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practice section 816164/816164A/816164B/816164C

6164, 6164A, 6164B, and 6164C 4Wire-to-2Wire SF-to-FXO Terminal Repeaters

contents

1. general description

1.01 The 6164, 6164A, 6164B, and 6164C 4Wire-to-2Wire SF-to-FXO Terminal Repeaters are Tellabs Type 10 plug-in modules that provide both active transmission interface and full-duplex signaling conversion between a 4wire metallic facility that uses 2600Hz SF signaling and a 2wire metallic foreign-exchange (FX) or off-premises-station (OPS) link that uses foreign-exchange office-end (FXO) loop signaling. All four 6164X modules meet the specifications given in AT&T Technical Reference Pub 43002 for Network Channel Terminating Equipment (NCTE) Criteria, and, in addition, the 6164A and 6164C meet the specifications given in Pub 43004 for Transmission and Signaling Loopback Criteria.

1.02 In the event that this practice section is reissued, the reason for reissue will be stated in this paragraph. In those parts of this practice that apply equally to the 6164, 6164A, 6164B, and 6164C, all four modules are, for convenience, referred to as the *6164X module*.

1.03 While all four 6164X NCTE modules share the same basic transmission-interface and signaling-conversion circuitry, they differ through the presence or absence of loopback capability and of front-panel jacks. Table 1 lists the differences between the four 6164X modules.

module	front-panel jacks	loopback
6164	yes	no
6164A	yes	yes
6164B	no	no
6164C	no	yes

table 1. 6164X module selection guide

1.04 All four 6164X modules offer the following features:

- 4wire-to-2wire conversion via an integral magnetic hybrid.
- From 0 to 24dB of prescription-set gain or loss in both the transmit and receive channels at the facility-side ports.

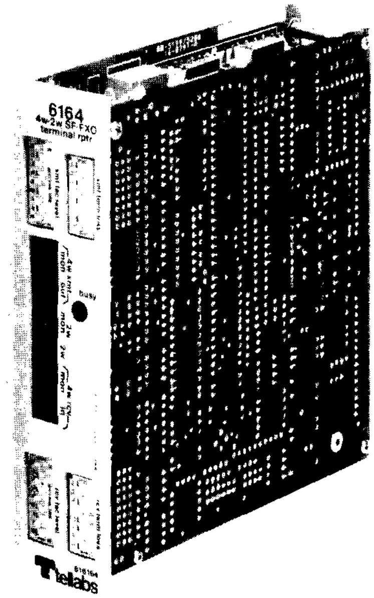


figure 1. 6164A 4Wire-to2Wire SF-to-FXO Terminal Repeater module

- From 0 to 24dB of prescription-set loss in both the transmit and receive channels at the terminal side (on the 4wire side of the hybrid).
- Prescription receive-channel amplitude equalization equivalent to that provided by the Western Electric 309B Prescription Equalizer.
- Isolation transformers at both facility side 4wire ports and at the 2wire terminal-side 2wire port.
- Independently switch-selectable 1200 or 600-ohm terminating impedance at each facility-side 4wire port and switch-selectable 900 or 600-ohm in series with 2.15μF at the terminal-side 2wire port.
- Integral 2600Hz SF tone oscillator.
- Switch-selectable loop-start or ground-start operation.
- Integral compromise balance network (CBN), with provision for external precision balance network (PBN).
- From 0 to 0.030μF of switch-selectable network build-out (NBO) capacitance in 0.002μF increments.
- Full pulse correction in the receive path.
- Switch-selectable normal or inverted incoming SF states.
- Loop-current limiting.
- Reverse-battery and overvoltage protection.
- Opening and monitoring bantam-type jacks at all ports (6164 and 6164A only).
- Local or remote signaling loopback and equal-level transmission loopback (6164A and 6164C only).

1.05 The loopback circuitry on the 6164A and 6164C provides the following features:

- Ability to remotely perform facility, level, and equalization transmission tests.
- Ability to remotely test the following signaling circuitry:
  1) SF detector.
  2) SF transmitter (both augmented and normal levels).
  3) Transmit path cut.
- Manually activated (local) loopback via switch option.
- Manually activated (local) loopback via ground on the MLB lead or contact closure between the MLB and MLBG leads.
- 2713Hz tone-activated (remote) loopback with second-tone or automatic timeout (see below) loopback deactivation.
- Automatic deactivation of tone loopback after switch-selectable 4-minute or 20-minute timeout interval.
- From −23 to +24dB of prescription-set gain (in switch-selectable 1dB increments) for true equal-level loopback.
- Front-panel status-indicating LED that lights when the module is in loopback.

2. application

2.01 The 6164X 4Wire-to-2Wire SF-to-FXO Terminal Repeater module is typically used to interface a 4wire SF transmission facility with a 2wire metallic signaling link that uses the type of loop signaling normally associated with the office end of a foreign-exchange (FX) or off-premises-extension (OPS) circuit. No external transmission interface circuitry is needed because the 6164X module combines the functions of a 4wire line amplifier, an SF transceiver, an SF-to-FXO signaling converter, and a 4wire-to-2wire hybrid terminating set. Figures 2, 3, and 4 show three typical applications.

2.02 In its transmit and receive channels, the 6164X module provides from 0 to 24dB of prescription gain or loss in 0.1dB increments at the 4wire facility-side ports, and from 0 to 24dB of prescription loss in 0.1dB increments in both the receive and transmit paths at the 4wire side of the hybrid (see block diagram) to facilitate proper setting of internal TLP levels. Prescription receive equalization is provided by a circuit equivalent to the WECo 309B, and the terminating impedance at the

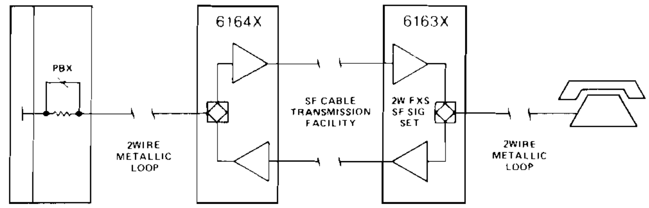


figure 3. Typical short-haul (all-metallic) off-premises-extension (OPS) application of 6164X NCTE module

facility-side ports can be independently switch-selected for balanced 1200 or 600-ohm terminating impedance. The terminal-side 2wire port can be switch-optioned for balanced 900 or 600-ohm terminating impedance in series with 2.15μF.

2.03 Table 1 in section 1 of this practice will aid in determining which module is best suited for a particular application. Typically, if loopback is required, it need only be provided by one module of a loop-extending pair of 6164X's (usually at the terminal end). Front-panel jacks may be unnecessary if prescription alignment is to be used exclusively.

2.04 In applications where the serving telephone company uses facility-side SF signaling, each module fulfills Registered Facility Interface Codes OC13A, OC13B, OC13C, OL13A, OL13B, and OL13C.

2.05 The 6164X 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 6164X holds the 2wire loop open toward the local switching equipment. When the office end is idle, the 6164X 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 6164X to transmit SF tone. Receipt of this tone by the FXS signaling unit initiates ringing toward the station or PBX 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 6164X, upon this loss of incoming tone, closes the 2wire loop toward the local switching equipment. Incoming SF tone pulses indicate dialing.

2.06 In ground-start operation, just as in loop-start, the 6164X module 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 6164X holds the

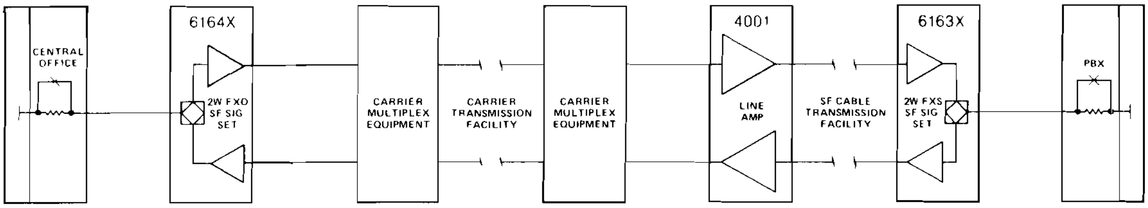


figure 2. Typical foreign-exchange (FX) application of 6164X NCTE module

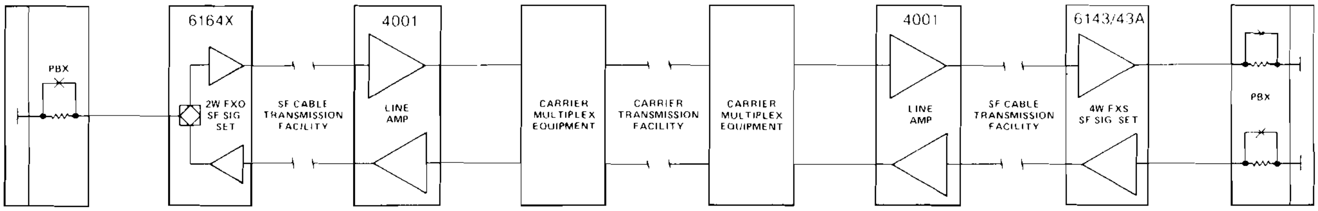


figure 4. Typical long-haul off-premises-extension (OPS) application of 6164X NCTE module

2wire loop open toward the local switching equipment. Similarly, when the office end is idle, the 6164X transmits low-level SF tone. Receipt of this tone by the distant FXS signaling unit holds the tip-lead open toward the PBX trunk circuit at that end. On calls from the office end to the station end, the local switching equipment grounds the tip lead, causing the 6164X to remove outgoing SF tone. Subsequent receipt of ringing voltage from the local switching equipment causes the 6164X to transmit high-level SF tone amplitude modulated at 20Hz. Receipt of this tone by the FXS signaling unit causes that 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 6164X closes the 2wire 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 6164X. This removal of SF tone grounds the ring side of the 2wire path toward the local switching equipment. The switching equipment returns ground on the tip side, and the 6164X 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.

2.07 When the distant station is off-hook, the 6164X provides a path for loop current flow via the A and B leads and the tip and ring leads of its integral hybrid. Supervisory limits in applications involving the 6164X depend upon the sensitivity of the local switching equipment.

2.08 Signaling-tone states for the 6164X are consistent with the conventional SF-signaling formats of FXO and office-end OPS service. These states are listed in tables 2 and 3 for loop-start and ground-start operation, respectively.

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

table 2. Loop-start signaling-tone states

2.09 The 6164X interfaces the receive path on the facility side and the 2wire path at the terminal side at any TLP from −17 to +7. Idle-state SF tone is received at a level of −20dBm0. A higher level of −8dBm0 is received during break portions of dial pulses and for about 400ms at the beginning of each tone interval. Within approximately 13ms of detection, a band-elimination filter (BEF) is inserted into the receive transmission path to prevent propagation of SF tone beyond the module.

local 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 3. Ground-start signaling-tone states

2.10 The 6164X interfaces the transmit path on the facility side and the 2wire path at the terminal side at any TLP from +8 to −16 and transmits tones at either of two levels. During the idle state, the module transmits SF tone at −20dBm0. During dial pulsing and also for the first 400ms each time it applies tone to the facility, the 6164X transmits SF tone at a higher level of −8dBm0. This momentarily increased tone level aids in detection of supervisory-state changes and incoming dial pulsing.

2.11 The transmit voice path through the 6164X is cut (opened) during dialing and whenever SF tone is transmitted. The path cut is inserted within a few milliseconds of any interruption of local loop current and approximately 125 milliseconds after transmission of SF tone ceases. These path cuts prevent transmission of noise, transients, speech, and other interfering signals during critical signaling intervals.

2.12 Generally, if loopback is to be used, the terminal-end module will be the one requiring loopback capabilities (6164A or 6164C). Equal-level transmission loopback is made possible via the loopback level switches, which provide from −23 to +24dB of gain in 1dB increments. The loopback circuitry also provides signaling loopback functions for remote testing of the SF and E&M signaling circuitry.

2.13 When the 6164X is in loopback and its signaling circuitry is operational, the module repeats all signaling states that it receives. For example, if an on-hook (ground) is sent to a 6164X in loopback, the module responds by transmitting an on-hook (ground). If an off-hook (negative battery) is sent to the 6164X, it responds by transmitting an off-hook.

2.14 Several modes of loopback initiation and removal are available. All are selected via option switches. These modes are described in section 3 of this practice.

3. installation

inspection

3.01 The 6164X 4Wire-to-2Wire SF-to-FXO Terminal Repeater module should be visually inspected upon arrival to find any 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 6164X mounts in one position of a Tellabs Type 10 Mounting Shelf, in one position of a Tellabs 262U Universal Network Terminating System Assembly, or in one position of a Tellabs 260A Signaling and Terminating System Assembly, all of which are available in configurations for relay-rack and apparatus-case installation. The module plugs physically and electrically into a 56-pin connector at the rear of its shelf or assembly position.

3.03 In applications where a 6164X module is to be installed in a 262U Assembly, no additional connections need be made. This is because all of the assembly's internal connections are factory-prewired and because external wiring is simplified through the use of female 25-pair connector-ended cables arranged in accordance with Universal Service Order Code (USOC) RJ2HX. If the customer's terminal equipment is cabled in accordance with USOC RJ2HX, direct connection between the 262U Assembly and the customer's equipment is possible. If not, cross-connections between the assembly and the local terminal equipment must be made at an intermediate connectorized terminal block or by means of an optional adapter cable available as a list number for the 262U Assembly.

installer connections

3.04 When a 6164X module is to be installed in a conventional Type 10 Shelf, external connections to the module must be made. Before making any connections to the mounting shelf or assembly, make sure that power is **off** and modules are **removed.** Modules should be put into place only **after** they are properly optioned and **after** wiring is completed.

3.05 Table 4 lists external connections to the 6164X module. All connections to non-prewired mountings are made via wire-wrapping to the 56-pin connector at the rear of the module's shelf or assembly position. Pin numbers are found on the body of the connector.

connect:	**to pin:**
4WIRE RCV TIP	7
4WIRE RCV RING	13
4WIRE XMT TIP	41
4WIRE XMT RING	47
4WIRE RCV SX	9
4WIRE XMT SX	43
2WIRE TIP (terminal side)	55
2WIRE RING (terminal side)	49
SLEEVE (traffic-monitoring or sleeve lead)	1
EXTERNAL PBN	5 and 15
A lead	51
B lead	3
MLB (manual loopback)	18
MLBG (manual loopback ground)	37
RING GEN	46
−BATT (−42 to −54Vdc filtered input)	35
GND (ground)	17

table 4. External connections to 6164X

option selection

3.06 A number of option switches must be set before the 6164X can be placed into service. These switches and their functions are described in paragraphs 3.07 through 3.11. The locations of the switches on the module's printed circuit board are shown in figure 5. Table 5 summarizes all switch options and provides a convenient checklist for optioning the module.

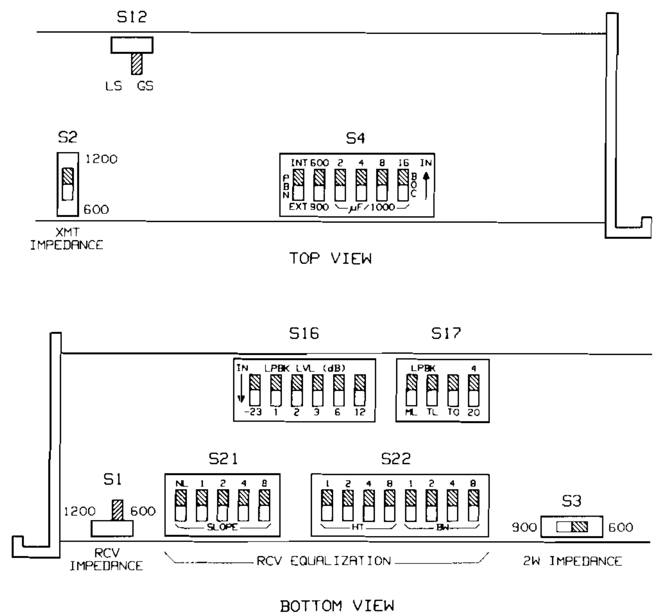


figure 5. 6164X option switch locations

option	paragraph	switch	selection	settings	checklist
facility-side 4w receive in impedance	3.07	S1	600 ohms	600	
			1200 ohms	1200	
facility-side 4w transmit out impedance	3.07	S2	600 ohms	600	
			1200 ohms	1200	
2W terminal side impedance	3.08	S3	600 ohms	600	
			900 ohms	900	
loop-start or ground-start operation	3.09	S12	loop start	LS	
			ground start	GS	
PBN internal or external	3.10	PBN	internal CBN	INT	
			external PBN	EXT	
terminal-side impedance	3.10	600/900	600 ohms	600	
			900 ohms	900	
terminal-side build-out capacitance (μF/1000 switches)	3.10	2	add 0.002μF	IN	
		4	add 0.004μF	IN	
		8	add 0.008μF	IN	
		16	add 0.016μF	IN	
Note: *The following options are on the 6164A and 6164C only.*					
manual loopback activation	3.11	LPBK ML	loopback off	(up)	
			loopback on	ML	
tone loopback activation	3.11	LPBK TL	disabled	(up)	
			enabled	TL	
tone loopback automatic timeout enable	3.11	LPBK TO	disabled	(up)	
			enabled	TO	
automatic timeout duration	3.11	LPBK 4/20	4 minutes	4	
			20 minutes	20	

table 5. 6164X option-switch summary and checklist

impedance matching

3.07 Two-position slide switches *S1* and *S2* on the main board select balanced 1200 or 600-ohm terminating impedance for the module's facility-side (4wire) ports as follows:

switch	port
S1	receive input (facility side)
S2	transmit output (facility side)

Option the facility-side ports (rcv in and xmt out) for 1200 ohms when interfacing loaded cable or for 600 ohms when interfacing nonloaded cable or carrier.

3.08 Two position slide switch *S3* selects 900 or 600-ohm terminating impedance at the module's terminal-side (2wire) port. Option the 2wire port for 900 ohms when it interfaces loaded cable or 900-ohm equipment and for 600 ohms when it interfaces nonloaded cable or 600-ohm equipment.

signaling options

3.09 Switch *S12* selects either loop-start or ground-start operation. To select loop-start operation, set *S12* to *LS*. To select ground-start operation, set *S12* to *GS*.

terminal-side compromise balance network (CBN) optioning

3.10 The integral CBN is aligned via six-position DIP switch *S4* as follows:

PBN, INT/EXT:

The *PBN* switch conditions the 6163X for use either with its internal CBN or with an external PBN. Set the *PBN* switch to *INT* if the 6164X's internal CBN is to be used. If an external precision balance network (PBN) is to be used, connect it to pins 5 and 15 and set the *PBN* switch to *EXT*.

600/900, compromise balance network:

The *600/900* switch selects the impedance of the CBN. Set it for the same impedance selected for the 2wire port.

BOC, μF/100 build-out capacitance:

Network build-out capacitance is introduced via the *μF/1000* switches. The values of the switches are denoted in thousandths of a microfarad and are cumulative; thus, the amount of BOC introduced is the sum of those switches set to *IN*.

loopback optioning (6164A and 6164C only)

3.11 The four-position *LPBK* DIP switch on the module's subassembly is used to select several loopback functions as follows:

ML, manual loopback:

Set the *ML* switch toward *ML* to manually place the module into loopback. Please note that when manual loopback is in effect, loopback cannot be deactivated by 2713Hz tone. Set the *ML* switch away from *ML* to deactivate manual loopback.

TL, tone loopback:

Set the *TL* switch toward *TL* to enable tone-activated loopback. In this mode, loopback is activated when a 2713Hz tone burst is applied to the facility-side receive input pair (pins 7 and 13) for a minimum of 2.5 seconds and then removed. When loopback is activated in this manner, it can be deactivated in either of two ways. One is application of a second 2713Hz tone for a minimum of 1.2 seconds; the other is automatic timeout deactivation after a selected length of time (see below).

TO, loopback timeout:
If automatic deactivation of tone-activated loopback after a timeout period is desired, set the *TO* switch toward *TO*. With the *TO* switch away from *TO*, tone-activated loopback can only be deactivated by a second tone burst.

4/20, loopback timeout duration:
The *4/20* switch selects the timeout period for automatic deactivation of tone-activated loopback. Set this switch to *4* if a 4-minute timeout period is desired or to *20* if a 20-minute timeout is desired. (This switch is enabled only when loopback timeout is selected via the *TO* switch.)

alignment

3.12 Alignment of the 6164X module comprises the following procedures performed in sequence (all option switches should already be properly set as described above):

A. Setting the receive-channel levels.
B. Introducing receive-channel equalization, if necessary.
C. Setting the transmit-channel levels.
D. Setting the loopback-path level (6164A and 6164C only).

3.13 Because internal levels of +7TLP in the receive path and −16TLP in the transmit path must be maintained regardless of external levels, two level control circuits are present in each path, as shown in figure 6.

3.14 The 6164X module is primarily intended for *prescription* alignment. This involves setting all gain and equalization switches according to specifications on the circuit layout record (CLR) prior to installation of the module. Simply indicate the proper settings in the *checklist* column of table 6; then refer to the table while performing the alignment procedure. In cases where CLR specifications are unavailable or inadequate, non-prescription alignment is necessary. These procedures are given in paragraphs 3.15 through 3.18.

Note: *Because the 6164B and 6164C do not have test jacks, non-prescription alignment of these modules is not recommended. If, however, non-prescription alignment is necessary, the use of a Tellabs 9801 or 9802 Card Extender or an external jackfield is strongly recommended to simplify alignment. The 6164B/C can also be aligned if measurements are made at the numbered pins at the rear of the module's mounting position and care is taken to avoid double terminations. In some instances, it may be necessary to remove some wire-wrapping connections at the module's mounting-shelf connector before tone can be applied or measured.*

non-prescription alignment

3.15 **Initial settings:**

A. Ensure that all impedance options are properly set.
B. Set all positions of the front-panel *xmt fac level*, *xmt term loss*, *rcv fac level*, and *rcv term loss* DIP switches to the *out* position for no gain or loss.
C. Set all receive equalization DIP switches (SLOPE, HT and BW) to the *out* position for no equalization.

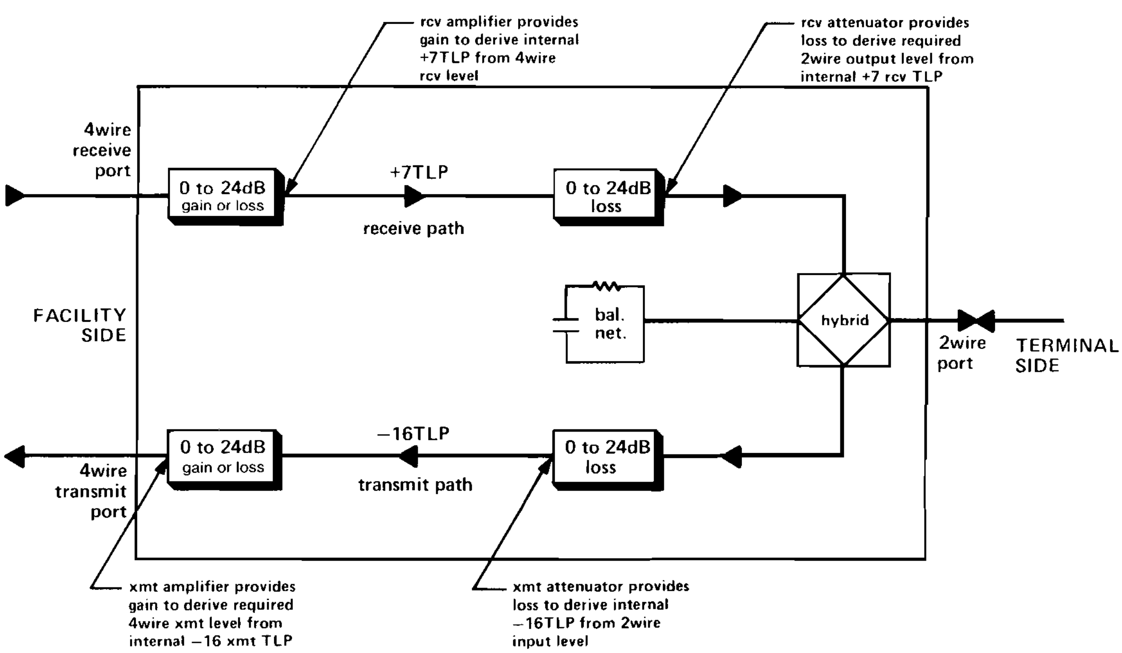


figure 6. Level coordination in the 6164X

alignment function	switch	selections	setting	checklist
transmit-channel loss or gain	front-panel *xmt fac level* loss/gain	loss	ls	
		gain	gn	
transmit-channel facility-side level adjustment	front-panel *xmt fac level* DIP switch*	0.1dB (gain or loss)	0.1 to IN	
		0.2dB (gain or loss)	0.2 to IN	
		0.4dB (gain or loss)	0.4 to IN	
		0.8dB (gain or loss)	0.8 to IN	
		1.5dB (gain or loss)	1.5 to IN	
		3.0dB (gain or loss)	3.0 to IN	
		6.0dB (gain or loss)	6.0 to IN	
		12.0dB (gain or loss)	12.0 to IN	
transmit-channel terminal-side flat loss	front-panel *xmt term loss* DIP switch*	0.1dB loss	0.1 to IN	
		0.2dB loss	0.2 to IN	
		0.4dB loss	0.4 to IN	
		0.8dB loss	0.8 to IN	
		1.5dB loss	1.5 to IN	
		3.0dB loss	3.0 to IN	
		6.0dB loss	6.0 to IN	
		12.0dB loss	12.0 to IN	
receive-channel loss or gain	front-panel rcv fac level loss/gain	loss	ls	
		gain	gn	
receive-channel facility-side level adjustment	front-panel *rcv fac level* DIP switch*	0.1dB (gain or loss)	0.1 to IN	
		0.2dB (gain or loss)	0.2 to IN	
		0.4dB (gain or loss)	0.4 to IN	
		0.8dB (gain or loss)	0.8 to IN	
		1.5dB (gain or loss)	1.5 to IN	
		3.0dB (gain or loss)	3.0 to IN	
		6.0dB (gain or loss)	6.0 to IN	
		12.0dB (gain or loss)	12.0 to IN	
receive-channel terminal-side flat loss	front-panel *rcv term loss* DIP switch*	0.1dB loss	0.1 to IN	
		0.2dB loss	0.2 to IN	
		0.4dB loss	0.4 to IN	
		0.8dB loss	0.8 to IN	
		1.5dB loss	1.5 to IN	
		3.0dB loss	3.0 to IN	
		6.0dB loss	6.0 to IN	
		12.0dB loss	12.0 to IN	
receive-channel equalization	*SLOPE*	loaded or nonloaded cable	down for loaded up for nonloaded	
		1	1 to IN	
		2	2 to IN	
		4	4 to IN	
		8	8 to IN	
	HT (height)	1	1 to IN	
		2	2 to IN	
		4	4 to IN	
		8	8 to IN	
	BW (bandwidth)	1	1 to IN	
		2	2 to IN	
		4	4 to IN	
		8	8 to IN	
loopback gain/loss	*S16-1* through *S16-6**	23dB loss	S16-1 to IN	
		1dB gain	S16-2 to IN	
		2dB gain	S16-3 to IN	
		3dB gain	S16-4 to IN	
		6dB gain	S16-5 to IN	
		12dB gain	S16-6 to IN	

* The xmt level, rcv level, and loopback level (S16) DIP-switch positions are cumulative. Total transmission loss or gain in each channel and total loopback-path loss or gain are the sum of the respective DIP-switch positions set to IN.

table 6. 6164X alignment-switch summary and checklist

D. Set all loopback level DIP switches to the *up* position (6164A and 6164C only) for no loopback path gain or loss.

3.16 **Receive-channel level adjustment:**

A. Connect the receive portion (properly terminated) of a transmission measuring set (TMS) to the *2W in* jack. Request the distant location to send 1004Hz at the level specified on the CLR. Verify that tone is present and measure its level.

B. Determine whether the measured level is higher or lower than +7dBm.
   1. If the measured level is lower than +7dBm, set the front-panel *rcv fac level gn/ls* switch to *gn.* Then set to *IN* the proper combination of front-panel *rcv fac level* switches that equals the required gain.
   2. If the measured terminal-side level is higher than +7dBm, set the front-panel *rcv fac level gn/ls* switch to *ls.* Then set to *IN* the proper combination of front-panel *rcv fac level* switches that equals the required amount of loss.

C. Refer to the CLR for the specified receive output level.

D. Calculate the difference between this specified output level and the internally derived +7dBm level.

E. Set to *in* the proper combination of front-panel *rcv term loss* DIP-switch positions that adds up to this difference.

3.17 **Transmit-channel level adjustment:**

A. Remove the transmit speech path cut by seizing the circuit from the terminal side. As an alternative, if the TMS being used for alignment is equipped with a holding coil, this can be used to seize the circuit.

B. Connect the transmit portion of the TMS (properly terminated) to the *2W in* jack. Send 1004Hz from the terminal-side location at 0.0dBm0.

C. Connect the receive portion of the TMS (properly terminated) to the *4W xmt out* jack.

D. Set to *IN* the proper combination of *xmt term loss* DIP-switch positions so that a −16dBm level is acheived.

E. Refer to the CLR for the specified transmit output level.

F. Request personnel at the distant end to measure and report their receive level.

G. Calculate the difference between this specified level and the measured level.

H. Determine whether the specified level is higher or lower than the measured level.
   1. If the specified level is lower, set the front-panel *xmt fac level gn/ls* switch to *gn.* Then set to *IN* the proper combination of front-panel *xmt fac level* switches that equals the calculated difference.
   2. If the specified level is higher, set the front-panel *xmt fac level gn/ls* switch to *ls.* Then set to *IN* the proper combination of front-panel *xmt fac level* switches that equals the calculated difference.

receive-channel equalization alignment

3.18 The receive-channel equalizer on the 6164X is functionally identical to the Western Electric 309B Prescription Equalizer. Prescription settings for the equalizer can be found in BSP (Bell System Practice) section 332-912-232, and manual alignment procedures for the equalizer can be found in BSP section 332-912-234.

loopback level adjustment

3.19 To adjust the 6164X's loopback-level-control circuitry to provide equal-level loopback, proceed as follows:

A. From the CLR, determine the specified receive input and receive output levels.

B. Subtract the receive output level from the receive input level. The result is the amount of gain required in the loopback path.

C. On the 6164X's loopback subassembly, set to *on* that combination of *lpbk lvl* DIP-switch positions which most closely approximates the amount of gain determined in step B.

4. circuit description

4.01 This circuit description is intended to familiarize you with the operation of the 6164X 4Wire-to-2Wire SF-to-FXO Terminal Repeater modules. Attempts to troubleshoot these modules internally are not recommended and may void your warranty. Please refer to the 6164X block diagram, section 5 of this practice, as an aid in following this circuit description. Figures 7 and 8 are function sequence flowcharts that illustrate sequential operation of the 6164X on incoming and outgoing calls. Horizontal paths identify events occuring simultaneously, and vertical paths denote sequential events. Dotted lines indicate elapsed time.

receive path

4.02 A transformer at the 4wire receive input port interfaces the transmission facility and derives tip, ring, and simplex leads. The transformer's secondary windings are coupled to a resistive switch-selectable 600 or 1200-ohm *impedance-matching* network and to a *buffer.*

4.03 Lightning protection is provided for the *buffer* by varistors. The output of the *buffer* is connected to prescription *rcv fac level* circuitry for level coordination and thence to a series-connected active prescription *amplitude equalizer* that is equivalent to the Western Electric 309B Prescription Equalizer. The output of the *amplitude equalizer* is connected to a *BEF* (band-elimination filter), which, at the appropriate time, filters out 2600Hz SF tone. The *rcv term loss* attenuating network provides the proper terminal equipment levels without affecting the levels of the signal that the *SF detector* receives. Conversion from 4wire to 2wire transmission is achieved by the integral magnetic *hybrid,* which drives the 2wire port via switch-selectable 600 or 900-ohm impedance-matching circuitry.

transmit path
4.04 Signals from the *hybrid* drive a *buffer,* which, in turn, feeds the prescription *xmt term loss* circuitry for terminal-side level coordination, after which SF tones from the *2600Hz oscillator* can be inserted via the *SF tone control* circuit. The transmit signal is then routed through the *xmt fac level* prescription level-control circuitry for facility-side level coordination and then is applied to a *driver,* which is protected from lightning by varistors. The *driver* drives the 4wire transmit output port via switch-selectable 600 or 1200-ohm *impedance-matching* circuitry and via a transformer that derives tip, ring, and simplex leads.

terminal-side 2wire section
4.05 The 6164X uses a toll-grade magnetic *hybrid* for 4wire-to-2wire conversion. An integral *compromise balance network* (CBN) is connected to the hybrid to make it possible to adjust for maximum transhybrid loss by simulating 600 or 900-ohm terminal-end terminating impedance and providing prescription build-out capacitance. If desired, the integral CBN can be switched out and an external PBN can be connected to pins 5 and 15.

SF signaling
4.06 At the terminal end of the SF signaling path, the *loop signaling and loopback interface* circuit determines the state of the local loop and communicates with the *control logic* to initiate a proper transmit path cut and SF tone transmission. The *control logic* circuit also receives an indication from the *SF detector* when tone is received and causes the *loop signaling and loopback interface* to output the proper loop conditions.

loopback (6164A and 6164C only)
4.07 Both transmission and signaling loopback of the module is activated when the *LB* relay operates. This relay is controlled by the *loopback detector and control* circuit, which operates the relay when any of three things happens:

A. A 2713Hz tone of correct level and duration is detected in the receive path.
B. The external loopback lead (pin 18) is grounded or connected to pin 37.
C. The *ML* DIP switch is closed.

4.08 In case A (tone loopback), loopback can be deactivated by either a second 2713Hz tone or by automatic timeout circuitry. In case B, if the external loopback lead is grounded, the ground must be removed to deactivate loopback. In case C, if the *ML* switch is closed, it must be opened again to deactivate loopback.

4.09 When the module is in loopback, the *LB* relay contacts disconnect the terminal-side port from the 6164X circuitry and connect the output of the receive-path output *driver* to the input of the transmit-path *buffer.* Signaling loopback is such that SF signals received at the module are echoed back onto the facility.

power supply
4.10 The *power supply* in the 6164X module is a series-regulated bipolar supply that uses a zener diode to derive a reference source. A diode in series with the negative input lead protects against reversed voltage connections.

6. specifications

transmission

alignment level ranges, facility-side ports
4wire rcv port: −17 to +7TLP (interface levels above +7TLP not recommended)
4wire xmt port: −16 to +8TLP (interface levels below −16TLP not recommended)

alignment level ranges, 2wire port
2wire-port input: +8 to −16TLP
2wire-port output: +7 to −17TLP

overload points
4wire rcv port: 0dBm0
4wire xmt port: +3dBm0
2wire-port input: +3dBm0
2wire-port output: 0dBm0

facility-side gain or loss (xmt and rcv)
0 to 24dB of gain or 0 to 24dB of loss in switch-selectable 0.1dB increments, with gain or loss selected via switch option

terminal-side loss (xmt and rcv)
0 to 24dB of loss in switch-selectable 0.1dB increments

receive-channel amplitude equalization
slope-type equalization for nonloaded cable or bump-type equalization for loaded cable (functionally equivalent to that provided by WECo 309B Prescription Equalizer)

total harmonic distortion
less than 1% at overload point

2wire to transmit out frequency response re 1004Hz
300 to 500Hz ± 1.0dB
500 to 3400Hz ± 0.8dB

receive in to 2wire frequency response re 1004Hz (BEF removed)
300 to 500Hz +0.0, −1.7dB
500 to 3400Hz ± 1.0dB

4wire-port-port terminating impedance
600 or 1200 ohms, balanced, individually switch-selectable

2wire-port terminating impedance
600 or 900 ohms in series with 2.15μF, switch-selectable

insertion loss (600 ohms at all ports)
0 ± 0.2dB at 1004Hz

internal noise
17dBrnC0 maximum at maximum gain

4wire longitudinal balance
greater than 60dB, 200 to 3000Hz

specifications continued on page 13

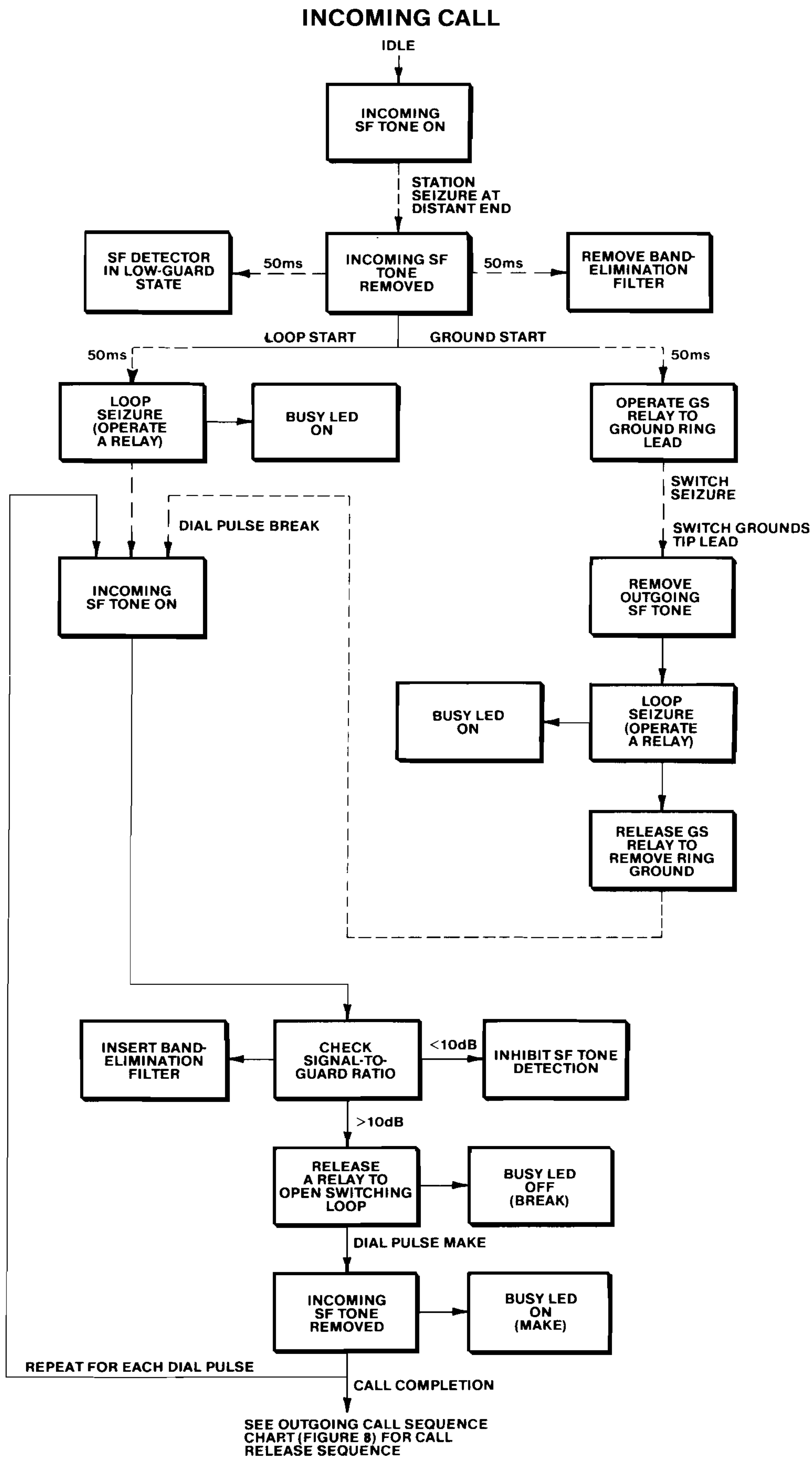


figure 7. Function sequence flowchart, incoming call

OUTGOING CALL

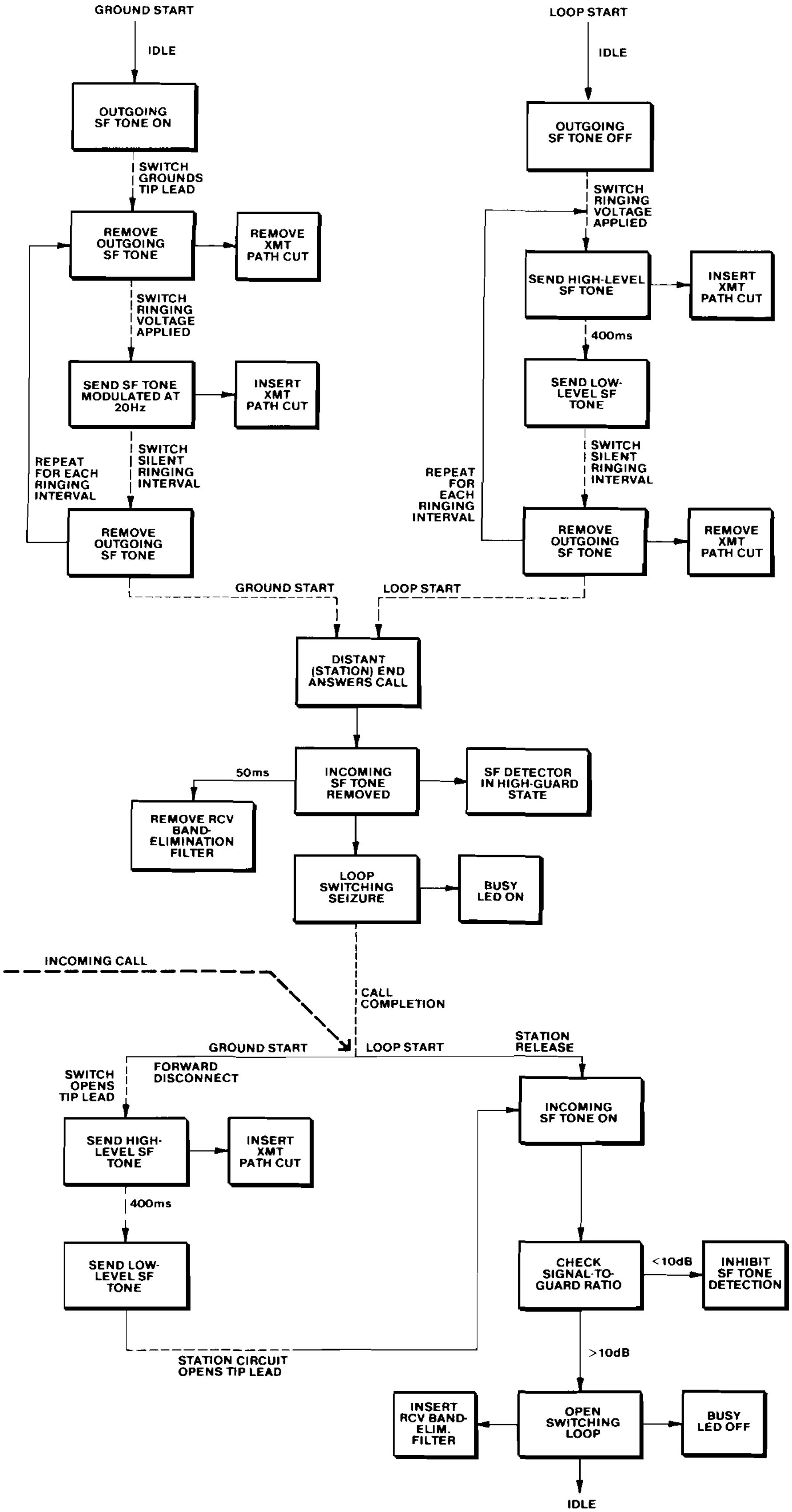
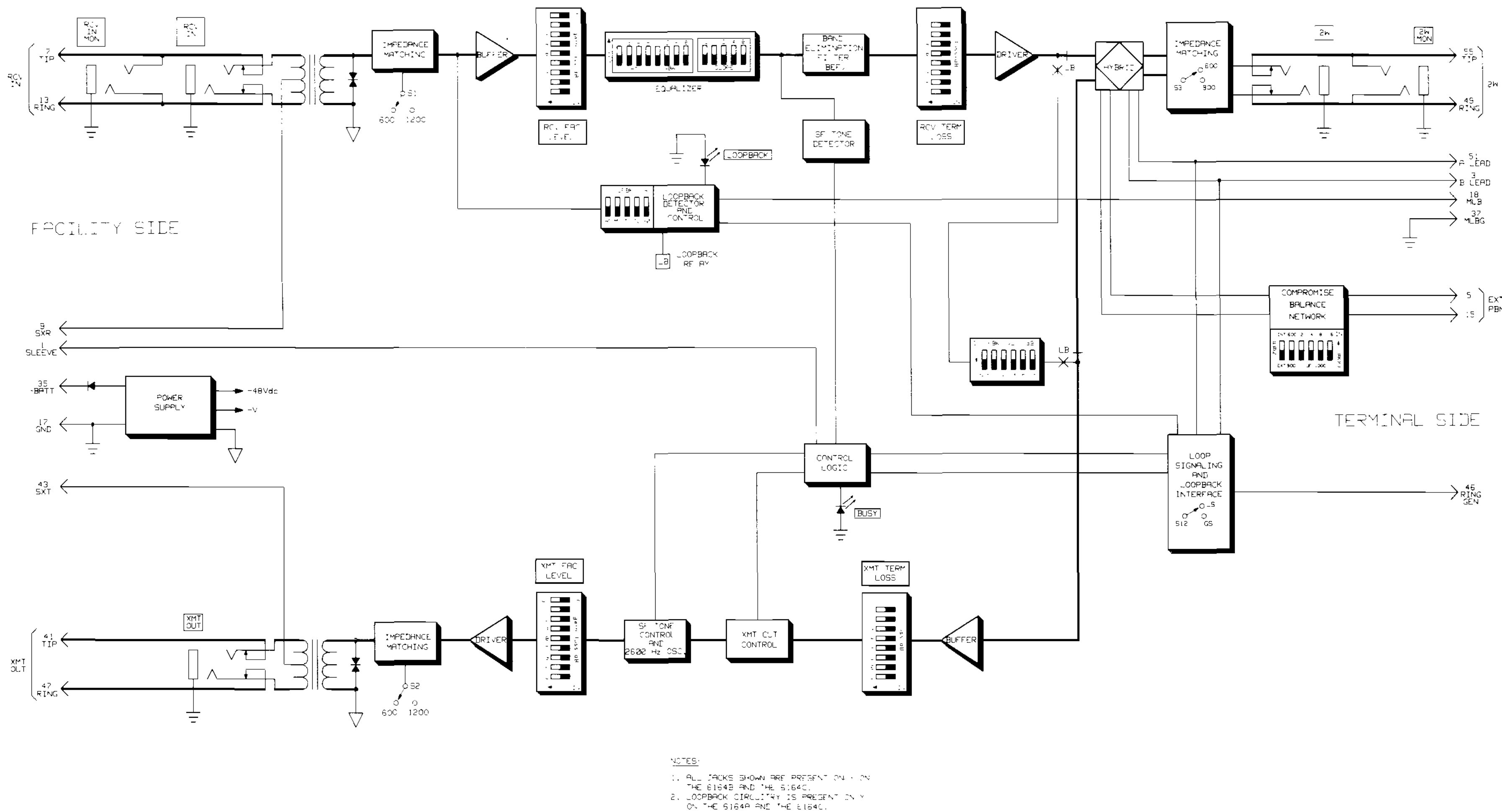


figure 8. Function sequence flowchart, outgoing call



5. block diagram

2wire longitudinal balance
greater than 55dB, 200 to 3000Hz

4wire echo return loss
23dB minimum vs. 600 or 1200 ohms

2wire echo return loss
22dB minimum vs. 600 or 900 ohms in series with 2.15μF

intrinsic transhybrid loss
greater than 35dB ERL

crosstalk between adjacent modules
80dB minimum, 200 to 3400Hz

peak-to-average ratio (P/AR) (BEF removed)
98 minimum, without equalization

SF transmit section

internal SF tone oscillator frequency
2600 ± 5Hz for life of unit

SF tone levels
high (augmented) level: −8dBm0 ± 1dB
low level: −20dBm0 ± 1dB

high-level timing
high-level tone is transmitted for 400 ± 100ms when tone switches from OFF to ON

SF tone states, loop start
idle: no tone
busy: no tone
ringing: tone transmitted

SF tone states, ground start
idle: continous tone transmitted
tip-lead ground: no tone
ringing: modulated tone

SF tone modulation, ground start
20 ± 3Hz during ringing

forward disconnect delay, ground start
removal of tip ground to application of tone: 550 ± 50ms

transmit-path-cut insertion
transmit speech path is cut (opened) 20 ± 7ms before transmission of SF tone

transmit-path-cut removal
transmit speech path cut is removed 125 ±50ms after detection of an off-hook condition

SF receive section

SF tone detection
frequency: 2600 ± 15Hz
level range: 0 to −27dBm0

SF tone rejection threshold
−37dBm0

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

maximum line noise
51dBrnC0

ring ground delay, ground start
50 ± 10ms after cessation of incoming SF tone

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

band-elimination-filter timing
- **insertion time: 13 ± 7ms**
- **insertion duration for SF tones shorter than 175 ± 60ms: 225 ± 50ms (with BEF insertion duration longer than tone duration in all cases)**
- **insertion duration for SF tones longer than 175 ± 60ms: duration of SF tone plus 50 ± 10ms**

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

pulse rate	input break	output break
8pps	30 to 85%	58 ± 2%
10pps	35 to 80%	58 ± 2%
12pps	44 to 80%	58 ± 2%

2wire loop conditions

maximum 2wire loop current
35 ± 5mA

ringing-voltage detection threshold
65Vrms minimum, 16 to 67Hz

traffic-monitoring (sleeve) lead

traffic-monitoring (sleeve) lead states
idle condition: open circuit (diode clamped to negative input potential)
busy condition: ground (100mA maximum source capacity)
dial pulsing: ground (see above) during pulse break portions of dial pulses

loopback (6164A and 6164C only)

tone-loopback frequency
2713Hz ± 7Hz

tone-loopback activation/deactivation level
−30 to −3dBm

tone-loopback activate time
2.5 ± 0.5 seconds minimum
(activates upon removal of tone)

tone-loopback deactivate time
1.2 ± 0.3 seconds minimum
(deactivates during tone)

automatic timeout (tone loopback only)
4 or 20 minutes, switch-selectable

signal-to-guard ratio
greater than 6dB; less than 18dB

loopback-path gain
−23 to +24dB in switch-selectable 1dB increments

loopback level accuracy
± 0.5dB

common specifications

input voltage
−42 to −54Vdc, filtered, positive-ground referenced

dimensions
5.58 inches (14.2cm) high
1.42 inches (3.6cm) wide
5.96 inches (15.1cm) deep

current requirements (0-ohm loop)

6164 and 6164B		
condition	**busy**	**idle**
−48Vdc	75mA	60mA
−52Vdc (max. output)	100mA	90mA

6164A and 6164C			
condition	**loopback**	**busy** (0dBm)	**idle**
−48Vdc	on	85mA	70mA
	off	80mA	65mA
−52Vdc (max. output)	on	110mA	100mA
	off	105mA	95mA

operating environment
32° to 122°F (0° to 50°C), humidity to 95% (no condensation)

weight
10 ounces (284 grams)

mounting
relay rack or apparatus case via one position of a Tellabs Type 10 Mounting Shelf. Can also be mounted in one position of a Tellabs 262U Universal Network Terminating System Assembly or in one position of a Tellabs 260A Signaling and Terminating System Assembly.

7. testing and troubleshooting

7.01 The *troubleshooting guide* in this section may be used to assist in the installation, testing, or troubleshooting of any of the 6164X 4Wire-to-2Wire SF-to-FXO Terminal Repeater modules. The guide is intended as an aid in the localization of trouble to a specific module. Proper operation of the module can be verified by observing its actual operation while referring to the function sequence flowcharts (figures 6 and 7,). 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 as directed below. We strongly recommend that no internal (component-level) testing or repairs be attempted on the 6164X module. Unauthorized testing or repairs may void the module's warranty. Also, if the module is part of a registered system, unauthorized repairs will result in noncompliance with Part 68 of the FCC Rules and Regulations.

Note: *Warranty service does not include removal of permanent customer markings on the front 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 guide, contact Tellabs Customer Service as follows (telephone numbers are given below):

USA customers: Contact Tellabs Customer Service at your Tellabs Regional Office.
Canadian customers: Contact Tellabs Customer Service at our Canadian headquarters in Mississauga, Ontario.
International customers: Contact your Tellabs distributor.

US atlantic region: (203) 798-0506
US capital region: (703) 478-0468
US central region: (312) 969-8800
US southeast region: (305) 645-5888
US southwest region: (214) 869-4114
US western region: (702) 827-3400
Canada: (416) 624-0052

7.03 If a module is diagnosed as defective, follow the *replacement* procedure in paragraph 7.04 when a critical service outage exists (e.g., when a system or a critical circuit is down and no spares are available). If the situation is not critical, follow the *repair and return.* procedure in paragraph 7.05.

replacement

7.04 To obtain a replacement module, notify Tellabs via letter or telephone (see addresses and numbers below), or via TWX (910-695-3530 in the USA, 610-492-4387 in Canada). Be sure to provide all relevant information, including the 8X6164X 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 module 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 module, shipment prepaid, to Tellabs (attn: repair and return).

in the USA: Tellabs, Inc.
4951 Indiana Avenue
Lisle, Illinois 60532
telephone (312) 969-8800

in Canada: Tellabs Communications Canada, Ltd.
1200 Aerowood Drive, Unit 39
Mississauga, Ontario, Canada L4W2S7
telephone (416) 624-0052

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.

troubleshooting guide

trouble condition	possible causes (check before assuming module is defective)
module completely inoperative	1) No input power. 2) Improper wiring.
cannot derive proper 4wire-to-2wire transmission levels	1) *Rcv fac gain* and/or *rcv term loss* level switches improperly set. 2) 4wire receive and 2wire impedance DIP switches (*S1* and *S3*) improperly set. 3) Receive equalization DIP switch (*S21*and *S22*) improperly set.
cannot derive proper 2wire-to-4wire transmission levels	1) *Xmt term loss* and/or *xmt fac gain* level switches improperly set. 2) 2wire and 4wire transmit impedance DIP switches (*S3* and *S2*) improperly set.
objectionable echo or "hollow" sound at distant end of 4wire facility	1) Internal CBN DIP switch improperly set. 2) NBO capacitance DIP switch improperly set. 3) External or plug-on PBN (if used) misaligned. 4) External PBN (if used) improperly wired. 5) Level switches improperly set. 6) Equalization switches improperly set. 7) Impedance switches improperly set.
no signaling in one or both directions	1) Loop-start/ground-start switch (*S12*) improperly set. 2) Improper level and/or frequency of incoming SF tone. 3) Improper level and/or frequency of outgoing SF tone. 4) *Fac gain* and/or *term loss* level switches improperly set for one or both channels.
cannot activate or deactivate manual loopback (6164A and 6164C only)	1) *Man lpbk* pushbutton not depressed for proper duration and, for activation only, then released. 2) Ground on MLB lead (pin 18).
cannot activate or deactivate tone loopback (6164A and 6164C only)	1) Switches *S17-1* through *S17-2* (loopback activation and deactivation modes) improperly set. 2) Tone not applied for proper duration and, for activation only, then removed. 3) Tone at improper frequency or below −30dBm0 detection threshold. 4) Ground on MLB lead (pin 18).
cannot activate or deactivate ground-controlled loopback (6164A and 6164C only)	1) MLB lead (pin 18) improperly wired. 2) Source of external ground defective.
cannot derive transmission loopback (6164A and 6164C only)	1) Module not in loopback (*lpbk* LED unit).
cannot derive proper loopback transmission level (6164A and 6164C only)	1) Loopback-level DIP switch (*S16*) improperly set. 2) Module not in loopback (*lpbk* LED unlit).

tellabs

technical manual
76-A826164
rev A

addendum section A826164/826164A/826164B/826164C

Addendum: Issue 2 6164/X-Series 4Wire-to-2Wire SF-to-FXO Terminal Repeaters

1.01 This addendum to practice section 816164/81614A/816164B/816164C, revision A (dated 1 May 1985), covers changes to the 6164, 6164A, 6164B, and 6164C 4Wire-to-2Wire SF-to-FXO Terminal Repeater modules resulting in the Issue 2 versions of these modules (Tellabs part numbers **826164, 826164A, 826164B,** and **826164C**). These modules differ from their Issue 1 counterparts as follows:

- At the facility-side ports (receive input and transmit output), a switch-selectable choice of 1200, 600, or 150-ohm terminating impedance is now available at each port. (The Issue 1 modules offered 1200 or 600 ohms only.)
- In both the receive and transmit channels, the front-panel **facility-side** level switches offer gain only (instead of the gain or loss available on the Issue 1 modules). These switches are relabeled *rcv fac gain* and *xmt fac gain* to reflect this change in function.
- A bypass option (*IN/OUT* position on *SLOPE* DIP switch, *S21*) allows the receive-channel equalizer on the Issue 2 modules to be electrically bypassed, i.e., excluded from the circuit.
- A facility-side simplex-lead pinout has been added so that the receive input simplex (RCV IN SX) lead appears on pins 9 and 11. (The RCV IN SX lead appeared only on pin 9 on the Issue 1 modules.)
- Power-cross protection has been added for all tip and ring leads.
- A power LED has been added to the front panel.

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

facility-side impedance optioning information for Issue 2 6164/X modules

1.03 When optioning the Issue 2 6164/X modules, please disregard figure 5 and the terminating-impedance optioning information in paragraph 3.07 and table 5 of the attached practice. Instead, refer to figure 1 of this addendum and set the *RCV IMPD* and *XMT IMPD* positions of *S1* as follows:

- For 1200 ohms (*150* and *600* positions of *RCV IMPD* and *XMT IMPD* toward *1200*) to interface loaded cable.
- For 600 ohms (*150* position of *RCV IMPD* and *XMT IMPD* toward *1200,* and *600* position of *RCV IMPD* and *XMT IMPD* toward *600*) to interface nonloaded cable or carrier.
- For 150 ohms (*150* position of *RCV IMPD* and *XMT IMPD* toward *150,* and *600* position of *RCV IMPD* and *XMT IMPD* toward *1200*) to provide a small amount of amplitude equalization for long sections of nonloaded cable through the deliberate impedance mismatch.

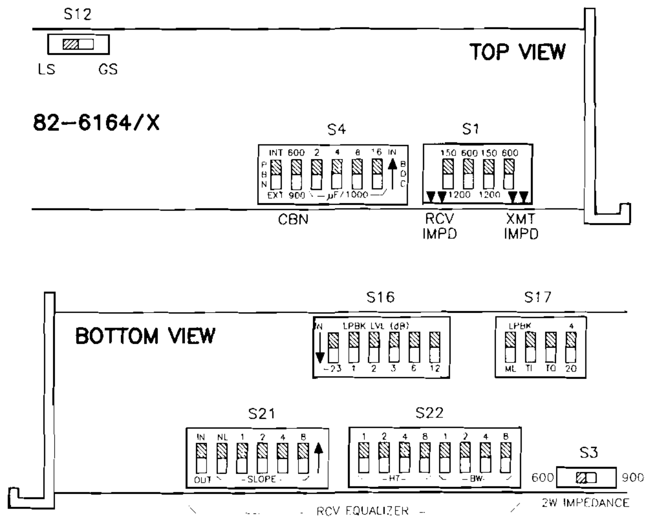


figure 1. Issue 2 6164/X option switch locations

facility-side level adjustment information for Issue 2 6164/X modules

1.04 When adjusting facility-side receive and transmit transmission levels on the Issue 2 6164/X modules, please disregard the information concerning the *rcv fac level gn/ls* switch in paragraph 3.16, step B, and the *xmt fac level gn/ls* switch in paragraph 3.17, step H, as well as the information about these *gn/ls* switches in table 6. Instead, insert facility-side gain into the receive and transmit channels as follows:

- **In the receive channel**, to obtain a +7dBm transmission level, set to *IN* the proper combination of front-panel *rcv fac gain* dB-value DIP switch positions.
- **In the transmit channel**, to obtain the specified transmit output level, set to *IN* the proper combination of front-panel *xmt fac gain* dB-value DIP switch positions.

receive-equalizer bypass switch on Issue 2 6164/X modules

1.05 When setting switch options on the Issue 2 6164/X modules (see figure 1 of this addendum), be certain to set the receive-equalizer bypass switch (*IN/OUT* position of the *SLOPE* DIP switch, *S21*) as follows before adjusting the equalizer:

- To the *IN* position if the receive equalizer is to be included in the circuit.
- To the *OUT* position if the receive equalizer is to be excluded from the circuit, i.e., electrically bypassed.