

J99395LA, LB, LC, AND PA SPECIAL ACCESS SIGNALING UNITS

DESCRIPTION

TYPE G SIGNALING SYSTEM

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1. GENERAL

1.01 This section describes the single-frequency (SF) G-signaling units which are a component part of the Type G Signaling System. These units are as listed:

- GLA, CLEI-SFXTA20, SD-7C058—Office End, Loop Control, 4W/2W, 900 Ohms
- GLB, CLEI-SFXTV20, SD-7C060—Office End, Loop Control, 4W/2W, 900 Ohms With Built-in Gain Transfer
- GLC, CLEI-SFXTC20, SD-7C068—Office End, Loop Control, 4W/2W, 1100 Ohms
- GPA, CLEI-SFXTA40, SD-7C059—Office End, 4-Wire Extension

1.02 This section is reissued to include the GLC unit and to remove the GSA, GSB, and GRA units. The GSA, GSB, and GRA units are being relocated in Section 179-407-101. Since this reissue is a general revision, no revision arrows have been used to denote significant changes.

1.03 Figure 1 is a line drawing illustrating the various details of the faceplates of the special access units. Figures 2 through 5 are illustrations showing the locations of the switches.

A. System and Unit Description

1.04 The G-signaling bay into which the GLA, GLB, GLC, and GPA units are inserted is described in Section 179-400-100. These units are placed into service by inserting the unit into the guides of the module shelf and sliding them toward the rear of the shelf. A locking device on the faceplate of the unit locks the SF unit in place when there is sufficient contact with the backplane, which is located at the rear of the shelf.

1.05 The components of the SF units, which are primarily hybrid integrated circuits (HIC), transformers, relays, and passive components, such as resistors and capacitors, are mounted on an epoxy coated metallic base printed wiring board. The slide switches, which are used to cut in the different option features and to cut resistors in and out of the circuit when the precision balance network (PBN) and the 4-wire equalizer are adjusted, are shown in Fig. 2 through 5. When the switches in the PBN circuit are operated (closed), the red numbers are exposed and, when nonoperated (open), the white numbers are exposed. The switches in the equalizer circuit are different. These switches have the numbers 1, 2, 4, and 8 stamped on them, plus the SL switch has an L and N for loaded and nonloaded cable. When the switches with numerals are operated (closed), the numeral is covered. When the numeral is exposed, the switch is nonoperated (open). The loaded and nonloaded switches are open when the N is exposed and closed when the L is exposed. When nonloaded cable is used, the switch must be open; therefore, the N will be showing. The printed wiring board is approximately 10.3 inches deep and 7.3 inches high. All interconnections between bay and SF unit are via 50 gold finger connections which are a part of the printed wiring board.

1.06 The transmission level of the transmit and receive circuit paths of the GLA, GLC, and GPA units is adjusted with variable pads that are located on the faceplate of the units (see Fig. 1). These pads permit the introduction of attenuation in the transmit and receive paths over a range of 0 to 16.5 dB in 0.1-dB steps. The GPA unit also has an equalizer circuit in the transmission path of the transmit converter circuit. The equalizer circuit has three sets of switches, bandwidth, height, and slope, which, when operated, control the gain of the equalizer circuit. The equalizer plus the 0- to 16.5-dB

attenuator, controls the output level of the transmit circuit. These switches are located on the printed wiring board. The operation of these switches will be discussed later in this section.

1.07 The GLB unit has gain transfer features which eliminate the need for pads in the transmit and receive paths. The GLB unit has gain control and slope control circuits in the transmit and receive paths which control the output levels. The output levels are controlled by adjusting a potentiometer and two attenuators in each transmission path. The potentiometers, which are located on the faceplate, have a range of 0 to 2 dB (see Fig. 1). The transmit and receive attenuators have a range of 0 to 10 dB and the slope control attenuators have a range of 0 to 7 dB. The transmit, receive, and slope control attenuators are located on the printed wiring board. The adjustment of these controls will be discussed later in this section. There are also four pin jacks on the faceplate which provide access to the LINE RCV and LINE TRMT ports. Many of the timing pulses and signal levels discussed in this section will not be accessible for making electrical measurements since the majority of the circuits are inside the HICs.

B. Application and Compatibility

1.08 The GLA, GLB, GLC, and GPA special access units provide the interface with a 4-wire transmission facility on one side and switching equipment on the other side. The GLC unit was specifically designed to provide an interface for voice and tone transmission from a Remote Switching System (RSS) office to an Electronic Switching System (ESS) via an analog carrier facility. A call setup and signaling between the ESS and RSS is controlled via an independent 2-way data link. A G-signaling unit, except for the GLC, is required at one end of the signaling link, and a compatible G, F auxiliary with FU () converter, or E unit at the other end. For signaling between the RSS and ESS offices, only one GLC unit is required, which is located at the ESS office. Table A lists each unit, function, application, and type E or F unit that it is capable of electronically replacing. Table B lists the units that are compatible with each other. The GLA, GLB, GLC, and GPA units are used at the central office end of a trunk.

1.09 The GLA, GLB, and GLC units are used for 900-ohm 2-wire applications. The GLA, GLB, and GLC units are suitable for a maximum external

conductor resistance of 1200 ohms. Where longer extensions are required, the 4-wire unit, GPA, is employed utilizing the built-in simplex A and B leads and equalizer circuit.

1.10 The GLA, GLB, and GPA units can be used in the loop-start (LS) or ground-start (GS) mode of operation while the GLC unit can only be used in the loop-start mode of operation. In the GLA and GLB units, the A and B leads are used in both LS and GS modes. The A and B leads are used for LS only in the GLC unit. In the GPA unit, the A and B leads are associated with the receive and transmit sides of the metallic extension facility. The A and B leads in the GPA can be reversed by operating a slide switch located on the printed wiring board. Selection of the LS or GS mode can be accomplished by operating the LS/GS switch (see Fig. 2 through 5) to the mode desired.

2. OPERATIONAL PRINCIPLES

2.01 The GLA, GLB, and GLC units are used at the office end of the trunk. These units are 900-ohm, 4-wire to 2-wire units. The GPA unit is also an office end unit and is 4-wire to 4-wire. Since the GLA, GLB, and GLC are 4-wire to 2-wire units, a hybrid transformer is used in the voice frequency terminating circuit. The GPA unit being a 4-wire to 4-wire unit uses two separate transformers which form a 4-wire extension circuit. The GL₋ and GPA units are divided into four functional sections (Fig. 6 through 9): (1) transmitter converter circuit, (2) receiver converter circuit, (3) signaling circuit, and (4) voice frequency terminating circuit (GL₋) or 4-wire extension circuit (GPA).

A. Transmitter Circuit

2.02 The transmitter portion of the G-signaling unit provides both speech and signaling transmission functions. The GLC unit does not transmit any signaling functions toward the Remote Switching System (RSS). Only voice is transmitted toward the RSS SF converter. The transmitter can be divided into four functional areas: (1) transmission path, (2) tone injection circuit (not used in GLC), (3) high level timing and control circuit, and (4) cut timing and control circuit. Since the transmission path of the GLA and GLC is different from the GLB and GPA units, the transmission paths will be discussed separately. The GLB unit has gain transfer features and the GPA unit has 4-wire equalization features in the transmission path.

GLA and GLC Units

2.03 The *transmission path* of the transmitter circuit of the GLA and GLC units consists of an input buffer amplifier, an output amplifier, and an output transformer. The transmission path provides a balanced 600-ohm output at the LINE TRMT port (T and R terminals), and has a fixed loss of 4.0 dB when the attenuators are set to zero.

GLB Unit

2.04 The *transmission path* of the GLB unit consists of an input buffer amplifier, a variable gain amplifier, slope control, an output amplifier, and output transformer. The variable gain amplifier has a 0- to 2-dB potentiometer located on the faceplate and a 0- to 10-dB attenuator located on the PWB. The potentiometer can be continuously adjusted and the attenuator can be adjusted in 1.0-dB steps. The transmission path has a fixed loss of 6 dB when the attenuators are set to zero. With a -10 to $+2$ dBm₀ signal from the office, the TRMT controls can be adjusted to maintain -16 dB TLP at the LINE TRMT carrier port. The value at which the TRMT controls are to be set is calculated by algebraically subtracting the signal level received from the office from -10 dB. Disregard the plus or minus sign in the value obtained and set the attenuator and potentiometer to agree with the numerical value. ***The attenuator and potentiometer must be set to zero when the precision balance network (PBN) is being adjusted per the adjustment procedure in Section 179-407-501 for unknown cable gauges.*** After the adjustment of the PBN is completed, reset the controls to the calculated value.

2.05 The slope control is used to compensate for frequency response of the cable which decreases as frequency increases. The slope control, *ST*, is a ten step 0- to 7-dB attenuator which is located on the PWB. Operation of the attenuator to one of the ten positions sets the slope function to provide gain increases with frequency of the values indicated by the attenuator setting between 1000 and 2800 Hz. The slope settings have been properly chosen to compensate for cable roll-off. When the slope of the cable is known, it is best to set the slope control for the lowest value of slope required. If the slope of the cable is not known, use the graphs for 2-wire equalizer settings in Section 179-407-502 to determine the slope control settings for nonloaded cable. If the cable gauge and

length are known, use the tables in Section 179-407-502. For loaded cable, slope 1 is normally used. The slope settings are essentially independent of the gain settings.

GPA Unit

2.06 The *transmission path* of the transmitter circuit for the GPA is identical to the GLA and GLC with the exception that the GPA unit has a 4-wire equalizer circuit. When the attenuator, slope, bandwidth, and height controls are all set to zero, the transmission path has a fixed loss of 0.5 dB. The 4-wire equalizer circuit is capable of reducing over 10 dB of 2800-Hz roll-off to -0.5 through $+2.25$ dB and reducing approximately 4 dB of 400-Hz slope to -0.5 through $+1.5$ dB. The binary weighted slope, bandwidth, and height switches (8, 4, 2, and 1) are closed for a functional value of 0 and open for a functional value of 15. The equalizer circuit is flexible enough to equalize 15 dB of loaded or nonloaded cable of any gauge. The 15-dB maximum cable length is compatible with the $+6$ dB TLP maximum and -9 dB TLP minimum 1-kHz transmission levels set to avoid crosstalk. The equalization of the GPA unit is such that either MFT or V4 equipment can be accommodated at the far end of the cable without restricting the range of the other equipment. The GPA unit provides only post equalization. In other words, the cable generated attenuation distortion will be corrected in the circuit receiving the distorted signal. When the cable makeup is known, set the loaded/nonloaded slope, bandwidth, and height switches per tables in Section 179-407-502. If the cable makeup is unknown, or consists of cable for which loss data cannot be readily calculated, calculate the switch settings per Section 179-407-501.

GLA, GLB, and GPA Units

2.07 The *tone injection circuit* applies a 2600-Hz tone from the tone generator circuit in the GYA unit to the transmission path. The tone injection circuit is controlled by the signal on the HL lead. The signal on the HL lead is generated by the HL logic circuit in the signaling circuit. The HL logic is activated by signals from the ground detector and ringing detector circuits (see Fig. 6, 7, and 9).

2.08 The *high level timing and control circuit* determines the level of the 2600-Hz tone. The HL timer circuit controls the level of the 2600-Hz tone to either -24 dBm or -36 dBm. The initial level

of tone to the line is at -24 dBm. If tone is present for more than 400 ms, the HL timer causes the level to be reduced to -36 dBm where it remains for the duration of the idle state. High level (-24 dBm) tone is transmitted initially so that the far end detector, which is in the narrowband state, can easily detect the presence of tone. The tone is reduced to the low level (-36 dBm) after 400 ms to minimize the probability of crosstalk in adjacent channels. After 400 ms of transmitted tone, the trunk is idle and the far end detector is in the broadband state. When the detector is in the broadband state, the low level tone is adequate to maintain tone detection.

GLA, GLB, GLC, and GPA Units

2.09 The *cut timer and control circuit* provides a cut in the transmission path to prevent the possibility of noise and/or voice from interfering with signal detection at the far end. This cut is controlled by the signals on the CT and HL leads. The signal on the CT lead is generated by the cut gate circuit in the signaling circuit. The signal on the CT lead is applied to one of the two inputs of an **OR** gate which controls the cut circuit of the transmission path. The signal on the HL lead is applied to the input of the HO timer. The output of the HO timer is applied to the other input of the **OR** gate which controls the cut of the transmission path. The signal on the CT lead provides a continuous cut during an idle condition. The output of the HO timer, which is controlled by the HL signal, provides a 120-ms holdover cut following an on- or off-hook transition.

B. Receiver Circuit

2.10 The receiver circuit provides a transmission path and detects the presence or absence of 2600-Hz supervisory and dial pulse signals. These signals are converted from 2600-Hz tone to a dc state which is applied to the associated timing and control circuits of the receiver circuit. The receiver circuit can be divided into four functional areas: (1) transmission path, (2) signal-guard detector circuit, (3) the guard timing and control circuit, and (4) band-elimination filter (BEF) timing and control circuit. Since the transmission path of the GLA, GLC, and GPA is different from the GLB, the GLB unit having gain transfer features, the transmission path will be discussed separately.

-3.5 Sig Req at PBX
 -5.6 Cable Loss
 $+2.1$ RCV Output Level Req

GLA, GLC, and GPA Units

2.11 The *transmission path* of the receiver circuit consists of an input transformer, an input and output amplifier for obtaining essentially zero gain, and a BEF. The BEF is inserted into or removed from the transmission paths with a bypass circuit. When 2600-Hz tone is applied to the input of the receiver circuit, the bypass circuit is biased to a cutoff condition inserting the BEF. When tone is removed, the bias no longer exists, and the bypass circuit removes the BEF. The transmission in the GLA and GLC units provides a balanced 600-ohm input at the LINE RCV (T1, R1) terminals, and a fixed loss of 4.0 dB when the attenuators are set to zero.

GLB Unit

2.12 The *transmission path* of the receiver circuit consists of an input transformer, an input and output amplifier, BEF, variable gain amplifier, slope control, and a test-operate circuit.

2.13 The BEF is inserted into and removed from the transmission path with a bypass circuit. When 2600-Hz tone is applied, the bypass circuit is biased to a cutoff condition inserting the BEF. When tone is removed, the bypass circuit removes the BEF.

2.14 The *variable gain amplifier* has a 0- to 2-dB potentiometer located on the faceplate (see Fig. 1) and a 0- to 10-dB attenuator located on the PWB (see Fig. 3). The potentiometer can be continuously adjusted and the attenuator can be adjusted in 1.0-dB steps. With a signal level of $+7$ dBm at the LINE RCV terminals, the output level being transmitted to the station, PBX, or CO can be varied over a range of -5 to $+7$ dBm by adjusting the RCV controls (potentiometer and attenuator). When the attenuators are set to zero, there is 0-dB fixed loss. The value at which the RCV controls are to be set is calculated by algebraically subtracting the cable loss from the signal level required at the station, PBX, or central office. This value will be the value required at the output of the receiver circuit. Algebraically subtract this value from the $+7$ dBm reference level at the output of the receiver circuit and set the RCV controls to this value. An example of this calculation is as follows:

$+7.0$ RCV Reference Level
 $+2.1$ RCV Output Required
 $+4.9$ RCV Control Setting

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Disregard the plus or minus sign in the value obtained for the RCV controls setting and set the attenuator and potentiometer to agree with the numerical value. Adjust the potentiometer for a value

between 0.6 dB and 1.5 dB of the value obtained and adjust the attenuator for the remainder of the value as shown in the following examples:

RCV OUTPUT LEVEL REQ	TOTAL RCV		
	CONTROL SETTING	POT.	ATTN
+1.1	5.9	0.9	5.0
+1.2	5.8	0.8	5.0
+1.3	5.7	0.7	5.0
+1.4	5.6	0.6	5.0
+1.5	5.5	1.5	4.0
+1.6	5.4	1.4	4.0
+1.7	5.3	1.3	4.0
+1.8	5.2	1.2	4.0
+1.9	5.1	1.1	4.0
+2.0	5.0	1.0	4.0

The signal level at the output of the receive circuit can be varied over a range of -5 to $+7$ dBm by varying the potentiometer and attenuator. **These controls must be set to zero when the PBN is being adjusted per the adjustment procedure in Section 179-407-501 for unknown cable gauges.** After the adjustment of the PBN is completed, reset the controls to the calculated value.

2.15 The *slope* function is achieved in the receiver circuit the same way as it was in the transmitter circuit. The slope control attenuator is located on the PWB and is designated as **SR**. The explanation of the slope control is the same as that in 2.05.

2.16 The *test-operate (T-0) circuit* is used to make loop gain measurements. The test-operate circuit is connected and disconnected to the voice transmission path with the T-O switch (Fig. 3) which is mounted on the printed wiring board. When the switch is operated to the T position, the light emitting diode (LED) on the faceplate (Fig. 1) lights. Also when the switch is operated to the T position, the LG and OSC jacks, which are located on the faceplate, are connected to the voice transmission path. Due to the 20-dB pads in the test circuit, when the signal applied to the OSC input is set at $+10$ dBm level, the signal that is actually applied to the loop will give a meter reading of 0 dBm at the LG jack representing a zero loss loop.

GL₋ and GPA Units

2.17 The *signal and guard detection circuit* monitors the transmission path of the receiver circuit and separates the voiceband into two frequency segments: (1) signal (2600-Hz) and (2) guard (voice). This is done by the signal and guard filter which has two filtration characteristics: a bandpass filter for the signal and a BEF for the guard. These filters are both tuned to a center frequency of 2600 Hz. The relative gains of both the signal and guard channels are adjusted during manufacture to provide a signal to guard ratio of approximately 10 dB. This essentially means that at the LINE RCV port the signal level must exceed the

guard level by 10 dB in order for tone to be detected. The signal to guard comparison technique aids in minimizing the possibility of 2600-Hz components of the voice frequencies, which are present during the talk period, from being detected as valid tone. Such an occurrence may result in a condition known as "*talk off*" (call termination). The detection and comparison of the signal and guard creates the E1 signal which essentially is an indication of the presence or absence of tone. The E1 signal is distributed to the associated circuits where timing, delay, and other functions are performed.

2.18 The *guard timer circuit* in the GL₋ and GPA units controls the insertion and removal of the guard amplifier causing the receiver to be placed in a broadband or narrowband mode of operation. Approximately 50 ms after the initial removal of tone from the line (seizure), the pulse corrector of the receiver signaling circuit places a low signal state on the GD lead causing the G timer to insert the guard amplifier into the signal-guard detector circuit. Insertion of the guard amplifier places the receiver in the narrowband mode. This reduces the possibility of a false disconnect during the talk period. When tone has been received for approximately 33 ms, the pulse corrector places a low signal state on the GD lead activating the G timer. After a 180-ms delay, the G timer removes the guard amplifier placing the receiver in the broadband mode. During the idle period (tone on), the broadband state minimizes the possibility of noisy conditions, such as deep carrier fades, from causing false seizure. Also, during a free call, tone is not removed toward the calling end. If the signal-guard detector circuit remained in the narrowband state, conversation and/or noise from the called end could override the detection of tone and initiate billing.

2.19 The *BEF timer* controls the insertion and removal of the BEF in the transmission path of the receiver circuit. When the signal on the E1 lead

indicates that tone has been removed from the line, the BEF timer delays this indication that tone has been removed for 300 ms before removing the BEF from the transmission path. This relatively slow removal of the BEF prevents a condition of fast in and out cycling of the BEF which may be detected by the customer during speech simulation of tone. When a high signal state on the E1 lead indicates that tone has been received, the BEF timer delays the indication of tone on by 12 ms and inserts the BEF into the transmission path. The fast insertion of the filter prevents the transmission of tone burst in excess of 14.5 ms beyond the signaling unit where the tone burst may interfere with subsequent signaling. The BEF is removed from the transmission path of the receiver circuit during the conversation period except in the case of the free call. For a free call condition, tone is not removed toward the calling end, so the BEF must remain inserted to eliminate the 2600-Hz signaling tone from the transmission path of the receive circuit.

C. Voice Frequency (VF) Terminating Circuit and 4-Wire Extension Circuit

GL_VF Terminating Circuit

2.20 The terminating circuit of the GLA unit is similar to the GLB with the exception that the GLB terminating circuit has a precision balance network (PBN) and the buildout capacitor (BOC) network can be switched from the network side of the hybrid to the line side of the hybrid. The terminating circuit in the GLC unit does not have the NBOC. The terminating circuit provides conversion from 2-wire (900 ohms) to 4-wire (600 ohms) operation by means of a hybrid transformer. The hybrid provides approximately 4 dB of loss from the 4-wire to the 2-wire ports. The terminating circuit in the GLA and GLC units also contains four attenuators which are located in the 4-wire port of the hybrid. These attenuators provide up to 16.5 dB of loss in the transmit and receive paths plus the 4-dB loss in the hybrid. The attenuator allows for the audio level at the carrier side to be adjusted to -16 dB TLP and the signal level at the equipment side to be varied over a range of +3 to -13.5 dBm. The GLB unit does not require attenuators in the terminating circuit since these units have variable gain amplifiers in the transmission paths which are continuously adjustable over a 12-dB range. The BOC has an adjustment range of 0 through 0.126 μ fd in 0.002- μ fd steps. In the GLB unit, when the BOC is to be used on the network side or line

side of the hybrid, switch S2 must be operated to the NLC position for the NBOC function and to the LC position for the LBOC function. Switch S4 must be operated to the COMP position, which also cuts in the compromise network, to use the NBOC function. In the GLA unit, the NBOC is always on the network side of the hybrid. When the NBOC is used on the network side of the hybrid, it permits balancing against office cabling. The capacitance value to be set in the NBOC network when used on the network side is $C = (N/127) (0.002 \mu\text{fd})$, where N = number of feet in office cable. When it is used on the line side of the hybrid (GLB), it permits the near end of the cable to be built out to 6000 feet. To calculate the capacitance value to build out the near end of the cable to 6000 feet, use the formula $C = (6-N)(0.016 \mu\text{fd})$, where N equals the near end section of cable in thousands of feet. The capacitance value arrived at in the LBOC and NBOC formulas is in microfarads. The capacitance values stamped beside of the LBOC and NBOC switches are shown in nanofarads. When a capacitance value is arrived at with either formula, operate the switches to the closed position that will add up to the calculated value. The BOC can only be used on the line side when the PBN is used. In the GLA unit, operate the six segments of switch S1 to vary the capacitance and in the GLB unit, operate the six segments of switch S3. When the white numerals are exposed on switches S1 and S3, the switches are open; and when the red numerals are exposed, the switches are closed.

2.21 The PBN is used only in the GLB unit. The PBN is a combination of two active networks, one for loaded cable and the other for nonloaded cable. The networks are selected by operating NLC-LC switch S2 to LC for loaded cable and NLC for nonloaded cable. Figures 10 and 11 are simplified schematics and graphs which show the effect of the M (S5-1), R1 (S5-456), R2 (POT), R (S5-789), and Z (S5-23 and POT) switches and pots on the impedance of loaded and nonloaded cables.

2.22 The impedance of the PBN is controlled by R2 and Z potentiometers and a nine element switch, S5 (Fig. 3). When the GLB unit is connected to a loaded cable, the M, R, and Z switches plus the Z potentiometer control the impedance. As can be seen in Fig. 10, the Z controls increase and decrease the magnitude of the cable impedance over the frequency band, while the R switches increase and decrease the impedance over the low frequency band. When 25-gauge MAT cable is used, the M control in-

creases the high end roll-off to about 3.6 kHz. The R1 and Z switches plus the R2 and Z potentiometers control the impedance of nonloaded cable. As can be seen in Fig. 11, the Z control increases and decreases the magnitude of the cable impedance over the frequency band, while the R2 control changes the slope of the cable impedance at the higher frequencies. The R1 switches increase and decrease the impedance at the low frequencies.

2.23 When the type, gauge, and length of cable in the loop are determined from records, switch S5 and potentiometers R2 and Z must be set as prescribed in prescription tables in Section 179-407-502. The switch and potentiometer settings must be made prior to plugging the units into the module. If, during the installation test, the units do not meet the requirements of the transmission facility or the cable makeup is unknown, the units must be plugged into a GTA test extender (SD-7C080-01, 02) and adjustments made per Section 179-407-501.

GPA 4-Wire Extension Circuit

2.24 The 4-wire extension circuit is used in the GPA unit and consists of two transformers, four attenuators, 4-wire equalizer circuit, and four switches. The GPA unit has a fifth switch which is used for the make-busy function of the sleeve leads when the MB relay operates. These switches are physically located on the PWB and are designated HMLO, REV, SX/AB, and AB/MB. The two HMLO switches allow for the selection of three taps on each transformer for the purpose of equalization of long and short lengths of nonloaded cable and H88 loaded cable (see Table C). The 1200-ohm tap (H) is for H88 loaded cable, the 600-ohm tap (M) is preferred for nonloaded cable, and the 150-ohm tap (L) is for long length of nonloaded cable. The tap selection of the HMLO switch (receiving) along with the switch settings of the 4-wire equalizer, as prescribed in Section 179-407-502, provide the necessary equalization to obtain the proper frequency response. Post equalization is required at the station end of the circuit. The REV switch reverses the orientation of the A and B leads. The SX/AB switch connects the A and B leads to either the simplex lead of the transformer or to the S and S2 leads. In the GPA unit, when the SX/AB switch is in the AB position, the AB/MB switch must be in the AB position. The AB/MB switch connects the S and S2 leads to either the A and B leads or to a set of make-busy relay contacts.

D. Signaling Circuit

GL₋ and GPA Units

2.25 The signaling circuit in the GL₋ units is similar to the GPA unit. The signaling circuit can be divided into four major circuits: (1) loop closure detector, (2) ringing detector, (3) ground detector, and (4) logic and pulse corrector.

2.26 Loop Closure Detector: The loop closure detector circuit is activated when the loop current reaches approximately 11.66 ma dc. Since the minimum expected loop current is 16 ma dc, loop closure is detected in approximately 16 ms. This is the total delay time through the delay timer. For larger loop currents, detection time is decreased to approximately 10 ms. Loop open is detected in approximately 88 ms. When the external loop resistance drops to less than 500 ohms, the buildout resistors (BOR) are inserted into the line by the BOR relays. If the BORs are not inserted, the energy of the step-by-step selector "A" relays is high enough that the oscillatory loop current during dial pulsing could cause the "A" relay to split the dial pulses. The detection time for the BOR insertion circuit depends on the magnitude of the loop current. The detection time ranges from 16 ms for 45 ma dc to 4 ms for 100 ma. The buildout resistors are removed in 210 ms regardless of the current level in order to block false operation during dial pulsing and wink signaling.

2.27 Ringing Detector: The ringing detector incorporates an optical isolator to detect ringing. The ringing detector is insensitive to tip and ring reversal which probably will occur during loop-start operation. Also, either voltage polarity may be used with the ringing generator in the central office. The sensitivity of the ringing detector is reduced so that low level voice frequency simulation of 20 Hz will not operate the detector. The ringing detector has a delay timer which is activated when a ringing signal is detected. The delay timer, when activated, generates three output signals which are ring cut (RNG CT), loop-start ring (LS RNG), and input to the 20 pulse per second oscillator which produces the ground-start ring (GS RNG). The RNG CT signal is applied to the cut gate and the GS RNG and LS RNG signals are applied to the HL logic circuit. The LS RNG signal is derived from the envelope of the 2-second ring signal. The GS RNG is generated by the 20-pps oscillator and is a 20-Hz signal. In ground-start mode, any ringing signal between 17 and 35 Hz that is detected

is converted into 20-Hz ringing signal. The ringing detector makes the unit immune to longitudinal signals of 25-Hz, 60-Hz, and lightning pulses. The 25-Hz signal is generated by electric railroad trains and the 60-Hz signal is generated by power lines.

2.28 Ground Detector: The ground detector circuit is more sensitive to the electrical environment of the line than the other circuits in the signaling section. The ground detector must detect a ground condition when the resistance to ground is equal to or less than approximately 800 ohms. In the loop-start operation, the S relay, which is part of the ground detector circuit, is released causing the ground detector to be disconnected from the line. Release of the S relay also causes the tip to be grounded. In the ground-start operation the ground detector is connected to the tip through the S relay contact. The threshold of detection for the ground detector is set between 10,000 ohms for no detection and 800 ohms for guaranteed detection. Tip ground is detected in approximately 110 ms and removal of tip ground is detected in approximately 210 ms. The delay timer guards the ground detector from falsely responding to 25-Hz longitudinal signals. The output signals of the ground detector are applied to the HL logic circuit.

2.29 Logic and Pulse Corrector: The logic and pulse corrector circuit which interfaces the receiver and transmitter converter circuits with the signaling circuits can be divided into six sections. These sections are: pulse corrector, carrier group alarm/make-busy, HL logic, cut gate, S logic, and H-R-D logic.

2.30 The pulse corrector circuit is interfaced with 2600-Hz supervision. When the E-1 lead switches to the tone on (idle state), the GD output from the pulse corrector activates the G timer in the receiver converter. After 250 ms, the GX output from the G timer responds and switches the pulse corrector to supervisory (tone gap bridging state). When the E-1 lead switches to the tone off (busy state), the GD output switches the G timer. After 55 ms the GX output from the G timer switches the pulse corrector to the dial pulse correcting state. Dial pulses of 7.5 to 12.5 pulses per second (pps) are corrected to a constant 56 percent break output. The CT-R output of the pulse corrector furnishes cut signals for the envelope duration of each dial pulse numeral and for the voice path while 2600 Hz is being transmitted. The CT-R signal also forces a continuous loop closure during dial pulsing.

2.31 The inputs to the carrier group alarm/make-busy circuit provide for trunk release (ALM), make-busy (ALB) two seconds after alarm, and alarm ring ground (ALMRG) where the ring lead is grounded for the duration of the alarm. The ALM-ALB leads are interlocked inside the CGA circuitry so that the ALB function will not occur until ALM has occurred. These leads are also interlocked outside the CGA circuitry so that the MB relay will not operate until the ALM has occurred. The ALM-ALO options provide for continuous alarm or for an alarm override option.

2.32 The HL logic circuit output signal controls the level of the 2600-Hz tone from the transmitter circuit. The HL logic circuit is controlled by input signals from the ringing detector and ground detector circuits. The output from the ringing detector (RNG OUT) will not control the tone level until a tip ground condition is detected by the ground detector circuit.

2.33 The cut gate circuit provides voice path cut in the transmitter circuit any time 2600-Hz tone is to be transmitted. In order to remove the cut, the following conditions must exist: tip ground must be detected, ringing must not be present, no dial pulses should be present, and the distant end must be off-hook, removing cross cut control.

2.34 The S logic circuit responds to loop closure. Dial pulses have no effect on the S logic circuit until loop closure occurs. After loop closure occurs, the dial pulse input to the S logic maintains loop closure as the R relay breaks the loop during dial pulsing.

2.35 The H-R-D logic circuit is used to prevent simultaneous seizure from both ends of the trunk during ground-start operation. During the idle ground-start state, the D/R-1 relay is operated closing the ring circuit and the D/R-2 relay is released which removes the ring ground. When the CO seizes the trunk first, tip ground is detected and the D function of the logic circuit is disabled. This condition blocks the response of the logic circuit to the R relay. The D function is not reset until both ends of the trunk go on-hook. When the PBX seizes the trunk, the R relay operates and the D/R-1 relay releases and the D/R-2 relay operates. Operation of the D/R-2 relay applies ring ground to the CO. When the CO answers, the tip is grounded. The tip ground is detected (H function) and the D function is removed. With tip ground detected, the D/R-1 relay operates and D/R-2

relay releases which in turn closes the loop and removes the ring ground.

3. SIGNALING OPERATION

3.01 The following figures and table are provided to accompany the description of the signaling operation of the special access signaling units.

- (1) Table D lists conditions of the A and B leads and the application of the 2600-Hz tone under various circuit conditions.
- (2) Figures 6 through 9 show simplified schematics of the GL₁ and GPA units.

GLA, GLB, GLC, AND GPA UNITS

3.02 The GLA, GLB, and GPA units are capable of operating in either the loop-start or ground-start mode of operation. The GLC unit is capable of operating in the loop-start mode only. The LS/GS switch must be operated to the desired mode of operation. When the GL₁ and GPA are in the loop-start mode, tone is received but no tone is transmitted. When the GLA, GLB, and GPA units are operated in the ground-start mode, tone is transmitted and received.

Loop-Start Operation

3.03 Station Originated Calls: When the station end goes off-hook, 2600-Hz tone is removed from the line. Upon removal of tone, the receiver converter circuit in the GLA, GLB, or GPA unit conditions the logic and pulse corrector circuit to operate the R relay. Operation of the R relay closes the loop toward the central office equipment. When the office equipment is ready to receive dial pulses, dial tone is applied to the line and transmitted to the station end. The station can now proceed to dial. The station end unit transmits the dial pulses in the form of tone pulses. The receiver converter circuit of the GL₁ or GPA unit receives the tone pulses and injects them into the pulse corrector circuit in the form of dc pulses. The pulse corrector circuit provides a constant 56 percent break output through the contacts of the R relay. Operation of the R relay at the dial pulse rate opens and closes the loop circuit which pulses the switching equipment.

3.04 Central Office Originated Calls: When the central office originates a call, the GLA,

GLB, or GPA unit is seized by the application of a tip ground on the A lead and a ringing signal on the ring conductor (B lead). The ringing is detected by the ringing detector circuit. The output of the ringing detector conditions the HL logic circuit. The HL output conditions the transmitter converter circuit, causing a burst of 2600-Hz tone to be transmitted from the GLA, GLB, or GPA unit toward the station end. The tone burst lasts for the duration of the 2-second ringing envelope. The 2600-Hz tone generator is disconnected from the GLC unit; thereby eliminating any transmission of tone from the GLC unit. The HL output also causes a cut to be inserted in the transmission path of the transmitter converter circuit. When the station end answers, the tone being transmitted by the station end is removed. The receiver converter circuit in the GL₁ or GPA unit detects the removal of tone and conditions the logic circuit, causing the R relay to operate. Operation of the R relay closes the loop. The central office ringing is tripped and the cut in the transmission voice path is removed. Removal of the voice path cut is delayed 125 ms.

3.05 In the loop-start mode, disconnect is recognized only if it occurs at the station end. When the station end disconnects, SF tone is received and the loop is opened toward the central office equipment.

Ground-Start Operation

3.06 PBX Originated Calls: When the PBX seizes the line first, ground is applied to the ring lead toward the central office and the 2600-Hz tone is removed. The removal of tone is detected by the receiver converter circuit of the GLA, GLB, or GPA unit. The output of the converter circuit conditions the logic and pulse corrector circuit causing the R and D/R-2 relays to operate and the D/R-1 relay to release. With the D/R-1 relay released, the loop is still open even though the R relay is operated. With the D/R-2 relay operated, the ring ground is passed on to the central office line circuit. The central office equipment responds to the ring ground by sending a tip ground back to the GLA, GLB, or GPA unit. The ground detector in the GLA, GLB, or GPA unit detects the tip ground. The output of the ground detector conditions the logic and pulse corrector circuit causing the D/R-1 relay to operate and the D/R-2 relay to release. With D/R-1 relay operated, the loop is closed causing the loop closure detector circuit to be activated. The output of the loop closure detector

operates the S relay which removes the ground detector from the line forcing a ground detection. The output from the ground detector circuit conditions the HL logic circuit which causes the transmitter converter circuit in the GLA, GLB, or GPA unit to remove the 2600-Hz tone being transmitted toward the PBX. No tone means tip ground to the PBX end which is passed on to the PBX trunk circuit. The PBX switches to loop conditions causing the removal of the cut in the voice path of the transmitter converter circuit. The circuit is now ready to transmit address information from the PBX to the central office. Dial pulsing is performed the same as it was in loop-start (3.03).

3.07 Central Office Originated Call: When the central office seizes the line first, the tip (A lead) is grounded and ringing is applied. These two events happen simultaneously. Grounding of the tip lead is detected in 110 ms by the ground detector circuit. The ground detector output conditions the HL logic which causes the transmitter converter circuit to remove the 2600-Hz supervisory tone to the station end. Detection of the ringing signal by the ringing detector is delayed 225 ms which allows time for the PBX to detect the seizure. The 20-pulse-per-second (pps) oscillator output from the ringing detector circuit conditions the HL logic circuit. The output from the HL logic causes the transmitter converter circuit in the GLA, GLB, or GPA unit to transmit 2600-Hz tone at a 20-pps rate toward the PBX as a ringing signal. When the unit recognizes the tip ground, the cut in the voice path is removed which allows the ringing signal to pass through the PBX circuits. When the PBX answers, loop condition is established and loop closure is returned to the GLA, GLB, or GPA unit at the CO end. The loop closure from the PBX conditions the signaling circuit (turns off the tone) which causes the R relay to operate. Operation of the R relay establishes a loop closure to the CO causing ringing to be tripped.

3.08 When the units are operated in the ground-start mode, disconnect signals are recognized at either the station or central office end. If the disconnect originates at the station, the transmitter converter circuit in the GS_ or GRA unit is conditioned to transmit 2600-Hz tone to the central office end. The receiver converter circuit of the GLA, GLB, or GPA unit detects the tone which causes the R relay to release. Releasing of the R relay establishes an open loop which indicates a disconnect to the central office. The central office responds to the open loop by

removing ground from the tip (A lead). Removal of tip ground conditions the transmitter converter circuit in the GLA, GLB, or GPA unit to transmit tone to the station or PBX end. If the disconnect originates at the central office, the ground is removed from the tip lead (A lead) causing the signaling circuit to be activated. The HL output from the signaling circuit in the GLA, GLB, or GPA unit conditions the transmitter converter circuit to transmit 2600-Hz tone to the station or PBX end. When the disconnect signal is returned from the station or PBX, 2600-Hz tone is received by the receiver converter circuit. Detection of the 2600-Hz tone conditions the signaling circuit causing the R relay to operate which establishes the idle condition.

4. CARRIER GROUP ALARM (CGA)

4.01 The GL_ and GPA units are provided with CGA control features. The CGA circuit of these units is placed into service by operating slide switches which are located on the printed wiring board.

GL_ AND GPA UNITS

4.02 The CGA circuit in the GL_ and GPA units has four switches; alarm-alarm override (ALM-ALO), alarm make-busy (ALB), alarm ring ground (ALMRG), and make busy ground option (MBGO). The ALM-ALO switch provides continuous alarm (trunk release) when in the ALM position, and alarm override when in the ALO position. The ALB switch provides a trunk make busy 2-1/2 seconds after an alarm. When the ALMRG switch is in the ARG position, a 400-ohm ring ground is provided toward the central office for the duration of the alarm. The MBGO switch provides a local ground on the S lead when in the MBG position. The ALM and ALB inputs are interlocked in the pulse corrector circuit so that alarm make busy will not occur until alarm has occurred. The two inputs are also interlocked to prevent the operation of the MB relay until alarm has occurred. The MB relay provides a closure between the S and S2 leads for the duration of the alarm.

5. TRANSMISSION CIRCUITS

GL_ UNIT

5.01 The GL_ unit allows conversion from 2-wire 900-ohm operation to 4 wire 600 ohms. The

conversion is obtained by a 2-transformer hybrid terminating circuit. The build-out capacitor (BOC) circuit associated with the terminating circuit in the GLA and GLB units can be varied from 0.0 to 0.126 μfd in 0.002 μfd steps. The BOC can be connected through the LC/NLC switch to either the network side or line side of the hybrid transformer in the GLB unit. In the GLA unit it is always on the network side of the hybrid transformer. The GLC unit does not have a BOC network. When the BOC is connected to the network side of the hybrid transformer, it permits balancing against office cabling. When the BOC is used on the line side of the hybrid, it permits the near end cable to be built out to 6000 feet. The GLA and GLB units have a compromise network (COMP NET) of 900 ohms plus 2.15 μfd , whereas the COMP NET in the GLC unit consists of an 1100-ohm resistor in parallel to a 100-ohm resistor plus a 0.0301 μfd capacitor. The COMP NET can be cut in and out of the circuit in the GLB unit. When the GLB unit has the precision balance network cut in, the COMP NET is cut out with a switch.

GPA UNIT

5.02 The GPA unit incorporates a 4-wire extension circuit for use with 4-wire cable extensions. This circuit allows impedance matching and frequency equalization. Impedance matching is obtained by taps on the transformers in the transmit and receive paths. These taps are designated as H, M, and L and are selected by operating two slide switches. These taps have ohmic values of H=1200, M=600, and L=150. Equalization is obtained by operating the loaded/nonloaded (L/NL), bandwidth (BW), height (HT), and slope (SL) switches of the 4-wire equalizer circuit. These switches are located on the printed wiring board. The transformers also have center taps on the cable side which can be selected by operating the SX/AB switch to the AB position when simplex features are desired.

6. PULSING CHARACTERISTICS

RECEIVING FOR GL_ AND GPA UNITS

6.01 The GL_ and GPA units receive dial pulses in the range of 7.5 to 12.5 pps. The output of the receiver circuit is a constant 56 percent break. This is independent of the input percent break within the range from 29 to 90 percent break at 7.5 pps to 48 to 85 percent break at 12.5 pps.

7. TRANSMISSION CHARACTERISTICS FOR GL_ AND GPA UNITS

7.01 The transmitter circuit of the GLB and GPA units contains equalizer circuits. The equalizer circuits in the GLB are 2-wire pre and post equalizers whereas the GPA has 4-wire post equalizers. The adjustment settings of these equalizer circuits are found in the prescription tables and graphs in Section 179-407-502 when the cable gauge is known. When the cable gauge is unknown, the equalizers will be adjusted per Section 179-407-501.

A. 2-Wire Operation

GLA and GLC Units

7.02 The line transmit and line receive ports of the GLA and GLC units are 600 ohms and interface with the analog carrier. The LINE RCV port is +7 dB TLP and the LINE TRMT port is -16 dB TLP.

7.03 The receive circuit provides a +3 dBm0 reference level to the tip and ring at the switching equipment side for the GLA and GLC units. The attenuators in the circuit are capable of varying this level to -13.5 dBm0. The losses of the receive circuit with and without the band-elimination in the circuit can be seen in Fig. 12 and 13.

7.04 The transmit circuit provides a -9 dBm0 reference level to the switching equipment side for the GLA and GLC units. The -9 dBm0 gives a -16 dB TLP at the LINE TRMT port. The attenuators in the transmit circuit are capable of maintaining the -16 dB TLP at the LINE TRMT port when the level on the tip and ring is varied up to +4.5 dBm0. The losses of the transmit circuit can be seen in Fig. 13.

GLB Unit

7.05 The transmit and receive circuit of the GLB unit is different from the GLA and GLC units in that the GLB unit has 2-wire equalizer circuits (slope control) and has 12-dB attenuator circuits instead of the 16.5 dB. The LINE TRMT port and LINE RCV port interface with the analog carrier. The LINE RCV port is at +7 dB TLP and the LINE TRMT port is -16 dB TLP.

7.06 The receive circuit provides a +6 dBm0 reference level to the tip and ring at the switching equipment side of the GLB unit. In order for the +6

dBm0 to exist, the 10-dB attenuator on the printed wiring board (PWB) must be set to zero, and the 2-dB attenuator on the faceplate set for 1.0 dB. The reference level can be varied over a range of -5 to +7 dBm0 by operating the two attenuators. The slope control will increase the level at 2800 Hz as much as 7 dB with very little change at 1 kHz. The losses of the receive circuit with and without the band-elimination filter can be seen in Fig. 14 and 15.

7.07 The transmit circuit provides a -9 dBm0 reference level to the switching equipment side of the GLB unit. The -9 dBm0 reference level gives a -16 dBm0 to the LINE TRMT port. In order for the -9 dBm0 to exist, the 10-dB attenuator on the PWB must be set for zero, and the 2-dB attenuator on the faceplate set for 1 dB. The 12-dB attenuator is capable of maintaining the -16 dBm0 level at the LINE TRMT port when the signal on the tip and ring at the drop side or switching equipment side is varied over a range of -10 to +2 dBm0. The slope control allows these levels to be increased by 7 dB in magnitude at 2800 Hz with very little change at 1 kHz. The losses of the transmit circuit can be seen in Fig. 15. The high loss between 2200 and 2800 Hz, as shown in Fig. 12 and 14, is due to the presence of the band-elimination filter.

B. 4-Wire Operation

GPA Unit

7.08 The transmit and receive circuits of the GPA unit are 600 ohm and interface with the analog carrier. The LINE RCV port is +7 dB TLP and the LINE TRMT port is -16 dB TLP.

7.09 The receive circuit provides a +6.5 dBm0 reference level to the T1 and R1 leads at the switching equipment side of the GPA unit. The attenuators in the receive circuit are capable of varying the +6.5 dBm0 to a level of -10 dBm0. The losses of the receive circuit with and without the band-elimination filter can be seen in Fig. 16 and 17.

7.10 The transmit circuit provides a -15.5 dBm0 reference level to the T and R leads at the

switching equipment side of the GPA unit. The -15.5 dBm0 gives a -16 dBm0 at the LINE TRMT port when the attenuators are set to zero, the SL, HT, and BW slide switches are closed, and the L/N switch is set to the L position. The attenuators in the transmit circuit are capable of holding the LINE TRMT port at -16 dBm0 for variations on the T and R up to +1 dBm0. The losses of the transmit circuit can be seen in Fig. 17.

7.11 Impedance values suitable for terminating line facilities are selected by operating slide switches located on the PWB. These switches are designated HMLO and provide 1200-ohm, 600-ohm, 150-ohm, and open terminations. The 1200-ohm setting (H) is for H88 loaded cable, the 600-ohm setting (M) is preferred for short lengths (Table C) nonloaded cable, and the 150-ohm setting (L) is for long lengths nonloaded cable with V4 equipment at the other end.

8. MAINTENANCE

8.01 The GLA and GLC units require adjustments to the attenuators, NBOC for the GLA only, and CGA switches. The GLB unit requires the same adjustments as the GLA and GLC units plus adjustments to the precision balancing network and the slope control. The GPA unit requires prescription adjustments to the attenuators and 4-wire equalizer circuit. Any G-signaling unit not meeting circuit requirements should be returned to Western Electric Company for repairs. Defective units should be replaced with spare units.

8.02 The type G test extender SD-7C080-01, 02 is designed to provide access to the transmission and signaling ports. Use of the test extender necessitates the removal of the G-signaling unit from the bay.

8.03 Description and adjustment practices on other components within the type G signaling system can be found under individual component headings in the BSP index Section 179-000-000.

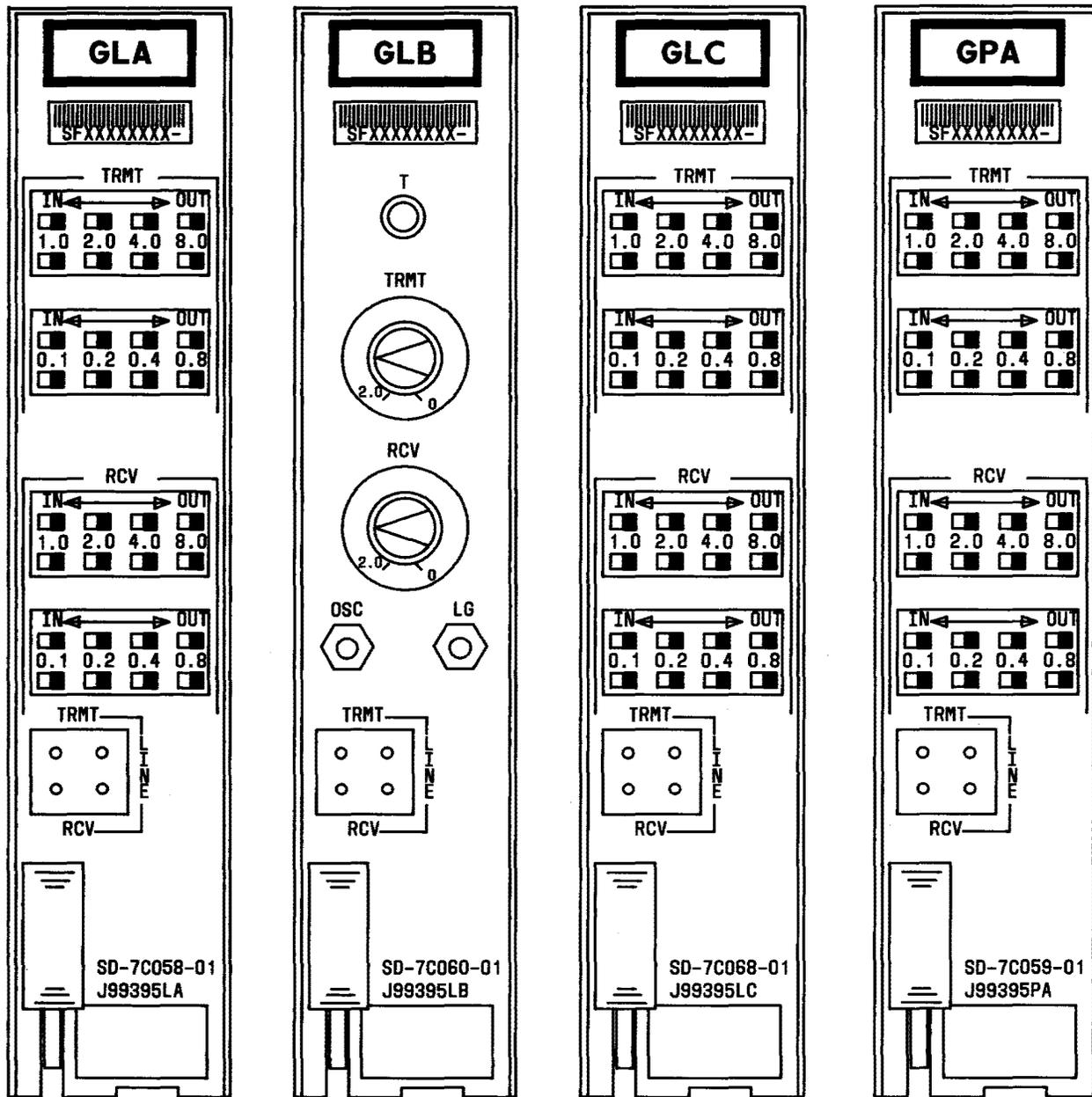


Fig. 1—GLA, GLB, GLC, and GPA Faceplates

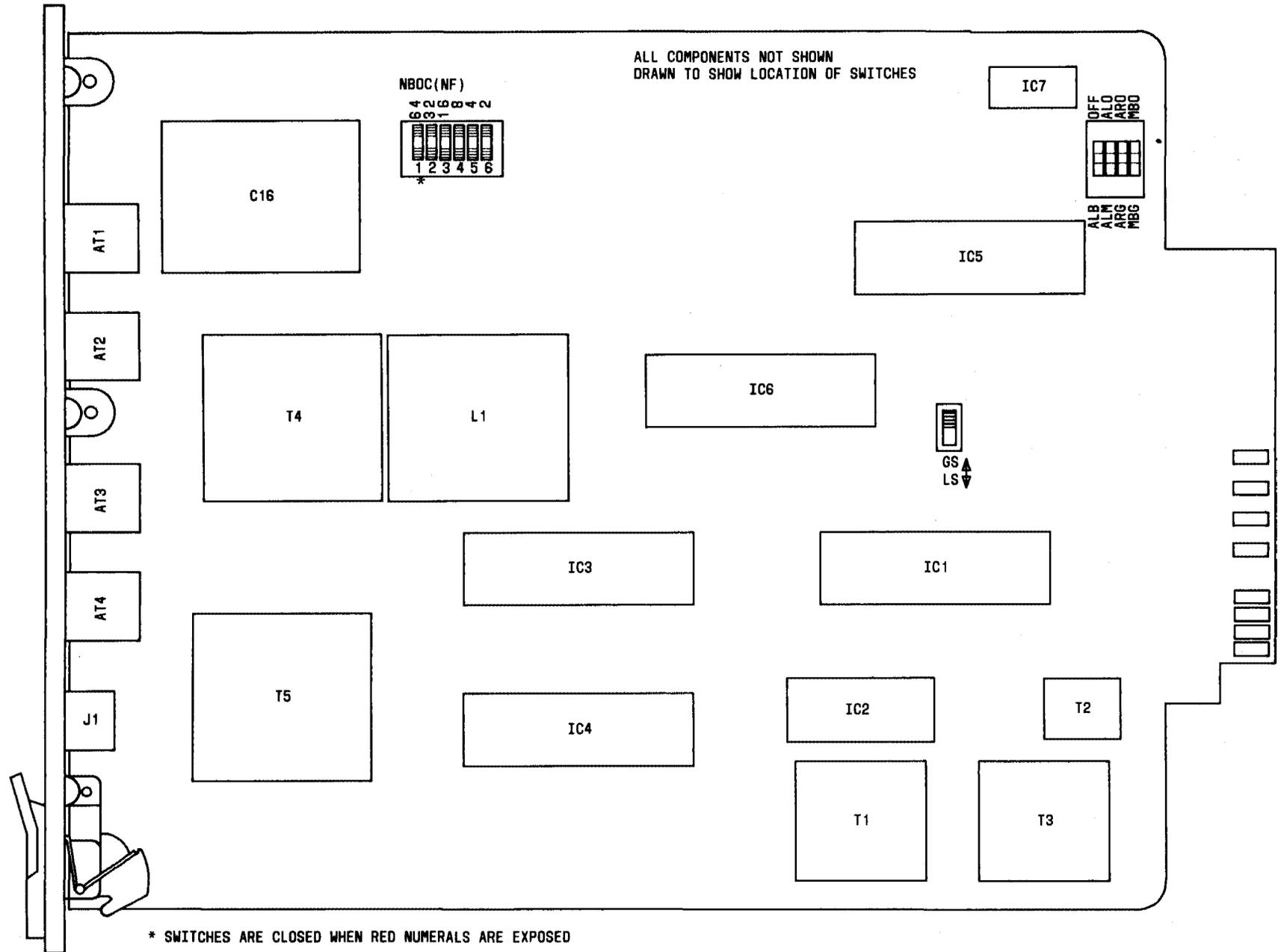
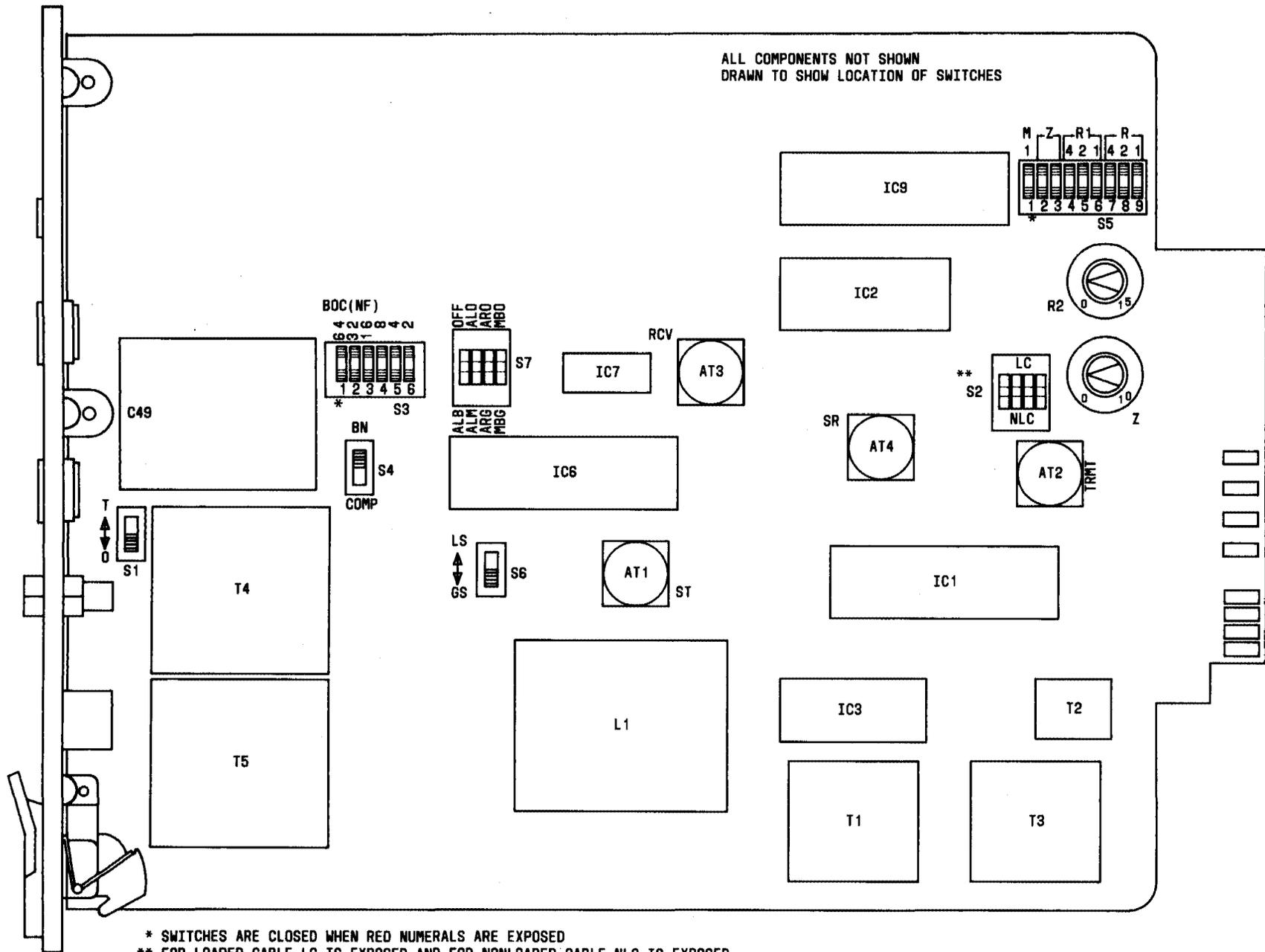


Fig. 2—Illustration of GLA Unit Showing Location of Switches



* SWITCHES ARE CLOSED WHEN RED NUMERALS ARE EXPOSED
 ** FOR LOADED CABLE LC IS EXPOSED AND FOR NONLOADED CABLE NLC IS EXPOSED

Fig. 3—Illustration of GLB Unit Showing Location of Switches

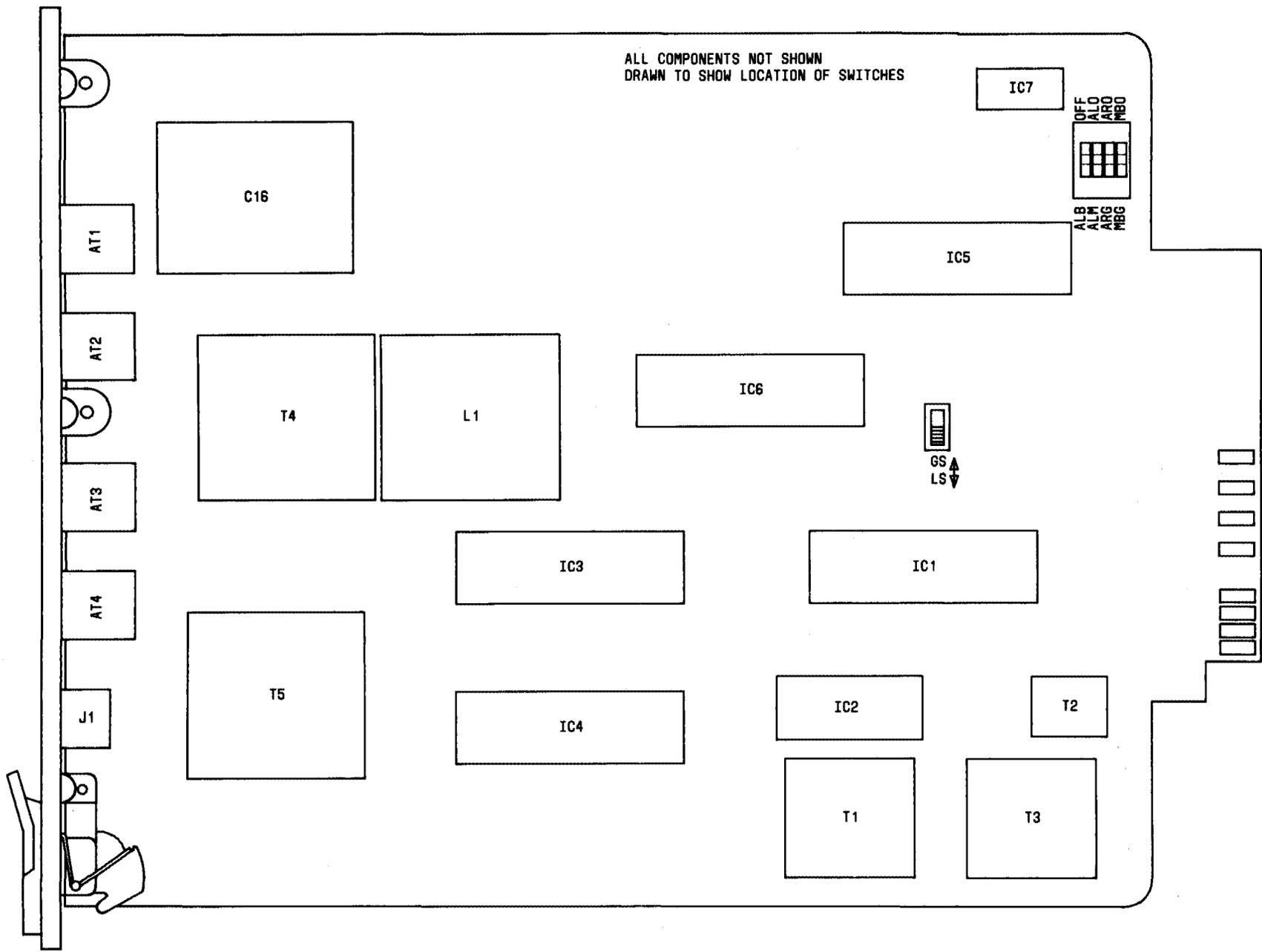
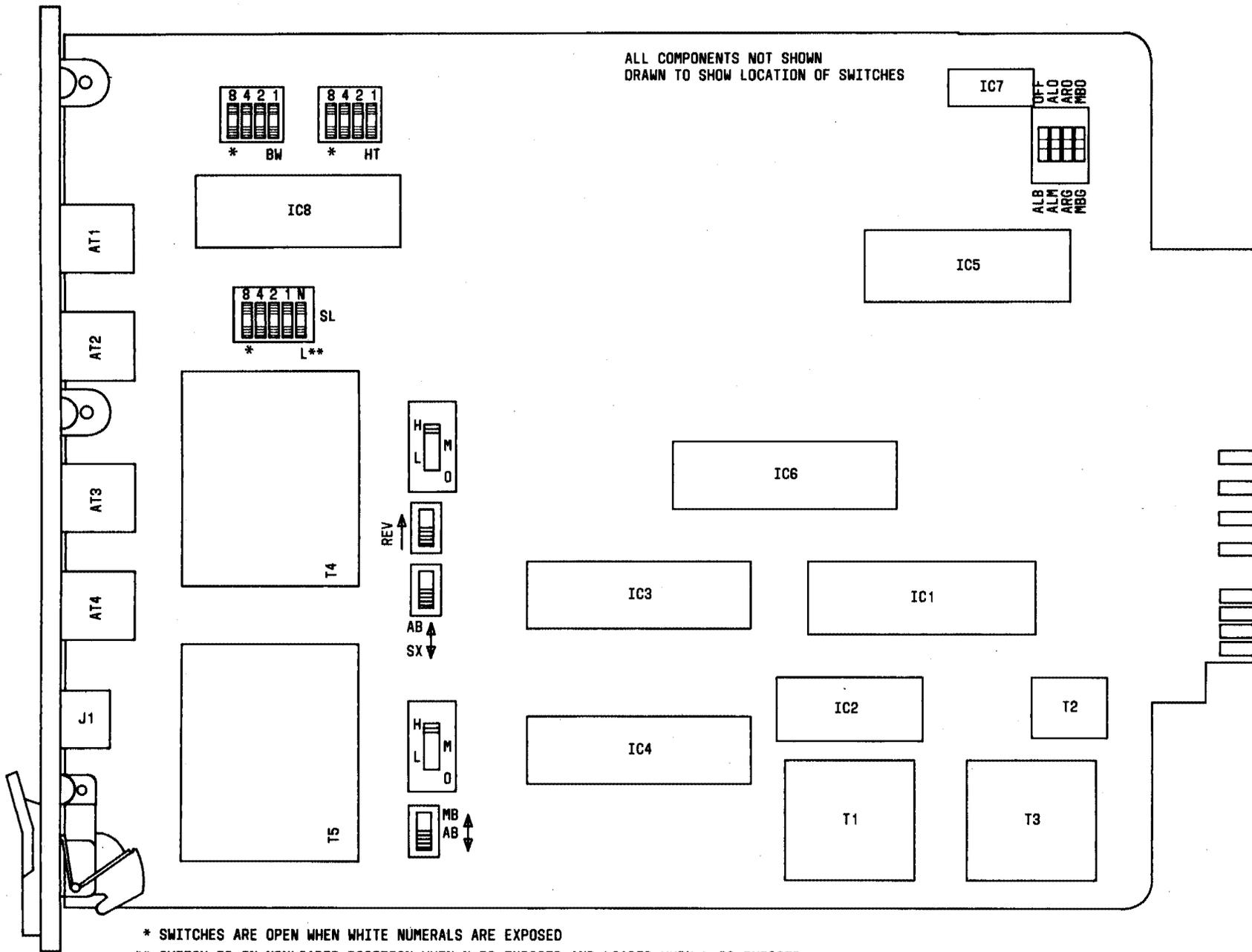


Fig. 4—Illustration of GLC Unit Showing Location of Switches



* SWITCHES ARE OPEN WHEN WHITE NUMERALS ARE EXPOSED
 ** SWITCH IS IN NONLOADED POSITION WHEN N IS EXPOSED AND LOADED WHEN L IS EXPOSED

Fig. 5—Illustration of GPA Unit Showing Location of Switches

TABLE A

TYPE G SIGNALING UNITS — GENERAL INFORMATION AND APPLICATION

SF UNIT	FUNCTIONAL DESCRIPTION	GENERAL APPLICATION	SPECIFIC USE	TYPE E AND F SF UNITS REPLACED
GLA	Special Access CO End	LS or GS	2-Wire 900 Ohm	FLA + FUA, E2L, E2LA, E1A + Term. Set
GLB	Special Access CO End	LS or GS Gain Transfer	2-Wire 900 Ohm	FLA + FUD, E2L, E2LA, E1A + Term. Set
GLC	Special Access CO End	LS	2-Wire 1100 Ohm	None
GPA	Special Access CO End	LS or GS	4-Wire 600 Ohm	FPA + FUA, E1P + Type 4182 Network
GRA	Special Access Station End	LS or GS	4-Wire 600 Ohm	FRA + FUA, E1R + Type 4182 Network
GSA	Special Access Station End	LS or GS	2-Wire 900 Ohm	FSA + FUA, E2S, E2SA, E1R + Term. Set
GSB	Special Access Station End	LS or GS Gain Transfer	2-Wire 900 Ohm	FSA + FUD, E2S, E2SA, E1R + Term. Set

TABLE B
COMPATIBILITY OF SF SIGNALING UNITS

AT OR TOWARD CENTRAL OFFICE END	MODE OF OPERATION	AT OR TOWARD CUSTOMER END											
		GRA	GSA GSB	GA— GBA	FRA	FRD	FSA FSB	FSC FSD	FA— FB— FWA	E2BK E2BKA E3BK E3BKA OR E4B	E2S	E2SA	E1R
GLA & GLB	LS	✓	✓	1, 3	✓	✓	✓	✓	1, 3	1	✓	No	✓
	GS	✓	✓	No	✓	✓	✓	No	No	No	✓	✓	✓
GLC	LS	Compatible with Remote Switching System											
GPA	LS	✓	✓	1, 3	✓	✓	✓	✓	1, 3	1	✓	No	✓
	GS	✓	✓	No	✓	✓	✓	No	No	No	✓	✓	✓
GA_ & GBA	LS	No	No		2, 3	No	2, 3						
	GS	No	No		No	No	No						
FLA & FLB	LS	✓	✓	1, 3	✓	✓	✓	✓	1, 3	1	✓	No	✓
	GS	✓	✓	No	✓	✓	✓	No	No	No	✓	✓	✓
FPA	LS	✓	✓	1, 3	✓	✓	✓	✓	1, 3	1	✓	No	✓
	GS	✓	✓	No	✓	✓	✓	No	No	No	✓	✓	✓
FPD	LS	✓	✓	No	✓	✓	✓	✓	No	No	✓	No	✓
	GS	✓	✓	No	✓	✓	✓	✓	No	No	✓	✓	✓
FLC & FLD	LS	✓	✓		✓	✓	✓	✓			✓	No	✓
FA_ FB_ FWA	LS	No	No		2, 3	No	2, 3						
	GS	No	No		No	No	No						
E2L	LS	✓	✓		✓	✓	✓	✓			✓	No	✓
	GS	✓	✓		✓	✓	✓	No			✓	✓	✓
E2LA	LS	No	No		No	No	No	No					
	GS	✓	✓		✓	✓	✓	No					
E1P	LS	✓	✓		✓	✓	✓	✓			✓	No	
	GS	✓	✓		✓	✓	✓	No			✓	✓	

Note 1: When used with SD-96252-01 DLL circuit.

Note 2: When used with SD-96251-01 DLL circuit.

Note 3: Not a desirable arrangement.

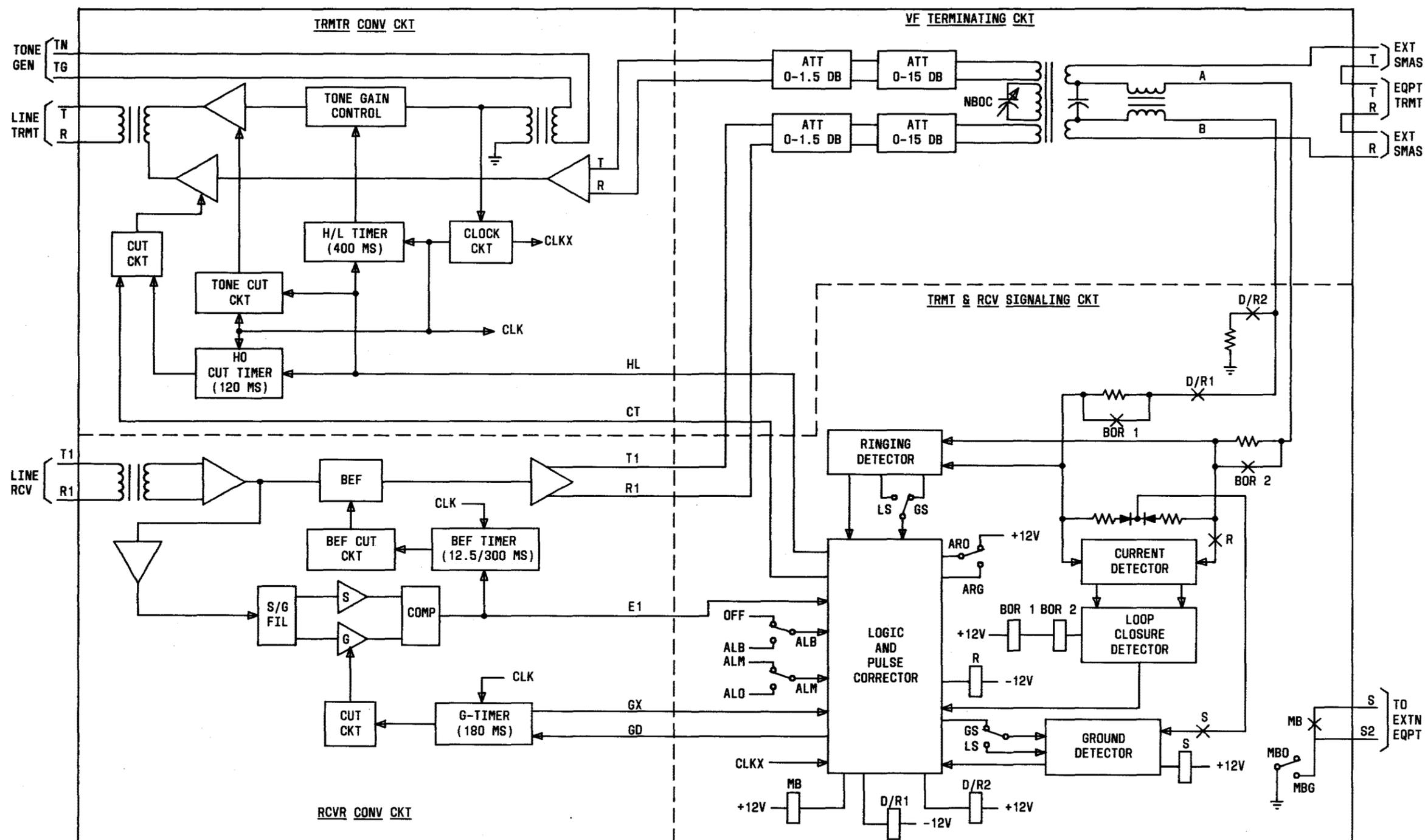


Fig. 6—GLA Unit

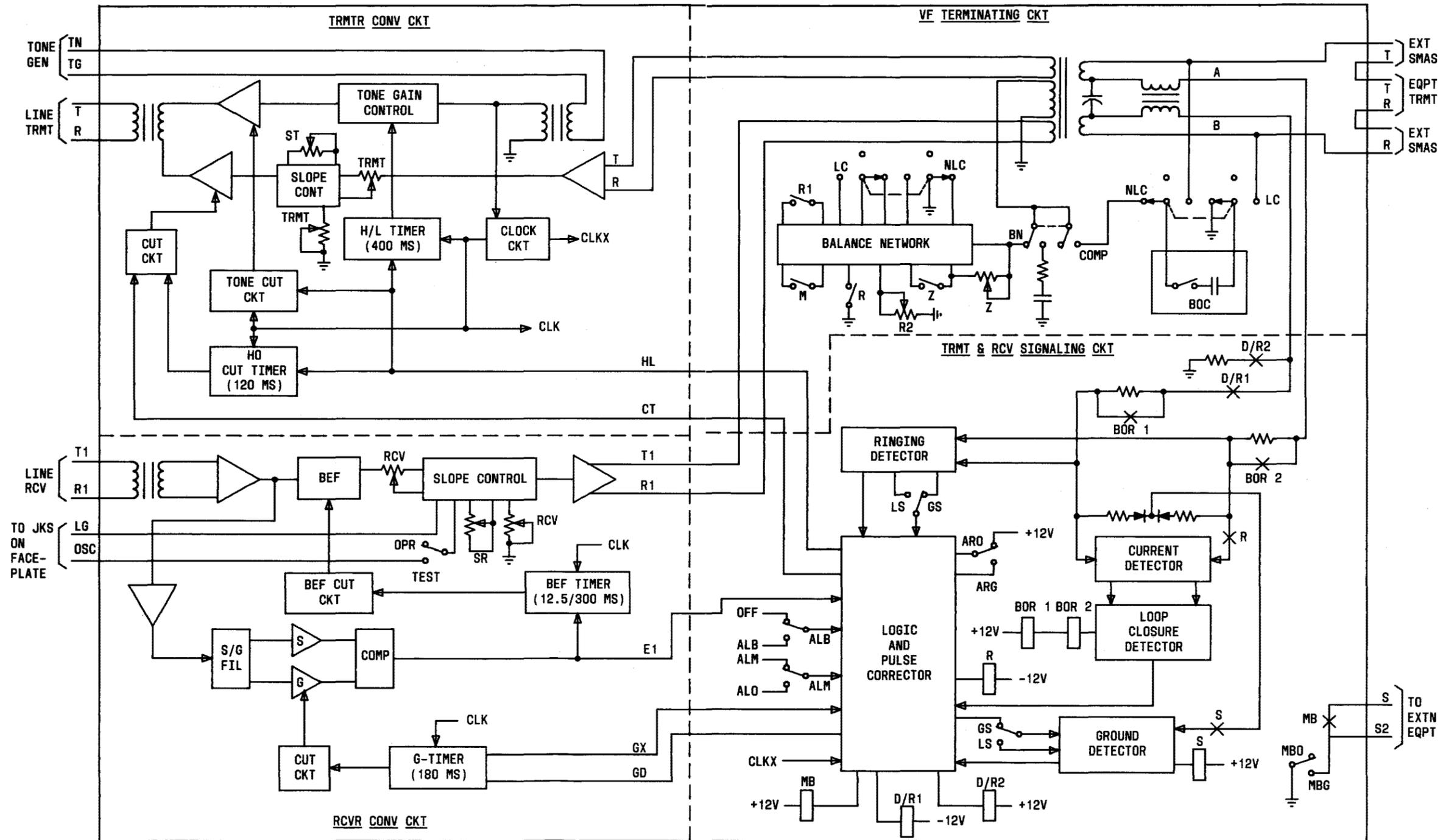


Fig. 7—GLB Unit

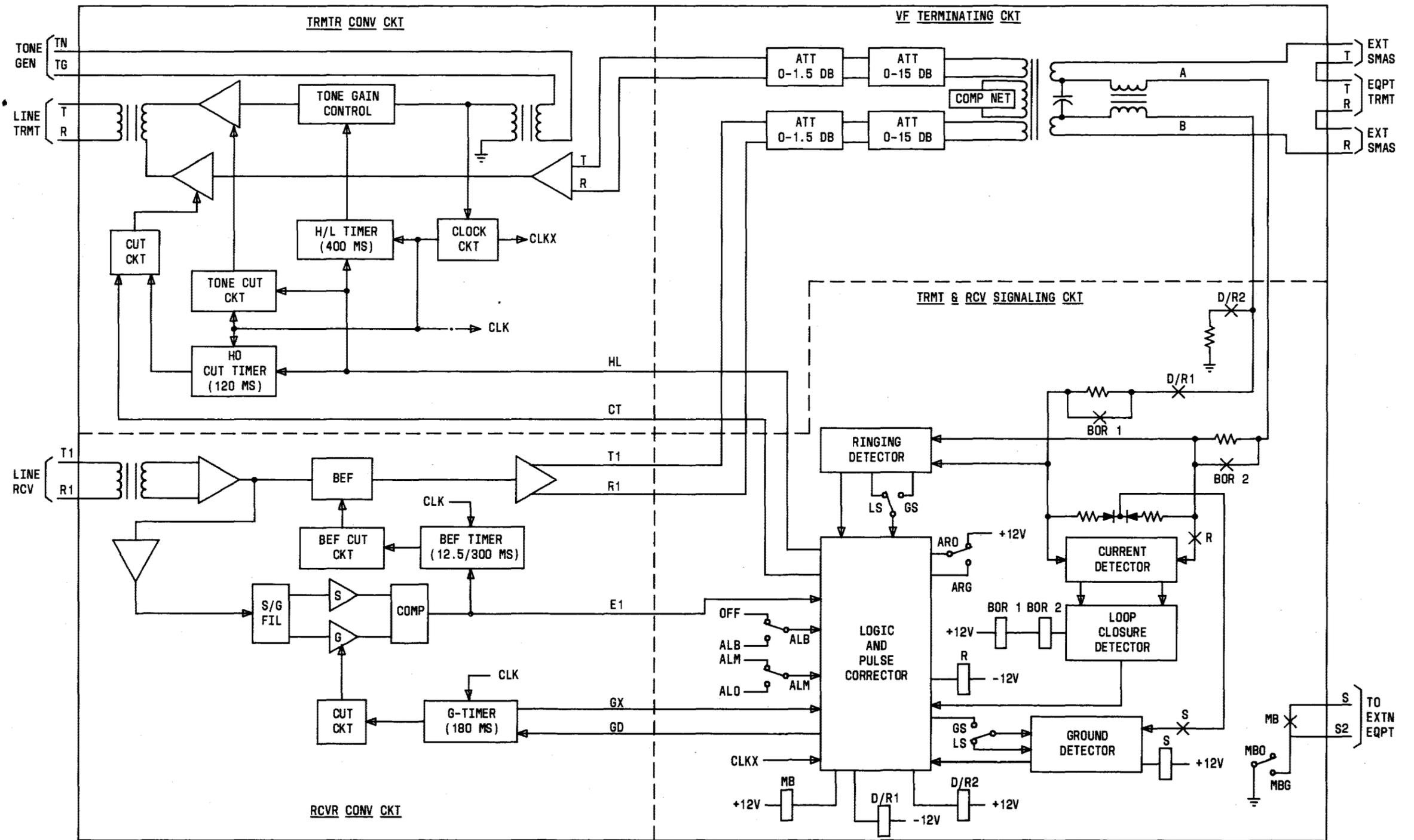


Fig. 8—GLC Unit

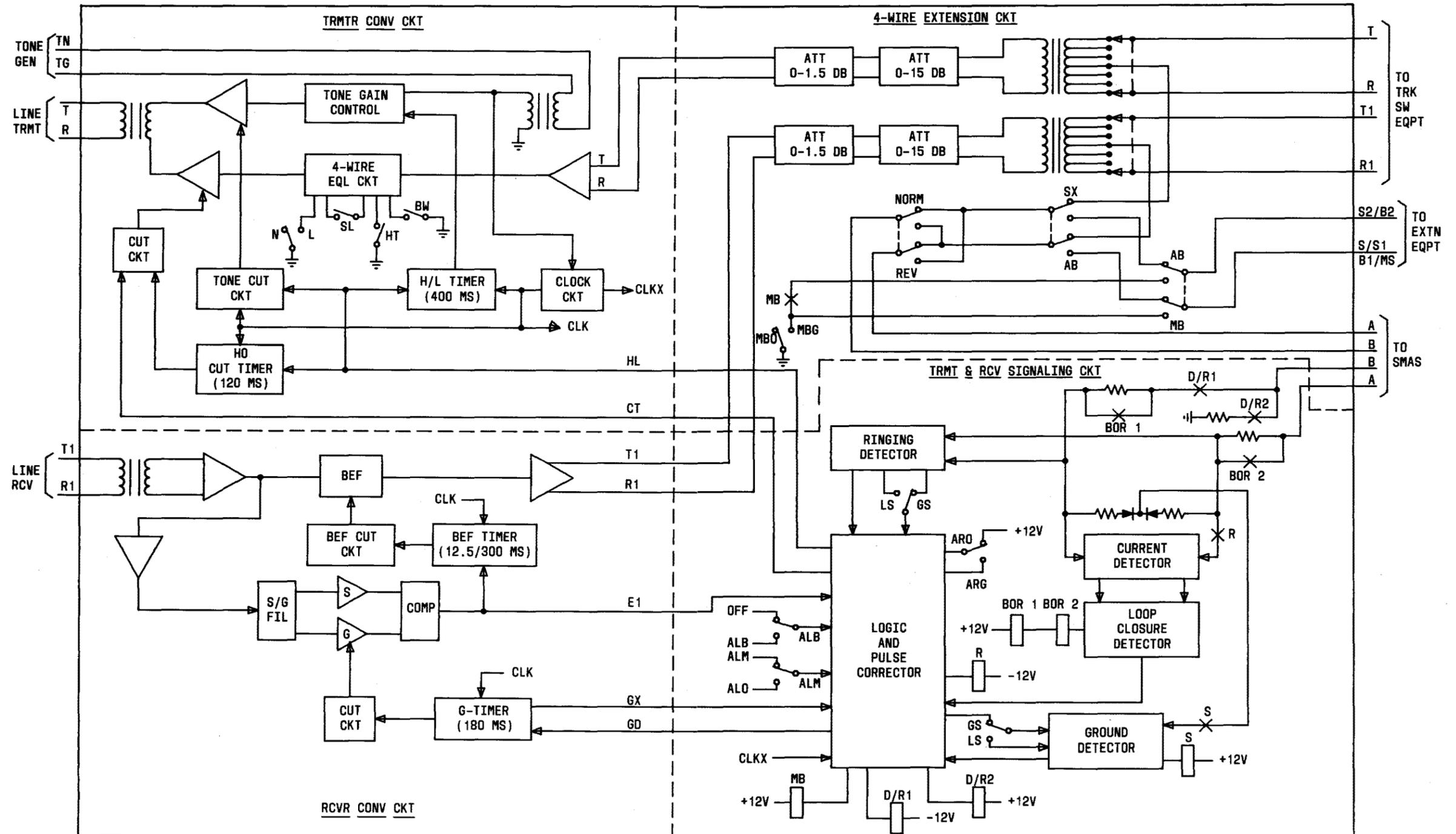
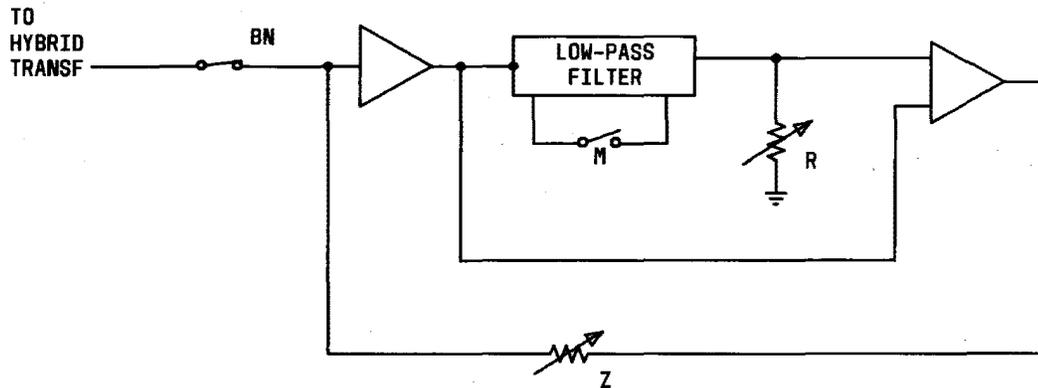
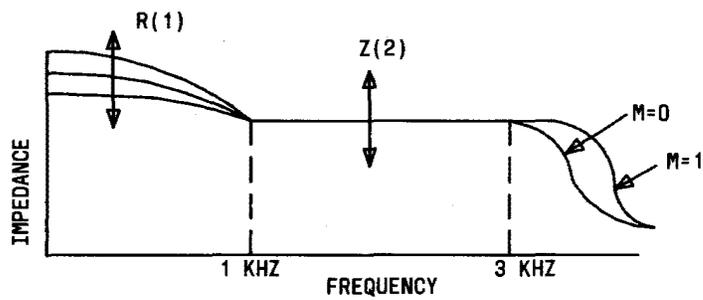


Fig. 9—GPA Unit

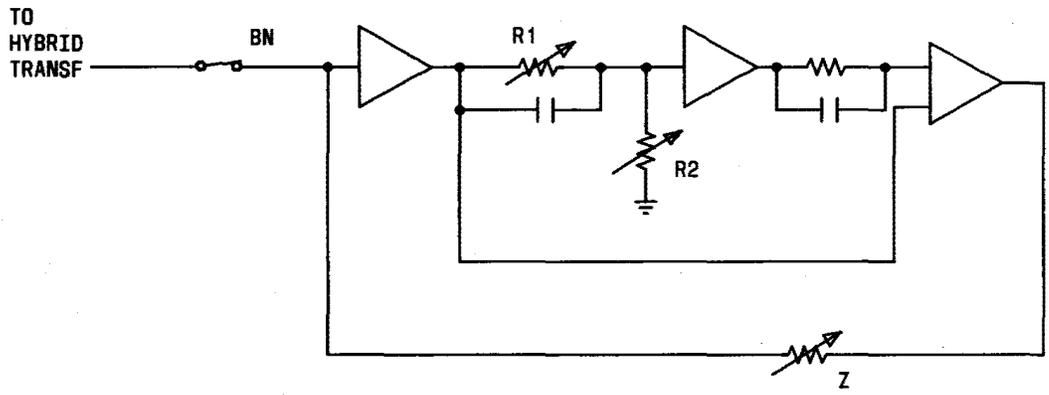


BALANCE NETWORK FOR LOADED CABLE

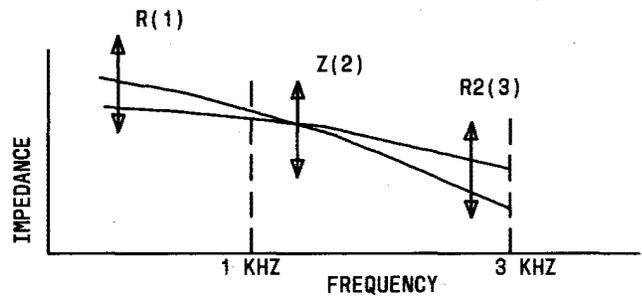


1. R CONTROL (S5-789) ADJUST THE CABLE IMPEDANCE AT LOW FREQUENCIES
2. Z CONTROL ADJUST THE CABLE IMPEDANCE AT ALL FREQUENCIES
3. M CONTROL ADJUST THE HIGH END ROLL-OFF TO 3.6 KHZ

Fig. 10—Simplified Schematic of Balance Network for Loaded Cable and Graph Showing the Effects the Controls Have on the Cable Impedance



BALANCE NETWORK FOR NONLOADED CABLE



1. R1 CONTROL (S5-456) ADJUST THE CABLE IMPEDANCE AT LOW FREQUENCIES
2. Z CONTROL (S5-23+POT) ADJUST THE CABLE IMPEDANCE AT ALL FREQUENCIES
3. R2 CONTROL (POT) ADJUST THE CABLE IMPEDANCE AT HIGH FREQUENCIES

Fig. 11—Simplified Schematic of Balance Network for Nonloaded Cable and Graph Showing the Effects the Controls Have on the Cable Impedance

TABLE C

NONLOADED REPEATER SECTION—4-WIRE UNITS				
WIRE GAUGE	COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4
	(600-600)	(150-600)	(150-150)	(150-150)
	SHORT LENGTH	MEDIUM LENGTH	LONG LENGTH	EXTRA LONG LENGTH
19LC*	8 — 11 Kf	11.1 — 18 Kf	18.1 — 33 Kf	33.1 — 45 Kf
19HC†	7 — 9	9.1 — 16	16.1 — 28	28.1 — 38
22	4 — 8	8.1 — 14	14.1 — 22	22.1 — 30
24	3 — 7.5	7.6 — 12	12.1 — 17	17.1 — 22
25 MAT	3 — 9.0	9.1 — 15	15.1 — 18	18.1 — 25
26	2 — 7	7.1 — 10	10.1 — 15	15.1 — 20

* Low Capacitance

† High Capacitance

Note 1: In computing the length of a facility, include the length of all bridged taps. Gauge of bridge taps is immaterial.

Note 2: The upper lengths in columns 1 thru 3 have been chosen to limit the loss at 3 kHz to about 1.0 dB more than at 1 kHz.

Note 3: The ranges of lengths in column 4 confine the 3-kHz roll-off to the range 1.0 to 3.0 dB.

Note 4: The impedance values (600-600), (150-600), and (150-150) shown above indicate the impedance values at the G-signaling unit and at the far end equipment.

TABLE D

MODE OF OPERATION	CONDITION OF TRUNK	GPA AND GL__ UNITS			GRA AND GS__ UNITS		
		CONDITION OF SIG & TRMSN LEADS			CONDITION OF SIG & TRMSN LEADS		
		A & B LOOP	2600-HZ TONE		A & B LOOP	2600-HZ TONE	
			TRMT	RCV		TRMT	RCV
LOOP-START CALL ORIGINATED AT STATION END	Idle	Open	OFF	ON	Open	ON	OFF
	Seizure	Closed	OFF	OFF	Closed	OFF	OFF
	Pulsing	Open-Closed	OFF	ON-OFF	Open-Closed	ON-OFF	OFF
	Talking	Closed	OFF	OFF	Closed	OFF	OFF
LOOP-START CALL ORIGINATED AT CENTRAL OFFICE END	Idle	Open	OFF	ON	Open	ON	OFF
	Seizure	Ready for Ringing	ON	ON	Open	ON	ON
	Ringing	Open	ON	ON	Open	ON	ON
	Talking	Closed	OFF	OFF	Closed	OFF	OFF
GROUND-START CALL ORIGINATED AT STATION END †	Idle	Open	ON	ON	Open	ON	ON
	Seizure	B Lead Grounded	ON	OFF	B Lead Grounded	OFF	ON
	Pulsing	Open-Closed	ON	ON-OFF	Open-Closed	ON-OFF	ON
	Talking	Closed	OFF	OFF	Closed	OFF	OFF
GROUND-START CALL ORIGINATED AT CENTRAL OFFICE END	Idle	Open	ON	ON	Open	ON	ON
	Seizure	A Lead Grounded	OFF	ON	Open	ON	OFF
	Ringing	Open	ON*	ON	Open	ON	ON*
	Talking	Closed	OFF	OFF	Closed	OFF	OFF

* In the GROUND-START mode, during the ringing interval, 2600-Hz tone is interrupted at a 20 pps rate.

† GROUND-START does not apply to GLC unit.

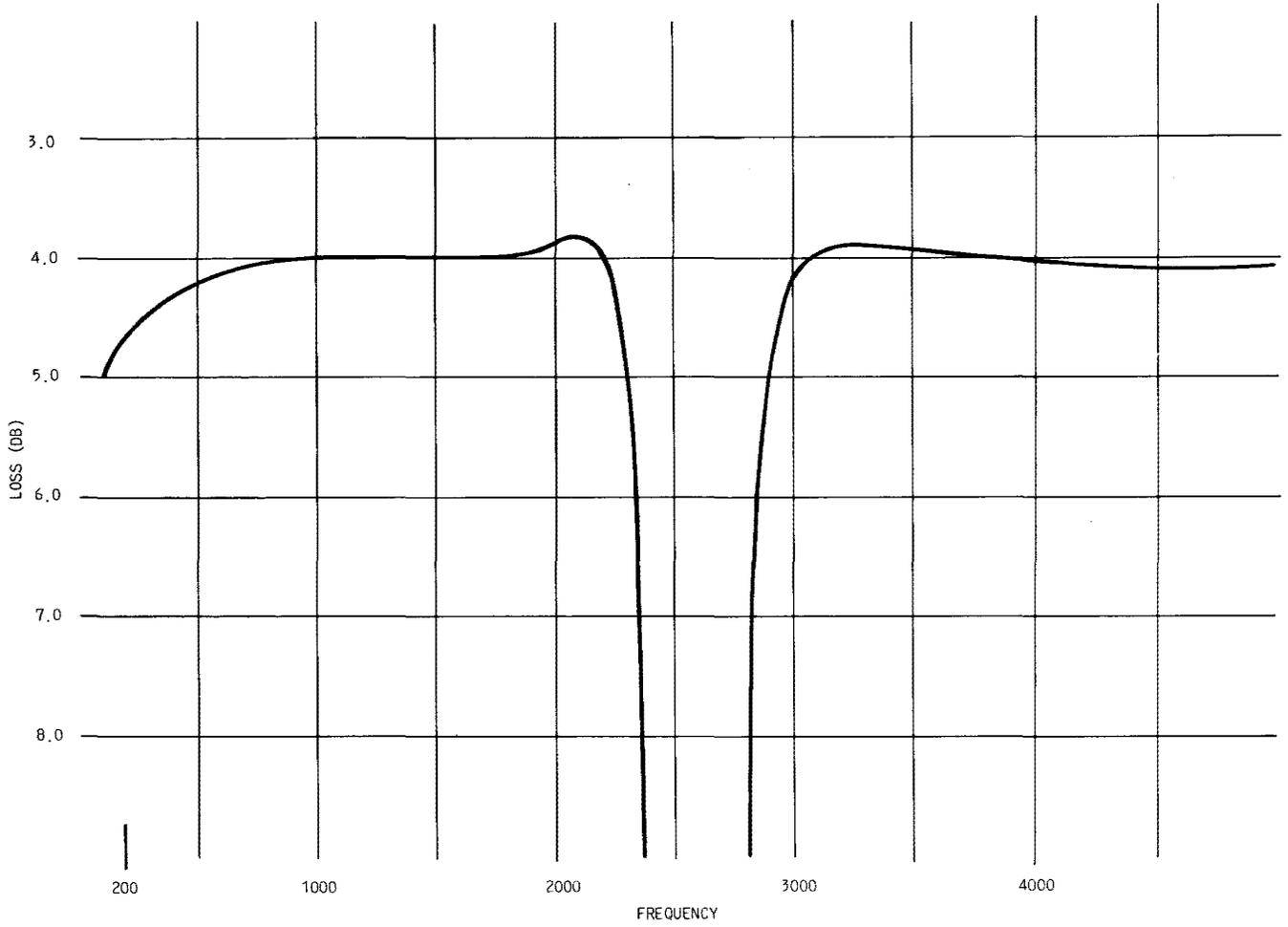


Fig. 12—Nominal Insertion Loss for Receive Circuit of GLA and GLC Units With BEF IN and Attenuators Set on Zero

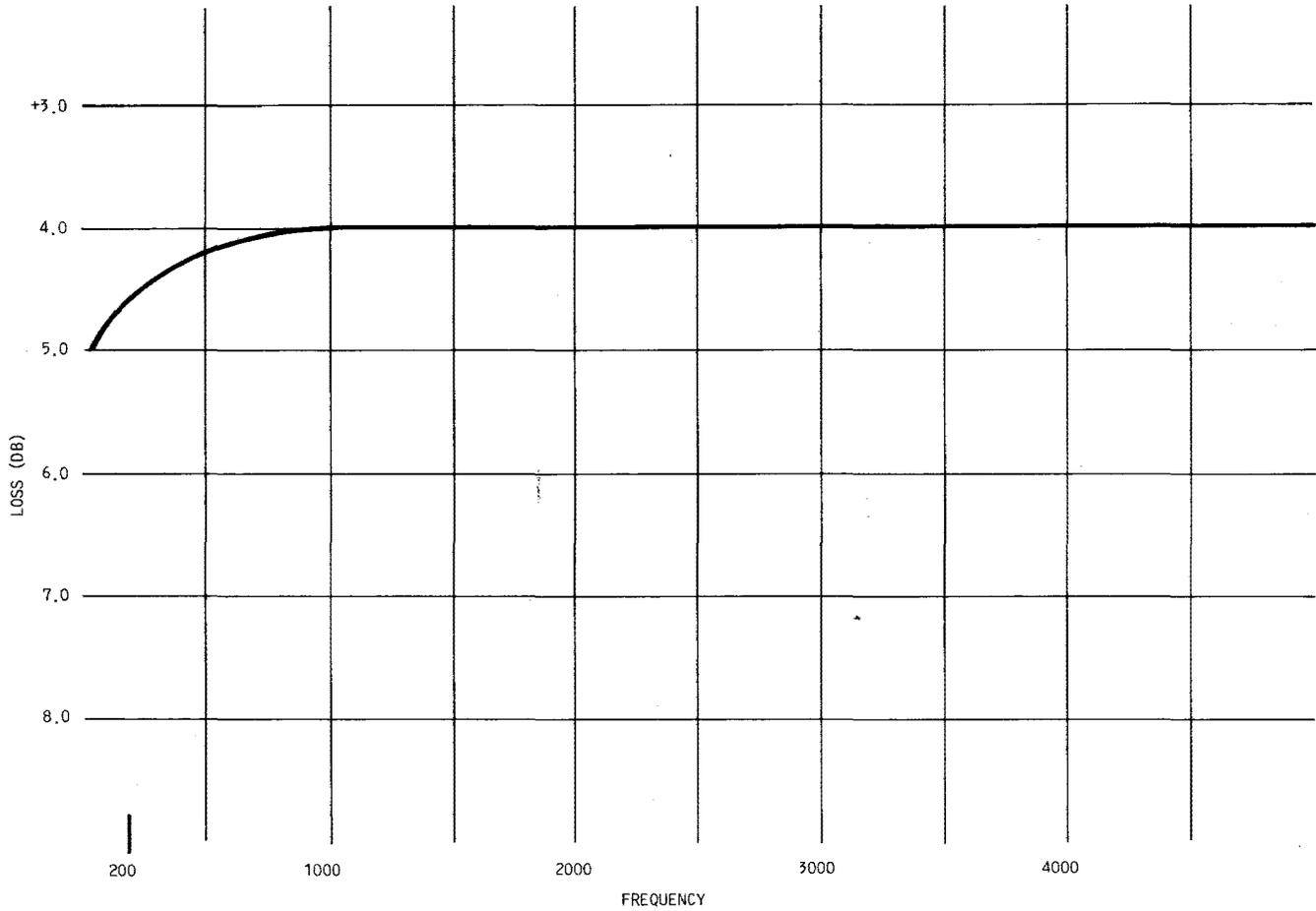


Fig. 13— Nominal Insertion Loss for Transmit and Receive Circuit of GLA and GLC Units With BEF OUT and Attenuators Set on Zero

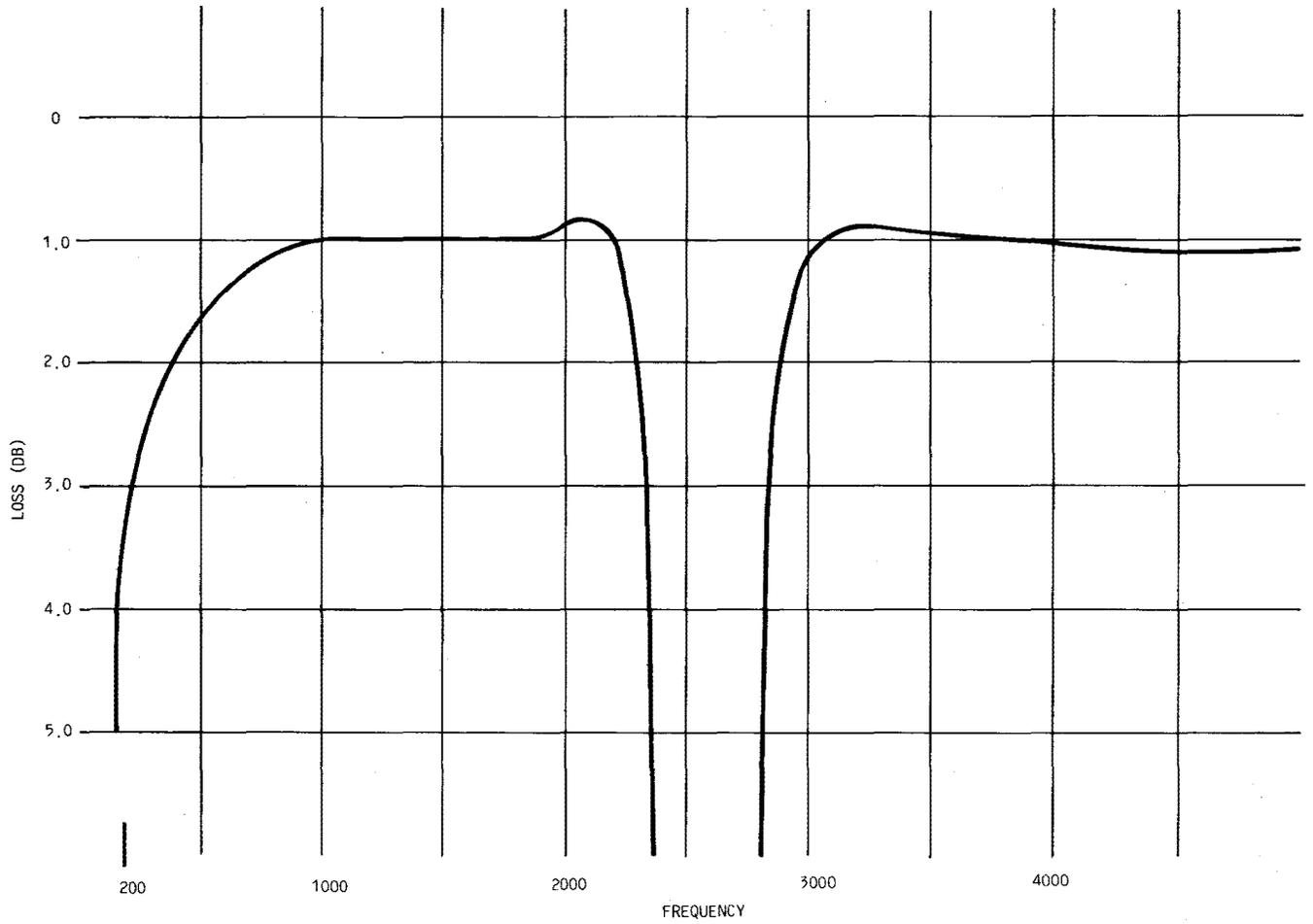


Fig. 14—Nominal Insertion Loss for Receive Circuit of GLB Unit With BEF IN and Attenuators Set on Zero

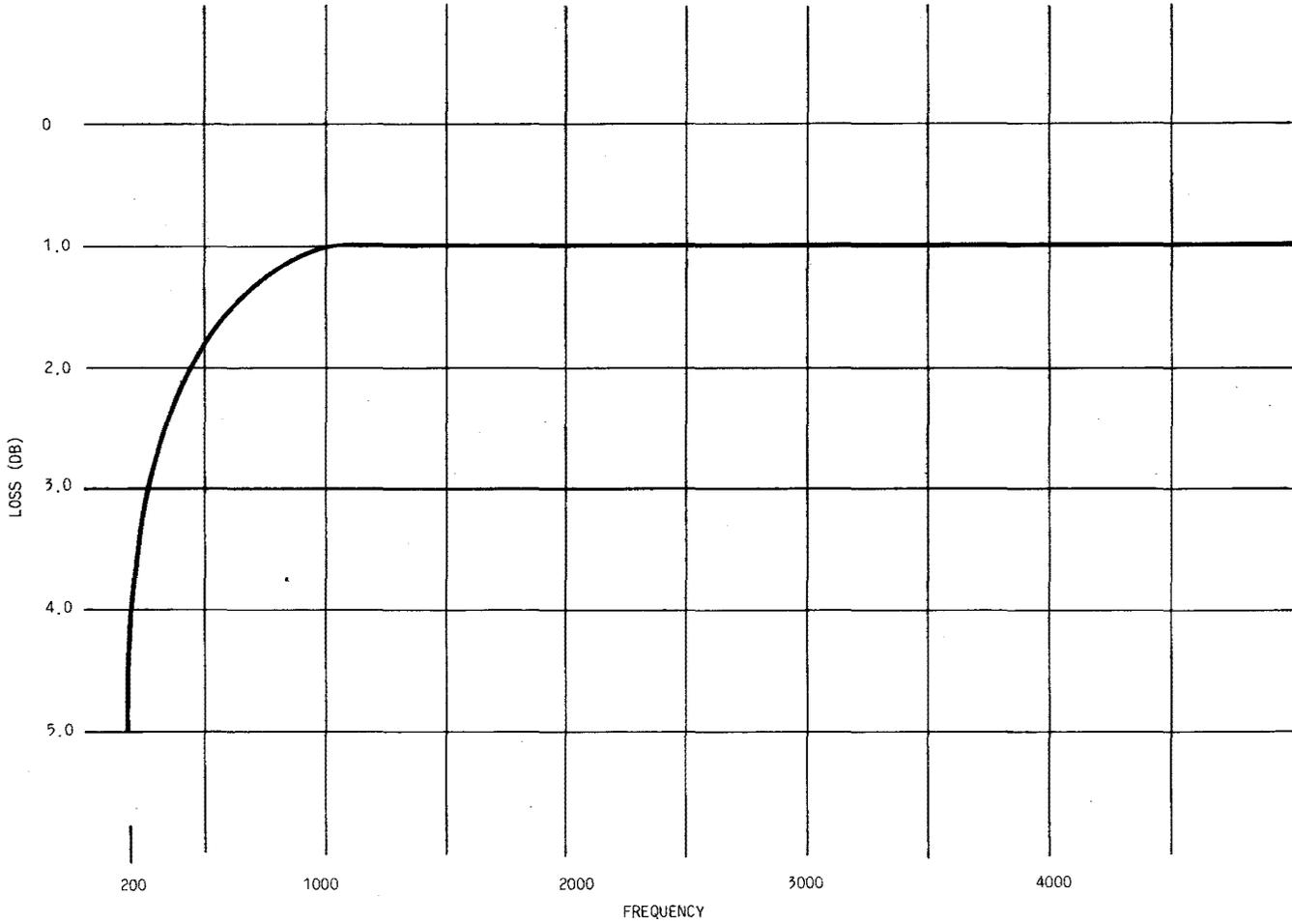


Fig. 15—Nominal Insertion Loss for Transmit and Receive Circuits of GLB Unit With BEF OUT and Attenuators Set on Zero

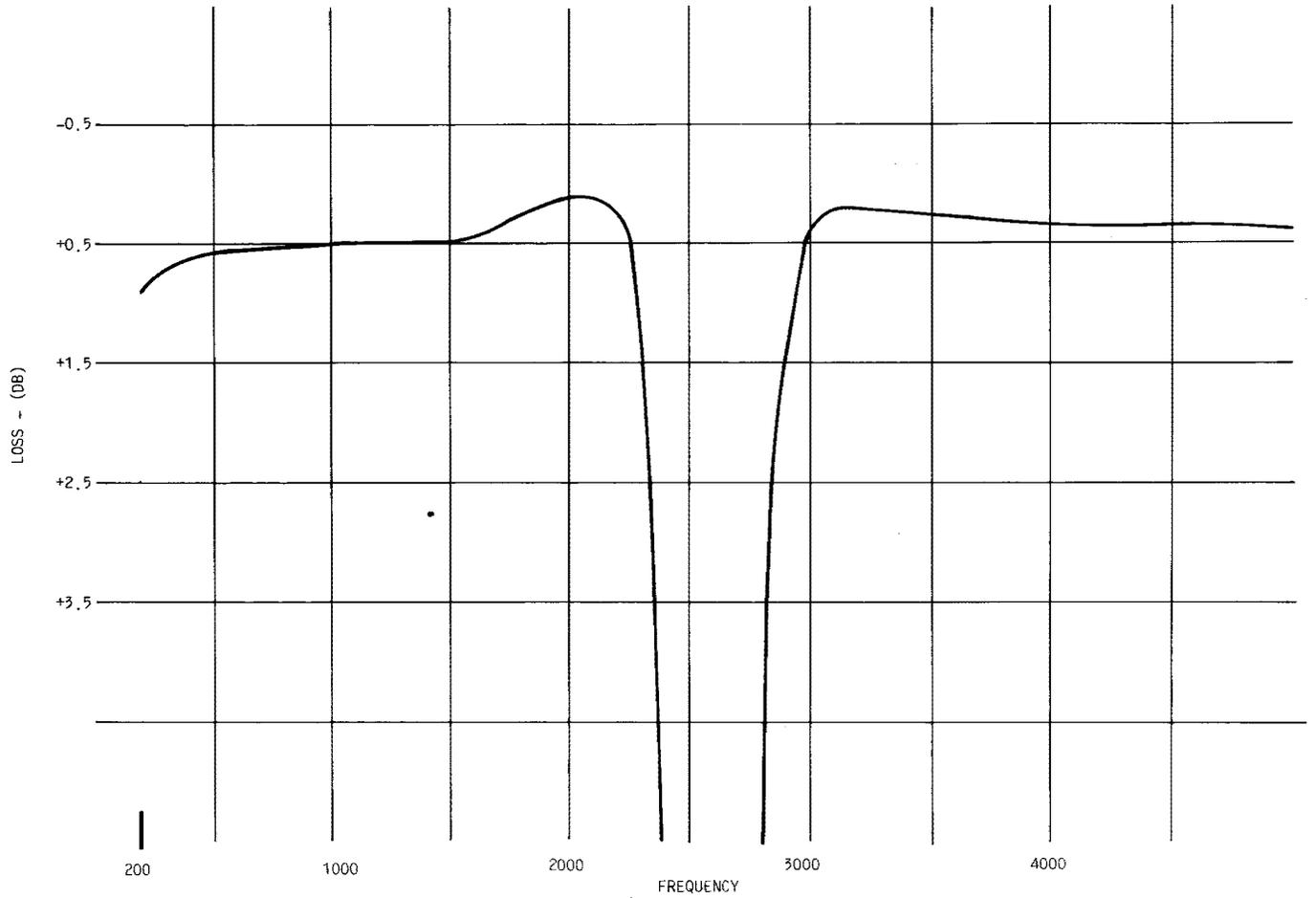


Fig. 16—Nominal Insertion Loss for Receive Circuit of GPA Unit With BEF IN and Attenuators Set on Zero

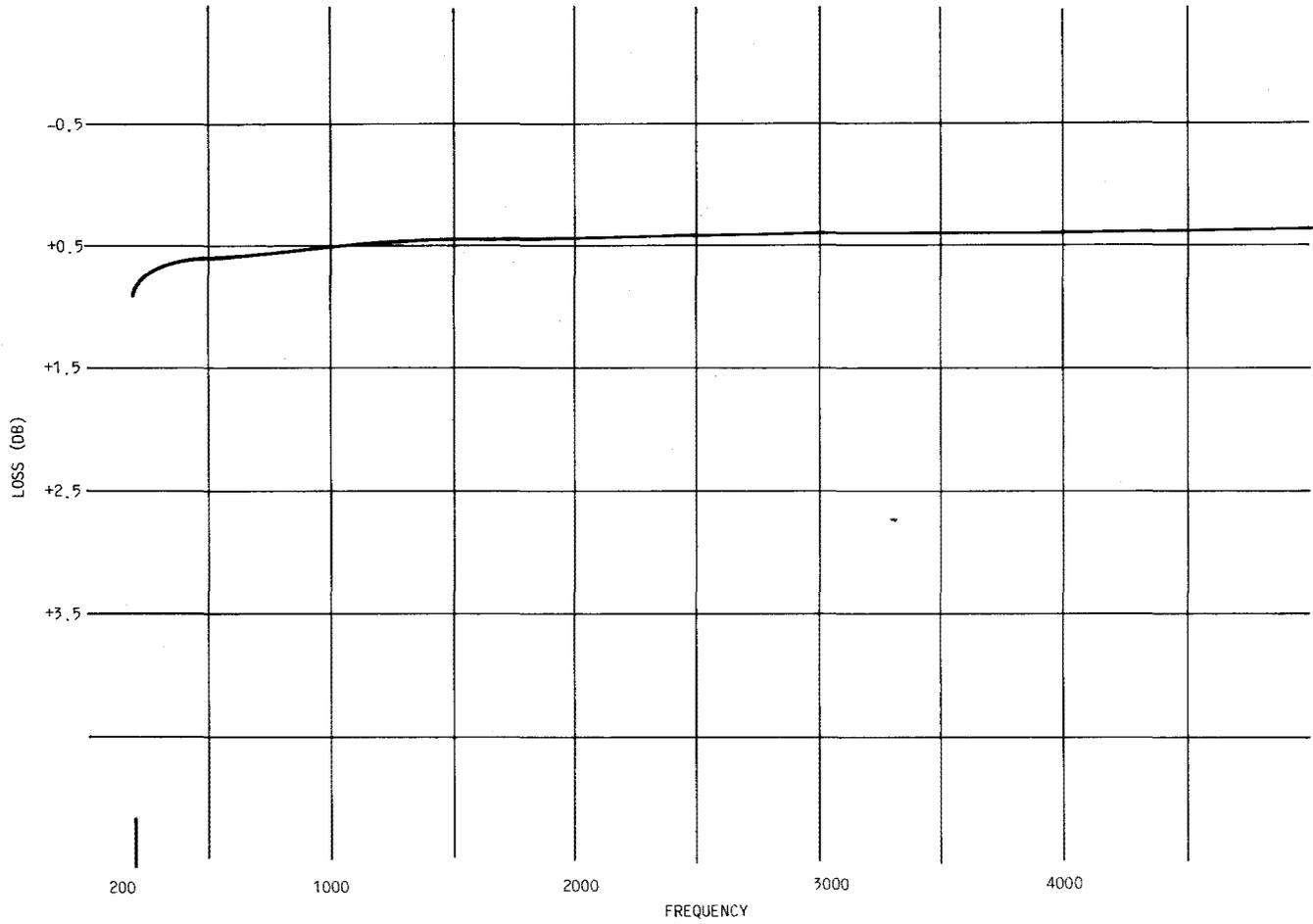


Fig. 17—Nominal Insertion Loss for Transmit and Receive Circuits of GPA Unit With BEF OUT and Attenuators Set on Zero