Tellabs
technical manual
76-816041
rev A

practice section 816041

6041 Network Terminating Module

contents

1. general description

1.01 The Tellabs 6041 Network Terminating Module (figure 1) provides signaling conversion and transmission interface between a 2wire metallic transmission facility and a 2wire PBX trunk. Specifically, the 6041 provides extended-range E&M (DX) signaling over A and B leads derived from the 2wire facility, conversion between that DX signaling and terminal-side E&M signaling, and extension of this E&M signaling toward the 2wire termination. Transmission interface is accomplished via an integral repeat coil. This module is designed to provide DX1 operation with a choice of either Type I or Type II E&M-lead interfacing. When optioned for Type II interfacing, DX2 operation can also be accommodated. As a member of Tellabs' 262U Universal Network Terminating System of modules and enclosures, the 6041 fulfills Registered Facility Interface Codes TL11M and TL12M in applications where the telephone company uses DX signaling over the 2wire facility.

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

1.03 The 6041 contains an electronic DX set designed for end-to-end use with conventional relay-type DX sets or other electronic units. Maximum DX signaling range is 5000 ohms of external loop resistance.

1.04 The 6041 is designed to operate in the DX1 mode, in which M-lead signals are input to and E-lead signals are output from the module. Either Type I or Type II E&M-lead interfacing may be switch-selected. In general, Type I interfacing is used with electromechanical switching systems, while Type II interfacing is used in electronic switching environments. Figures 2 and 3 in section 2 of this Practice show Type I and Type II E&M-lead interfacing arrangements, respectively.

1.05 When the 6041 is optioned for Type II E&M-lead interfacing, DX2 operation (M-lead output, E-lead input) can be implemented via an external wiring change (see paragraphs 2.03 and 3.04). Figure 4 in section 2 of this Practice shows the Type II/DX2 interfacing arrangement.

1.06 The 6041 incorporates a resistive and capacitive DX balancing network as well as A&B-lead

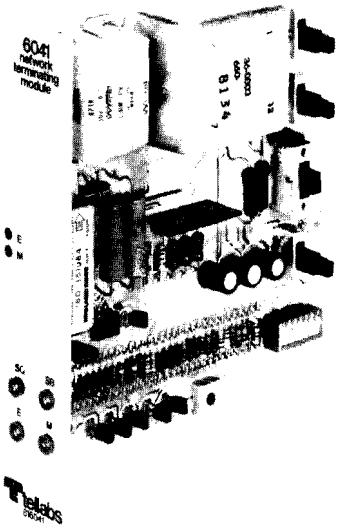


figure 1. 6041 Network Terminating Module

midpoint capacitors. The balancing network can be switch-optioned to provide up to 6750 ohms of balancing resistance (in 250-ohm increments) and up to approximately 6μF of capacitive balance (in 2μF increments). The A&B-lead midpoint capacitors associated with the facility (DX signaling) side of the 6041 can be switch-optioned for 0, 2, or 4μF of capacitance.

1.07 An impedance-matching transformer facing the 2wire facility can be switch-optioned for balanced 600 or 900-ohm terminating impedance. This transformer is center-tapped to derive the A and B leads required for DX signaling. A switch option permits normal or reverse operation of these leads. Fixed 600-ohm impedance (in series with a 2μF capacitive component) is presented at the 6041's 2wire terminal-side port.

1.08 A dial-pulse-trimming potentiometer on the module's printed circuit board compensates dial pulse make/break ratios for optimum performance. The 6041 accommodates dial pulsing speeds of 8 to 14 pulses per second (pps).

1.09 Four test points on the front panel of the 6041 allow test access to the module's signaling leads (E, M, SG, and SB).

1.10 The 6041 is designed to operate on filtered −44 to −56Vdc input. Nominal current requirement (at −48Vdc input) is 60mA. Maximum current requirement (at −52Vdc input) is 75mA.

1.11 A Type 10 module, the 6041 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 may be mounted across a 19-inch rack, while up to 14 modules may be mounted across a 23-inch rack. In either case, 6 inches of vertical rack space is used.

1.12 As a member of Tellabs' 262U Universal Network Terminating System of modules and enclosures, the 6041 can also be mounted in any of Tellabs' prewired 262 or 262U System Mounting Assemblies, versions of which are available for apparatus case or relay rack installation. In these Assemblies, all internal connections are prewired and external connections are facilitated through the use of connectorized cables. All Assemblies housing nine or more modules are provided with individual module fusing. Further information is available in the Tellabs brochures describing the 262 and 262U Universal Network Terminating Systems and in the Tellabs practices describing the 6042 and 6044 Network Terminating Modules.

2. application

2.01 The 6041 Network Terminating Module provides transmission interface and signaling conversion between a 2wire metallic facility using DX signaling and a 2wire PBX trunk using E&M signaling. This single module combines the functions of a 2wire repeat coil and an E&M-to-DX signaling converter. In applications where the serving telephone company uses DX signaling over a 2wire facility, the 6041 fulfills Registered Facility Interface Codes TL11M and TL12M.

2.02 As stated above, the electronic DX set in the 6041 is designed to operate in the DX1 mode, in which M-lead signals are input to and E-lead signals are output from the module. Either Type I or Type II E&M-lead interfacing may be switch-selected (see figures 2 and 3). In general, Type I interfacing is used with electromechanical switching systems while Type II interfacing is used in electronic switching environments. With Type I interfacing, incoming and outgoing signaling 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. Type II E&M-lead interfacing permits direct interconnection of trunk circuits or signaling units without intermediate signaling-lead conversion (which is required with conventional Type I E&M-lead interfacing).

2.03 When optioned for Type II E&M lead interfacing, an external wiring change permits the 6041 to operate in the DX2 mode, in which E-lead signals are input to and M-lead signals are output from the module. The DX2 mode is used in tandem applications of DX signaling units, or in other situations where a terminal-side E&M-lead signaling interface must be accommodated. The DX2 mode eliminates the need for a pulse link repeater in these situations. The Type-II/DX2 signaling interface is shown in figure 4.

2.04 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 6041, however, because this module incorporates 1250 ohms of internal balance network resistance. Therefore, **the 6041 must be resistively balanced against the resistance of the signaling loop alone.** In 2wire DX applications where signaling takes place over A and B leads derived from the 2wire facility, signaling loop resistance is simply the resistance of the metallic facility between DX signaling units. From 0 to 6750 ohms of resistance can be switched into the 6041's balance network in 250-ohm increments.

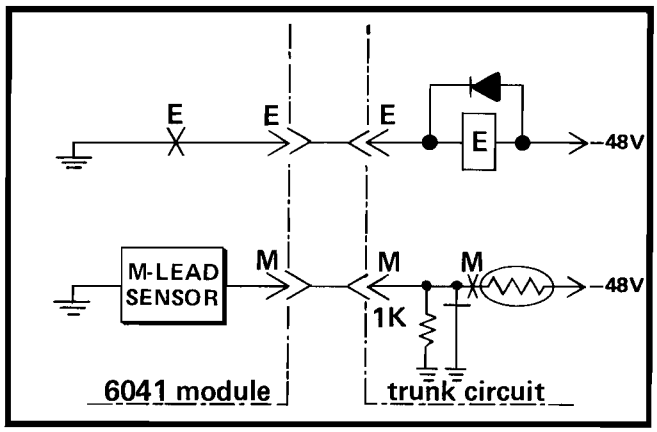


figure 2. Type I interface

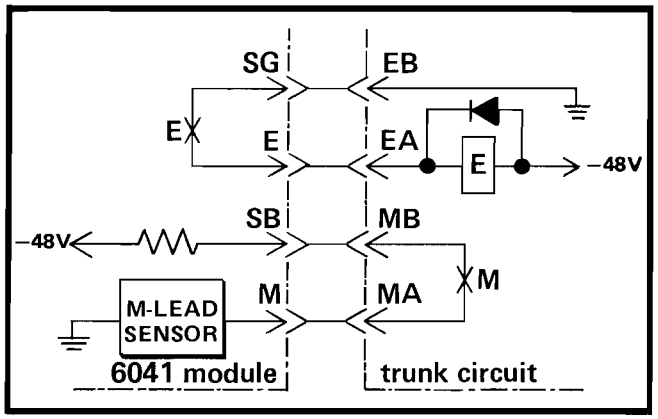


figure 3. Type II interface

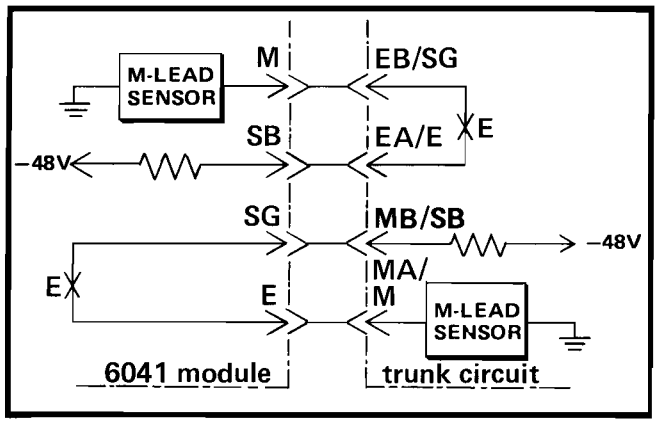


figure 4. Type II/DX2 interface

2.05 The 6041 provides up to 6μF 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 capacitance of the facility is calculated by summing the cable capacitance (usually 0.083μF/mile), the midpoint capacitance, and the capacitance contributed by any transmission devices in the circuit. Tables 5 through 7 in section 3 of this Practice contain balance network capacitance values for various 2wire facilities.

2.06 Switchable midpoint capacitors on the facility (DX-signaling) side of the 6041 allow either 0, 2, or 4μF of capacitance to be introduced across the midpoint of the A and B leads to compensate for midpoint capacitance introduced by equipment at the distant facility-side termination. In 2wire circuits, the midpoint capacitance value may be 0, 2, or 4μF, as required. If an associated device (such as a term set) contributes capacitance across the midpoint of the signaling leads, the 0μF option may be selected to reduce excessive midpoint capacitance, which can cause dial pulse distortion. Tables 5 through 7 in section 3 of this Practice contain midpoint capacitance values for various 2wire facilities.

2.07 Switch-selectable terminating impedance options at the module's 2wire facility-side port allow the 6041 to interface loaded cable (900 ohms) or nonloaded cable (600 ohms). Fixed 600-ohm impedance is provided at the module's 2wire terminal-side port.

2.08 The impedance-matching transformer at the 6041's facility-side port is center-tapped to derive A and B leads required for DX signaling. A reverse/normal option switch may be used to reverse the reference and signal assignments applied, respectively, to the B lead (receive) and the A lead (transmit). This reversal option provides a convenient means (as opposed to rewiring) of contending with a transmission pair reversal in the circuit.

3. installation

Caution: *Because the 6041 contains a mercury-wetted relay, this module should always be held in an upright position and* **gently** *tapped before installation. The module should then be kept in an upright position (i.e., with the front handle perpendicular to the ground and nomenclature right side up) until installed. This procedure ensures that the mercury is in the proper location within the relay (not shorting the contacts, etc.).*

inspection

3.01 The 6041 Network Terminating Module 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 6041 module mounts in one position of a Tellabs Type 10 Mounting Shelf, 262, or 262U Network Terminating System Assembly, all of which are available in configurations for relay rack or apparatus case installation. The module plugs physically and electrically into a 56-pin connector at the rear of its mounting position. For installation of a 262 or 262U System Assembly, refer to the schematic or wiring diagram available on that Assembly.

installer connections

3.03 Before making any connections to the mounting 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.

3.04 Table 1 lists external connections to the 6041 module. If the module is to be used in a Type-II/DX2 interface (see paragraph 2.03), wire those leads marked with an asterisk (*) as directed in table 2. Be sure to make all other connections as indicated in table 1. Note that the 6041 **must** be optioned for **Type II** E&M-lead interfacing to provide DX2 operation. All connections are made via wire-wrapping at the module's mounting shelf position. Pin numbers are found on the body of the connector.

3.05 When a 6041 is installed in a 262 or 262U System Assembly, all internal connections to the Assembly are factory prewired and external wiring is simplified through the use of female 25-pair microribbon 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 262 or 262U System 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.

connect:	to pin:
T (facility-side tip)	41
R (facility-side ring)	47
T1 (terminal-side tip)	55
R1 (terminal-side ring)	49
E (E lead)	23*
M (M lead)	21*
SB (signal-battery lead required for Type II E&M)	1*
SG (signal-ground lead required for Type II E&M)	19*
BATT (–44 to –56Vdc battery)	35
GND (ground)	17

*If Type-II/DX2 interface is required, wire these leads as indicated in table 2. Be sure to make all other connections as indicated above.

table 1. Installer connections to 6041

on 6041, connect:	to trunk circuit's:
M lead (pin 21)	EB/SG lead
SB lead (pin 1)	EA/E lead
SG lead (pin 19)	MB/SB lead
E lead (pin 23)	MA/M lead

table 2. External wiring changes to 6041 for Type-II/DX2 interface

option selection

3.06 Five option switches must be set before the 6041 is placed into service. The location of each control on the module's printed circuit board is shown on figure 5. After these options are selected, no further alignment of the 6041 is required.

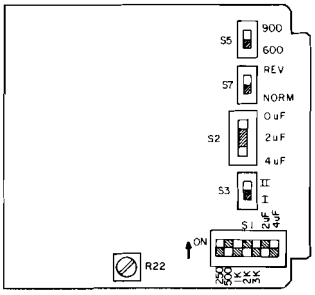


figure 5. Option switch locations

3.07 Switch *S5* selects either 600 or 900-ohm terminating impedance options at the 6041's facility-side port. Determine the type of facility that the module interfaces at this port and set *S5* to either *600* (nonloaded cable) or *900* (loaded cable).

3.08 Switch *S3* selects either Type I or Type II E&M-lead interfacing. In general, Type I E&M-lead interfacing is used with electromechanical switching systems, while Type II interfacing is used in electronic switching environments. Determine the type of terminal equipment that the module interfaces and set *S3* to either *I* (Type I) or *II* (Type II).

3.09 Switch *S7* selects either normal or reverse operation of the module's DX signaling leads. This option reverses the reference and signal assignments applied, respectively, to the B lead (receive) and the A lead (transmit). Set *S7* to *NORM* for normal DX-lead operation or to *REV* for reversed DX-lead operation, as required.

3.10 Switch *S1* is a 7-position DIP switch that selects the resistance value of the balance network (positions *S1-1* through *S1-5)* and the balance network capacitance value (positions *S1-6* and *S1-7).* Determine the required amount of loop resistance (see paragraph 2.04) and set *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 switch positions set to *OFF* (open), as indicated in table 3. From 0 ohms (all positions *ON*) to 6750 ohms (all positions *OFF*) may be provided in 250-ohm increments.

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 3. Balance network resistance values

3.11 Switch positions *S1-6* and *S1-7* select up to 6μF of balance network capacitance. These switches are set during installation to ensure that local M-lead transitions do not cause transitions of the local E-lead. In general, the proper capacitance will equal the sum of the capacitance of the associated cable pair. The various settings of *S1-6* and *S1-7* are summarized in table 4. Tables 5 through 7 contain balance network capacitance values for various 2wire facilities. If introducing the calculated amount of capacitance does not prevent E-lead chatter, increase the amount of capacitance to the next increment.

dip switch S1 positions S1-6	S1-7	switched capacitance of balance network
off	off	0μF
on	off	2μF
off	on	4μF
on	on	6μF

table 4. Balance network capacitance values

cable gauge	cable length	midpoint* capacitance	balance capacitance
all gauges	0-30 miles	2μF	2μF
	30 miles +	2μF	4μF

table 5. Balance network capacitance matching, 2wire circuits (no repeaters)

cable gauge	cable length	midpoint* capacitance	balance capacitance
19	0-25 miles	2μF	2μF
	25 miles +	2μF	4μF
22	0-18 miles	2μF	2μF
	18 miles +	2μF	4μF
24	0-12½ miles	2μF	2μF
	12½ miles +	2μF	4μF
26	0-9 miles	2μF	2μF
	9 miles +	2μF	4μF

table 6. Balance network capacitance matching, 2wire circuits (with one repeater)

cable gauge	cable length	midpoint* capacitance	balance capacitance
19	0-18 miles	2μF	2μF
	18 miles +	2μF	4μF
22	0-11 miles	2μF	2μF
	11 miles +	2μF	4μF
24	0-5 miles	2μF	2μF
	5 miles +	2μF	4μF
26	0-2 miles	2μF	2μF
	2 miles +	2μF	4μF

table 7. Balance network capacitance matching, 2wire circuits (with two repeaters)

*If the midpoint capacitance value listed is provided by associated equipment, set the midpoint capacitance (switch *S2*) for 0μF.

3.12 Switch *S2* selects either 0, 2, or 4μF of A&B-lead midpoint capacitance. Midpoint capacitance is introduced to compensate for the midpoint capacitance of equipment at the distant (facility-side) end of the circuit. Set *S2* to the *0μF, 2μF,* or *4μF* position, as appropriate. Tables 5 through 7 contain midpoint capacitance values for various 2wire facilities.

3.13 Dial-pulse-trimming potentiometer *R22* provides a nominal degree of dial-pulse make/break ratio compensation 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.

4. circuit description

4.01 This circuit description is intended to familiarize you with the 6041 Network Terminating Module for application and engineering purposes only. Attempts to troubleshoot the 6041 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.

4.02 Both ends of a DX signaling system are balanced symmetrical circuits connected by two metallic conductors. In the case of the 6041, 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.

4.03 The 6041 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 detects 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 (potentiometer *R22*) 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.

4.04 In the transmit signaling direction, an *opto-coupled M-lead sense* circuit determines the state of the local M lead and operates an active bidirectional driver that provides the current changes in the DX loop toward the distant location.

4.05 Transmission interface is accomplished via an integral repeat coil whose input/output transformer is center-tapped to derive the A and B leads required for DX signaling. Norm/rev switch *S7* provides the means to reverse operation of these leads, when required. This input/output transformer derives switchable 600 and 900-ohm facility-side impedance terminations, as well as a fixed 600-ohm terminal-side impedance termination (in series with a 2μF capacitive component).

6. specifications

input/output impedance
2wire facility side: 600 or 900 ohms balanced, switch-selectable
2wire terminal side: 600 ohms balanced (in series with 2μF)

insertion loss
0.4 ±0.1dB at 1000Hz

frequency response
±0.5dB, 300 to 4000Hz, re 1000Hz

DX loop resistance
5000 ohms maximum

balance network
resistance: 0 to 6750 ohms in switch-selectable 250-ohm increments
capacitance: 0 to 6μF in switch-selectable 2μF increments

A&B-lead midpoint capacitance
0, 2, or 4μF, switch-selectable

E-lead output capability
500mA non-inductive
100mA inductive 60V

pulsing range
8 to 14pps

pulsing distortion
±1% via internal adjustment (potentiometer R22)

envelope delay distortion
less than 100μs, 500 to 4000Hz

current capacity
100mA maximum total unbalanced current

power requirement
−44 to −56Vdc filtered input

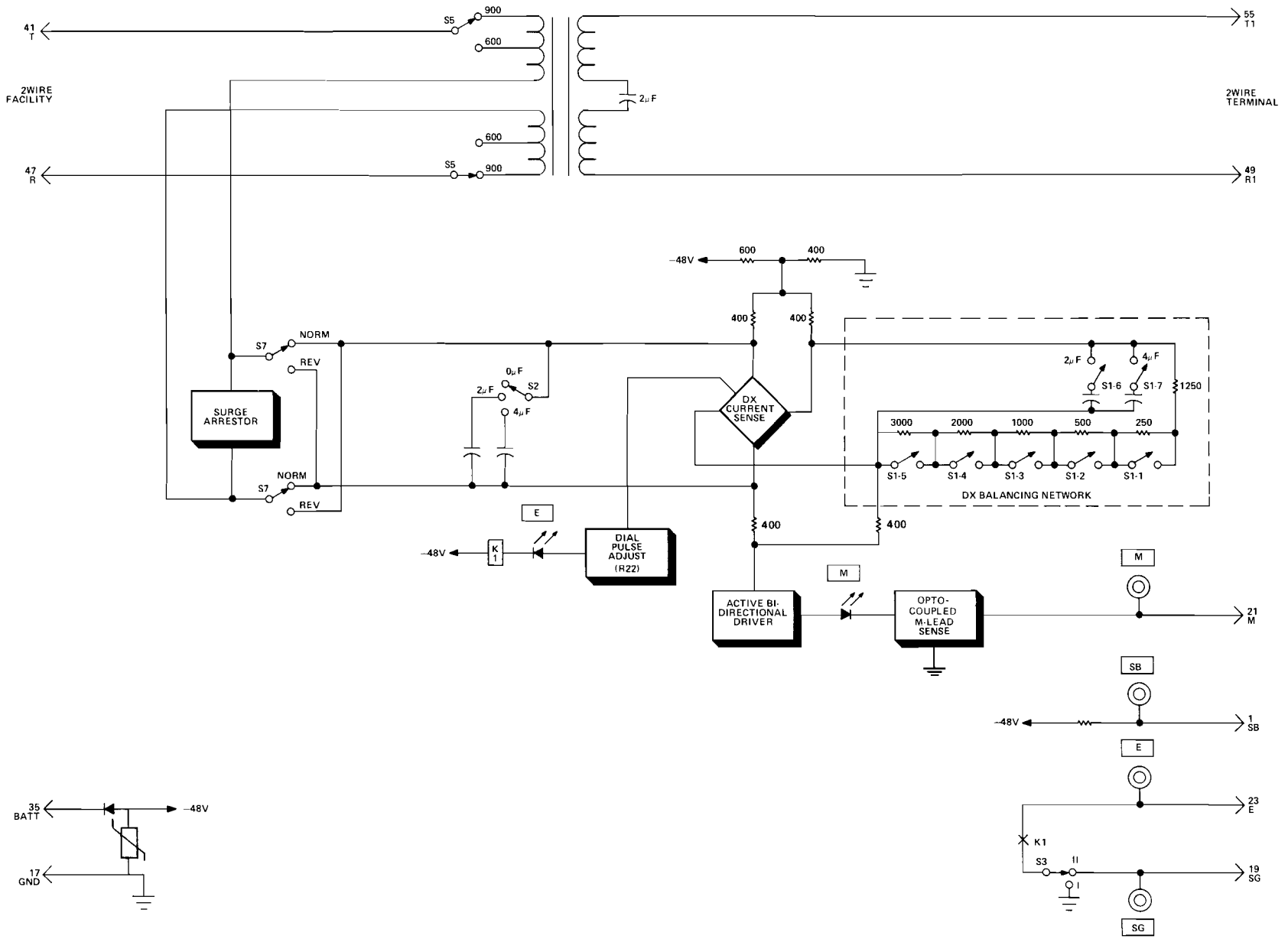
current requirements
60mA nominal (re −48Vdc input)
75mA maximum (re −52.1Vdc input)

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
13 ounces (368.5 grams)

mounting
relay rack or apparatus case via one position of Tellabs 262 or 262U System Assembly or Type 10 Mounting Shelf



6041 Network Terminating Module 816041

5. block diagram

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 6041 Network Terminating module. 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 6041 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, although an attempt will be made to do so. If a module must be marked* **defective**, *we recommend that it be done on a piece of tape or on a removable stick-on label.*

7.02 If a situation arises that is not covered in the Checklist, contact Tellabs Customer Service 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 6041 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 6041 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 8X6041 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 6041 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 6041 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 11
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 appears on page 8

testing guide checklist

Note 1: *Because the 6041 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 6041, remove the module from the mounting shelf and repeat this procedure before taking any further corrective action.*
Note 2: *The transmission continuity test for the 6041 module is most conveniently performed when a Tellabs 9801 Card Extender or an external jackfield is used to provide access to the appropriate module ports. Thus, this procedure is based on the assumption that a Card Extender or jackfield will be used. Jack designations are those on the 9801.*

test	test procedure	normal result	if normal conditions are not met, verify:
circuit idle	Connect VOM (set to 50Vdc or 250Vdc scale) from E-lead test point to ground.	More than 44Vdc present ☐. E-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 M-lead test point to ground.	Less than 1Vdc present ☐. M-lead LED off ☐.	Wiring ☐. Input from near-end signaling equipment idle ☐. Replace and retest ☐.
circuit busy	Connect VOM (set to 50Vdc or 250Vdc scale) from E-lead test point 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 test point to ground.	More than 44Vdc present ☐. M-lead LED on ☐.	Power ☐. Wiring ☐. Input from near-end signaling equipment busy ☐. Replace and retest ☐.
pulsing	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) ☐.
transmission continuity*	Arrange for distant (terminal) end to send 1004Hz test tone at CLR-specified level. Measure tone at 9801's *xmt in* jack with appropriately terminated transmission measuring set (TMS).	TMS indicates CLR-specified level ☐.	Cable faults ☐. Power ☐. Wiring ☐. Replace and retest ☐.
	Disconnect TMS from *xmt in* jack and measure tone at 9801's *xmt out* jack.	TMS indicates CLR-specified level minus 0.4 ±0.1dB ☐.	Power ☐. Wiring ☐. Terminating impedances correct ☐. Replace and retest ☐.

*Do not use an unbalanced measuring device for 2wire level measurements since erroneous readings will occur.

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