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rev B

practice section 816944

6944 4Wire FXO SF Signaling Set

contents

1. general description

1.01 The Tellabs 6944 4Wire Foreign-Exchange Office-End (FXO) SF Signaling Set module (figure 1) provides signaling and transmission interface between a 4wire transmission facility and the office end of a metallic 4wire foreign-exchange (FX) or off-premise-extension (OPX) signaling link. Specifically, the 6944 provides single-frequency (SF) signaling over the 4wire facility, conversion between that SF signaling and the loop signaling used at the office end of an FX or OPX circuit, and extension of this loop signaling toward the 4wire termination (a CO or PBX line circuit). Level coordination in both the transmit and receive paths is provided by means of adjustable precision attenuators. Conventional 2600Hz SF tone is standard. Other frequencies are optionally available.

1.02 The 6944 module, which is the functional equivalent of Western Electric's FPA Signaling Unit, is designed to operate in association with a foreign-exchange station-end (FXS) SF signaling set (Tellabs 6943 or 6923 or equivalent) at the opposite end of the 4wire facility.

1.03 Features and options of the 6944 include the following: switch selection of the most frequently used options; operation in either the loop-start or ground-start supervisory mode; switchable 150, 600, or 1200-ohm terminating impedance on the terminal (office) side of the module; an internal SF oscillator (use of an external master SF tone source is optional); an integral transmit-path equalizer for use with loaded cable; and full precision receive pulse correction. A front-panel LED indicates busy, and front-panel test points access facility-side transmit and receive ports. The 6944 module provides a circuit status lead that may be used as a local sleeve lead or as a traffic-monitoring lead. Alarm leads compatible with most carrier group alarm (CGA) formats are also available. Access points on the module provide compatibility with switched-access testing.

1.04 In the transmit direction, the 6944 converts local office ringing and supervisory states to outgoing SF tone conditions. An integral 20Hz modulator provides outgoing SF tone modulated at a 20Hz rate during ringing, independent of local ringing frequency, in ground-start operation. The ringing detector recognizes incoming ringing at any frequency between 17 and 67Hz and is compatible with most conventional ringing schemes.

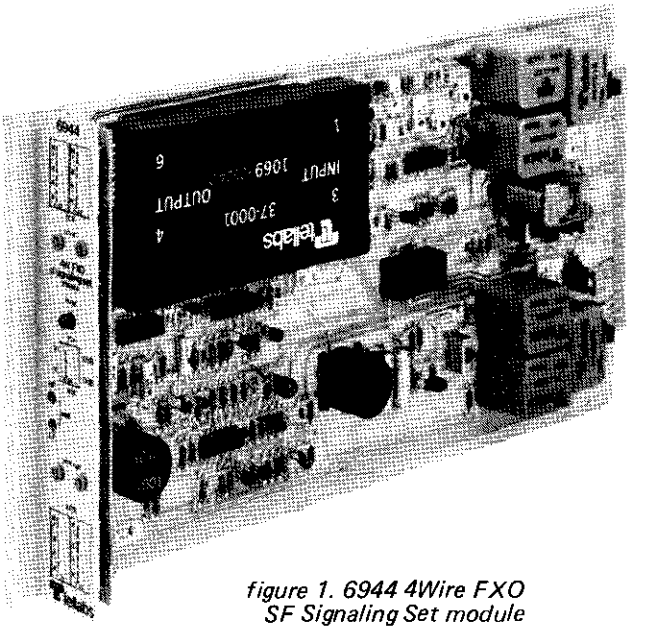


figure 1. 6944 4Wire FXO SF Signaling Set module

1.05 The receive portion of the 6944 converts incoming SF tones to local loop-signaling supervisory and dial pulse states corresponding to those at the station end of the signaling path. A precision pulse corrector ensures loop dial pulsing with optimum make-break ratio toward the local switching equipment.

1.06 Adjustable precision attenuators (controlled by front-panel switches) are provided in both the transmit and receive paths to coordinate terminal-side (i.e., office-side) levels with −16 transmit and +7 receive transmission level points (TLP's) at the module's facility-side ports. The attenuation range in both channels is 0 to 26.5dB in 0.1dB increments. A front-panel-adjustable amplitude equalizer in the transmit path introduces small amounts of low-end and high-end response-slope correction for post-equalization of an office-side loop consisting of loaded cable.

1.07 On the facility side, the 6944 provides fixed, balanced 600-ohm terminating impedance at both the transmit and the receive port. On the terminal (office) side, balanced, switch-selectable terminating impedances of 150, 600, and 1200 ohms are available at both the transmit and the receive port.

1.08 The 6944 is equipped with an integral SF signaling tone oscillator and thus does not require an external (master) SF tone source. Provision is made, however, for operation with such a tone supply if desired. Selection of internal or external tone source is made via a slide switch on the module.

1.09 The 6944 module is a member of Tellabs' 6900 family of central-office-configured signaling and terminating modules. It is electrically and mechanically interchangeable with the other modules in the 6900 family and with the modules in the 4900 family of terminating and level control modules. Common pin assignments in the 6900 and 4900 families permit the use of a universal wiring scheme to increase system flexibility.

1.10 The 6944 module mounts in one position of a Tellabs Type 16 Mounting Shelf or in one position of the lower shelf of a Tellabs 269-series Mounting Assembly. The Type 16 Shelf is available in versions for 19 and 23 inch relay rack installation. Both versions mount 12 modules and occupy 4 vertical mounting spaces (7 inches) in a standard relay rack. The Shelves are provided (at the customer's option) either unwired, equipped with jumpers to bypass switched-access testing points, completely universally wired, or universally wired with a connectorized backplane.

1.11 The 6944 operates from nominal −48Vdc filtered battery supply. Maximum current requirements range from 28mA at idle to 45mA when busy.

2. application

2.01 The 6944 4Wire FXO SF Signaling Set module is designed to interface a 4wire transmission facility with a 4wire CO or PBX line circuit in conventional office-end foreign-exchange (FXO) or off-premise-extension (OPX) SF signaling applications. The module provides SF signaling over the 4wire facility, loop signaling toward the office-end 4wire termination, and conversion between the two signaling modes. The CO or PBX line circuit interfaced by the 6944 may operate in either the loop-start or ground-start supervisory mode (see paragraphs 2.06 through 2.08).

terminal-side (office-side) interface

2.02 Signaling and transmission between the 6944 and the local CO or PBX take place over a local 4wire metallic loop. The FX or OPX loop-signaling path is extended from the 6944 to the switching equipment via simplex connection of the module's A1 (internal A) and B1 (internal B) leads to the transmit and receive pairs, respectively, of the local 4wire metallic loop. Transformer coupling is provided at the 6944's terminal-side (i.e., office-side) interface, with switch-selectable 150, 600, or 1200-ohm terminating impedance at both the transmit input and receive output ports.

facility interface

2.03 The 6944 is designed to interface the 4wire transmission facility at conventional −16 transmit and +7 receive transmission level points (TLP's). If these TLP's are not present, a Tellabs 4744 or 4944 Line Amplifier or 490X Pad Module (or equivalent) will be required in conjunction with the 6944. Transformer coupling with fixed, balanced 600-ohm terminating impedance is provided at both the transmit and receive ports on the facility side.

level control

2.04 Adjustable attenuators in the transmit and receive paths provide for interfacing the −16 transmit and +7 receive facility-side TLP's with conventional terminal-side levels. From 0 to 26.5dB of loss may be introduced in 0.1dB increments via front-panel DIP switches (see figure 2). Total attenuation in either channel is the sum of that channel's switches set to the *IN* position.

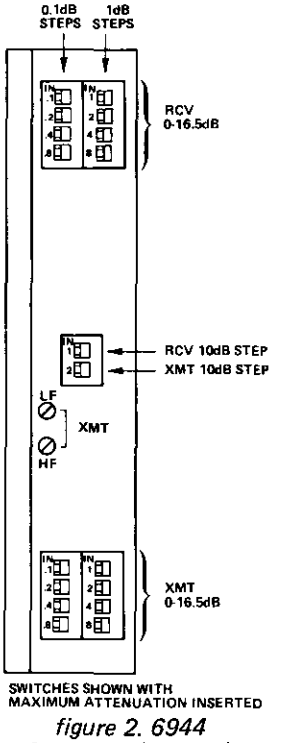


figure 2. 6944 front-panel controls

transmit-path equalization

2.05 High-frequency and low-frequency amplitude equalizers in the 6944's local transmit path provide adjustable post-equalization for local loops consisting of loaded cable. The high-frequency equalizer introduces up to 3dB of "bump" equalization at 3400Hz, and the low-frequency equalizer provides up to 4dB of low-end roll-off beginning at about 1000Hz. Both equalizers are continuously adjustable over their effective ranges via front-panel-accessible controls. No equalization is introduced when these controls are adjusted fully counterclockwise.

supervisory states, loop start

2.06 The 6944 module accommodates a conventional loop-start supervisory format. When the distant (station) end is idle (on-hook), the associated foreign-exchange station-end (FXS) signaling unit transmits SF tone. Receipt of this tone by the 6944 holds the 4wire loop open toward the local switching equipment. When the office end is idle, the 6944 does not transmit SF tone. **On calls from the office end to the station end,** receipt of ringing voltage from the local switching equipment causes the 6944 to transmit SF tone. Receipt of this tone by the FXS signaling unit initiates ringing toward the station or PBX trunk circuit. **On calls from the station end to the office end,** a station-end off-hook condition causes the FXS unit to cease SF tone transmission. The 6944, upon this loss of incoming tone, closes the 4wire loop toward the local switching equipment. Incoming SF tone pulses indicate dialing.

supervisory states, ground start

2.07 In ground-start operation, just as in loop start, the 6944 accommodates a conventional supervisory format. When the station end is idle, the associated FXS signaling unit transmits SF tone. Receipt of this tone by the 6944 holds the 4wire loop open toward the local switching equipment. Similarly, when the office end is idle, the 6944 transmits low-level SF tone (see paragraph 2.10). Receipt of this tone by the distant FXS signaling unit holds the tip lead open toward the PBX trunk circuit. **On calls from the office end to the station end,** the local switching equipment grounds the tip lead, causing the 6944 to remove outgoing SF tone. Subsequent receipt of ringing voltage from the local switching equipment causes the 6944 to transmit high-level SF tone (see paragraph 2.10), amplitude-modulated at 20Hz. Receipt of this tone by the FXS signaling unit causes the unit to close the tip lead and apply ringing toward the PBX trunk circuit. When the PBX answers, the FXS unit ceases SF tone transmission. Upon this loss of incoming tone, the 6944 closes the 4wire loop to trip ringing and establish the connection. **On calls from the station end to the office end,** the distant PBX grounds the ring side of the line, cutting off the SF tone being received by the 6944. This removal of SF tone grounds the simplex lead associated with the receive output port via the B1 (internal B) lead. The switching equipment returns ground via the simplex lead associated with the transmit input port and the A1 (internal A) lead, and the 6944 ceases SF tone transmission. This loss of SF tone at the station end closes the tip side toward the PBX, completing the loop. Dialing can commence at this time.

2.08 An option switch on 6944 modules manufactured after approximately August, 1978, permits reversal of the module's internal A and B leads. This provides proper module operation and eliminates the need for rewiring in ground-start applications where tip and ring inputs from the CO or PBX are inverted. (In loop-start applications, inversions of these inputs have no effect upon module operation.)

signaling tone states

2.09 Signaling tone states for the 6944 are consistent with conventional F-signaling formats for FX and OPX service. These states are listed in tables 1 and 2 for loop-start and ground-start operation, respectively.

loop condition	SF tone	
	receive	transmit
idle	on	off
ringing	on	on
off-hook	off	off
dialing	off-on-off	off

table 1. Signaling tone states, loop start

signaling tone levels

2.10 Normal idle SF tone level is −20dBm0 in both directions of transmission. The 6944 interfaces the 4wire transmission facility at −16 transmit and +7 receive TLP's; thus, the nominal received SF tone level is −13dBm at the 4wire receive input port and the transmitted tone level is −36dBm. For the first 400 milliseconds of any SF tone transmission by the 6944 (or by the associated FXS signaling set at the opposite end of the facility), however, SF tone is transmitted at an augmented level of −24dBm (−8dBm0). This momentarily increased tone level aids in detection of supervisory or signaling state changes. During ringing in the ground-start mode, the 6944 transmits high-level SF tone modulated by an internal 20Hz source.

loop condition	SF tone	
	receive	transmit
idle	on	on
incoming seizure (ground applied to ring lead at station)	off	on
seizure acknowledgement (switch grounds local tip lead)	off	off
dialing	off-on-off	off
busy	off	off
station on-hook	on	off
CO release	on	on
outgoing seizure (switch grounds local tip lead)	on	off
ringing	on	on-off-on at 20Hz rate
station answer	off	off
CO release (forward disconnect)	off until FXS signaling unit opens tip lead, then on	on
idle	on	on

table 2. Signaling tone states, ground start

loop current and supervisory range

2.11 When the distant station is off-hook, the 6944 provides a path for loop current flow via A and B leads simplex-connected to the local transmit and receive pairs. Current limiting is provided by an integral resistance lamp whose resistance at 23mA is between 200 and 300 ohms. Lamp resistance increases as current through it increases so that the maximum loop current under 0-ohm loop conditions is approximately 80mA. During incoming seizure in the ground-start mode, the 6944 applies ground to the local B lead through the resistance lamp. Supervisory limits in applications involving the 6944 are dependent upon sensitivity of the local switching equipment, and range calculations should take into account the nominal 300-ohm resistance of the lamp in the 6944 and the fact that loop current flows through the **simplexed** transmit and receive conductors between the 6944 and the local switching equipment.

receive pulse correction

2.12 A precision pulse corrector in the 6944's SF receive section ensures optimum pulsing toward the local switching equipment. For incoming dial-generated SF tone pulses at rates between 8 and 12 interruptions per second, the pulse corrector provides pulses of 58±2 percent break toward the

switch. (See section 6 of this Practice for detailed pulsing specifications.) The pulse corrector will ignore input tone bursts shorter than about 20ms.

transmit path cut

2.13 To prevent speech and transient energy from interfering with transmission of signaling tone, the voice path through the transmit portion of the 6944 is cut (opened) whenever SF tone is transmitted. The path cut is inserted within a few milliseconds of detection of the idle state (ground-start mode only) or of ringing, and is removed approximately 200 milliseconds after outgoing signaling tone is removed.

tone source

2.14 The 6944 is equipped with an integral SF tone oscillator and therefore does not require an associated master SF tone supply. If operation from a master SF tone supply is desired, however, provision is made (via a slide switch) for connection of the external SF tone source, rather than the internally generated signal, to the tone control circuitry. The external signal should be 0.5 ±1Vrms, 2600 ±2Hz, unbalanced. Input to the 6944 is capacitively coupled and presents a load impedance of approximately 75 kilohms to the tone source.

power and ringing

2.15 The 6944 module operates on filtered input potentials between −42 and −56Vdc, ground referenced. The positive side of the dc power supply must be connected to earth ground. Ground-start operation of the 6944 requires a low-resistance ground that is common with the ground of the local switching equipment power supply.

2.16 The ringing detector in the 6944 senses input ringing between the A and B leads, which means that both superimposed and grounded ringing schemes can be accommodated. Local ringing may be applied between either conductor and ground or across tip and ring. The 6944 will sense any ringing frequency between 17 and 67Hz, with a sensing threshold of about 50Vrms.

carrier group alarm

2.17 Carrier group alarm (CGA) input leads on the 6944 allow the module to be forcibly removed from service when the associated carrier system malfunctions so that seizure of a disabled circuit is prevented. These CGA leads, designated *ALM* (alarm master) and *ALO* (alarm override), are compatible with most CGA formats. With the appropriate CGA option strapping installed (strap ALM and/or ALO; see paragraph 3.08), forced release of any call in progress can be effected by application of an external ground (from the CGA unit, e.g., a Tellabs 6858 CGA Module) to either the ALM or ALO lead. This ground causes the module's A and B leads to be opened, preventing both incoming and outgoing seizure and effectively removing the module from service until the carrier system is repaired.

2.18 To provide for forced release, only the ALM or ALO lead (not both) need be enabled, i.e., only one of the straps need be installed and the respective external lead connection made. Enabling the ALO lead provides the capability of restoring to service a 6944 that was previously forced to the idle state during a failure of the associated carrier system. The ALO lead is normally wired to a local override control (usually located on the CGA unit) that may be activated during a carrier failure to override the 6944's forced-idle state. The 6944 can then be patched to an alternate carrier system for the duration of the failure. If this capability is not desired, the ALM lead should be enabled instead. External connections for both leads may be made in prewired shelf installations, and the desired lead enabled via the appropriate strap option when the module is installed.

traffic-monitoring provision and E-and-M capability

2.19 Two additional strap options on the 6944 (straps IT and E) permit a choice of either traffic monitoring of circuit seizures or E-and-M operation of the module. (Both options cannot be implemented simultaneously because the same connector pin is involved.) When strap IT (incoming traffic) is installed (see paragraph 3.09), the 6944 derives a traffic-monitoring lead on pin 21. This lead functions much like a local sleeve lead, providing a ground output when the local loop is seized and also during dial pulsing, and remaining open when the circuit is idle. When strap E is installed (see paragraph 3.09), the 6944 derives an E lead on pin 21 that allows the module to function as a "pseudo" E-and-M SF signaling unit (provided that M-lead control of outgoing SF tone is supplied to the 6944 from the associated switching or control equipment). With strap E installed, the output of the derived E lead is open during idle and also during the break portion of dial pulses, and is grounded otherwise.

Note: *Because the traffic-monitoring option is frequently used and the E-lead option rarely used, the 6944 is normally shipped with strap IT factory-installed.*

echo control devices and switched-access testing

2.20 Certain internal points in the 6944's circuitry are brought out to access points at the 56-pin connector. These access points are normally jumpered at the connector to provide circuit continuity. However, use of an associated echo control device or an application involving switched-access testing requires the connector access points. An echo suppressor or canceller, for example, is inserted into the circuit via connector access between the 6944's SF signaling section and the transmit and receive attenuators. For in-service switched-access testing of the 6944, connector access is provided to the input and output ports of the module's signaling sections, to the attenuator pads, and to the module's A and B leads. See paragraphs 3.03 and 3.04 for additional information.

3. installation

inspection

3.01 The 6944 4Wire FXO SF Signaling Set module 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

3.02 The 6944 module mounts in one position of a Tellabs Type 16 Mounting Shelf. Before inserting a module into position, verify that all options are properly set, connector wiring is correct, and power and ringing generator connections are properly fused and protected. The module plugs into a 56-pin connector at the rear of the Shelf.

wiring

3.03 All external connections to the 6944 are made via wire wrap at the 56-pin connector at the rear of the module's mounting shelf position. Pin numbers are found on the body of the connector. In all applications except those involving switched-access testing or use of an associated echo control device, 13 jumper wires must be installed at the connector to provide continuity across internal access points that are brought out to the connector. (Access to internal sections of the 6944 is provided at the connector to permit operation with echo control devices or switched-access testing systems that must interface the module between its various subcircuits.) Factory-wired shelves with jumpers already installed may be used, or the jumpers may be installed in the field per table 3. If field-installed, jumpers should be wired **before** external connections are made. If the 6944 module is to be used in an application involving switched-access testing consult Tellabs' Customer Service group at (312) 969-8800 for drawings and details. If the module is to be used in conjunction with a Tellabs 6920 Echo Suppressor or 6921 Digital Echo Canceller, see table 4 for wiring information.

on 6944, connect pin:		
SF RCV OUT	56 to 54 52 to 50	RCV PAD IN
RCV PAD OUT	48 to 46 44 to 42	4W RCV
XMT A LEAD	40 to 38	A1 (internal A lead)
XMT B LEAD	36 to 34	B1 (internal B lead)
EG	28 to 26	E GND
E LEAD	24 to 22	E1 (internal E lead)
M LEAD	20 to 18	M1 (internal M lead)
XMT PAD IN	16 to 14 12 to 10	4W XMT
XMT PAD OUT	8 to 6 4 to 2	SF XMT IN

table 3. Jumper wiring for applications without switched-access testing or echo control devices

3.04 External connections to the 6944 are listed in table 5. Those connections **not** marked by an asterisk are mandatory for normal operation of the module; those marked by **one** asterisk (*) are optional; those marked by **two** asterisks (**) are not applicable to the 6944 but are required as part of the universal wiring scheme for all 6900 and 4900-family modules. A Type 16 (or equivalent) Shelf wired in accordance with all connections listed in table 5 will accept any 6900 or 4900 module on an interchangeable basis, provided either that jumpers are installed per table **4** or that the Shelf is wired for switched-access testing or for use with an echo control device. If an installation is dedicated to use only with the 6944 module and no flexibility or interchangeability requirements are expected, wiring time may be saved by making only the mandatory connections (i.e., those without asterisks) listed in table 5. Be aware that, while lead nomenclature may vary from one module to the next in the 6900 and 4900 families, basic function (and wiring) remain universal.

connect 6944 pin:		to 6920 or 6921 pin:
SF RCV OUT	56 to 55 52 to 53	RCV IN
RCV PAD IN	54 to 51 50 to 49	RCV OUT
XMT PAD OUT	8 to 7 4 to 5	XMT IN
SF XMT IN	6 to 3 2 to 1	XMT OUT

Jumper wiring is the same as that listed in table 3 except for those pins listed above that interconnect with the 6920 or 6921.

table 4. Interconnections and jumper wiring for applications where 6944 module is used with 6920 Echo Suppressor or 6921 Echo Canceller

connect:	to pin:
4W RCV IN T (4wire receive input tip)	55
4W RCV IN R (4wire receive input ring)	53
4W XMT OUT T (4wire transmit output tip)	3
4W XMT OUT R (4wire transmit output ring)	1
4W RCV OUT T (4wire receive output tip)	51
4W RCV OUT R (4wire receive output ring)	49
4W XMT IN T (4wire transmit input tip)	7
4W XMT IN R (4wire transmit input ring)	5
–BATT (–48Vdc input)	15
GND (ground)	25
SXT (simplex transmit)	35
SXR (simplex receive)	33
*ALM (CGA alarm master)	47
*ALO (CGA alarm override)	45
*N (N lead)	30
*E or S (E lead or traffic monitoring/sleeve lead)	21
*M (M lead)	19
*EXT. OSC. (external SF oscillator)	11
**ALB (CGA alarm battery)	43
**BY1 (make-busy ground output/contact closure)	39
**BY2 (make-busy contact closure)	37
**MB lead for looped M-lead operation	32
**D lead	31
**F lead	29
**G lead	27
**RING GENERATOR	23

*Optional
**Not applicable to 6944 but required as part of universal wiring scheme for all 6900/4900 modules.

table 5. External connections to 6944

option selection

3.05 All frequently used options on the 6944 are selected via slide switches or DIP switches located on the module's printed circuit board as

shown in figure 3. A small number of less frequently used options are implemented by means of wire straps, also shown in figure 3. Tables 6 and 7 list all switch options and strap options, respectively, and indicate the option choices, which are explained below. The 6944 should be completely optioned and its optioning verified before alignment is attempted.

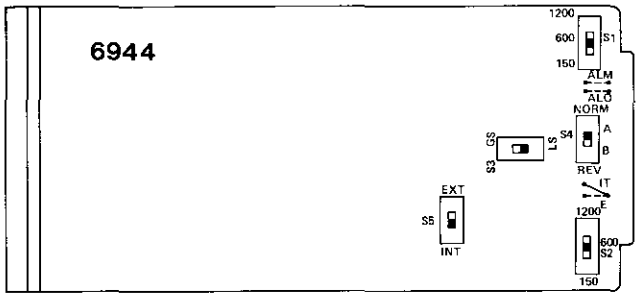


figure 3. 6944 option switch locations

terminal-side 4wire-termination switch options

3.06 On the terminal side of the 6944, switches *S1* and *S2* are used to select either 150, 600, or 1200-ohm terminating impedance at the receive output and transmit input ports, respectively. Set *S1* and *S2* to the *1200* position for interface with loaded cable, to the *600* position for interface with nonloaded cable, or to the *150* position for interface with long sections of nonloaded cable (e.g., greater than 14 kilofeet of 24AWG cable).

section of 6944	switch	option	function
4wire termination, terminal (office) side	S1	150, 600 or 1200	selects 150, 600, or 1200 ohm terminating impedance at receive output port
	S2	150, 600, or 1200	selects 150, 600, or 1200 ohm terminating impedance at transmit input port
signaling and supervision	S3	LS or GS	selects loop-start (LS position) or ground-start (GS position) supervisory mode
	S4	NORM or REV	selects normal (NORM position) or reversed (REV position) A and B-lead operation. Used only in ground-start applications; see paragraph 3.07.
	S5	INT or EXT	includes (INT position) or excludes (EXT position) integral SF tone oscillator

table 6. Switch options

signaling and supervision switch options

3.07 In the 6944's SF signaling and loop-supervision sections, switch *S3* is used to select either the loop-start or ground-start supervisory mode. Set *S3* to the *LS* position for loop-start operation or to the *GS* position for ground-start operation, as required. Switch *S4* is used to select normal or reversed operation of the module's internal A and B leads. In ground-start applications where tip and ring inputs from the CO or PBX are **inverted** (see paragraph 2.08), set *S4* to the *REV* position. In ground-start applications where these inputs are **not inverted** and in all loop-start applications, set *S4* to the *NORM* position. Switch *S5* conditions the module for use with its integral SF tone oscillator or with an external master SF tone source. Set *S5* to the *INT* position if the module's integral SF oscillator is to be used or to the *EXT* position if an external SF tone source is to be used.

section of 6944	strap	function
CGA circuitry	ALM*	when installed, enables forced-release function via ALM lead
	ALO*	when installed, enables forced-release function via ALO lead
metering (incoming)	IT**	with strap installed, circuit seizure (as result of incoming tone) causes metering output on pin 21
signaling	E*	with strap installed, E lead is functional on pin 21

*These straps normally **not** factory-installed on all 6944's.
**This strap normally factory-installed on all 6944's.

table 7. Wire strap options

CGA strap options

3.08 Carrier group alarm (CGA) strap options on the 6944 are used to forcibly remove the module from service when the associated carrier system malfunctions so that seizure of a disabled circuit is prevented. This is done by forcing the release of any call in progress via either the ALM (alarm master) lead (pin 47) or the ALO (alarm override) lead (pin 45) as described in paragraphs 2.17 and 2.18. To enable either lead for CGA forced release, the appropriate strap must be installed on the module's printed circuit board and the respective external lead connection made. If the ALM lead is to be used, install strap ALM as shown in figure 3 and connect the external ALM lead to pin 47. If the ALO lead is to be used, install strap ALO as shown in figure 3 and connect the external ALO lead to pin 45.

Caution: *Extreme care must be taken when soldering on printed-circuit boards to prevent damage to the delicate foil. Use a soldering iron whose tip temperature is 800° F or less, use only 60/40 or 63/37 tin/lead rosin-core solder, and do not hold the tip of a hot iron on a solder connection for longer than 2 seconds.*

traffic-monitoring and E-lead strap options

3.09 Additional strap options on the 6944 permit a choice of either monitoring of circuit seizures or E-and-M operation of the module, as described in paragraph 2.19. If traffic monitoring of circuit seizures is desired, leave strap IT in place (strap IT is normally factory-installed on all 6944 modules) and connect an external traffic-monitoring lead to pin 21. If it is desired that the module function as a "pseudo" E-and-M SF signaling unit, remove or cut strap IT, install strap E as shown in figure 3, and connect external E and M leads to pins 21 and 19, respectively.

Caution: *With strap IT installed, the module's traffic-metering-lead output is derived by means of a PNP transistor that is ON when the circuit is busy and OFF during idle. If this lead is used to drive a relay, diode suppression must be provided across the relay coil to prevent damage to the transistor caused by transients during the relay's release.*

alignment

3.10 Alignment of the 6944 consists of adjusting the front-panel *xmt* and *rcv* attenuator switches to accommodate the desired terminal side (i.e., office-side) transmit and receive levels, and, if necessary, adjusting the high-frequency and low-frequency equalizers in the transmit path to compensate for the frequency response characteristics of a local loop consisting of loaded cable. Before aligning the 6944, verify that associated transmission equipment is aligned for facility-side interface transmission levels of +7dB receive and −16dB transmit.

3.11 Access to the appropriate ports of the 6944 is conveniently provided by means of a Tellabs 9807 Card Extender or a prewired jackfield. Using a properly terminated transmission measuring set (TMS), align the module as indicated below (jack designations are those on the 9807):

Note: *It is suggested that alignment be performed with the 6944's terminal-side interface transformers (switches* S1 *and* S2*) optioned for 600-ohm terminating impedance. If another terminating impedance is required for a particular application, it may be selected* **after** *alignment.*

3.12 **receive section:**

A. Condition the TMS for 1000Hz output at a +7dBm level into a 600-ohm load, and insert the signal at the *rcv SF in* jack.

B. With the receive portion of the TMS terminated in 600 ohms (see note above), measure the level at the *4W rcv drop or bal net out* jack. Adjust the module's *rcv* attenuator switches until the desired receive level is achieved.

3.13 **transmit section:**

Note: *When the transmit-channel equalizers are to be used, the* **final** *transmit-path level adjustment should not be made until* **after** *the equalizer adjustment is completed because equalizer settings affect levels through the transmit path at all frequencies.*

A. Temporarily remove the transmit path cut by inserting an opening plug into the *rcv SF in* jack to remove incoming SF tone.

B. If transmit-path post-equalization of the office-side loop **is not required** (e.g., in applications where the loop consists of nonloaded cable), ensure that the front-panel *xmt HF* and *LF* equalizer controls are adjusted fully counterclockwise; then proceed to step C. If transmit-path post-equalization of an office-side loop consisting of loaded cable **is required**, proceed as follows:

1. Arrange for 1000Hz tone to be sent from the office end at the level specified on the circuit level record (CLR) card.

2. Condition the receive portion of the TMS for 600-ohm terminated measurement and measure the 1000Hz signal level at the *xmt SF out* jack. Adjust the module's *xmt* attenuator switches until a level of −16 ±0.1dBm is measured.

3. For high-frequency equalization, leave the TMS connected as described above, arrange for 3000Hz tone to be sent from the office end, and note the received signal level. Adjust the *xmt HF* equalizer control until the desired level (relative to the 1000Hz level) is achieved.

4. For low-frequency equalization, leave the TMS connected as described above and arrange for 300Hz tone to be sent from the office end, and note the received signal level. Adjust the *xmt LF* equalizer control until the desired level (relative to the 1000Hz level) is achieved.

5. Again have 1000Hz tone sent at the level specified on the CLR. Readjust the *xmt* attenuator switches, if necessary, to achieve a level of −16 ±0.1dBm. If desired, a frequency run may be made to verify overall frequency response. Use a representative selection of frequencies between 300 and 3000Hz. If the equalizer adjustment must be altered, the *xmt* attenuator switches must be readjusted again for the required −16 ±0.1dBm level. When all equalizer and attenuator adjustments are completed, proceed to step E.

C. In applications where equalization is not used, condition the TMS for 1000Hz tone output at the level and impedance specified for the terminal side (i.e., office-side) transmit interface. Insert this signal at the *4W xmt drop or 2W in* jack.

D. Condition the receive portion of the TMS for 600-ohm terminated measurement and measure the signal level at the *xmt SF out* jack. Adjust the module's *xmt* attenuator switches until a level of −16 ±0.1dBm is measured.

Note: *As an alternative to steps C and D, steps B1 and B2 may be performed instead.*

E. This completes alignment of the transmit path. Remove the opening plug and all test cords, and return switches *S1* and *S2* to their proper impedance settings.

4. circuit description

4.01 To provide the clearest possible understanding of the operation of the 6944 4Wire FXO SF Signaling Set module, sequence charts (figures 4 and 5) 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 6944 functional block diagram (section 5 of this Practice) may aid in understanding the sequence charts.

6. specifications

local 4wire interface

terminal-side (i.e., office-side) impedance (receive output and transmit input ports)
150, 600, or 1200 ohms, balanced, switch-selectable

impedance variation
600 or 1200 ohms ±10%, 300 to 4000Hz;
150 ohms ±15% 300 to 4000Hz

insertion loss
0.5 ±0.2dB at 1000Hz

frequency response
±1dB re 1000Hz level, 300 to 4000Hz

maximum simplex (SX) current
100mA balanced; maximum unbalance of 5mA

equalization
high-frequency: 0 to 3 ±0.5dB "bump" centered at 3400 ±50Hz re 1000Hz level, continuously adjustable
low-frequency: 0 to 3dB roll-off at 300Hz re 1000Hz level, continuously adjustable

4wire attenuators

range
0 to 26.5dB in 0.1dB increments

impedance
600 ohms, unbalanced

accuracy
±0.05dB for 0.1, 0.2, 0.4, and 0.8dB steps,
±0.1dB for 1, 2, 4, 8, and 10dB steps

SF transmit section, transmission parameters

alignment level, facility interface
−16dBm

insertion loss
0 ±0.2dB at 1000Hz

frequency response
±0.2dB re 1000Hz level, 300 to 4000Hz

4wire line impedance (transmit output port)
600 ohms ±5%, balanced, 300 to 4000Hz

noise
20dBrnC0 maximum

nonlinear distortion
less than 1% THD at 0dBm0

overload
greater than +10dBm0

envelope delay
less than 20μs, 400 to 4000Hz

longitudinal balance
greater than 60dB at transmit facility port, 200 to 4000Hz

SF transmit section, signaling parameters

SF oscillator (internal)
frequency: 2600Hz; other frequencies must be specified at time of order
stability: ±2Hz for 6 months; ±5Hz for life of unit

SF tone states
loop start: idle — no tone
busy — no tone
ringing — tone transmitted
ground start: idle — continuous tone transmitted
tip lead ground — no tone
ringing — modulated tone

SF tone levels
high level: −24 ±2dBm
low level: −36 ±1dBm

transmit path cut
cut removal delay: 225 ±100ms after removal of outgoing SF tone

modulation — ground start
20Hz ±3Hz during ringing

forward disconnect delay — ground start
removal of tip ground to tone on: 300 to 350ms

SF receive section, transmission parameters

alignment level, facility interface
+7dBm

insertion loss
0 ±0.2dB at 1000Hz

frequency response
±0.2dB re 1000Hz level, 300 to 4000Hz, with band-elimination filter out

4wire line impedance (receive input port)
600 ohms ±5%, balanced, 300 to 4000Hz

internal noise
less than 10dBrnC0

nonlinear distortion
less than 1% THD at 0dBm0

overload
no clipping below +5dBm0

envelope delay
less than 20μs, 400 to 4000Hz, band-elimination filter excluded

longitudinal balance
greater than 60dB at receive facility port, 200 to 4000Hz

SF receive section, signaling parameters

SF tone frequency
2600Hz nominal; other frequencies must be specified at time of order

SF tone threshold
−24dBm (maximum)

SF tone rejection
55dB minimum, 2590 to 2610Hz (2600Hz option)

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

signal-to-guard ratio for signal detection
8 to 12dB

maximum line noise
58dBrnC

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

specifications continued on page 12

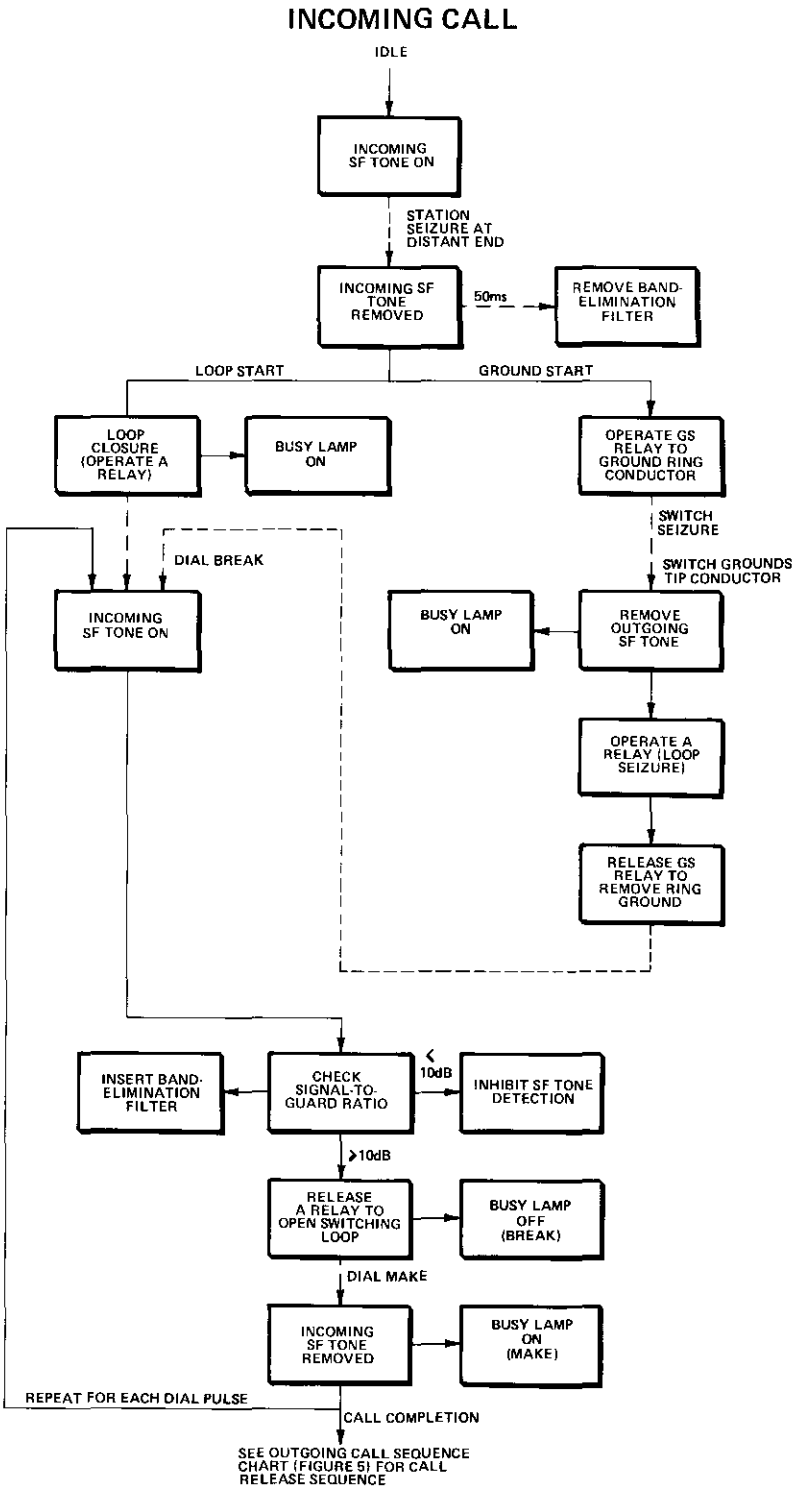


figure 4. Function sequence chart, incoming call

OUTGOING CALL

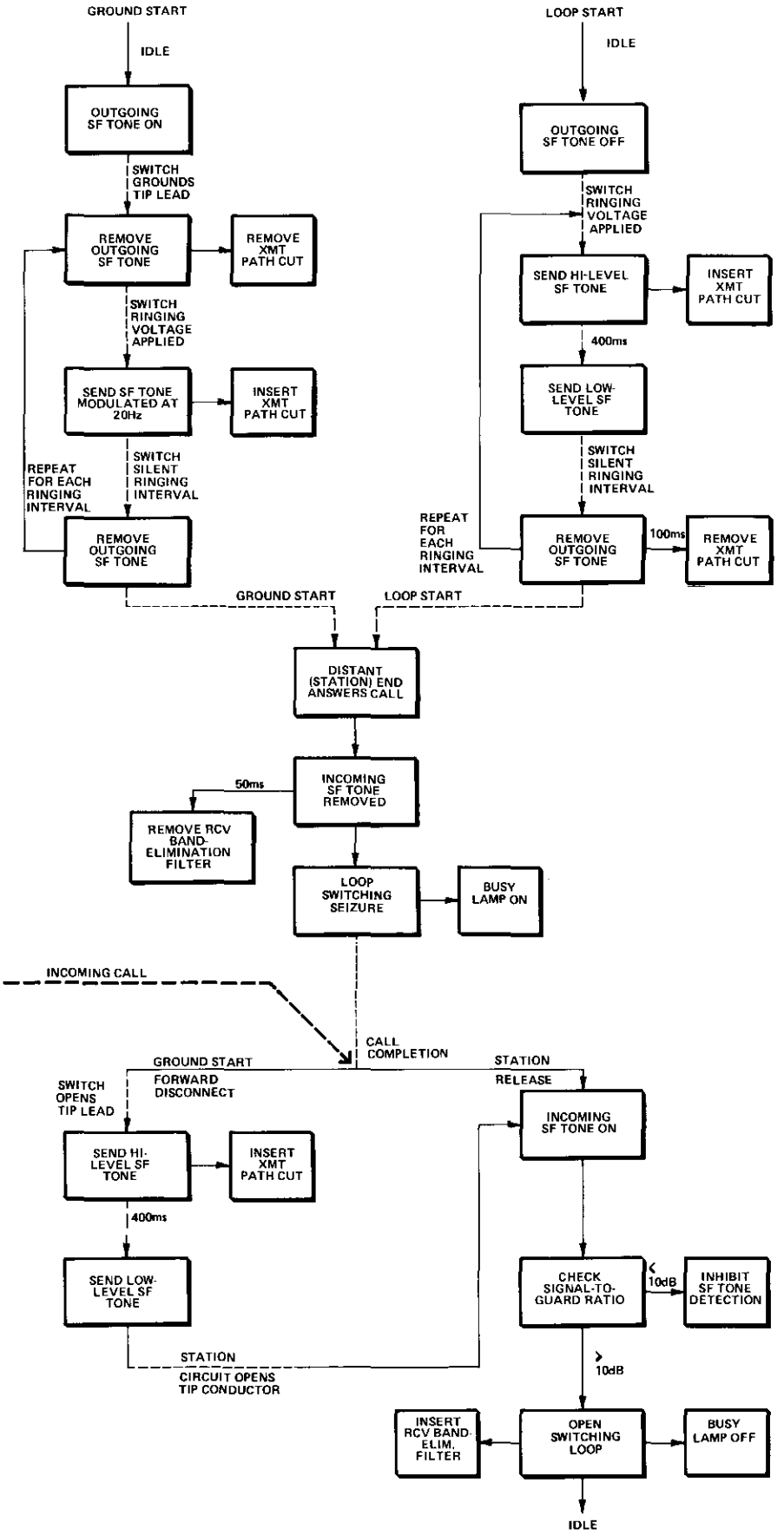
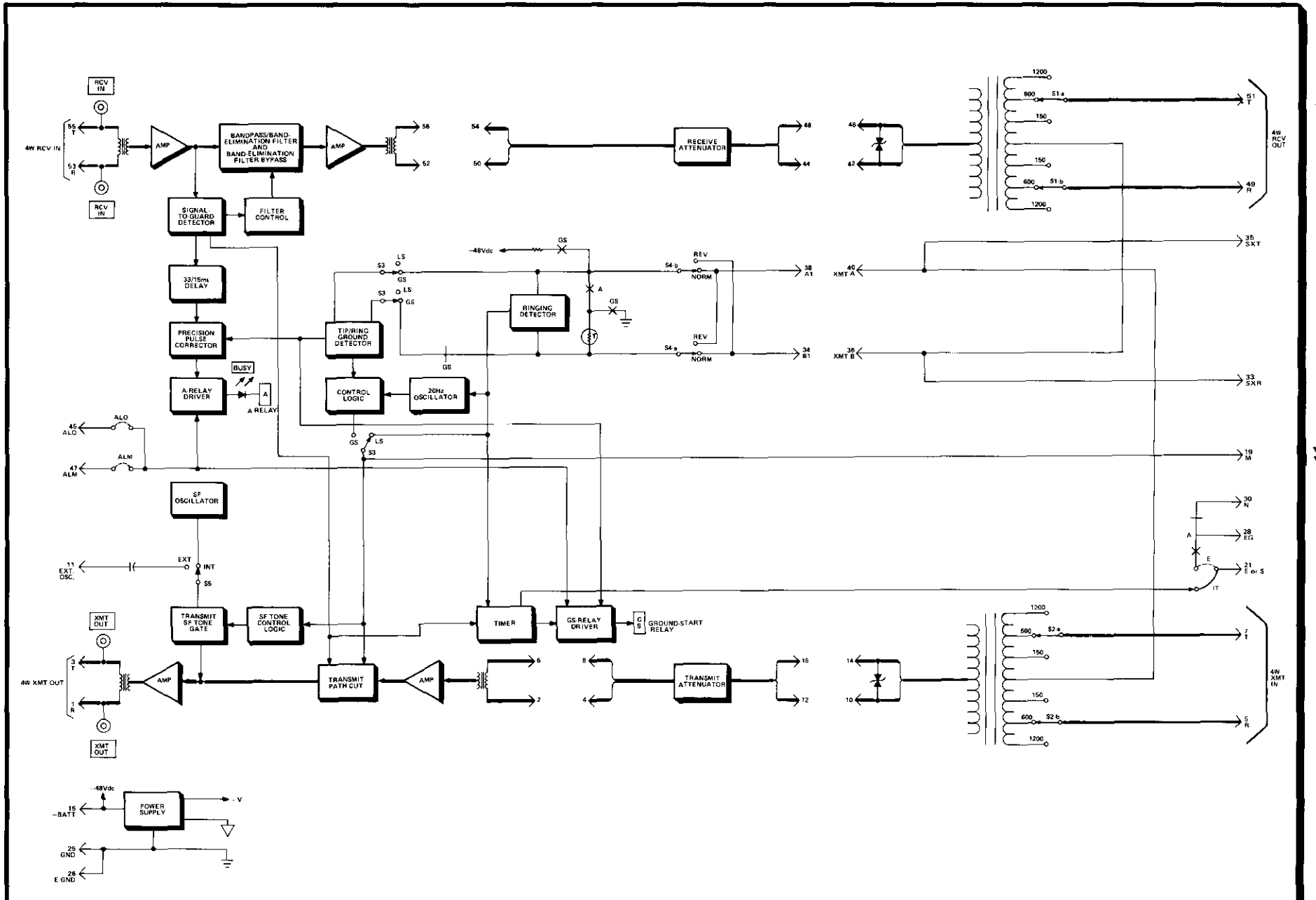


figure 5. Function sequence chart, outgoing call



6944 4Wire FXO SF Signaling Set module 816944

5. block diagram

band-elimination filter timing
insertion time: 13 ±8ms
removal time: 50 ±10ms or duration of tone +50 ±10ms, whichever is longer

dial pulse characteristics — SF to loop
(input pulses shorter than 31ms ignored)

pulse rate	input break ratio	output break
8pps	30 to 85%	57 ±2%
10pps	35 to 85%	58 ±2%
12pps	40 to 80%	59 ±2%

external oscillator (optional)

frequency
2600 ±2Hz

level
0.5Vrms

load impedance
75 kilohms minimum, unbalanced

4wire loop conditions

loop current limiting
less than 100mA, 200 ohms resistance minimum

longitudinal balance
60dB minimum, 200 to 4000Hz

ring ground delay (ground start)
100ms nominal after loss of incoming SF tone

tip ground response delay (ground start)
100ms nominal tone removal delay

ringing voltage detection threshold
50Vac rms minimum, 17 to 67Hz

power requirements

input voltage
–42 to –56Vdc, filtered, ground referenced

input current
idle: 24 to 28mA
busy: 40 to 45mA

physical

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

dimensions
6.71 inches (17.04cm) high
1.42 inches (3.61cm) wide
12.94 inches (32.87cm) deep

weight
29 ounces (0.822kg)

mounting
relay rack via one position of a Tellabs Type 16 Mounting Shelf; may also be mounted in one position of lower shelf of a Tellabs 269-series Mounting Assembly

7. testing and troubleshooting

7.01 The Testing Guide Checklist in this section may be used to assist in the installation, testing, or troubleshooting of the 6944 4Wire FXO SF Signaling Set 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 6944 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 6944 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 6944 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 8X6944 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 6944 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 6944 module, shipment prepaid, to Tellabs (attn: repair and return).

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

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

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

testing guide checklist

Note 1: *The testing procedure for the 6944 module is most conveniently performed when a Tellabs 9807 Card Extender or an external jackfield is used to provide access to the appropriate points in the module. The following procedure is therefore based on the assumption that a Card Extender or jackfield will be used. Jack designations are those on the 9807.*
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: *Tests marked with an asterisk (*) require presence of jumpers listed in table 3.*

test	test procedure	normal results	if normal conditions are not met, verify:
receive-channel idle, loop start or ground start*	Connect transmit portion of pulsing test set (PTS) arranged to transmit 2600Hz tone at −20dBm to *rcv SF in* jack. Insert opening plug into *A&B facility (line)* jack.	With tone on, front-panel *busy* LED extinguished ☐.	Wiring ☐. Tone level (−20dBm) ☐. Tone frequency (2600 ±10Hz) ☐. Test set connections ☐. Replace module and retest ☐.
receive-channel seizure (incoming), loop start, module only*	Leave transmit portion of PTS connected as above. Connect receive portion of PTS to *A&B facility (line)* jack and arrange PTS to monitor loop signaling.	With tone on, PTS indicates loop open ☐. With tone off, PTS indicates loop closure ☐. Front-panel *busy* LED lighted ☐.	Power ☐. Switch *S3* set to *LS* ☐. Same as above ☐.
receive-channel pulsing (incoming), loop start, module only	Leave PTS connected as above. Arrange PTS to transmit dial pulses (2600Hz tone bursts) at −1dBm and at various speeds and percent breaks.	For 8 to 12pps and 40% to 70% break inputs, loop pulses corrected to 58 ±3% break ☐. Front-panel *busy* LED follows pulsing ☐.	Power ☐. Tone level (−1dBm) ☐. Tone frequency (2600 ±10Hz) ☐. Test set connections ☐. Replace module and retest ☐.
receive-channel seizure (incoming), ground start, module only	Connect transmit portion of PTS arranged to transmit 2600Hz tone at −20dBm to *rcv SF in* jack. Connect VOM arranged to measure 250Vdc as follows: VOM positive to B1 lead (pin 34), VOM negative to −48Vdc.	With tone on, front-panel *busy* LED is off and VOM indicates 0Vdc ☐. With tone off, VOM indicates approximately 50Vdc (office battery) and front-panel *busy* LED lights ☐.	Power ☐. Wiring ☐. Tone level (−20dBm) ☐. Tone frequency (2600 ±10Hz) ☐. Test set connections ☐. Switch *S3* set to *GS* ☐. Replace module and retest ☐.
	Disconnect VOM. Arrange receive portion of PTS to monitor loop signaling. Remove tone; then connect receive portion of PTS to *A&B facility (line)* jack.	PTS indicates loop closed ☐.	Same as above ☐.
receive-channel pulsing (incoming), ground start, module only †	Leave PTS connected as above. Initiate receive-channel seizure, ground-start, by removing incoming (from PTS) 2600Hz tone. Arrange transmit portion of PTS to transmit dial pulses (2600Hz tone bursts) at −1dBm and at various speeds and percent breaks.	For 8 to 12pps and 40% to 70% break inputs, loop pulses corrected to 58 ±3% break ☐. Front-panel *busy* LED follows pulsing ☐.	Power ☐. Wiring ☐. Tone level (−1dBm) ☐. Tone frequency (2600 ±10Hz) ☐. Test set connections ☐. Replace module and retest ☐.
receive-channel transmission*	Set *S1* for 600 ohms if not already set. Initiate recieve-channel seizure as outlined in appropriate section (loop start or ground start) above. Disconnect transmit portion of PTS from *rcv SF in* jack. Connect transmission measuring set (TMS) arranged for 1004Hz output at 0dBm and 600 ohms to *rcv SF in* jack. Connect receive portion of TMS terminated in 600 ohms to *4W rcv drop or bal net out* jack. Set module's front-panel *rcv* attenuator switches to 0dB.	TMS indicates 0 ±0.2dBm ☐.	Power ☐. Wiring ☐. Front-panel *rcv* pads set for 0dB loss ☐. Input tone level and impedance ☐. Proper TMS termination ☐. Replace module and retest ☐.

checklist continued on page 14

test	test procedure	normal results	if normal conditions are not met, verify:
receive-channel transmission* (continued)	To verify attenuator function, introduce loss specified on circuit level record (CLR) card via front-panel *rcv* attenuator switches and note TMS reading.	TMS indicates comparable decrease in level ☐.	Replace module and retest ☐.
transmit-channel signaling (loop start)*	Ensure that incoming (from PTS) 2600Hz tone is present. Set switch *S5* to *INT* position or verify external SF tone supply if *S5* is set to *EXT*. Connect receive portion of TMS terminated in 600 ohms to *xmt SF out* jack. Connect ringing voltage to *A&B facility (line)* jack.	Before ringing voltage applied, no SF tone present at *xmt SF out* jack ☐ and front-panel *busy* LED extinguished (tone must be present in receive channel) ☐. When ringing voltage applied, tone level of −24 ±2dBm observed for first 400 ±100ms. Level then decreases to −36 ±2dBm for duration of ringing application ☐, and front-panel *busy* LED remains off ☐.	Power ☐. Switch *S5* properly set ☐. Switch *S3* set to *LS* ☐. Wiring ☐. Ringing voltage between 50Vac and 130Vac ☐. Test set connections and termination ☐. Replace module and retest ☐.
transmit-channel signaling (ground start)*	Set switch *S5* to *INT* position or verify external SF tone supply if *S5* is set to *EXT*. Connect receive portion of TMS terminated in 600 ohms to *xmt SF out* jack. Connect jumper wire from connector pin 38 to connector pin 26.	Before jumper wire connected, tone level of −36 ±2dBm observed ☐ and front-panel *busy* LED off (tone must be present on receive channel for LED to be off) ☐. When jumper wire installed, tone removed from *xmt SF out* jack ☐ and front-panel *busy* LED remains off ☐.	Power ☐. Switch *S5* properly set ☐. Switch *S4* set to *NORM* ☐. Switch *S3* set to *GS* ☐. Wiring ☐. Test set connections and termination ☐. Replace module and retest ☐.
	Maintain connections as above. Connect negatively biased ringing voltage to ring terminal and ground to tip terminal of *A&B facility (line)* jack. Remove jumper before proceeding to next test.	When ringing voltage applied, tone level of −30dBm (−24dBm, 50% duty cycle) observed ☐ and front-panel *busy* LED remains off ☐.	Ringing voltage (50 to 130Vac) ☐. Ringing applied to ring conductor; tip conductor at ground ☐. Same as above ☐.
transmit-channel transmission and path cut (loop start)*	Connect TMS arranged for 1004Hz output at −16dBm and 600 ohms to *4W xmt drop or 2W in* jack. Set *S2* for 600 ohms if not already set. Connect receive portion of TMS terminated in 600 ohms to *xmt SF out* jack. Set module's front-panel *xmt* attenuator switches for 0dB loss.	TMS indicates −16 ±0.2dBm ☐.	Power ☐. Wiring ☐. Front-panel *xmt* pads set for 0dB loss ☐. Input tone level and impedance ☐. Proper TMS termination ☐. Replace module and retest ☐.
	Connect ringing voltage to *A&B facility (line)* jack.	When ringing voltage applied, tone level of −24 ±2dBm observed for first 400 ±100ms, indicating transmit path cut ☐. Level then decreases to −36 ±2dBm and remains at this level for duration of ringing voltage application ☐.	Ringing voltage between 50Vac and 130Vac ☐. Same as above ☐.
	Disconnect ringing voltage from *A&B facility (line)* jack. To verify attenuator function, introduce loss specified on CLR card via front-panel *xmt* attenuator switches and note TMS reading.	TMS indicates comparable decrease in level from −16dBm level ☐.	Replace module and retest ☐.

test	test procedure	normal results	if normal conditions are not met, verify:
transmit-channel transmission and path cut (ground start)*	Connect TMS arranged for 1004Hz output at −16dBm and 600 ohms to *xmt pad in* jack. Connect receive portion of TMS terminated in 600 ohms to *xmt SF out* jack. Set module's front-panel *xmt* attenuator switches for 0dB loss.	TMS indicates −36 ±2dBm ☐.	Power ☐. Wiring ☐. Proper TMS termination ☐. Replace module and retest ☐.
	Connect jumper wire from connector pin 38 to connector pin 26.	TMS indicates −16 ±0.2dBm, indicating removal of transmit path cut ☐.	Front-panel *xmt* pads set for 0dB loss ☐. Input tone level and impedance ☐. Same as above ☐.
	To verify attenuator function, introduce loss specified on CLR card via front-panel *xmt* attenuator switches and note TMS reading.	TMS indicates comparable decrease in level ☐.	Replace module and retest ☐.
	Remove jumper wire between connector pins 38 and 26.	For 300 to 500ms after removal of jumper wire, tone level of −24 ±2dBm observed ☐. Level then decreases to −36 ±2dBm and remains at this level ☐.	Power ☐. Wiring ☐. Proper TMS termination ☐. Replace module and retest ☐.
4wire receive level*	Connect receive portion of TMS (properly terminated) to *4W rcv drop or bal net out* jack. Request distant end to seize circuit and send 1004Hz tone at proper test level for circuit.	Level within ±0.2dB of level specified on CLR card ☐. Level varies as front-panel *rcv* attenuator switches adjusted ☐.	Receive level from 4wire facility OK; measure via TMS (in bridging mode) connected to *rcv line mon* jack ☐. If this level OK, verify settings of option switches *S1* and *S2* ☐. Wiring ☐. Replace module and retest ☐.
4wire transmit level*	Connect TMS arranged for 1004Hz output at level and impedance specified on CLR card to *4W xmt drop or 2W in* jack. Request distant end to measure incoming 1004Hz tone level.	Level at distant end within ±0.2dB of level specified on CLR card ☐. Level varies as front-panel *xmt* attenuator switches adjusted ☐.	With 6944 properly aligned, 4wire transmit level from module is −16 ±0.2dBm; measure via TMS connected to *xmt SF out* jack ☐. If this level OK, verify alignment of 4wire facility ☐. If this level not OK, verify front-panel *xmt* attenuator switch settings ☐ and *S1* and *S2* settings ☐. Replace module and retest ☐.

†To perform this test, the receive-loop portion of the PTS must provide a ground path on the tip lead associated with the *A&B facility (line)* jack.

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