tellabs
technical manual
76-816173
rev A

practice section 816173

6173 4Wire-to-4Wire SF-to-DX Intermediate Repeater

contents

1. general description

1.01 The 6173 4Wire-to-4Wire SF-to-DX Intermediate Repeater module (figure 1) provides both active transmission interface and bidirectional signaling conversion between a 4wire facility that uses 2600Hz single-frequency (SF) signaling and a 4wire trunk or line that uses duplex (DX) signaling. Providing greater signaling range than conventional E&M signaling, DX signaling is extended toward the termination via DX signaling leads to the facility pairs rather than via separate E&M signaling leads. The 6173 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 6173 module offers the following features and options:

- 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 ports.
- From 0 to 24dB of prescription-set loss, in switch-selectable 0.1dB increments, in both the transmit and receive channels at the terminal-side ports.
- Active prescription slope-type or bump-type amplitude equalization, equivalent to that provided by the Western Electric (WECo) 309B Prescription Equalizer, in both the transmit and receive channels.
- Independently switch-selectable post-equalization, pre-equalization, or equalizer bypass (exclusion) for both the transmit and receive equalizers.
- Isolation transformers that are center-tapped to derive balanced simplex (SX) leads at all four ports.
- Terminal-side SX-lead reversal switch.
- Switch-selectable 0 or 4μF of midpoint capacitance for the DX signaling leads.

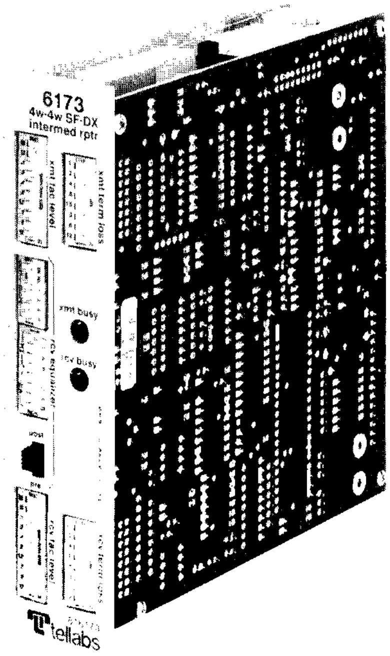


figure 1. 6173 4Wire-to-4Wire SF-to-DX Intermediate Repeater module

- Independently switch-selectable 1200, 600, or 150-ohm terminating impedance at all four ports.
- Integral 2600Hz SF tone oscillator.
- Minimum-break transmit pulse correction.
- Full precision receive pulse correction.
- Maximum signaling and supervisory range of 5000 ohms for the external DX loop.
- Integral DX balance network that provides from 0 to 6750 ohms of resistance, switch-selectable in 250-ohm increments, and from 0 to 7μF of capacitance, switch-selectable in 1μF increments.
- Front-panel LED's that light to indicate SF-to-DX busy (*rcv busy* LED) and DX-to-SF busy (*xmt busy* LED).
- Lightning surge protection at all transmission ports.
- 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 80mA typical at idle (at −48Vdc) and 100mA maximum (at −54Vdc).
- 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 6173 4Wire-to-4Wire SF-to-DX Intermediate Repeater module is typically used at a telephone company central office (CO) to interface a 4wire SF transmission facility, convert that facility's SF signaling to duplex (DX) signaling, and extend that signaling to a distant termination (e.g., a PBX at a customer's premises). DX signaling, which is extended toward the termination via DX signaling leads to the facility pairs, is used in applications requiring greater signaling range than would be possible with conventional E&M signaling (which is extended toward the termination via separate E&M leads). The 6173 module combines the functions of a 4wire line amplifier, an SF transceiver, an SF-to-DX signaling converter, and a 4wire pad/transformer module. No external transmission interface circuitry is required because the 6173 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, and amplitude equalization) between the SF facility and the DX trunk or line. Figure 2 shows a typical application.

terminal interface

2.02 The 6173 interfaces the terminal-side trunk or line via prescription attenuators in the transmit and receive paths (see paragraph 2.04) and via transformers at the transmit input and receive output ports. Each terminal-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 terminal-side transformers are center-tapped to derive balanced simplex (SX) leads, by which the DX signaling path is extended toward the terminal equipment. Connection of these SX leads to the module's integral DX unit is controlled by an option switch that selects either a normal or reversed arrangement (see the block diagram, section 5 of this practice). In the normal arrangement, the transmit input simplex (XMT IN SX) lead is associated with the transmit input pair, and the receive output simplex (RCV OUT SX) lead is associated with the receive output pair. In the reversed arrangement, the XMT IN SX lead is associated with the receive output pair, and the RCV OUT SX lead is associated with the transmit input pair. The SX-lead reversal option is provided to accommodate signaling-lead reversals at other points in the circuit.

facility interface

2.03 The 6173 interfaces the facility-side SF signaling facility via prescription amplifiers in the transmit and receive paths (see paragraph 2.04) and via transformers at the transmit output and receive input ports. Like the terminal-side transformers, each facility-side transformer provides balanced, switch-selectable 1200, 600, or 150-ohm terminating impedance. Also, both facility-side transformers are center-tapped to derive balanced 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

2.04 Prescription-set transmit and receive amplifiers on the facility side of the 6173 allow the module to interface the SF signaling facility directly, i.e., without a separate facility-side line amplifier. These amplifiers, in conjunction with the prescription-set transmit and receive attenuators on the module's terminal side, provide for full coordination between

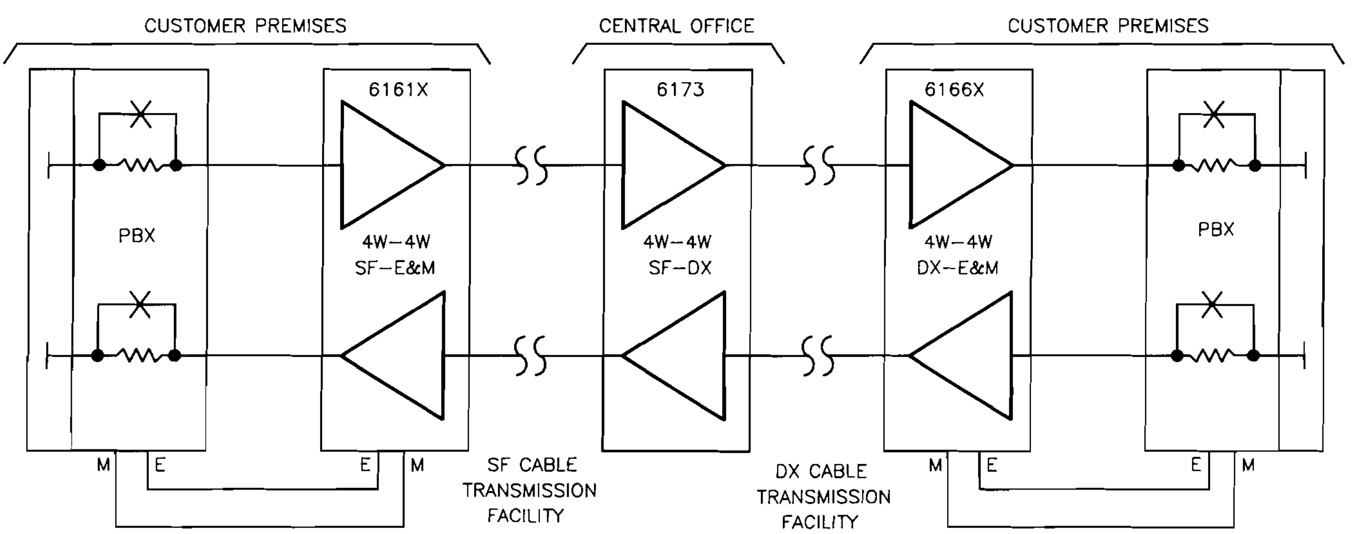


figure 2. Typical application of 6173 module

facility-side and terminal-side levels (see figure 3). 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 receive 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 transmit output level. Both facility-side amplifiers in the 6173 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, receive input TLP's from −17 to +7 can be accommodated and receive output TLP's from +7 to −17 can be derived. In a similar manner, transmit input TLP's from −16 to +8 can be accommodated and transmit output 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 of that channel's front-panel *fac level* and *term loss* switches set to *IN*. The overload point for the receive input and receive output ports is 0dBm0. The overload point for the transmit input and transmit output ports is +3dBm0.

receive-channel amplitude equalization

2.05 Active prescription amplitude equalization functionally equivalent to that provided by the Western Electric 309B Prescription Equalizer is available in the receive channel of the 6173. 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. An additional switch option conditions the equalizer to provide either post-equalization of the receive input pair or pre-equalization of the receive output pair, as required. For post-equalization, the equalizer is inserted before the receive-channel band-elimination filter (see paragraph 2.11). For pre-equalization, the equalizer is inserted after the band-elimination filter. If no equalization is required, the equalizer can be electrically bypassed by means of another switch option.

2.06 Figures 4 and 5 show typical response curves for the 309B-equivalent equalizer in the slope mode. Figure 4 shows the curves for nonloaded cable, while figure 5 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.

2.07 Figures 6 and 7 show typical response curves for the 309B-equivalent equalizer in the bump mode. Figure 6 shows the curves representing various height settings versus a wide bandwidth setting, while figure 7 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

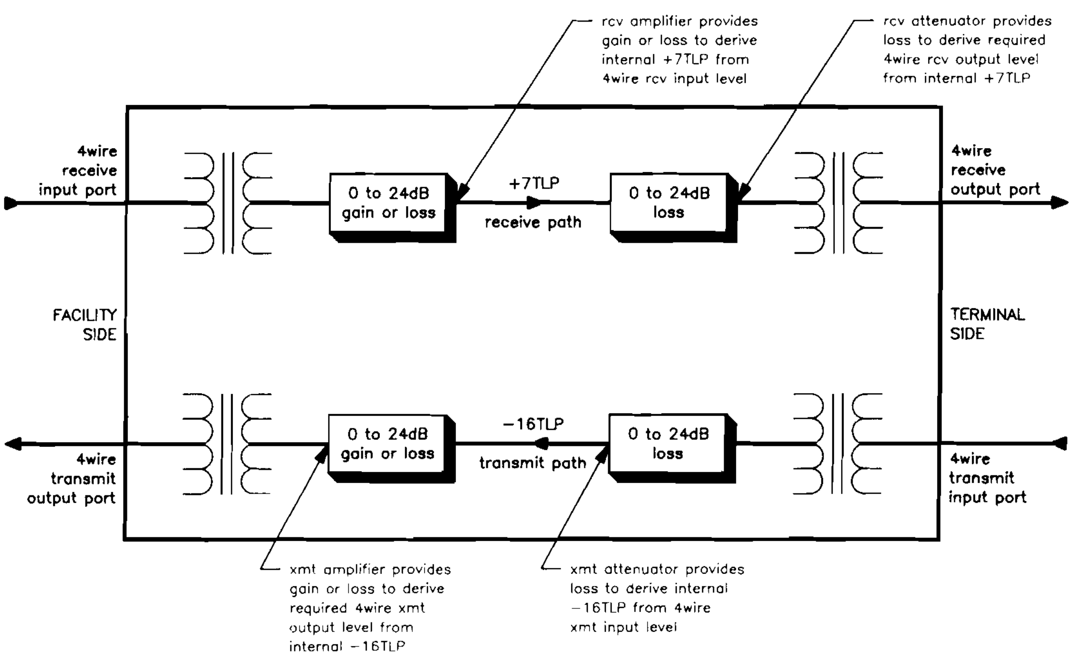


figure 3. Level coordination in 6173 module

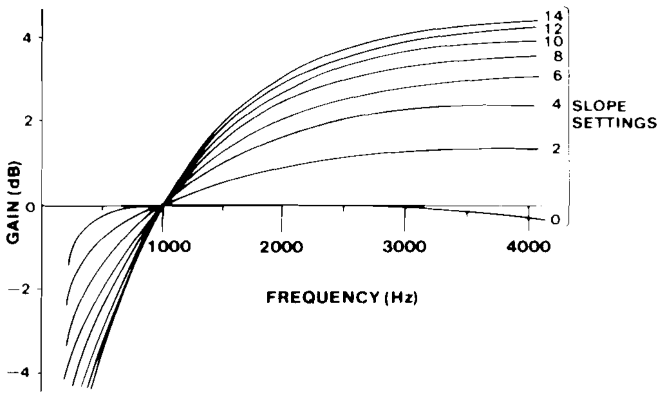


figure 4. Typical response curves for receive and transmit equalizers in slope mode, nonloaded cable

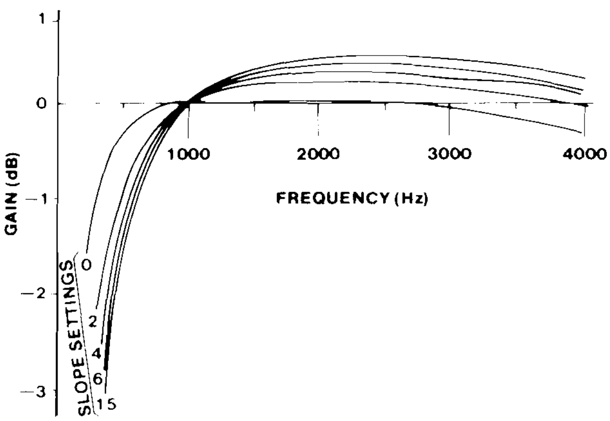


figure 5. Typical response curves for receive and transmit equalizers in slope mode, loaded cable

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

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.

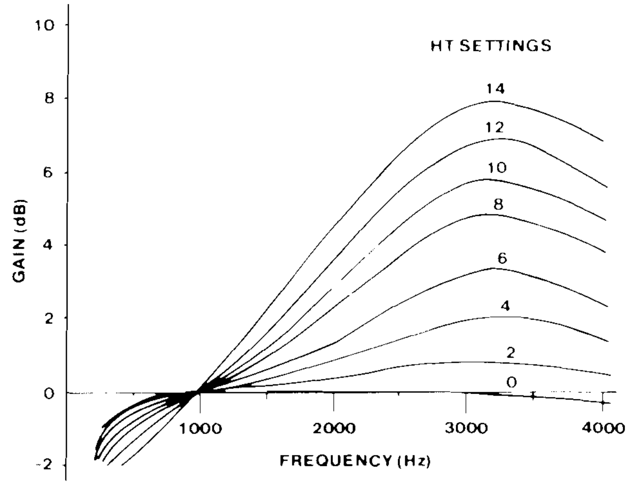


figure 6. Typical response curves for receive and transmit equalizers in bump mode, BW switch = 14

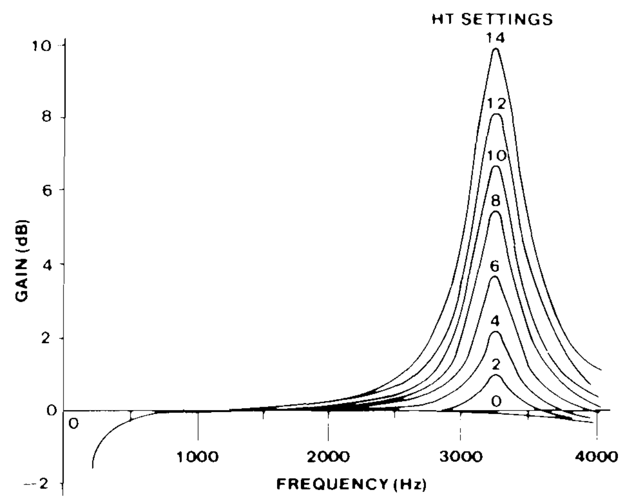


figure 7. Typical response curves for receive and transmit equalizers in bump mode, BW switch = 3

transmit-channel amplitude equalization

2.08 Active 309B-equivalent prescription amplitude equalization identical to that provided in the receive channel is available in the 6173's transmit channel as well. A switch option conditions the transmit equalizer to provide either post-equalization of the transmit input pair or pre-equalization of the transmit output pair. For post-equalization, the equalizer is inserted into the transmit path before the transmit path cut (see paragraph 2.15). For pre-equalization, the equalizer is inserted into the transmit path after the point at which SF tone is inserted (see the 6173 block diagram, section 5 of this practice). If no equalization is required, the equalizer can be electrically bypassed by means of another switch option.

signaling-tone states

2.09 In a typical application, received SF tone indicates an idle (on-hook) condition at the distant end of the 4wire facility, and SF tone transmitted by the 6173 indicates an idle condition at the DX port. Absence of SF tone indicates a busy condition at

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

either end. Dial pulses are transmitted as a sequence of SF tone bursts. The module is designed for simultaneous bidirectional signaling operation, which means that it can receive and transmit signaling and supervisory information regardless of the supervisory states at the two ends of the facility. Tables 3 and 4 list signaling tone states (as well as band-elimination-filter and transmit-path-cut states) for local and distant call origination, respectively.

incoming SF tone detection

2.10 The 6173 is designed to interface 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. The 6173'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 receive input 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.

2.11 The 6173'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. See tables 3 and 4 for details concerning BEF insertion.

receive pulse correction

2.12 To ensure optimum pulsing toward the local termination, the 6173's full precision receive pulse corrector corrects incoming pulsing (tone bursts) at 8 to 12 pulses per second to provide outgoing pulsing at a nominal 58±4 percent break. The 6173 recognizes signaling-state changes in the receive path regardless of the local transmit-path signaling state.

outgoing SF tone transmission

2.13 The 6173 is designed to interface the transmit path on the facility 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.

delay circuit and transmit pulse correction

2.14 The 6173 contains a delay circuit to delay detection of on-hook-to-off-hook and off-hook-to-on-hook transitions by about 18ms to prevent inadvertent transmission or interruption of SF tone and to ensure that transients associated with signaling-state changes in the local terminal equipment do not affect SF tone transmission. A minimum-break pulse corrector in the transmit path ensures a 50ms minimum break duration and a 25ms minimum make duration during dialing, regardless of input break or pulsing rate. The minimum-break pulse corrector has no effect upon pulsing breaks longer than 50ms.

transmit path cut

2.15 To prevent speech and transient energy from interfering with detection of SF signaling tone at the distant end of the circuit, the voice path

circuit condition	SF tone states		local condition of xmt path cut			local rcv-path band-elimination-filter (BEF) insertion
	xmt	*rcv*	*before*	*change*	*after*	
idle	on	on	cut	none	cut	inserted
seizure	on/off transition	on	cut	stays cut 125±50ms after seizure	not cut	inserted
distant end returns *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 incoming DX 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 incoming DX transition from busy to idle	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

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) insertion
	xmt	*rcv*	*before*	*change*	*after*	
idle	on	on	cut	none	cut	inserted
seizure, distant end	on	on/off transition	cut	remains cut 625±125ms after cessation of SF tone	not cut	removed 50±5ms after cessation of SF tone
distant end returns *delay-dial* signal	on/off transition	off	not cut	cut 125±50ms after incoming DX transition from idle to busy	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 incoming DX transition from busy to idle	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 incoming DX transition from idle to busy	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

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

through the transmit portion of the 6173 is cut (opened) during dialing and whenever SF tone is transmitted or received. Details concerning insertion and removal of the transmit path cut are provided in tables 3 and 4.

SF tone source

2.16 The module is equipped with an integral 2600Hz SF tone oscillator and therefore does not require an associated master SF tone supply.

DX signaling loop limits

2.17 For proper DX signaling operation, total resistance of the DX signaling loop between the 6173 and the DX unit associated with the local terminal equipment must not exceed 5000 ohms. In 4wire applications, total DX signaling loop resistance equals one-half of the loop resistance of the transmit input pair plus one-half of the loop resistance of the receive output pair.

signaling-lead midpoint capacitance

2.18 To prevent unwanted signaling-state changes toward the terminal-side termination, a switch option on the 6173 allows 4μF of capacitance to be placed across the midpoint of the 6173's DX signaling leads. This midpoint capacitance is necessary in all 4wire applications except those involving an unusually short DX signaling link. In short-link applications, the midpoint capacitor is switch-optioned out of the circuit for 0μF of midpoint capacitance, which allows easier alignment of the 6173's integral DX balance network than would otherwise be possible with a short DX link.

DX balancing

2.19 A resistive and capacitive DX balance network in the 6173 is used to balance the module's internal DX impedance against that of the external DX signaling link. Proper balance ensures optimum performance of the 6173's DX unit for the specific length (in ohms) of the DX signaling link and also minimizes pulse distortion.

2.20 **Resistive Balance.** The amount of resistance required in the balance network is simply the total resistance of the external 4wire DX signaling link (see paragraph 2.17). This is because a 1260-ohm resistive component integral to the 6173's balance network automatically compensates for the resistance of the DX unit associated with the terminal equipment at the opposite end of the DX signaling link. The five *KILOHMS* positions of the 6173's DX-balance-network DIP switch introduce from 0 to 6750 ohms of resistance, in 250-ohm increments, to permit matching (within 125 ohms) of DX-link resistance up to 5000 ohms.

2.21 **Capacitive Balance.** No specific formula exists for calculating the amount of capacitance required to properly balance the circuit. This amount depends upon a variety of factors. For example, little capacitive balance is required in most 4wire DX circuits because the signaling pairs are separated by substantial relative distances and are therefore coupled by very little mutual capacitance. Numerous other factors, including cable gauge and splicing format, also affect the DX signaling link. The cumulative effect of these factors makes prediction of the required amount of balancing capacitance difficult. A trial-and-error procedure is therefore necessary to achieve proper capacitive balance. The three *μF* positions of the 6173's DX-balance-network DIP switch allow from 0 to 7μF of capacitance to be introduced into the circuit in 1μF increments.

power

2.22 The 6173 is designed to operate on filtered, ground-referenced input potentials between −42 and −54Vdc. The positive side of the dc power supply should be connected to earth ground. Maximum current required at −54Vdc is 100mA.

3. installation

inspection

3.01 The 6173 4Wire-to-4Wire SF-to-DX 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 6173 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 6173 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 6173. 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:
RCV IN TIP	7
RCV IN RING	13
XMT OUT TIP	41
XMT OUT RING	47
RCV OUT TIP	5
RCV OUT RING	15
XMT IN TIP	55
XMT IN RING	49
RCV IN SX (simplex, facility side)	9
XMT OUT SX (simplex, facility side)	43
RCV OUT SX (simplex, terminal side)	3
XMT IN SX (simplex, terminal side)	51
−BATT (−42 to −54Vdc filtered input)	35
GND (ground)	17

table 5. External connections to 6173

option selection
3.05 Several option switches must be set before the 6173 is placed into service. Locations of these switches and of certain alignment switches on the module's printed circuit board are shown in figure 8. 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 8 and table 6, and set each option switch on the 6173 as required.

Note: *Switch numbers on main printed circuit board may not be visible.*

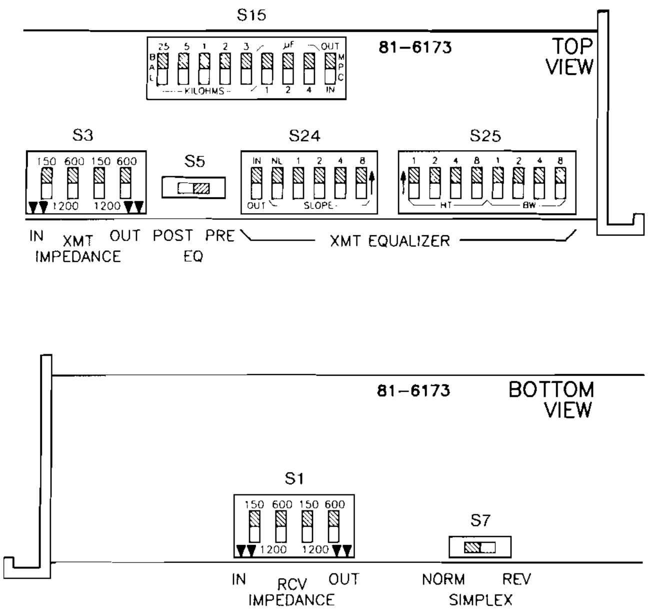


figure 8. 6173 option switch locations

alignment overview
3.06 Alignment of the 6173 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. Introducing transmit-channel equalization, if necessary.
E. Adjusting the integral resistive and capacitive DX balance network.

prescription alignment
3.07 The 6173 is primarily intended for **prescription alignment.** This involves setting all level-control and equalization DIP 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 6173 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 6173 by setting each switch as indicated in the table (or on the CLR, if preferred).

4. circuit description

4.01 To provide the clearest possible understanding of the operation of the 6173 4Wire-to-4Wire SF-to-DX Intermediate Repeater module, function sequence flowcharts (figures 9 through 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 occurring simultaneously, and vertical paths denote sequential events. Dotted lines indicate elapsed time. These flowcharts can be used to verify normal operation by observing the module's response and comparing it to that shown in the flowcharts. Reference to the 6173 block diagram (section 5 of this practice) will aid in understanding the flowcharts.

4.02 The flowcharts are intended to familiarize you with the operation of the 6173 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
receive input port: −17 to +7TLP
transmit output port: −16 to +8TLP

alignment level ranges, terminal-side ports
receive output port: +7 to −17TLP
transmit input port: +8 to −16TLP

overload points
receive input and output ports: 0dBm0
transmit input and output ports: +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

amplitude equalization, xmt and rcv channels
active prescription slope or bump-type equalization for nonloaded or loaded cable, functionally equivalent to that provided by the WECo 309B Prescription Equalizer. Each channel's equalizer can be conditioned for post- or pre-equalization operation or electrically bypassed (excluded) via switch option

specifications continued on page 16

option	switch	selection	setting	checklist
terminating impedance, receive input port (facility side)	*RCV IMPEDANCE (S1) IN* 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, receive output port (terminal side)	*RCV IMPEDANCE (S1) OUT* 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, transmit input port (terminal side)	*XMT IMPEDANCE (S3) IN* 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, transmit output port (facility side)	*XMT IMPEDANCE (S3) OUT* 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	
normal or reversed terminal-side SX leads	*SIMPLEX NORM/REV* switch (*S7*) on main board	normal (XMT IN SX associated with xmt input pair, RCV OUT SX associated with rcv output pair)	NORM	
		reversed (XMT IN SX associated with rcv output pair, RCV OUT SX associated with xmt input pair)	REV	
midpoint capacitance on terminal-side SX leads*	*MPC* (*S15*) switch (righthand *IN/OUT* switch) on baby board	$4\mu F$*	IN	
		$0\mu F$*	OUT	
* Normal applications require an *IN* setting for the *MPC* switch, while short-loop applications require an *OUT* setting.				

table 6. Summary and checklist of 6173 switch options

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 equalizer	*IN/OUT* position of front-panel *rcv equalizer SLOPE* DIP switch	equalizer included in circuit	IN	
		equalizer bypassed (excluded)	OUT	
post-equalization or pre-equalization operation for receive-channel equalizer	front-panel *rcv equalizer post/pre* switch	post-equalization	post	
		pre-equalization	pre	
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	

table 7 continued on next page

alignment function	switch	selection	setting	checklist
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	
inclusion or bypass (exclusion) of transmit-channel equalizer	*IN/OUT* position of main-board *XMT EQUALIZER SLOPE* DIP switch (*S24*)	equalizer included in circuit	IN	
		equalizer bypassed (excluded)	OUT	
post-equalization or pre-equalization operation for transmit-channel equalizer	*POST/PRE EQ* switch (*S5*) on main board	post-equalization	POST	
		pre-equalization	PRE	
introduction of transmit-channel 309B-equivalent equalization	*SLOPE NL* position of main-board *XMT EQUALIZER SLOPE* DIP switch (*S24*)	nonloaded cable	toward NL	
		loaded cable	away from NL	
	SLOPE 1, 2, 4, 8 positions of main-board *XMT EQUALIZER SLOPE* DIP switch (*S24*)**	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 main-board *XMT EQUALIZER HT/BW* DIP switch (*S25*)**	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 main-board *XMT EQUALIZER HT/BW* DIP switch (*S25*)**	affected bandwidth	BW 1 to 1	
			BW 2 to 2	
			BW 4 to 4	
			BW 8 to 8	
DX balance network resistance (0 to 6750 ohms) †	*KILOHMS* positions of baby-board *BAL/MPC* DIP switch (*S15*) †	250 ohms	toward .25	
		500 ohms	toward .5	
		1000 ohms	toward 1	
		2000 ohms	toward 2	
		3000 ohms	toward 3	
DX balance network capacitance (0 to 7μF) †	*μF positions of baby-board BAL/MPC* DIP switch (*S15*) †	1μF	toward 1	
		2μF	toward 2	
		4μ	toward 4	

* 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 and transmit equalization DIP switches are cumulative. These switch positions may be set in any combination as required.

† The DX balance network's resistance and capacitance switches (*KILOHMS* and *μF* positions of the *BAL/MPC* DIP switch, *S15*) are cumulative. Total resistance and capacitance introduced are the sums of those *KILOHMS* and *μF* switch positions, respectively, set toward their respective values.

table 7. Summary and checklist of 6173 alignment switches

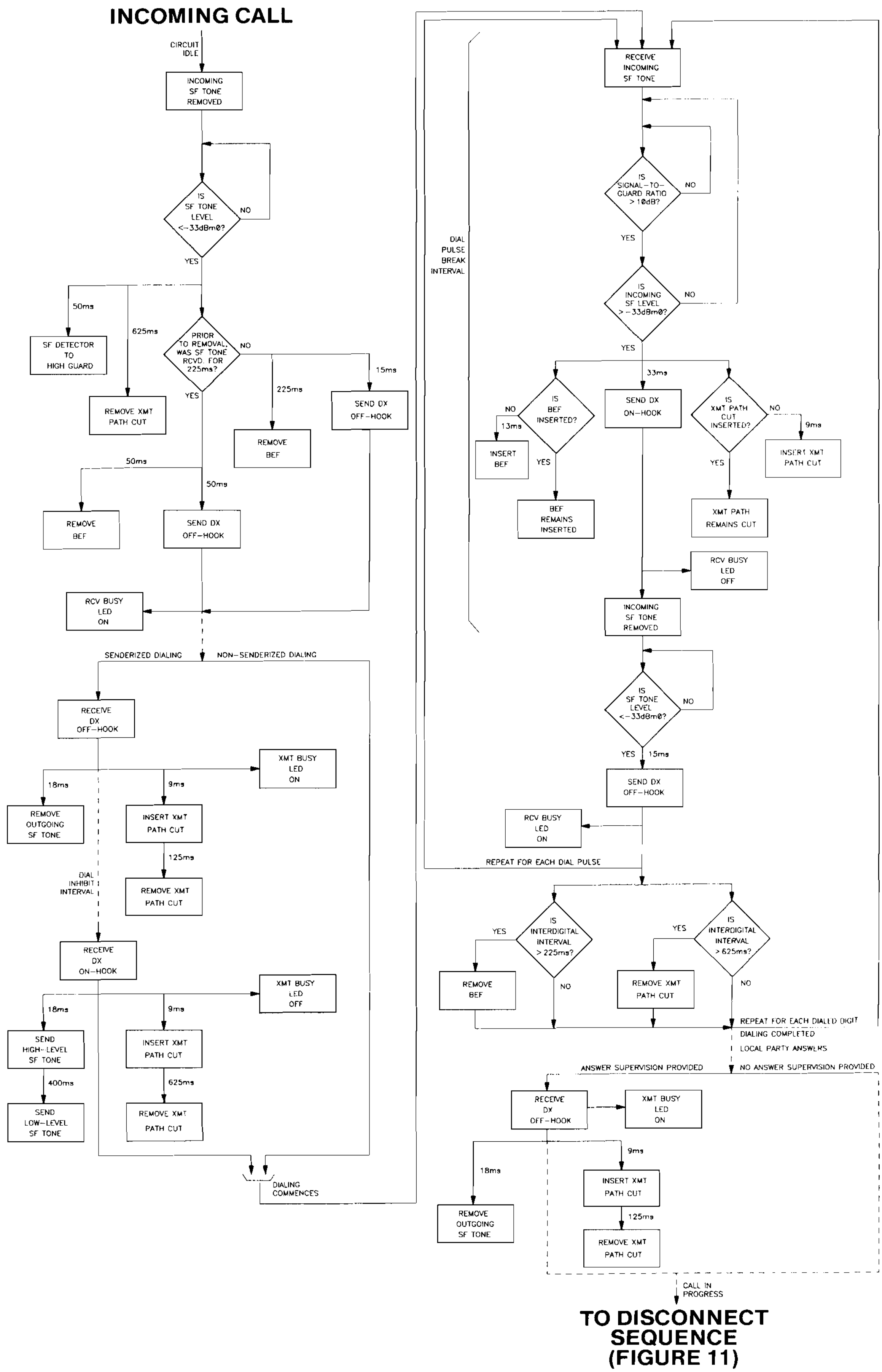


figure 9. Function sequence flowchart, incoming call

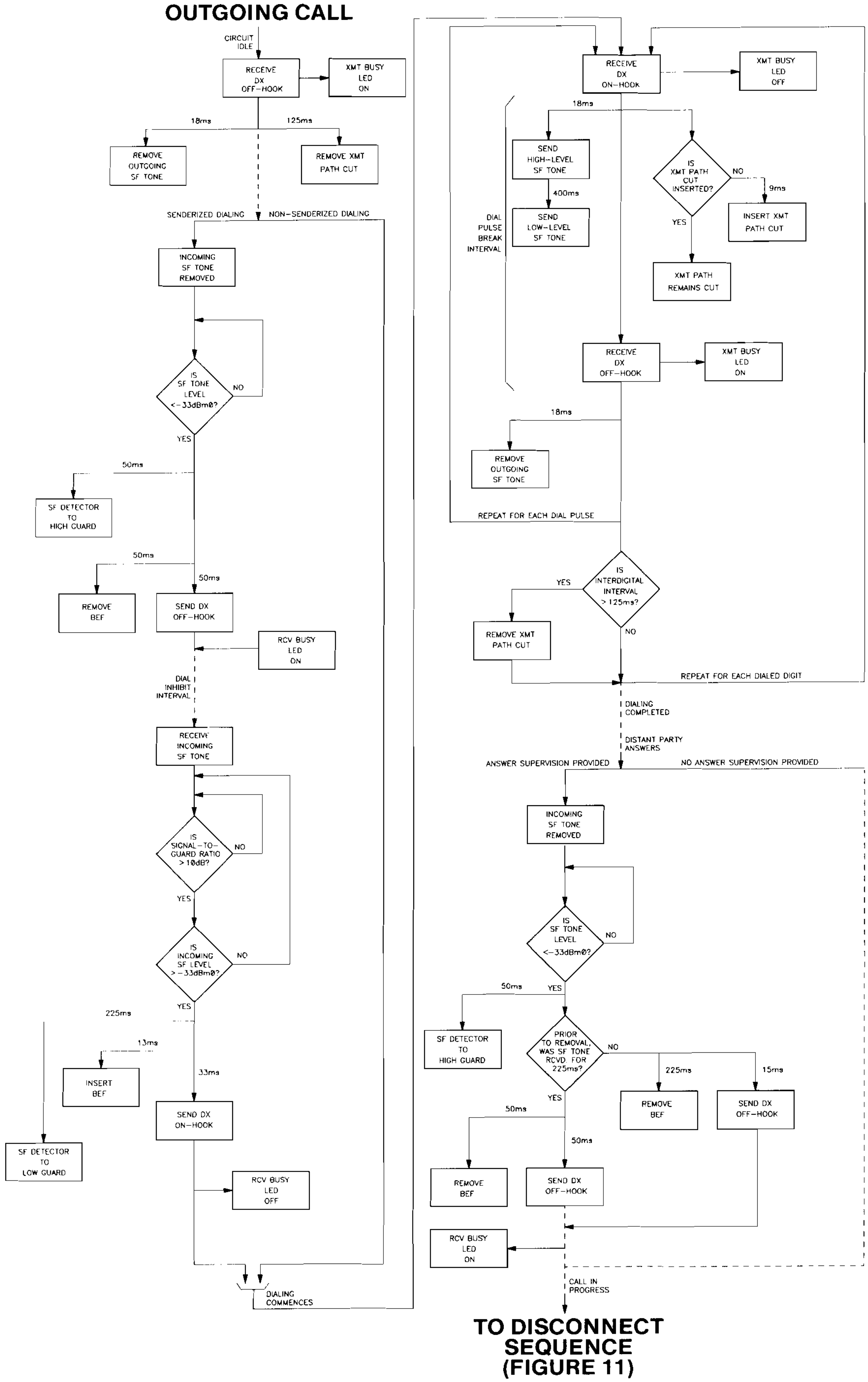


figure 10. Function sequence flowchart, outgoing call

DISCONNECT SEQUENCE

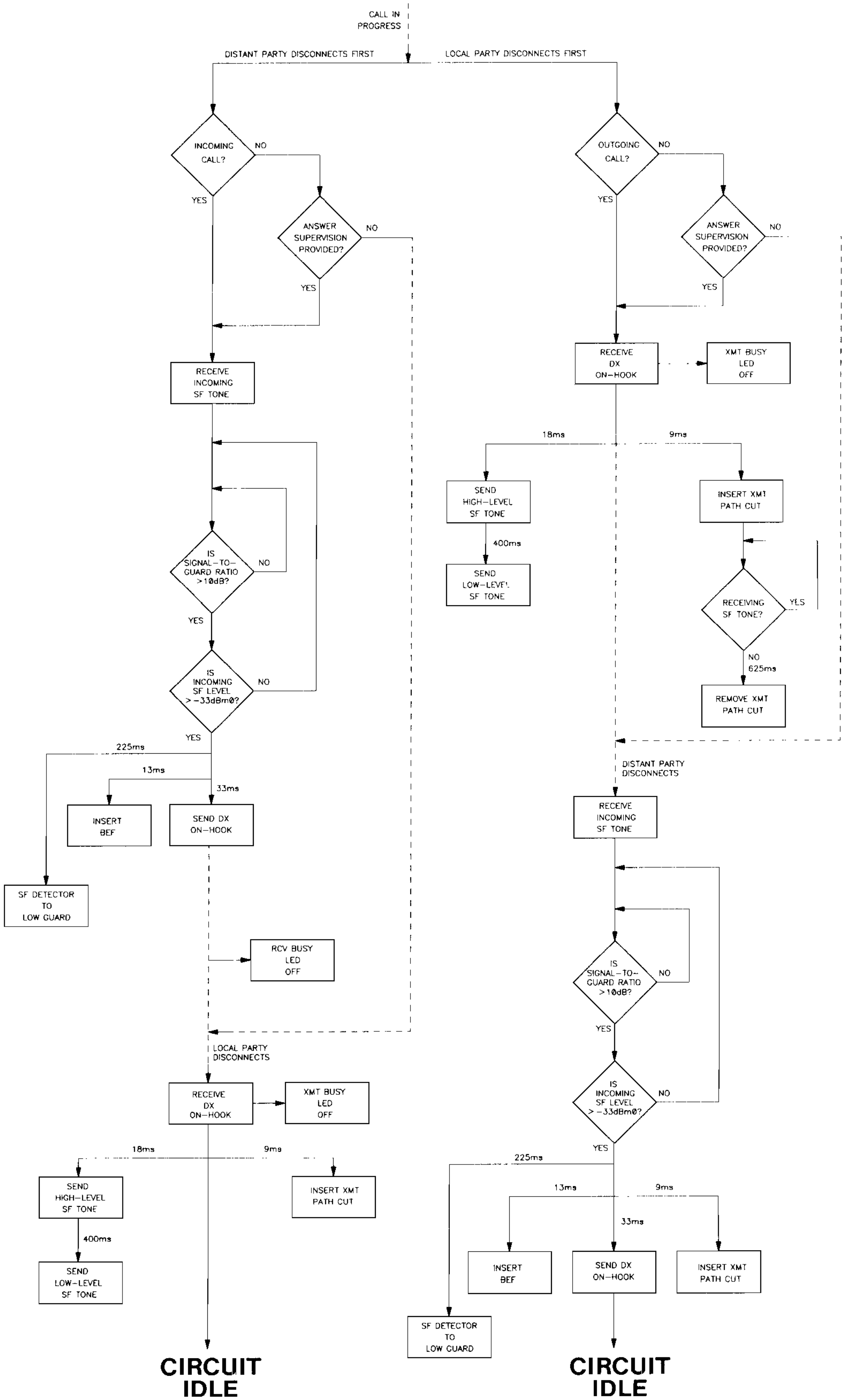
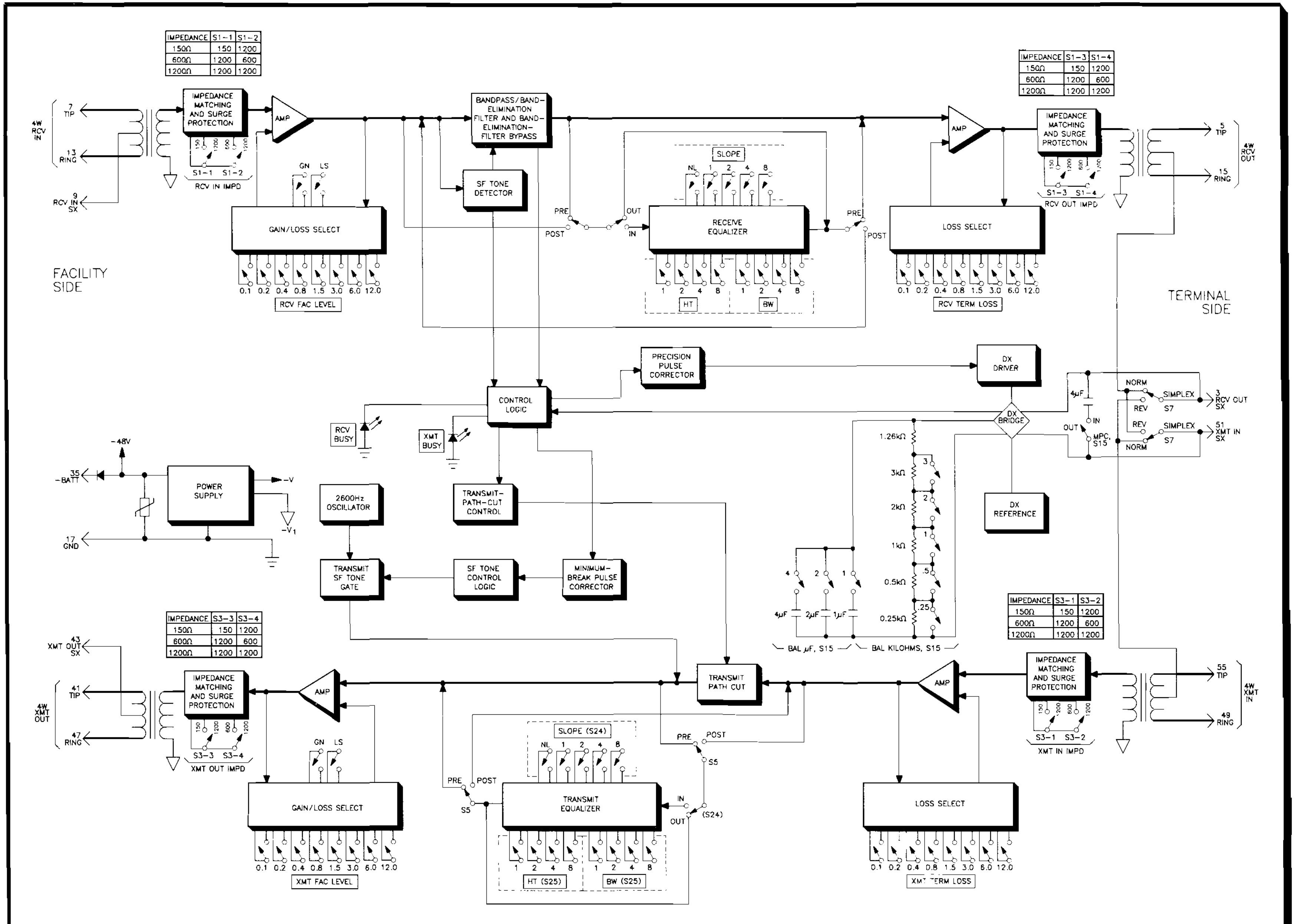


figure 11. Function sequence flowchart, disconnect for incoming and outgoing calls



6173 4Wire-to-4Wire SF-to-DX Intermediate Repeater **816173**

5. block diagram

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

frequency response, xmt and rcv channels, with no equalization and with receive-channel BEF removed
+0.0, −2.0dB at 200Hz, re 1004Hz
+0.3, −0.6dB, 300 to 3000Hz, re 1004Hz
+0.0, −1.3dB at 3400Hz, re 1004Hz

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

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

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

echo return loss, terminal and facility
greater than 23dB at all three impedance settings

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

crosstalk loss between xmt and rcv channels
75dB minimum, 200 to 3400Hz

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 (local call origination) and table 4 (distant call origination) in section 2 of this practice

pulsing characteristics
- **input breaks and makes shorter than the DX-port delay are not recognized**
- **input breaks of a duration between that of the DX-port delay and 50ms are transmitted as 50±2ms tone bursts**
- **input makes of a duration between that of the DX-port delay and 25ms are repeated as 25±2ms 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) 15±7ms before transmission of SF tone

transmit-path-cut removal
transmit speech path cut is removed 125±50ms after detection of an off-hook condition if SF tone is being received

SF receive section

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

SF tone rejection threshold
−37dBm0

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

incoming SF tone states
see table 3 (local call origination) and table 4 (distant call origination) in section 2 of this practice

maximum line noise
51dBrnCO

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 DX) for rates of 8 to 12 pulses per second
input break: 50% to 75%
output break: 58±4%

DX signaling

DX loop resistance
5000 ohms maximum

dial-pulsing rate
7.5 to 12.5pps

dial-pulse distortion
3 percent maximum

balance network
resistance: 0 to 6750 ohms in switch-selectable 250-ohm increments
capacitance: 0 to 7μF in switch-selectable 1μF increments

midpoint capacitance
0μF or 4μF, switch-selectable

common specifications

input power requirements
voltage: −42 to −54Vdc, filtered, positive-ground referenced
idle current: 80mA typical at −48Vdc
busy current: 100mA maximum at −54Vdc

dc earth potential difference
greater than ±45Vdc

ac induction
greater than 35Vrms

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
11.5 ounces (326 grams)

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

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 receive-channel transmission levels	1) Front-panel *rcv fac level* and/or *rcv term loss* DIP switches improperly set. 2) Main-board receive impedance DIP switch (*S1*) improperly set. 3) Front-panel receive post-/pre-equalization switch and/or receive 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 transmit-channel transmission levels	1) Front-panel *xmt fac level* and/or *xmt term loss* DIP switches improperly set. 2) Main-board transmit impedance DIP switch (*S3*) improperly set. 3) Main-board transmit post-/pre-equalization switch (*S5*) and/or transmit equalizer bypass switch (*IN/OUT* position of *S24*) improperly set. 4) Main-board transmit equalization DIP switches (*S24* [*SLOPE*] and *S25* [*HT* and *BW*]) improperly set. 5) Circuit not seized. 6) Test-equipment impedance improperly set or test equipment not terminated.
xmt busy or *rcv busy* LED on when circuit is idle or off when circuit is busy	1) Main-board normal/reversed SX-lead switch (*S7*) improperly set. 2) Inputs from near end or distant end not idle or busy at appropriate times. 3) Module's integral DX balance network improperly aligned. 4) Fault in cable.
improper dial pulsing	1) One or more option switches improperly set. 2) Module's integral DX balance network improperly aligned. 3) Improper supply voltage (should be between −42 and −54Vdc). 4) Excessive cable leakage. 5) Excessive longitudinal voltage on facility.