tellabs
technical manual
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9662 4Wire E&M SF Signaling Set with Gain

contents

1. general description

1.01 The Tellabs 9662 4Wire E&M SF Signaling Set module with Gain (figure 1) provides signaling and transmission interface between a 4wire transmission facility and a 4wire trunk circuit. The 9662 provides level control in both the transmit and receive paths, bidirectional amplitude equalization, and full-duplex signaling conversion between SF signaling on the transmission facility and the E&M signaling of a trunk circuit associated with a two-way dial/supervisory telephone circuit. Conventional 2600Hz SF tone is standard; other frequencies are optionally available. The 9662 differs from conventional 4wire E&M SF signaling sets in that it contains integral amplifiers to accommodate a variety of facility interface levels.

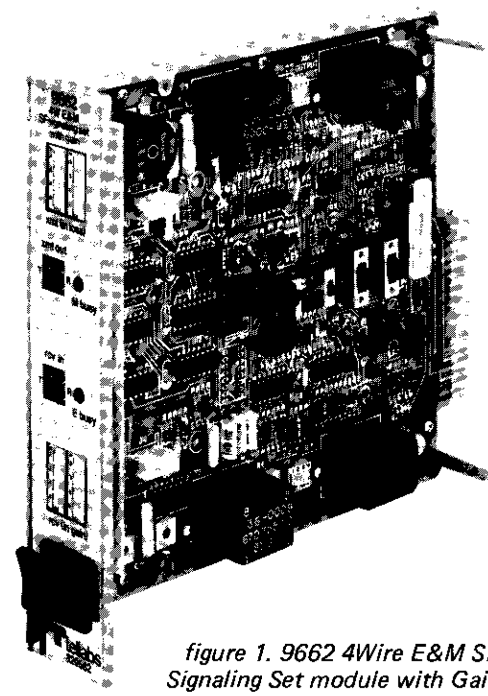


figure 1. 9662 4Wire E&M SF Signaling Set module with Gain

1.02 This Practice section is reissued to cover changes to the 9662 module resulting in the Issue 2 version (Tellabs part number 829662). The Issue 1 version contains an integral equalizer in the receive channel only. Equalization in the Issue 2 version is provided by the optional Tellabs 9908A Active Slope Equalizer plug-on subassembly. The 9662 accommodates two 9908A's so that equalization can be provided in the transmit channel, the receive channel, or both. The Issue 2 9662 also contains an SX ONLY/MTM-1/2/MTM-2/S option switch not present on the Issue 1 version.

1.03 Features and options of the 9662 include the following: precision amplifiers and attenuators; optional transmit-channel and receive-channel active equalizers; switch selection of all options; an internal SF oscillator; switchable normal or inverted M-lead signaling; switchable E-lead contact configuration for Type I, II, or III signaling interface; switchable SX ONLY, MTM-1/2, or MTM-2/S MFT configuration; and transmit and receive minimum-break pulse correction. Front-panel LED's indicate E-lead and M-lead busy status, and front-panel test points access facility-side transmit and receive ports.

1.04 Level coordination in the transmit channel is provided by precision attenuators on the terminal side and precision level-control circuitry (providing either gain or loss) on the facility side. The terminal-side attenuators can be prescription-set to provide from 0 to 24dB of loss in discrete 0.1dB increments. The facility-side level-control circuitry can be switch-optioned to provide a fixed +5, +3, 0, or −16 transmission level point (TLP) with respect to a conventional transmit TLP of −16.

1.05 Level coordination in the receive channel is provided by a precision amplifier on the facility side and precision level-control circuitry (providing either gain or loss) on the terminal side. The facility-side amplifier can be prescription-set to provide from 0 to 24dB of gain in discrete 0.1dB increments. The terminal-side level-control circuitry can be switch-optioned to provide a −2, 0, +2, or +7 TLP with respect to a conventional receive TLP of +7.

1.06 Equalization for nonloaded cable can be optionally provided in either or both channels via one or two Tellabs 9908A Active Slope Equalizer subassemblies. The 9908A provides up to 7.5dB of slope equalization at 3000Hz (re 1000Hz) in 0.5dB increments. The subassemblies plug physically and electrically into four-pin connectors located on the 9662's printed circuit board.

1.07 Transformer coupling with fixed, balanced 600-ohm terminating impedance is provided in both channels on the terminal side of the 9662. Transformer coupling with balanced, switch-selectable 150-, 600-, or 1200-ohm terminating impedance is provided in both channels on the 9662's facility side. In addition, the terminal-side transformers are center-tapped to derive balanced simplex leads.

1.08 In the transmit channel the 9662 converts local M-lead inputs to outgoing SF tone signals. A minimum-break pulse corrector ensures transmission of recognizable tone pulses. A transmission path cut circuit with a nominal 15ms pre-cut delay interval prevents transient interference with outgoing signaling tones. An option switch is provided for M-lead signaling-state inversion.

1.09 The receive portion of the 9662 converts incoming SF signaling tones to local E-lead states. A minimum-break pulse corrector ensures transmission of recognizable E-lead pulses. Recognition delays prevent response to spurious SF tone bursts and to momentary tone interruptions.

1.10 The 9662 module is a member of Tellabs' 9600 family of Metallic-Facility-Terminal (MFT)-configured modules. It is electrically and mechanically compatible with the other modules in the 9600 family and with the Western Electric MFT modules.

1.11 The 9662 module mounts in one position of a Western Electric MFT single-module (MTM-1), MFT double-module (MTM-2/S or MTM-2), or Customer-Premises Facility Terminal (CPFT) Shelf. The MTM-1, MTM-2/S, and MTM-2 Shelves are designed for 23-inch relay rack installation, while the CPFT Shelf is designed for customer-premises applications. The module plugs physically and electrically into a 40-pin connector located at the rear of the Shelf. Refer to paragraph 3.02 for specific mounting information.

2. application

2.01 The main application of the 9662 4Wire E&M SF Signaling Set module with Gain is as a stand-alone module used to interface a 4wire E&M trunk circuit in a variety of E&M SF signaling applications (e.g., toll and tie line). Figure 2 shows a typical application of this type. The 9662 provides full-duplex signaling conversion between the transmission facility and an E&M trunk circuit associated with a two-way dial/supervisory telephone circuit. When used in this application, the 9662 mounts in a Western Electric MTM-1 or MTM-2 MFT mounting shelf. Another application of the 9662 is in an intermediate location requiring an associated DX signaling set. In this application, the 9662 interfaces a 4wire metallic facility (using DX signaling) on its terminal side with a 4wire metallic or carrier facility (using SF signaling) on its facility side.

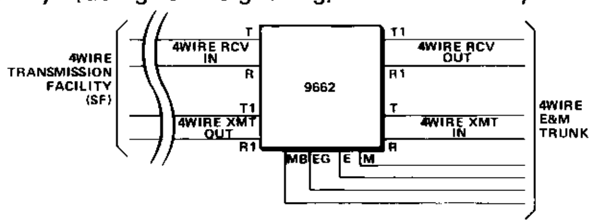


figure 2. 9662 terminal application

Figure 3 shows a typical application of this type. When used in this application, the 9662 mounts in a Western Electric MTM-2/S MFT mounting shelf. The 9662 can also be optioned (in MTM-1 mounted applications) to provide access to the simplex leads on pins 4 and 7 instead of the E&M leads. This feature provides direct compatibility with the Western Electric J99343SF MFT module.

In the paragraphs that follow, the descriptions apply specifically to the **main** application of the 9662 described above.

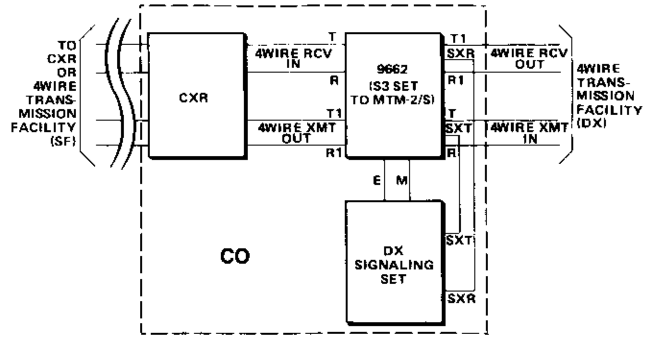


figure 3. 9662 intermediate application

terminal interface

2.02 The 9662 interfaces the local (terminal-side) 4wire E&M trunk circuit via prescription-set transmit-channel attenuators, receive-channel level-control circuitry that provides either gain or loss, and transformers that provide fixed 600-ohm terminating impedance at both the transmit and receive ports. Transient protection is provided at both ports. Each of the two terminal-side transformers is center-tapped to derive a balanced simplex lead.

facility interface

2.03 The 9662 interfaces the 4wire transmission facility via a prescription-set receive-channel amplifier, transmit-channel level-control circuitry that provides either gain or loss, and transformers that can be switch-optioned for a balanced impedance match of 1200 ohms (for loaded cable), 600 ohms (for nonloaded cable or carrier), or 150 ohms (to provide a small degree of slope equalization for nonloaded cable through a deliberate impedance mismatch).

level control

2.04 Precision level-control circuitry in both channels of the 9662 provides for interfacing transmit and receive facility-side levels with terminal-side levels in accordance with good transmission design. Integral amplifiers allow the 9662 to accommodate a variety of facility-side interface levels rather than only the conventional −16 transmit and +7 receive TLP's to which SF units without amplifiers are generally limited. In the transmit channel, facility-side level-control switches can be set to provide a +5, +3, 0, or −16TLP with respect to the conventional −16 transmit TLP, and terminal-side attenuation switches can be prescription-set to provide from 0 to 24dB of loss in 0.1dB increments. In the receive channel, facility-side gain switches can be prescription-set to provide from 0 to 24dB of gain in 0.1dB increments, and terminal-side level-control switches can be set to provide a −2, 0, +2, or +7TLP with respect to the conventional +7 receive TLP. The two TLP-selection switches are four-position DIP switches located on the 9662's printed circuit transmit-attenuation and receive-gain switches are eight-position DIP switches located on the 9662's front panel. The latter two switches are cumulative; the amount of transmit loss or receive gain is the sum of that channel's switch positions set to *IN*.

2.05 If transmit output and receive input levels other than those available via the 9662's TLP-selection switches are required, these levels can be provided through the use of printed-circuit-board potentiometers associated with the TLP-selection switches. With the receive TLP switch set for a +7 TLP, the receive output level is variable between +7 and −20dBm with respect to a +7 TLP. With the transmit TLP switch set for a +5 TLP, the transmit output level is variable between +5 and −20dBm with respect to a −16 TLP. Figure 4 summarizes both level-control and terminating-impedance selections at all four of the module's ports. See paragraphs 3.09 through 3.11 for details on setting levels.

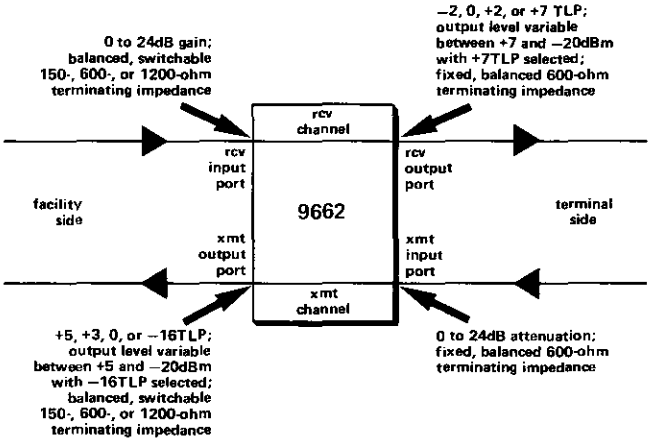


figure 4. Facility-side and terminal-side interfaces

amplitude equalization

2.06 To compensate for the frequency response of nonloaded cable, slope equalization can be optionally provided in either or both channels via one or two Tellabs 9908A Active Slope Equalizer subassemblies. The 9908A introduces up to 7.5dB of slope equalization at 2804Hz (re 1000Hz with 0dB gain) in 0.5dB increments. Frequency response of the 9908A is shown graphically in figure 5 and in tabular form in table 1.

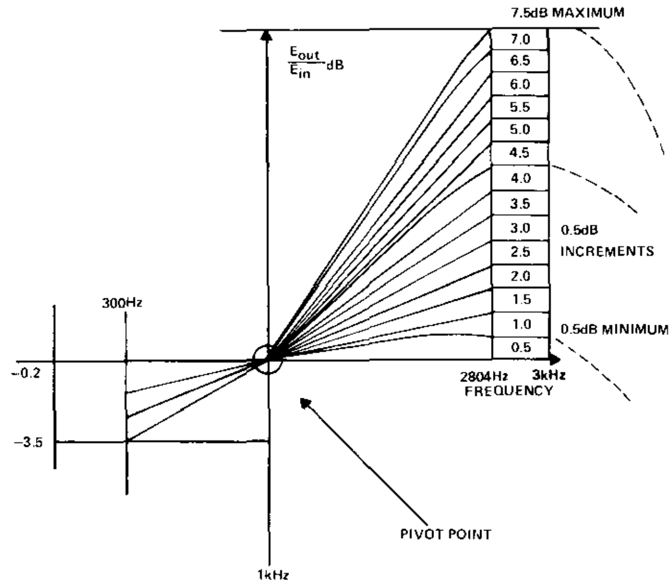


figure 5. Typical response curves for 9908A Equalizer subassembly

operating modes

2.07 In typical (Type I) E&M SF signaling applications, the 9662's receive channel provides an E-lead output that is open when SF tone is present at the receive input port and that is at circuit ground when no SF tone is present. In the transmit channel, the 9662 transmits SF tone when the local M lead is either open or at ground potential and ceases SF tone transmission when the M lead is at local negative battery potential.

2.08 The E-lead output from the 9662 is derived via a mercury-wetted contact relay with a normally

9908A switch setting (in dB)	frequency										
	300Hz	400Hz	500Hz	800Hz	1000Hz	1500Hz	1800Hz	2500Hz	2804Hz	3000Hz	3200Hz
0	−0.2	−0.1	−0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.5	−0.5	−0.4	−0.3	−0.1	0.0	+0.2	+0.3	+0.4	+0.5	+0.5	+0.5
1.0	−0.8	−0.7	−0.6	−0.2	0.0	+0.4	+0.6	+0.9	+1.0	+1.0	+1.0
1.5	−1.1	−0.9	−0.8	−0.2	0.0	+0.6	+0.9	+1.3	+1.4	+1.5	+1.5
2.0	−0.8	−0.6	−0.5	−0.2	0.0	+0.4	+0.7	+1.5	+1.9	+2.2	+2.5
2.5	−1.1	−0.9	−0.7	−0.2	0.0	+0.6	+1.0	+2.0	+2.4	+2.7	+3.0
3.0	−1.5	−1.2	−1.0	−0.3	0.0	+0.8	+1.3	+2.4	+2.9	+3.2	+3.5
3.5	−1.8	−1.5	−1.2	−0.4	0.0	+1.0	+1.6	+2.8	+3.4	+3.7	+4.7
4.0	−1.8	−1.5	−1.1	−0.4	0.0	+1.1	+1.8	+3.4	+4.1	+4.5	+4.9
4.5	−2.2	−1.7	−1.4	−0.5	0.0	+1.3	+2.1	+3.9	+4.6	+5.1	+5.4
5.0	−2.5	−2.0	−1.6	−0.6	0.0	+1.5	+2.4	+4.3	+5.1	+5.5	+5.9
5.5	−2.8	−2.3	−1.8	−0.6	0.0	+1.7	+2.7	+4.7	+5.5	+6.0	+6.5
6.0	−2.5	−2.0	−1.6	−0.6	0.0	+1.5	+2.5	+5.0	+6.0	+6.7	+7.4
6.5	−2.8	−2.2	−1.8	−0.6	0.0	+1.7	+2.8	+5.4	+6.5	+7.2	+7.9
7.0	−3.2	−2.5	−2.0	−0.7	0.0	+1.9	+3.1	+5.8	+7.0	+7.7	+8.4
7.5	−3.5	−2.8	−2.3	−0.8	0.0	+2.1	+3.4	+6.3	+7.5	+8.2	+8.9

table 1. Typical frequency response of 9908A Equalizer subassembly

open (E) contact. This contact can be switch optioned to provide Type I, II, or III E&M signaling-lead interface. (Refer to paragraph 2.10 for additional information.) Regardless of the signaling format, however, the relay is energized when the 9662 senses no SF tone present at the receive input port and is de-energized when SF tone is detected. The minimum-break receive pulse corrector is arranged to control the pulsing relay such that, following tone recognition, the relay is de-energized for a minimum time interval of 50ms. After this 50ms input break interval, the relay will energize upon absence of tone.

2.09 An M-lead option switch allows the 9662 to accommodate either normal or inverted M-lead signaling states. In the normal state, the 9662 transmits SF tone when the local M lead is either open or at ground potential and removes SF tone when the local M lead is at negative battery potential. In the inverted state, the 9662 transmits SF tone when the M lead is at negative battery potential and removes SF tone when a ground potential or open is applied to the M lead. (In either case, the minimum-break transmit pulse corrector ensures that the minimum duration of any outgoing tone pulse will be 50ms.) When the 9662's M-lead inversion capability is used, the 9662 can be arranged back-to-back with another E&M signaling device, at an intermediate location, without the need for an intermediate pulse link repeater.

E&M signaling interface

2.10 The 9662 accommodates both single-lead and looped-signaling-lead E&M 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. Figure 6 shows the connections required for Type I, II, and III E&M signaling interfaces.

incoming tone detection

2.11 The 9662 is designed to interface the receive side of the 4wire transmission facility (via the receive in port) at a programmed TLP of +7 to −17; thus, idle SF tone is received at a nominal level of −20dBm0. An augmented level of −8dBm0 is typically received during break portions of dial pulses and for about 400 milliseconds at the beginning of each tone interval. The 9662's receiver will reliably detect SF tone levels as low as −31dBm0, provided that the SF tone energy is at least 10dB above the level of all other signals simultaneously present at the receive input. The SF tone detector is actually a signal-to-guard ratio comparator that compares energy in a narrow band of frequencies centered at the SF tone frequency with energy in the entire voice band. This detection arrangement aids significantly in prevention of talk-off, but it places an upper bound on allowable circuit noise. In general, received noise in excess of 58dBrnC may interfere with detection of low-level signaling tones.

2.12 Within approximately 13 milliseconds of detection of received SF tone, a band-elimination filter (BEF) is inserted into the receive transmission path to prevent propagation of SF tone beyond the local SF unit. An internal timing circuit ensures that the filter remains inserted during dial pulsing and during momentary losses of tone continuity. (See tables 2 and 3 for details covering BEF insertion.)

2.13 The minimum-break pulse corrector in the receive path is designed to ignore momentary losses of SF tone up to 50 milliseconds in duration. This corrector also ensures that E-lead breaks have a minimum duration of 50ms. The 9662 recognizes signaling-state changes in the receive direction independent of the local M-lead state.

transmit-direction signaling

2.14 The 9662 is designed to interface the transmit side of the transmission facility at a programmed TLP of −16 to +8, and to transmit SF tone at

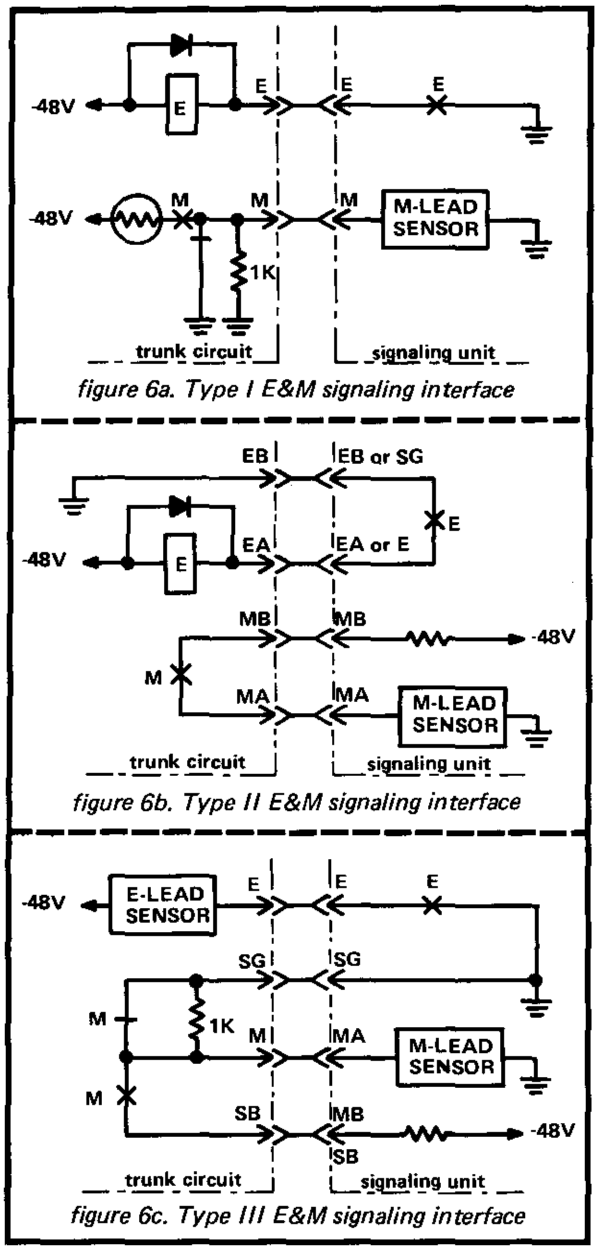


figure 6a. Type I E&M signaling interface

figure 6b. Type II E&M signaling interface

figure 6c. Type III E&M signaling interface

figure 6. E&M signaling interfaces

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±8ms after receipt of tone
local end dialing	off/on—on/off transitions, ending with on/off transition.	on	not cut	precut 18±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 18±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±8ms after receipt of tone
idle	on	on	cut	none	cut	inserted

table 2. SF tone state, transmit cut, and receive BEF insertion conditions — local 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, 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 18±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±8ms 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±8ms 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 18±5ms then continuously cut	cut	inserted
idle	on	on	cut	none	cut	inserted

table 3. SF tone state, transmit cut, and receive BEF insertion conditions — distant-location call origination

either of two levels. Specifically, SF tone is transmitted at −20dBm0 during idle and at an augmented level of −8dBm0 during dial pulsing and for approximately 400ms each time tone is applied to the facility. This momentarily increased tone level aids in detection of supervisory-state changes and incoming dial pulsing.

delay circuit and transmit pulse correction

2.15 A symmetrical delay of approximately 20 milliseconds is provided between the input M lead and the tone transmission gate. This delay prevents inadvertent transmission or interruption of SF tone in response to momentary M-lead transitions. This delay is also instrumental in prevention of transient interference with tone transmission, as noted in paragraph 2.18.

2.16 A minimum-break pulse corrector is used in the transmit path to ensure a 50-millisecond minimum-break duration during dialing. This type of pulse correction does not interfere with supervisory winks and momentary signaling-state changes and helps to ensure that recognizable pulses are transmitted. The pulse corrector does not alter the duration of tone intervals resulting from M-lead state changes longer than 50 milliseconds.

transmit path cut

2.17 The transmit-channel voice transmission path through the 9662 is cut (opened) during idle circuit conditions, and is not cut when the local M lead is in the busy condition. The path is cut during dialing in either direction and is momentarily cut in response to any transition of the M lead while the E lead is in the off-hook state. These path cuts prevent transmission of noise, transients, speech, and other interfering signals during critical signaling intervals.

2.18 The transmit path cut is inserted within 5 milliseconds of an M-lead state change. Tone transmissions in response to M-lead state changes are delayed approximately 20 milliseconds, resulting in a nominal pre-cut interval of 15 milliseconds. This ensures that any transients associated with signaling state changes in the local trunk circuit will not affect signaling tone transmission. Details concerning insertion and removal of the transmit path cut are provided in tables 2 and 3.

tone source

2.19 The 9662 contains an integral 2600Hz SF tone oscillator and therefore does not require an external SF tone supply. No leads are supplied for an external SF tone supply.

power

2.20 The 9662 module is designed to operate on filtered input potentials between −42 to −56Vdc, ground referenced. The positive side of the dc power supply should be connected to earth ground. Current requirements range from 45mA at idle to a maximum of 65mA.

3. installation

inspection

3.01 The 9662 4Wire E&M SF Signaling Set module with Gain should be visually inspected upon arrival 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

> **Caution:** *The 9662 uses a mercury-wetted relay for E-lead output. Before installation, the module should be held in an upright position and tapped gently on a hard surface to ensure that the mercury is properly positioned within the relay. Once tapped, the module should be kept in an upright position until installation and installed in a vertical, upright position.*

3.02 As an MFT-configured module, the 9662 mounts in one position of a Western Electric MFT single-module (MTM-1), MFT double-module(MTM-2/S or MTM-2), or Customer-Premises Facility Terminal (CPFT) Shelf. The MTM-1 is a 12-position central-office-type shelf that is factory-wired to accept up to 12 MFT-configured units such as the 9662. The MTM-2/S is a 12-position central-office-type shelf that is factory-wired to accept up to six MFT-configured transmission units and up to six companion signaling units. The MTM-2 is a 12-position central-office-type shelf that is factory-wired to accept up to six MFT-configured transmission/signaling modules in a stand-alone application. The MTM-1, MTM-2/S, and MTM-2 are designed for 23-inch relay rack installation. For smaller, customer-premises installations, a Western Electric CPFT Shelf is also available. Each module plugs physically and electrically into a 40-pin connector at the rear of the mounting shelf position. A locking catch on the front panel of each module ensures secure mounting in the MFT shelf.

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.

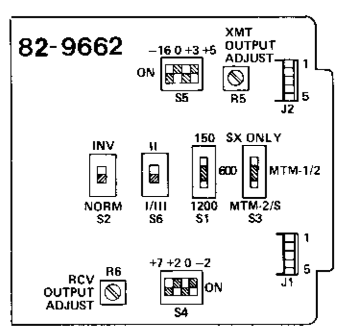
3.04 Table 4 lists external connections to the 9662 module. All connections are made via wire wrapping at the 40-pin connector at the rear of each module's mounting shelf position. Pin numbers are found on the body of the connector.

connect:	to pin:
4W RCV IN T (4wire receive input tip)	3
4W RCV IN R (4wire receive input ring)	2
4W RCV OUT T1 (4wire receive output tip)	6
4W RCV OUT R1 (4wire receive output ring)	5
4W XMT OUT T1 (4wire transmit output tip)	14
4W XMT OUT R1 (4wire transmit output ring)	13
4W XMT IN T (4wire transmit input tip)	17
4W XMT IN R (4wire transmit input ring)	19
E1 (E lead, normally open contact)	23, 24
M (M lead)	25, 26
−48Vdc (filtered, ground-referenced)	11
GND (ground)	18
SXR (receive simplex lead)	16
SXT (transmit simplex lead)	15
CH GND (chassis ground)	1
EG/SG (E ground) (SX ONLY and MTM-1/2) or SXR1 (MTM-2/S)	12
MB (MB lead for looped M-lead operation) (SX ONLY and MTM-1/2) or SXT1 (MTM-2/S)	10
SXT2 (MTM-2/S)	8
SXR2 (MTM-2/S)	9
M (MTM-1/2 and MTM-2/S) or SXR (SX ONLY)	4
E (MTM-1/2 and MTM-2/S) or SXT (SX ONLY)	5

table 4. External connections to 9662

option selection

3.05 All options on the 9662 module are selected via slide switches or DIP switches located as shown in figure 7. Table 5 lists all options and indicates the option choices, which are explained in the following paragraphs. The 9662 should be completely optioned and its optioning checked before alignment is attempted.



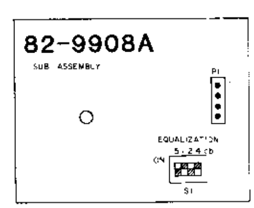


figure 7. 9662 and 9908A subassembly option locations

facility-side impedance options

3.06 Facility-side impedance-matching transformers (transmit and receive) may be switch-optioned via switch *S1* for either 150-, 600-, or 1200-ohm balanced terminating impedance. Determine the type of transmission facility the 9662 module interfaces on its facility side, and set switch *S1* to the *150, 600,* or *1200* position as required.

section of 9662	switch or potentiometer	option	function
facility impedance (xmt and rcv)	S1	150, 600 or 1200 ohms	selects facility-side impedance of 150 ohms (nonloaded cable), 600 ohms (nonloaded cable or CXR), or 1200 ohms (loaded cable)
SF signaling, M lead	S2	NORM or INV	selects normal (NORM position) or inverted (INV position) M-lead operation
MFT mounting configuration	S3	SX ONLY, MTM-1/2, MTM-2/S	selects simplex leads only (SX ONLY), single-module or double-module (MTM-1/2), or double-module with signaling set (MTM-2/S) mounting configuration
receive output adjust (terminal level)	S4-1 thru S4-4	−2, 0, +2, or +7TLP	selects receive output TLP
receive output adjust (terminal level)	R6	continuously adjustable	when *S4* is in +7 position, *R6* provides a +7 to −20dBm range with respect to a +7TLP
transmit output adjust (facility level)	S5-1 thru S5-4	+5, +3, 0, or −16TLP	selects transmit output TLP
transmit output adjust (facility level)	R5	continuously adjustable	when *S5* is in +7 position, *R5* provides a +5 to −20dBm range with respect to a −16TLP
E-lead signaling option	S6	I/III, or II	configures the module for Type I, II, or III E&M signaling interface
xmt (in loss)	front-panel xmt (in loss) attenuation switches	0 to 24dB attenuation in 0.1dB increments (cumulative as labeled)	selects transmit-channel attenuation (0.1dB increments)
rcv (in gain)	front-panel rcv (in gain) switches	0 to 24dB gain in 0.1dB increments (cumulative as labeled)	selects receive-channel gain (0.1dB increments)
9908A equalizer subassembly (optional xmt and rcv)	S1 on 9908A subassembly	0.5 to 7.5dB equalization (cumulative as labeled)	selects up to 7.5dB (in 0.5dB increments) of slope equalization at 2804Hz (re 1000Hz)

Note: *In order to install the two 9908A subassemblies, two straps (one for the transmit and one for the receive channel) must be removed. These straps are plug-on jumpers located on female connectors J1 and J2 on the printed circuit board.*

table 5. Options on 9662 module

SF signaling options

3.07 In the 9662 module's SF signaling section, switch *S2* selects normal or inverted M-lead operation. Set *S2* to the *NORM* position for normal M-lead operation or to the *INV* position when inverted M-lead operation is desired. Switch *S6* configures the 9662 for Type I, II or III E&M signaling interface. Determine the type of signaling format required, and set switch *S6* to the *I/III* or *II* position.

MFT mounting options

3.08 Switch *S3* conditions the 9662 for any one of four MFT mounting configurations: SX ONLY (for MTM-1 mounted applications requiring access to the simplex leads instead of the E&M leads on pins 4 and 7), MTM-1 or 2, or MTM-2/S. Determine the MFT configuration in which the 9662 is being mounted, and set switch *S3* to the *SX ONLY*, *MTM-1/2*, or *MTM-2/S* position as required. (Select the *MTM-2/S* position when the 9662 is used with a companion signaling module, such as a DX set.)

alignment

3.09 Alignment of the 9662 consists of adjusting the transmit-channel attenuation and TLP-selection switches and the receive-channel gain and TLP-selection switches to accommodate the desired facility-side and terminal-side levels. In addition, potentiometers (located on the printed circuit board) associated with both the transmit-channel and receive-channel TLP-selection switches permit selection of nonstandard TLP's. Before aligning the 9662, verify that the 9662 is properly optioned for the correct facility impedance of 150, 600, or 1200 ohms. Facility-side (transmit output and receive input) test points are provided on the 9662 for alignment and testing purposes. Access to the terminal-side (transmit input and receive output) ports of the 9662 must be provided by an associated jackfield or at the module's 40-pin connector. If the connector pins are used as measurement points, care must be taken to avoid double terminations.

receive channel

3.10 Alignment of the **receive channel** consists of the following: setting of the TLP-selection switches and, if required, the associated potentiometer to provide the specified receive-channel output level; adjustment of the front-panel *rcv (in gain)* switches to derive the receive channel's internal level of +7TLP; and adjustment of the optional 9908A Equalizer subassembly to provide the required amount of slope equalization. Align the receive channel as indicated below:

A. Connect the receive portion of a properly bridged transmission measuring set (TMS) to the front-panel *rcv in* test points. Request the distant facility-side location to send 1000Hz and 2804Hz tones at a 0dBm0 level. Measure and record the level at which each tone is received.

B. Determine the CLR-specified receive-channel output TLP and set TLP-selection switch *S4* to the *−2, 0, +2* or *+7* position. Disconnect the receive portion of the TMS from the front-panel *rcv in* test points and connect it to the receive output port via an external jackfield, or to connector pins 5 and 6.

C. Request the distant facility-side location to again send 1000Hz tone at 0dBm0. Set the proper combination of front-panel *rcv (in gain)* switches to the *IN* position until the receive output level corresponds to the level selected via TLP-selection switch *S4*.

D. If a nonstandard TLP is required, set *S4* to the *+7* position and adjust *R6* for the desired TLP. The achievable range is from +7 to −20dBm with respect to a +7TLP.

E. Optional equalization (via the 9908A Equalizer subassembly): Determine the difference between the 1000Hz and 2804Hz tone levels measured in step A. Referring to table 5 and figure 7, set to *ON* the proper combination of switch positions on the receive channel 9908A subassembly's four-position DIP switch *S1* that adds up to this difference (i.e., the amount of equalization required).

transmit channel

3.11 Alignment of the **transmit channel** consists of the following: setting of the TLP-selection switches and, if required, the associated potentiometer to provide the specified transmit-channel output level; adjustment of the front-panel *xmt (in loss)* switches to derive the transmit channel's internal level of −16TLP; and adjustment of the optional 9908A Equalizer subassembly to provide the required amount of slope equalization. Align the transmit channel as indicated below:

A. Before alignment of the transmit channel, the transmit speech path cut must be removed. This can be done either by seizing the circuit from the local trunk or by temporarily placing battery on the 9662's M lead by removing incoming SF tone. As an alternative, the transmit path cut may be removed by setting switch *S2* to the *INV* position with the local M lead at ground potential.

B. Determine the specified transmit channel output TLP and set level-control switch *S5* to the *−16, 0, +3* or *+5* position.

C. Set switch *S1* to the 600-ohm position. Condition the transmit portion of the TMS for 1000Hz tone output at the level and impedance specified on the CLR for the 4wire transmit terminal interface. Connect this signal to the transmit channel's input port via an external jackfield or via connector pins 17 and 19.

D. Condition the receive portion of the TMS for 600-ohm bridged measurement, and measure the signal level at the front-panel *xmt out* test points. Set the proper combination of front-panel *xmt (in loss)* switches to the *IN* position so that the output level corresponds to the level selected via TLP-selection switch *S5*.

E. If a nonstandard TLP is required, set *S5* to the *+5* position and adjust *R5* for the desired TLP. The achievable range is from +5 to −20dBm with respect to a −16TLP.

F. Reset switch *S1* for the specified facility-side transmit impedance.

G. Optional equalization (via the 9908A Equalizer subassembly): Refer to the CLR card for the specified transmit-channel output level (facility side) at 2804Hz. Referring to table 5 and figure 7, set to *ON* the proper combination of switch positions on the transmit channel 9908A subassembly's four-position DIP switch *S1* that adds up to the desired equalization at 2804Hz (re 1000Hz).

4. circuit description

4.01 To provide the clearest possible understanding of the operation of the 9662 4Wire E&M SF Signaling Set module with Gain, function sequence charts (figures 8 and 9) that illustrate sequential operation of the module on incoming and outgoing calls are presented in lieu of a more conventional circuit description. Horizontal paths identify events occurring simultaneously, and vertical paths denote sequential events. Dotted lines indicate elapsed time. These charts may be used to determine whether a module is performing normally by observing the module's response and comparing it to that shown in the chart. Reference to the 9662 block diagram (section 5 of this Practice) may aid in understanding the sequence charts.

4.02 The sequence charts are intended to familiarize you with the operation of the 9662 for engineering, application, and troubleshooting purposes. However, attempts to test or troubleshoot the 9662 internally are not recommended and may void your warranty. Procedures for recommended testing and troubleshooting in the field should be limited to those prescribed in section 7 of this Practice.

6. specifications

common specifications

receive gain
0 to 24dB in 0.1dB increments

receive output adjust
−2, 0, +2, and +7TLP via DIP switch; +7 to −20dBm via potentiometer

INCOMING CALL

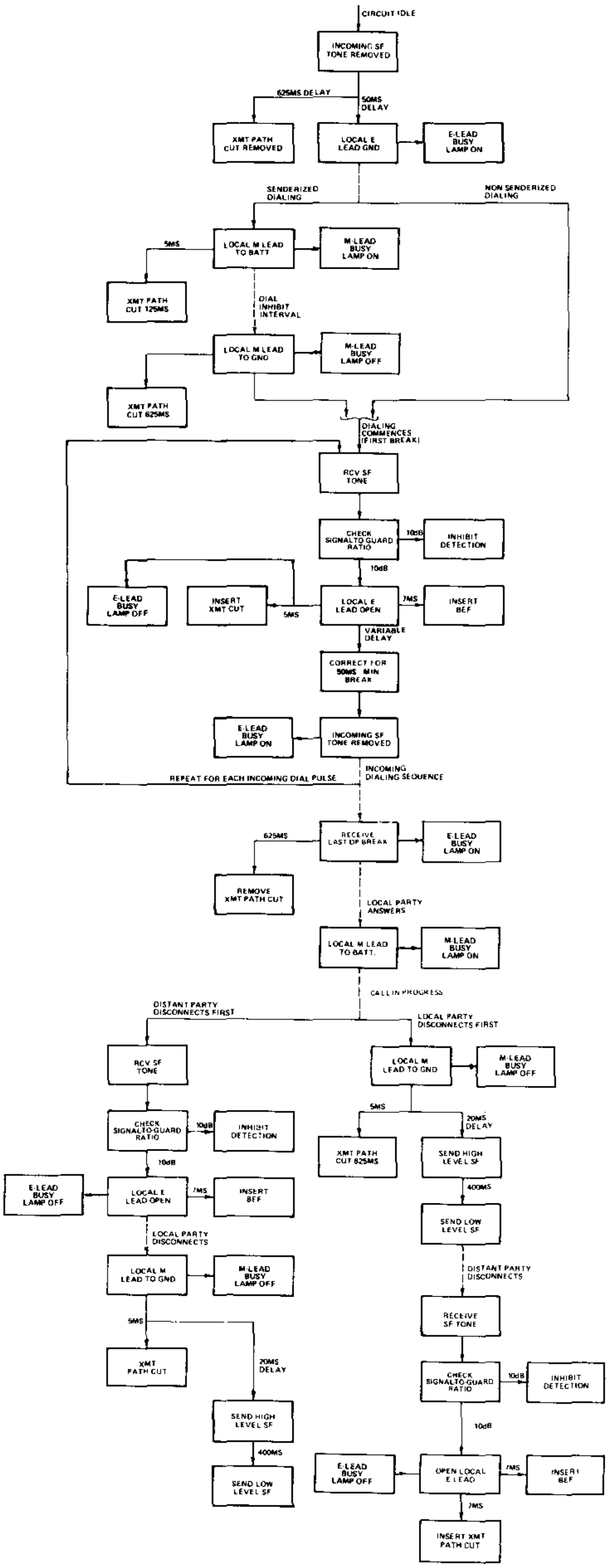


figure 8. Function sequence chart, incoming call

OUTGOING CALL

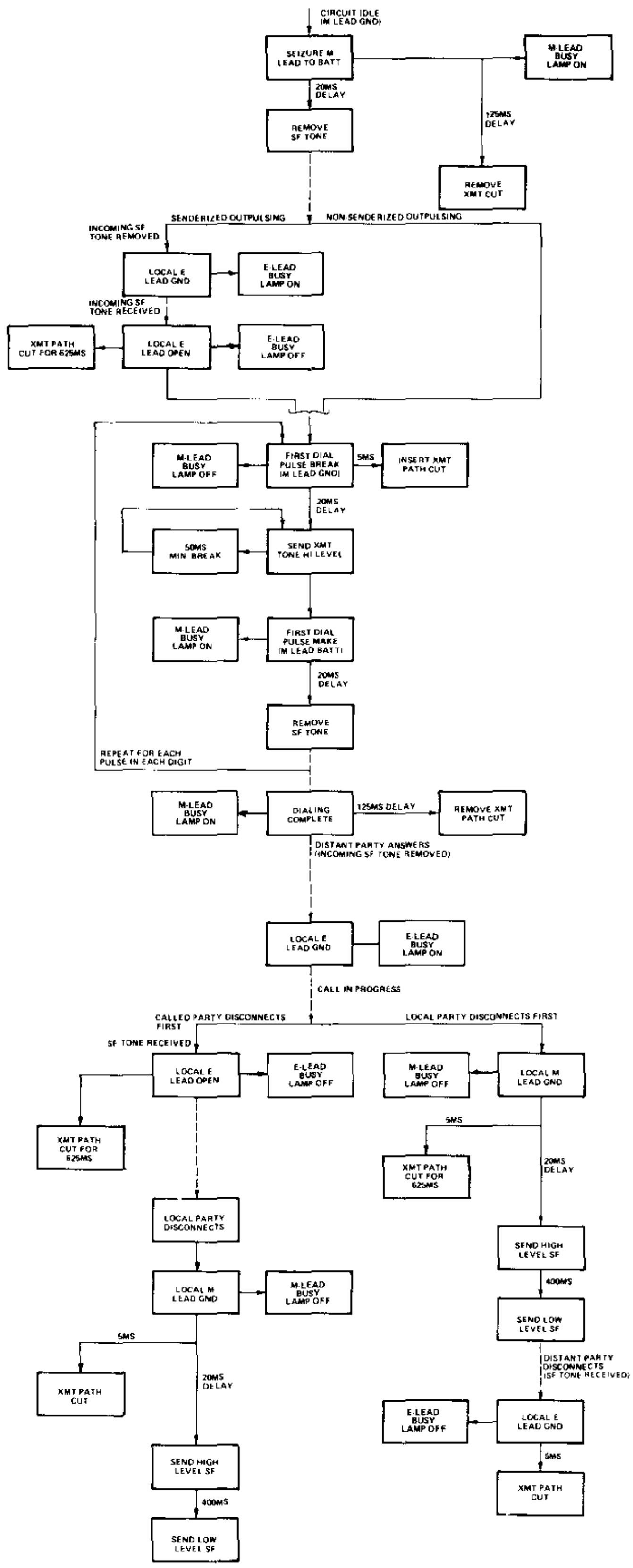
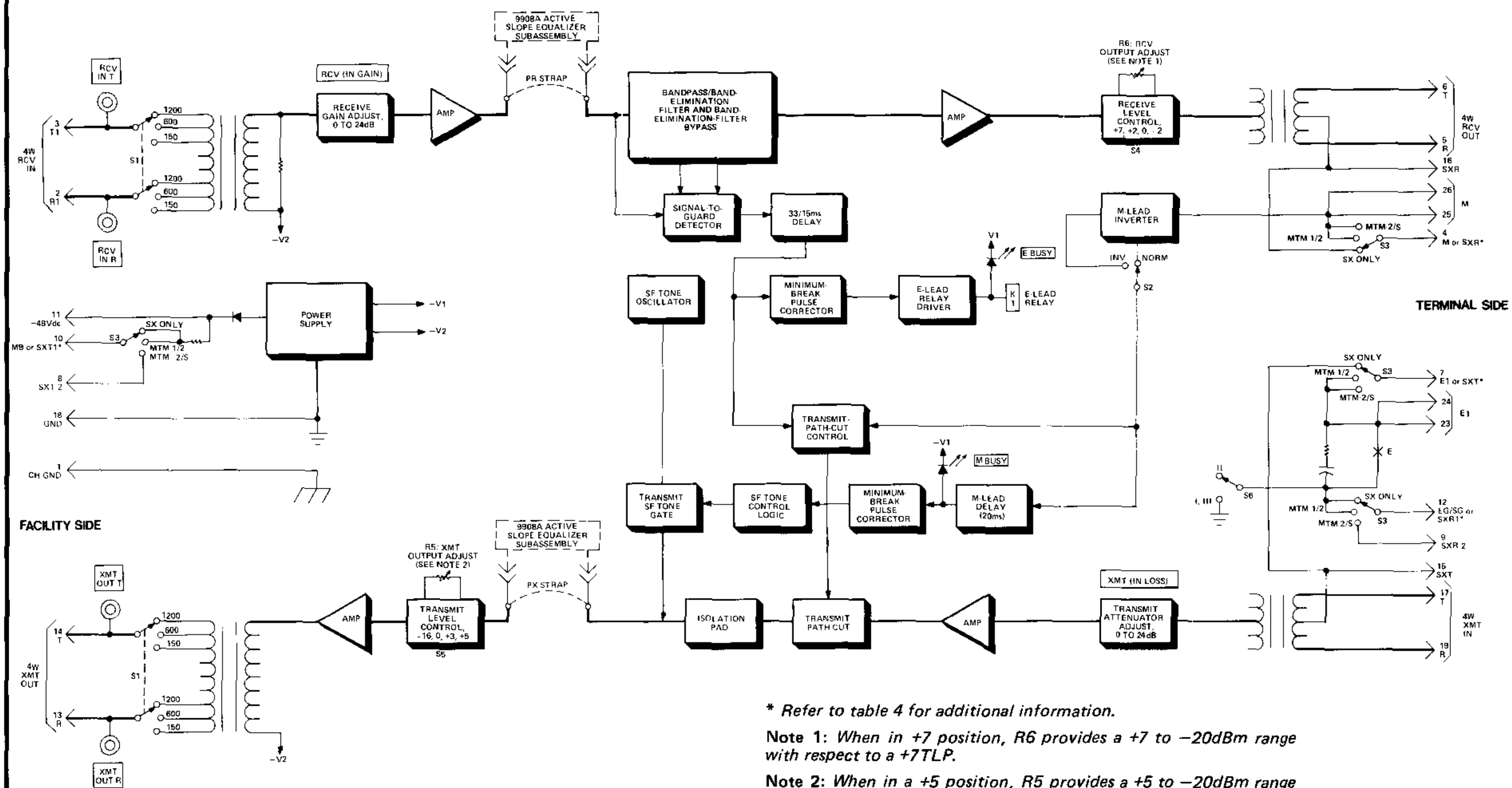


figure 9. Function sequence chart, outgoing call



* *Refer to table 4 for additional information.*

Note 1: *When in +7 position, R6 provides a +7 to −20dBm range with respect to a +7TLP.*

Note 2: *When in a +5 position, R5 provides a +5 to −20dBm range with respect to a −16TLP.*

9662 4Wire E&M SF Signaling Set module with Gain 829662

5. block diagram

transmit attenuation
0 to 24dB in 0.1dB increments

transmit output adjust
+5, +3, 0, and −16TLP via DIP switch; +5 to −20dBm via potentiometer

optional transmit and/or receive equalization
0 to 7.5dB in 0.5dB increments

accuracy
±0.05dB for 0.1, 0.2, 0.4, and 0.8dB steps, ±0.1dB for 1.5, 3, 6, and 12dB steps

terminal impedance
600 ohms balanced, 300 to 4000Hz

facility impedance
switchable, 150, 600, or 1200 ohms balanced 300 to 4000Hz

terminal return loss
ERL greater than 20dB

facility return loss

impedance	150 ohms	600 ohms	1200 ohms
ERL	>15dB	>20dB	>18dB

overload point
greater than +5dBm0

noise (xmt and rcv)
20dBrnC maximum, 0 gain or loss

delay distortion
less than 20μs, 400 to 4000Hz, without equalizer; with 7.5dB equalization, less than 225μs, 400 to 4000Hz re 1800Hz

longitudinal balance (xmt and rcv)
greater than 60dB, 200 to 4000Hz

harmonic distortion
less than 1% at 0dBm0

insertion loss
±0.15dB re 1000Hz, 0 gain or loss

cross coupling
less than 75dB at 1000 and 3000Hz

crosstalk between adjacent modules in shelf
less than 95dB at 1000 and 3000Hz

frequency response
300 to 500Hz: insertion loss ±0.5dB (re 1000Hz)
500 to 3000Hz: insertion loss ±0.3dB (re 1000Hz)

insertion loss (due to impedance change)
±0.7dB, 1200 ohms
±0.95dB, 150 ohms

input power
input voltage: −42 to −56Vdc, filtered, ground-referenced
input current: idle, 45mA; busy, 65mA

simplex current
100mA maximum; 3mA maximum unbalanced

signaling — transmit section

M-lead delay
18 ±5ms delay between M-lead state change and SF tone state change

SF tone states
idle: tone transmitted
busy: no tone
dialing: tone transmitted during breaks of dial pulses

augmented SF level
−8 ±2dBm0

idle SF level
−20 ±1dBm0

M-lead signaling states, normal mode
idle: open or ground
busy: negative battery

M-lead signaling states, inverted mode
idle: negative battery
busy: open or ground

augmented level timing
high-level tone is transmitted for 400 ±100ms following each off-hook-to-on-hook transition of M-lead

minimum break
M-lead on-hook pulses less than the M-lead delay are not recognized

M-lead pulse corrector
input on-hook intervals of a duration between that of the M-lead delay and 50ms are transmitted as tone bursts of 50 ±2ms; input breaks longer than 50ms are transmitted as tone bursts equal in duration to the input break duration ±2ms

internal SF oscillator frequency and stability
2600 ±2Hz for 6 months, 2600 ±5Hz for life of unit (other frequencies are optionally available)

transmit path cut
transmit speech path is cut 18 ±5ms before any transmission of SF tone; see tables 2 and 3

signaling — receive section

SF tone frequency
2600Hz ±0.3%; other frequencies must be specified at time of order

SF tone threshold
−26.5 ±2.5dBm

SF tone rejection
55dB minimum, 2590 to 2610Hz

signaling bandwidths
high guard state, 75Hz nominal
low guard state, 300Hz nominal

signal to guard ratio
10 ±2dB

maximum line noise
58dBrnC (at 0dB gain)

guard circuit transition timing
high-to-low, 225 ±60ms
low-to-high, 50 ±10ms

band-elimination filter (BEF)
insertion delay: 13 ±7ms
removal time: either 225 ±50ms or receive tone duration 50 ±10ms, whichever is longer

SF to E lead

pulse rate	*input break ratio*
8pps	32 to 80%
10pps	38 to 79%
12pps	44 to 76%

input breaks of a duration between that of the E-lead seizure delay and 50ms are transmitted as breaks of 50 ±2ms. input breaks longer than 50ms are transmitted as breaks equal in duration to the input break duration ±2ms.

seizure delay — removal of SF to E-lead ground
60 ±20ms

release delay — application of SF to E-lead open
33 ±3ms

E-lead contact rating
contact resistance: 20 milliohms maximum
current: 1A maximum
voltage: 200Vdc maximum
contact protection: external transient protection required with inductive loads.

physical

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

dimensions
7.91 inches (20.1cm) high
1.70 inches (4.32cm) wide
9.76 inches (24.8cm) deep (excludes locking catch)

weight
27 ounces (765 grams)

mounting
relay rack via one position of Western Electric MTM-1, MTM-2, MTM-2/S, or CPFT Shelf

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 9662 4Wire E&M SF Signaling Set module with Gain. 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 9662 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, 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: (213) 595-7071
Lisle Headquarters: (312) 969-8800
Mississauga Headquarters: (416) 624-0052

7.03 If a 9662 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 9662 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 8X9662 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 9662 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 9662 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

Note 1: *The testing procedure for the 9662 4Wire E&M SF Signaling Set module with Gain is most conveniently performed when an external jackfield is used to provide access to the appropriate points in the module. In view of this, the following procedure is based on the assumption that such a jackfield will be used.*
Note 2: *Certain of the following tests require that an option switch or an alignment control be adjusted to a specific setting to perform the test. Be sure that all option switches and alignment controls are returned to the required settings for your particular application at the conclusion of the test.*
Note 3: *To be certain that improper positioning of mercury within the 9662's mercury-wetted E-lead output relay will not be a cause of malfunction, ensure that the module has been tapped gently on a hard surface and kept upright until installation as directed in the* **caution** *notice on page 6.*

test	test procedure	normal result	if normal conditions are not met, verify:
receive channel (E lead) idle (S3 in MTM-1 or MTM-2 position)	Connect pulsing test set arranged to transmit 2600Hz tone at −20dBm0 to receive input port (pins 2 and 3). Connect receive portion of pulsing test set to pin 23 and arrange test set to monitor E lead. Set switch *S1* to *600*-ohm position, set switch *S2* to *NORM*, and set switch *S6* to *I/III* position.	With tone present, front-panel *E busy* LED extinguished ☐. Pulsing test set indicates E-lead open ☐.	Power ☐. Tone level (−20dBm0) ☐. Tone frequency (2600±10Hz) ☐. Test set connections ☐. Switch *S1* set to *600*-ohm position ☐. Switches *S2* and *S6* set to the required positions ☐. Replace module and retest ☐.
receive channel (E lead) busy	Remove 2600Hz tone.	With tone absent, front-panel *E busy* LED lighted ☐. Pulsing test set indicates E-lead ground ☐.	Power ☐. Ground present on connector pin 12 (EG/SG lead) ☐. Test set connections ☐. Replace module and retest ☐.
receive channel (E lead) pulsing	Arrange pulsing test set to transmit dial pulses (2600Hz tone bursts) at −8dBm0 and at various speeds and percent breaks, and connect it to receive input port (pins 2 and 3).	Input tone bursts between 36 and 50ms corrected to 50±2ms E-lead outputs ☐. Input tone bursts greater than 50ms are repeated as breaks equal in duration to input tone bursts ±2ms ☐.	Power ☐. Tone level (−8dBm0) ☐. Tone frequency (2600±10Hz) ☐. Ground present on connector pin 12 (EG/SG lead) ☐. Test set connections ☐. Replace module and retest ☐.
receive-channel transmission	Disconnect pulsing test set from receive input port (pins 2 and 3). Connect transmit portion of TMS, arranged for 1004Hz output at 0dBm and 600 ohms, to receive input port (pins 2 and 3). Connect receive portion of TMS, arranged for 600-ohm terminated measurement, to receive output port (pins 5 and 6). Set module's front-panel *rcv (in gain)* and PCB-mounted receive TLP-selection switches to 0dB.	TMS indicates 0 ±0.2dBm ☐.	Power ☐. Front-panel *rcv (in gain)* switches set for 0dB loss ☐. Input tone level ☐. Wiring ☐. Proper TMS termination ☐. Switch *S1* set to *600*-ohm position ☐. Replace module and retest ☐.
	To verify level control, introduce gain via front-panel *rcv (in gain)* switches and note TMS reading.	TMS indicates comparable increase in level ☐.	Replace module and retest ☐.
transmit-channel (M lead) idle	Connect pulsing test set arranged to transmit M-lead signals (idle = ground, busy = battery) to pin 25. Connect TMS to transmit output port (pins 14 and 13), remove negative battery potential from M lead (pin 25), and apply ground to M lead.	After application of M-lead ground, tone level of −36±2dBm is observed and remains at this level for duration of M-lead ground ☐. Front-panel *M busy* LED extinguished ☐.	Power ☐. Test set connections ☐. Proper termination of SF section of pulsing test set ☐. Switch *S2* set to *NORM* ☐. Switch *S1* set to *600*-ohm position ☐. Replace module and retest ☐.

testing guide checklist continued on next page

test	test procedure	normal result	if normal conditions are not met, verify:
transmit-channel (M lead) busy	Maintain connections as above but apply battery (−48Vdc) to M lead (pin 25).	No SF tone present at front-panel *xmt out* test points ☐. Front-panel *M busy* LED lighted ☐.	Power ☐. Test set connections ☐. Switch *S2* properly set ☐. Replace module and retest ☐.
transmit-channel (M lead) pulsing	Maintain connections as above but arrange pulsing test set to transmit M-lead dial pulses at various speeds and percent breaks.	Input breaks between 28 and 50ms corrected to 50 ±2ms tone bursts ☐. Input breaks between 50 and 80ms repeated as tone bursts equal in duration to input breaks ±2ms ☐.	Same as above ☐.
transmit path cut	Arrange transmit portion of TMS for 2600Hz tone output at −20dBm0, and connect this signal to receive input port (pins 2 and 3). Connect pulsing test set arranged to transmit M-lead signals (idle = ground, busy = battery) to pin 25. Arrange transmit portion of second TMS for 1004Hz tone output at −16dBm and connect this signal to transmit input port (pins 17 and 19). Connect receive portion of TMS arranged for 600-ohm terminated measurement to front-panel *xmt out* test points. Set module's front-panel *xmt (in loss)* and PCB mounted transmit TLP-selection switches to 0dB. Send M-lead signals (via pulsing test set) as indicated above.	Tone level of −36 ±2dBm observed after M-lead transition to ground ☐. When M lead changes to battery potential, signal level at *xmt out* test points increases to 0 ±0.2dBm at 1004Hz, indicating removal of path cut ☐. While pulsing M lead at 10pps and 50% break, path is cut and signal level of −30dBm is observed ☐.	Power ☐. Wiring ☐. Test set connections ☐. Switch *S2* set to *NORM* ☐. Tone applied to receive input port (pins 2 and 3) at 2600 ±10Hz and −20dBm0 ☐. PCB-mounted transmit TLP-selection switches set for 0dB loss ☐. Proper impedance terminations on test equipment ☐. Front-panel *xmt (in loss)* switches set for 0dB ☐. Switch *S1* set to *600*-ohm position ☐. Replace module and retest ☐.
	Verify level control with M lead at battery as follows: introduce loss via front-panel *xmt (in loss)* switches and note TMS reading.	TMS indicates comparable decrease in level ☐.	Replace module and retest ☐.
	Disconnect 2600Hz TMS from receive input port (pins 2 and 3). Change M-lead state from ground to battery and vice versa.	As M-lead transitions occur, path is momentarily cut, resulting in signal level change from −36dBm to 0dBm ☐.	Same as first step of transmit path cut test ☐.