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rev A

practice section 816162/816162A/816162B/816162C

6162, 6162A, 6162B, and 6162C 4Wire-to-2Wire SF-to-E&M Terminal Repeaters

contents

1. general description

1.01 The 6162, 6162A, 6162B, and 6162C 4Wire-to-2Wire SF-to-E&M Terminal Repeaters are Tellabs Type 10 plug-in modules that provide both active transmission interface and signaling conversion between a 4wire metallic facility that uses 2600Hz single-frequency (SF) signaling and a 2wire PBX trunk or carrier channel that uses E&M signaling. All four 6162X modules meet the specifications given in AT&T Technical Reference Pub 43002 for Network Channel Terminating Equipment (NCTE) Criteria, and, in addition, the 6162A and 6162C 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 6162, 6162A, 6162B, and 6162C, all four modules are, for convenience, referred to as the *6162X module.*

1.03 While all four 6162X 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 6162X modules.

module	front-panel jacks	loopback
6162	yes	no
6162A	yes	yes
6162B	no	no
6162C	no	yes

table 1. 6162X module selection guide

1.04 All four 6162X modules offer the following features:

- 2wire-to-4wire 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.
- 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.

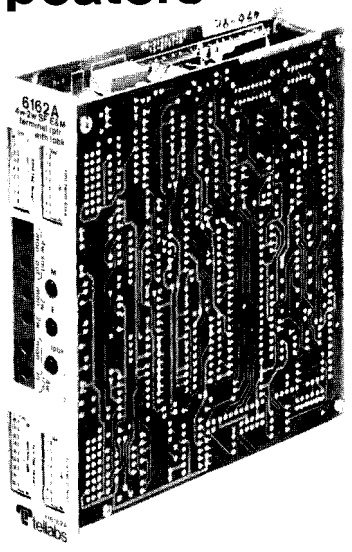


figure 1. 6162A 4Wire-to-2Wire SF-to-E&M Terminal Repeater module

- Isolation transformers at both facility-side 4wire ports and at the terminal-side 2wire port.
- Independently switch-selectable 1200 or 600-ohm terminating impedance at each 4wire facility-side port, and switch-selectable 900 or 600-ohm terminating impedance in series with 2.15μF at the terminal-side 2wire port.
- 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.
- Switch-selectable Type I, II, or III E&M interface.
- Switch-selectable A-side or B-side E&M signaling.
- Integral 2600Hz SF tone oscillator.
- Front-panel LED's that light to indicate local E-lead and M-lead busy.
- Reverse-battery and overvoltage protection.
- Opening and monitoring bantam-type jacks at all ports (6162 and 6162A only).
- Local or remote signaling and equal-level transmission loopback (6162A and 6162C only).

1.05 The loopback circuitry on the 6162A and 6162C 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.
  4) E&M detectors and signaling relay.
  5) Signaling logic.

- 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.
- 2713 Hz 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 time out interval.
- From −23 to +24dB of prescription-set gain (in switch-selectable 1dB increments) for true equal-level loopback.
- Option switch for busying out the module's terminal side during loopback, if desired.
- Front-panel status-indicating LED that lights when the module is in loopback.

2. application

2.01 The 6162X 4Wire-to-2Wire SF-to-E&M Terminal Repeater module is typically used to interface a 4wire SF transmission facility with a 2wire E&M trunk or line associated with a two-way dial/supervisory telephone circuit. No external transmission interface circuitry is needed because the 6162X module combines the functions of a 4wire-to-2wire line amplifier, an SF transceiver, an SF-to-E&M signaling converter and a 4wire/2wire pad/transformer module. Figures 2 through 4 show three typical applications.

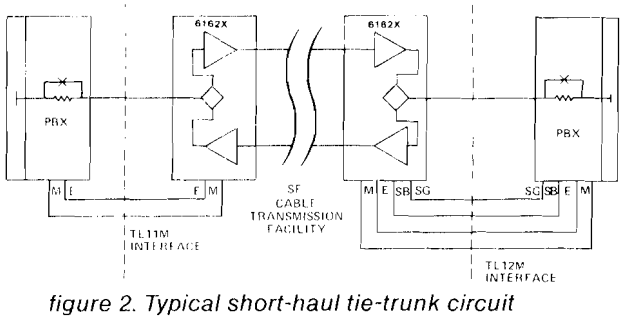


figure 2. Typical short-haul tie-trunk circuit using 6162X NCTE modules

2.02 In its transmit and receive channels, the 6162X module provides from 0 to 24dB of prescription gain or loss in 0.1 dB increments at the 4wire facility-side ports, and from 0 to 24dB of prescription loss in 0.1 dB 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-channel equalization can be introduced by a circuit equivalent to the WECo 309B. The terminating impedance at the facility-side ports can be independently switch-optioned 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 6162X'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, the 6162X module fulfills the signaling-application requirements listed in table 2. Please note that in this table, A-side and B-side are the E&M signaling arrangements of the port that the 6162X interfaces.

2.05 The 6162X module can be optioned to provide either A-side E&M signaling (where M-lead signals are incoming to and E-lead signals are outgoing from the module) or B-side E&M signaling (where E-lead signals are incoming to and M-lead signals are outgoing from the module) on the terminal side.

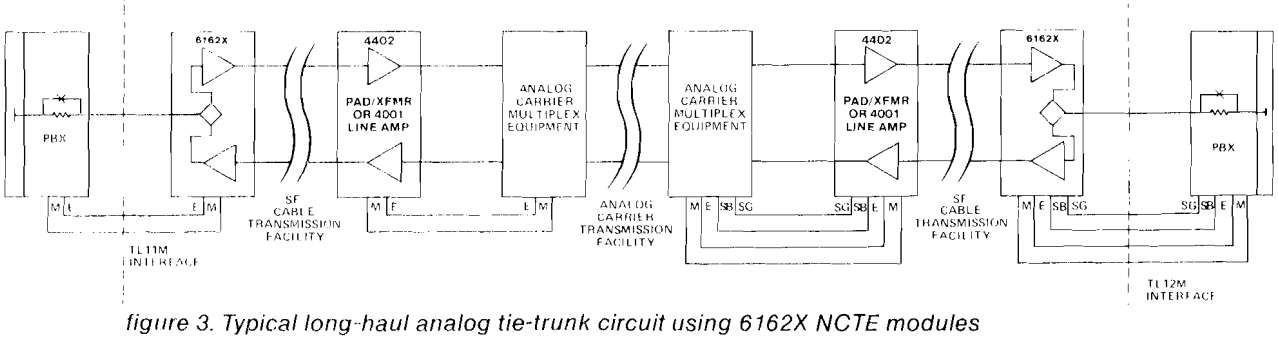


figure 3. Typical long-haul analog tie-trunk circuit using 6162X NCTE modules

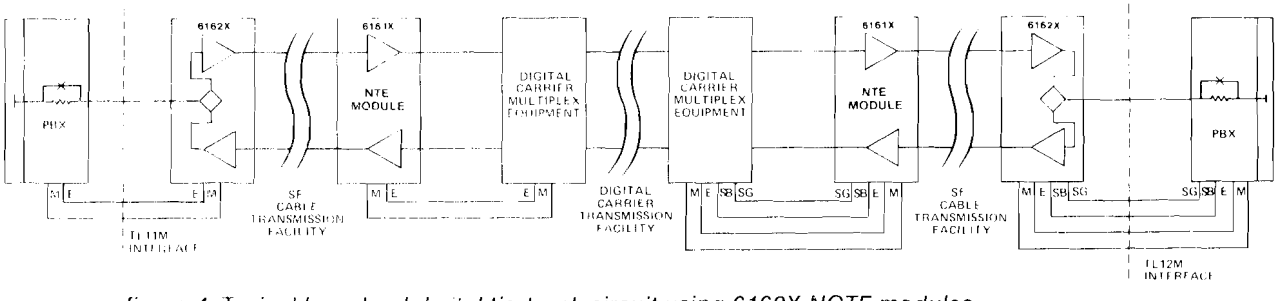


figure 4. Typical long-haul digital tie-trunk circuit using 6162X NCTE modules

Registered Facility Interface Code	E&M interface	E&M signaling arrangement*	6162XX signaling directions	
			E lead	M lead
TL11M	Type I	A side	out	in
TL11E	Type I	B side	in	out
TL12M	Type II	A side	out	in
TL12E	Type II	B side	in	out
N/A	Type III	A side	out	in
*Of port that 6162X is interfacing.				

table 2. SF signaling and E&M interface optioning for Registered Facility Interface Codes

2.06 In typical A-side E&M signaling with Type I interface, the 6162X provides an E-lead output that is open when SF tone is detected and that is at ground otherwise. In the transmit channel, SF tone is transmitted when the M lead is either open or at ground, and ceases when the M lead goes negative. The E-lead output from the 6162X is derived via relay contacts, which can be externally wired to accommodate any E-lead interface (Type I, II or III). The relay is energized when the module detects no SF tone at the receive input and is de-energized when the SF tone is detected. The 6162X's full precision receive pulse corrector restricts the pulsing relay to nominal 58% break.

2.07 In typical B-side E&M signaling with Type I interface, the 6162X provides an M-lead output that is at ground when SF tone is detected and is at battery potential otherwise. In the transmit channel, SF tone is transmitted when the E lead is open and ceases when the E lead goes to ground. The E-lead output from the 6162X is derived via relay contacts, which can be externally wired to accommodate either Type I or Type II E&M-lead interface (Type III interface cannot be used with B-side signaling). The relay is de-energized when the module detects no SF tone at the receive input and is energized when the SF tone is detected.

2.08 The 6162X interfaces the receive path on the facility 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. See tables 3 and 4 for details concerning BEF insertion.

2.09 The 6162X interfaces the transmit path on the facility 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 6162X 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.

2.10 The transmit voice path through the 6162X is cut (opened) during idle circuit conditions and is restored when the M lead (A-side signaling) or the E lead (B-side signaling) is in the busy condition. The path is also cut during dialing in either direction and is momentarily cut in response to any transition of the M lead while the E lead is in the off-hook state (A-side signaling) or in response to any transition of the E lead while the M lead is in

circuit condition	SF tone states		local condition of xmt path cut			local rcv-path band-elimination-filter (BEF)
	xmt	*rcv*	*before*	*change*	*after*	insertion
idle	on	on	cut	none	cut	inserted
seizure	on/off transition	on	cut	stays cut 125±50ms after seizure	not cut	inserted
distant end returns *delay-dial* signal	off	on/off transition	not cut	none	not cut	removed 50±5ms after cessation of SF tone
distant end sends *start-dial* signal	off	off/on transition	not cut	none	not cut	inserted 13±7ms after receipt of SF tone
local-end dialing	off/on and on/off transitions, ending with on/off transition	on	not cut	precut 15±7ms; remains cut as long as M-lead make/break transitions are less than 125±25ms apart; remains cut 125±50ms after last break/make transition*	not cut	inserted
distant end answers (free call	off	on	not cut	none	not cut	inserted
distant end answers (toll call)	off	on/off transition	not cut	none	not cut	removed 50±5ms after cessation of SF tone
talking	off	off	not cut	none	not cut	out of circuit
disconnect, local end first	off/on transition	off	not cut	precut 15±7ms; cut 625±125ms after M-lead transition from battery to ground*	not cut	out of circuit
disconnect, distant end	on	off/on transition	not cut	cut within 35ms	cut	inserted 13±7ms after receipt of SF tone
idle	on	on	cut	none	cut	inserted
*E-lead transition for B-side signaling.						

table 3. SF tone states and status of transmit path cut and receive BEF for local call origination

circuit condition	SF tone states		local condition of xmt path cut			local rcv-path band-elimination-filter (BEF)
	xmt	*rcv*	*before*	*change*	*after*	**insertion**
idle	on	on	cut	none	cut	inserted
seizure, distant end	on	on/off transition	cut	remains cut 625± 125ms after cessation of SF tone	not cut	removed 50±5ms after cessation of SF tone
distant end returns *delay-dial* signal	on/off transition	off	not cut	cut 125±50ms after M-lead transition from ground to battery*	not cut	out of circuit
local end returns *start-dial* signal	off/on transition	off	not cut	precut 15±7ms; remains cut 625±125ms after M-lead transition from battery to ground*	not cut	out of circuit
distant end transmits dial pulses	on	off/on and on/off transitions, ending with on/off transition	not cut	cut within 7ms of receipt of first tone pulse; remains cut as long as incoming break/make transitions are less than 625±125ms after last incoming on/off transition	not cut	inserted 13±7ms after receipt of first tone pulse; remains in circuit until 50± 5ms after last incoming on/off transition or 225±50ms, whichever is longer
local-end answers (free call)	on	off	not cut	none	not cut	out of circuit
local end answers (toll call)	on/off transition	off	not cut	cut 125±50ms after M-lead transition from ground to battery*	not cut	out of circuit
talking	off	off	not cut	none	not cut	out of circuit
disconnect, distant end	off	off/on transition	not cut	none	not cut	inserted 13±7ms after receipt of SF tone
disconnect, local end	off/on transition	on	not cut	precut 15±7ms; then continuously cut	cut	inserted
idle	on	on	cut	none	cut	inserted

*E-lead transition for B-side signaling.

table 4. SF tone states and status of transmit path cut and receive BEF for distant-location call origination

the off-hook state (B-side signaling). These path cuts prevent transmission of noise, transients, speech, and other interfering signals during critical signaling intervals.

2.11 Figures 5 through 9 show the various E&M signaling interfaces listed in table 2. Either Type I, II, or III E&M signaling interface can be selected via switch. Type I is often used with electromechanical switching systems, while Types II and III are often used in electronic switching environments.

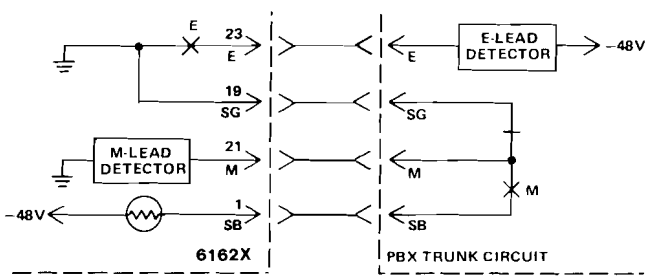


figure 7. Type III E&M interface; A side

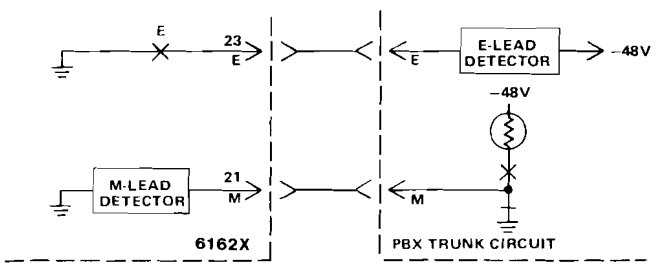


figure 5. Type I E&M interface (TL 11M); A side

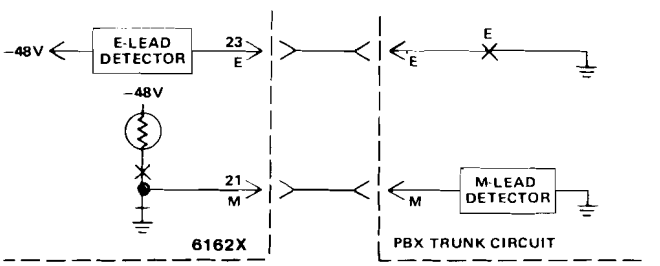


figure 8. Type I E&M interface (TL11E); B side

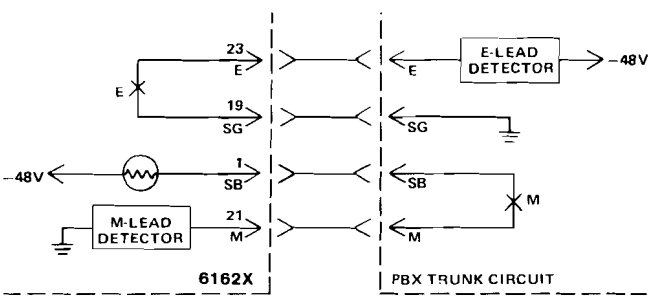


figure 6. Type II E&M interface (TL 12M); A side

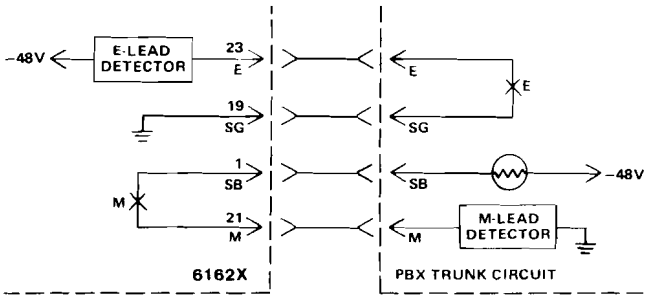


figure 9. Type II E&M interface (TL 12E); B side

2.12 The 6162X module uses relay contacts to derive E-lead and M-lead signaling. This facilitates interfacing with nonstandard E-lead and M-lead voltage levels and polarities. When these modules are used with Type II E&M interface, terminal-side equipment can use any convenient voltage or polarity.

2.13 Generally, if loopback is to be used, the terminal-end module will be the one requiring loopback capabilities (6162A or 6162C). Equal-level 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. Some examples of signaling loopback use are as follows:

A. After loopback is initiated, 2600Hz tone is transmitted toward the terminal end at −10dBm0 and again at −20dBm0. In both cases, the receive channel should echo back an SF tone at −20dBm0 after an initial 400ms tone burst at an augmented level of −8dBm0.
B. Pulsed SF tone is transmitted toward the terminal end. The receive channel should echo back pulsed SF tone at a nominal 58% break.

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 6162X 4Wire-to-2Wire SF-to-E&M 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 6162X 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 6162X 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 6162X 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 5 lists external connections to the 6162X 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
EXTERNAL PBN	5 and 15
A lead	51
B lead	3
E lead	23
M lead	21
SB lead	1
SG lead	19
MLB (manual loopback)	18
MLBG (manual loopback ground)	37
−BATT (−43 to −52Vdc filtered input)	35
GND (ground)	17

table 5. External connections to 6162X

option selection

3.06 A number of option switches must be set before the 6162X can be placed into service. These switches and their functions are described in paragraphs 3.07 through 3.12. The locations of the switches on the module's printed circuit board are shown in figure 10. Table 6 summarizes all switch options and provides a convenient checklist for optioning the module.

impedance matching

3.07 Two-position slide switches *S1* and *S2* on the main board select balanced terminating impedance of either 600 ohms or 1200 ohms for each of the module's facility-side 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.

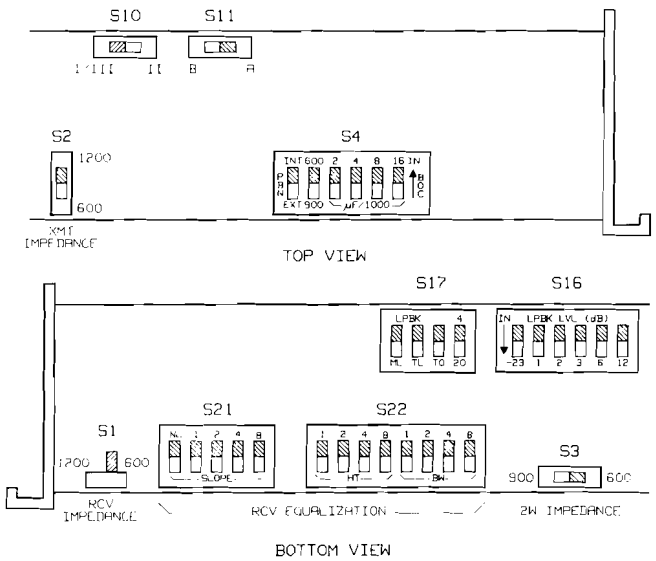


figure 10. 6162X option switch locations

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.

E&M signaling interface

3.09 Switch *S10* selects Type I, Type II, or Type III E&M interface. Determine the E&M interface of the terminal equipment interfaced by the 6162X and set *S10* to either *I/III* (Type I or Type III) or *II* (Type II), as appropriate.

3.10 Switch *S11* should be set according to which E&M signaling arrangement the terminal equipment uses (A-side or B-side). If the 6162X is to receive M-lead signals and send E-lead signals, set *S11* to *A*. If the module is to send M-lead signals and receive E-lead signals, set *S11 to* B. See table 7 for Registered Facility Interface Code cross-references.

option	paragraph	switch	selection	settings	checklist
facility-side receive in impedance	3.07	S1	600 ohms	600	
			1200 ohms	1200	
facility-side transmit out impedance	3.07	S2	600 ohms	600	
			1200 ohms	1200	
terminal side impedance	3.08	S3	600 ohms	600	
			900 ohms	900	
Type I, Type II or Type III E&M interface	3.09	S10	Type I or III	I/III	
			Type II	II	
A-side or B-side E&M signaling	3.10	S11	A-side int.	A	
			B-side int.	B	
PBN used	3.11	PBN	internal CBN	INT	
			external PBN	EXT	
terminal-side impedance	3.11	600/900	600 ohms	600	
			900 ohms	900	
terminal-side build-out capacitance (µF/1000 switches)	3.11	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 available on the 6162A and 6162C only.*					
busy out terminal side during loopback	3.12	LPBK BO	no busy out	(up)	
			busy out	BO	
manual loopback activation	3.12	LPBK ML	loopback off	(up)	
			loopback on	ML	
tone loopback activation	3.12	LPBK TL	disabled	(up)	
			enabled	TL	
tone loopback automatic timeout	3.12	LPBK TO	disabled	(up)	
			enabled	TO	
automatic timeout duration	3.12	LPBK 4/20	4 minutes	4	
			20 minutes	20	

table 6. 6162X option-switch summary and checklist

Registered Facility Interface Code	E&M signaling interface	terminal-equipment E&M signaling	switch settings	
			S10	S11
TL 11M	Type I	A side	I/III	A
TL 11E	Type I	B-side	I/III	B
TL 12M	Type II	A-side	II	A
TL 12E	Type II	B-side	II	B
N/A	Type III	A-side	I/III	A

table 7. A-side/B-side and Type I/II/III optioning for various Registered Facility Interface Codes

terminal-side compromise balance network (CBN) optioning

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

PBN, INT/EXT:
Generally, the 6162's integral compromise balance network (CBN) will be used unless the use of an external PBN is desired. Set the *PBN* switch to *INT* if the 6162X's internal CBN is to be used. If an external precision balance net work (PBN) is to be used, it should be connected to pins 5 and 15 and the *PBN* switch should be set to *EXT.*

600/900, compromise balance network:
The *600/900* switch selects the impedance of the CBN.

BOC; μF/1000 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 (6162A and 6162C only)

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

BO, busy out terminal side:
Set the *BO* switch toward *BO* if the terminal side is to be busied out during loopback or away from *BO* if not.

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.* otherwise, 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

3.13 Alignment of the 6162X 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 (6162A and 6162C only).

3.14 Because internal TLP 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. This is shown in figure 11.

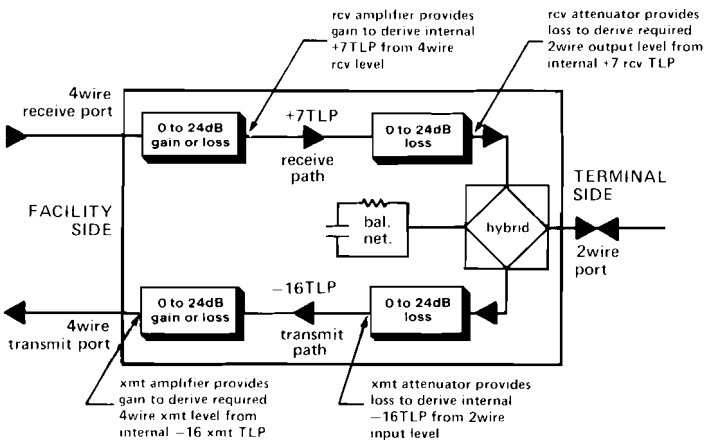


figure 11. Level coordination in 6162X

3.15 The 6162X 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 8; then refer to the table while performing the alignment procedure. In cases where CLR specifications are unavailable or inadequate, non-prescription alignment method is necessary. These procedures are given in paragraphs 3.16 through 3.19.

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	1	1 to IN	
		2	2 to IN	
		4	4 to IN	
		8	8 to IN	
	BW	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 8. 6162X alignment-switch summary and checklist

Note: *Because the 6162B and 6162C 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 6162B/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

3.16 **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. 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.
D. Set all loopback-level DIP switches to the *up* position (6162A and 6162C only) for no loopback path gain or loss.

3.17 **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.

3.18 **Transmit-channel level adjustment:**

A. Remove the transmit speech path cut by seizing the circuit from the terminal side.
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 achieved.
E. Refer to the CLR for the specified level at the distant end.
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, then 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, then 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

3.19 The receive-channel equalizer on the 6162X 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

3.20 To adjust the 6162X's loopback-level-control circuitry to provide equal-level loopback, proceed as follows:

A. From the CLR, determine the specified transmit input and receive output levels.
B. Subtract the receive output level from the transmit input level. The result is the amount of gain required in the loopback path.
C. On the 6162X'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 6162X 4Wire-to-2Wire SF-to-E&M Terminal Repeater modules. Attempts to troubleshoot these modules internally are not recommended and may void your warranty. Please refer to the 6162X block diagram, section 5 of this practice, as an aid in following this circuit description.

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 (BEF), 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. The conversion from 4wire to 2wire transmission is achieved by the integral magnetic *hybrid*, which drives the 2wire port via switch-selectable 600 or 1200-ohm impedance-matching circuitry.

transmit path

4.04 Signals from the *2-coil 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 6167X uses a toll-grade magnetic *hybrid* for 4wire-to-2wire conversion. An integral *compromise balance network (CBN)* is connected to the hybrid to maximize transhybrid loss by simulating 600 or 900 ohm terminal-side (2wire) terminating impedance and providing prescription build-out capacitance. If desired, the integral CBN can be switched out of the circuit 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 *E&M signaling interface* circuit determines the state of the local M lead (A-side signaling) or E lead (B-side signaling) and communicates with the *control logic* to initiate 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 *E&M signaling interface* to output the proper E-lead or M-lead states. Figures 11, 12, and 13 are function sequence flowcharts that illustrate the signaling operation of the 6162X with A-side signaling. Horizontal paths identify events occuring simultaneously, and vertical paths denote sequential events. Dotted lines indicate elapsed time.

loopback (6162A and 6162C only)

4.07 Both transmission loopback and signaling loopback of the module are activated when the *LB* relay operates. This relay is controlled by the *loopback detector and control* circuit, which operates the relay when any one of the following 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 6162X 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 6162X 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

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

specifications continued on page 15

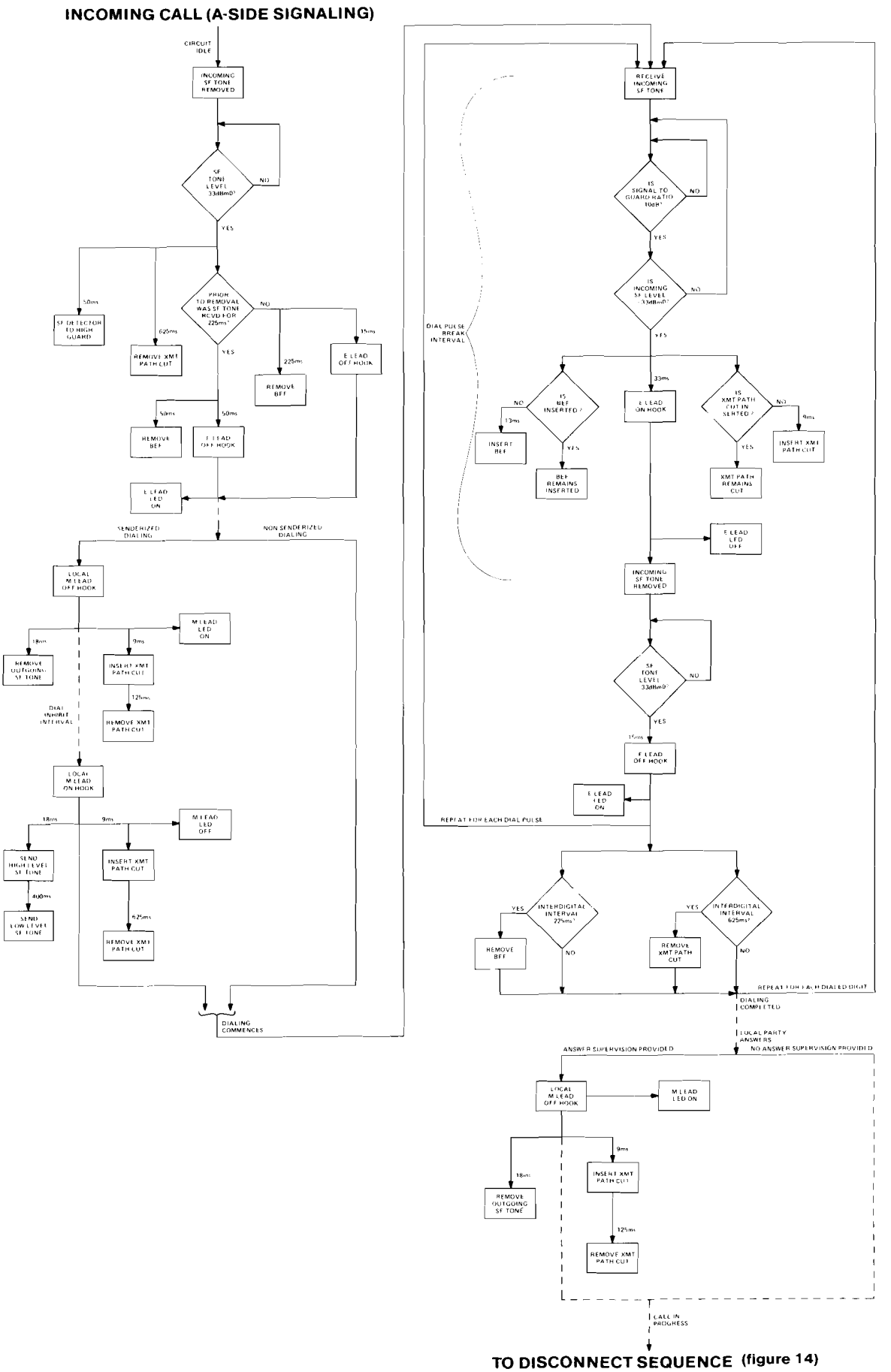


figure 12. Function sequence flowchart, incoming call

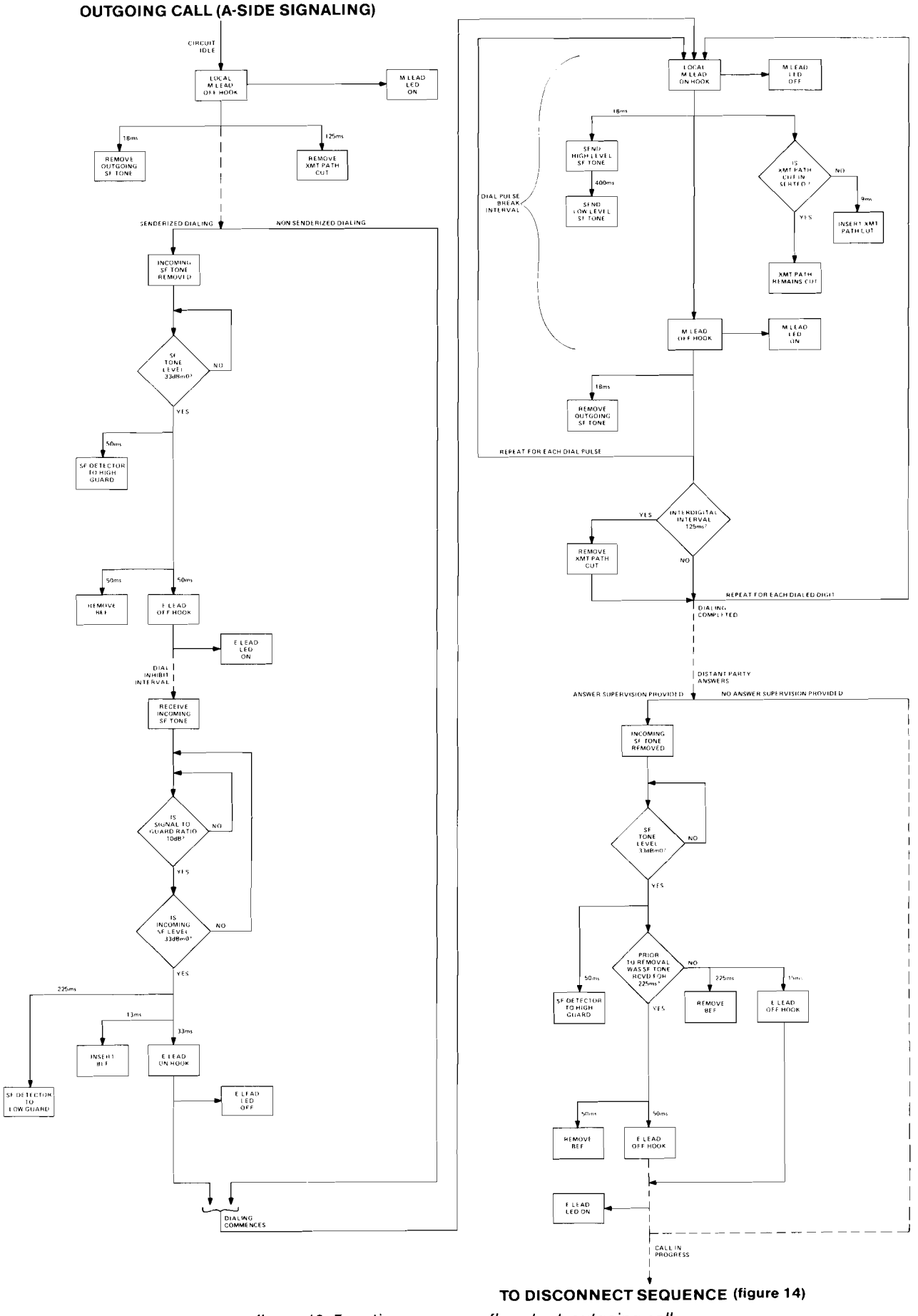


figure 13. Function sequence flowchart, outgoing call

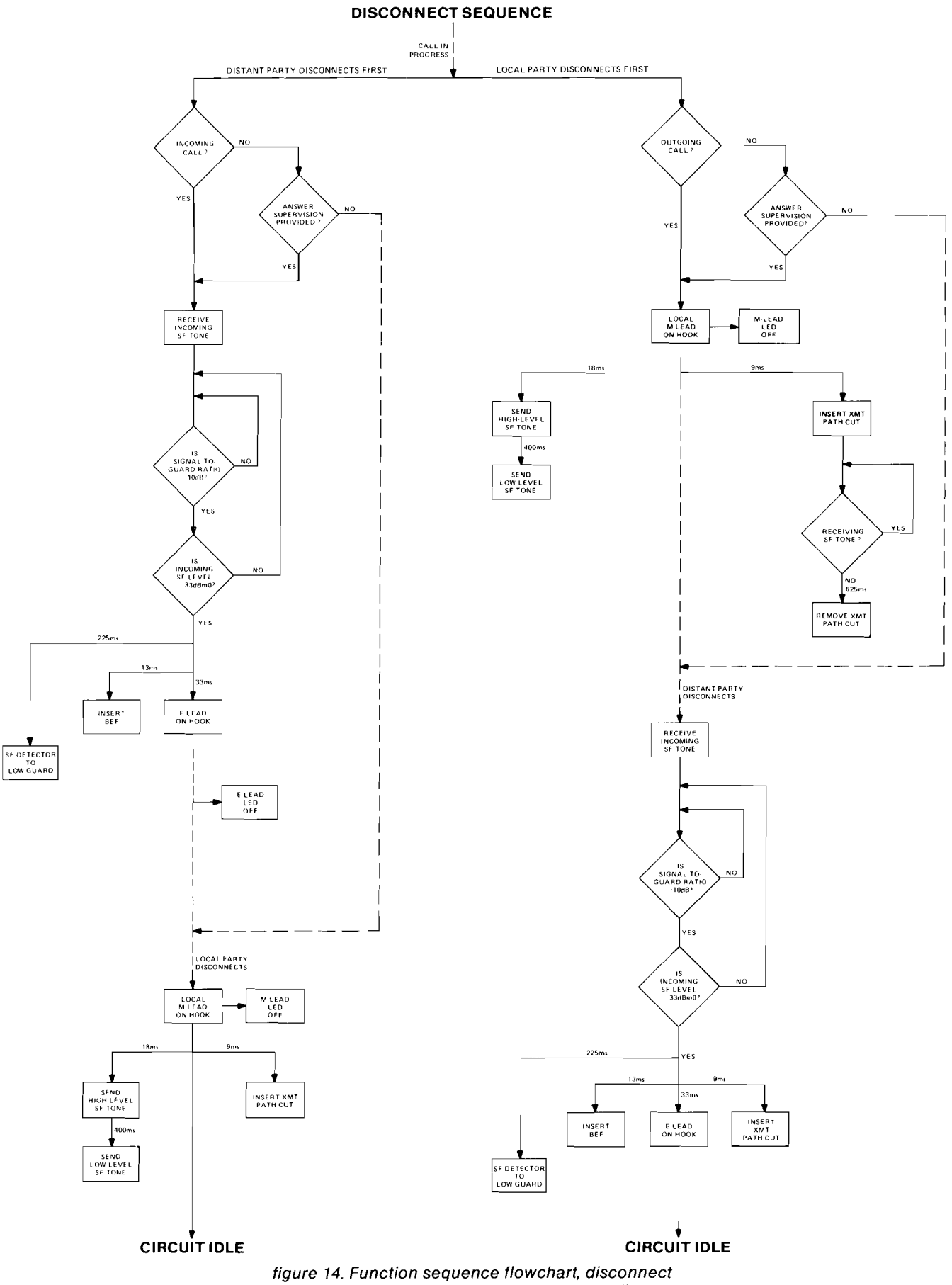
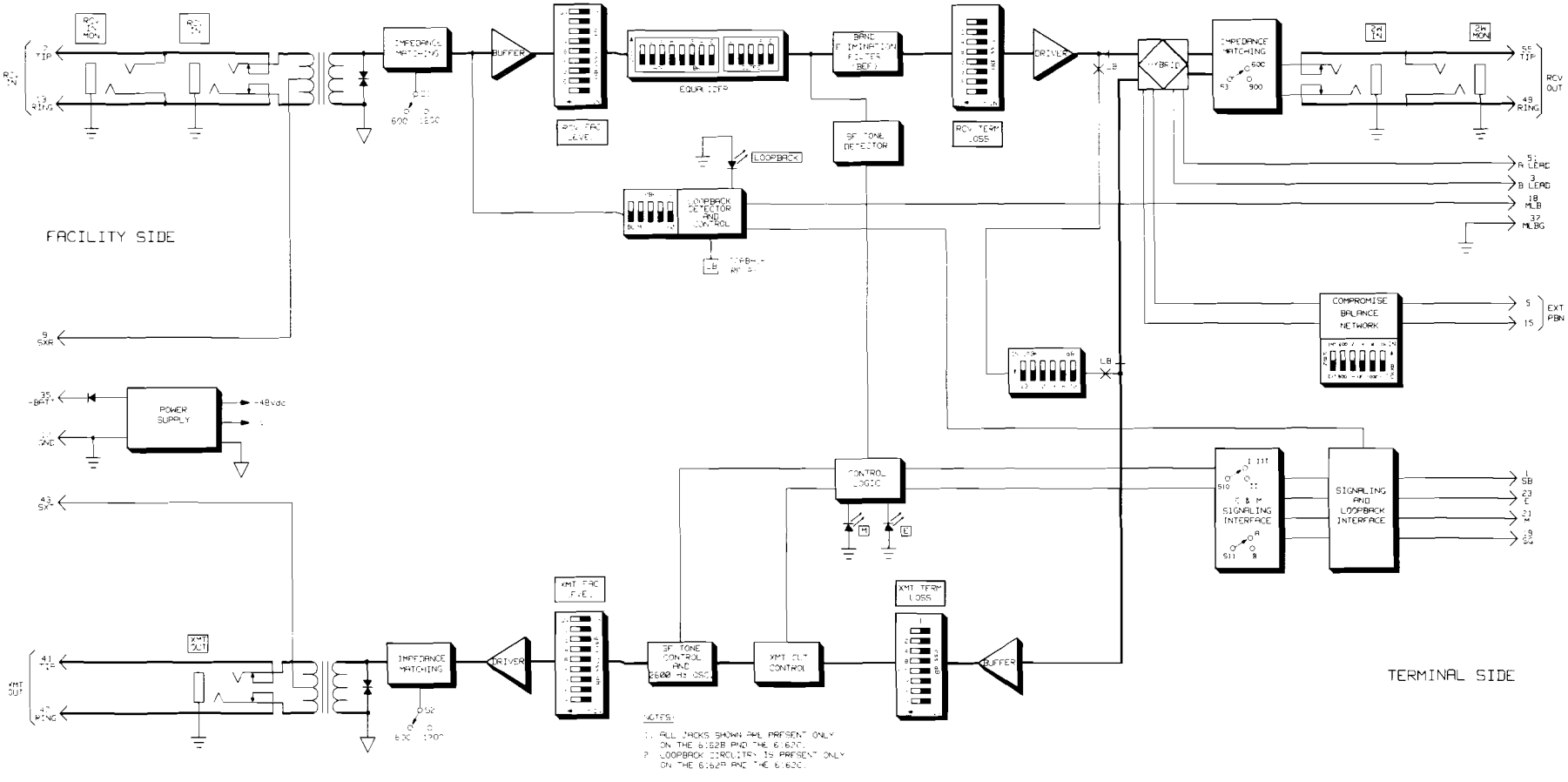


figure 14. Function sequence flowchart, disconnect sequence for incoming and outgoing calls



5. block diagram

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

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

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

insertion loss (600-ohm impedance at all ports)
0 ± 0.2dB at 1004Hz

internal noise
17dBrnC0 maximum at maximum gain

longitudinal balance (all ports)
greater than 60dB, 200 to 3000Hz

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

echo return loss (2wire ports)
22dB minimum vs. 600 or 900 ohms +2.15μF

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

intrinsic transhybrid loss
35dB minimum

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

dc current capability of hybrid
40mA maximum

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

SF tone states
idle: tone transmitted
busy: tone not transmitted
dialing: tone transmitted during the break portions of dial pulses

high-level timing
high-level tone is transmitted for 400 ± 100ms following each off-hook-to-on-hook transition of M lead (A-side signaling) or E lead (B-side signaling)

M-lead delay (A-side signaling) or E-lead delay (B-side signaling)
18 ± 5ms delay between M-lead or E-lead state change and SF-tone state change

pulsing characteristics (M lead to SF for A-side, E lead to SF for B-side)
- **input breaks and makes shorter than M-lead or E-lead delay are not recognized**
- **input breaks of a duration between that of M-lead or E-lead delay and 50ms are transmitted as 50ms tone bursts**
- **input makes of a duration between that of M-lead or E-lead delay and 25ms are repeated as 25ms silent (no tone) intervals**
- **input breaks longer than 50ms are transmitted as tone bursts equal in duration to the input break duration ± 2ms**
- **input makes longer than 25ms are repeated as silent (no tone) intervals equal in duration to the input make duration ±2ms**

transmit-path cut insertion
transmit speech path is cut (opened) 18 ± 5ms 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
range: 0 to −27dBm0

SF tone rejection threshold
−37 dBm0

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

maximum line noise
51dBrnC0

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 E lead (A side) or SF to M lead (B side) for pulse rates of 8, 10, and 12pps
input break: 50% to 75%
output break: 58% ± 4%

signaling relay (A-side E-lead, B-side M-lead) contact rating
maximum current: 1 ampere
maximum voltage: 200Vdc
contact resistance: 50 milliohms maximum
contact protection: internal transient protection is provided

E&M signaling, A side

E-lead current rating
500mA maximum (resistor-capacitor contact protection provided)

E-lead resistance
less than 0.5 ohms

M-lead sensitivity
−20Vdc minimum threshold; 500 ohms minimum external M-lead resistance from −48Vdc, will not detect 20 kohms or greater external M-lead resistance

E&M signaling, B side

M-lead current rating
500mA maximum (resistor-capacitor contact protection provided)

M-lead current from battery (Type I interface only)
100mA with less than 5-volt drop; current limiting above 200mA

E-lead sensitivity
500 ohms minimum external M-lead resistance to ground, will not detect 20kohms or greater external E-lead resistance

loopback (6162A and 6162C only)

tone-loopback frequency
2713Hz ± 7Hz

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

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

tone-loopback deactivate time
1.2 seconds minimum (deactivates immediately thereafter)

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

tone loopback guard ratio
greater than 6.0dB

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

loopback level accuracy
± 0.5dB

common specifications

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

current requirements

6161 and 6161B		
condition	**busy**	**idle**
−48Vdc	75mA	60mA
−52Vdc (max. output)	100mA	90mA

6161A and 6161C			
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)

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

weight
14 ounces (397 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 6162X 4Wire-to-2Wire SF-to-E&M 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 11, 12, and 13). 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 6162X 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. Telephone numbers are as follows:
US atlantic region: (203) 798-0506
US capital region: (703) 478-0468
US central region: (312) 357-7400
US southeast region: (305) 645-5888
US southwest region: (214) 869-4114
US western region: (702) 827-3400

Canadian customers: Contact Tellabs Customer Service at our Canadian headquarters in Mississauga, Ontario. Telephone (416) 624-0052.

International customers: Contact your Tellabs distributor.

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 8X6162X 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 L4W 2S
telephone (416) 624-0052

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

troubleshooting guide

trouble condition	possible causes
module completely inoperative	1) No input power. 2) Improper wiring.
cannot derive proper transmission levels	1) Front panel *gn/ls* switches improperly set. 2) Impedance option switches improperly set. 3) Receive equalization switches improperly set. 4) TMS impedance improperly set or TMS not terminated. 5) M lead or E lead not seized.
E-lead or M-lead LED on when lead is idle	1) Switch *S11* improperly set. 2) Inputs from near end or distant end not idle. 3) Fault in cable.
E-lead or M-lead LED off when lead is busy	1) Switch *S10* or *S11* improperly set. 2) Inputs from near end or distant end not busy. 3) Fault in cable.
improper dial pulsing	1) Improperly set option switches. 2) Improper supply voltage (should be between −42 and −54Vdc). 3) Excessive cable leakage. 4) Excessive longitudinal voltage on facility.
loopback not activating or not within 0.5dB of correct level	1) Switch *S17* improperly set. 2) Transmit or receive path not properly aligned. 3) Incorrect level or frequency of incoming loopback tone.

tellabs
technical manual
76-A826162
rev A

Addendum: Issue 2 6162/X-Series 4Wire-to-2Wire SF-to-E&M Terminal Repeaters

1.01 This addendum to practice section 816162/816162A/816162B/816162C, revision A (dated 1 May 1985), covers changes to the 6162, 6162A, 6162B, and 6162C 4Wire-to-2Wire SF-to-E&M Terminal Repeater modules resulting in the Issue 2 versions of these modules (Tellabs part numbers **826162, 826162A, 826162B,** and **826162C**). 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 6162/X modules

1.03 When optioning the Issue 2 6162/X modules, please disregard figure 10 and the terminating-impedance optioning information in paragraph 3.07 and table 6 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.

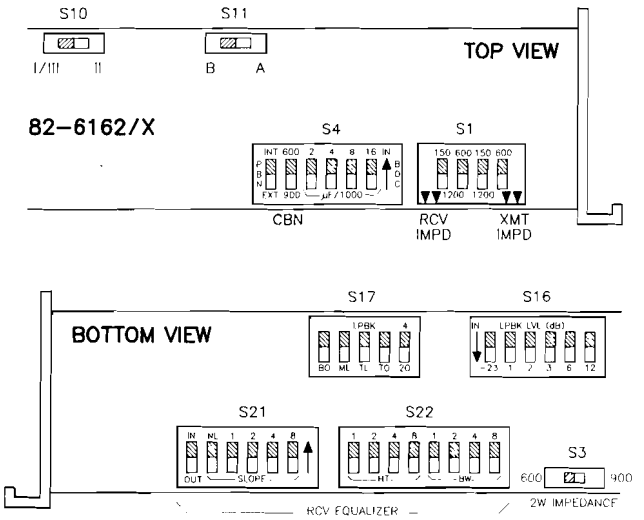


figure 1. Issue 2 6162/X option switch locations

facility-side level adjustment information for Issue 2 6162/X modules

1.04 When adjusting facility-side receive and transmit transmission levels on the Issue 2 6162/X modules, please disregard the information concerning the *rcv fac level gn/ls* switch in paragraph 3.17, step B, and the *xmt fac level gn/ls* switch in paragraph 3.18, step H, as well as the information about these *gn/ls* switches in table 8. 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 6162/X modules

1.05 When setting switch options on the Issue 2 6162/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.