tellabs
technical manual
76-836102
rev C

practice section 836102

6102 Signaling Converter, E and M★

contents

1. general description

1.01 The 6102 E&M Signaling Converter module (figure 1) provides conversion between conventional E&M loop signaling and the logic-level inter-module E&M signaling required by an associated SF or DX signaling module. On its terminal (loop-signaling) side, the 6102 accommodates Type I, II, or III E&M signaling interface. On its facility side, the 6102 not only provides intermodule E&M signaling but also, in SF signaling applications, controls SF tone-generation and transmit-path-cut functions in the associated SF signaling module.

1.02 This Practice section is reissued to coordinate with a Tellabs Videotape Training Program covering both the 6102 E&M Signaling Converter module and the 6101 SF Transceiver module.

1.03 Features and options of the 6102 include the following: switchable normal or inverted M-lead signaling, optional use of a 9901 Pulse Corrector subassembly to provide precision pulse correction on the E lead, integral minimum-break (50ms) pulse correction on both the E and M leads, and use of either an internal or external E-lead ground source. Front-panel LED's indicate busy on the E and M leads, and front-panel test points provide access to battery, ground, and the E and M leads.

1.04 The 6102 is designed primarily for use with an associated SF signaling module, i.e., Tellabs' 6101 SF Transceiver. In combination, the 6101 and 6102 provide a complete SF signaling system that is fully compatible with established criteria for either E-type or F-type signaling. The 6102 can also be used with a DX signaling module, i.e., Tellabs' 6001 or 6002. Frequently the 6102 is found in Tellabs' 261 Signaling and Terminating System, and, less commonly, in Tellabs' 260 Signaling and Terminating System.

1.05 In the transmit direction, the 6102 converts local M-lead inputs to intermodule M-lead states required by the associated SF or DX signaling module. The 6102 also controls a cut-and-terminate relay in the 6101 SF Transceiver to minimize signaling interference by noise, transients, speech, and reflected signaling-tone bursts. Associated with the transmission-path cut is a circuit that delays M-lead transitions sufficiently to ensure that the cut has been effected before signaling tone is transmitted.

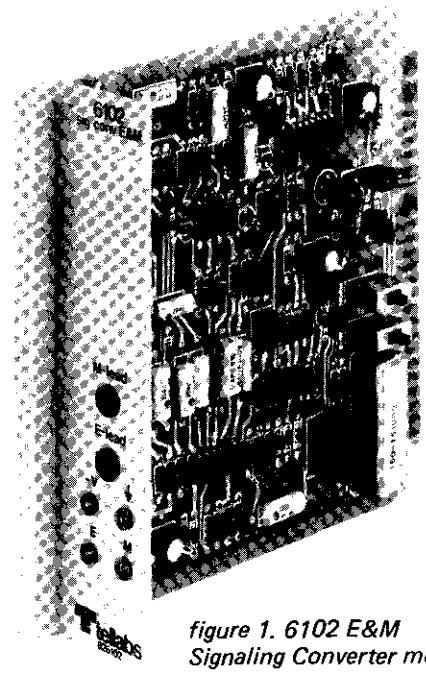


figure 1. 6102 E&M Signaling Converter module

1.06 The receive portion of the 6102 converts incoming intermodule E-lead states to the E-lead states required by local equipment.

1.07 Internal voltage regulation circuitry permits operation on −22 to −56Vdc filtered input. M-lead power is derived prior to regulation to permit operation with conventional M-lead potentials.

1.08 The 6102 mounts in one position of the 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. The 6102 also mounts in one position of a Tellabs 260 or 261 System Mounting Assembly.

2. application

2.01 The 6102 E&M Signaling Converter module is designed for use at either the originating end, a tandem location, or the terminating end of a 4wire E&M signaling circuit. The circuit may use either multifrequency (MF) or dial pulse (DP) address signaling and may use either the SF or DX signaling mode. Typically, the 6102 finds application in tie lines, standard toll signaling trunks, or private switched networks. It may be installed in a central office or in a PBX cabinet or KTU apparatus case.

2.02 The 6102 is most often used in conjunction with a 6101 SF Transceiver module, but it may also be used with a DX Signaling Set, i.e., Tellabs' 6001 or 6002, to provide E-lead and M-lead pulse correction for the DX signaling facility.

★ **A Tellabs Videotape Training Program is available for this product.**

2.03 In combination, the 6101 SF Transceiver and 6102 Signaling Converter provide a complete SF signaling system that is fully compatible with established criteria for either E-type or F-type in-band signaling. The 6101-6102 combination meets all Western Electric specifications for a 4wire E&M signaling unit (FWA). *[The 6101, 6102, and a Tellabs 420X Terminating Set are functionally equivalent to a Western Electric FAA and FUA. The 6101, 6102, and a Tellabs 4402 Pad/Transformer module are functionally equivalent to a Western Electric FBA and FUA.]*

2.04 When used with the 6101 SF Transceiver, the 6102 is capable of full-duplex operation; that is, the module can receive address signaling (DTMF [station] or MF [interoffice] signals) while simultaneously transmitting supervisory information (or vice versa). Tables 1 and 2 list SF-tone, transmit-path-cut, and band-elimination-filter (BEF) states for local and distant call origination, respectively.

2.05 The 6102 is often used in a Tellabs 260 or 261 Signaling and Terminating System, where it functions in conjunction with either a 6101 SF Transceiver or a 6001 or 6002 DX Signaling module. (Within the 260 and 261 universal wiring schemes, SF and DX signaling may be used interchangeably. The 6102 is interchangeable with other Tellabs Signaling Converter modules [e.g., the 6103, 6104, 6105, and 6106] in universally wired 260 or 261 Systems.) The 260 and 261 Systems commonly include a Line Amplifier on the facility side and a Term Set or Repeat Coil on the equipment side. When carrier is interfaced on the facility side, a Line Amp is not required. Typical applications of the 6102 are shown in figure 2.

circuit condition	SF tone		local condition of xmt path cut			local rcv path BEF state
	xmt	*rcv*	*before*	*change*	*after*	
idle	on	on	cut	none	cut	inserted
seizure, distant end	on	on/off transition	cut	remains cut 625±125ms after cessation of SF tone	not cut	removed 50±5ms after cessation of SF tone
local end returns *delay dial* signal	on/off transition	off	not cut	cut 125±50ms after M-lead transition from ground to battery.	not cut	out of circuit
local end returns *start dial* signal	off/on transition	off	not cut	precut 12±5ms, remains cut 625±125ms after M-lead transition from battery to ground	not cut	out of circuit
distant end transmits dial pulses	on	off/on—on/off transitions, ending with on/off transition	not cut	cut within 35ms of receipt of first tone pulse; remains cut as long as incoming break/make transitions are less than 625±125ms after last incoming on/off transition.	not cut	inserted 13 ±7ms after receipt of first tone pulse; remains in circuit until 50±5ms after last incoming on/off transition or 225±50ms, whichever is longer.
local end answers (free call)	on	off	not cut	none	not cut	out of circuit
local end answers (toll call)	on/off transition	off	not cut	cut 125±50ms after M-lead transition from ground to battery.	not cut	out of circuit
disconnect, distant end	off	off/on transition	not cut	none	not cut	inserted 13 ±7ms after receipt of SF tone
talking	off	off	not cut	none	not cut	out of circuit
disconnect, local end	off/on transition	on	not cut	precut 12±5ms then continuously cut	cut	inserted
idle	on	on	cut	none	cut	inserted

table 1. SF-tone, transmit-path-cut, and BEF states for distant call origination

circuit condition	SF tone		local condition of xmt path cut			local rcv path BEF state
	xmt	*rcv*	*before*	*change*	*after*	
idle	on	on	cut	none	cut	inserted
seizure	on/off transition	on	cut	stays cut 125±50ms after seizure.	not cut	inserted
distant end returns *dialing delay*	off	on/off transition	not cut	none	not cut	removed 50±5ms after cessation of tone.
distant end sends *start dial*	off	off/on transition	not cut	none	not cut	inserted 13 ±7ms after receipt of tone
local end dialing	off/on—on/off transitions, ending with on/off transition.	on	not cut	precut 12±5ms, remains cut as long as M-lead make/break transitions are less than 125±25ms apart; remains cut 125±50ms after last break/make transition.	not cut	inserted
distant end answers (free call)	off	on	not cut	none	not cut	inserted
distant end answers (toll call)	off	on/off transition	not cut	none	not cut	removed 50±5ms after cessation of tone.
talking	off	off	not cut	none	not cut	out of circuit
disconnect, local end first	off/on transition	off	not cut	precut 12±5ms, cut 625±125ms after M-lead transition from battery to ground.	not cut	out of circuit
disconnect, distant end	on	off/on transition	not cut	cut within 35ms	cut	inserted 13 ±7ms after receipt of tone
idle	on	on	cut	none	cut	inserted

table 2. SF-tone, transmit-path-cut, and BEF states for local call origination

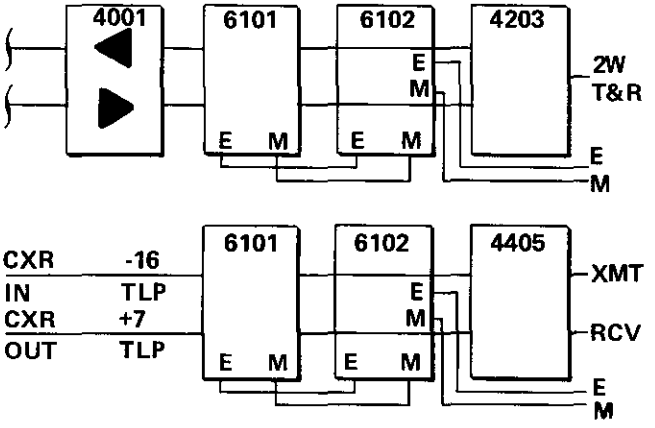


figure 2. Typical 6102 application with 6101 SF Transceiver

signaling

2.06 The 6102 accommodates both single-lead and looped-signaling-lead interfaces. The conventional single-lead (Type I) format is used in electromechanical switching system environments, while the newer looped formats (Type II and Type III interfaces) are used in electronic switching system environments. Figures 3 through 5 show the three E&M interfaces.

2.07 The 6102 may be switch-optioned for either internally derived or externally derived E-lead ground. In a Type I or Type III E&M interface, an internal E-lead ground is required. For Type II E&M signaling interface, an external ground potential is applied through the module's SG lead. The N lead is used to provide inverted E-lead signaling states (i.e., ground during idle and open during busy) when required.

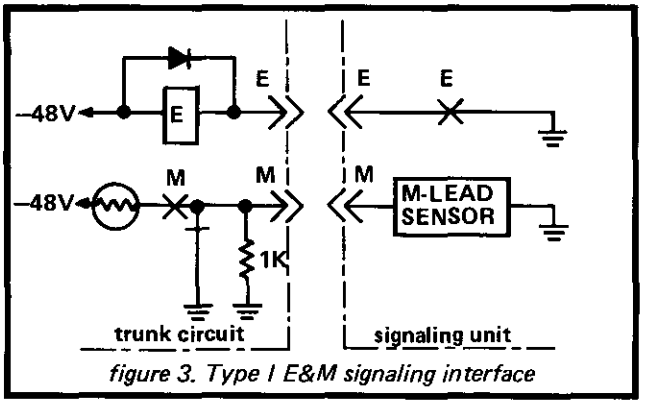


figure 3. Type I E&M signaling interface

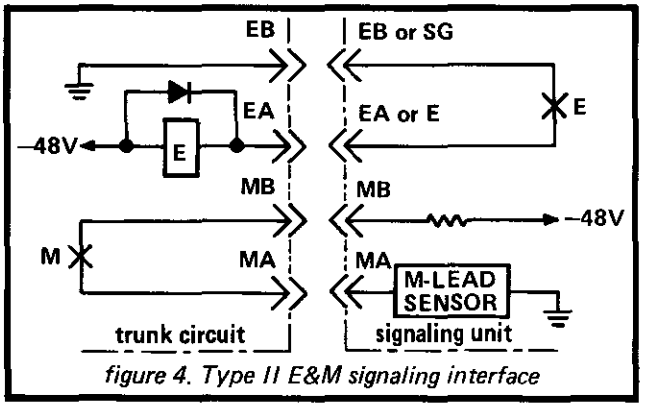


figure 4. Type II E&M signaling interface

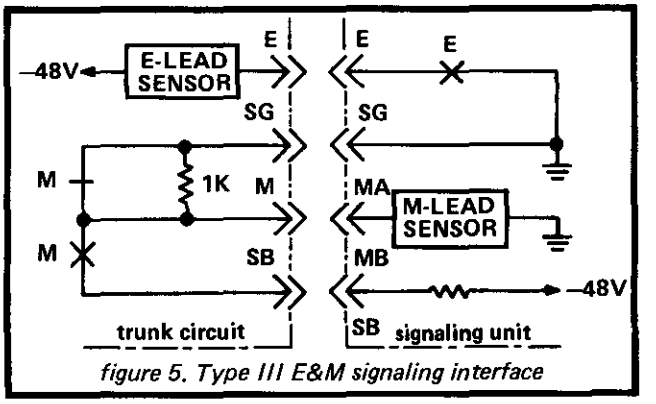


figure 5. Type III E&M signaling interface

2.08 To meet the requirements of all applications, including circuits with more than one dial-repeating circuit between the dial source and the M lead, minimum-break pulse correction is provided in both the E lead and the M lead. With these minimum-break correctors, all pulses received at 7.5 to 14pps and 30 to 50ms break are corrected to 50 ±2ms break. Pulses transmitted at 7.5 to 14pps and 20 to 50ms break are also corrected to 50 ±2ms break. In those applications requiring more precise E-lead (receive) pulse correction, an optional Tellabs 9901 precision Pulse Corrector subassembly may be plugged into a receptacle on the 6102's printed circuit board. The 9901 corrects pulses at 8 to 12pps and 30 to 70% break to 58 ±2% break, or pulses at 14pps and 40 to 65% break to 57 ±3% break. Use of the 9901 is determined by the pulse distortion inherent in a circuit and the ability of terminating equipment to interpret pulses. (A SxS office, for example, may not be as tolerant of pulse distortion as an ESS office.) While each circuit must be evaluated individually, the integral minimum-break correctors of the 6102 are normally adequate.

2.09 Neither the minimum-break pulse correctors nor the optional 9901 subassembly distorts supervisory wink pulses, so the 6102 may be safely used in circuits with senderized dial control supervision.

2.10 The switch option for inversion of the 6102's external M-lead states (i.e., battery during idle and ground during busy) allows use of the 6102 at tandem points in an E&M circuit or at any other point where E&M signaling units are directly interfaced (arranged back-to-back) without an intermediate pulse link repeater.

2.11 Front-panel LED's light to indicate busy on the intermodule E and M leads. Front-panel test points access equipment-side E and M leads as well as battery and ground.

Caution: *When applying potentials to these test points, be certain the modules are isolated from the switching equipment.*

2.12 In SF applications, the 6102's companion 6101 SF Transceiver operates with standard SF tone levels. SF tone levels are augmented during the first 400ms of tone transmission. Standard SF

tone level in the receive port is −13dBm, with −1dBm as the augmented level. Transmit tone level is −36dBm, with an augmented level of −24dBm. These levels are consistent with standard +7 receive and −16 transmit transmission level points (TLP's).

transmission

2.13 While transmission wiring bypasses the 6102 module, the 6102 does affect transmission through an associated 6101 SF Transceiver module. The transmit speech path through the 6101 is cut and terminated in both directions during idle circuit conditions, and is not cut while the local M lead is in the steadily seized condition. The transmit speech path is cut during dial pulsing in either direction, and is momentarily cut in response to signaling state changes in either the E-lead or M-lead circuit. These transmission interruptions are detailed in tables 1 and 2. Cut-and-terminate control in the 6102 permits dialing in either direction regardless of the status of the other direction. This allows use with associated loop-to-E&M converters in foreign-exchange applications.

2.14 An M-lead transition delay ensures that the transmission path cut precedes tone transmission. This 12 to 20ms delay prevents distortion (as a result of coincident noise or transients) of the first dial pulse in a series. This path cut also aids in the detection of dial control supervisory signals by preventing transmission of transients at the beginning of a start-dial signal.

power and range

2.15 Internal voltage regulation circuitry allows the 6102 to operate on filtered input voltages between −22 and −56Vdc. Power to the M lead is derived prior to regulation to permit conventional potentials to be used in M-lead operation. Range between a trunk circuit and the combination of the 6102 and its associated signaling module is dependent upon the sensing range of the trunk, as the range of the 6102 M-lead sensing circuitry is better than 2000 ohms. Facility-side range is dependent upon the capability of the associated SF or DX signaling unit.

3. installation

inspection

3.01 The 6102 E&M Signaling Converter 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 6102 mounts in one position of the Tellabs Type 10 Shelf, or in one position of a Tellabs 260 or 261 System Mounting Assembly. The module plugs physically and electrically into a 56-pin connector at the rear of the Shelf or Assembly.

installer connections

3.03 Before making any connections to the Mounting Shelf, make sure that power is **off** and modules are **removed**. The 6102 module should be plugged into place only **after** it is properly optioned and **after** wiring is completed.

> **Caution:** *The 6102 uses a mercury-wetted relay for E-lead output. Before installation, the module should always be held in an upright position and tapped gently on a hard surface. This procedure ensures proper settling of the mercury, preventing shorted relay contacts. The module should be kept upright and mounted in a vertical, upright position (i.e., with the front panel perpendicular to the ground and nomenclature right-side up) to operate properly. For this reason, the 6102 is not commonly used in the 260 System, which is often a desktop (horizontal) installation.*

3.04 Table 3 lists external connections to the 6102 Signaling Converter. All connections are made at the 56-pin connector at the rear of the module's mounting shelf position. Pin numbers are found on the body of the 56-pin connector.

connect:	to pin:
INTERMODULE E LEAD (from 6101 or 600X)	29
INTERMODULE M LEAD (to 6101 or 600X)	31
CT LEAD (to 6101)	27
EXTERNAL E LEAD (output to trunk, etc.)	5
EXTERNAL M LEAD (input from trunk, etc.)	21
SG/EB LEAD (if used – external ground)	3
N LEAD (if required)	1
MB/SB LEAD (if required)	7
−BATT (−22 to −56Vdc)	35
GND (internal ground)	17

table 3. External connections to the 6102 module

3.05 If precision pulse correction is required, Tellabs 9901 Pulse Corrector subassembly fits into a 4-pin receptacle on the 6102's printed circuit board. The 9901's plastic retainer fits into a hole on the board near the front panel (see figure 6). Properly mounted, the subassembly will not obstruct insertion into the mounting shelf.

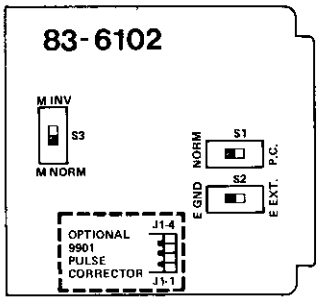


figure 6. 6102 switch option locations

3.06 A typical application of the 6102 involves its use in an SF signaling and terminating system with a 4001 Line Amp interfacing the facility and a 420X Term Set interfacing the station. Figure 7 shows the connections required in this application. Note that if the 6102 is provided in a Type 260 or 261 Signaling and Terminating System, all necessary connections are prewired as part of the System's universal wiring scheme.

options and alignment

3.07 All options on the 6102 module are selected via three slide switches located as shown in figure 6. These switches must be set as directed below before the module is placed into service.

3.08 Switch *S1* options the 6102 for use with or without a 9901 Pulse Corrector subassembly. Set

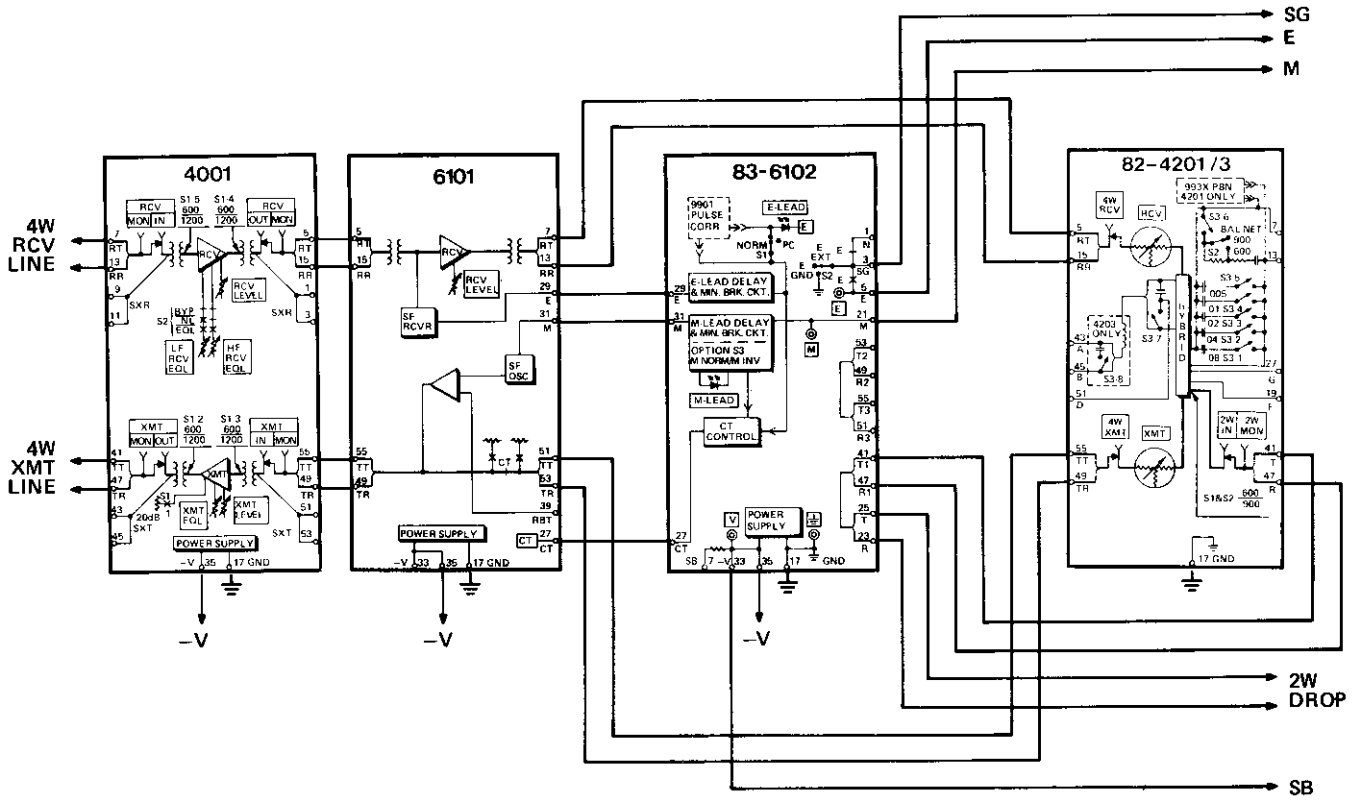


figure 7. Wiring diagram showing necessary connections for a typical SF signaling application

S1 to the *NORM* position if the 9901 subassembly **is not used**; set *S1* to the *PC* position if the 9901 assembly **is used.**

3.09 Switch *S2* options the 6102 for either internal or external E-lead ground (see paragraph 2.07). Set *S2* to the *E EXT* position if an external ground is used (and connect the SG/EB lead to pin 3). Set *S2* to the *E GND* position if an external ground (provided by the SG/EB lead) is not used and the module's internal ground is used instead.

3.10 Switch *S3* provides for inversion of the input M-lead states. (See paragraph 2.10.) Set *S3* to the *NORM* position for normal M-lead operation (i.e., ground = idle). Set *S3* to the *M INV* position for inverted M-lead operation (i.e., ground = busy).

3.11 The 6102 requires no alignment. In SF applications, however, the receive amplifier of the associated 6101 SF Transceiver should be adjusted for zero gain. Additionally, if an associated Line Amplifier is used at the facility interface, and a Term Set on the terminal side, these modules should be adjusted (at 1000Hz) to provide +7dBm receive and −16dBm transmit transmission levels to the 6101 module. Refer to either the Tellabs 260 or 261 System Practice or to the individual Practices on the associated Line Amps, Signaling modules, Term Sets, and Repeat Coils for detailed information on the optioning and alignment of these modules.

4. circuit description

4.01 This circuit description is intended to familiarize you with the 6102 E&M Signaling Converter module for engineering and application purposes only. Attempts to test or troubleshoot the 6102 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 6102 block diagram, section 5, as an aid in following this circuit description.

4.02 The 6102 consists of several timing and detection circuits for implementing the various E-lead and M-lead delays, and a multi-function timing circuit, controlled from both the E-lead and M-lead circuits, that controls insertion and removal of the transmit path cut in the 6101 module.

4.03 Incoming E-lead open-to-ground (make) transitions are delayed by approximately 17 milliseconds by the E-lead *make* (open-to-ground) *delay* timer, which is followed by a similar (and carefully matched) *break* (ground-to-open) *delay* timer. Associated with the *break delay timer* is a pulse-triggered monostable *minimum-break timer* that inhibits change of the *break delay timer* from break to make until 50 milliseconds have elapsed following the preceding break transition, regardless of the E-lead condition. This timer insures a minimum 50-millisecond break interval. Following the *break delay timer* are a *relay driver* and the E-lead relay.

Note: *Instructions for alignment of associated modules when the 6102 is used in the Tellabs 260 and 261 Signaling and Terminating Systems are also included in the Tellabs Videotape Training Program on this product. This and other Tellabs Training Programs are available in ¾-inch and ½-inch videotape formats. Contact your Tellabs representative through your training or engineering department for information about this program.*

4.04 The input M-lead signal is similarly processed through a series of *make delay* timers and a *minimum-break timer* to an *M-lead driver* transistor. The transistor (PNP) collector derives the output M-lead signaling state.

Note: *The output M lead is characterized by approximately 5.6 kilohms to −20Vdc potential when the circuit is busy, and by approximately 150 ohms to ground in the idle condition. These conditions are designed to provide proper input to Tellabs' 6101 SF Transceiver or 6001 or 6002 DX modules. They are not suitable for general M-lead signaling.*

4.05 Control inputs to the transmit cut-and-terminate circuit are provided from both the E-lead and the M-lead circuits. A 625-millisecond timer is activated by any transition of the E-lead from open-to-ground (make) when the local M-lead is idle, and a 125-millisecond timer is activated whenever the input M-lead makes a transition from idle (ground) to busy (battery).

4.06 The internal *voltage regulator* in the 6102 consists of a series transistor regulator with zener diode reference.

6. specifications

M-lead pulsing range
7.5 to 14pps

internal M-lead pulse correction
minimum-break type, 50 ±2ms minimum break duration

M-lead pulse distortion
±2ms, pulses longer than 50ms

M-lead transition delay
15 to 20ms

transmit precut (with 6101 only)
7 to 17ms

transmit cut-and-terminate removal delay (with 6101 only)
625 ±125ms (after E-lead transition from open to ground when local M lead is idle)

external M-lead resistance
2000 ohms maximum

E-lead pulsing range
7.5 to 14pps

internal E-lead pulse correction
pulses from 30 to 50ms break corrected to 50 ±2ms break

E-lead pulse correction (with optional 9901 precision Pulse Corrector)
input 8 to 12pps, 30 to 70% break corrected to 58 ±2% break; input 14pps, 40 to 65% break corrected to 57 ±3% break

E-lead pulse distortion (without optional 9901 precision Pulse Corrector)
±2ms, pulses longer than 50ms

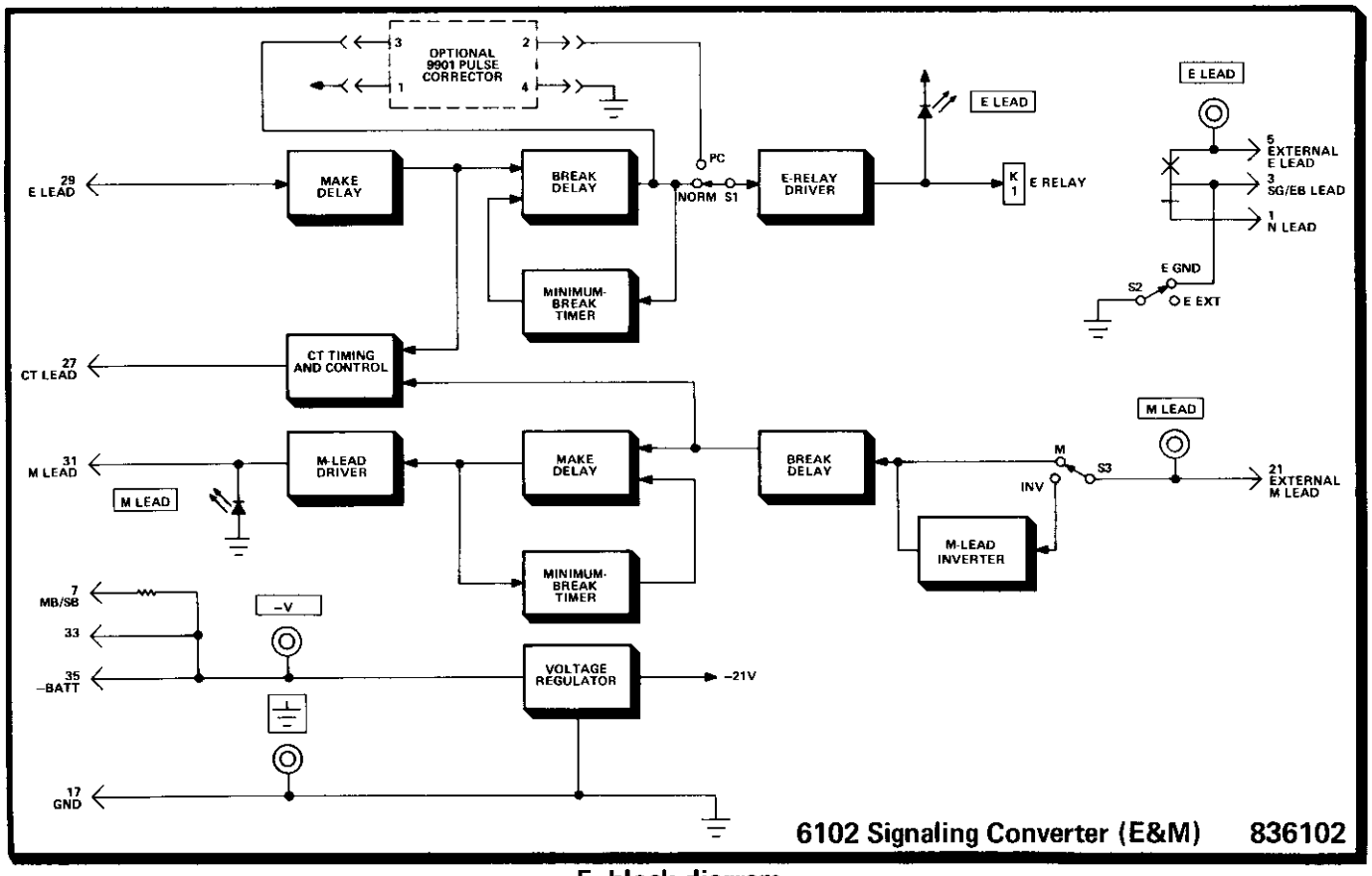
input power
−22 to −56Vdc, 20 to 30mA idle, 25 to 35mA busy

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
6 ounces (170 grams)
7 ounces (198 grams) with 9901 precision Pulse Corrector

mounting
relay rack or apparatus case via one position of a Tellabs Type 10 Mounting Shelf; also mounts in one position of a Tellabs 260 or 261 System Mounting Assembly



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 6102 Signaling Converter (E&M) 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 6102 module. Unauthorized testing or repairs may void the module's warranty.

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 or Mississauga Headquarters. Telephone numbers of the regional offices are as follows:

central: (314) 625-8800
northeast: (412) 787-7860
southeast: (305) 645-5888
western: (213) 595-7071

7.03 If a 6102 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 6102 module, notify Tellabs via letter (see below), telephone ((312) 969-8800 in the USA, (416) 624-0052 in Canada), or twx (910-695-3530). Be sure to provide all relevant information, including the 8X6102 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 6102 in the replacement module's carton, sign the packing slip included with the replacement module, 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 6102 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 on page 8

testing guide checklist

Note: *This testing guide checklist is based on the assumption that the 6102 is being tested with a 6101 SF Transceiver in a 260 or 261 Signaling and Terminating System with all modules inserted.*

test	test procedure	normal result	if normal conditions are not met, verify:
E-lead idle	Request distant location to send SF tone. Observe E-lead LED.	With tone present, LED is not lit ☐.	System alignment ☐. Received tone 2600 ±10Hz ☐. Switch *S1* on 6102 properly set ☐. Replace 6101 and retest ☐. Replace 6102 and retest ☐.
E-lead busy	Request distant location to remove SF tone. Observe E-lead LED.	With no tone present, LED lights ☐.	Option switches properly set ☐. E-lead resistance to ground is zero ☐. Replace 6101 and retest ☐. Replace 6102 and retest ☐.
E-lead pulsing	Request distant location to send dial pulses at various percent breaks. With TMS arranged for 600-ohm bridged measurement and connected to 4001's *rcv OUT MON* jack, verify pulse level is −1dBm. Use a pulsing test set (PTS) to measure percent break of E-lead output (pin 5).	Without 9901: input at 7.5 to 14pps and 30 to 50ms break corrected to 50 ±2ms break ☐, and pulses longer than 50ms break within ±2ms of input break ☐. With 9901: input at 7.5 to 12pps input and 30 to 70% break corrected to 58 ±2% break ☐. Input at 14pps and 40 to 65% break corrected to 57 ±3% break ☐.	Option switches properly set ☐. 9901 (if used) mounted properly ☐. Input noise does not exceed 56dBrnC ☐. Circuit alignment ☐. SF tone level ☐. Replace 6101 and retest ☐. Replace 6102 and retest ☐.
M-lead idle	Verify that switch *S3* on 6102 set to *M NORM*. Disconnect external M lead (pin 21) from switching equipment. Using TMS arranged for 600-ohm bridged measurement, monitor tone state at 4001's *xmt IN MON* jack.	For 300 to 500ms after application of M-lead ground, SF tone level is −24 ±1dBm ☐. Level diminishes to −36 ±1dBm and remains for duration of M-lead ground ☐. M-lead LED is not lit ☐.	External M lead isolated from switching equipment ☐. Wiring between 6101 and 6102 ☐. Switch *S3* on 6102 set correctly ☐. Replace 6101 and retest ☐. Replace 6102 and retest ☐.
M-lead busy	Same as above. Remove M-lead ground.	No SF tone present ☐. M-lead LED lights ☐.	Power to 6102 ☐. Wiring between 6101 and 6102 ☐. Switch *S3* on 6102 set correctly ☐. Replace 6102 and retest ☐. Replace 6101 and retest ☐.
M-lead pulsing	Verify switch *S3* on 6102 set to *M NORM*. Disconnect external M lead (pin 21) from switching equipment. Use PTS connected to 6102's external M lead to send dial pulses at varying percent breaks. Measure E-lead pulses at distant location.	At distant location input pulses at 7.5 to 14pps and 30 to 50ms break corrected to 50 ±2ms break ☐.	Wiring between 6101 and 6102 ☐. Power and ground to both modules ☐. Replace 6101 and retest ☐. Replace 6102 and retest ☐.
transmit path cut	With circuit idle, insert 1004Hz tone (0dBm0) at Term Set's *2w in* jack or at *xmt in* port of associated 4W Station Termination module. Connect TMS arranged for 600-ohm bridged measurement to Line Amp *xmt IN MON* jack (or pins 55 and 49 on 6101).	TMS indicates 2600Hz signal at −36 ±1dBm ☐.	Circuit idle in both directions ☐. Replace 6101 and retest ☐. Replace 6102 and retest ☐. Check wiring between pin 27 of 6101 and pin 27 of 6102 ☐.

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