

**J99395AA, AB, BA, AND BM—E AND M LEAD SIGNALING UNITS
DESCRIPTION**

TYPE G SINGLE-FREQUENCY SIGNALING SYSTEM

CONTENTS	PAGE	CONTENTS	PAGE
1. GENERAL	2	A. Transmitting Circuit	9
A. System and Unit Description	2	B. Receiving Circuit	9
B. Application and Compatibility	3	7. MAINTENANCE	10
2. OPERATION PRINCIPLES	3	Figures	
A. Transmitter Circuit	3	1. GAA and GBA Units	11
B. Receiver Circuit	4	2. GAA, GAB, GBA, and GBM Faceplates	12
C. Voice-Frequency Terminating Circuit	5	3. GAA and GAB Printed Wiring Board	13
D. Signaling Circuits	5	4. GBA Printed Wiring Board	14
3. SIGNALING OPERATIONS	6	5. GBM Printed Wiring Board	15
A. DP Operation—Transmitting	7	6. Block Diagram of GAA and GAB Units	19
B. DP Operation—Receiving	7	7. Block Diagram of GBA Unit	21
C. Supervision	7	8. Block Diagram of GBM Unit	23
D. Disconnect	7	9. Nominal Transhybrid Loss of GAA Unit	25
4. CARRIER GROUP ALARM	8	10. Nominal Transhybrid Loss of GAB Unit	25
A. GAA, GAB, and GBA Units	8	11. Receive Pulse Correction for the GA() and GB() Units	29
B. GBM Unit	8	12. Nominal Envelope Delay for the GA() Units	30
5. PULSING CHARACTERISTICS	9	13. Nominal Envelope Delay for the GB() Units	31
A. Transmitting	9	14. Nominal Insertion Loss for Transmit and Receive Circuits of GAA Units With BEF OUT and Attenuators Set on Zero	32
B. Receiving	9		
6. TRANSMISSION CHARACTERISTICS	9		

NOTICE

Not for use or disclosure outside the
Bell System except under written agreement

CONTENTS	PAGE
15. Nominal Insertion Loss for Transmit and Receive Circuits of GAB Units With BEF OUT and Attenuators Set on Zero	33
16. Nominal Insertion Loss for Transmit and Receive Circuits of GB() Units With BEF OUT and Attenuators Set on Zero	34
17. Nominal Insertion Loss for Receive Circuit of GAA Units With BEF IN the Circuit and Attenuators Set on Zero	35
18. Nominal Insertion Loss for Receive Circuit of GAB Units With BEF IN the Circuit and Attenuators Set on Zero	36
19. Nominal Insertion Loss for Receive Circuit of GB() Units With BEF IN the Circuit and Attenuators Set on Zero	37
20. Nominal Return Loss—Frequency Characteristics of GA() Units—2-Wire Side Against 900 Ohms Plus 2.15 μ fd	37

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 follows:

GAA, SD-7C061, SFEE900—2-wire 900-ohm E&M unit

GAB, SD-7C062, SFEE600—2-wire 600-ohm E&M unit

GBA, SD-7C063, SF60B00—4-wire E&M unit

◆GBM, SD-7C071, SFAXG3H—4-wire PLR unit.◆

These units convert dc office signals to ac tone signals which are suitable for transmission over carrier facilities.

1.02 This section is reissued for the following reasons:

- To include the GBM 4-wire pulse link repeater unit

- To add the NB4 and AB1 switches to Fig. 3.

Change arrows have been used to denote significant changes.

1.03 Figure 1 is a photograph of the GAA and GBA units showing the components used in the construction of the units. Figure 2 shows the details of the faceplates.

A. System and Unit Description

1.04 The G-signaling module and frame which the GAA, GAB, GBA, and GBM units plug into is described in Section 179-400-100. These units are placed into service by inserting them into the guides of the module shelf and sliding them to the rear of the shelf. A locking device on the faceplate of the unit locks the SF unit in place when sufficient contact with the backplane is made.

1.05 The components of the SF units, which are primarily hybrid integrated circuits (HIC), transformers and passive components such as resistors and capacitors, are mounted on a metallic base printed wiring board. The slide switches, which cut in the network build-out capacitors (NBOC) ◆in the GAA and GAB◆, carrier group alarm (CGA) features, and E lead interface ◆(M lead interface for the GBM)◆, are mounted on the printed wiring board (Fig. 3, 4, and 5). ◆The GBM unit has an additional 8-dB pad located in the transmit and receive paths. These pads are cut in and out of the circuit with switches which are located on the printed wiring board.◆ When these switches are operated (closed), the red numbers are exposed, and when nonoperated (open), the white numbers are exposed. The printed wiring board is approximately 10.3 inches long and 7.3 inches high. All interconnections between the shelf and SF unit are via 50 gold finger contacts which are part of the printed wiring board. The transmission levels of the transmit and receive paths are adjusted with variable attenuators that are located on the faceplate of the G-signaling unit (see Fig. 2). These attenuators permit the insertion of attenuation in the transmit and receive paths over a range of 0 through 16.5 dB in 0.1-dB steps. ◆The 8-dB pads in the GBM unit permit the attenuation to be increased to 24.5 dB.◆ There are four pin jacks on the faceplate which provide access to the LINE RECEIVE (+7 TLP) and LINE TRANSMIT (-16 TLP) ports. Many of the timing pulses and signal levels discussed in this section will not be accessible for mak-

ing electrical measurements since the majority of the circuits are inside the HICs.

B. Application and Compatibility

1.06 The G-signaling unit provides the interface between the 4-wire transmission facility and the switching equipment or station. With a G-signaling unit at one end of a signaling link, a compatible E, F auxiliary with FU() converter, FW() or G-signaling unit is required at the other end. The GA() and GB() units provide 2- and 4-wire transmission, respectively, with E&M lead signaling. Table A lists each unit function, application, and comparable type E and F units. Table B lists the units that are compatible on the line side. Section 179-100-312 gives signaling compatibility with switching circuits on the drop side.

1.07 The GA() units provide a terminating set for use in 2-wire offices. The GAA unit is designed to function in 900-ohm offices and the GAB is designed to function in 600-ohm offices.

1.08 The GBA and GBM units *do not* have a terminating set; therefore, they must either be used in a 4-wire office or with an external term. set. The GBA and GBM units have the same signaling function as the GAA and GAB units, with the exception that the transmit circuit in the GBM is controlled by the signal on the E lead and the receive signal timer circuit controls the M lead.

1.09 All G-type E&M units provide type I, II, or III interfaces without wiring changes on the mounting.

2. OPERATION PRINCIPLES

2.01 The GAA, GAB, GBA, and GBM units are similar in construction and functional operation with the exception that the GAA and GAB units are 4-wire to 2-wire units and the GBA and GBM units are 4-wire to 4-wire units. Since the GAA and GAB are 4-wire to 2-wire units, a hybrid transformer is used as a terminating circuit.

2.02 The GAA and GAB units can be divided into four functional sections; transmitter converter circuit, receiver converter circuit, voice-frequency terminating circuit, and signaling circuit (Fig. 6). Since the GBA and GBM units do not have the hybrid transformer, they will not have the voice-frequency terminating circuit (Fig. 7 and 8).

A. Transmitter Circuit

2.03 The transmitter sends 2600-Hz supervisory and dial pulse information and also provides a transmission path for speech and data. The transmitter circuit can be divided into four functional areas: (1) transmission path, (2) tone injection circuit, (3) high level timing and control circuit, (4) cut timing and control circuit.

2.04 The transmission path of the transmitter circuit provides a balanced 600-ohm output at the LINE TRMT port (T and R terminals). The 16.5-dB attenuators in the transmission path are adjusted to provide the required output to interface a 4-wire line or carrier transmission system. The GBM unit has an additional 8-dB pad in the transmission path which permits the attenuation range to be increased to 24.5 dB.

2.05 A 2600-Hz tone from the tone generator in the GYA unit is applied to the transmitter circuit. The application and removal of tone to the channel is controlled by the signal on the HL lead. The signal on the HL lead is generated by the tone control logic of the signaling circuit (see Fig. 6, 7, and 8).

2.06 The level of the 2600-Hz tone is controlled by the high-low (HL) timer. The initial application of tone to the line is at a level of -24 dBm (-8 dBm0). If tone is present for more than 400 ms, the HL timer reduces the level to -36 dBm (-20 dBm0) 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; therefore, the low level tone is adequate to maintain tone detection.

2.07 A cut in the transmission path is provided to prevent the possibility of noise and/or voice from interfering with signal detection at the far end. This cut, which occurs essentially at the same time that tone is turned on, is controlled by the signals on the CT and HL leads. The signal on the CT lead is generated by the cut and cross-cut control circuit of the signaling circuit (see Fig. 6, 7, and 8). The signal on the CT lead is injected into one of 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 holdover (HO) timer. The output of the HO timer is fed into the other input of the OR gate. The signal on the CT lead provides a timed cut of approximately 625 ms following an on-hook transition and 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 off-hook transition.

B. Receiver Circuit

2.08 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) the transmission path, (2) the signal-guard (S/G) detection circuit, (3) the guard (G) timing and control circuit, and (4) the band-elimination filter (BEF) timing and control circuit.

2.09 The transmission path of the receiver circuit provides a balanced 600-ohm input at the LINE RCV (T1, R1) terminals. The 16.5-dB attenuator in the receiver circuit is adjusted to provide the required output level to the switching equipment. The GBM unit has an additional 8-dB pad in the transmission path which permits the attenuation range to be increased to 24.5 dB.

2.10 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 S/G filter which has two filter characteristics: a bandpass filter for the signal and a band-elimination filter 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 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 or data signals, 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 es-

entially 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.

2.11 The guard timer circuit controls the insertion and removal of the guard amplifier causing the receiver to be placed in a broadband (BB) or narrowband (NB) mode of operation. Approximately 55 ms after the initial removal of tone from the line (seizure), the receive signal timer 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 50 ms, the receive signal timer places a high 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. An exception to the above operation takes place during a free call. In this case, tone is not removed toward the calling end. This causes the receiver in the originating unit to remain in the broadband state. The broadband state minimizes the possibility of voice and/or noise (from the called end) from overriding the detection of tone and erroneously initiating billing.

2.12 The band-elimination filter timer controls the insertion and removal of the band-elimination filter (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 event for 300 ms and removes the BEF from the transmission path. This relatively slow removal of the BEF prevents a condition of fast in and out cycling of the filter which may be detected by the customer during speech simulation of tone. When a low signal state on the E1 lead indicates that tone has been received, the BEF timer delays the event 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 they may interfere with subsequent signaling. Short bursts (over 12 ms) of data signals having a high content of 2600-Hz components may cause insertion of the band-elimination filter in the receive path. This operation may result

in errors in full-duplex data transmission, but will not cause "talk-off." 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 receiver circuit.

C. Voice-Frequency Terminating Circuit

2.13 The terminating circuit in the GAA and GAB units provides conversion from 2-wire (900 ohms for GAA, 600 ohms for GAB) to 4-wire (600 ohms) operation by means of a two transformer hybrid. The hybrids provide approximately 4 dB of loss between the 4-wire to 2-wire ports. The terminating circuit also contains four attenuators and network build-out capacitors (NBOC). The attenuators are located in the 4-wire ports of the hybrid and provide up to 16.5 dB of loss in the transmit and receive paths plus the 4 dB of loss in the hybrid. The attenuators allow for the audio level at the carrier side to be adjusted to -16 TLP and the signal level at the equipment side to be adjusted to a ± 3 dBm0. The NBOC has an adjustment range of 0.0 through 0.126 μ fd in 0.002 μ fd steps. The NBOC permits balancing against office cabling.

2.14 A compromise network of 900 ohms plus 2.15 μ fd for the GAA and 600 ohms plus 2.15 μ fd for the GAB is connected across the network side of the hybrids. There is no access available for the external precision network. Switch NB4 allows the capacitance on the network side of the hybrid to be increased by 3.24 μ fd. Switch AB1 allows for the removal of the midpoint capacitor on the line side of the hybrid transformers.

2.15 When the network side and line side of the hybrid transformers are terminated with equal impedances, the transhybrid loss is greater than 47 dB at 1000 Hz (Fig. 9 and 10). The echo return loss at the 2-wire port is greater than 30 dB over a frequency range of 500 through 2500 Hz. The echo return loss is greater than 15 dB when switch NB4 is closed.

2.16 The GBA unit *does not* have the terminating circuit; however, it does utilize the four attenuators in the same manner as did the GAA and GAB units. The GBM unit has the four attenuators plus two 8-dB pads.

D. Signaling Circuits

2.17 The signaling circuit contains two individual circuits: (1) the transmit signal timer with tone and cut control circuits, and (2) the receive signal timer with tone control and carrier group alarm (CGA) circuit. The CGA circuit has three output signals. Two of these signals are applied to the tone control circuit of the receive signal timer during a carrier failure condition. The third output signal controls the CGA relay. Since the CGA is a major circuit within the receive signal timer, it will be discussed in Part 4.

‡GAA, GAB, and GBA Units‡

2.18 The transmit signal timer and cut control circuits receive a dc signal from the switching office. This signal is either a battery-open or battery-ground and is applied to the M lead. Battery on the M lead corresponds to an off-hook condition while ground or open corresponds to an on-hook condition. The transmit signal timer creates an 18.5-ms delay between the time that a dc signal is applied to the M lead and a high or low appears on the HL lead. The high or low signal on the HL lead controls the HL and HO timers in the transmitter circuit which controls the transmission of 2600-Hz tone.

‡GBM Unit‡

2.19 The transmit signal timer and cut control circuits of the GBM unit receive a dc signal from an E and M type signaling system. This signal is either an open or a ground and is applied to the E and SG leads. An open applied to the E and SG leads corresponds to an on-hook condition while ground corresponds to an off-hook condition. The transmit signal timer creates an 18.5-ms delay between the time that a dc signal is applied to the E and SG leads and a high or low appears on the HL lead. The high or low signal on the HL lead controls the HL and HO timers in the transmitter circuit which controls the transmission of 2600-Hz tone.

‡GAA, GAB, GBA, and GBM Units‡

2.20 The minimum pulse generator (MPG) which is part of the transmit signal timer, controls the length of the on-hook/off-hook signal intervals. When the *on-hook* signal intervals on the M lead (E lead for the GBM unit) vary between 18.5 ms through 50 ms, the MPG will assure that a minimum

tone burst of 50.8 ms in length will be transmitted. When the **off-hook** signal intervals on the M lead vary between 11.0 ms and 25 ms, the MPG will assure that a minimum no-tone interval of 25 ms will be transmitted. For M lead on-hook signals of greater than 50 ms and off-hook signals of greater than 25 ms, the MPG controls the output tone burst and no-tone interval to within ± 1 ms of the input interval.

2.21 The cut and cross-cut circuit controls the cut in the transmission path of the transmitter circuit. This cut usually occurs when the transmitter is transmitting tone. Situations in which this is not the case are determined by the cross-cut circuit. One such situation is when the received tone is removed for greater than approximately 600 ms. In this situation, the cross-cut circuit causes the cut in the transmitter transmission path to be removed. Another similar situation is when tone is neither being transmitted nor received and then transmit tone is applied. The circuit will cause a cut in the transmitter transmission path for approximately 600 ms and then be removed.

◆GAA, GAB, and GBA Units◆

2.22 The receive signal timer provides the appropriate timing and pulse shaping functions for operation of the R relay. When the receiver circuit detects 2600-Hz tone, a dc signal is applied to the E1 lead which in turn is applied to the input of the receive signal timer. When the output of the receive signal timer activates the R relay, a closure between the E and SG leads is established. When it is desired to have the E lead grounded, the K switch, located on the printed wiring board, must be closed, which grounds the SG lead. The receive signal timer provides a signal which is fed back to the receiver circuitry to initiate the transition from the broadband state to the narrowband state and vice-versa.

◆GBM Unit

2.23 The receive signal timer provides appropriate timing and pulse shaping functions for operation of the R relay. When the receiver circuit detects 2600-Hz tone, a dc signal is applied to the E1 lead. The signal on the E1 lead is applied to the input of the receive signal timer, which activates the R relay. Operation of the R relay provides battery-ground/open signals on the M lead for use by the associated E and M type signaling system. When resistance battery is supplied by the GBM unit for **type I**

interface, the M switch must be closed and the SB switch opened. When resistance battery is supplied externally, via the SB lead for **type I and II interface**, the SB switch must be closed and the M switch opened.

GAA, GAB, GBA, and GBM Units◆

2.24 When the receiver circuit is in the broadband condition (idle state), a no-tone interval of at least 55 ms is required to operate the R relay and thus provide a closure between the E and SG leads. ◆Operation of the R relay in the GBM unit applies battery to the M lead indicating an off-hook condition. ◆When the receiver circuitry is in the narrowband condition, the receive signal timer generates a delay of 33 ms from the time the dc signal changes polarity on the E1 lead and the R relay releases. The timing is such that no-tone intervals as short as 14 ms are recognized as valid intervals between dial pulses, enabling the recognition of dial pulses of very high percent break. Received tone bursts of between 33 and 50 ms are stretched to 50 ms by the receive signal timer. Tone intervals greater than 50 ms are undistorted.

2.25 The receive signal timer provides an output signal which is applied to the transmit signal timer and cut control circuit. This signal indicates whether or not the unit is receiving tone and controls the operation of the cross-cut control features.

3. SIGNALING OPERATIONS

3.01 The following tables and figures may be helpful in discussing the G-signaling units.

- (1) Table C—Lists conditions of E and M leads under operating conditions. The effect of a condition on the M lead at one end of the trunk can be seen on the E lead at the other end of the trunk.
- (2) Table D—Lists conditions of transmitting and receiving circuits related to changes in 2600-Hz tone.
- (3) Figures 6 and 7—Simplified schematic of the GA() and GBA units.
- (4) ◆Figure 8—Simplified schematic of the GBM unit.◆

3.02 In the idle condition, both ends of the trunk are on-hook and 2600-Hz tone is transmitted

toward the line facility in both directions. With both ends on-hook, the M lead in the GAA, GAB, and GBA units is grounded, causing the tone injection circuit in the transmitter converter to be turned on. Also, with both ends on-hook, the receiver circuit receives tone which causes the R relay to be released, opening the circuit between the E and SG leads. In the GBM unit when both ends are on-hook, the E lead is open, causing the tone injection circuit in the transmitter converter to be turned on. With both ends on-hook, the receiver circuit in the GBM receives tone which causes the R relay to be released, grounding the M lead.

3.03 The GAA, GAB, GBA, and GBM units are designed to be used at either or both ends of a signaling link. Although the GAA and the GBA units are compatible with many different units (Table B), the following discussion will assume that a GAA unit is used at the originating end and a GBA unit is used at the terminating end.

A. DP Operation—Transmitting

3.04 When the originating end goes off-hook (seizure), battery is applied to the M lead of the GAA unit. Battery on the M lead activates the transmit signal timer circuit which after 18.5 ms, via the HL lead, turns off the tone circuit, removing the 2600-Hz tone from the line. The HL output signal of the transmit signal timer also causes the output circuit in the transmission path of the transmitter circuit to be turned on after 125-ms delay. When the output circuit is turned on, a through path for transmission is provided.

3.05 When dial pulsing starts, battery and ground (or open) are applied to the M lead, which controls the transmit signal timer. The output of the transmit signal timer controls the holdover cut timer which controls the transmission path cut circuit and the tone injection circuit. The tone injection circuit is turned on and off to correspond to the dialed address number. High level tone (-24 dBm) is applied to the channel toward the GBA unit. After dial pulsing is completed, the cut timing circuit delays turning on the output circuit of the transmission path for 125 ms which prevents singing.

B. DP Operation—Receiving

3.06 When the GAA unit at the originating end removes the tone from the line, the receiver

converter circuit of the GBA unit, at the terminating end, detects the no-tone condition and generates a no-tone signal at the comparator output. The output signal of the comparator circuit activates the band-elimination filter (BEF) timer and receiver signal timer circuits. After the no-tone signal is detected, the receiver signal timer operates the R relay after a delay of approximately 55 ms which closes the circuit between the E and SG lead. The GD signal resets the G-timer which activates the guard circuit, thus placing the receiver in the narrowband condition. Closure of the E and SG lead seizes the central office switching equipment. The BEF timer delays cutting the BEF from the transmission path for approximately 300 ms after the no-tone condition is detected. When dial pulses are received from the originating end, the R relay opens and closes the circuit between the E and SG lead at the rate of the dial pulses. The BEF timer keeps the BEF in the transmission path while dial pulses are being received. When the dial pulses cease, the BEF is removed after a 300-ms delay. After 600 ms, the voice path in the transmitter circuit is cut through via the cut and cross-cut control. Transmission can now take place in both directions.

C. Supervision

3.07 When the terminating end (GBA) answers, battery is placed on the M lead. Battery on the M lead activates the transmit signal timer circuit. After 18.5 ms, the output of the transmit signal timer circuit activates the transmitter HL circuit which keeps the transmission path cut for an additional 125 ms. The HL output of the transmit signal timer circuit also causes the tone circuit to be turned off, removing the 2600-Hz tone toward the originating end (GAA unit). The receiver converter circuit at the originating end detects the removal of tone from the terminating end. After 55 ms, the R relay operates, closing the circuit between the E and SG leads. The GD signal resets the G-timer, thus placing the receiver at the originating end in the narrowband condition.

D. Disconnect

3.08 When either end goes on-hook, battery is removed from the M lead of the associated unit. Removal of battery activates the transmit signal timer which after 18.5 ms causes the tone level circuit, in the transmitter converter circuit, to be turned on. With the tone level circuit turned on, 2600-Hz

high tone is transmitted toward the line and the transmit voice path is cut. At the other end of the trunk, the receiver circuit detects the tone. After the tone has been detected for 33 ms, the R relay releases, opening the circuit between the E and SG leads. The GD signal activates the G-timer which times an additional 180 ms and then disables the guard (G) circuit, thus placing the receiver in the broadband condition.

4. CARRIER GROUP ALARM

4.01 The carrier group alarm circuit (CGA) receives its inputs (ALM, ALO, and ALB) from the GYA unit. These inputs are normally +5 volts but change to -12 volts when there is a carrier failure. The various CGA features of the G-signaling units are selected by operating switches located on the printed wiring board (Fig. 3, 4, and 5). Table E lists the circuit release and make-busy switches which must be operated to obtain the correct condition for each circuit. When a carrier failure occurs, a -12V signal is applied to the ALM lead and remains in this state for the duration of failure. The voltage on the ALO lead also goes to -12V and remains until the GYA alarm is overridden. If the alarm is overridden, the voltage will return to a +5V state which places the unit in the nonalarm state. The ALO lead is used to obtain the alarm-override feature when the circuit is to be patched to another facility by way of the voice-frequency (VF) or carrier patch bay. During a carrier failure, the voltage on the ALB lead goes to -12 volts for 2.5 seconds and then returns to +5 volts. The signal on the wink (W) lead is used to release the step-by-step switch train. A trunk may be placed in one of three conditions: (1) circuit release, (2) circuit release make-busy, or (3) circuit release delay make-busy.

A. GAA, GAB, and GBA Units

Circuit Release

4.02 With only the BY switch closed, a carrier failure (CF) signal from the GYA unit will cause the R relay to release. Release of the R relay opens the circuit between the E and SG leads, which makes the unit appear idle and prevents seizure of the central office common equipment. If the ALO switch is closed and the CF signal is applied to the ALO lead at the same time as it is applied to the ALM lead, the results will be the same; the R relay will release. However, when the CF signal is removed from the ALO lead, the failure is overridden and the R relay reoperates.

Circuit Release—Make-Busy

4.03 With the ALO, ALB, DMB, and BY switches open, a CF signal on the ALM lead causes the R relay to release and the CGA relay to operate. If the B1 switch is closed, operation of the CGA relay applies a ground to the S1/MS lead which appears as a sleeve make-busy signal. If the B1 switch is open and the B2 switch is closed, a loop closure between B1 and B2 leads occurs when the CGA relay operates. This makes the trunk circuit busy to outgoing traffic. If the B3 switch is closed, operation of the CGA relay connects the W lead to the S/S1/B1, or MS lead. If the ALO switch was closed and the CF signal was removed from the ALO lead by the alarm override, the R relay would reoperate and the CGA relay would release, thus implementing the alarm override function.

Circuit Release—Delay Make-Busy

4.04 With the ALB, DMB, and BY switches closed and the ALO switch open, a CF signal applied to the ALM and ALB leads causes the R relay to release. After 2.5 seconds, the CF signal is removed from the ALB lead causing the R relay to reoperate. The BY switch being closed prevents the operation of the CGA relay. If the BY switch is open, the CGA relay will operate when the CF signal is removed from the ALB lead. Operation of the CGA relay opens the S1 to S2 leads and closes the S1 to W leads if the B3 and B4 switches are closed and B1 and B2 switches are open. This allows the "wink" signal from the GYA unit to control the sleeve lead to the step-by-step equipment. If the ALO switch is closed, the alarm override function is implemented the same as it is in the release make-busy circuit.

B. GBM Unit

Circuit Release—Make-Busy

4.05 With the ALO, ALB, and DMB switches open and the M switch closed, a CF signal (-12 volts) on the ALM lead causes the CGA relay to be operated and the R relay to release. Operation of the CGA relay and the release of the R relay connects -48 volts to the M lead which is connected to the signaling circuit. With -48 volts applied to the signaling circuit, the unit appears to be idle and prevents seizure of the central office common equipment. When the ALO switch is closed and a nonalarm state (+5 volts) is applied to the ALO lead, the CGA relay will

release. Release of the CGA relay applies a ground to the M lead, returning the circuit to a nonalarm state.

Circuit Release—Delay Make-Busy

4.06 With the ALB and DMB switches closed and the ALO switch open, a CF signal on the ALM and ALB leads causes the R relay to be released. When the signal on the ALB lead returns to a nonalarm state 2.5 seconds after the CF signal, the CGA and R relays will operate. Operation of the CGA and R relays applies -48 volts to the M lead, which makes the unit appear to be idle to the signaling circuit. When the ALO switch is closed and a nonalarm signal is applied to the ALO lead, the CGA relay will release. Release of the CGA relay applies a ground to the M lead, returning the circuit to a nonalarm state.

5. PULSING CHARACTERISTICS

A. Transmitting

5.01 The GA() and GB() units are limited to transmitting dial pulses in the range of 7.5 through 12.5 PPS. The percent break on the M lead can vary as follows:

PPS	% BREAK
7.5	15-90
10.0	20-89
12.5	25-86

Note: For input break intervals of less than 50 ms but greater than 18.5 ms, the output tone pulse will be between 50.7 and 52.0. For inputs with a make interval of less than 25 ms but greater than 11 ms, the output no-tone interval will be between 25.3 and 25.8 ms. The M lead output timer distortion will be within ±1 ms.

B. Receiving

5.02 The GA() and GB() units are limited to receiving dial pulses in the range of 7.5 through 12.5 PPS (Fig. 11). A minimum of 33 ms is required to operate the receiver. The receiver pulses can vary as follows:

PPS	% BREAK
7.5	26-90
10.0	34-85
12.5	43-80

Note: Receive pulses greater than 34 ms but less than 50 ms will give an output on the E lead between 51 and 52 ms. Pulses greater than 50 ms will give an output within ±1 ms of input pulse.

6. TRANSMISSION CHARACTERISTICS

6.01 The G-signaling units will remain stable unless there is a severe change in environmental conditions.

A. Transmitting Circuit

6.02 The envelope delay present in the transmit and receive circuits can be seen in Fig. 12 and 13. As can be seen in Fig. 12 and 13, the envelope delay for the transmit and receive circuits is, for all practical purposes, the same. For the GA() units, the delay is constant from 3000 Hz and up, while for the GBA unit the delay is constant from 1500 Hz and up. For the GA() units the delay rises fairly sharply below 2000 Hz, while for the GBA and GBM units it rises sharply below 1000 Hz. The difference in the curves is due to the terminating set in the GA().

6.03 The transmission path of the transmitter circuit provides adjustable attenuation with up to 16.5 dB of loss in 0.1-dB steps. These attenuators must be adjusted to obtain -16 TLP at the LINE TRMT port. The loss in the transmission path of the transmitter circuit can be seen in Fig. 14 through 16. The curves show much more loss in the GA() units than in the GBA and GBM units. The larger amount of loss (approximately 4 dB) is due to the terminating set in the GA() units.

B. Receiving Circuit

6.04 The receive path in the GA() and GB() units is provided with adjustable attenuation with up to 16.5 dB of loss in 0.1-dB steps. This allows the output level of the receiver to be varied well beyond the 0 through -8.9 TLP at the EQPT TRMT port of the GA(), and the 0 through -8.4 TLP at the EQPT RCV port of the GBA. The loss variation between the

input and output levels in the voice-frequency range with and without the band-elimination filter in the circuit is shown in Fig. 14 through 19. The terminating sets in the GA() units can again be seen to add more loss to the circuit. A sharp dip between 2200 and 3000 Hz in Fig. 17 through 19 is caused by the band-elimination filter.

6.05 The 2-wire return loss curve is shown in Fig. 20 for the compromise network of 900 ohms plus 2.15 μ fd.

7. MAINTENANCE

7.01 There are no field adjustments provided on the GA() and GB() units except for the atten-

uators, NBOC settings, and the other network and line side capacitors. The G-signaling units not meeting circuit requirements should be returned to Western Electric company for repair. Defective units should be replaced with spare units.

7.02 The type G test extender SD-7C080-01 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.

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

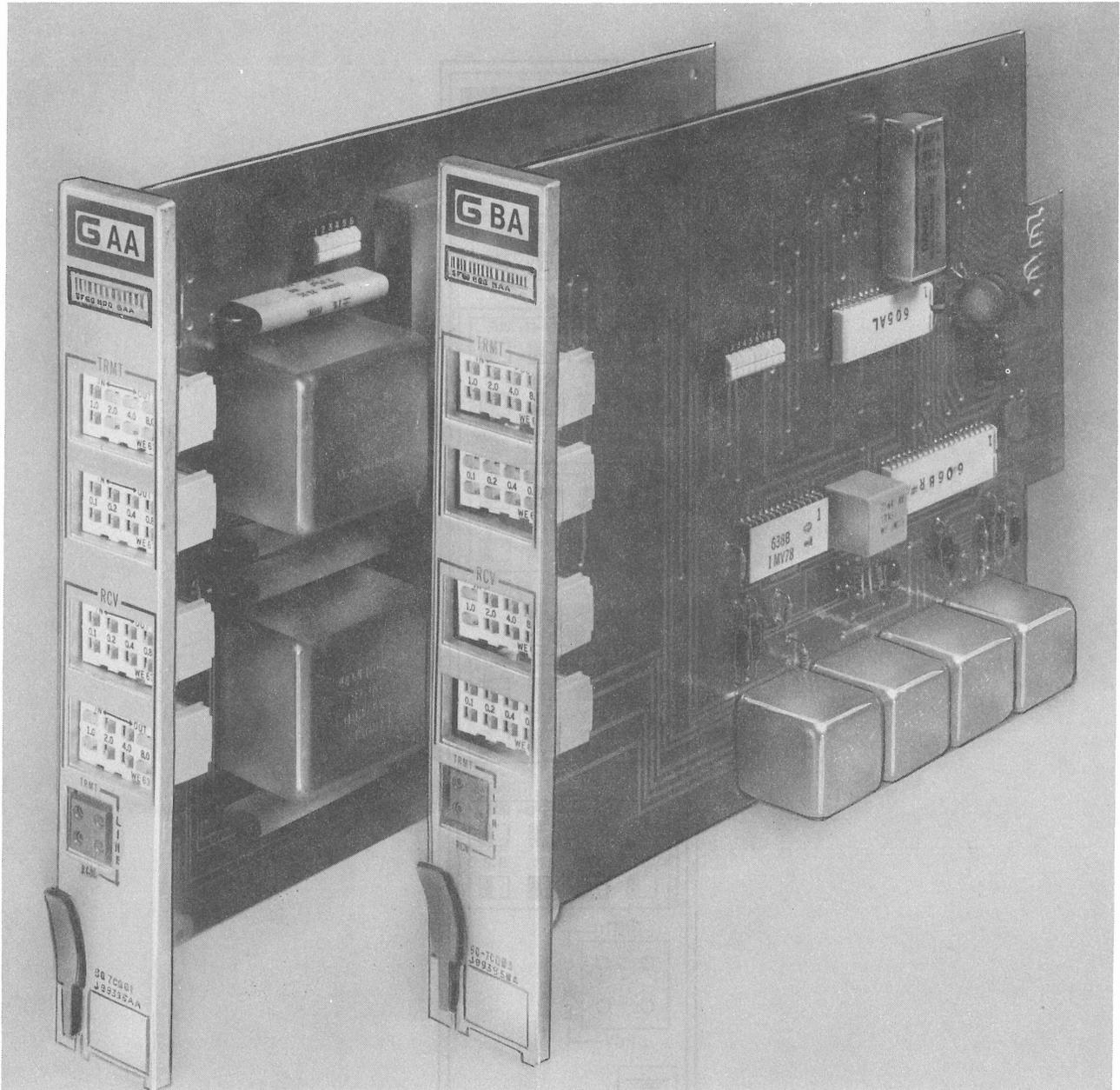


Fig. 1—GAA and GBA Units

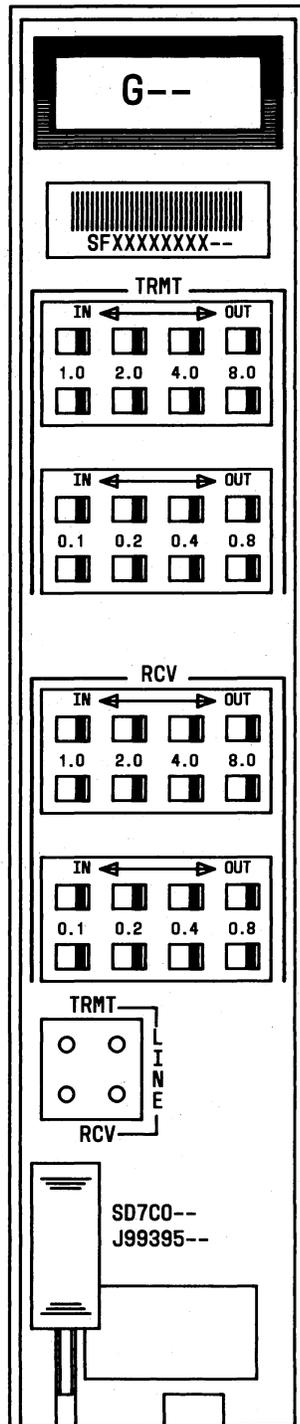
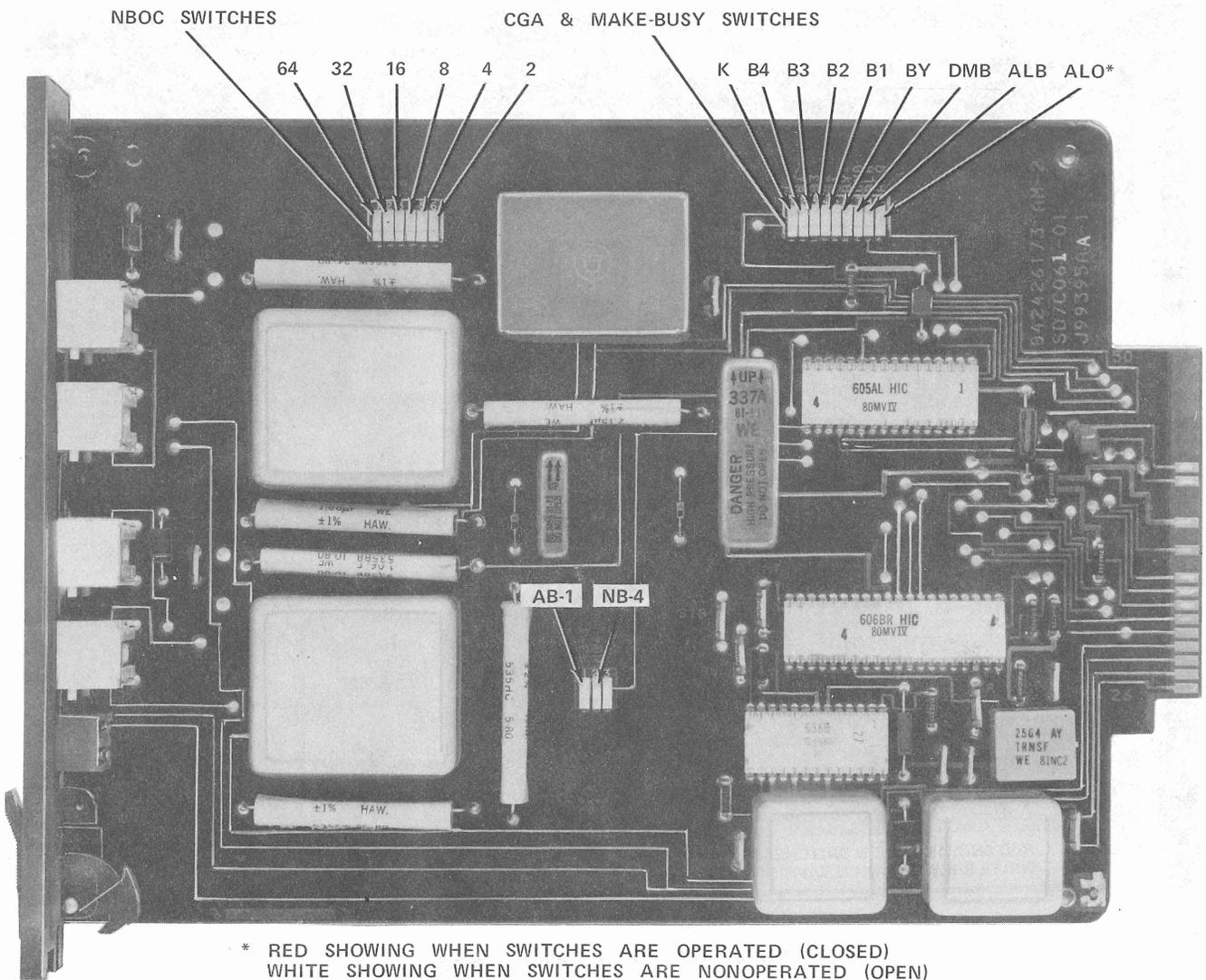


Fig. 2—GAA, GAB, GBA, and GBM Faceplates



* RED SHOWING WHEN SWITCHES ARE OPERATED (CLOSED)
 WHITE SHOWING WHEN SWITCHES ARE NONOPERATED (OPEN)

Fig. 3—GAA and GAB Printed Wiring Board

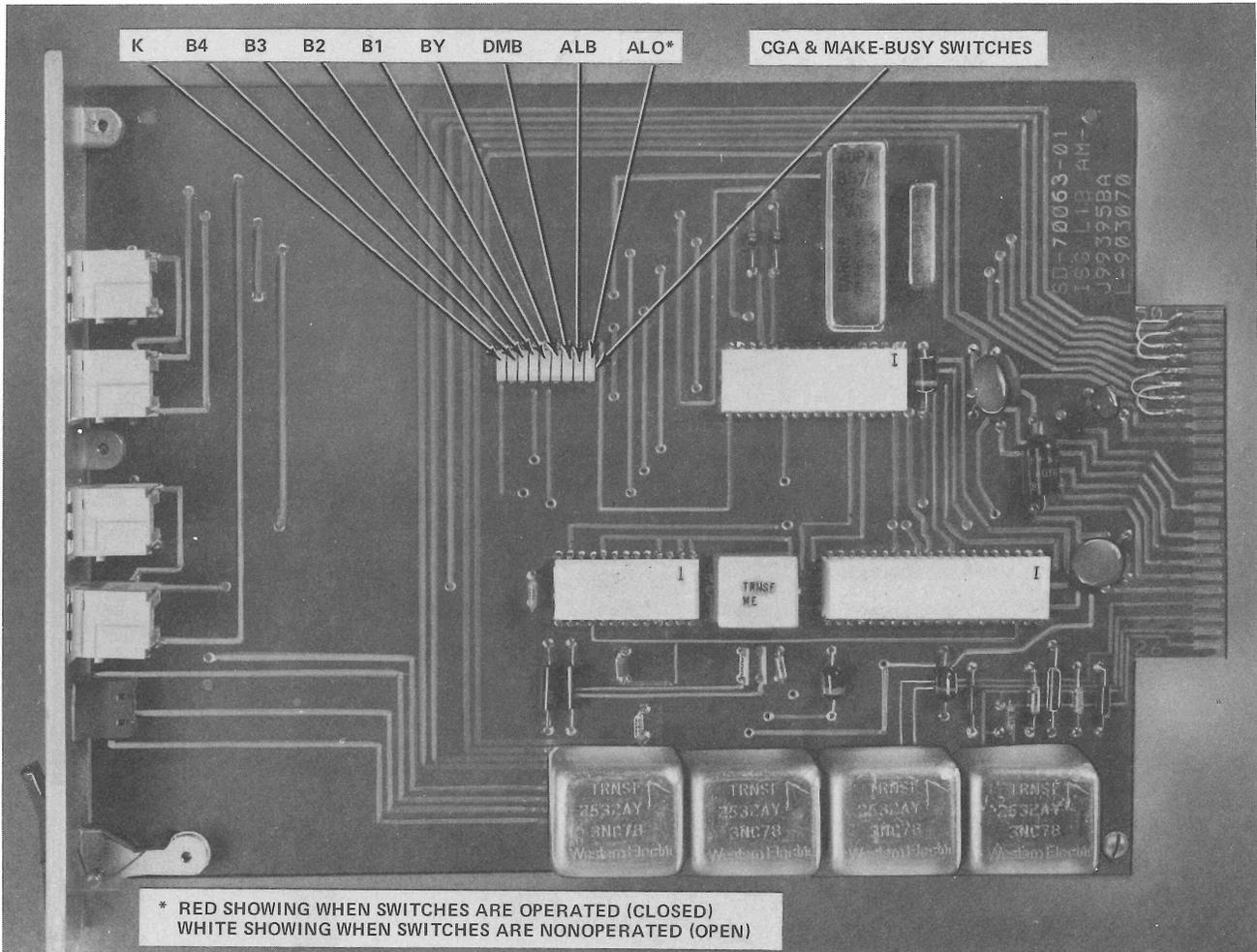
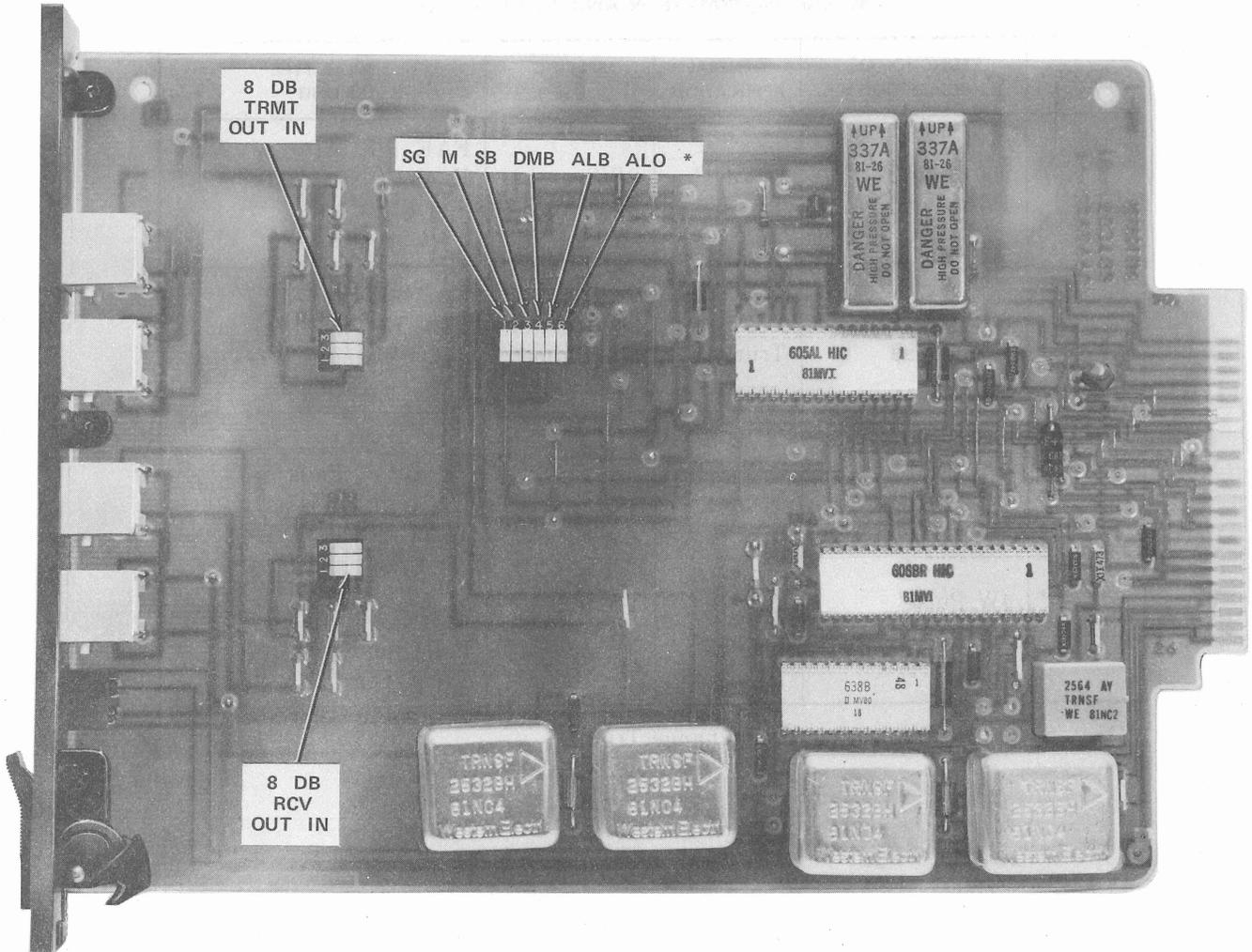


Fig. 4—GBA Printed Wiring Board



*RED SHOWING WHEN SWITCHES ARE OPERATED (CLOSED)
 WHITE SHOWING WHEN SWITCHES ARE NONOPERATED (OPEN)

Fig. 5—GBM Printed Wiring Board

TABLE A

**TYPE G SIGNALING UNITS
GENERAL INFORMATION AND APPLICATION**

CODE	FUNCTIONAL DESCRIPTION	GENERAL APPLICATION	SPECIFIC USE	SIMILAR TYPE SF UNIT
GAA	900-Ohm 2W E&M Lead	2-Way * Trunks	2-Wire Switching	FAE + FUA, E1A, E() B + Term. Set, FWA, or FWC + Term. Set
GAB	600-Ohm 2W E&M Lead	2-Way * Trunks	2-Wire Switching	FAF + FUA, E1A, E() B + Term. Set, FWA, or FWC + Term. Set
GBA	4W E&M Lead	2-Way * Trunks	4-Wire Switching DP or MF	FBC + FUA, E() B "P" Pads FWA, or FWC + Term. Set
GBM	4W Pulse Link Repeater	2-Way* Trunks	4-Wire Switching DP or MF	FBC + FUA, E() B "P" Pads FWA, or FWC + Term. Set

*Intertoll, Toll Connecting, or Exchange Trunks

TABLE B

COMPATIBILITY OF G-SIGNALING UNITS WITH E AND SF UNITS

		TERMINATING END																													
		GAA GAB		GBA GBM		GDA		FAA FAC FAD FAE FAF		FBA FBB FBC FBM FBN FBO		FDA FDB		FWA		FWB		FWC		E1AK E1AKD E1BK E1BKD		E2BK E2BKA E3BK E3BKA E4B		E2D		E3D		E4D		E5D	
		DP	MF	DP	MF	DP	MF	DP	MF	DP	MF	DP	MF	DP	MF	DP	MF	DP	MF	DP	MF										
		ORIGINATING END																													
GAA, GAB	DP	✓	✓	✓	✓	§	✓	✓	✓	✓	✓	§	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	§	✓	†,§	§				
	MF	✓	✓	✓	✓	§	✓	✓	✓	✓	✓	§	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	§	✓	†,§	§				
GBA, GBM	DP	✓	✓	✓	✓	§	✓	✓	✓	✓	✓	§	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	§	✓	†,§	§				
	MF	✓	✓	✓	✓	§	✓	✓	✓	✓	✓	§	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	§	✓	†,§	§				
GCA	DP	✓	✓	✓	✓	§	✓	✓	✓	✓	✓	§	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	§	✓	†,§	§				
	MF	✓	✓	✓	✓	§	✓	✓	✓	✓	✓	§	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	§	✓	†,§	§				
FAA, FAC FAD, FAE, FAF	DP	✓	✓	✓	✓	§	✓	✓	✓	✓	✓	§	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	§	✓	†,§	§				
	MF	✓	✓	✓	✓	§	✓	✓	✓	✓	✓	§	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	§	✓	†,§	§				
FBA, FBB, FBC FBM, FBN, FBO	DP	✓	✓	✓	✓	§	✓	✓	✓	✓	✓	§	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	§	✓	†,§	§				
	MF	✓	✓	✓	✓	§	✓	✓	✓	✓	✓	§	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	§	✓	†,§	§				
FCA	DP	✓	✓	✓	✓	§	✓	✓	✓	✓	✓	§	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	§	✓	†,§	§				
	MF	✓	✓	✓	✓	§	✓	✓	✓	✓	✓	§	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	§	✓	†,§	§				
FWA	DP	‡	‡	‡,§	‡	‡	‡	‡,§	‡	‡	‡	‡,§	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡								
	MF	✓	✓	✓	✓	§	✓	✓	✓	✓	✓	§	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓								
FWB	DP	‡	‡	‡,§	‡	‡	‡	‡,§	‡	‡	‡	‡,§	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡								
	MF	✓	✓	✓	✓	§	✓	✓	✓	✓	✓	§	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓								
FWC	DP		‡	‡,§	‡	‡	‡	‡,§	‡	‡	‡	‡,§	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡								
	MF	✓	✓	✓	✓	§	✓	✓	✓	✓	✓	§	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓								
E1AK, E1AKD, E1BK, E1BKD		*	✓	* ✓	* §	§	*	✓	* ✓	* ✓	* §	§																			
E2BK, E2BKA, E3BK, E3BKA, E4B		‡	‡	‡	‡	‡,§	§	‡	‡	‡	‡	‡,§	§																		
E2C		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓																		
E3C		✓	✓	✓	✓	§	✓	✓	✓	✓	✓	§	✓																		
E4C, E5C		✓	✓	✓	✓	§	§	✓	✓	✓	✓	§	§																		

* Transmission cut circuit SD-99778-01 required in all DP applications.
 † Release current of associated A relay or its equivalent must be greater than 3.7 ma.
 ‡ M lead pulse corrector SD-99766-06 required in all nonsenderized SXS applications.
 § Compatible only in association with trunk circuits having a long disconnect time (140 ms minimum).

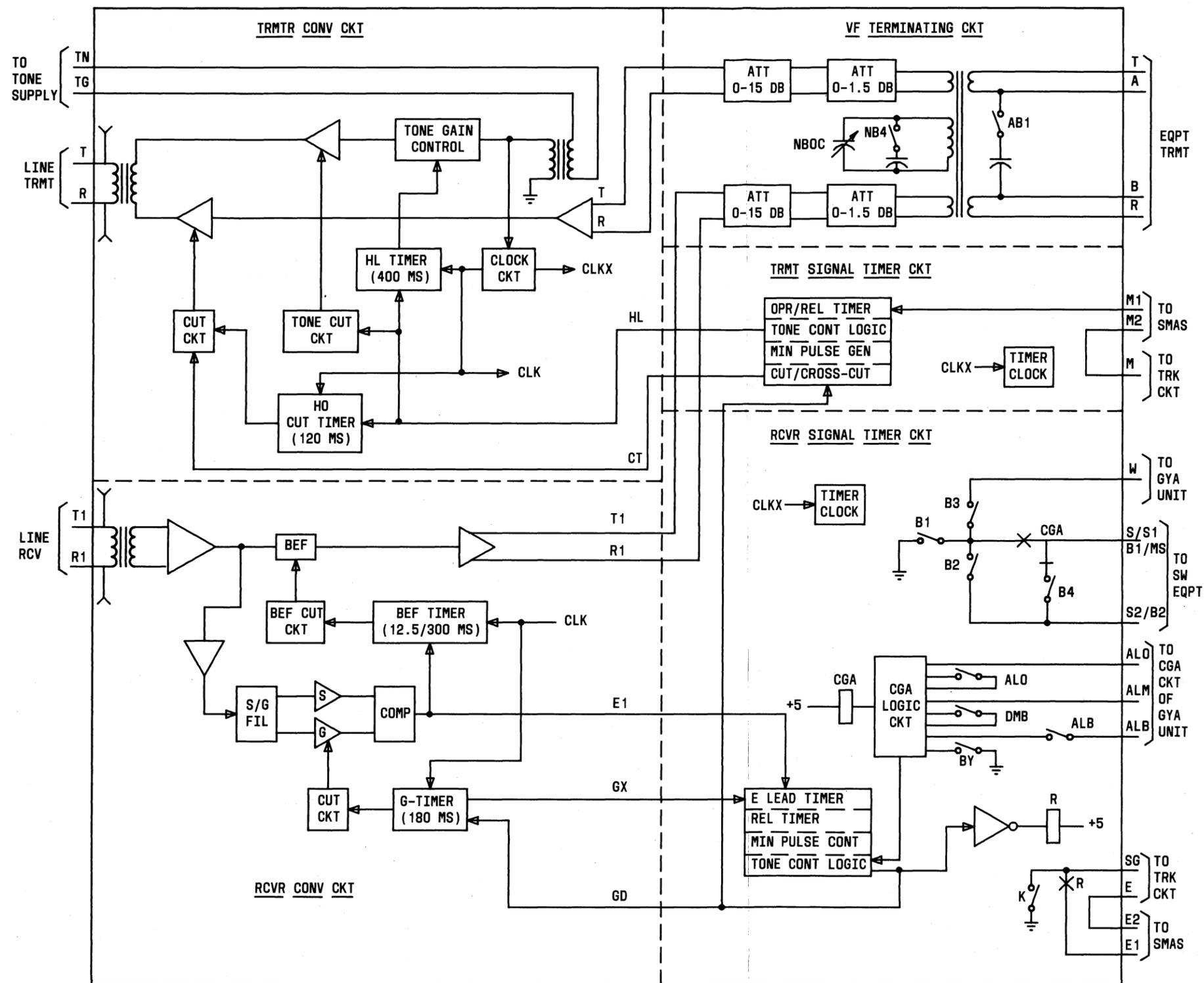


Fig. 6—Block Diagram of GAA and GAB Units

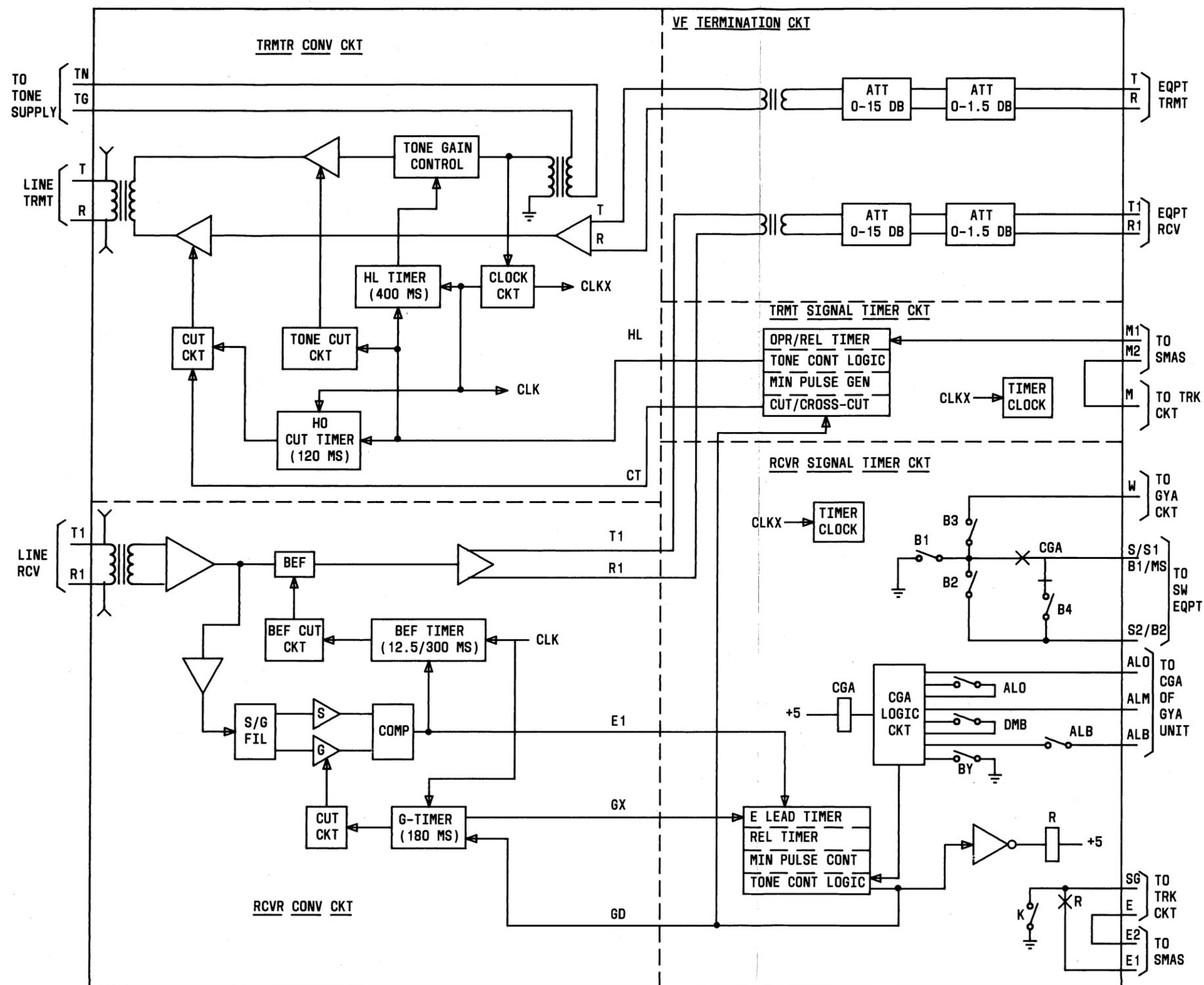


Fig. 7—Block Diagram of GBA Unit

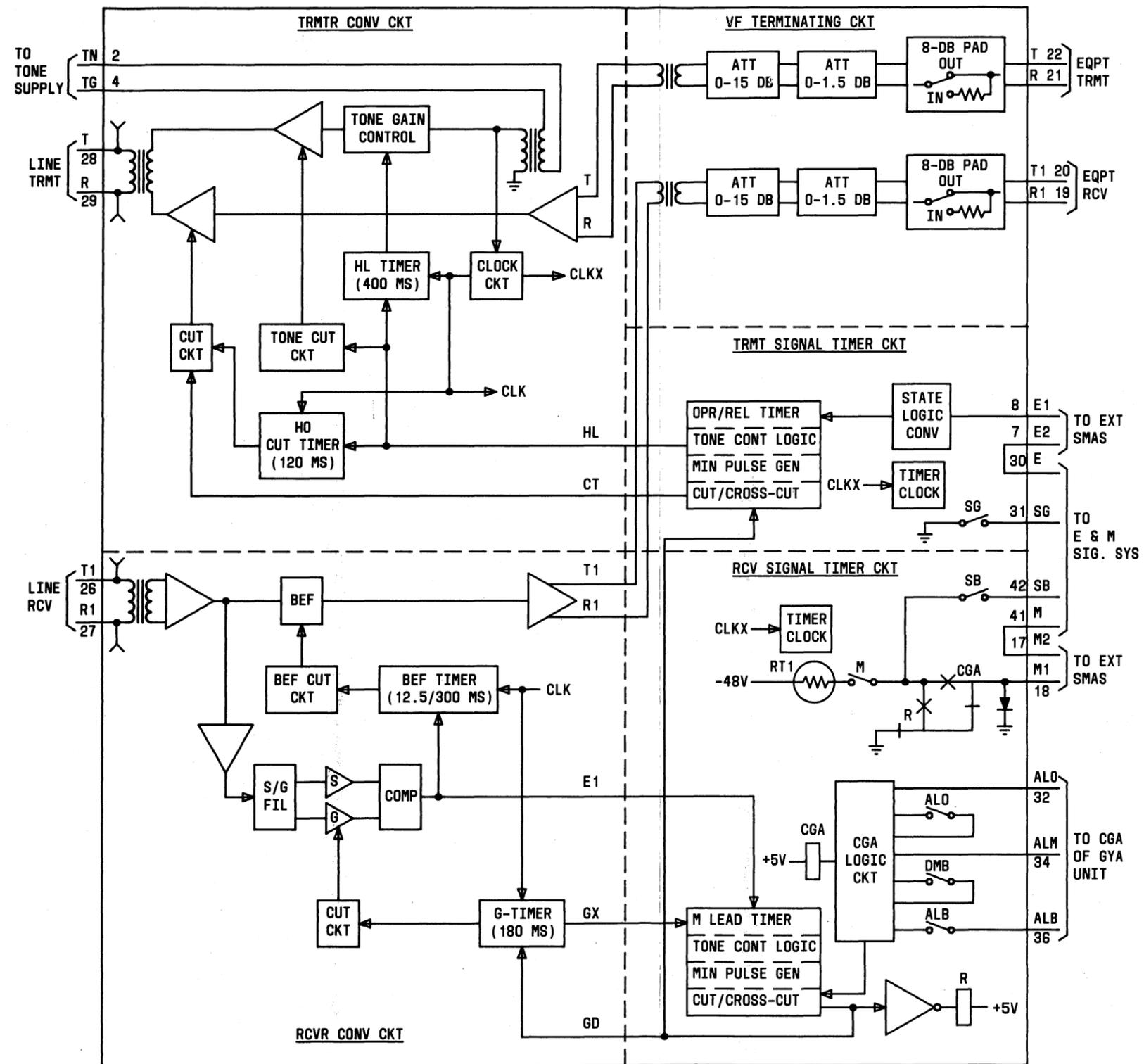


Fig. 8—Block Diagram of GBM Unit

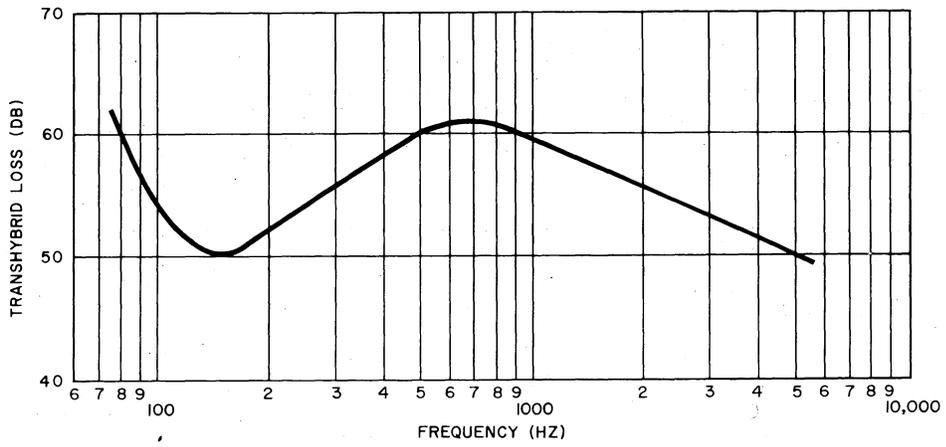


Fig. 9—Nominal Transhybrid Loss of GAA Unit

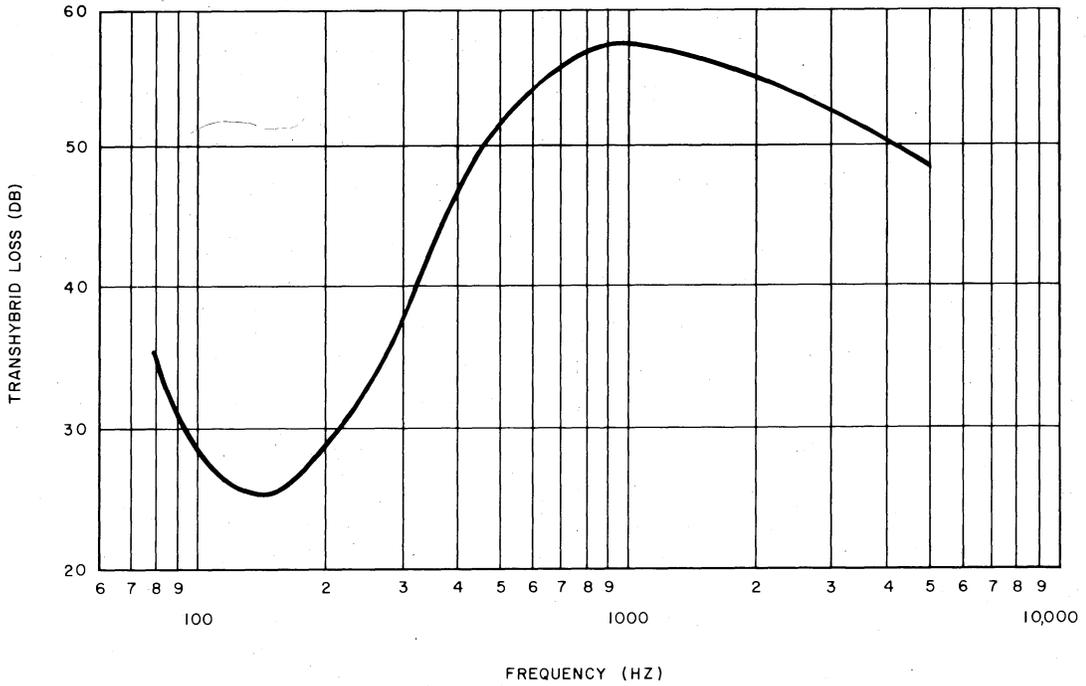


Fig. 10—Nominal Transhybrid Loss of GAB Unit

TABLE C

SF SIGNALS USED IN E AND M LEAD SIGNALING

GA_ OR GB_ UNIT (ORIGINATING END)				GA_ OR GB_ UNIT (TERMINATING END)			
SIGNAL OR STATE	M LEAD	E LEAD	SF TONE OUT	SF TONE OUT	E LEAD	M LEAD	SIGNAL OR STATE
Idle	Ground	Open	On	On	Open	Ground	Idle
Connect*	Batt	Open	Off	On	Ground	Ground	Connect
Stop Dialing	Batt	Ground	Off	Off	Ground	Batt	Stop Dialing*
Start Dialing	Batt	Open	Off	On	Ground	Ground	Start Dialing*
Dial Pulsing*	Ground Batt	Open	On Off	On	Open Ground	Ground	Dial Pulsing
Answer (Off-Hook)	Batt	Ground	Off	Off	Ground	Batt	Answer* (Off-Hook)
Ring Forward*	Ground	Ground	On	Off	Open	Batt	Ring Forward
Ringback	Batt	Open	Off	On	Ground	Ground	Ringback*
Flashing	Batt	Open Ground	Off	On Off	Ground	Ground Batt	Flashing*
Hang-up (On-Hook)	Batt	Open	Off	On	Ground	Ground	Hang-up* (On-Hook)
Disconnect*	Ground	Open	On	On	Open	Ground	Disconnect

* Terminal originating signal.

TABLE D

TYPES GA() AND GB() SIGNALING UNITS
CONDITION OF TRANSMITTING AND RECEIVING SPEECH PATHS RELATED TO CIRCUIT AND SIGNAL TONE CONDITIONS
(REFERENCES ARE TO SF UNIT AT NEAR END)

CIRCUIT CONDITION	SIGNAL TONE CONDITION		CONDITION OF TRANSMITTING SPEECH PATH			RECEIVING SPEECH PATH BANDSTOP FILTER
	OUTGOING	INCOMING	BEFORE	CHANGE	AFTER	
1. Idle	On	On	Cut	—	Cut	In circuit
2. Near End Seized	On-Off Transition	On	Cut	Stays cut additional 100-150 ms	Not Cut	In circuit
3. Far End Returns "Delay" Signal	Off	On-Off Transition	Not Cut	—	Not Cut	Switched out after 275-325 ms
4. Far End Returns "Start" Signal	Off	Off-On Transition	Not Cut	—	Not Cut	Switched in after 15±3 ms
5. Near End Dial Pulsing	Off-On Transition, Then On-Off, Off-On, Etc, End- ing with On-Off Transition	On	Not Cut	Cuts at first off-on tone transition and remains cut as long as outgoing make intervals (tone-off) are less than 110-130 ms. Remains cut 110-130 ms after last outgoing dial pulse (tone-on interval)	Not cut	In circuit
6a. Far End Answers— Free Call	Off	On	Not Cut	—	Not Cut	In circuit
6b. Far End Answers— Pay Call	Off	On-Off Transition	Not Cut	—	Not Cut	Switched out after 275-325 ms
7. Talking—Pay Call	Off	Off	Not Cut	—	Not Cut	Out of circuit
8. Near End Hangs Up First	Off-On Transition	Off	Not Cut	Cuts at off-on tone transition and remains cut for 570-600 ms	Not Cut	Out of circuit
9. Far End Hangs Up Later	On	Off-On Transition	Not Cut	Cut after 35 ms	Cut	Switched in after 15±3 ms
10a. Idle	On	On	Cut	—	Cut	In circuit
10b. Far End Seized	On	On-Off Transition	Cut	Stays cut additional 630-670 ms	Not Cut	Switched out after 275-325 ms
11. Near End Returns "Delay" Signal	On-Off Transition	Off	Not Cut	Cuts at on-off tone transition and remains cut for 110-130 ms	Not Cut	Out of circuit
12. Near End Returns "Start" Signal	Off-On Transition	Off	Not Cut	Cuts at off-on tone transition and remains cut for 570-600 ms	Not Cut	Out of circuit
13. Far End Dial Pulsing	On	Off-On Transition, Then On-Off, Off-On, Etc, End- ing with On-Off Transition	Not Cut	Cut as long as incoming on-off transi- tions are less than 600-630 ms apart. Remains cut 600-630 ms after last incoming on-off transition	Not Cut	Switched in after 15±3 ms. Remains in circuit until 275-325 ms after last incoming on-off transition
14a. Near End Answers —Free Call	On	Off	Not Cut	—	Not Cut	Out of circuit
14b. Near End Answers —Pay Call	On-Off Transition	Off	Not Cut	Cut for 110-130 ms	Not Cut	Out of circuit
15. Talking—Pay Call	Off	Off	Not Cut	—	Not Cut	Out of circuit
16. Far End Hangs Up First	Off	Off-On Transition	Not Cut	—	Not Cut	Switched in after 15±3 ms
17. Near End Hangs Up Later	Off-On Transition	On	Not Cut	Cut	Cut	In circuit
18. Idle	On	On	Cut	—	Cut	In circuit

TABLE E

CGA TRUNK-RELEASE AND DELAY MAKE-BUSY ARRANGEMENTS

SF UNIT	TYPE OF APPLICATION	FEATURE	SWITCHES TO BE CLOSED (NOTES 1 AND 2)
GAA GAB GBA	2-Way or 1-Way Outgoing— With Circuit Patchbay (Excluding ESS Offices)	Circuit Release — Delayed Make-Busy	ALB, BY, DMB
	1-Way Incoming	Circuit Release	BY
	No. 1 or No. 2 ESS Offices	Circuit Release	BY
	No. 1 Crossbar or Crossbar Tandem — 2-Way or 1-Way Outgoing — Without Circuit Patchbay	Circuit Release Make-Busy	B1
	No. 4 Crossbar — 2-Way or 1-Way Outgoing — Without Circuit Patchbay	Circuit Release Make-Busy	B1
	No. 5 Crossbar — 2-Way or 1-Way Outgoing — Without Circuit Patchbay	Circuit Release Make-Busy	B2
	Step-by-Step — 1-Way Incoming (Calling Cust Disc) Joint Hold (Cust and OPR Disconnect)	Circuit Release — Delay Make-Busy	ALB, B3 B4, DMB
GBM	2-Way or 1-Way Outgoing With Circuit Patchbay	W/ALM OVRD	ALO, ALB, DMB
		W/O ALM OVRD	ALB, DMB
	1-Way Incoming	W/ALM OVRD	ALO
		W/O ALM OVRD	

Notes:

1. When the switches are operated to the ON (closed) position, the red numbers are visible and when operated to the OFF (open) position, the white numbers are visible.
2. When alarm-override is required, operate the ALO switch to the ON (closed) position.

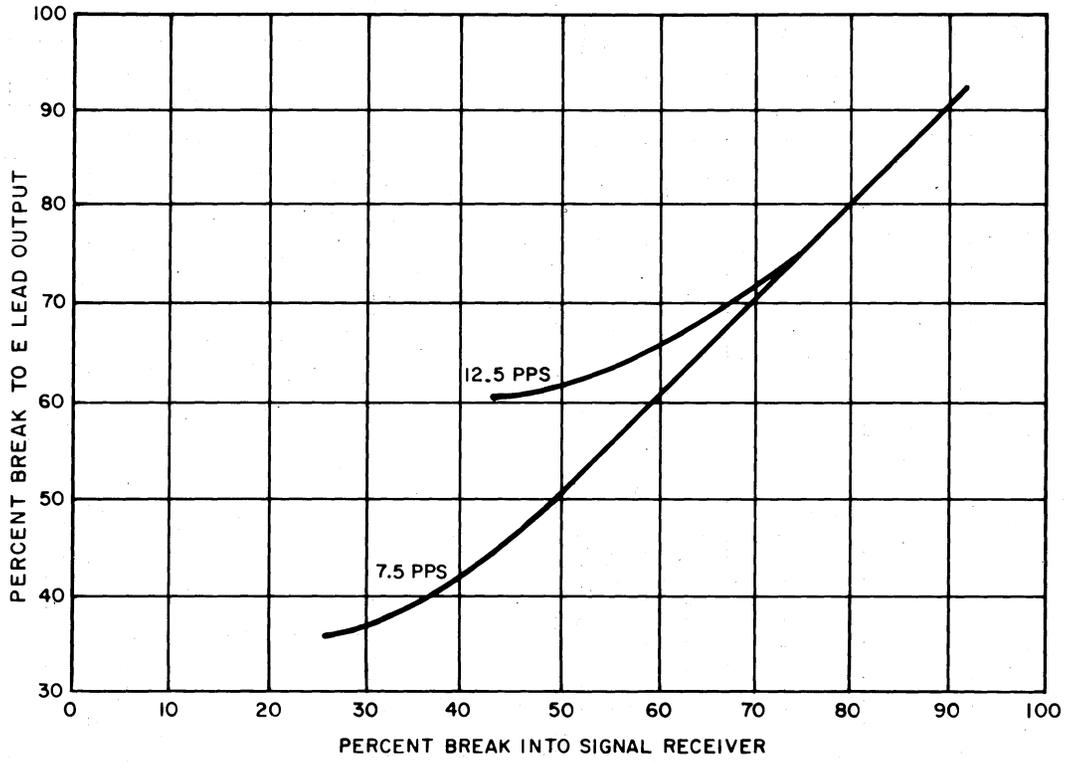


Fig. 11—Receive Pulse Correction for the GA() and GB() Units

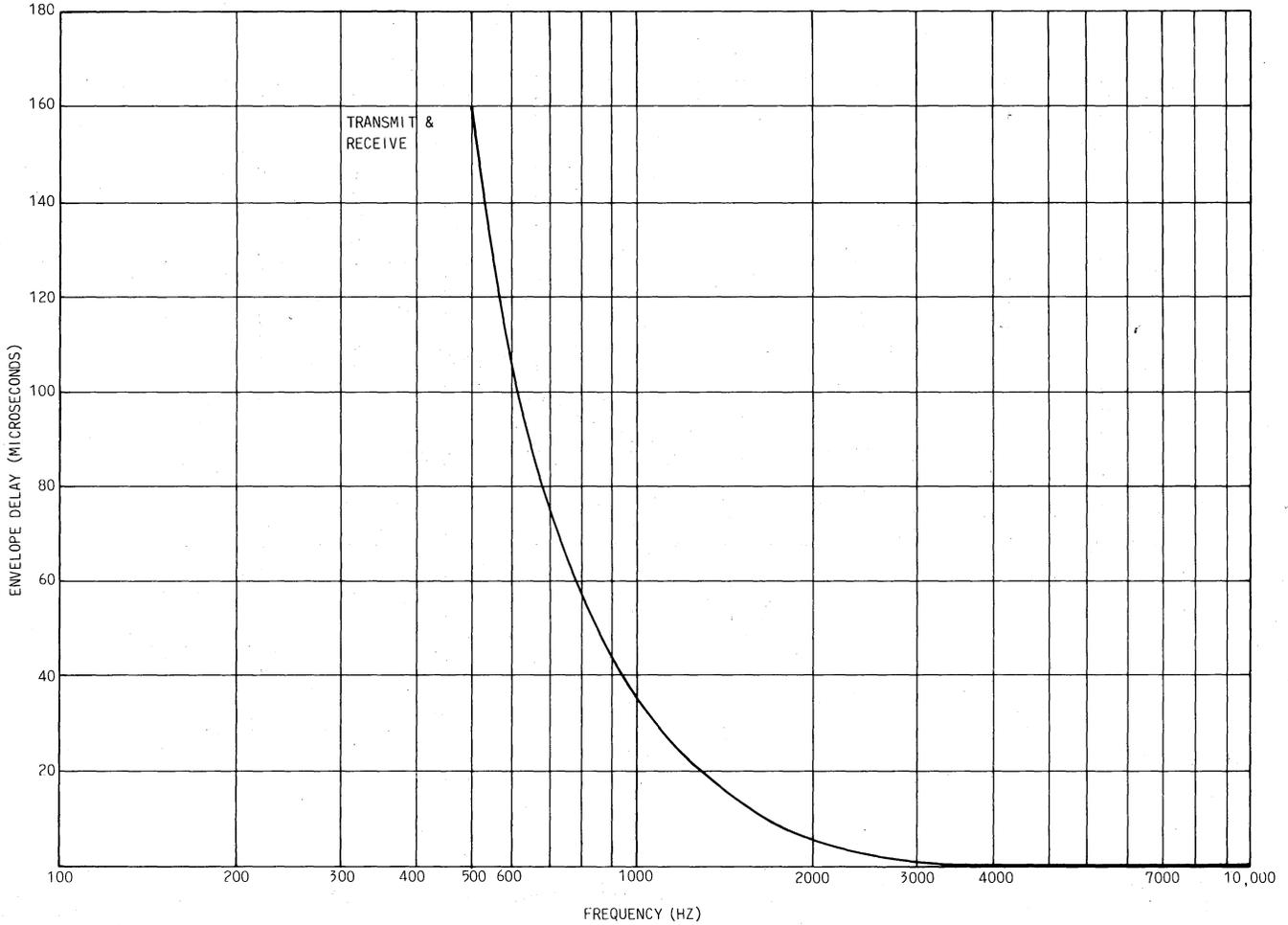


Fig. 12—Nominal Envelope Delay for the GA() Units

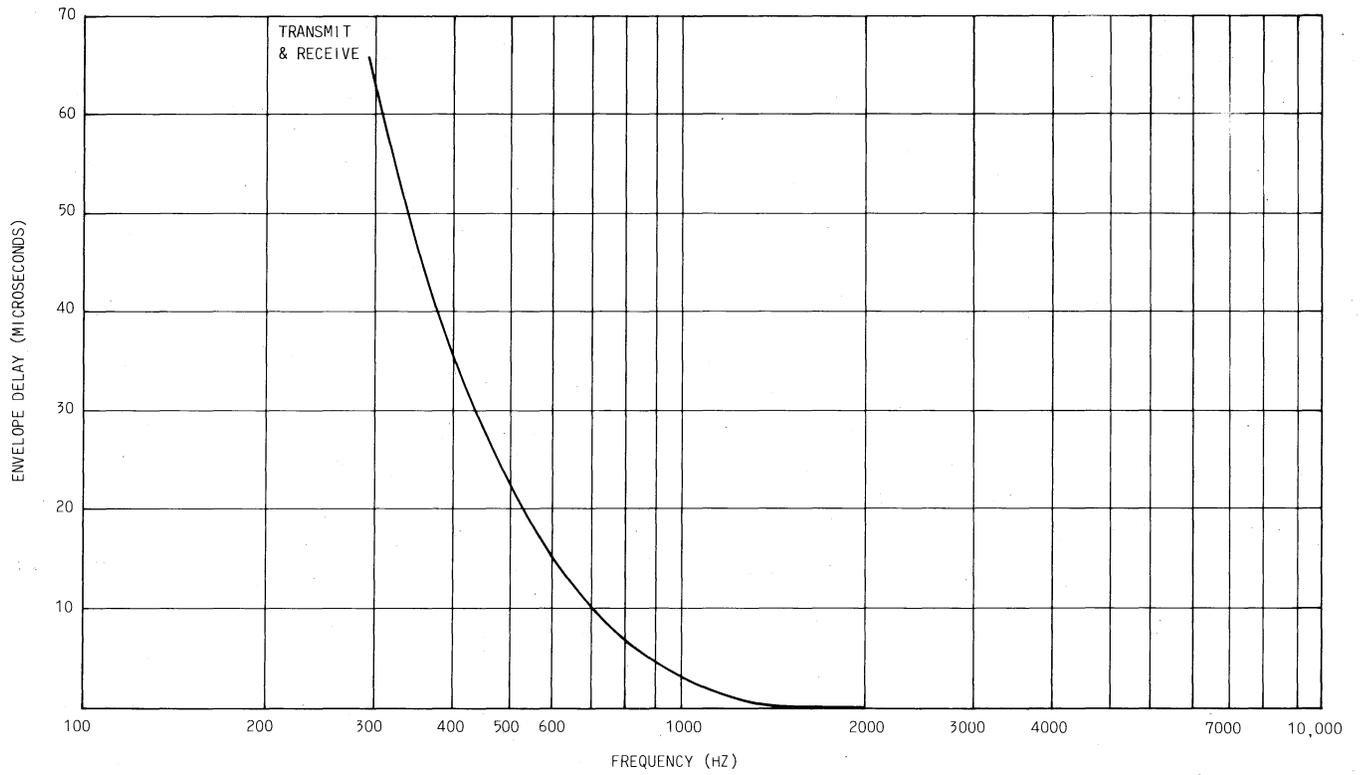


Fig. 13—Nominal Envelope Delay for the GB() Units

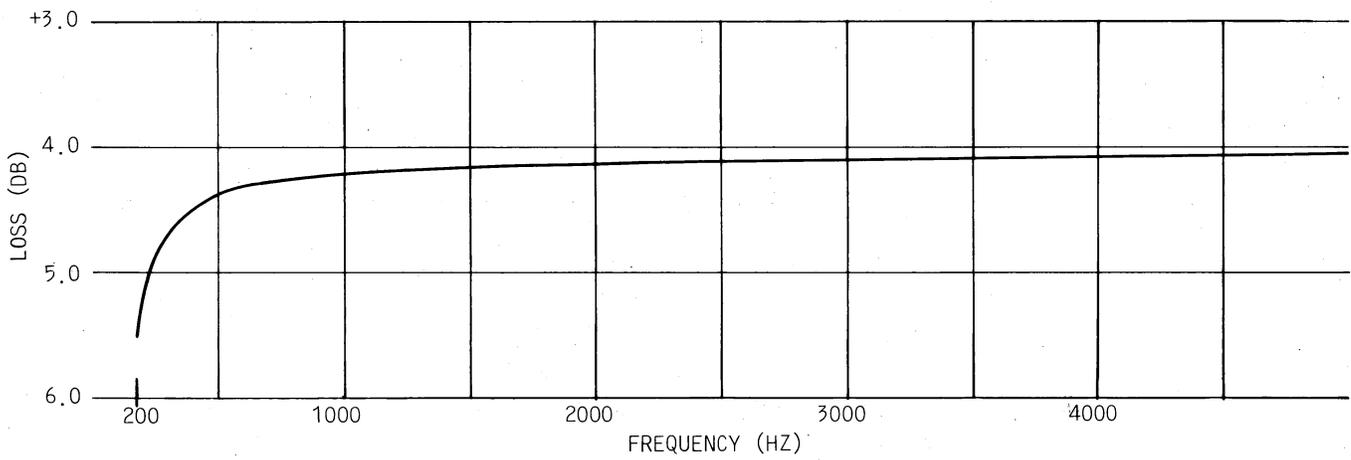


Fig. 14—Nominal Insertion Loss for Transmit and Receive Circuits of GAA Units With BEF OUT and Attenuators Set on Zero

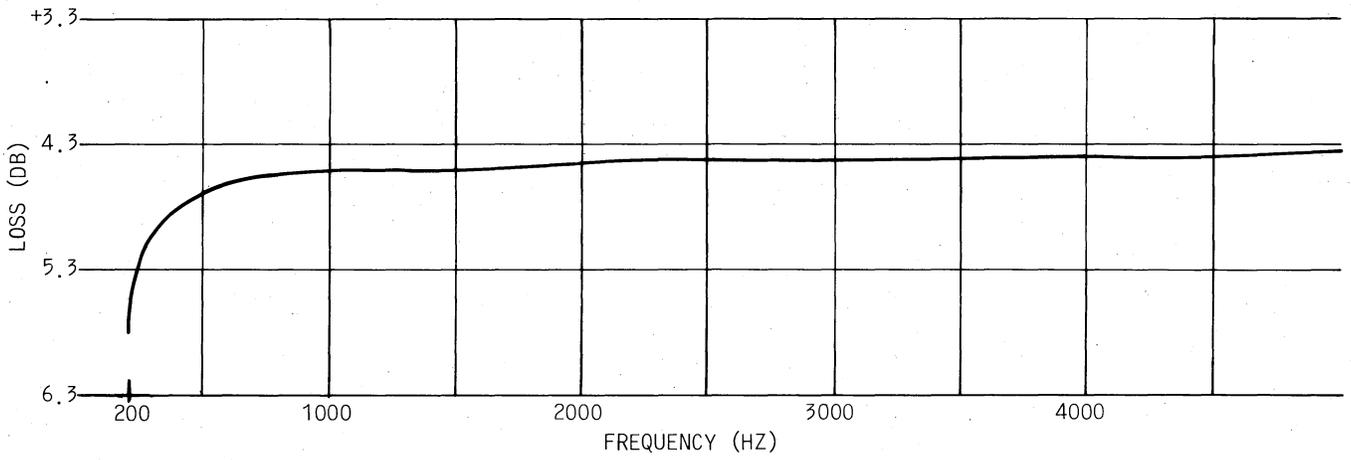


Fig. 15—Nominal Insertion Loss for Transmit and Receive Circuits of GAB Units With BEF OUT and Attenuators Set on Zero

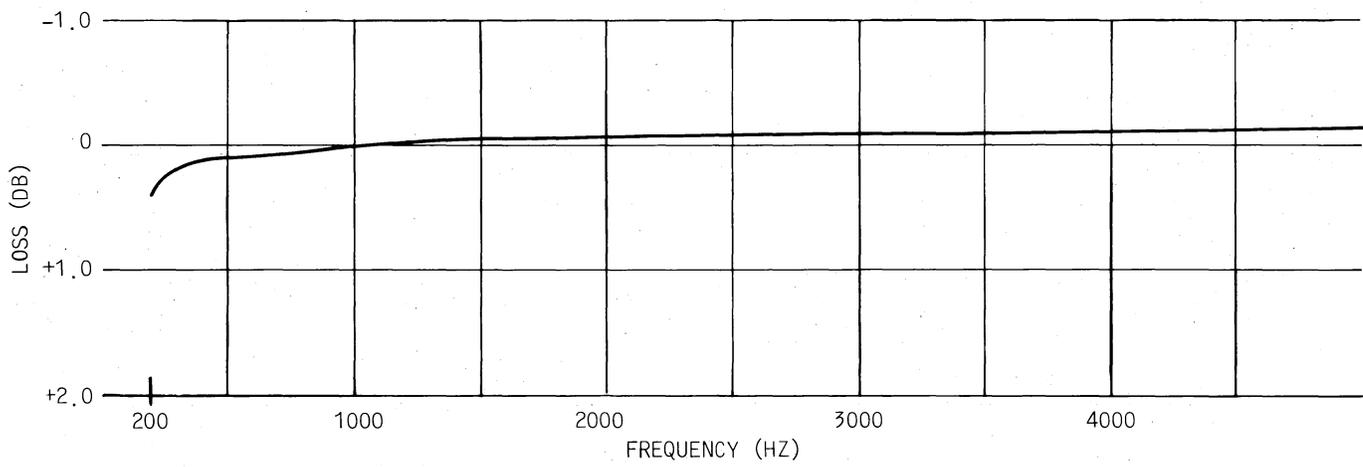


Fig. 16—Nominal Insertion Loss for Transmit and Receive Circuits of GB() Units With BEF OUT and Attenuators Set on Zero

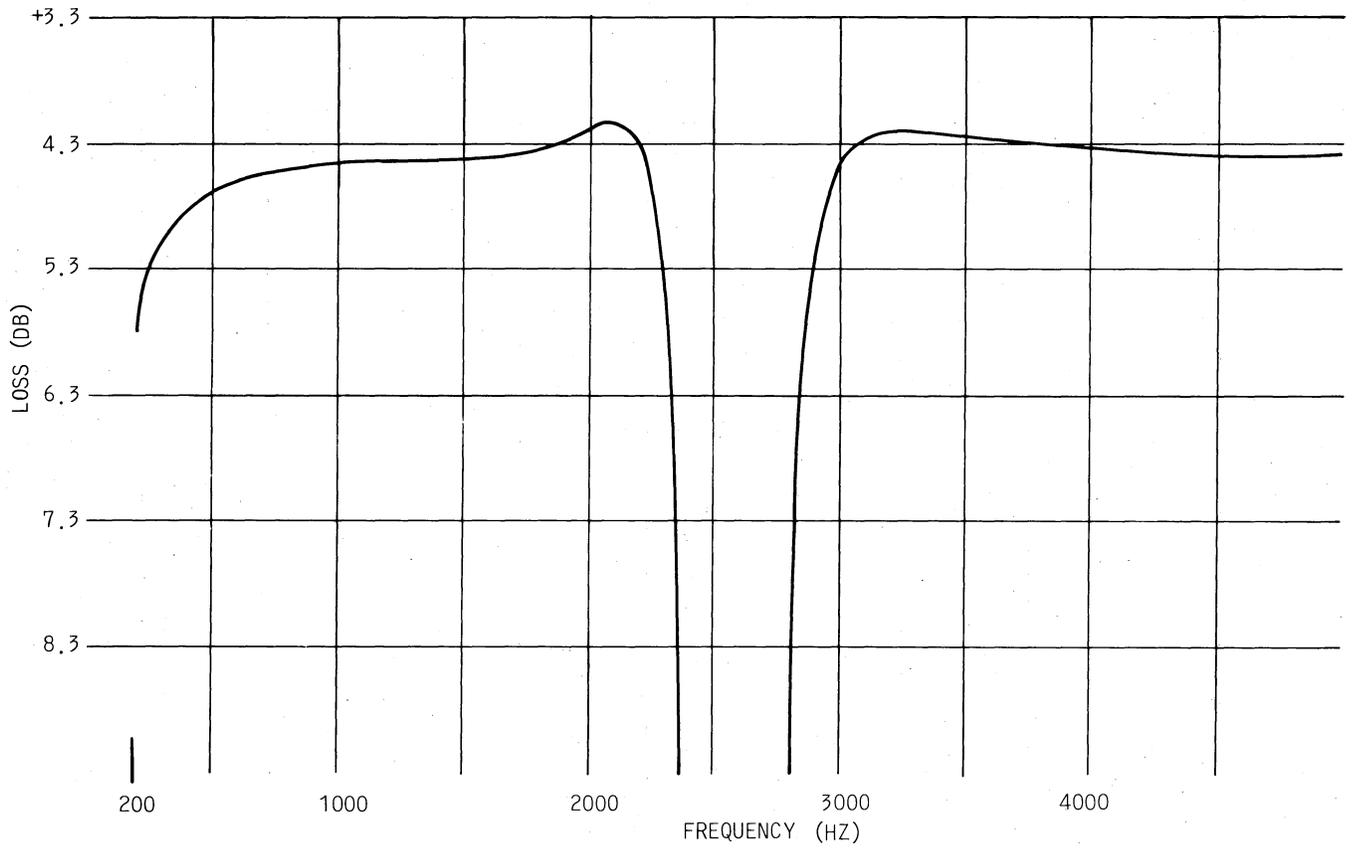


Fig. 17—Nominal Insertion Loss for Receive Circuit of GAA Units With BEF IN the Circuit and Attenuators Set on Zero

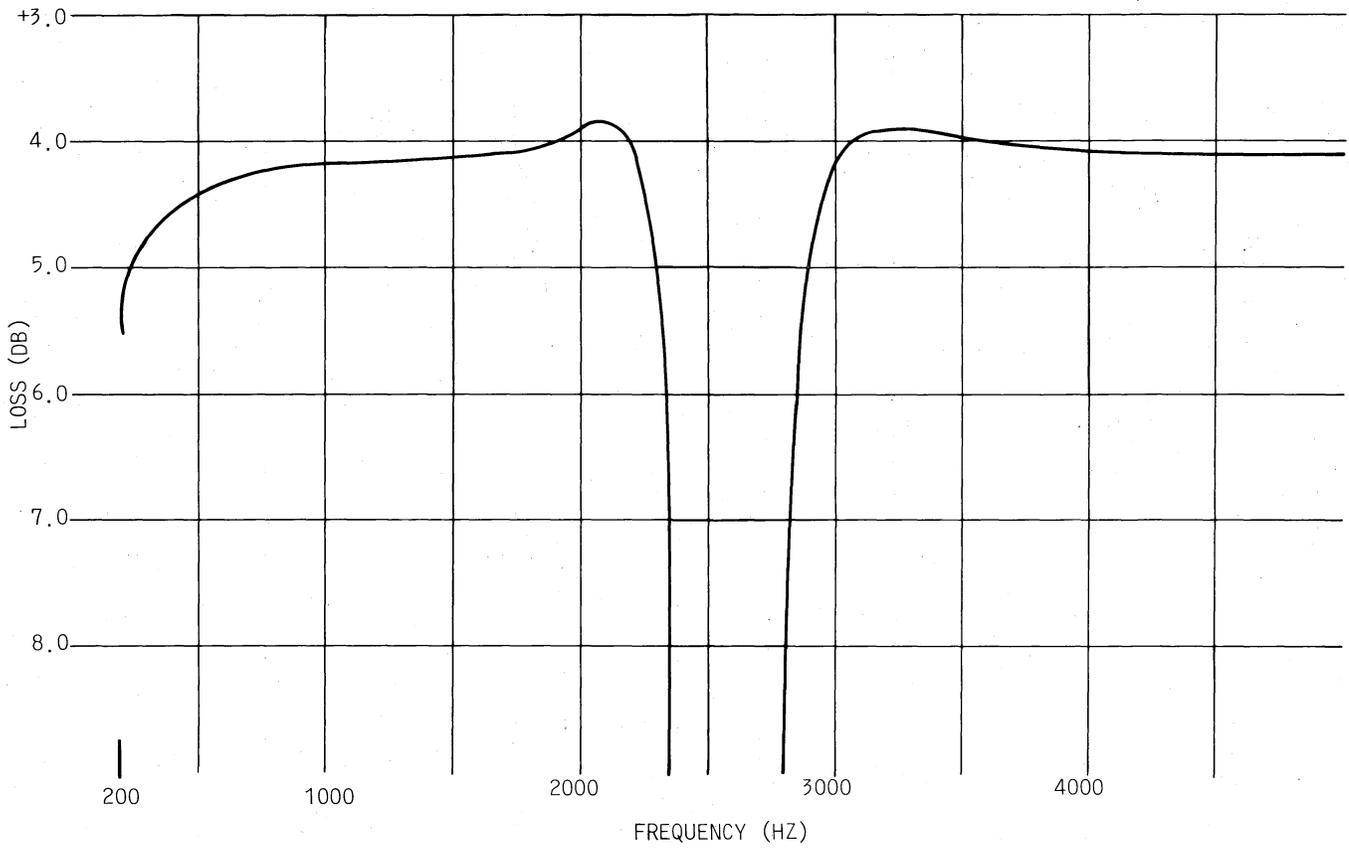


Fig. 18— Nominal Insertion Loss for Receive Circuit of GAB Units With BEF IN the Circuit and Attenuators Set on Zero

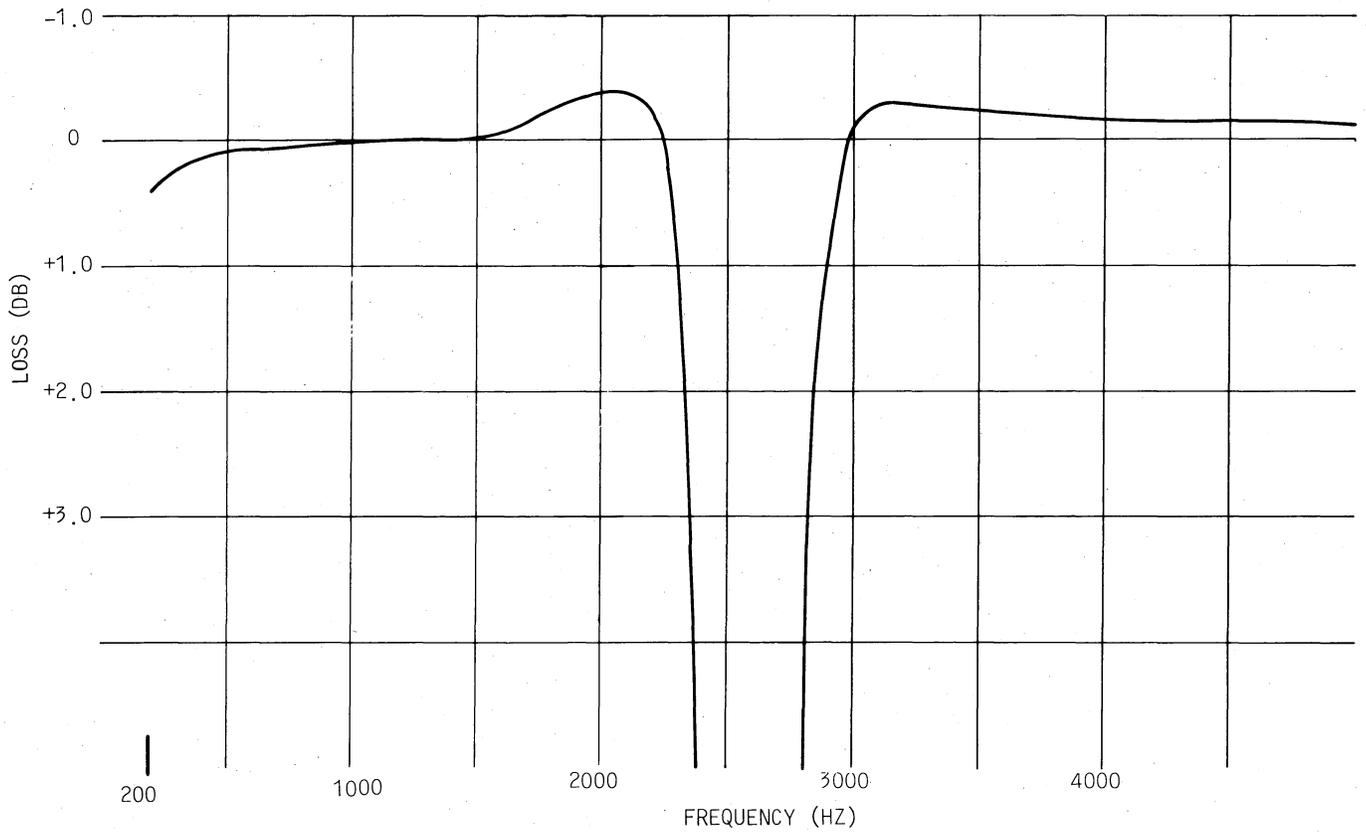


Fig. 19—Nominal Insertion Loss for Receive Circuit of GB() Units With BEF IN the Circuit and Attenuators Set on Zero

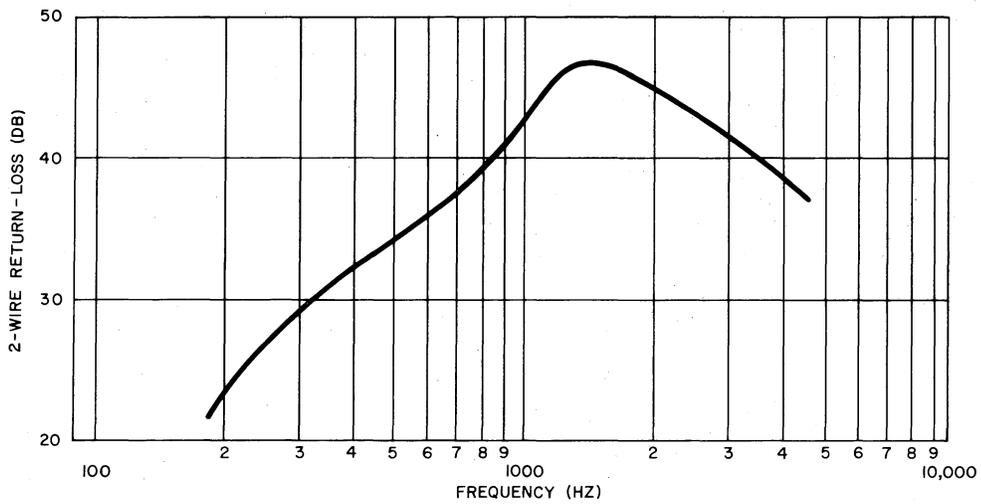


Fig. 20—Nominal Return Loss—Frequency Characteristics of GA() Units—2-Wire Side Against 900 Ohms Plus 2.15 μ fd