tellabs
technical manual
76-816178
rev A

> **Note:** On early versions of this module, the *IN* setting for the *Z* and *R/R1* DIP switches (*S25* and *S26*) is **down**, i.e., toward the main printed circuit board. On later versions of the module, the *IN* setting for these switches is up, i.e., toward the baby board, as shown in figure 9.

practice section 816178

6178 4Wire-to-2Wire SF-to-FXO Intermediate Repeater

contents

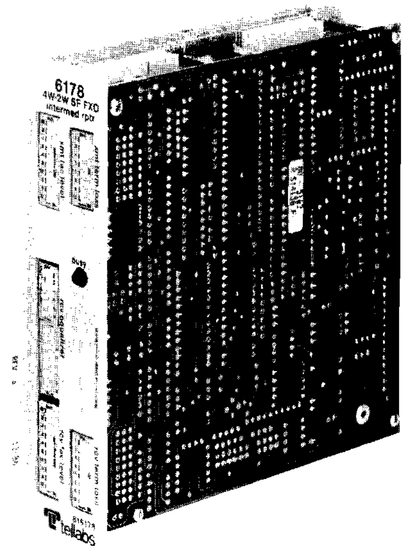


figure 1. 6178 4Wire-to-2Wire SF-to-FXO Intermediate Repeater module

1. general description

1.01 The 6178 4Wire-to-2Wire SF-to-FXO Intermediate Repeater module (figure 1) provides both active transmission interface and bidirectional signaling conversion between a 4wire metallic facility that uses 2600Hz single-frequency (SF) signaling and a 2wire metallic link (to a CO switch or PBX) that uses foreign-exchange office-end (FXO) loop signaling. This type of loop signaling is normally associated with the office (switching-equipment) end of both foreign-exchange (FX) and off-premises-station (OPS) circuits. The 6178 is designed in accordance with the specifications given in AT&T Technical Reference PUB 43001: Functional Criteria for Voice-Frequency Terminating Equipment/Metallic Facilities/Central Office.

1.02 In the event that this practice section is revised or reissued, the reason for revision or reissue will be stated in this paragraph.

1.03 The 6178 module offers the following features and options:

- 4wire-to-2wire conversion via an integral magnetic hybrid.
- From 0 to 24dB of prescription-set gain or loss, in switch-selectable 0.1dB increments, in both the transmit and receive channels at the facility-side 4wire ports.
- From 0 to 24dB of prescription-set loss, in switch-selectable 0.1dB increments, in both the transmit and receive channels on the module's terminal (2wire) side ports. This loss is actually introduced on the 4wire side of the hybrid.
- Active prescription slope-type or bump-type amplitude equalization, equivalent to that provided by the Western Electric (WECo) 309B Prescription Equalizer, in the receive channel.
- Isolation transformers that are center-tapped to derive simplex (SX) leads at both facility side 4wire ports.
- Independently switch-selectable 1200, 600, or 150-ohm terminating impedance at the facility-side ports.
- Switch-selectable 900 or 600-ohm terminating impedance in series with 2.15μF at the terminal-side 2wire port.
- Integral 2600Hz SF tone oscillator.
- Switch-selectable loop-start or ground-start operation.
- Full precision receive pulse correction.
- Integral compromise balance network (CBN) with switchable 900 or 600-ohm impedance in series with 2.15μF of capacitance.
- Integral precision balance network (PBN) functionally equivalent to either the WECo 4240B PBN (for nonloaded cable) or the WECo 4240C PBN (for loaded cable), as selected via switch option.
- From 0 to 0.126μF of line build-out capacitance (LBOC) in switch-selectable 0.002μF increments.
- Traffic-monitoring (sleeve) lead.
- Loop current limiting.
- Lightning surge protection at all transmission ports.
- Front-panel LED that lights to indicate busy.
- Reverse-battery protection, transient-limiting circuitry, and RC (resistance-capacitance) filtering and decoupling networks to minimize crosstalk coupling and the effects of noise on the input power leads.
- Operation on filtered, ground-referenced −42 to −54Vdc input power with current requirements of 65mA typical at idle (at −48Vdc) and 114mA maximum (at −54Vdc) with one channel at maximum output.
- Type 10 module for mounting in a variety of Tellabs Type 10 Mounting Shelves, which are available in versions for relay-rack (occupying 6 inches of vertical rack space) and apparatus-case installation.

2. application

2.01 The 6178 4Wire-to-2Wire SF-to-FXO Intermediate Repeater module is designed to interface a 4wire transmission facility that uses SF signaling with a 2wire metallic link that uses FXO signaling. This link is a line or trunk that typically terminates in a CO switch or PBX at the office (switching-equipment) end of an FX or OPS circuit. The 6178 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. No external interface circuitry is required because the 6178 is a complete SF signaling and terminating circuit, less power, on a single Type 10 card. Thus, the module provides not only bidirectional signaling conversion but also active transmission interface (impedance matching, level control, amplitude equalization, and 4wire-to-2wire conversion) between the SF facility and the FXO link. Figures 2 and 3 show typical applications.

terminal (2wire) interface, balance network, and line build-out capacitance (LBOC)

2.02 The 6178 interfaces the terminal-side 2wire FXO link via prescription attenuators in the transmit and receive paths on the 4wire side of the integral magnetic hybrid (see paragraph 2.07) and via the hybrid itself. This hybrid provides switch-selectable 900 or 600-ohm terminating impedance (in series with 2.15μF) at the 2wire port. The 900-ohm option is selected for interface with loaded cable or with 900-ohm office-end equipment. The 600-ohm option is selected for interface with nonloaded cable or with 600-ohm office-end equipment. To ensure that adequate hybrid balance is provided in any application, the hybrid in the 6178 can be switch-optioned to function with the module's internal compromise balance network (CBN) or internal precision balance network (PBN).

2.03 **Compromise Balance Network (CBN).** With the internal CBN selected, the 2wire-port impedance switch automatically selects the same impedance for the CBN as is selected for the 2wire port: 600 or 900 ohms in series with 2.15μF. If the CBN does not provide adequate hybrid balance (i.e., sufficient transhybrid loss), use of the PBN is required.

2.04 **Precision Balance Network (PBN).** When the internal CBN does not provide adequate transhybrid balance, the internal PBN can be selected instead. This internal PBN can be switch-optioned for use with loaded cable, in which case it is functionally equivalent to the Western Electric (WECo) 4240C PBN, or for use with nonloaded cable, in which case it is functionally equivalent to the WECo 4240B PBN. When optioned to balance nonloaded cable, the PBN operates as follows:

- The *Z* switch affects impedance equally at all frequencies.
- The *R/R1* switch affects impedance at low frequencies.
- The *R2* switch affects impedance at midband frequencies.

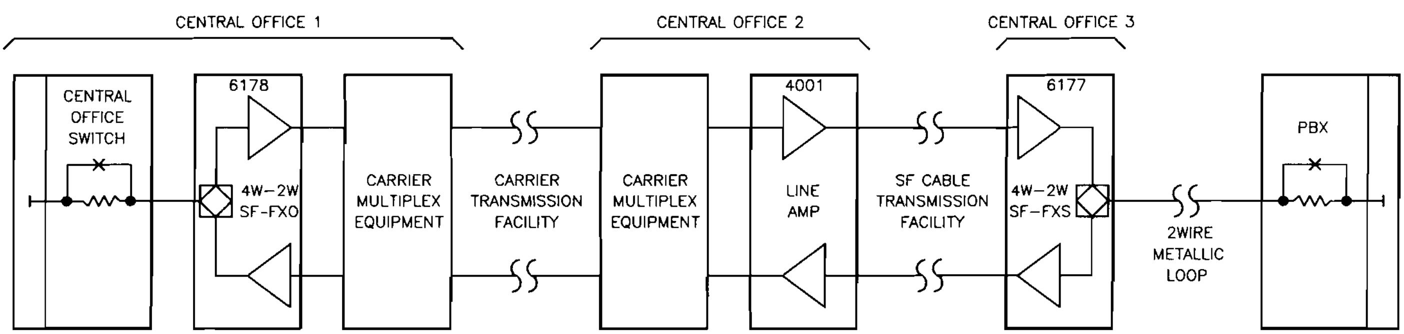


figure 2. Typical foreign-exchange (FX) application of 6178 module

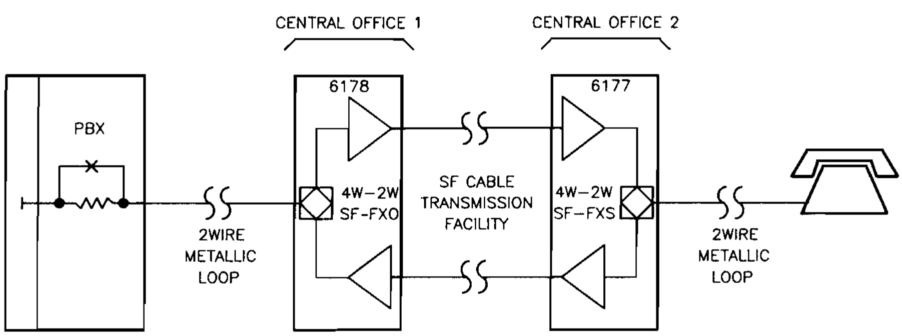


figure 3. Typical off-premises-station (OPS) application of 6178 module

When optioned to balance loaded cable, the PBN operates as follows:

- The *Z* switch affects impedance at all frequencies.
- The *R/R1* switch affects impedance at low frequencies.
- The *R2* switch is nonfunctional.

2.05 **Line Build-Out Capacitance (LBOC).** To further improve hybrid balance, especially in applications where the PBN is optioned for loaded cable, from 0 to 0.126μF of line build-out capacitance (LBOC) can be introduced across the hybrid's 2wire port. Generally, LBOC is not used when the PBN is optioned for nonloaded cable.

facility (4wire) interface

2.06 The 6178 interfaces the facility-side 4wire SF signaling facility via prescription amplifiers in the transmit and receive paths (see paragraph 2.07) and via transformers at the transmit output and receive input ports. Each facility-side transformer provides balanced, switch-selectable 1200, 600, or 150-ohm terminating impedance. The 1200-ohm option is used for interface with loaded cable; the 600-ohm option, for interface with nonloaded cable or carrier; and the 150-ohm option, to provide a small amount of slope-type amplitude equalization for nonloaded cable through the deliberate impedance mismatch. Both facility-side transformers are center-tapped to derive simplex (SX) leads, which can be used to provide sealing current to a metallic facility from a local source external to the module, or which can be strapped together to establish a return path for sealing current applied at the distant end of the facility.

level control

2.07 Prescription-set transmit and receive amplifiers on the facility side of the 6178 allow the module to interface the SF signaling facility directly, i.e., without a separate facility-side line amplifier. The module's amplifiers, in conjunction with the prescription-set transmit and receive attenuators on the module's terminal side, provide for full coordination between facility-side (4wire) and terminal-side (2wire) levels (see figure 4). In the receive channel, the facility-side amplifier is set to provide the gain or loss necessary to derive a +7 transmission level point (TLP) within the module. This internal TLP is then used as a reference as the module's terminal-side receive attenuator is set to provide the loss necessary to derive the required terminal-side 2wire output level. In the transmit channel, the terminal-side attenuator is set to provide the loss necessary to derive a −16TLP within the module. This internal TLP is then used as a reference as the module's facility-side transmit amplifier is set to provide the gain or loss necessary to derive the required facility-side 4wire transmit output level. Both facility-side amplifiers in the 6178 provide from 0 to 24dB of gain or 0 to 24dB of loss in switch-selectable 0.1dB increments. Both terminal-side attenuators provide from 0 to 24dB of loss in switch-selectable 0.1dB increments. Thus, 4wire receive TLP's from −17 to +7 can be accomodated and 2wire output TLP's from +7 to −17 can be derived. In a similar manner, 2wire input TLP's from −16 to +8 can be accomodated and 4wire transmit TLP's from +8 to −16 can be derived. Total facility-side gain or loss and total terminal-side loss introduced into a channel are the respective sums

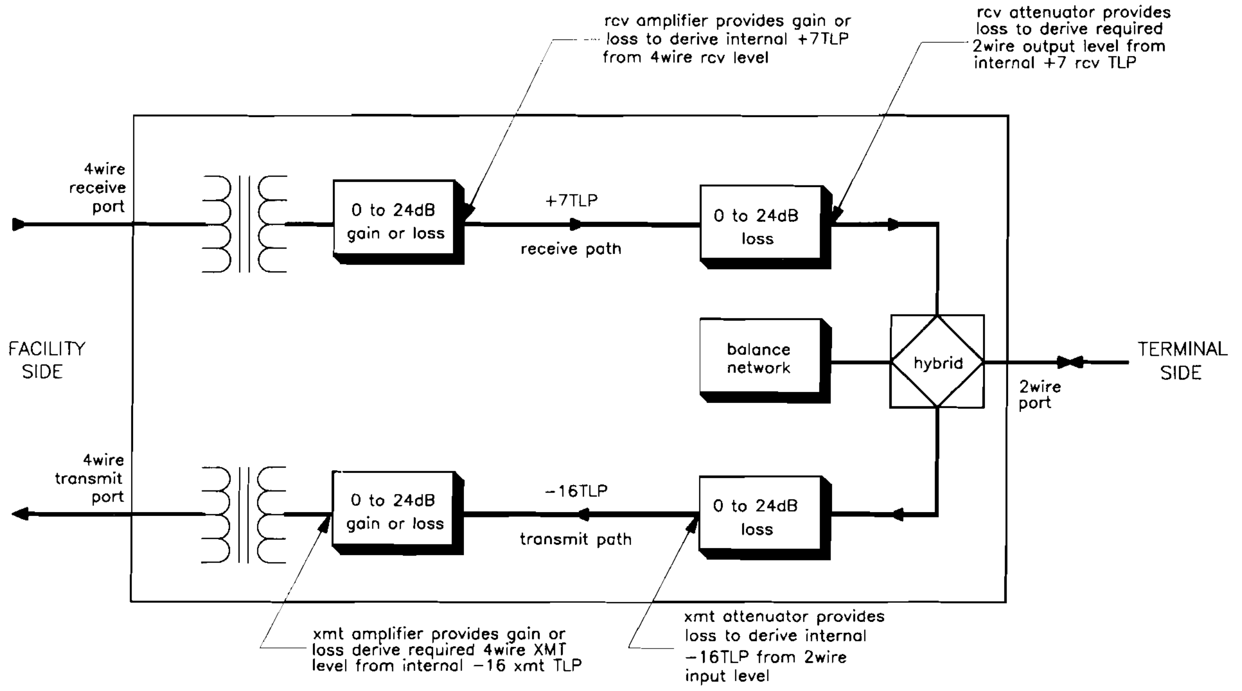


figure 4. Level coordination in 6178 module

of that channel's front-panel *fac level* and *term loss* switches set to *IN*. The overload point for the 4wire receive port and the 2wire port output is 0dBm0. The overload point for the 2wire port input and the 4wire transmit port is +3dBm0.

receive-channel amplitude equalization

2.08 Active prescription amplitude equalization functionally equivalent to that provided by the Western Electric (WECo) 309B Prescription Equalizer is available in the receive channel of the 6178 for post-equalization of the 4wire receive pair. This equalizer provides low-end slope equalization down to 404Hz and high-end bump equalization centered at 3250Hz for loaded or nonloaded cable, as selected via switch option. Degree of slope, height of bump, and affected bandwidth are also controlled by option switches on the module. If no equalization is required, the equalizer can be electrically bypassed by means of another switch option.

2.09 Figures 5 and 6 show typical response curves for the 309B-equivalent equalizer in the slope mode. Figure 5 shows the curves for nonloaded cable, while figure 6 shows the curves for loaded cable. For comparison purposes, all frequency-response curves in both figures are drawn with the same 0dB-gain reference point (1004Hz). Actually, all of these curves except those for a *SLOPE* switch setting of *0* are raised above the 0dB level at 1004Hz by as much as 11.4dB. The exact amount by which a particular curve is raised depends upon the *SLOPE* and *NL* (nonloaded/loaded) switch settings selected. These amounts are listed in table 1.

2.10 Figures 7 and 8 show typical response curves for the 309B-equivalent equalizer in the bump mode. Figure 7 shows the curves representing various height settings versus a wide bandwidth setting, while figure 8 shows the curves representing various height settings versus a narrow bandwidth setting. For comparison purposes, all frequency-response curves in both figures are drawn with the same 0dB-gain reference point (1004Hz). Actually, all of these curves except those for a height (*HT*) switch setting of *1* or *0* and/or for a bandwidth (*BW*) switch setting of 5 or less are raised above the 0dB level by as much as 3.9dB. The exact amount by which a particular curve is raised depends upon the *HT* and *BW* switch settings selected. These amounts are listed in table 2.

supervisory states, loop start

2.11 The 6178 module accomodates 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 6178 holds the 2wire loop open toward the local switching equipment. When the office end is idle, the 6178 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 6178 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 6178, upon this loss of incoming tone, closes the 2wire loop toward the local switching equipment. Incoming SF tone pulses indicate dialing.

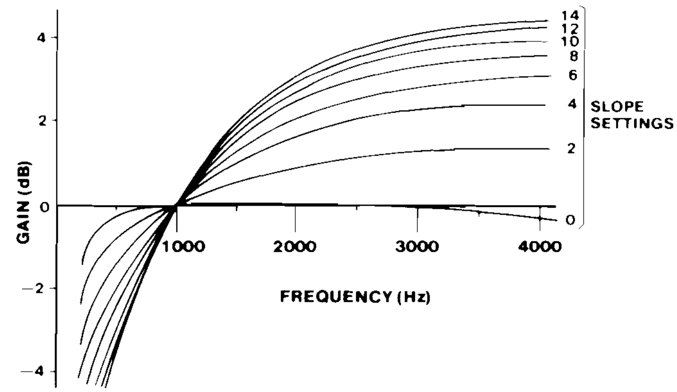


figure 5. Typical response curves for receive equalizer in slope mode, nonloaded cable

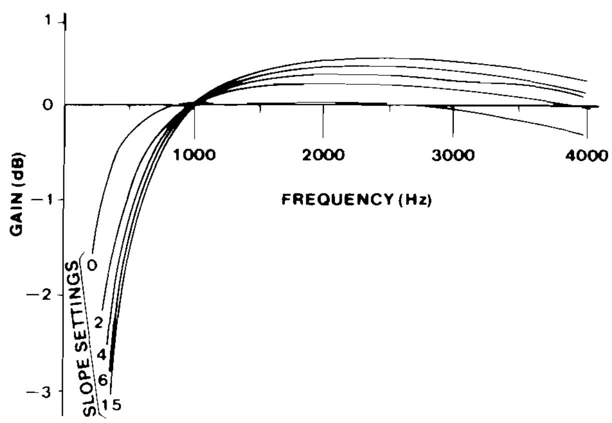


figure 6. Typical response curves for receive equalizer in slope mode, loaded cable

SLOPE switch setting	L/NL (loaded/nonloaded) switch setting	
	L	NL
0 (slope disabled)	0.0dB	0.0dB
1	1.4	0.4
2	2.6	0.9
3	3.7	1.4
4	4.7	1.8
5	5.5	2.3
6	6.3	2.8
7	7.2	3.4
8	7.8	3.7
9	8.4	4.2
10	9.0	4.6
11	9.5	5.0
12	10.0	5.4
13	10.5	5.8
14	11.0	6.2
15	11.4	6.6

table 1. Equalized gain (in dB) at 1004Hz in slope mode

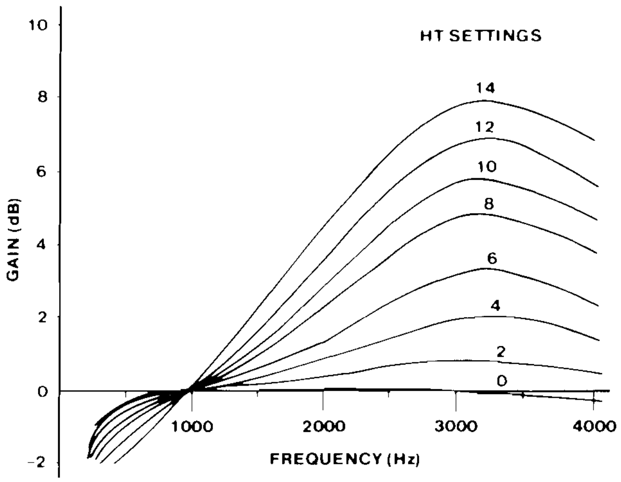


figure 7. Typical response curves for receive equalizer in bump mode, BW switch = 14

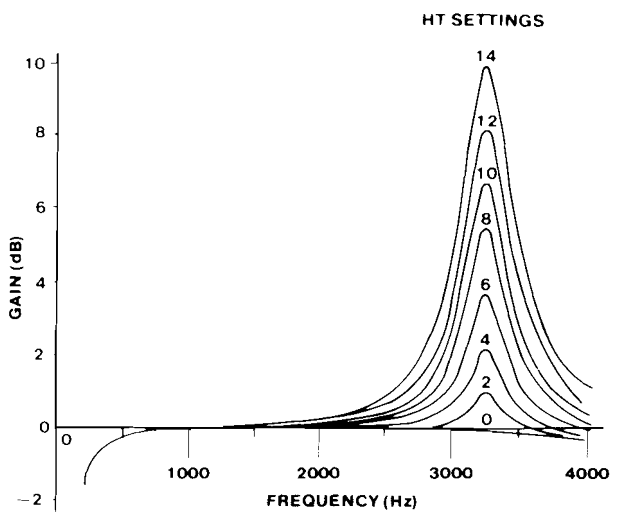


figure 8. Typical response curves for receive equalizer in bump mode, BW switch = 3

supervisory states, ground start

2.12 In ground-start operation. just as in loop-start, the 6178 module accomodates a conventional supervisory format. When the station end is idle, the associated FXS signaling unit transmits SF tone. Receipt of this tone by the 6178 holds the 2wire loop open toward the local switching equipment. Similarly, when the office end is idle, the 6178 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 6178 to remove outgoing SF tone. Subsequent receipt of ringing voltage from the local switching equipment causes the 6178 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 to ground and to 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 6178 closes the 2wire loop to trip ringing and establishes 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 6178. 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 6178 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.

loop current and supervisory range

2.13 When the distant station is off-hook, the 6178 provides a path for loop-current flow by providing a loop closure toward the local switching equipment. Supervisory limits in applications involving the 6178 depend upon the sensitivity of the local switching equipment.

HT switch setting*	BW switch setting**									
	6	7	8	9	10	11	12	13	14	15
2	0.0dB	0.0dB	0.0dB	0.0dB	0.0dB	0.0dB	0.0dB	0.1dB	0.1dB	0.2dB
3	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.3
4	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.4
5	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.3	0.5
6	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.4	0.7
7	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.5	0.9
8	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.7	1.2
9	0.0	0.1	0.1	0.2	0.2	0.3	0.4	0.5	0.8	1.5
10	0.1	0.1	0.2	0.2	0.2	0.3	0.4	0.6	1.0	1.7
11	0.1	0.1	0.2	0.2	0.3	0.4	0.5	0.7	1.2	2.0
12	0.1	0.1	0.2	0.3	0.3	0.4	0.6	0.9	1.4	2.4
13	0.1	0.2	0.3	0.3	0.4	0.6	0.8	1.1	1.7	2.8
14	0.1	0.2	0.3	0.4	0.5	0.7	0.9	1.3	2.0	3.3
15	0.2	0.3	0.4	0.5	0.7	0.9	1.2	1.7	2.5	3.9

* An *HT* switch setting of *0* disables the bump function. An *HT* switch setting of *1* introduces 0.1dB of gain or less at 1004Hz.
** A *BW* switch setting of *0* through *5* introduces 0.1dB of gain or less for all *HT* switch settings.

table 2. Equalized gain (in dB) at 1004Hz in bump mode

signaling-tone states

2.14 Signaling-tone states for the 6178 are consistent with the conventional F-signaling formats for FXO and office-end OPS service. These states are listed in tables 3 and 4 for loop-start and ground-start operation, respectively.

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

table 3. Loop-start signaling-tone states

local loop condition	SF tone receive	SF tone 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 4. Ground-start signaling-tone states

incoming SF tone detection

2.15 The 6178 is designed to interface the receive path on the facility (4wire) side at any TLP from −17 to +7. Idle-state SF tone is normally received at a level of −20dBm0. A higher level of −8dBm0 is normally received during break portions of dial pulses and for about 400ms at the beginning of each tone interval. The 6178's SF tone detector reliably detects tone levels as low as −27dBm0, provided that the SF tone energy is approximately 12dB above the level of all other signals simultaneously present at the 4wire receive port. The SF tone detector is actually a signal-to-guard ratio comparator that compares energy in a narrow band of frequencies centered at the SF tone frequency with energy in the entire voice band. This detection arrangement aids significantly in prevention of talk-off, but it places an upper bound on allowable circuit noise. In general, received noise in excess of 51dBrnC0 may interfere with detection of low-level signaling tones.

2.16 The 6178's SF tone detector is designed to ignore momentary losses of SF tone during periods of otherwise continuous receipt of tone and to ignore momentary tone bursts to prevent false signaling. Within approximately 13ms of detection of incoming SF tone, a band-elimination filter (BEF) is inserted into the receive transmission path to prevent propagation of SF tone beyond the module. An internal timing circuit ensures that the filter remains inserted during dial pulsing and during momentary losses of tone continuity.

receive pulse correction

2.17 The 6178 contains an integral precision pulse corrector in its SF receive section. To ensure optimum pulsing toward the local termination, this pulse corrector corrects incoming pulsing (SF tone bursts) at 8 to 12 pulses per second to provide outgoing dial pulsing at 58±3 percent break. The pulse corrector ignores incoming tone bursts shorter than approximately 20ms.

outgoing SF tone transmission

2.18 The 6178 is designed to interface the transmit path on the facility (4wire) side at any TLP from +8 to −16. 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 module 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.

transmit path cut

2.19 To prevent speech and transient energy from interfering with detection of SF signaling tone at the distant end of the circuit, the transmit voice path through the 6178 is cut (opened) whenever SF tone is transmitted or received.

power

2.20 The 6178 is designed to operate on filtered, ground-referenced input potentials between −42 and −54Vdc. The positive side of the dc power supply must be connected to earth ground. Maximum current required at −54Vdc is 114mA, not including loop current and with one channel at maximum output.

ringing

2.21 The ringing detector in the 6178 senses incoming ringing (from the local switching equipment) across the tip and ring leads. Both superimposed and grounded ringing schemes can be accommodated. The 6178 can sense any ringing frequency from 16 to 67Hz, and the module's ringing-voltage sensing threshold is approximately 65Vrms.

traffic monitoring

2.22 The 6178 permits traffic monitoring of circuit seizures via a traffic-monitoring output lead (pin 1) that functions much like a local sleeve lead. This lead provides a ground output when the local 2wire (office-end) loop is seized and also during the break portion of dial pulses. When the circuit is idle, the lead is open.

3. installation

inspection

3.01 The 6178 4Wire-to-2Wire SF-to-FXO Intermediate 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 6178 mounts in one position of a Tellabs Type 10 Mounting Shelf. The module plugs physically and electrically into a 56-pin connector at the rear of its shelf position.

installer connections

3.03 When a 6178 module is to be installed in a non-prewired Type 10 Shelf, external connections to the module must be made. Before making any connections to the shelf, ensure that power is **off** and modules are **removed.** Modules should be put into place only **after** they are properly optioned and **after** wiring is completed.

3.04 Table 5 lists external connections to the 6178 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 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
2WIRE TIP	55
2WIRE RING	49
4WIRE RCV SX (simplex, facility side)	9
4WIRE XMT SX (simplex, facility side)	43
SLEEVE (traffic-monitoring or sleeve lead)	1
A lead	51
B lead	3
−BATT (−42 to −54Vdc filtered input)	35
GND (ground)	17

table 5. External connections to 6178

option selection

3.05 Several option switches must be set before the 6178 is placed into service. Locations of these switches and of certain alignment switches on the module's printed circuit board are shown in figure 9. Table 6 summarizes all switch options and provides a convenient **checklist** that can be filled out either prior to installation for prescription optioning or during installation to serve as a record for later reference. Refer to figure 9 and table 6, and set each option switch on the 6178 as required.

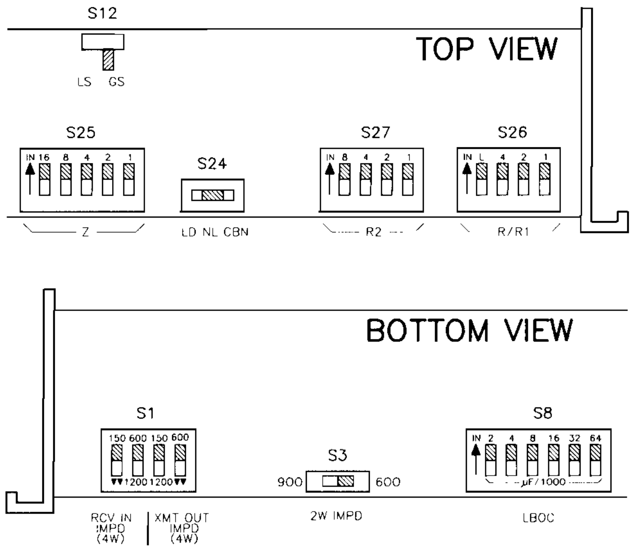


figure 9. 6178 option switch locations

alignment overview

3.06 Alignment of the 6178 module comprises the following procedures (all option switches should already be properly set as described above):

A. Setting the receive-channel facility-side and terminal-side levels.
B. Introducing receive-channel equalization, if necessary.
C. Setting the transmit-channel terminal-side and facility-side levels.
D. Either inserting and optioning the integral CBN (if not already done), or inserting and aligning the integral PBN, if necessary.
E. Introducing line build-out capacitance (LBOC) on the terminal-side, if necessary.

prescription alignment

3.07 The 6178 module is primarily intended for **prescription alignment.** This involves setting all level-control, equalization, balance-network, and LBOC switches in accordance with specifications on the circuit layout record (CLR) before plugging the module into its shelf position. Table 7 in this practice summarizes all alignment switches on the 6178 and provides a convenient **checklist** for prescription alignment. To use this table, simply indicate all required alignment-switch settings in the **checklist** column. Then, at installation time, align the 6178 by setting each switch as indicated in the table (or on the CLR, if preferred).

Note: *Prescription alignment procedures for the precision balance network (PBN) can be found in Bell System Practice (BSP) section 332-912-222. Manual alignment procedures for the PBN can be found in BSP section 332-912-221.*

option	switch	selection	setting	checklist
terminating impedance, 4wire receive port (facility side)	*RCV IN IMPD* (*S1*) switches (lefthand *150* and *600* switches) on main board	1200 ohms (for loaded cable)	150 switch toward 1200, 600 switch toward 1200	
		600 ohms (for nonloaded cable or carrier)	150 switch toward 1200, 600 switch toward 600	
		150 ohms (extra equalization for nonloaded cable)	150 switch toward 150, 600 switch toward 1200	
terminating impedance, 4wire transmit port (facility side)	*XMT OUT IMPD* (*S1*) switches (righthand *150* and *600* switches) on main board	1200 ohms (for loaded cable)	150 switch toward 1200, 600 switch toward 1200	
		600 ohms (for nonloaded cable or carrier)	150 switch toward 1200, 600 switch toward 600	
		150 ohms (extra equalization for nonloaded cable)	150 switch toward 150, 600 switch toward 1200	
terminating impedance, 2wire port (terminal side)*	*2W IMPD* switch (*S3*) on main board)*	900 ohms plus 2.15μF	900	
		600 ohms plus 2.15μF	600	
loop-start or ground-start operation	*LS/GS* switch (*S12*) on baby board	loop start	LS	
		ground start	GS	
balance network selection	*LD/NL/CBN* switch (*S24*) on main board	PBN, loaded cable	LD	
		PBN, nonloaded cable	NL	
		CBN	CBN	

* With the module's integral CBN optioned into the circuit via switch *S24*, switch *S3* automatically selects the same impedance for the CBN as is selected for the 2wire port.

table 6. Summary and checklist of 6178 switch options

4. circuit description

4.01 To provide the clearest possible understanding of the operation of the 6178 4Wire-to-2Wire SF-to-FXO Intermediate Repeater module, function sequence flowcharts (figures 10 and 11) that illustrate operation of the module on incoming and outgoing calls are presented in lieu of a more conventional circuit description. Horizontal paths identify events occuring simultaneously, and vertical paths denote sequential events. Dotted lines indicate elapsed time. These flowcharts can be used to determine whether a module is performing normally by observing the module's response and comparing it to that shown in the flowcharts. Reference to the 6178 block diagram (section 5 of this practice) may aid in understanding the flowcharts.

4.02 The flowcharts are intended to familiarize you with the operation of the 6178 for engineering, application, and troubleshooting purposes only. Attempts to test or troubleshoot this module internally are not recommended and may void its Tellabs warranty. Procedures for recommended testing and troubleshooting in the field should be limited to those prescribed in section 7 of this practice.

6. specifications

transmission

alignment level ranges, facility-side ports
4wire rcv port: −17 to +7TLP
4wire xmt port: −16 to +8TLP

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

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

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

insertion loss, xmt and rcv channels (600-ohm termination at all ports)
0±0.2dB at 1004Hz with all level-control switches set for no gain or loss

specifications continued on page 10

alignment function	switch	selection	setting	checklist
selection of receive-channel facility-side flat gain or loss	*GN* and *LS* positions of front-panel *rcv fac level* DIP switch	gain	GN to IN LS to OUT	
		loss	GN to OUT LS to IN	
amount of receive-channel facility-side gain or loss, as selected above*	dB-value positions of front-panel *rcv fac level* DIP switch*	0.1dB	.1 to IN	
		0.2dB	.2 to IN	
		0.4dB	.4 to IN	
		0.8dB	.8 to IN	
		1.5dB	1.5 to IN	
		3.0dB	3 to IN	
		6.0dB	6 to IN	
		12.0dB	12 to IN	
receive-channel terminal-side flat loss*	front-panel *rcv term loss* DIP switch*	0.1dB	.1 to IN	
		0.2dB	.2 to IN	
		0.4dB	.4 to IN	
		0.8dB	.8 to IN	
		1.5dB	1.5 to IN	
		3.0dB	3 to IN	
		6.0dB	6 to IN	
		12.0dB	12 to IN	
inclusion or bypass (exclusion) of receive-channel (post-) equalizer	*IN/OUT* position of front-panel *rcv equalizer SLOPE* DIP switch	equalizer included in circuit	IN	
		equalizer bypassed (excluded)	OUT	
introduction of receive-channel 309B-equivalent equalization	*SLOPE NL* position of front-panel *rcv equalizer SLOPE* DIP switch	nonloaded cable	toward NL	
		loaded cable	away from NL	
	SLOPE 1, 2, 4, 8 positions of front-panel *rcv equalizer SLOPE* DIP switch**	degree of slope	SLOPE 1 to 1	
			SLOPE 2 to 2	
			SLOPE 4 to 4	
			SLOPE 8 to 8	
	HT 1, 2, 4, 8 positions of front-panel *rcv equalizer HT/BW* DIP switch**	height of bump	HT 1 to 1	
			HT 2 to 2	
			HT 4 to 4	
			HT 8 to 8	
	BW 1, 2, 4, 8 positions of front-panel *rcv equalizer HT/BW* DIP switch**	affected bandwidth	BW 1 to 1	
			BW 2 to 2	
			BW 4 to 4	
			BW 8 to 8	
selection of transmit-channel facility-side flat gain or loss	*GN* and *LS* positions of front-panel *xmt fac level* DIP switch	gain	GN to IN LS to OUT	
		loss	GN to OUT LS to IN	
amount of transmit channel facility-side gain or loss, as selected above*	dB-value positions of front-panel *xmt fac level* DIP switch*	0.1dB	.1 to IN	
		0.2dB	.2 to IN	
		0.4dB	.4 to IN	
		0.8dB	.8 to IN	
		1.5dB	1.5 to IN	
		3.0dB	3 to IN	
		6.0dB	6 to IN	
		12.0dB	12 to IN	
transmit-channel terminal-side flat loss*	front-panel *xmt term loss* DIP switch*	0.1dB	.1 to IN	
		0.2dB	.2 to IN	
		0.4dB	.4 to IN	
		0.8dB	.8 to IN	
		1.5dB	1.5 to IN	
		3.0dB	3 to IN	
		6.0dB	6 to IN	
		12.0dB	12 to IN	

alignment function	switch	selection	setting	checklist
precision balance network (PBN) alignment, loaded-cable applications (*S24* set to *LD*)	*L* position of *R/R1* (*S26*) on main board	MAT cable (low-capacitance loaded cable)	L to IN	
		high-capacitance loaded cable	L to OUT	
	Z (*S25*) on main board***	1	1 to IN	
		2	2 to IN	
		4	4 to IN	
		8	8 to IN	
		16	16 to IN	
	1, 2, and *4* positions of *R/R1* (*S26*) on main board***	1	1 to IN	
		2	2 to IN	
		4	4 to IN	
	R2 (*S27*) on main board	NO SELECTION AVAILBLE: all four positions of *R2* are non-functional with *S24* set to *LD*	DON'T CARE	
line build-out capacitance (LBOC), terminal side, loaded-cable applications (*S24* set to *LD*)	*LBOC* (*S8*) on main board, *µF/1000****	0.002µF	2 to IN	
		0.004µF	4 to IN	
		0.008µF	8 to IN	
		0.016µF	16 to IN	
		0.032µF	32 to IN	
		0.064µF	64 to IN	
precision balance network (PBN) alignment, nonloaded-cable applications (*S24* set to *NL*)	*L* position of *R/R1* (*S26*) on main board	NO SELECTION AVAILABLE: *L* position of *R/R1* is non-functional with *S24* set to *NL*	DON'T CARE	
	Z (*S25*) on main board***	1	1 to IN	
		2	2 to IN	
		4	4 to IN	
		8	8 to IN	
		16	16 to IN	
	1, 2, and *4* positions of *R/R1* (*S26*) on main board***	1	1 to IN	
		2	2 to IN	
		4	4 to IN	
	R2 (*S27*) on main board***	1	1 to IN	
		2	2 to IN	
		4	4 to IN	
		8	8 to IN	

* The eight dB-value positions of the front-panel *rcv fac level* and *xmt fac level* DIP switches are cumulative, as are all eight positions of the *rcv term loss* and *xmt term loss* DIP switches. Total facility-side gain or loss and total terminal-side loss introduced into a channel are the sums of that channel's *fac level* and *term loss* switch positions set to *IN*.

** The *1, 2, 4,* and *8* positions of the *SLOPE, HT,* and *BW* receive post equalization DIP switches are cumulative. These switch positions may be set in any combination as required.

*** All five positions of switch *Z* (*S25*), all four positions of switch *R2* (*S27*), the *1, 2,* and *4* positions of switch *R/R1* (*S26*), and all six positions of switch *LBOC* (*S8*) are cumulative. These switch positions may be set in any combination as required.

table 7. Summary and checklist of 6178 alignment switches

receive-channel amplitude equalization
active prescription slope or bump-type equalization for nonloaded or loaded cable, functionally equivalent to that provided by the WECo 309B Prescription Equalizer, with electrical bypass (exclusion) of equalizer available via switch option

terminating impedances, 4wire ports
1200, 600, or 150 ohms, balanced, individually switch-selectable at each port

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

frequency response, 4wire rcv in to 2wire, with no equalization and with receive-channel BEF removed
+0.3, −2.0dB, 200 to 3000Hz, re 1004Hz
+0.3, −1.3dB, 3000 to 3400Hz, re 1004Hz

frequency response, 2wire to 4wire xmt out
+0.3, −2.0dB, 200 to 3000Hz, re 1004Hz
+0.3, −1.3dB, 3000 to 3400Hz, re 1004Hz

specifications continued on page 14

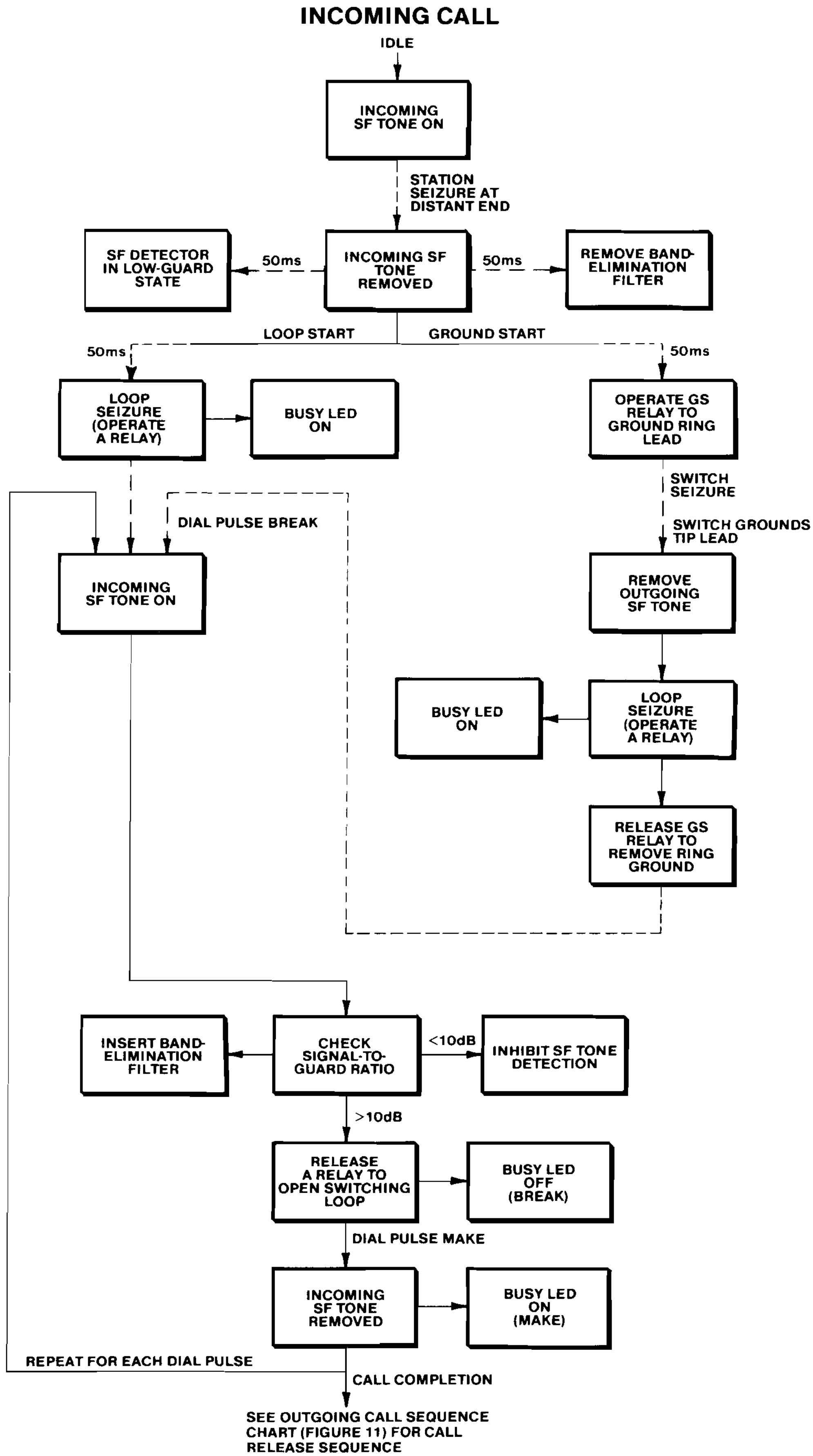


figure 10. Function sequence flowchart, incoming call

OUTGOING CALL

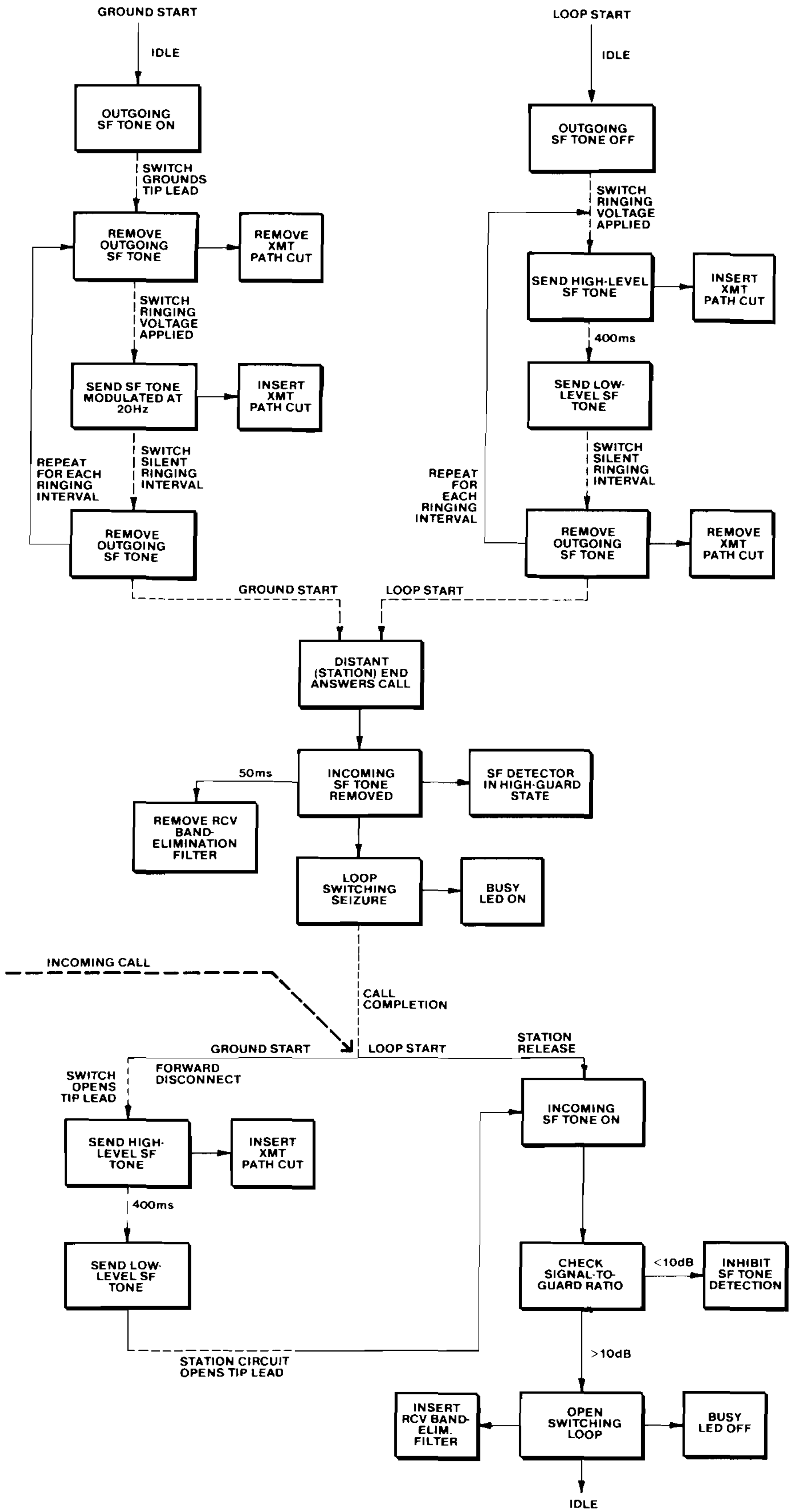
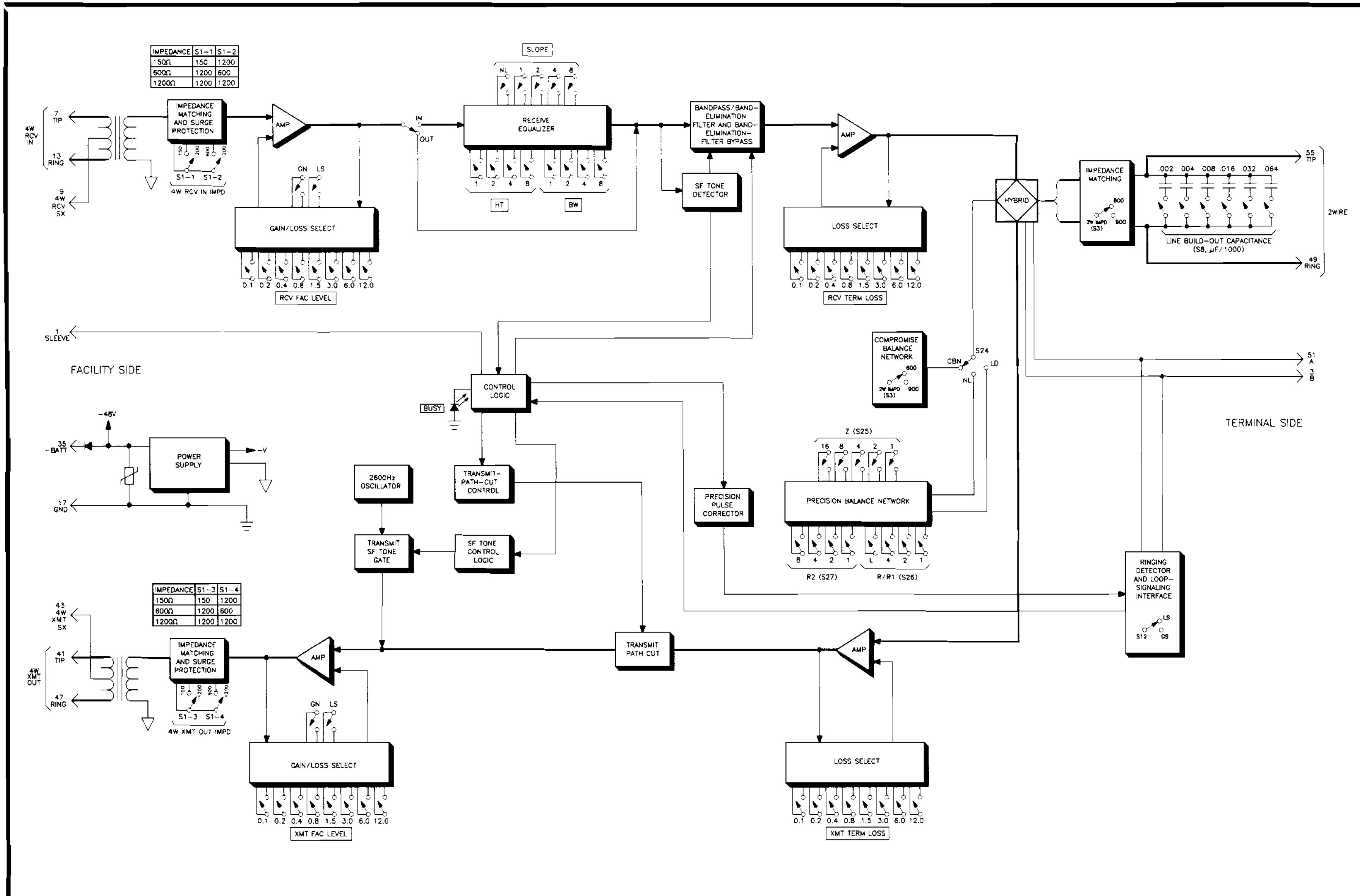


figure 11. Function sequence flowchart, outgoing call



6178 4Wire-to-2Wire SF-to-FXO Intermediate Repeater 816178

5. block diagram

compromise balance network (CBN)
switch-selectable for 600 ohms in series with 2.15μF or 900 ohms in series with 2.15μF

precision balance network (PBN)
functionally equivalent to either the WECo 4240B PBN (for nonloaded cable) or the WECo 4240C PBN (for loaded cable), as selected via switch option

line build-out capacitance (LBOC)
0 to 0.126μF in switch-selectable 0.002μF increments

total harmonic distortion, all ports
less than 1% at overload points

internal noise, xmt and rcv channels
17dBrnC0 maximum at maximum gain

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

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

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

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

SF transmit section

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

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

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

outgoing SF tone states
see table 3 (loop start) and table 4 (ground start) in section 2 of this practice

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) 13±10ms 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
−37dBm0

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

incoming SF tone states
see table 3 (loop start) and table 4 (ground start) in section 2 of this practice

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±3%
10pps	35 to 80%	58±3%
12pps	44 to 80%	58±3%

2wire loop conditions

maximum loop resistance
3000 ohms with −48Vdc input battery

maximum 2wire loop current (current-limited)
35±5mA with −48Vdc input battery

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 break portions of dial pulses

common specifications

input power requirements
voltage: −42 to −54Vdc, filtered, ground referenced
idle current: 65mA typical at −48Vdc
busy current: 114mA maximum at −54Vdc with one channel at maximum output

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

dimensions
5.58 inches (14.17cm) high
1.42 inches (3.61cm) wide
5.96 inches (15.14cm) deep

weight
13 ounces (369 grams)

mounting
relay rack or apparatus case via one position of a Tellabs Type 10 Mounting Shelf

7. testing and troubleshooting

7.01 The *troubleshooting guide* in this section may be used in conjunction with the function sequence flowcharts (figures 10 and 11) in section 4 of this practice to assist in the installation, testing, or troubleshooting of the 6178 4Wire-to-2Wire SF-to-FXO Intermediate Repeater module. The guide is intended as an aid in the localization of trouble to a specific module. If a module is suspected of being defective, a new one should be substituted and the test conducted again. If the substitute module operates correctly, the original module should be considered defective and returned to Tellabs for repair or replacement. We strongly recommend that no internal (component-level) testing or repairs be attempted. 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 non compliance with Part 68 of the FCC Rules and Regulations.

Note: *Warranty service does not include removal of permanent customer markings on the front panels of Tellabs modules, although an attempt will be made to do so. If a module must be marked* **defective,** *we recommend that it be done on a piece of tape or on a removable stick-on label.*

7.02 If a situation arises that is not covered in the *troubleshooting 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) 357-7400
US Southeast Region: (305) 834-8311
US Southwest Region: (214) 869-4114
US Western Region: (714) 850-1300
Canada: (416) 624-0052

7.03 If a 6178 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 6178 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 8X6178 part number that indicates the issue of the module in question. Upon notification, we shall ship a replacement 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's carton, sign the packling 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 carton prepaid to Tellabs.

repair and return

7.05 Return the defective 6178 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 2S7
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) Front-panel *rcv fac level* and/or *rcv term loss* DIP switches improperly set. 2) Main-board 4wire receive and/or 2wire impedance DIP switches (*S1* and *S3*, respectively) improperly set. 3) Front-panel equalizer bypass switch improperly set. 4) Front-panel receive equalization DIP switches (*SLOPE, HT,* and *BW*) improperly set. 5) Circuit not seized. 6) Test-equipment impedance improperly set or test equipment not terminated.
cannot derive proper 2wire-to-4wire transmission levels	1) Front-panel *xmt term loss* and/or *xmt fac level* DIP switches improperly set. 2) Main-board 2wire and/or 4wire transmit impedance DIP switches (*S3* and *S1*, respectively) improperly set. 3) Circuit not seized. 4) Test-equipment impedance improperly set or test equipment not terminated.
objectionable echo or "hollow' sound at distant end of 4wire facility	1) CBN being used when PBN is necessary. 2) Main-board PBN DIP switches (*Z* [*S25*], *R2* [*S27*], *R/R1* [*S26*]) improperly set. 3) Main-board LBOC DIP switch (*S8*) improperly set. 4) Level switches improperly set. 5) Equalization switches improperly set. 6) One or more impedance switches improperly set.
improper or 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 level* and/or *term loss* DIP switches improperly set for one or both channels.