therefore, *the 6044A must be resistively balanced against the resistance of the signaling loop alone.* In 4wire DX applications, where signaling takes place over the simplex leads of the transmit and receive pairs, signaling loop resistance is equal to one-half of the loop resistance of either pair (i.e., the simplex loop resistance of the transmit and receive pair). From 0 to 6750 ohms of resistance can be switched into the 6044A balance network in 250-ohm increments.

2.12 The 6044A provides up to 7μF of balance-network capacitance. Switched capacitance values in the balance network should be matched as closely as possible to the total capacitance of the facility to ensure that local M-lead transitions do not cause transitions of the local E-lead . In general, the required amount of capacitance is equal to the amount of capacitance connected across the DX loop plus the nominal capacitance of the associated cable pair. The 6044A contains a fixed 4μF capacitor in its balance network. An additional 3μF of capacitance can be switched into the balance network in 1μF increments. In most cases, however, this additional switched capacitance is not required in 4wire DX applications.

loopback

2.13 Integral facility-side loopback circuitry in the 6044A allows signals at the 4wire receive input port to be looped back to the 4wire transmit output port for testing of both the module and the facility. Figure 6 shows the loopback path through the module. Prescription loopback-level-control circuitry introduces from 0 to 23dB of loss or gain into the loopback path in switch-selectable increments (23dB loss; 0.5, 1.5, 3, 6, and 12dB gain) to provide true equal-level loopback. The terminal equipment can, if desired, be busied out via switch option to prevent inadvertent seizure of the trunk or line circuit. This option can be used with DX1 signaling and Type I E&M interface only. In these applications, the option busies out the terminal equipment by grounding the E lead.

2.14 **Manual Loopback.** Manual loopback, which is convenient for local testing, is controlled by setting the manual loopback DIP switch (*S2-2*, located on the loopback subassembly) to the *ON* position. Loopback is deactivated by setting switch *S2-2* to the *OFF* position. (Loopback **cannot** be deactivated by applying nominal 2713Hz tone to the module's facility-side receive input pair when the 6044A is in the manual loopback mode.)

2.15 **Tone Loopback.** Tone loopback, which is convenient for remote testing, is activated by applying nominal 2713Hz tone to the 6044A's facility-side receive input pair (pins 7 and 13). This tone must fall within a 35Hz (±17.5Hz) bandwidth centered at 2713Hz and must be at a level above −20dBm. The duration of this activation tone must be at least 1.4 seconds, and loopback is activated only upon **removal** of the tone. When the module is optioned for tone loopback activation, three different loopback-deactivation options are available. The first is **no timeout**, i.e., second-tone deactivation, which is also known as **two-tone loopback**. With this option, loopback can be deactivated only by applying nominal 2713Hz tone again, this time for at least 0.7 second, after which loopback deactivation occurs regardless of whether or not the tone is removed. (The difference in the required durations of the loopback-activation and loopback-deactivation tones prevents the accidental looping back of other modules that may be in the circuit.) The second loopback-deactivation option is automatic deactivation after a **2.6-minute timeout**, and the third is automatic deactivation after a **20.8-minute timeout**. These timeout modes not only allow a choice of test-period duration but also provide the additional benefit of preventing the 6044A from being left in the loopback state after testing is completed. In both timeout modes, loopback can be deactivated prior to expiration of the timeout interval by applying nominal 2713Hz tone for at least 0.7 second.

3. installation

Caution: *Because the 6044A contains a mercury-wetted relay, the module should always be held in an upright position (i.e., with the front handle perpendicular to the ground and the nomenclature right side up) and tapped gently before installation. The module should then be kept upright until installed. This procedure ensures that the mercury is in the proper location within the relay (not shorting the contacts, etc.).*

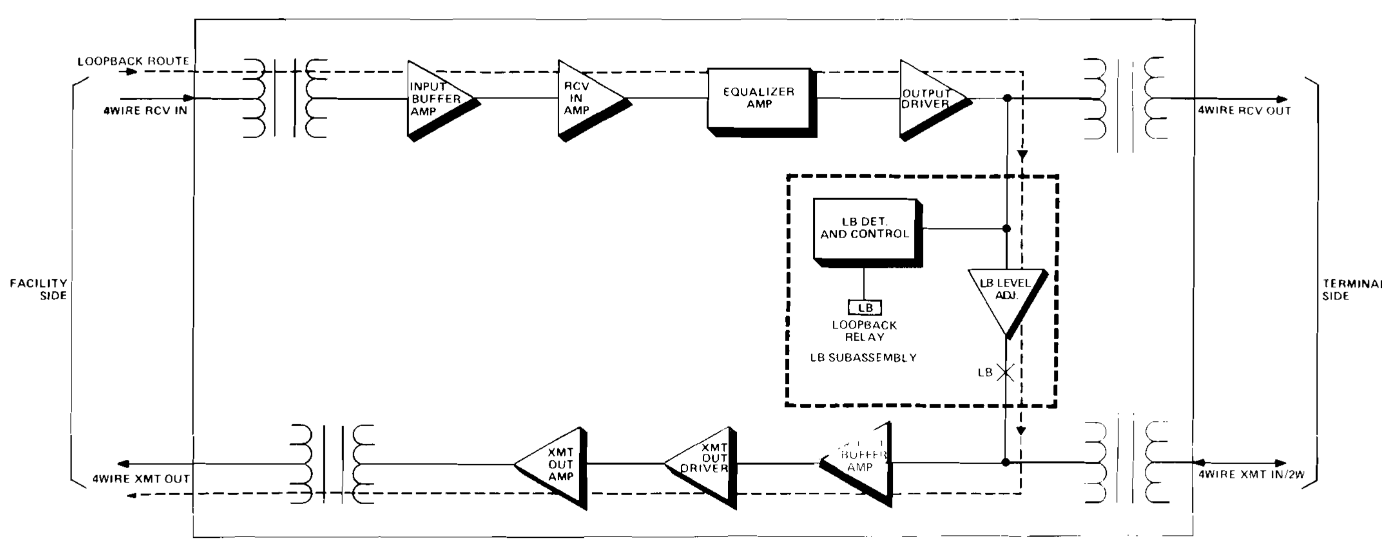


figure 6. Loopback route through 6044A

inspection

3.01 The 6044A 4W-4W DX Network Terminating Module with Loopback should be visually inspected upon arrival in order to find possible damage incurred during shipment. If damage is noted, a claim should immediately be filed with the carrier. If stored, the module should be visually inspected again prior to installation.

mounting

3.02 The 6044A module mounts in one position of a Tellabs Type 10 Mounting Shelf or in one position of a Tellabs 262U Network Terminating System Assembly, both of which are available in configurations for relay-rack and apparatus-case installation. The module plugs physically and electrically into a 56-pin connector at the rear of its Shelf or Assembly mounting position.

3.03 In applications where a 6044A module is to be installed in a 262U Assembly, no external connections need be made. This is because all of the Assembly's internal connections are factory-prewired and because external wiring is simplified through use of female 25-pair micro-ribbon connector-ended cables arranged in accordance with Universal Service Order Code (USOC) RJ2HX. If the customer's terminal equipment has been cabled in accordance with USOC RJ2HX, direct cable connection of the 262U Assembly and the customer's equipment is possible. If not, cross-connections between the 262U Assembly and the local terminal equipment must be made at an intermediate connectorized terminal block.

installer connections

3.04 When a 6044A module is to be installed in a conventional Type 10 Shelf, external connections to the module must be made. Before making any connections to the shelf, make sure that power is **off** and modules are **removed.** Modules should be put into place only **after** they are properly optioned and **after** wiring is completed.

3.05 Table 1 lists external connections to the 6044A module. All connections are made via wire wrapping to the 56-pin connector at the rear of the module's mounting shelf position.

option selection

3.06 Five option switches must be set before the 6044A can be placed into service. The location of each switch on the module's printed circuit board is shown in figure 6. Switch designations are indicated adjacent to each switch.

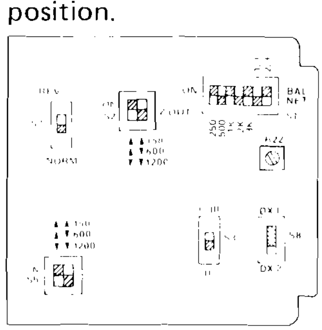
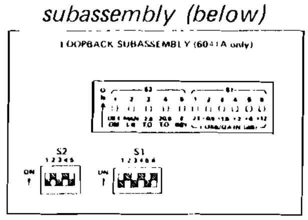


figure 7. Option switch locations on 6044A module (above) and subassembly (below)



3.07 Seven-position DIP switch *S1* **on the module's printed circuit board** is used to select the resistance value of the DX balance network (positions *S1-1* through *S1-5)* and the balance network capacitance (positions *S1-6* and *S1-7*). Determine the required amount of loop resistance (see paragraph 2.11) and set positions *S1-1* through *S1-5* to match this amount as closely as possible. Switch positions are cumulative; total resistance introduced is the sum of those positions set to *OFF* (i.e., set toward the resistance values indicated adjacent to *S1*), as indicated in table 2. From 0 ohms (*S1-1* through *S1-5 ON*) to 6750 ohms (*S1-1* through *S1-5 OFF*) may be introduced in 250-ohm increments.

connect:	to pin:
XMT TIP OUT (facility side)	41
XMT RING OUT (facility side)	47
XMT SIMPLEX OUT (facility side)	45
RCV TIP IN (facility side)	7
RCV RING IN (facility side)	13
RCV SIMPLEX IN (facility side)	11
XMT TIP IN (terminal side)	55
XMT RING IN (terminal side)	49
XMT SIMPLEX IN (terminal side)	29
RCV TIP OUT (terminal side)	5
RCV RING OUT (terminal side)	15
RCV SIMPLEX OUT (terminal side)	53
A (A lead)	43
A1 (A1 lead)	25
B (B lead)	51
B1 (B1 lead)	31
E (E lead)	23
M (M lead)	21
SG (signal ground lead)	19
SB (signal battery lead)	1
−BATT (−44 to −56Vdc, filtered)	35
*GND (ground in)	17

*In Type I E&M interfacing arrangements, the 6044A and the terminal (drop)-side equipment must share a common power-supply ground connection.

table 1. External connections to 6044A

DIP switch *S1* positions	OFF	ON
S1-1	250 ohms	0 ohms
S1-2	500 ohms	0 ohms
S1-3	1000 ohms	0 ohms
S1-4	2000 ohms	0 ohms
S1-5	3000 ohms	0 ohms

table 2. Balance network resistance values

3.08 Switch positions *S1-6* and *S1-7* are used to select up to 3μF of balance network capacitance over and above the fixed 4μF of capacitance provided by the module. These switch positions are set at the time of installation to ensure that local M-lead transitions do not cause transitions of the local E-lead. In general, the proper capacitance is equal to the sum of the capacitance connected across the DX loop plus the nominal capacitance of the cable pair. Switch positions are cumulative; total capacitance introduced is the sum of those positions set to *ON* (i.e., set toward the capacitance values indicated adjacent to *S1*), as indicated in table 3.

3.09 Switch *S2* (labeled *Z OUT*) is used to select 1200, 600, or 150-ohm terminating impedance at the module's facility-side transmit output port, while switch *S5* (labeled *Z IN*) is used to select

DIP switch *S1* positions		switched capacitance of balance network*
S1-6	*S1-7*	
OFF	OFF	0μF
ON	OFF	1μF
OFF	ON	2μF
ON	ON	3μF
*Total capacitance equals switched capacitance plus 4μF.		

table 3. Balance network capacitance values

1200, 600, or 150-ohm terminating impedance at the module's facility-side receive input port. The various settings of *S2* and *S5* are indicated on the module's printed circuit board and summarized in table 4.

xmt out impedance	*S2-1*	*S2-2*
rcv in impedance	*S5-1*	*S5-2*
1200 ohms	off	off
600 ohms	on	off
150 ohms	on	on

table 4. Facility-side terminating-impedance options

3.10 Switch *S3* is used to select Type I, Type II or Type III E&M-lead interfacing. Determine the type of terminal equipment that the module interfaces and set *S3* to either *I/III* (Type I or Type III) or *II* (Type II), as appropriate.

Note: *If Type III operation is required, ensure that switch* S8 *is set to* DX1.

3.11 Switch *S7* is used to select reversed or normal operation of the facility-side DX signaling leads. Set *S7* to the *NORM* position for normal DX-lead operation or to the *REV* position for reversed DX-lead operation.

3.12 Switch *S8* is used to select either DX1 or DX2 operation. Set *S8* to the *DX1* position for DX1 operation or to the *DX2* position for DX2 operation.

loopback option switches

3.13 Six-position DIP switch *S1* on the 6044A's loopback subassembly is used to select the loopback signal level. Determine the amount of gain or loss required to provide equal-level loopback, and set positions *S1-1* through *S1-6* to match this amount as closely as possible. Switch *S1* introduces from 0 to 23dB of loss or gain into the loopback in switch-selectable 0.5dB increments. Switch positions are cumulative; total loss or gain introduced is the sum of those positions set to *ON.*

3.14 Five-position DIP switch *S2* on the 6044A's loopback subassembly is used to select several loopback-related functions. Switch *S2-1* enables or disables the loopback detector (see note below). Set *S2-1* to the *ON* position to enable the detector or to the *OFF* position to disable the detector. Switch *S2-2* activates the manual loopback mode (see note below). Set *S2-2* to the *ON* position to activate manual loopback or to the *OFF* position when manual loopback is not used. Switch *S2-3* activates 2.6-minute loopback timeout. Set *S2-3* to the *ON* position to activate 2.6-minute timeout or to the *OFF* position when 2.6-minute timeout is not used. Switch *S2-4* activates 20.8-minute loopback timeout. Set *S2-4* to the *ON* position to activate 20.8-minute timeout. (*S2-3* must also be set to *ON* for this feature to function properly.) Set *S2-4* to the *OFF* position when 20.8-minute timeout is not used. Switch *S2-5* grounds the E lead during loopback operation to busy out the terminal-side equipment (applicable for Type I E&M interface and DX1 mode only). Set *S2-5* to the *ON* position to provide E-lead ground when the 6044A is in the loopback mode. (E-lead ground is not present when the 6044A is **not** in the loopback mode.) Set *S2-5* to the *OFF* position to provide an open E lead during loopback operation (as well as when the module is not in the loopback mode).

Note: *The manual loopback mode can be activated (via* S2-2*) even if the loopback detector is disabled (via* S2-1*).*

3.15 Dial-pulse-trimming potentiometer *R22* provides a nominal degree of dial-pulse make-break ratio compensation (±5%) for dial pulses transmitted at a rate of 8 to 14pps. Potentiometer *R22* is factory-set and probably will not require adjustment. However, if dial-pulse make-break ratios do not meet circuit specifications, *R22* should be adjusted to provide optimum performance.

alignment

Note: *A condensed alignment procedure, figures 8 and 9, is included to simplify alignment of the 6044A.*

3.16 **Receive Level Adjustment.** After all option switches are set and verified, turn all front-panel controls fully counterclockwise. Adjust the receive-channel level for the desired gain (or loss) as follows:

A. Connect the transmit portion of a transmission measuring set (TMS), arranged for 1004Hz output at the level and (if possible) the impedance specified on the circuit layout record (CLR), to the *rcv in* jack.

B. Connect the receive portion of the TMS, arranged for 600-ohm terminated measurement, to the *rcv out* jack.

C. Turn the *rcv level* control clockwise until the receive portion of the TMS indicates the required level.

D. Make a frequency run, measuring and recording levels at appropriate intervals. If the measured levels meet the conditioning requirements of the circuit, equalization is not required and no further receive-channel adjustments are necessary. If equalization is required, proceed to paragraph 3.17.

3.17 **Receive Equalization Adjustment.** If equalization is received, the following procedure should be performed (end-to-end measurements must be made to correctly adjust the equalizer):

A. Disconnect the transmit portion of the TMS from the *rcv in* jack while leaving the receive portion of the TMS connected to the *rcv out* jack.

B. Request that personnel at the distant (receive channel) end send 300, 1004, and 3000Hz tones at the level and impedance specified on the CLR. Measure and record the level of each tone.

C. Turn the *rcv equal* control clockwise until the 3000Hz level is equal to the 300Hz level.

D. Have 300, 1004, and 3000Hz tones sent again. Measure and record the level of each tone.

E. Turn the *rcv equal* control clockwise until the 3000Hz level is equal to the 300Hz level measured in step D.

F. Repeat steps D and E until the measured frequency response satisfies the conditioning requirements of the circuit.

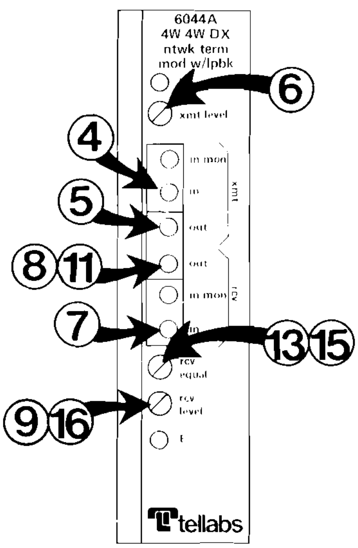
G. Have the distant (receive-channel) end send 1004Hz tone at the CLR-specified level and impedance. Readjust (if necessary) the *rcv level* control for the specified level.

3.18 **Transmit Level Adjustment.** Adjust the transmit-channel level as follows:

A. Connect the transmit portion of the TMS, arranged to output 1004Hz tone at the level specified on the CLR and, if possible, at 600 ohms, to the *xmt in* jack.

B. Connect the receive portion of the TMS, arranged for terminated measurement at the impedance specified on the CLR, to the *xmt out* jack.

C. Turn the *xmt level* control clockwise until the receive portion of the TMS indicates the required level.



This condensed alignment procedure is included to simplify alignment of the 6044A module. Detailed alignment instructions are provided in paragraphs 3.15 through 3.18.

To prepare for alignment:

1 Set all option switches for your particular application. See paragraphs 3.07 through 3.14 for optioning information.

2 Tap the module gently and plug it into a prepared mounting. Hold the 6044A upright and gently tap the module in the palm of your hand to ensure that the mercury is properly seated within the 6044A's mercury-wetted relay.

3 Turn all front-panel controls fully counterclockwise.

Align the transmit channel.

4 Connect the transmit portion of a TMS, arranged for 1004Hz output at 600 ohms and the level specified on the CLR, to the *xmt in* jack.

5 Connect the receive portion of the TMS, arranged for terminated measurement at the impedance specified on the CLR, to the *xmt out* jack.

6 Turn the front-panel *xmt level* control clockwise until the receive portion of the TMS indicates the required level.

Align the receive channel.

7 Connect the transmit portion of a TMS, arranged for 1004Hz output at the impedance and level specified on the CLR, to the *rcv in* jack.

8 Connect the receive portion of the TMS, arranged for 600-ohm terminated measurement, to the *rcv out* jack.

9 Turn the front-panel *rcv level* control clockwise until the receive portion of the TMS indicates the required level.

Perform receive-channel frequency run and equalize if necessary.

10 Make a frequency run, measuring and recording levels at 300, 1004, and 3000Hz. If the measured levels meet the conditioning requirements of the circuit, equalization is not required. If not, perform the equalization procedure described in the following steps.

11 With the transmit portion of the TMS disconnected, connect the receive portion of the TMS, arranged for 600-ohm terminated measurement, to the *rcv out* jack.

12 Request that personnel at the distant (receive channel) end of the circuit send 300, 1004, and 3000Hz tones at the level and impedance specified on the CLR. Measure and record the level of each tone.

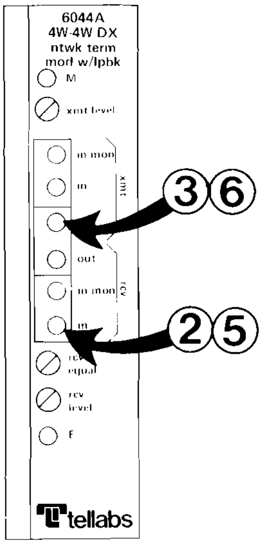
13 Turn the *rcv equal* control clockwise until the 3000Hz level is equal to the 300Hz level measured in step 12.

14 Have 300, 1004, and 3000Hz tones sent again. Measure and record the level of each tone.

15 Turn the *rcv equal* control clockwise until the 3000Hz level is equal to the 300Hz level measured in step 14. Repeat steps 14 and 15 until the measured frequency response satisfies the conditioning requirements of the circuit.

16 Have the distant (receive channel) end send 1004Hz tone at the CLR-specified level and impedance. Readjust (if necessary) the *rcv level* control for the required level.

figure 8. Transmit and receive channel alignment



Check signaling-lead reference-lead voltages on-hook.

1 With the E and M leads from the trunk circuit disconnected, connect a pulsing test set, arranged to send an on-hook, to the 6044A's M lead (DX1) or E lead (DX2). Verify that the *M* LED (DX1) or *E* LED (DX2) is not lit.

2 Connect a test cord to the *rcv in* jack and measure the voltage at the plug (either tip or ring). The measured voltage should be approximately −1Vdc (*S7* set to *NORM*) or −19 Vdc (*S7* set to *REV*).

3 Connect the test cord to the *xmt out* jack and measure the voltage at the plug. The measured voltage should be approximately −19Vdc (*S7* set to *NORM*) or −1Vdc (*S7* set to *REV*).

Check signaling-lead and reference-lead voltages off-hook.

4 With the E and M leads from the trunk circuit disconnected, connect a pulsing test set, arranged to send an off-hook, to the M lead (DX1) or E lead (DX2). Verify that the *M* LED (DX1) or *E* LED (DX2) is lit.

5 Connect a test cord to the *rcv in* jack and measure the voltage at the plug (either tip or ring). The measured voltage should be approximately −47Vdc (*S7* set to *NORM*) or −19Vdc (*S7* set to *REV*).

6 Connect the test cord to the *xmt out* jack and measure the voltage at the plug. The measured voltage should be approximately −19Vdc (*S7* set to *NORM*) or −47Vdc (*S7* set to *REV*).

Perform an end-to-end alignment and signaling check.

After local alignment of the 6044A is completed, end-to-end measurements should be made to verify overall operation of the circuit in which the 6044A is used. These checks should include verification of transmit and receive channel transmission levels, receive channel frequency response, and pulsing speed and per cent break.

figure 9. Signaling-lead and reference-lead voltage check

loopback-level adjustment

3.19 To adjust the 6044A's loopback-level-control circuitry to provide true equal-level loopback, proceed as follows:

A. From the CLR, determine the specified terminal-side input and output levels.

B. Subtract the terminal-side input level from the terminal-side output level. The result will be the amount of **loss** required in the loopback path, as indicated in the following equation (also see example below):

terminal-side output level	−	terminal-side input level	=	amount of loss to be inserted in loopback path

C. Set to *ON* that combination of DIP-switch *S1* positions which most closely approximates the amount of loss determined in step B.

Example: In a hypothetical application, the CLR-specified terminal-side input level is −2dBm and the CLR-specified terminal-side output level is +2dBm. Thus, we subtract −2dBm from +2dBm as follows:

+2dBm − (−2dBm) = +4dB

Thus, 4dB is the amount of **loss** to be introduced into the loopback path via DIP switch *S1*. (If the result of the subtraction were **negative**, this would be the amount of **gain** required in the loopback path.) To introduce the required amount of loss, we first set switch *S1-1* to *ON* to introduce 23dB of loss and then set the remainder of the *S1* positions to provide the closest possible approximation to 19dB of gain without exceeding it (23dB of loss plus 19dB of gain equals 4dB of loss, the required amount). In this example, the closest we can get to 19dB of gain without exceeding it is 18.5dB (*S1-1, S1-2,* and *S1-5* set to *ON, S1-3* and *S1-4* set to *OFF*). Thus, we end up introducing 4.5dB of loss (23dB of loss plus 18.5dB of gain) into the loopback path, which puts us within 0.5dB of true equal-level loopback — a tolerance that should suffice in nearly all applications.

3.20 **Signaling-Lead and Reference-Lead Voltage Check.** To ensure that dc potentials on the DX-signaling and reference leads are correct for both on-hook and off-hook states, proceed as follows:

A. **On-Hook.** With the E and M leads from the trunk circuit disconnected, connect a pulsing test set arranged to send an **on-hook** to either the 6044A's M lead (for DX1 operation) or E lead (for DX2 operation). Verify that the *M* LED (DX1) or the *E* LED (DX2) is not lit. Connect a test cord to the module's *rcv in* jack and use a VOM to measure the voltage at the plug (either tip or ring). Acceptable voltages are summarized in table *6*. Disconnect the test cord from the *rcv in* jack, connect it to the *xmt out* jack, and measure the voltage at the plug. Again, see table *6* for acceptable voltages.

B. **Off-Hook.** With the E and M leads from the trunk circuit disconnected, connect a pulsing test set arranged to send an **off-hook** to either

on-hook	xmt out	rcv in
S7 set to *NORM*	−19Vdc	−1Vdc
S7 set to *REV*	−1Vdc	−19Vdc
off-hook	**xmt out**	**rcv in**
S7 set to *NORM*	−19Vdc	−47Vdc
S7 set to *REV*	−47Vdc	−19Vdc

table 5. Signaling and reference lead voltages

the 6044A's M lead (for DX1 operation) or E lead (for DX2 operation). Verify that the *M* LED (DX1) or the *E* LED (DX2) is lit. Connect a test cord to the module's *rcv in* jack and use a VOM to measure the voltage at the plug (either tip or ring). See table *5* for acceptable voltages. Disconnect the test cord from the *rcv in* jack, connect it to the *xmt out* jack, and measure the voltage at the plug. Again, see table *5* for acceptable voltages.

4. circuit description

4.01 This circuit description is intended to familiarize you with the 6044A 4W-4W DX Network Terminating Module with Loopback for application and engineering purposes only. Attempts to troubleshoot the 6044A internally are not recommended and may void your warranty. Procedures for recommended testing and troubleshooting in the field are limited to those prescribed in section 7 of this Practice. Please refer to the 6044A block diagram, section 5 of this Practice, as an aid in following this circuit description.

receive section

4.02 The receive section of the 6044A uses an input transformer to interface the tip and ring leads of the 4wire facility and to derive the receive input simplex lead. A switch option provides for reverse or normal operation of the simplex lead. A secondary of the transformer is connected to the receive channel's flat *gain amplifier* and to the input impedance circuit, which consists of three resistors. Switch selection of one, two, or all three resistors provides the 1200, 600, or 150-ohm receive input impedance.

4.03 Diodes limit the *gain amplifier's* input voltage to external power potentials and provide lightning protection for the amplifier. Following the *gain amplifier* is a *slope equalizer* section that provides up to 7.5dB of equalization at 2804Hz (re 1000Hz). The receive channel *power amplifier* follows the *slope equalizer*. The gain of the *power amp* is controlled by the *gain amp* to provide the −18 to +16dB gain range in the receive channel. The *power amp* is connected to a secondary of the output transformer that interfaces the 4wire terminal side and derives the receive output simplex lead. The secondary of the output transformer is also connected to a fixed resistor that provides 600-ohm impedance at the 4wire terminal side.

transmit section

4.04 The transmit section of the 6044A uses an input transformer to interface the tip and ring leads of 4wire terminal-side equipment and to derive the transmit input simplex lead. A secondary of the transformer is connected to the transmit channel's flat *gain amplifier* and to a fixed resistor that provides 600-ohm impedance at the 4wire terminal side.

4.05 Diodes limit the *gain amplifier's* input voltage to external power potentials and provide lightning protection for the amplifier. The transmit channel's *power amplifier* follows the *gain amplifier*. The gain of the *power amplifier* is controlled by the *gain amp* to provide the −18 to +16dB gain range in the transmit channel. The *power amp* is also connected to the secondary of the output transformer that interfaces the tip and ring leads of the 4wire facility side and also derives the transmit output simplex lead. A switch option permits reverse or normal operation of the simplex lead. The secondary of the transformer is also connected to the output impedance circuit, which consists of three resistors. Switch selection of one, two, or all three resistors provides the 1200, 600, or 150-ohm transmit-output impedance.

DX signaling section

4.06 Both ends of a DX signaling system are balanced symmetrical circuits connected by two metallic conductors. In the case of the 6044A, these conductors are derived metallic simplex conductors. One conductor in the DX signaling system carries supervisory and pulsing signals, using combinations of local ground and battery. Differences in ground or battery potentials between each end of the DX signaling system create nonsupervisory currents in the signaling conductor. The second conductor in the DX system 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 conductor is equal to and opposite that created in the first conductor. The current in the second conductor cancels the effect of these unwanted potential differences in the first conductor, thus providing compensation for ground-potential and battery-supply variations. Additionally, the circuit is balanced against longitudinal ac line voltages and currents.

4.07 The 6044A uses an active DX signaling unit that derives local signaling from currents transmitted over derived metallic simplex conductors. The *DX current sense* circuit is a balanced bridge-type detector that senses differential voltage changes across four 400-ohm resistors that replace the four windings of the DX relay normally used in conventional relay-type DX sets. The differential voltage changes are sensed and directly coupled to a relay-driver circuit that includes a dial-pulse adjustment to compensate for dial-pulse distortion introduced in the transmission facility. A mercury-wetted contact relay is used to derive the local E-lead output (in the DX1 mode) or the local M-lead output (in the DX2 mode). In the DX1 mode, the output relay is operated during busy and not operated during idle. In the DX2 mode, these states are reversed. Resistor-capacitor contact protection is provided for both the relay's normally open and normally closed contacts.

4.08 In the transmit signaling path, an *M-lead opto-coupler* (DX1) or *E-lead opto-coupler* (DX2) determines the state of the local M-lead (DX1) or E-lead (DX2) and operates an active bidirectional driver that provides the current changes in the DX loop toward the distant location.

tone-activated loopback
4.09 The input for tone-activated loopback is obtained from the output of the *balanced output driver.* The 2713Hz-loopback tone is sensed by the *loopback detector and control* circuit, which operates the *LB* relay immediately after tone is applied for approximately 1.4 seconds and removed. Depending upon the switch-optioning of the loopback subassembly, the *LB* relay releases after a second application of 2713Hz tone (0.7 second minimum duration), or automatically at the conclusion of a preset 2.6 or 20.8-minute interval. (Application of loopback tone for at least 0.7 second before the conclusion of the preset interval will release loopback immediately.)

manual loopback
4.10 Manual loopback is activated via a switch-option on the module's subassembly, which, when properly set, operates the *LB* relay. The *LB* relay remains operated (looped) until the switch position is reset. In the manual loopback mode, loopback cannot be deactivated by applying 2713Hz tone. The subassembly's manual loopback option switch must be reset to deactivate loopback.

4.11 The *power supply* in the 6044A module is series-regulated bipolar supply that uses a zener diode as a reference source. A series diode in the negative input lead protects the circuit against reversed input power connections.

6. specifications

input/output impedance
facility side: 1200, 600, or 150 ohms, balanced, switch selectable
terminal side: 600 ohms, fixed, balanced

gain range (transmit and receive)
−18 to +16dB, continuously adjustable via front-panel controls

frequency response (no equalization)
±0.5dB, 300 to 4000Hz, re 1000Hz
±0.25dB, 500 to 3000Hz, re 1000Hz

equalization (receive channel only)
0 to +7.5dB at 2804Hz re 1000Hz, continuously adjustable via front-panel control

maximum output level
+12dBm

harmonic distortion
1% maximum at +12dBm output level

4wire return loss (all ports)
23dB ERL maximum

delay distortion
150μs maximum, 500 to 3000Hz, re 1800Hz, no equalization

noise
16dBrnC maximum at maximum gain adjustment

longitudinal balance
60dB maximum, 200 to 4000Hz

equal-level crosstalk (receive to transmit or transmit to receive)
80dB minimum, 200 to 4000Hz

adjacent-module crosstalk
80dB minimum, 200 to 4000Hz

DX loop resistance
5000 ohms maximum

pulsing range
8 to 14pps

pulsing distortion
±3% without adjustment
±1% via internal adjustment (potentiometer *R22*)

balance network
resistance: 0 to 6750 ohms in switch-selectable 250-ohm increments
capacitance: 7μF total (4μF of fixed capacitance plus an additional 3μF in switch-selectable 1μF-increments)

midpoint capacitance
4μF, fixed

E&M signaling
DX1 mode:
- **E-lead current rating**
  - **500mA maximum (resistor-capacitor contact protection provided)**
- **E-lead resistance**
  - **less than 0.5 ohms**
- **M-lead sensitivity**
  - **−20Vdc minimum threshold**
  - **5000 ohms maximum external M-lead resistance from −48Vdc**

DX2 mode:
- **M-lead current rating**
  - **500mA maximum (resistor-capacitor contact protection provided)**
- **M-lead current from battery (Type I interface only)**
  - **100mA with less than 5-volt drop, current limiting above 200mA**
- **E-lead sensitivity**
  - **5000 ohms maximum external E-lead resistance to ground**

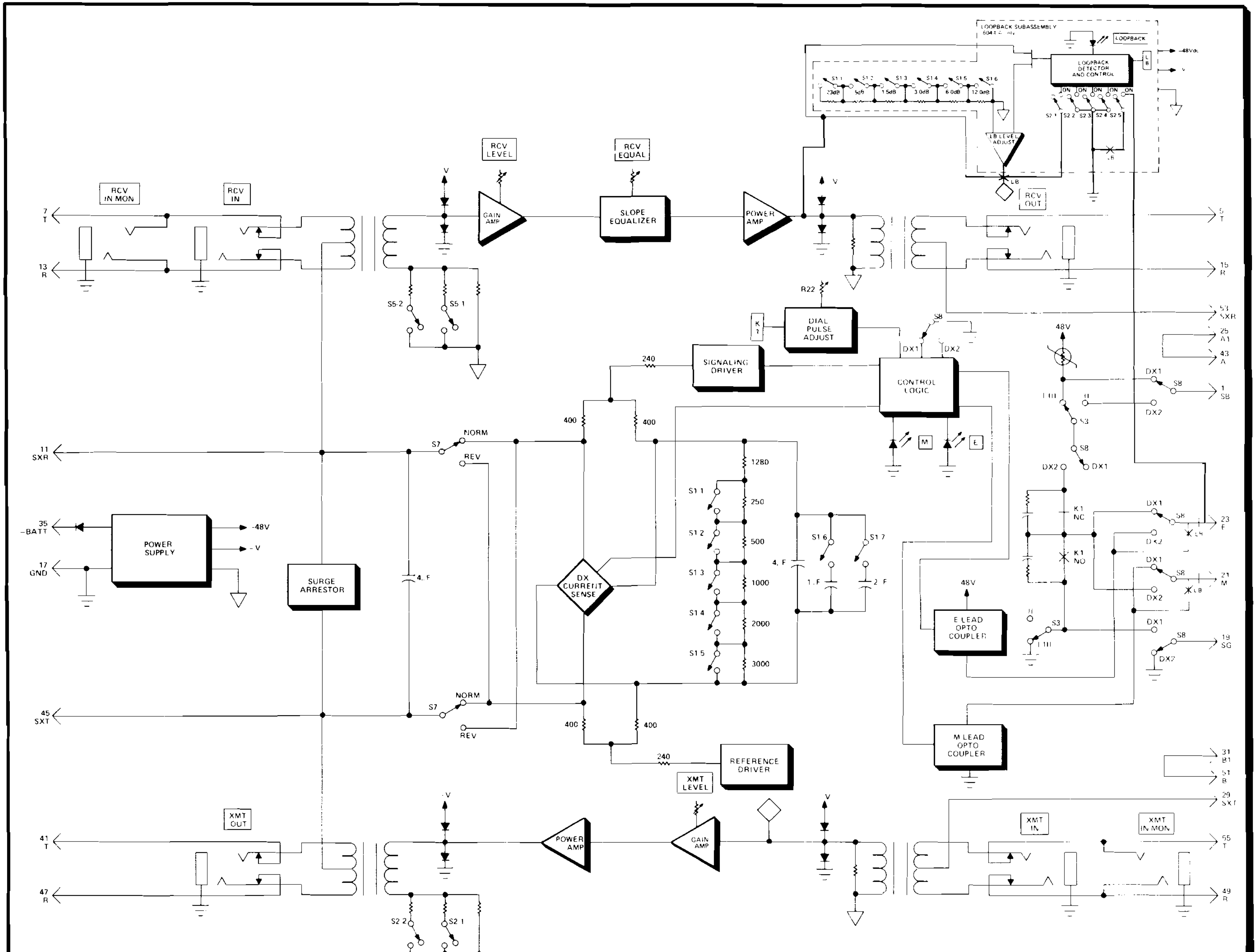
tone-loopback attack time
activation: 1.4 seconds minimum (loopback activates upon removal of tone)
deactivation: 0.7 seconds minimum (deactivation immediately thereafter)

loopback timeout
2.6±0.4 minutes or 20.8±3.0 minutes, switch-selectable

loopback tone requirements
frequency, 2713±17.5Hz; threshold level, −20dBm

loopback signal-to-guard ratio
greater than 3dB

specifications continued on page 11



6044A 4W-4W DX Network Terminating Module with Loopback 826044A

looped level accuracy
within 0.5dB

current requirements at −52Vdc input (tone, ground-controlled, or manual mode)
activated: module current plus 25mA

equal-level loopback
switch-selectable in −23, 0.5, 1.5, 3.0, 6.0, and 12.0dB increments via DIP switch on subassembly

E-lead ground during loopback
on or off, switch-selectable via DIP switch on subassembly

power requirement
−44 to −56Vdc, filtered, ground referenced

current requirements (0-ohm loop)

	at −48Vdc, typical	at −52Vdc, maximum
idle (DX1)	35mA	45mA
idle (DX2*)	40mA	50mA
busy (0dBm output level*)	70mA	85mA
*add M-lead current in DX2 mode		

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

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

weight
15.5 ounces (439 grams)

mounting
relay rack or apparatus case via one position of Tellabs Type 10 Mounting Shelf, or one position of a 262U Universal Network Terminating System Assembly

7. testing and troubleshooting

7.01 The Testing Guide Checklist in this section may be used to assist in the installation, testing, or troubleshooting of the 6044A 4W-4W DX Network Terminating Module with Loopback. The Checklist is intended as an aid in the localization of trouble to a specific module. If a module is suspected of being defective, a new one should be substituted and the test conducted again. If the substitute module operates correctly, the original module should be considered defective and returned to Tellabs for repair or replacement. We strongly recommend that no internal (component-level) testing or repairs be attempted on the 6044A module. Unauthorized testing or repairs may void the module's warranty.

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

7.02 If a situation arises that is not covered in the Checklist, contact Tellabs Customer Service at your Tellabs Regional Office or at our Lisle, Illinois, or Mississauga, Ontario, Headquarters. Telephone numbers are as follows:

US central region: (312) 969-8800
US northeast region: (412) 787-7860
US southeast region: (305) 645-5888
US western region: (702) 827-3400
Lisle Headquarters: (312) 969-8800
Mississauga Headquarters: (416) 624-0052

7.03 If a 6044A is diagnosed as defective, the situation may be remedied by either *replacement* or *repair and return.* Because it is more expedient, the *replacement* procedure should be followed whenever time is a critical factor (e.g., service outages, etc.).

replacement

7.04 To obtain a replacement 6044A module, notify Tellabs via letter (see addresses below), telephone (see numbers above), or twx (910-695-3530 in the USA, 610-492-4387 in Canada). Be sure to provide all relevant information, including the 8X6044A part number that indicates the issue of the module in question. Upon notification, we shall ship a replacement module to you. If the module in question is in warranty, the replacement will be shipped at no charge. Pack the defective 6044A in the replacement module's carton, sign the packing slip included with the replacement, and enclose it with the defective module (this is your return authorization). Affix the preaddressed label provided with the replacement module to the carton being returned, and ship the module prepaid to Tellabs.

repair and return

7.05 Return the defective 6044A module, shipment prepaid, to Tellabs (attn: repair and return).

in the USA: Tellabs Incorporated
4951 Indiana Avenue
Lisle, Illinois 60532

in Canada: Tellabs Communications Canada, Ltd.
1200 Aerowood Drive, Unit 39
Mississauga, Ontario, Canada L4W 2S7

Enclose an explanation of the module's malfunction. Follow your company's standard procedure with regard to administrative paperwork. Tellabs will repair the module and ship it back to you. If the module is in warranty, no invoice will be issued.

testing guide checklist

Note: *Because the 6044A contains a mercury-wetted relay, this module should always be held in an upright position and tapped gently before installation. The module should then be kept in an upright position until installed. This procedure ensures that the mercury is in the proper location within the relay. If trouble is encountered with an installed 6044A, remove the module from the mounting shelf and repeat this procedure before taking any further corrective action.*

test	test procedure	normal result	if normal conditions are not met, verify:
circuit idle (DX1)	Connect VOM (set to 50Vdc or 250Vdc scale) from E lead (pin 23) to ground.	More than 44Vdc present ☐. *E*-lead LED off ☐.	Power ☐. Wiring ☐. Distant-end signaling input idle ☐. Reverse/normal switch *S7* set correctly ☐. Wiring to near-end signaling equipment ☐. Cable faults ☐. Replace and retest ☐.
	Connect VOM (set to 50Vdc or 250Vdc scale) from M lead (pin 21) to ground.	Less than 1Vdc present ☐. *M*-lead LED off ☐.	Wiring ☐. Input from near-end signaling equipment idle ☐. Replace and retest ☐.

test	test procedure	normal result	if normal conditions are not met, verify:
circuit idle (DX2)	Connect VOM (set to 50Vdc or 250Vdc scale) from M lead (pin 21) to ground.	Less than 1Vdc present □. *M*-lead LED off □.	Power □. Wiring □. Distant-end signaling input idle. Reverse/normal switch *S7* set correctly □. Balance network resistance set correctly □. Wiring to near-end signaling equipment □. Cable faults □. Replace and retest □.
	Connect VOM (set to 50Vdc or 250Vdc scale) from E lead (pin 23) to ground.	More than 44Vdc present □. *E*-lead LED off □.	Wiring □. Input from near-end signaling equipment idle □. Replace and retest □.
circuit busy (DX1)	Connect VOM (set to 50Vdc or 250Vdc scale) from E lead (pin 23) to ground.	Less than 1Vdc present □. *E*-lead LED on □.	Switch *S3* set for Type I □. Distant-end signaling input busy □. Reverse/normal switch *S7* set correctly □. Balance-network resistance set correctly □. Wiring to near end signaling equipment □. Cable faults □. Replace and retest □.
	Connect VOM (set to 50Vdc or 250Vdc scale) from M lead (pin 21) to ground.	More than 44Vdc present □. *M*-lead LED on □.	Power □. Wiring □. Input from near-end signaling equipment busy □. Replace and retest □.
circuit busy (DX2)	Connect VOM (set to 50Vdc or 250Vdc scale) from M lead (pin 21) to ground.	More than 22Vdc present □. *M*-lead LED on □.	Switch *S3* set for Type I □. Distant-end signaling input busy □. Reverse/normal switch *S7* set correctly □. Wiring to near end signaling equipment □. Cable faults □. Replace and retest □.
	Connect VOM (set to 50Vdc or 250Vdc scale) from E lead (pin 23) to ground.	Less than 1Vdc present □. *E*-lead LED on □.	Power □. Wiring □. Input from near-end signaling equipment busy □. Replace and retest □.
pulsing (DX1)	Isolate DX circuit at both ends, and connect pulsing test set to E and M leads at each end of circuit. Send via M lead and receive via E lead.	Distant end sends off-hook (0% break); near-end reads 0% break □. Distant end sends on-hook (100% break); near-end reads 100% break □. Distant end sends 10pps at 58% break; near-end reads 58% ±4% break while simultaneously sending 10pps □; while sending 100% break □; and while sending 0% break □.	All option switches set correctly □. Correct resistance and capacitance values in DX balance network □. (Change balance network resistance and/or capacitance to next increment above or below, and retest □.) Power supply voltage between −44 and −56Vdc □. Power supply grounding □. No excessive cable leakage □. No excessive longitudinal voltage present on facility (less than 25Vrms) □.
pulsing (DX2)	Same as above except send via E lead and receive via M lead.	Same as above □.	Same as above □.
transmit channel gain	Connect properly terminated TMS (receive) to *xmt out* jack. Using transmit portion of TMS, insert 1004Hz test signal at *xmt in* jack.	With *xmt level* control adjusted fully counterclockwise (CCW), output level approx. 18dB lower than input level □. With *xmt level* control fully clockwise (CW), output level apprx. 16dB higher than input level □.	Power □. Wiring □. Impedance terminations (check for double terminations) □. Impedance switches properly set □. Output not exceeding +12dBm overload point □.
receive-channel gain	Connect properly terminated TMS (receive) to *rcv out* jack. Using transmit portion of TMS, insert 1004Hz test signal at *rcv in* jack.	With *rcv level* control fully CCW, output level approx. 18dB lower than input □. At full CW, output level about 16dB higher than input □.	Power applied to module □. Wiring □. Terminating impedances correct □. Output level not exceeding +12dBm overload point □.
loopback	Option 6044A for tone loopback with auto-release after 2.6 minutes, align xmt and rcv channels for 0dB gain, set all front panel *rcv eql* switch positions to *out*, and be certain that the equal-level loopback switches on the subassembly are properly set. With transmit portion of TMS connected to *rcv in* jack, send 2713Hz tone at −10 ±1dBm level for at least 2 seconds. Change tone frequency to 1004Hz and measure level at *xmt out* jack with receive portion (properly terminated) of TMS.	Loopback activated after tone frequency changed □. Output level equals input level ±0.5dB □. Loopback releases automatically after 1.3 minutes □.	*S1* optioning on subassembly □. *Xmt, rcv level,* and *rcv eql* adjustments □. Input tone level and frequency □. Power □. Wiring □. Replace and retest □.