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Standard N

"COMPANION*" AND "LOGIC*" HANDS-FREE UNITS

QUS1A, QUS1B, AND QUS1C

SHOP REPAIR

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1. INTRODUCTION

1.01 This section describes electrical and mechanical shop repair procedures for the QUS1A and the QUS1B COMPANION Hands-Free Units (HFU) and the QUS1C LOGIC HFU.

1.02 These procedures include a summary of the operating characteristics of the HFU, operation tests, disassembly procedures, and overall and specific fault location guides.

1.03 The overall fault location guide is used in conjunction with unit operation tests and provides assistance in troubleshooting with the unit fully assembled.

1.04 The specific fault location procedures are used to test the relay and printed circuit boards, when removed from the unit.

1.05 An acoustic test is described which is used to check the integrity of the acoustic sealing of the case when the unit is reassembled.

1.06 Other information supplied, includes a list of test equipment required, location of test points, and assembly and ordering information. A circuit description of the PCB, illustrated by relevant schematics, is given in Part 3.

2. OPERATING CHARACTERISTICS

2.01 The COMPANION hands-free unit is supplied in two configurations.

- QUS1A COMPANION 1 (Fig. 1) – a cord connected unit, primarily used in residential locations
- QUS1B COMPANION 2 (Fig. 2) – a cord connected unit, primarily used in business locations

2.02 The LOGIC hands-free unit is supplied in a single configuration, QUS1C (Fig. 3) and is a plug-connected unit for use with telephone sets of the LOGIC series.

2.03 The features of the COMPANION and the LOGIC hands-free units are listed in Table A. For further information on these features, refer to Section 512-6251-200.

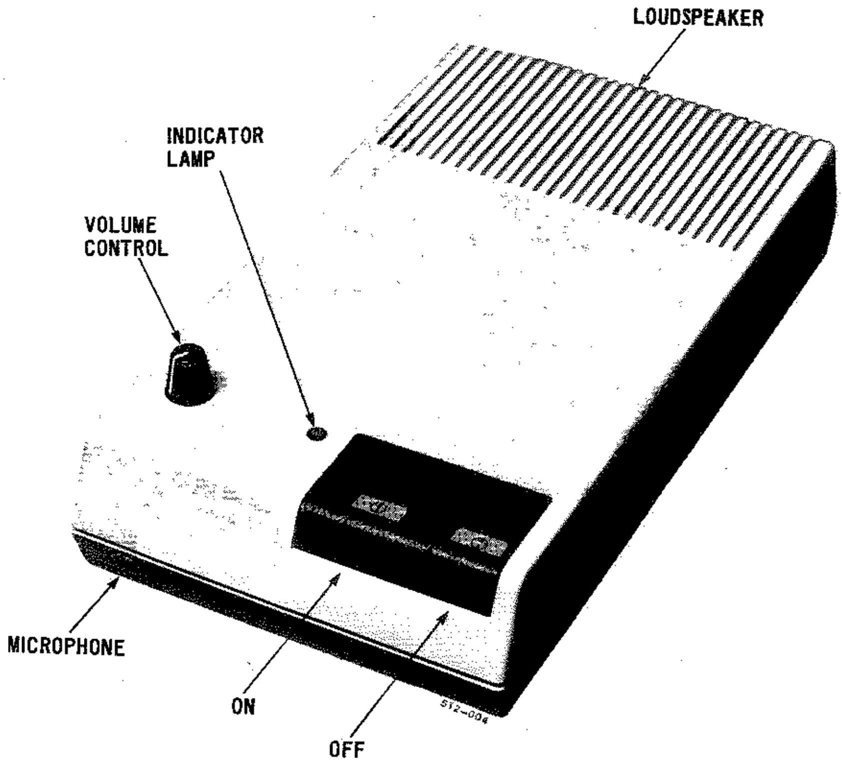


Fig. 1 – QUS1A – COMPANION 1 – HFU

POWER SUPPLIES

2.04 The power supply may be obtained, for a single unit, from a separately mounted transformer (NE-2012B, or equivalent). For multiple installations a common power supply may be used. This entails the selection of a transformer capable of supplying an open-circuit voltage at 25 V ac. When fully loaded, with all HFU operating, the transformer should deliver not less than 16 V ac at each HFU. The maximum load of the HFU is calculated as 100 mA.

> ***Caution:** On multiple installations each unit must be connected directly to the transformer terminals. Multiple connections are not to be made between HFU.*
>
> *Note 1:* For single installations component protection is provided by the source impedance of the NE-2012B transformer, when used. This protection may not be provided with other power supplies.
>
> *Note 2:* Neither side of the power supply shall be grounded.

2.05 Power supply connection may be made via spare conductors in the telephone set mounting cord, or via a separate two conductor mounting cord. Conductor size may be 22, 24, or 26 gauge, but with the following cable length limitations.

- 22 AWG – 400 feet, max.
- 24 AWG – 250 feet, max.
- 26 AWG – 150 feet, max.

CONTROLS AND MODE INDICATOR

2.06 The COMPANION and the LOGIC HFU are equipped as follows.

A. Volume Control

2.07 A rotary, potentiometer control is used to set the loudspeaker volume. Operation of this control does not affect the level of the transmitted signal.

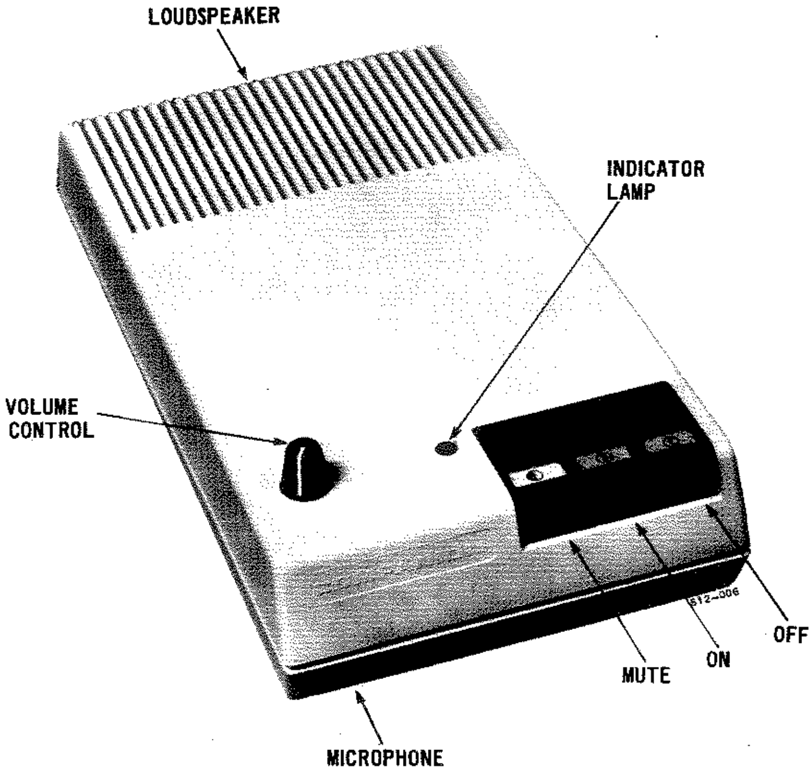


Fig. 2 — QUS1B — COMPANION 2 — HFU

B. "ON" Key

2.08 A piano-type key is used to "switch-on" the HFU. This key must be depressed momentarily to perform on-hook dialing at the telephone set, or to answer an incoming call with the handset on-hook. To transfer to hands-free operation during a call, the key must be held depressed until the handset is replaced on-hook, at the telephone set. To hold a call with transmission and reception simultaneously cut off, the key is maintained in the depressed position. This key is designated by a green identification symbol on the key face.

C. "OFF" Key

2.09 A nonlocking piano-type key is momentarily depressed to terminate a call. This key is designated by a red identification symbol on the key.

Note: The QUS1A COMPANION 1 is not equipped with automatic cutoff. To transfer from hands-free to handset operation the OFF key must be held depressed until the handset is lifted at the telephone set.

D. Mute Key

2.10 For the QUS1B and the QUS1C, only, a piano type key is provided to cut off transmission during a call. This does not affect reception. Transmission is cut off only while the key is held depressed. This key is designated by an amber identification symbol on the keyface.

E. Mode Indicator

2.11 A red, Light Emitting Diode (LED) is used to monitor the voice switching circuit of the unit. The LED is lit when the unit is in the transmit mode and unlit when the unit is in the receive mode.

FUNCTIONAL DIFFERENCES BETWEEN HFU

2.12 The QUS1A and the QUS1B, COMPANION, HFU differ from each other, functionally, in the following particulars.

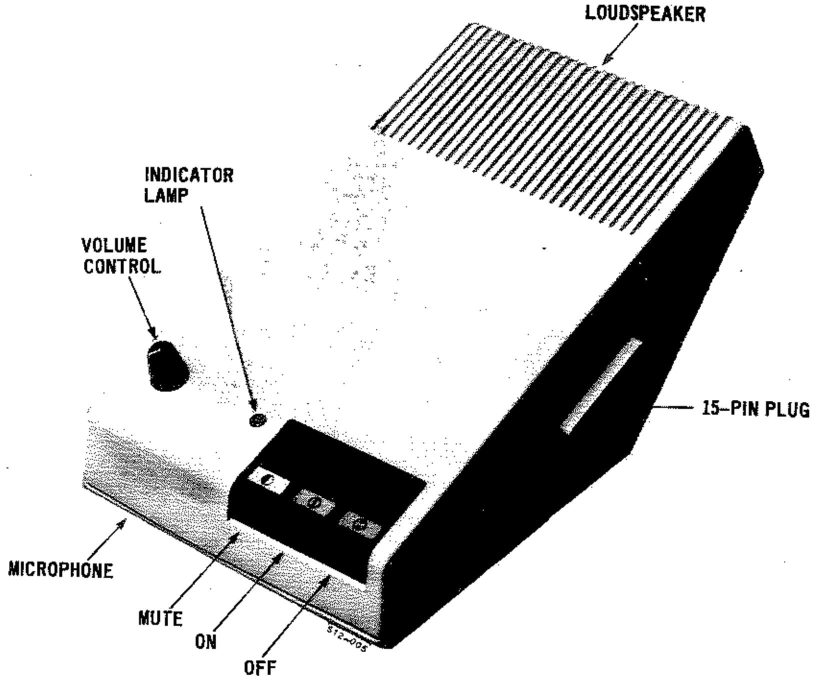


Fig. 3 — QUS1C — LOGIC — HFU

2.13 *QUS1A, COMPANION 1 (Fig. 1).* This unit is designed for use with single line, rotary or pushbutton dial residential telephone sets. The unit, which incorporates basic hands-free service is equipped with only two control keys: — ON and OFF. This model does not include on-hook dialing, automatic transfer, hold, or transmit muting. The unit is equipped with a 4-conductor, NE-D4QD, retractile, mounting cord for connection to the associated telephone set and power source.

2.14 *QUS1B, COMPANION 2 (Fig. 2).* This unit is designed to be used in business applications and is compatible with rotary or pushbutton dial telephone sets. The unit is equipped with ON, OFF and MUTE control keys and features automatic cutoff, on-hook dialing, station busy lamp and ringer cutoff facilities. The unit is equipped with a 16-conductor NE-D16QC mounting cord for connection to the associated telephone set and power source.

2.15 *QUS1C, LOGIC HFU (Fig. 3).* This unit, which is functionally identical to the QUS1B, COMPANION 2, is supplied with a 15 pin integral plug for plug-in attachment to any of the LOGIC series of telephone sets. The plug mates with a matching jack on the side of the associated LOGIC telephone set and permits connection to the power source and all lines of the telephone set.

TABLE A
COMPARISON OF COMPANION AND LOGIC HFU

FEATURES	QUS1A	QUS1B	QUS1C
Access to CO or PBX lines	●	●	●
Compatible with Key Telephone System	●**	●	●
"A" Lead Control		●	●
Automatic Cutoff		●	●
On-Hook Dialing * †		●	●
Transmit Muting		●	●
Transmit and Receive Muting	●	●	●
Common Signal or Bridged Ringer Cutoff		●	●
External Busy Lamp or Relay Control		●	●
Auxiliary Transfer Contacts for Optional Control ‡		●	
Indicator Lamp	●	●	●
Three Key – Electrical Control		●	●
Two Key – Mechanical Lock Control	●		
4-Conductor Retractile Cord	●		
16-Conductor Cord		●	
15-Pin Connector			●

* Presupposing that on-hook dialing is physically possible on the associated telephone set.

† This feature is compatible with rotary and pushbutton dial sets. Pushbutton dial sets require a special dial, e.g., NE-35Q3B or equivalent.

‡ Available only if transfer contacts of the relay have not already been used, e.g., for on-hook dialing.

** If "A" lead control is not required.

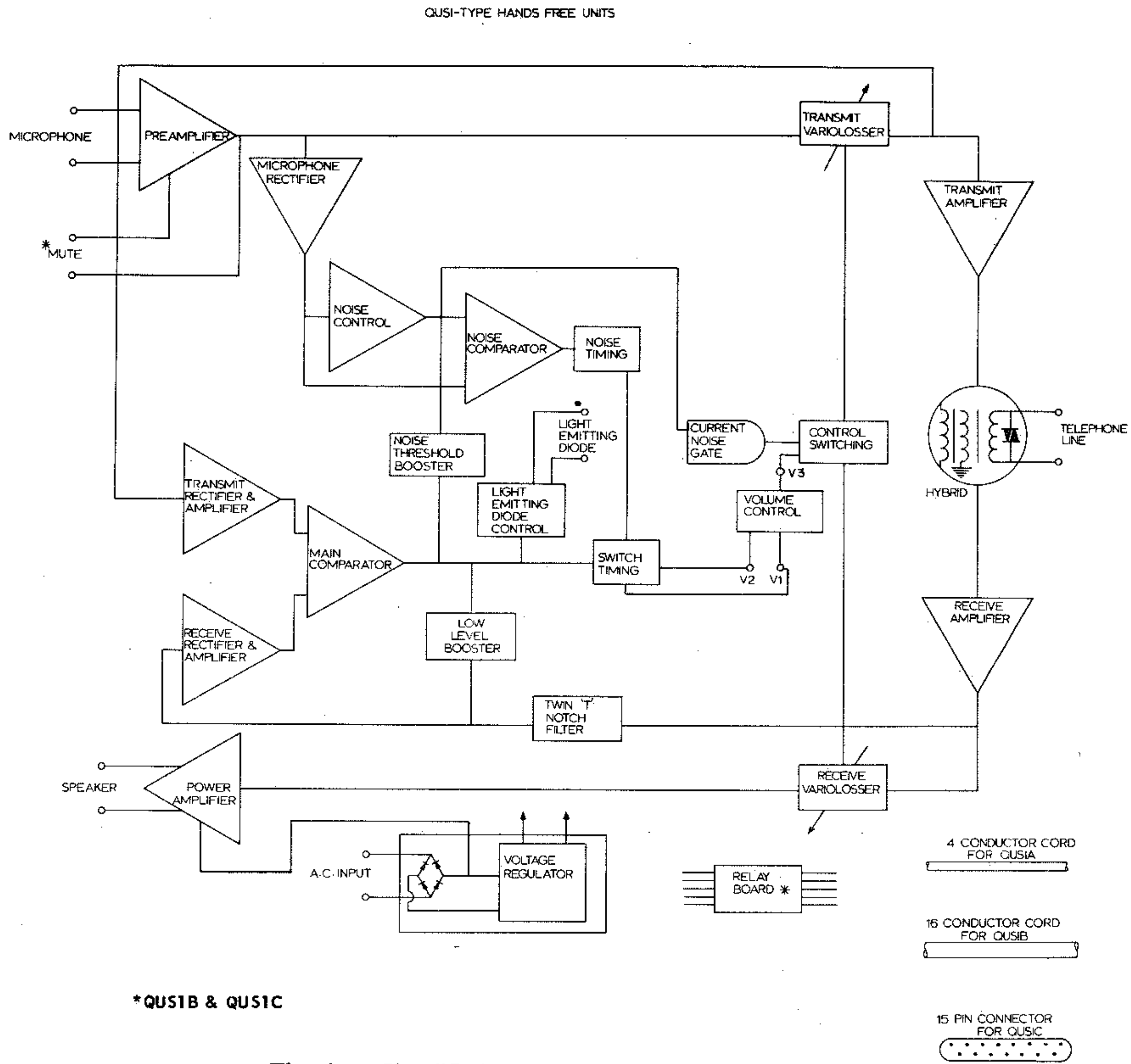


Fig. 4 — Simplified Block Schematic of the PCB

3. PRINTED CIRCUIT BOARD (PCB) CIRCUIT DESCRIPTION

SUMMARY

3.01 The hands-free unit (see simplified block diagram, Fig. 4) operates in one of three modes; transmit, receive or standby. In the active modes, when either the line (receive) or the voice (transmit) signal is greater than the other, the corresponding channel (receive or transmit) is switched-on. This prevents oscillation due to speaker/microphone or hybrid sidetone coupling. In the absence of transmit or receive signals, the circuit idles in the standby mode with the circuits balanced to allow transmission of some background noise and easier reception of line signals.

3.02 The incoming ac signals from the microphone and line are amplified and directed through the audio circuit to the transmit and receive variolosser (TVL and RVL). The two variolossers are electronic attenuators whose degree of attenuation is oppositely controlled by a common dc voltage from a control circuit. They thus act as switches for their respective channels to switch the audio circuit to the appropriate operating mode.

Note: For HFU 1 to 600 the PCB is designated "HFU 600" and equipped with transmit variolosser MC8 and receive varilosser MC9 (microcircuits 1496L). For HFU after No. 600 the PCB is designated "Phase 1" and is equipped with transmit variolosser AR1 (Hybrid microcircuit QMS1A) and receive variolosser AR2 (Hybrid microcircuit QMS2A) "Phase 1" PCB are identified by the letter B (Fig. 38).

3.03 The control circuit rectifies and amplifies a portion of both the transmit signal following the TVL and the receive signal reaching the RVL and compares the dc magnitudes of these signals. A dc control voltage is generated whose magnitude is "low" (6.2 V) or "high" (7.8 V) depending on which channel, transmit or receive, carries the greatest signal. This control voltage is applied to both variolossers whose balanced arrangement is such that the attenuation of the variolosser in the dominant channel is greatly decreased. The attenuation of the other variolosser is simultaneously increased by an identical amount. This switches the channel with the greatest signal on, and switches the channel with the lesser signal, off.

Transmit Mode

3.04 In the transmit mode, the receive channel is switched off (i.e., greatly attenuated) by the RVL which prevents the line signal from passing to the loudspeaker terminals. The transmit channel is switched on (i.e., attenuation reduced) by the TVL which permits the microphone signal to pass to the line terminals. In the receive mode, the transmit channel is switched off by the TVL and the receive channel is switched on by the RVL in the reverse process.

Standby Mode

3.05 The circuit idles in the standby mode when neither line nor microphone signals are present (i.e., room noise only). In this mode, the control voltage signal is such that the TVL imposes moderately low attenuation in the transmit channel and the RVL imposes moderately high attenuation in the receive channel. Therefore, both channels are in a quiescent mode.

Comparator Functions

3.06 The switching speed of the variolossers is controlled by the control switching circuit which is biased through the bias network. The control-switches, i.e., transistor switches Q16, Q17, Q18 (See Fig. 18), are controlled by the outputs from the main comparator and the noise comparator through the timing circuits.

3.07 The main comparator compares the magnitude of the rectified signals from the line and the microphone. Its output is normally low (about 2 volts) but if the signal voltage exceeds the microphone signal voltage plus a switching threshold or bias, the main comparator output switches to a high voltage (about 11 volts).

3.08 The noise comparator compares the steady state input level at the microphone (i.e., room noise) to the full microphone signal (i.e., voice signal) plus noise. Its output is normally high (about 11 volts) but if the voice signal is sufficiently greater than the background noise, the noise comparator output drops to a lower voltage (about 2 volts). The purpose of the noise comparator is to compensate for the presence of room noise in the transmit channel when switching from standby to full transmit.

3.09 The output states of the main comparator and noise comparator jointly establish the dc control signal which sets the variolossers for the appropriate operating mode. The main comparator is normally in the transmit mode and sets the threshold for the receive mode. The noise comparator is normally in the standby mode and sets the threshold for the transmit mode. If neither threshold is overcome, the circuit remains in standby.

DETAILED DESCRIPTION (See Fig. 18)

3.10 The audio circuit consists of the following components:

- QUX1A Electret microphone assembly
- Preamplifier (MC1A)
- Transmit variolosser (MC8 or AR1)
- Hybrid (Q2, Q3, Q4, Q5)
- Receive variolossers (MC9 or AR1)
- Power amplifier (MC6, Q8, Q9)
- Loudspeaker

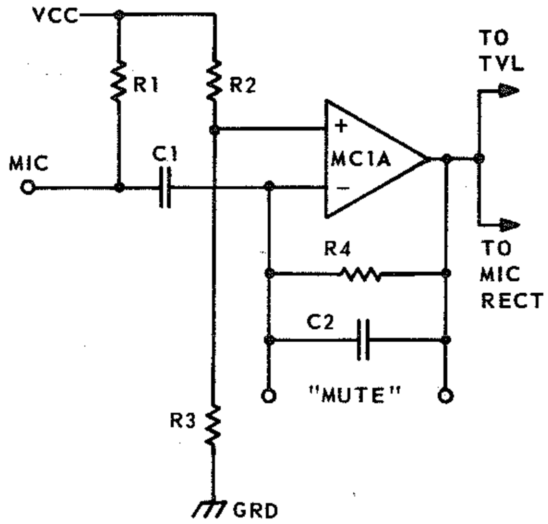


Fig. 5 — Preamplifier Configuration

Electret Microphone

3.11 The QUX1A Electret microphone is connected to a JFET which serves as a current source for the preamplifier MC1(A) (Fig. 5). An incoming microphone signal is passed to the (—) input of the MC1(A) where it is amplified approximately 36 dB (gain determined by R4 and JFET resistance of 1.5 k) to ensure adequate levels at the microphone rectifier and the transmit variolosser. Low frequency rolloff at 160 Hz is provided by C1 and R1; operating bias for MC1(A) is provided by R2 and R3; and high frequency rolloff at 3.6 kHz is provided by C2 and R4, which also reduces random noise.

3.12 The preamplifier passes the microphone signal to both the TVL (MC8 or AR1) where it is attenuated according to the control circuit switching signal from MC5(B), and to the microphone rectifier, where it is rectified and passed through the noise control circuit (see 3.27). From the transmit variolosser, the microphone signal is passed through an emitter follower Q1 so that the variolosser will not be overloaded by the input impedance of the transmit rectifier and amplifier MC2(A). The signal from Q1 feeds both the control circuits through MC2(A) and the hybrid.

Note: Shorting R4 with the mute switch (not available on QUS1A unit) reduces the gain of the preamplifier to nearly zero and thereby cuts off outgoing transmission.

3.13 The hybrid is a balanced bridge network which minimizes sidetone while transmitting the microphone signal to the line terminals and receiving the line signal. Due to the network's balanced nature, the amount of sidetone attenuation depends on the telephone line impedance.

3.14 The transmit gain of the hybrid network depends on the open loop gain of Q2 and Q3, the transformer electrical parameters and the balancing network components. The balance of the network, which must be preserved over all possible line conditions, also depends on these parameters.

3.15 The receive gain of the network depends on the transformer electrical parameters, the line terminating impedance R20 reflected in parallel with R21, and the voltage gain of Q4 and Q5.

3.16 The incoming line signal is received at the hybrid and is passed to the receive amplifier (Q4 and Q5) while the hybrid network protects the transmit amplifier from sidetone effects. The amplified line signal is then passed both to the receive variolosser (MC9 or AR2) [where it is attenuated according to the control circuit switching signal from MC5(B)], and to the control circuit via the receiver rectifier and amplifier MC2(B). If the HFU is in the transmit mode, the receive channel is switched off (high attenuation). If the HFU is in the receive mode, the receive channel attenuation decreases to a low value and the line signal is passed to the power amplifier.

Power Amplifier

3.17 The power amplifier (Fig. 6), consists of a dual operational amplifier MC6 (A and B) and two class B biased output transistors, Q8 and Q9. The power amplifier has an output of 360 mW, which is used to drive the loudspeaker. The entire voltage gain is developed by MC6(A) which is kept on at all times to reduce turn-on and turn-off thump. The unity gain of MC6(B) is sufficient to drive the output transistors while supplying enough open loop gain to cancel crossover distortion. Diode CR5 prevents the relay and power amplifier from remaining on after V_{BB} is removed. Resistors R41 and R43 set the dc operating bias voltage for MC6 at 13.0 V. Bias resistor R42 prevents loading of the incoming RVL signal which is applied to the (+) input of MC6(A) through the coupling capacitor C17. Bypass capacitor C16 prevents hum at the power amplifier output and because it has a longer charge time than C19

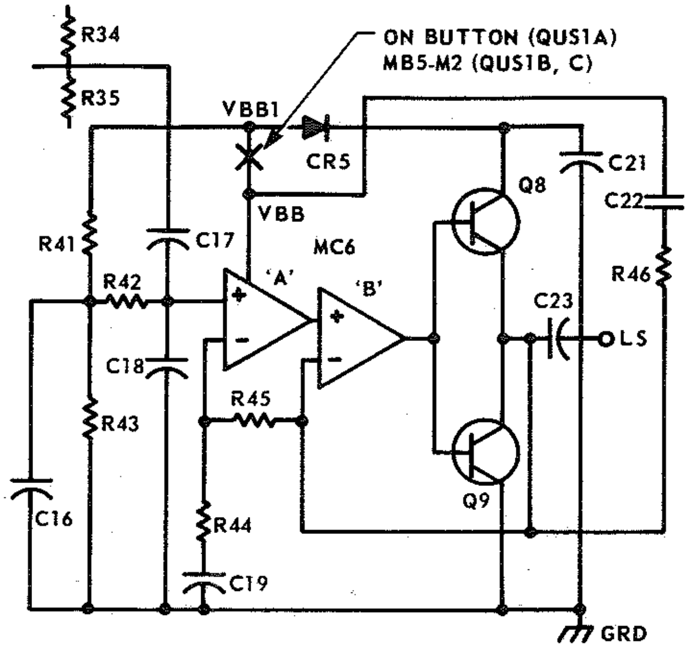


Fig. 6 — Power Amplifier Configuration

prevents turn-on thump. Capacitor C19 is used for dc blocking and along with R44 provides low-frequency rolloff at 110 Hz. High-frequency rolloff at 3.6 kHz is provided for MC6(A) by C18 and R35 (the variolosser output resistor). To ensure temperature stability, the transistors are biased class B and Q8 is placed in the feedback loop. Stabilization is provided by R46 and C22 while C21 prevents high frequency oscillations due to power supply lead impedance.

Loudspeaker

3.18 A high impedance loudspeaker is used so that the power supply voltage does not decrease below the level required for proper operation of the voltage regulation circuits. The combined load of the loudspeaker and power amplifier is thus insufficient to affect regulation.

Control Circuit

3.19 The control circuit consists of the following components:

- transmit-rectifier (MC2A)
- receive-rectifier (MC2B)
- microphone rectifier (MC1B)
- main comparator (MC4A)
- noise comparator (MC5A)
- control- and timing-switches [Q14, Q16, Q17, Q18, Q19, MC5(B)] noise circuit switches (Q11, Q15)
- low-level booster (Q13)
- noise-threshold booster
- high-pass filter (Q10)
- light-emitting diode control (Q6)

3.20 The control circuit which rectifies a portion of the ac signals in the transmit and receive channels of the audio circuit (3.03) is, in turn, monitored by a noise control circuit. The noise control circuit provides a dc signal dependent on room noise alone which permits the control circuit to compensate for noise effects (see 3.26).

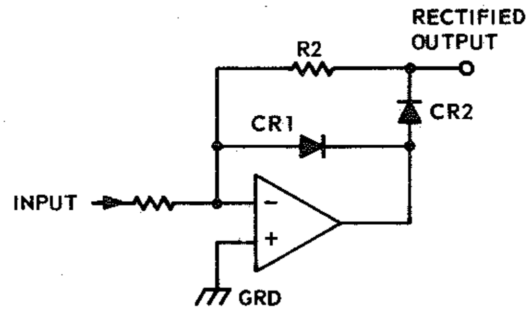


Fig. 7 — Typical Operational Amplifier Configuration

3.21 A simple diode rectifier would not be able to rectify small signals from the audio circuit. Consequently, an operational amplifier (Fig. 7) is used as a rectifier/amplifier where half-wave rectification is required for the control circuit (i.e., MC2A, MC2B, MC1A). For a positive input signal, the amplifier output is low, CR1 is forward biased and, due to virtual grounding of the amplifier, there is no output voltage. For a negative input signal, the amplifier output is positive, CR2 is forward biased, and the output voltage is generated across R2. Because of the high open loop gain of the operational amplifier even small signals may be rectified.

Standby Mode Operation

3.22 In the absence of line or microphone signals, the circuit idles in the standby mode. The noise comparator MC5(A) is biased to the high output or receive state (about 11 volts) by R60. Potentiometer R71, (factory adjusted) biases the main comparator MC4(A) to the low output or transmit state (about 2 volts). The MC4(A) output causes C38 to charge to approximately TP10 (6.2 V) which turns Q16 and Q17 off. Capacitor C40 charges to TP16 plus the base-collector diode drop across Q18 which turns Q18 on. This connects the voltage dividers R85 and R86 between TP16 (7.8 V) and TP10 (6.2 V) and therefore sets the control voltage at the (+) input of MC5(B) at 6.6 V. In the absence of noise, the output of MC5(B) follows the (+) input signal and supplies a switching control voltage (6.6 V) to the voltage dividers at the TVL and RVL respectively. The voltage divider ratio and the end point voltage at TP18 and TP15 set the switched loss through the TVL and RVL at 17 dB and 45 dB respectively. The circuit is therefore in partial transmit with the transmit channel semi-on and the receive channel semi-off (see Table B).

Note: When an incoming line signal, which has forced the circuit into the receive mode, terminates, the circuit hangs for a short time (dependent on the incoming line level and room noise) and then comes very slowly back to idling. (Unless forced into the transmit mode by an incoming microphone signal in which case the transition is rapid.)

Receive Mode Operation

3.23 A signal, received from the line at TP2, enters the control circuit and is fed through the high-pass, 60 Hz audio filter Q10. The signal is then applied to the (—) input of the receive rectifier and amplifier, MC2(B), where it is rectified and amplified 20 dB (20 log R57/R56). Capacitor C31 charges through R58 and the rectified signal at TP47 is applied to the (+) input of MC4(A). Potentiometer R71 plus resistor R72 bias the (—) input of MC4(A). Potentiometer R71 has been adjusted to set the main comparator for the low output (transmit) state, that is the threshold is set for receive mode operation (Fig. 8).

TABLE B
SUMMARY OF SWITCHING CONDITIONS

OPERATING MODE	MAIN COMPARATOR OUTPUT	NOISE COMPARATOR OUTPUT	SWITCHED* AND INSERTION‡ LOSSES	
			TVL LOSS	RVL LOSS
Standby	Low	High	17(11+6)	45(50+6—11)
Receive, Volume CCW	High	High or Low	17(11+6)	45(50+6—11)
Receive, Volume CW	High	High or Low	56(50+6)	6
Transmit	Low	Low	6	56(50+6)

* 50 dB or 11 dB
‡ 6 dB

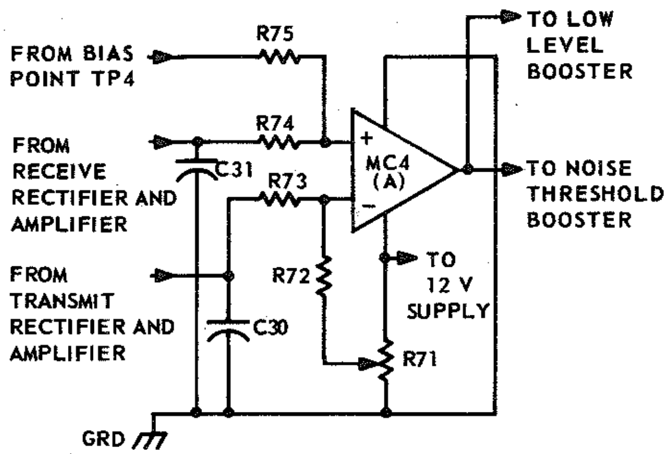


Fig. 8 — Main Comparator Configuration

3.24 When C31 is charged high enough by an incoming line signal to exceed the threshold set at the (+) input of MC4(A), the main comparator switches to the receive or high output state (approximately 11 volts). [If a microphone signal is also present, the charge on C31 must exceed the R71 threshold plus the charge on C30 to switch MC4(A).] Capacitor C38 then charges through R76 and CR17. The voltage across C38 is applied to the bases of Q16 and Q17 through R83. Transistor Q16, the volume control, and R85 are in series, therefore, as C38 charges, the conduction of Q16 increases and R85 and the volume control are connected between TP16 (7.8 V) and TP10 (6.2 V). The volume control is used to vary the level at the (+) input of MC5(B). The switching control voltage will also be variable in this range. With the control voltage at 7.8 V (volume control set fully ccw) the RVL and TVL losses are 6 dB and 56 dB respectively and the circuit is in the full receive mode, (transmit channel off, receive channel on). The lower the volume control setting, the less the switched loss in the receive channel and the more natural the conversation.

Transmit Mode Operation

3.25 A voice signal received at the microphone is fed from the output of the preamplifier to both the TVL and the noise control circuit. The TVL passes the signal through Q1 to the (—) input of transmit-rectifier and -amplifier MC2(A) where it is rectified, amplified 34 dB (20 log R50/R47), and passed into the main control circuit. Low frequency rolloff at 300 Hz for MC2(A) is provided by C24 and R47. The rectified signal at TP46 charges C30 through CR6 and R51 and is fed into the (—) input of the main comparator MC4(A) through R73. Potentiometer R71 biases MC4(A) to the transmit mode. Thus, in the absence of a receive signal at the (+) input greater than the bias threshold plus the transmit signal voltage, the main comparator output is low and in the transmit mode. The circuit mode is then determined at the noise comparator.

> *Note:* The switching response or speed of the main comparator is determined by the attack and release times of C30 and C31, which set the voltage at the transmit (—) and receive (+) inputs to the comparator. The attack time for charging C31 is determined by R58; the release time by R57 and R58. The attack time for C30 is determined by R51; the release time by R50 and R51.

3.26 The noise control signal from the preamplifier is rectified and amplified 20 dB (20 log R63/R62) by MC1(B). The rectified signal charges C34 through R64 and the signal voltage at TP48 is applied to the (—) input of the noise comparator, MC5(A) through R93. Resistor R60 sets the noise comparator to the high output (receive) state. The main comparator is biased by R71 to the low output (transmit) state. When C34 is charged high enough to exceed the threshold set by R60, the noise comparator MC5(A) switches to the low output (transmit) state (2.2 V) and C40 discharges, through R88 and Q19 towards TP10 (6.2 V). Diode CR20 is reverse biased and Q19 turns on. The base of Q19 draws current through R89. As C40 discharges to 6.2 V, the conductance of Q18 is decreased and the voltage divider R85 and R86 is removed from TP16. The (+) input of MC5(B) is thereby connected in series to TP10 (6.2 V) by way of the volume control wiper and R85. In the absence of noise, the switching control voltage from MC5(B) is also 6.2 V. The TVL and RVL losses are then set at 6 dB and 56 dB respectively and the circuit is in full transmit with the receive channel off and the transmit channel on.

NOISE CIRCUIT

General

3.27 Room noise may be defined as any steady input to the microphone. The noise circuit is designed to compensate for room noise and thereby make voice transmission more efficient by comparing the noise portion of the microphone signal to the full signal. Noise level thereby directly influences the switching of the noise comparator and therefore the control circuit switching itself.

3.28 The noise circuit performs two basic functions.

(a) To compensate for background or room noise, the circuit is designed so that any increase in noise level at the microphone results in a corresponding rise in the noise comparator switching threshold. This means that a higher microphone signal voltage is required to switch from standby (high) to full transmit (low) output. This reduces the effect of noise on the circuit switching and thereby aids the receive channel when the unit is situated in a noisy environment.

(b) In the transmit mode, to compensate for the user's tendency to speak more loudly, the TVL introduces some switched loss and the RVL switched loss is decreased in direct proportion to the noise level. The greater attenuation in the transmit channel reduces the transmitted voice to normal level.

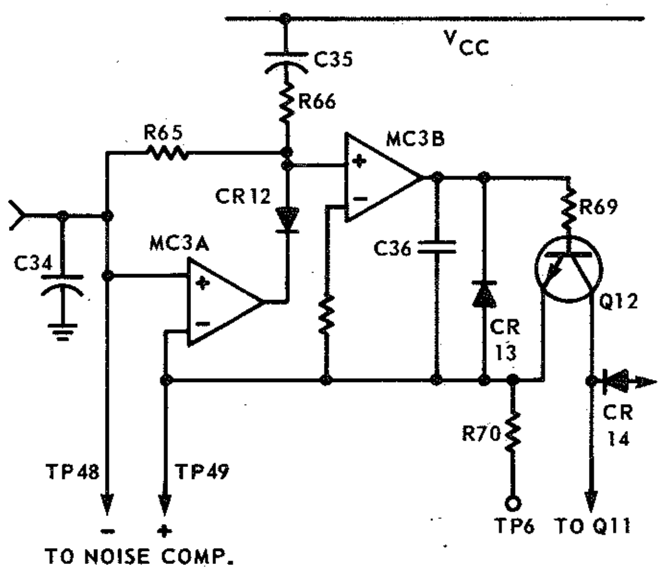


Fig. 9 — Noise Circuit Configuration

Operation

3.29 The rectified microphone signal voltage developed across C34 at TP48 is applied to the (+) input of MC3(A) which switches to the high output state. This reverse biases CR12 and thereby disconnects the junction of R65 and R66 from the MC3(A) output. Therefore, C35 slowly discharges toward the 12 V supply level through R65 and R66 to TP48. The rising voltage at the R65 — R66 junction is applied to the (+) input of MC3(B) causing the MC3(B) output to rise. The MC3(B) output is applied to the base of Q12 through R69. The current through R70 from the Q12 emitter increases maintaining the voltage drop across the Q12 base-emitter and R69. The TP49 voltage is fed back to the (—) inputs of MC3, (A) and (B). When the TP49 voltage becomes just greater than that at TP48, MC3(A) switches to the low state, CR12 is forward biased, and the discharge of C35 is halted at the level of C34. Capacitor C36 stabilizes the noise circuit while R67 establishes unity gain through MC3(B) and Q12. Therefore, the voltage at the Q12 emitter follows the (+) input of MC3(B) which is the average or noise component of the voltage signal across C34. The full rectified microphone signal (voice-plus-noise) is then across C34 (TP48) and the noise component alone is at the Q12 emitter (TP49).

3.30 If the noise level is reduced, C34 discharges through R65, R64, R63, CR11 and the MC1(B) output circuit, to the new level. When the (+) input level of MC3(A) drops below the (—) input level, MC3(A) switches to the low output state, forward biasing CR12. This causes C35 to quickly charge to the new level at TP48 through R66 and the MC3(A) output circuit. Resistor R66 limits this charging current to avoid sharp drops in the 12 V supply.

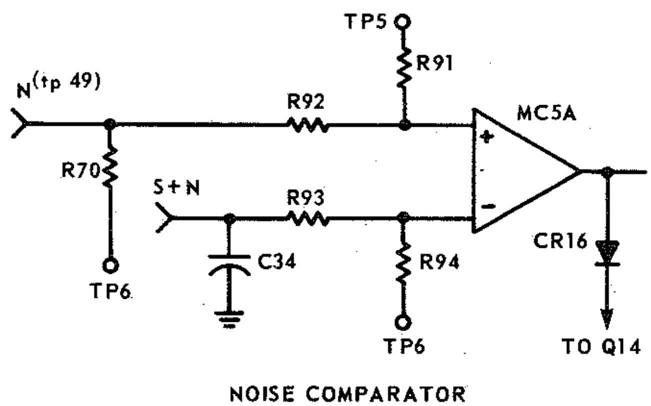


Fig. 10 — Noise Comparator Configuration

Noise Comparator

3.31 The voice-plus-noise signal at TP48 is applied to the (—) input of the voice comparator MC5(A) through voltage divider, R93 and R94. The noise signal at TP49 is applied to the (+) input of the

MC5(A) through voltage divider, R91 and R92. The (+) input of MC5(A) is biased from TP5 thereby establishing a threshold for the switching of the noise comparator from high to low output (standby to full transmit). The full voice-plus-noise signal is attenuated 6 dB by R93 and R94. Therefore, the threshold of voice signal required to switch the noise comparator to the low output state increases at half the rate of increase of the noise level. For example, if the noise level at TP49 increases 20 dB, the voice-plus-noise signal at TP48 would have to increase 26 dB to reach the new threshold and switch MC5(A) to full transmit. In this way, the receive channel is compensated in the switching circuit for the presence of noise at the microphone.

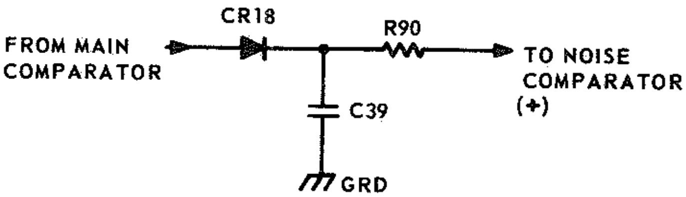


Fig. 11 — Noise Threshold Booster Configuration

Noise Threshold Booster

3.32 The noise threshold booster (Fig. 11) applies a delaying signal to the (+) (noise) input of the noise comparator when the main comparator switches from high to low output (receive to transmit). This signal keeps the noise comparator output high (standby) for a short time following the termination of a signal from the line and hence prevents room echoes from causing the unit to switch to full transmit before reverting to standby. The delay is sufficiently short that it does not interfere with normal interruptions in the conversation.

3.33 When the main comparator output switches to receive (high), C39 charges through CR18 and applies 11 volts through R90 to the (+) input of the noise comparator. When the signal on the line terminates, the main comparator output switches to transmit (low). CR18 is reverse biased, and C39 discharges through R90 and the (+) input circuit of the noise comparator MC5(A). The output of MC5(A) remains high for the C39 discharge time (50 — 100 ms) regardless of any signal to the (—) input of MC5(A). After this time, the (+) input loses control of the noise comparator and the transmit mode may be initiated.

Noise Current Control of the Variolossers

3.34 The noise current control (Fig. 12) increases the loss through the TVL in proportion to the noise signal. The resulting decreased signal level in the transmit channel is passed through the Q1 emitter to the (—) input of the transmit rectifier amplifier [MC2(A)]. Therefore, the voltage level at the (—) input of the main comparator is also proportionately reduced. Consequently, a lower line signal level at the (+) input to the main comparator MC4(A) is required to switch MC4(A) from low to high output (i.e., transmit to receive). The level of noise on the line is thereby reduced, but, since speech is louder in a noisy environment, the transmitted speech level remains the same.

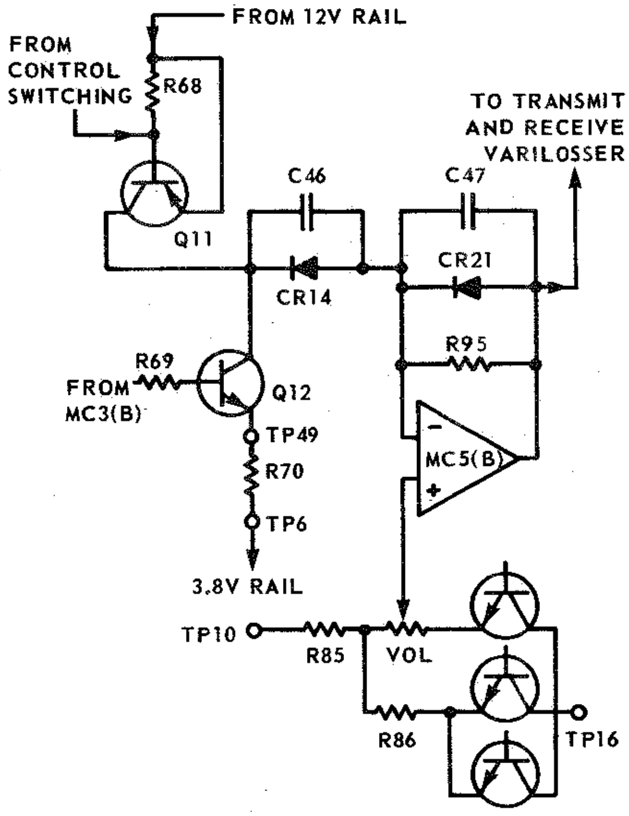


Fig. 12 — Noise Current Control Configuration

3.35 The noise current is the current through R70, required to develop the noise voltage between TP49 and TP6. This current flows in the Q12 collector circuit which consists of CR14 and C46 in parallel and CR21, R95, and C47 in parallel across the (—) input and the output of MC5(B) which supplies the control voltage to the variolossers. Capacitors C46 and C47 provide Radio Frequency Interference (RFI) suppression.

3.36 In the absence of noise current through CR21 and R95 but with a speech signal present (i.e., transmit mode operation), the (+) and (—) input voltages and output voltage of MC5(B) are at TP10 (6.2 V). This is because Q16, Q17, and Q18 are all open which results in no current flowing through R85, R86, or the volume control. When noise current is present, a voltage drop develops across R95 and CR21 (in the forward direction). The (—) input voltage of MC5(B) drops and the MC5(B) output voltage rises. This increased output voltage increases the TVL loss through R6 and R7 (formerly 6 dB) and decreases the RVL loss through R29 and R30 (formerly 56 dB) an equal amount. CR21 provides for the non-linearity between the increase in noise level and the corresponding increase in talking level.

3.37 When a line signal is present and the circuit switches to the receive mode, the noise current must be removed from the feedback path (CR21 and R95). This prevents the noise current from decreasing the RVL loss further than normal for the receive mode and producing unsatisfactory increase of dial tone and other line noises in the loudspeaker. When C38 is charged by the receive mode high output from the main comparator, Q15 turns on and current flows through R68 and R84. [From TP14 (12 V) to TP16 (7.8 V).] The current through R84 turns Q11 on, connecting Q12 collector to the 12-volt line and reverse biasing CR14 which removes the Q12 collector from the output circuit of MC5(B) and connects it to the 12-volt line. This disconnects the noise current control for receive mode operation and permits the noise current through Q12 collector to continue during receive.

Low Level Booster

3.38 The low level booster circuit (Fig. 13) prevents chopping (i.e., the loss of initial speech syllables) when low level signals are being received from the telephone line by making the signals appear strong initially. If a line signal is just above the switching threshold for the main comparator, the main comparator output switches high and C31 will charge to the line signal voltage. However, with such a weak signal, the time required for C31 to discharge to a level below the threshold is less than the time interval between syllables or words in a normal conversation. To increase this initial discharge time for low level line signals without affecting high level performance a boost signal is applied to the (—) input of the receive rectifier when the main comparator switches to high output. The amplitude and duration of the boost signal is such that a weak receive signal is initially increased and sustained long enough to prevent switching of the main comparator between syllables or words in a conversation.

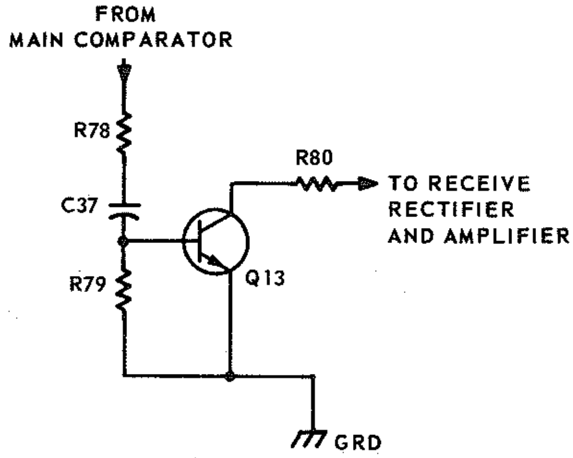


Fig. 13 — Low Level Booster Configuration

3.39 When the main comparator switches to high output, C37 charges through R78 and a voltage drop is introduced across R79 which is applied to the Q13 base, turning Q13 on and effectively grounding, through R80, the (—) input of the receive rectifier MC2(B). The width of this pulse is determined by R79, and C37; the amplitude is determined by R80 (equivalent to an average line signal of approximately —21 dB). The pulse momentarily increases the line signal, resulting in a higher initial charge on C31 so that the main comparator does not switch off between syllables or words.

High Pass Filter

3.40 The high pass filter (consisting of Q10, C25, C28, C29, R52, R53, R54, R55) is a fourth-order high-pass positive feedback Butterworth-Thomson Filter (Fig. 14). Its purpose is to attenuate 60 Hz noise that may be on the telephone line connected to the unit, before such noise reaches the (—) input of the receiver-rectifier where it could affect the control circuit.

Light-Emitting Diode

3.41 The main comparator output is applied to the base of Q6 (Fig. 15). When the system is in the standby or transmit mode the output is insufficient to cause Q6 to conduct and the base of Q7 is maintained high. Transistor Q7 is thus "turned-on" and the LED becomes lit, with current flow through Q7 limited by resistor R40. When the system is in the receive mode the main comparator output is high enough to turn on Q6, which drags down the base of Q7. With Q7 now in the nonconducting state the LED does not light. Transistor Q6 is biased by R37 and R38 and transistor Q7 is biased by R49. More recent units have Q7 collector terminals replaced by a jumper and R39 removed.

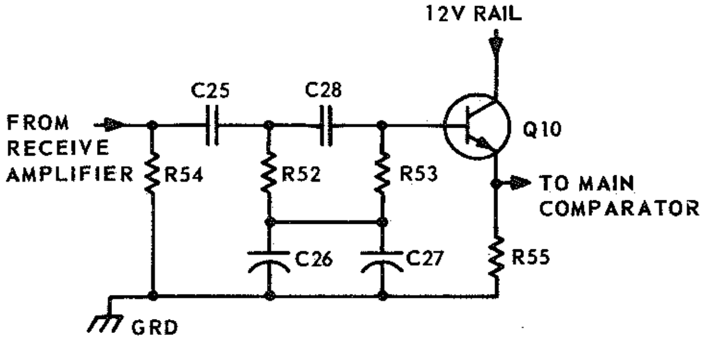


Fig. 14 — High Pass Filter Configuration

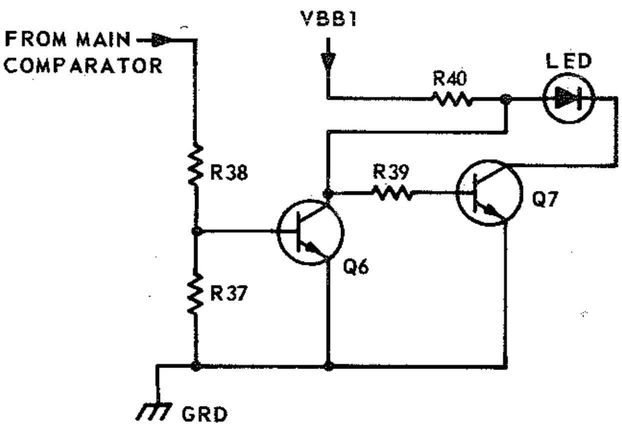


Fig. 15 — Light-Emitting Diode Control

Power Circuit and Bias Network

3.42 The power amplifier and relay and the LED control are powered from the rectified but unregulated dc power supply point V_{BB}. The remainder of the circuit is supplied at 12 volts from the output of the voltage regulator MC7.

> *Note:* To prevent instability in the unit due to voltage fluctuations when the unit is switched on, only the power amplifier is turned off when the unit is not in use.

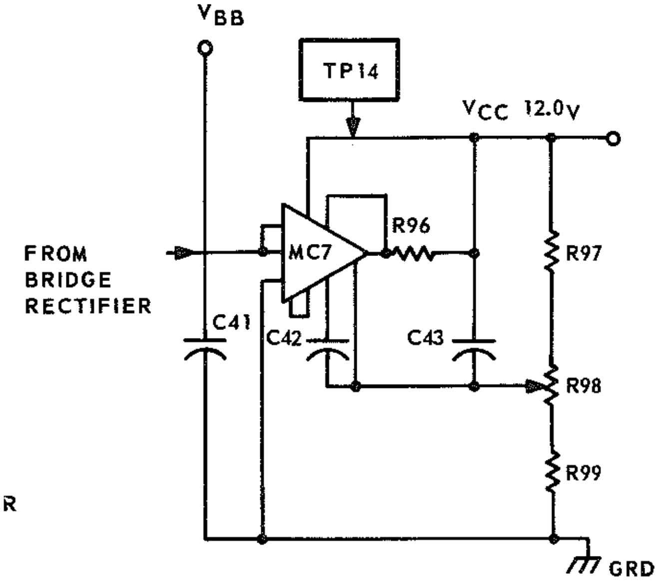
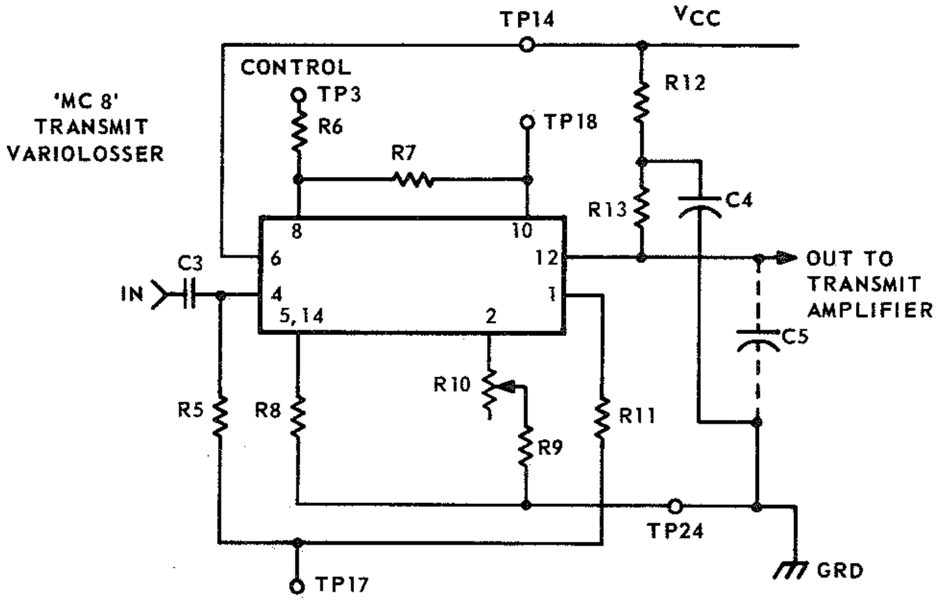


Fig. 16 — Voltage Regulator Configuration

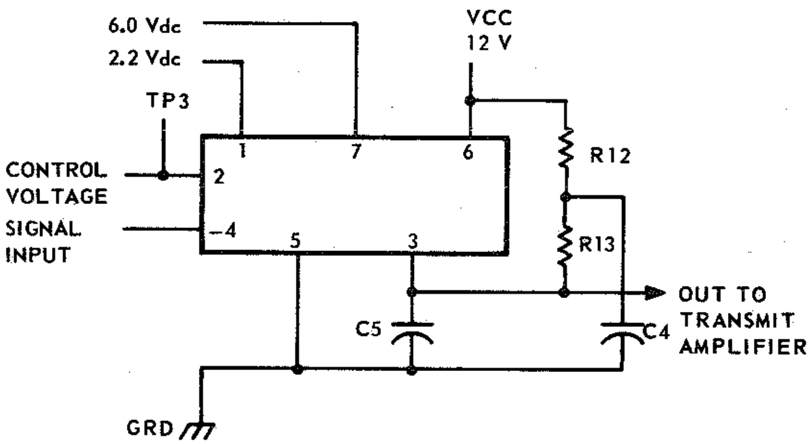
3.43 The voltage regulator is a monolithic regulator consisting of a temperature compensated reference voltage, error amplifier, power series pass transistor, and current limit circuitry (Fig. 16). Resistor R96 is for current limiting, protecting MC7; capacitor C42 is for frequency compensation, eliminating high frequency oscillation in the regulator; and capacitor C43 provides negative feedback to minimize noise on the 12.0 V rail. The voltage divider formed by R97, R98, and R99 is required to adjust the voltage regulator output to 12.0 volts.

3.44 The power source is connected at terminals TF1 and TF2. Diodes CR22 through CR25 act either as a full wave bridge rectifier for an ac power source, or as a polarity guard for a dc power source. Capacitor C41 is a ripple suppression filter which provides storage capability for the operation of the power amplifier and requires a series source impedance of 100 to 150 ohms. This series impedance permits long-term signal power limiting for the protection of the loudspeaker and should be included either in the wiring resistance, or with a series resistor if a power supply with low source impedance is used.

> *Note:* The NE-2012B power transformer is recommended for use with single HFU. When used, this power supply produces adequate source impedance for C41.



(a) — Bias Circuit HFU 600



(b) — Bias Circuit Phase 1

Fig. 17 — Transmit Variolosser Bias Circuit

3.45 The bias network consists of several series connected resistive circuits connected across the full regulated voltage Vcc (12 volts) between TP14 and TP24. These circuits are used to set up operating biases in the individual switching and amplifier circuits of the system. Capacitor C45 across R101 ensures that no audio feedback takes place between the variolossers, which receive bias from TP17.

3.46 The circuit arrangement for the input/output and biasing terminals of the variolossers for HFU 600 and Phase 1 configurations are identical. The only difference between these configurations is in the control voltage connections to pins 8 and 10. For the HFU 600 configuration only, the bias voltages are obtained in the bias network and applied to pins 10 and 8 of the TVL and RVL respectively. The biasing of the TVL is as described in 3.47. The biasing of the RVL is similar, but the connections to pin 8 and 10 are reversed.

3.47 The ratio of R6 to R7 sets the attenuation range of the TVL for a given control voltage (see Fig. 17A). R5 and R11 are effectively bypassed bias resistors connected to TP17 which determine the current through R8, R9 and R10 in series. Resistor R8 and the bias voltages on pins 1 and 4 set the TVL operating currents high enough that the transistors are not "starved" and low enough that current drain is not excessive. Fixed resistor R9 and variable resistor R10 eliminate dc shift and minimize "thump" that occurs at the output because of control voltage changes. Resistor R13 is the load, which provides bias and permits maximum audio output to the following stages. Low frequency rolloff at about 160 Hz is provided by C3 and R5, with C5 reducing shot noise after the TVL. The dc couplers C4 and R12 reduce power supply noise and the possibility of motor boating because of the common power supply.

3.48 As can be seen in Fig. 17 the bias voltages for the Phase 1 configurations are supplied directly from the bias network. Otherwise the operation of both "HFU 600" and "Phase 1" variolossers is similar.

4. OVERALL FAULT LOCATION AND REPAIR

4.01 The recommended troubleshooting and repair sequence is summarized in Fig. 19. This flowchart is intended to guide the user directly to the appropriate test or repair information, thus eliminating unnecessary reading.

Inspection

4.02 Hands-free units, received for repair, must be correctly identified (Part 2) and a visual and mechanical inspection performed. Check for broken, worn, loose or missing parts and verify the mechanical operation of the keys and controls.

Operation Tests

4.03 When all apparent mechanical defects have been rectified, electrical tests must be performed. These consist of a Unit Operation Test (Chart 1), and a Control Key Operation Test (Chart 2 for QUS1A; Chart 3 for QUS1B and QUS1C). Unit operation tests are carried out with the unit connected to a telephone set. If testing the QUS1C LOGIC HFU, use a telephone set of the LOGIC series. Information on connecting telephone sets to the HFU is contained in Section 512-6251-400 or 512-6251-401.

Fault Location

4.04 If a unit operation test cannot be completed successfully, refer to the fault location guide (Chart 4). If a control key operation test cannot be completed successfully, replace the control key assembly (4.05) and repeat the test.

Replacement of Parts

4.05 All defective parts should be replaced using the procedures described in 4.05 A through K. For ordering information refer to Part 9.

A. Cover Assembly

Removal

(1) Loosen the three captive screws in the base.

(2) Lift the cover off the base, taking care not to break the wiring to the LED.

Assembly

(1) Ensure that LED leads are held in lead guiding posts.

(2) Ensure that the foam pads are in place and that no wires will be pinched by the cover.

(3) Invert the cover and place it on a table top or other flat surface. Place the base on top of the cover.

(4) Tighten the three screws in the base.

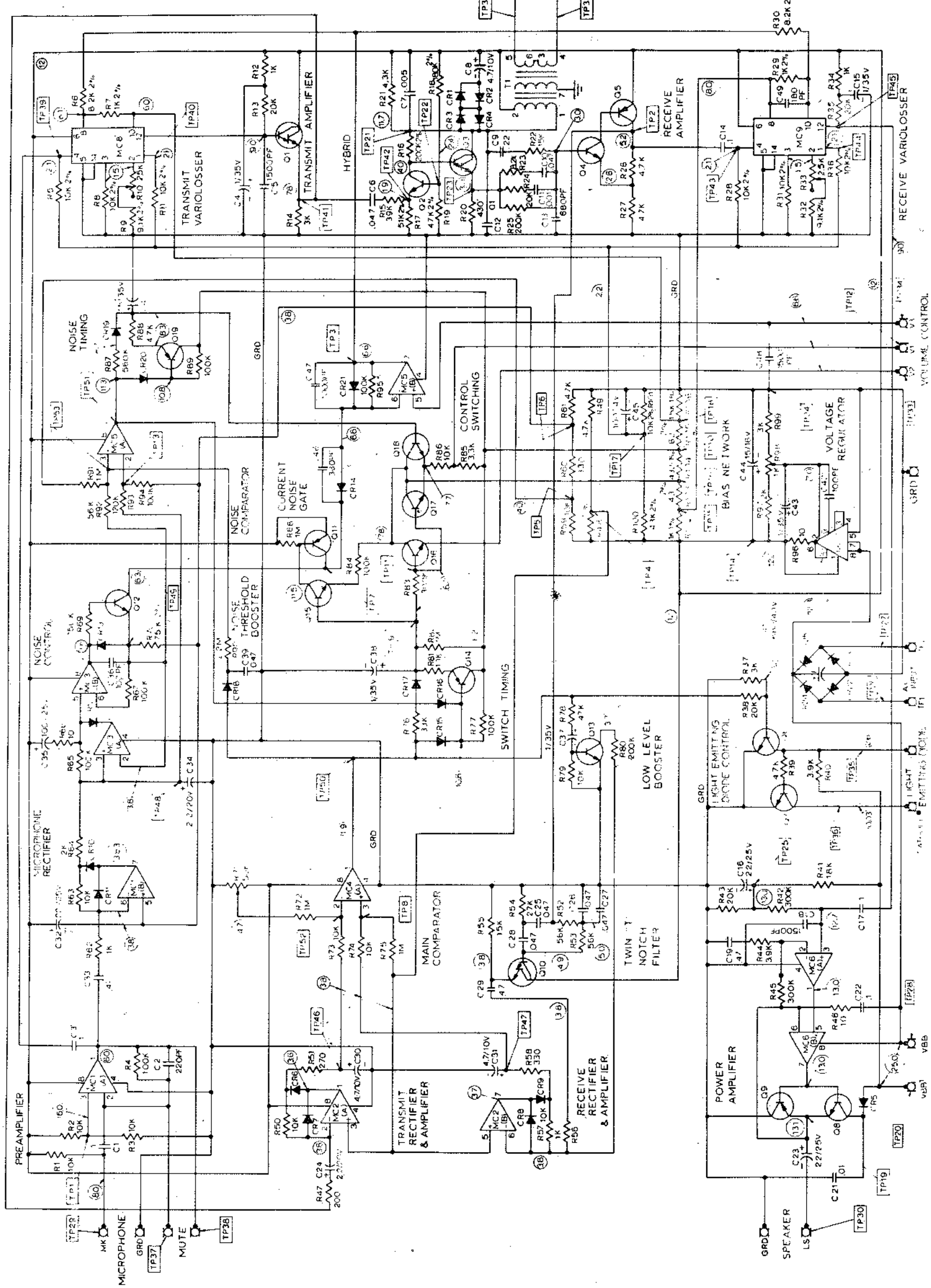
B. Volume Control

Removal

(1) Remove the cover assembly (4.05 A).

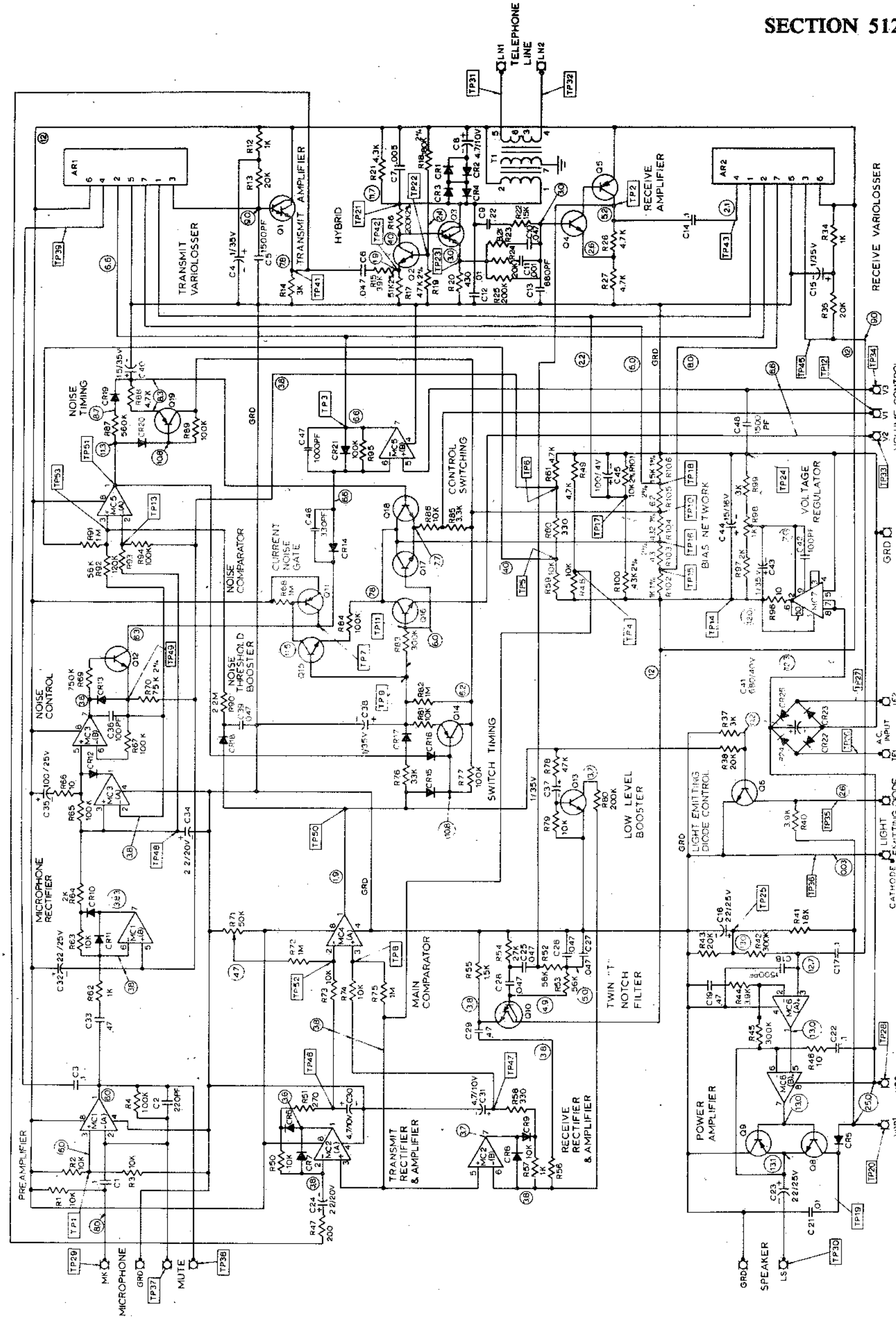
(2) Remove the two screws holding the volume control to the mounting frame assembly.

(3) Disconnect the volume control wires from cord tip connectors V1, V2, and V3.



(a) — HFU 600

Fig. 18 — PCB Assembly Schematic



(b) — Phase 1

Fig. 18 — PCB Assembly Schematic

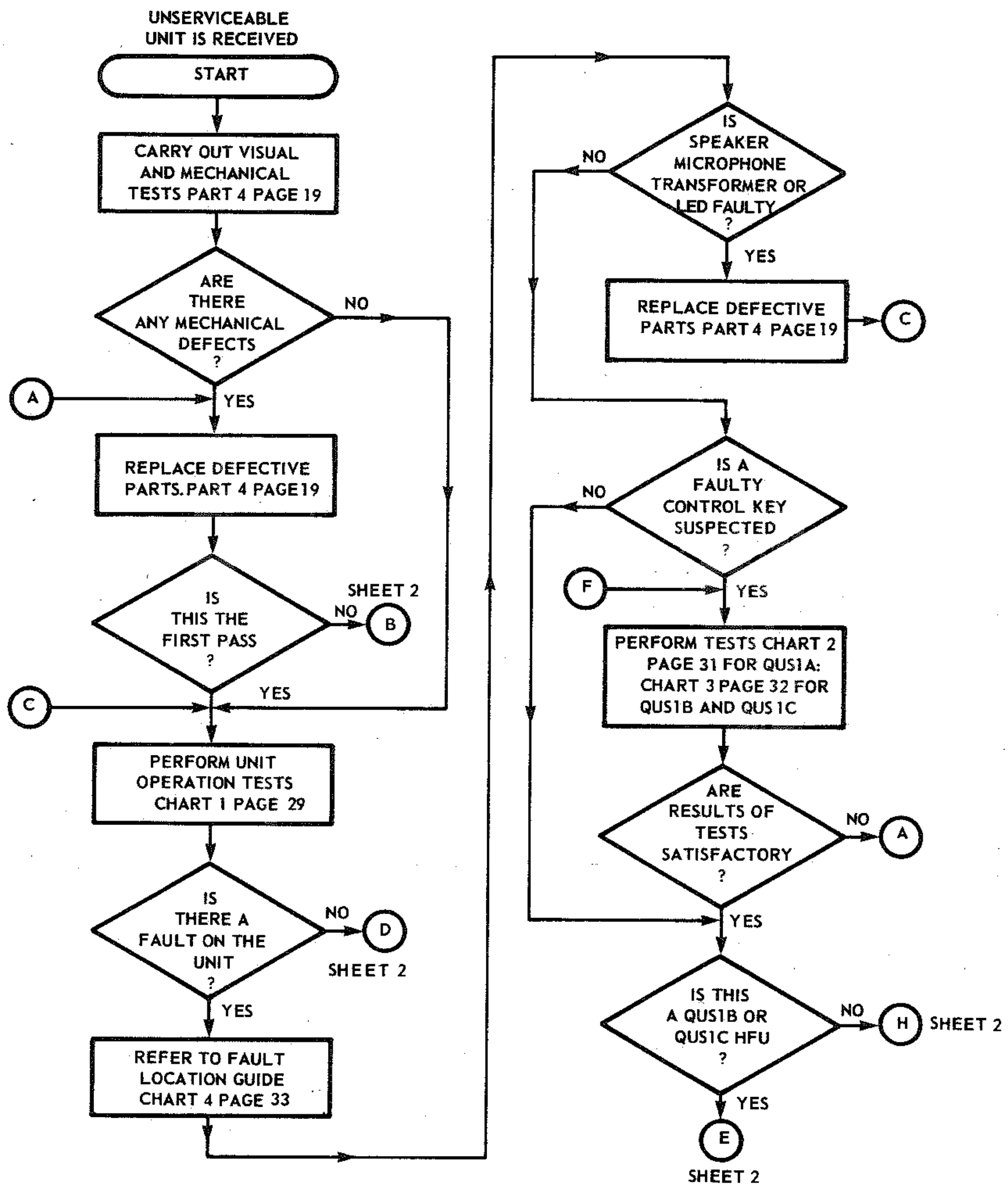


Fig. 19 (Sheet 1 of 2) — Trouble Shooting Flowchart

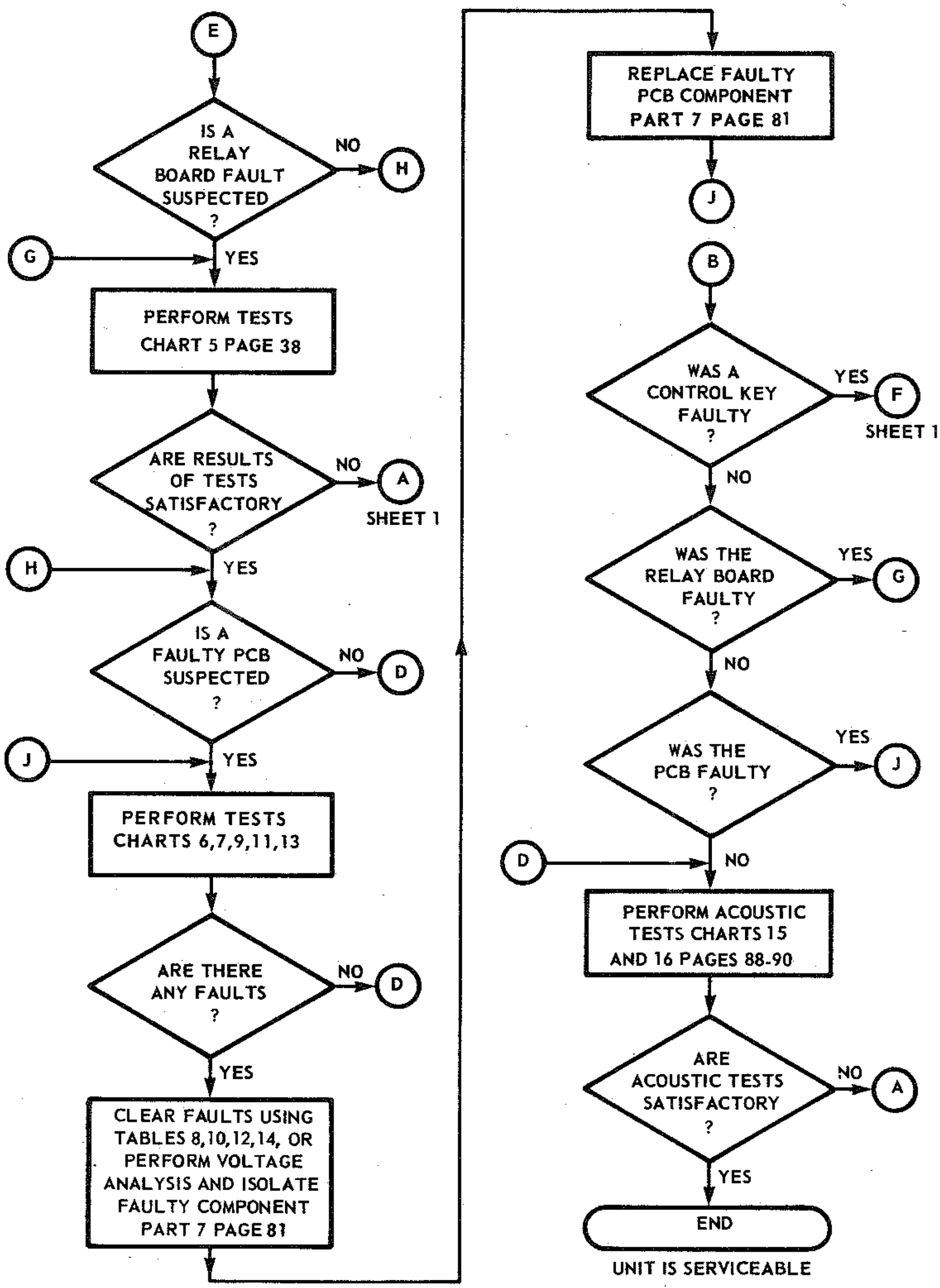


Fig. 19 (Sheet 2 of 2) — Trouble Shooting Flowchart

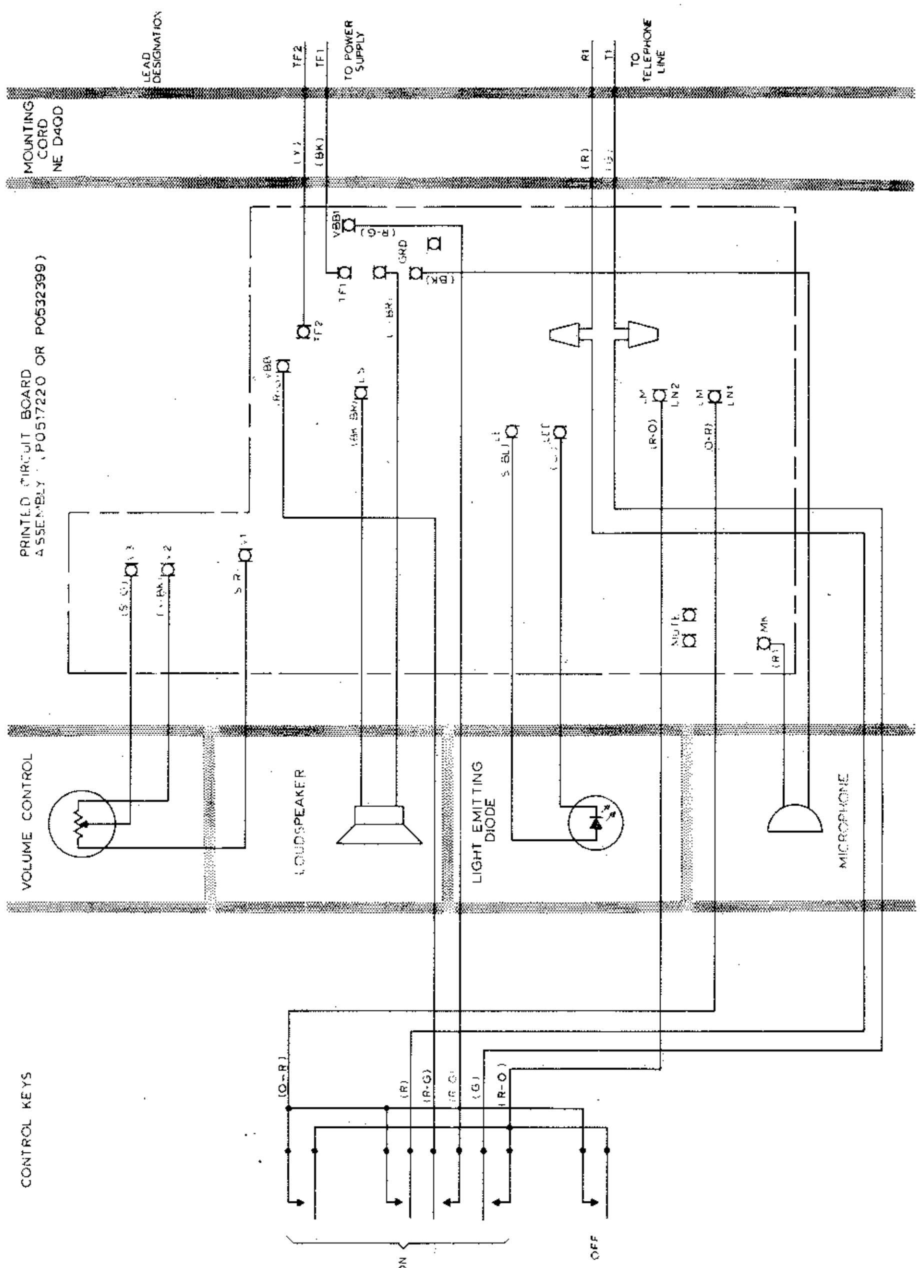


Fig. 20 — Schematic Diagram, QUS1A

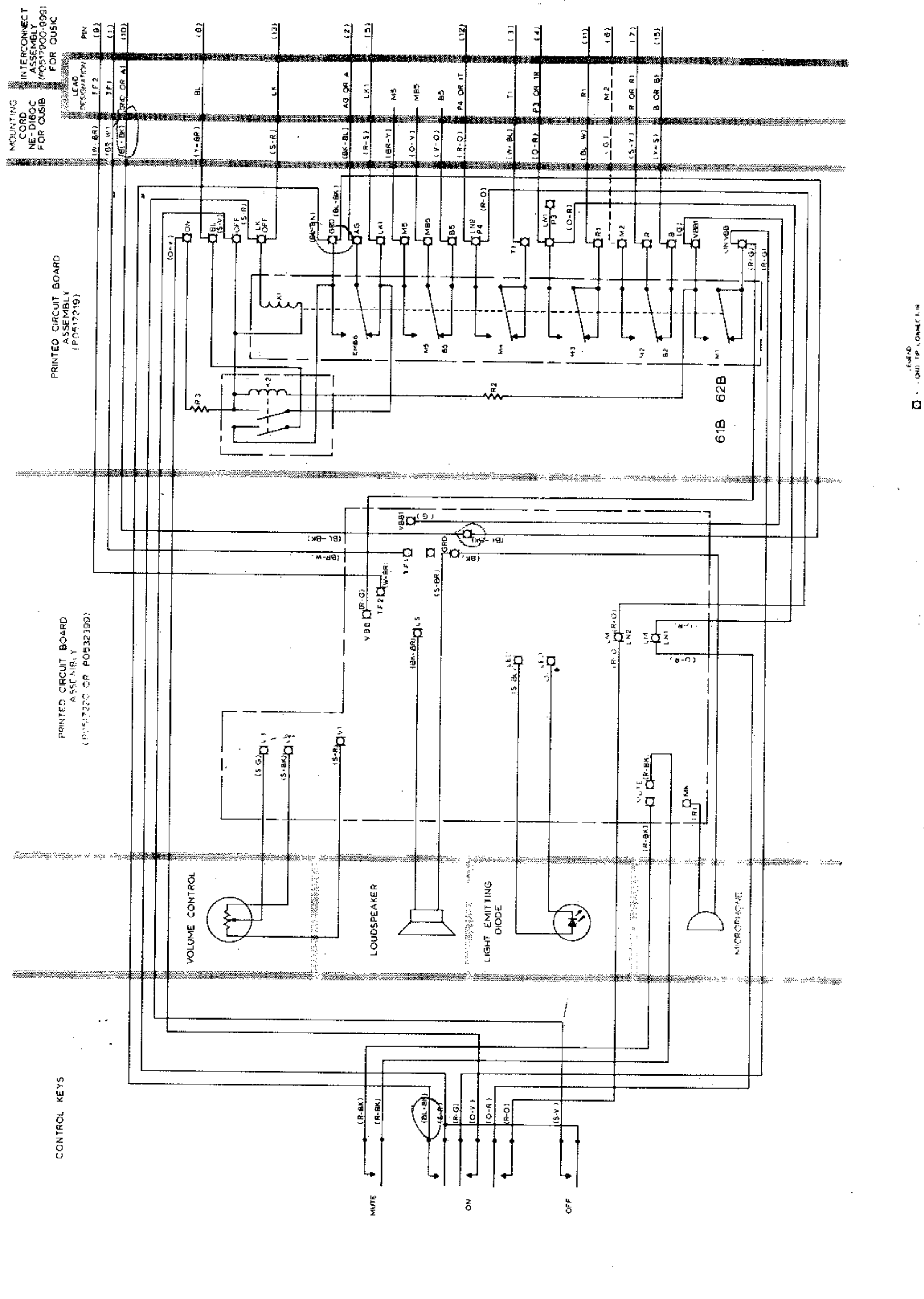


Fig. 21 — Schematic Diagram QUS1B and QUS1C

Assembly

(1) Insert the volume control wires in the slots under the seal on the mounting frame.

(2) Reconnect the wires to cord tip connectors V1, V2, and V3 (Fig. 18 or Fig. 19).

(3) Fasten the volume control to the mounting frame with the two screws.

(4) Replace the cover (4.05 A).

C. Mounting Frame Assembly

Removal

(1) Remove the cover assembly (4.05 A).

(2) Remove the volume control (4.05 B).

(3) Remove the four screws holding the mounting frame to the base.

(4) Disconnect the key wires (Fig. 20 or Fig. 21).

(5) Lift the mounting frame straight out of the base.

Assembly

(1) Position the mounting frame above the mounting posts and press into place with the wires passing under the gasket.

(2) Replace the mounting frame and tighten the four screws securing the frame.

(3) Replace the key wires (Fig. 20 or 21).

(4) Replace the volume control (4.05 B).

(5) Replace the cover assembly (4.05 A).

D. Microphone

Removal

(1) Remove the cover assembly (4.05 A).

(2) Remove the volume control (4.05 B).

(3) Remove the mounting frame (4.05 C).

(4) Remove the screw and washer in the microphone clamping bracket.

(5) Disconnect the microphone wires from cord tip connectors MK and GRD.

(6) Lift the microphone out of the base.

Note: It is not necessary to disconnect the wires on the volume control and the mounting frame assembly to remove the microphone.

Assembly

(1) Position the microphone and clamping bracket.

(2) Replace washer and screw and tighten the screw in the bracket.

(3) Place leads between lead guiding posts.

(4) Replace the mounting frame (4.05 C).

(5) Replace the volume control (4.05 B).

(6) Reconnect the microphone wires to cord tip connectors MK and GRD.

(7) Replace the cover assembly (4.05 A).

E. Speaker Assembly

Removal

(1) Remove the cover assembly (4.05 A).

(2) Disconnect the speaker wires from cord tip connectors LS and GRD.

(3) Remove the four screws holding the speaker assembly to mounting posts.

Assembly

(1) Position speaker assembly on the mounting posts.

(2) Replace and tighten the four screws to secure the speaker.

(3) Reconnect speaker wires to cord tip connectors LS and GRD.

(4) Replace the cover assembly (4.05 A).

F. Cord

Removal

(1) Disconnect the cord from the telephone set or connecting block.

(2) Remove the cover assembly (4.05 A).

(3) Remove the speaker assembly (4.05 E).

(4) Disconnect the cord from the cord tip connectors (Fig. 20 or Fig. 21).

(5) Remove the screw in the cord stay, and pull the cord through to the inside of the unit.

Assembly

(1) Install the mounting cord from the inside of the unit ensuring that the grommet is properly fitted in the opening.

(2) Replace the screw in the cord stay.

(3) Reconnect the wires (Fig. 20 or Fig. 21).

(4) Replace the speaker assembly (4.05 E).

(5) Replace the cover assembly (4.05 A).

G. Printed Circuit Board Assembly (Relay)

Removal

(1) Remove the cover assembly (4.05 A).

(2) Disconnect the wires from the relay circuit board.

(3) Remove the two screws holding the circuit board to the base, and lift the printed circuit board.

Assembly

(1) Place the printed circuit board in position over the screw holes.

(2) Replace the printed circuit board and tighten the two screws to secure the board.

(3) Reconnect the wires (Fig. 21).

H. Printed Circuit Board Assembly

Removal

(1) Remove the cover assembly (4.05 A).

(2) Remove the speaker assembly (4.05 E).

(3) Remove the relay circuit board [4.05 G (QUS1B and QUS1C)].

(4) Disconnect the wires from the printed circuit board.

(5) Remove the screws holding the printed circuit board to the base and lift the circuit board.

Assembly

(1) Position the printed circuit board, with the foam pad placed under it, on the mounting posts.

(2) In the QUS1A, replace the four screws. In the QUS1B and QUS1C, replace only the two screws on the right side of the board.

(3) Reconnect the wires (Fig. 20 or Fig. 21).

(4) Replace the relay circuit board [4.05 G (QUS1B, and QUS1C)].

(5) Replace the cover assembly (4.05 A).

I. Base

Removal

(1) Remove the cover assembly (4.05 A).

(2) Remove the volume control (4.05 B).

(3) Remove the mounting frame assembly (4.05 C).

(4) Remove the microphone (4.05 D).

(5) Remove the speaker assembly (4.05 E).

(6) Remove the screw in the cord stay.

(7) Remove circuit boards (4.05 G and 4.05 H).

Note: All components may be removed without disconnecting wires from the circuit boards by pulling the cord through to the inside of the unit, through its hole in the base.

Assembly

(1) Install the cord (4.05 F).

(2) Replace the circuit boards (4.05 G and 4.05 H).

(3) Replace the speaker assembly (4.05 E).

(4) Replace the microphone (4.05 D).

(5) Replace the mounting frame assembly (4.05 C).

(6) Replace the volume control (4.05 B).

(7) Replace the cover assembly (4.05 A).

J. LED

Removal

(1) Remove the cover assembly (4.05 A).

(2) Disconnect LED leads.

(3) Push the LED out from inside the cover.

Assembly

(1) Place LED leads through hole in cover assembly.

(2) Push the LED in place from the outside of the cover assembly.

(3) Reconnect LED leads.

(4) Replace the cover assembly.

K. Keys

Removal

(1) Remove the cover assembly (4.05 A).

(2) Remove the retaining clip from the shaft.

(3) Slide shaft out of keys.

Assembly

(1) Place the keys in position in the cover assembly.

(2) Push the shaft into place.

(3) Replace the retaining clip on the shaft.

(4) Replace the cover assembly (4.05 A).

TEST EQUIPMENT

4.06 Before attempting to carry out any of the tests described in this section, ensure that the necessary test equipment is readily available. A list of test equipment required is given in Table C. This listing is comprehensive, inasmuch as it includes the required ranges for test instruments and lists recommended types. For some of the tests extra components (i.e., resistors, etc.) are required. These also are included as test equipment in Table C.

CHART 1 – UNIT OPERATION TEST

EQUIPMENT REQUIRED:

A telephone set, connected to the hands-free unit as per Section 512-6251-400 or -401.

Note: If tests cannot be completed successfully, refer to Chart 4, Fault Location Guide.

STEP	PROCEDURE	INDICATION
1	Depress ON key momentarily.	Indicator light comes on while key is depressed. Dial tone is heard on the loudspeaker and the light goes out when the key is released.
2	Rotate Volume Control clockwise.	Volume of dial tone increases.
3*	Depress OFF key, momentarily.	Line disengaged – dial tone silenced at loudspeaker.
3†‡	At the telephone set, dial the first digit of the test center number.	Dial tone silenced. Indicator lamp comes on.
4*	At the telephone set, lift the handset and dial the test center number.	Ringing is heard. Test center answers.
4†	Complete dialing of test center number.	Ringing is heard. Test center answers.
5†**	Lift handset on the telephone set.	Audio output is transferred from the loudspeaker to the handset.
6	Hold ON key depressed. Replace handset at telephone set, release the ON key.	Indicator lamp “ON”. Audio transferred from handset to loudspeaker as ON key is released.
7†	Request test center to talk, then hold the MUTE key depressed for 20 seconds and reply.	Test center is heard on loudspeaker while MUTE key is depressed but test center does not hear speech. Operation is normal after test.

CHART 1 (Cont) – UNIT OPERATION TEST

STEP	PROCEDURE	INDICATION
8	Request test center to talk and continue talking while holding ON key depressed for 20 seconds.	Indicator lamp "ON" but no speech heard by either party. Operation normal after test.
9	Request test center to call back after call is terminated. Depress OFF key. Release line key at telephone set.	Indicator lamp "OFF". No speech from loudspeaker. Ringing commences.
10	Depress appropriate line pickup key of telephone set and momentarily depress the ON key of the hands-free unit.	Ringing stops and indicator lamp comes "ON". Conversation can be initiated.
11	Operate the HOLD key of the telephone set.	Speech removed from loudspeaker. Indicator lamp remains ON. The line hold feature (flashing line lamp) operates at the telephone set.
12	Operate a line pickup key at the telephone set.	Speech returns to loudspeaker. The line hold feature releases at the telephone set.
13†**	Lift handset of the telephone set.	Speech transferred from loudspeaker to handset. Indicator light is "OFF", and handset operation is normal.
14*	Depress OFF key momentarily.	Call terminated.
15†	Replace handset.	

* QUS1A only
† QUS1B and QUS1C only
‡ Omit if the unit is not wired for on-hook dialing.
** Omit if the unit is not wired for automatic transfer to handset.

CHART 2 — CONTROL KEY TEST — QUS1A HFU

EQUIPMENT REQUIRED:

VOM and NE-2012B transformer.

Note 1: If tests cannot be completed successfully replace the control key assembly as per 4.05 K.

Note 2: A telephone set is not required for this test. If the unit is already connected to a telephone set, disconnect before commencing test.

STEP	PROCEDURE	INDICATION
1	Connect the transformer to the yellow and black leads of the mounting cord. Plug the transformer into a 120 V ac 60 Hz outlet.	No indication.
2	Set the VOM to the X1 (ohms) range and connect to the red and green leads of the mounting cord.	VOM should show an open circuit.
3	Very slowly, press the ON switch.	The needle of the VOM should move from infinity to zero just before the LED comes on.
4	Release the ON switch.	The VOM should show a reading of 120 ohms. The LED should remain lit.
5	Press the OFF switch slowly.	The needle of the VOM moves to zero.
6	Release the OFF switch.	The needle of the VOM moves from zero to infinity. The LED goes off.

CHART 3 – CONTROL KEY TEST – QUS1B AND QUS1C HFU

EQUIPMENT REQUIRED:

VOM, NE-2012B transformer and 1 jumper lead.

Note 1: If tests cannot be completed successfully replace the control key assembly as per 4.05 K.

Note 2: A telephone set is not required for this test. If the unit is already connected to a telephone set disconnect before commencing tests.

STEP	PROCEDURE	INDICATION
1	Connect the transformer to the BR-W (Pin 1) and W-BR (Pin 9) of the cord (connector). Plug the transformer into a 120 V ac 60 Hz outlet.	No indication.
2	Set the VOM to the X1 (ohms) range and connect between O-R (Pin 4) and R-O (Pin 12) of the cord (connector).	VOM shows a reading of approximately 120 ohms.
3	Very slowly press the ON switch.	The needle on the VOM should move to a zero indication just before the LED comes on.
4	Very slowly, release the ON switch.	The needle on the VOM should return to the 120 ohms (approx.) reading after the LED goes out.
5	Connect the S-R (Pin 13) and BL-BK (Pin 10) of the cord (connector) together. Press and release the ON switch.	The LED comes on and stays on.
6	Press and release the OFF switch.	The LED goes out.

MUTE SWITCH

Note: The following test entails removal of the HFU cover, thus disturbing the acoustical sealing. This is not desirable at this stage of testing. Therefore, this test should only be performed when the MUTE switch is definitely suspected of being faulty from the previous tests listed in Chart 1.

STEP	PROCEDURE	INDICATION
7	Unplug the transformer from the power source and remove the cover per 4.05 A. Unplug the two R-BK leads from the MUTE terminals (TP37 and TP38) on the PCB. Set the VOM to the X1 (ohms) range and connect it across the two leads. Press the MUTE key.	The needle on the VOM should move to a zero indication.
8	Disconnect the VOM and plug the two R-BK leads into the MUTE terminals (TP37 and TP38) on the PCB. Replace cover on HFU per 4.05 A.	

CHART 4 — FAULT LOCATION GUIDE

INDICATION	POSSIBLE FAULTS	ACTION
1) With a line pick-up key selected at the telephone set the LED indicator does not light when the ON switch is pressed and/or there is no dial tone when the switch is released.	1. No commercial power.	Check commercial power outlet fuses.
	2. Defective LED.	Check if relay can be heard to operate and if dial tone is present when switch is released. If so, LED is probably faulty and should be replaced (4.05 J).
	3. Defective NE-2012B transformer.	Check if there is output from the NE-2012B transformer at terminals TF1 and TF2 in the unit. If no output, replace transformer.
	4. Defective ON switch.	Perform control key tests. (Chart 2 for QUS1A; Chart 3 for QUS1B and QUS1C).
	5. Defective relay board. (QUS1B and QUS1C only).	Perform relay board continuity test. (Chart 5.)
	6. Defective PCB.	Perform PCB tests. (Charts 6, 7, 9, 11, and 13.)
2) With no line selected at the telephone set, the LED indicator does not light when the ON switch is pressed.	1. Defective LED.	Check if relay can be heard to operate. If so, LED is disconnected at PCB or is defective. Defective LED should be replaced (4.05 J).
	2. Defective control key.	Perform control key tests. (Chart 3).
	3. Defective PCB.	Perform PCB tests. (Charts 6, 7, 9, 11, and 13.)

CHART 4 (Cont) – FAULT LOCATION GUIDE

INDICATION	POSSIBLE FAULTS	ACTION
3) No dial tone in speaker.	1. Defective speaker.	Check for dial tone at speaker terminal (LS and GRD on PCB). If dial tone present, speaker is defective and should be replaced (4.05 E).
	2. Incorrect wiring of unit to telephone set.	Check connections (refer to Section 512-6251-401 or 512-6251-400).
	3. Defective relay or contacts (QUS1B and QUS1C only).	Perform relay board continuity test (Chart 5).
	4. Defective PCB.	Perform PCB tests. Charts 6, 7, 9, 11, and 13.)
4) Dial tone remains after dialing.	1. Loose connections between unit and telephone set.	Check connections as per Section 512-6251-401.
	2. Defective relay or contacts.*	Perform relay board continuity test. (Chart 5).
5) Indicator lamp (LED) goes off when transmitting with no received signal present.	1. Defective PCB.	Perform PCB tests. (Charts 6, 7, 9, 11, and 13.)
6) Speech remains on speaker or LED indicator remains ON when handset of telephone set is lifted.	1. Loose connections or incorrect wiring.	Check connections as per Section 512-6251-400 or 512-6251-401.
	2. Defective relay circuit board.*	Perform relay board continuity test. (Chart 5)
7) Far-end party hears speech with near-end MUTE key depressed (QUS1B and QUS1C only).	1. Defective control key assembly leads (R-BK for both leads).	Perform control key tests. (Chart 3).
	2. Disconnected at PCB.	Reconnect leads to TP37 and TP38 terminals.

* QUS1B and QUS1C only.

CHART 4 (Cont) – FAULT LOCATION GUIDE

INDICATION	POSSIBLE FAULTS	ACTION
8) No speech received with MUTE key depressed.	Defective wiring.	Perform PCB test. (Charts 6, 7, 9, 11, and 13.)
9) Transmission continues when ON key is held depressed.	Defective control key assembly.	Perform control key tests. (Chart 2 for QUS1A and Chart 3 for QUS1B and QUS1C.)
10) Speech remains on speaker or indicator lamp remains on when OFF key is held depressed.	Defective control key assembly.	Perform control key tests. (Chart 2 for QUS1A and Chart 3 for QUS1B and QUS1C.)
11) Volume of dial tone in speaker is not affected by volume control.	Defective volume control.	Replace volume control (4.05 B).
	Defective PCB.	Perform PCB tests. (Charts 6, 7, 9, 11, and 13.)
12) No apparent reception.	Defective wiring.	Perform PCB tests. (Charts 6, 7, 9, 11, and 13.)
13) No apparent transmission.	Defective microphone.	Replace microphone (4.05 D).
	Defective PCB.	Perform PCB tests. (Charts 6, 7, 9, 11, and 13.)
14) Dial pulses heard in speaker.	Defective control key assembly.	Perform control key tests. (Chart 2 for QUS1A and Chart 3 for QUS1B and QUS1C.)
	Defective relay board assembly.	Perform relay board continuity test. (Chart 5).
	Incorrect connection to telephone set (No dial mute contact).	Check wiring of telephone set.

TABLE C
TEST EQUIPMENT REQUIRED

(*Note:* Ancillary components also included)

CATEGORY	RECOMMENDED (OR EQUIV) TYPE	WHERE USED	REMARKS
VOM	AVO Model 20	Charts 2, 3, 4, and 6	Ranges required: — 0-30 volts dc 0-1 kilohm
VTVM Model 310B	Ballantine	Charts 7 through 14	
Frequency Generator	Wavetek Model 135	Charts 7 through 16	
Storage Oscilloscope	Hewlett Packard 1201A	Charts 7 through 14	
Digital Voltmeter	Simpson Model 460	Table H	
Frequency Response Tracer	Bruel and Kjaer Model 4712	Chart 16	
Microphone Amplifier	Bruel and Kjaer Model 2606	Chart 16	
Artificial Mouth	L M Ericsson LTM 357526	Chart 15	
Free Field Microphone	Bruel and Kjaer Type 414S	Chart 16	To include Cathode Follower
Sound Level Calibrator	Bruel and Kjaer Type 4320	Charts 15 and 16	
Transformer	NE-2012B	Charts 2 through 10	115 V ac; 50/60 Hz Input 26 V ac Output

TABLE C (Cont)
TEST EQUIPMENT REQUIRED

CATEGORY	RECOMMENDED (OR EQUIV) TYPE	WHERE USED	REMARKS
Bridge Rectifier	Use four 1N-4002 diodes	Chart 5	Connect as shown on Fig. 7.
Key Telephone Set connected to Key Telephone Circuit	LOGIC for QUS1C hands-free Units	Chart 1	
Loudspeaker	As available	Chart 15	4 inch or equiv.
Anechoic Chamber	Eckel Industries Inc.	Chart 15	
Potentiometer	As available	Charts 6 through 14	50 K ohms
Potentiometer	As available	Chart 7	10 K ohms
Various resistors	1 watt	Charts 7 through 10 Charts 7 through 10 Charts 6 through 10 Charts 6 through 10 Chart 5 Chart 7	100 K ohms 10 K ohms 600 ohms 51 ohms 500 ohms 4.7 ohms
1 LED indicator	P0525768	Charts 6 through 10	
1 Diode	1N-4002	Charts 5, 7	
680 mfd capacitor	As available	Chart 5	100 WVDC
Various jumper wires		Charts 3 and 6 through 14	various lengths required
Bench Vice	Flotran Industries	Charts 6 through 14	Jaws to open to at least 4 1/2 inches

5. RELAY BOARD TESTS

5.01 The QUS1B, COMPANION 2 and the QUS1C LOGIC HFU are equipped with a relay board. This relay board carries out switching operations which provide automatic transfer and muting and permits on-hook dialing at the telephone set.

Note: The QUS1A, COMPANION 1, HFU is not equipped with a relay board.

5.02 All functions of the relay board may be tested by operating the relays and performing continuity tests between appropriate contacts. These operations, which are described in Chart 5 are carried out with the relay board removed from the hands-free unit. A bench vice is not required to support the relay board as the unit is compact and easily handled.

CHART 5 — RELAY BOARD CONTINUITY TEST

EQUIPMENT REQUIRED:

Transformer; bridge rectifier; 680 mfd, 40 working volts capacitor;

500 ohm resistor; VOM.

Note: If tests cannot be completed successfully, replace the relay board assembly as per 4.05 G.

STEP	PROCEDURE	INDICATION
1	Connect the relay board to the test set-up as shown in Fig. 22. ***Caution: Do not apply 115 V ac power to the transformer until all other connections have been completed.***	Relay K1 operated, Relay K2 released.
2	Set the VOM to the X1 range and carry out the continuity tests in Table D.	As listed in Table D.
3	Remove the jumper wire from between terminals ON-V_{BB} and ON.	Relay K1 operated, Relay K2 operated.
4	Set the VOM to the X1 range and carry out the continuity tests in Table E.	As listed in Table E.
5	Connect one end of the jumper to the OFF terminal. Apply the other end of the jumper to the LK-OFF and hold until the relays are seen to release.	Relay K1 and Relay K2 release.
6	With the VOM set at the lowest resistance range, carry out the continuity tests in Table F. ***Caution: When tests are completed disconnect transformer from 115 V ac power before removing ancillary equipment from relay board.***	As listed in Table F.

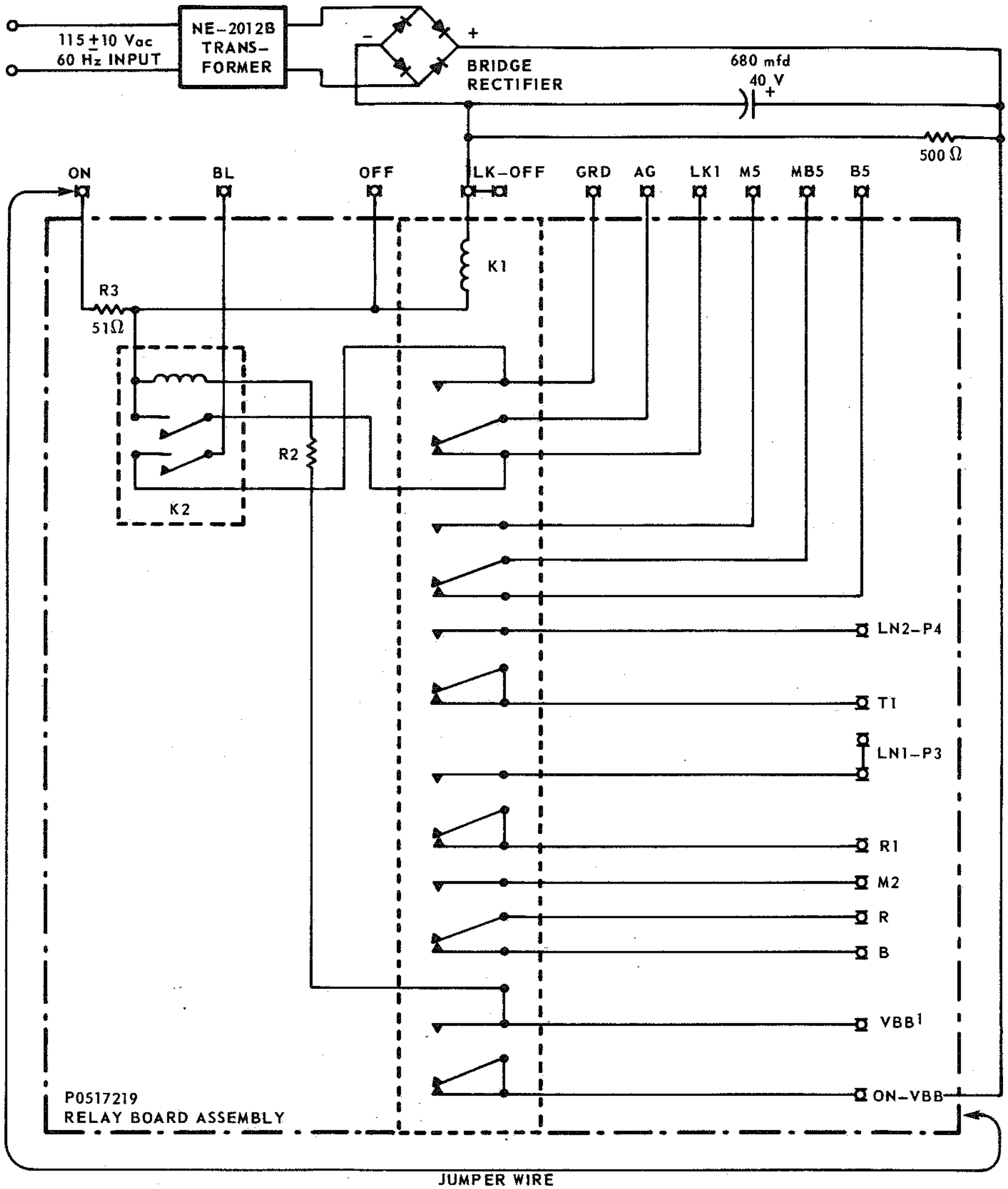


Fig. 22 — Continuity Test Set-Up for Relay Board Assembly

TABLE D
CONTINUITY TESTS ON RELAY BOARD WITH K1 ONLY OPERATED

FROM TERMINAL	TO TERMINAL	EXPECTED RESULT
AG	GRD	CONTINUITY
AG	LK1	OPEN CIRCUIT
AG	BL	OPEN CIRCUIT
BL	GRD	OPEN CIRCUIT
LK1	ON	OPEN CIRCUIT
LK1	OFF	OPEN CIRCUIT
LK1	LK-OFF	OPEN CIRCUIT
MB5	M5	CONTINUITY
MB5	B5	OPEN CIRCUIT
T1	LN2-P4	CONTINUITY
R1	LN1-P3	CONTINUITY
R	M2	CONTINUITY
R	B	OPEN CIRCUIT
V_{BB1}	ON-V_{BB}	CONTINUITY
ON	OFF	CONTINUITY (51 OHMS)

TABLE E
CONTINUITY TEST ON RELAY BOARD WITH K1 AND K2 OPERATED

FROM TERMINAL	TO TERMINAL	EXPECTED RESULT
AG*	GRD	CONTINUITY
AG	BL	CONTINUITY
AG*	LK1	OPEN CIRCUIT
LK1	ON	CONTINUITY (51 OHMS)
LK1	OFF	CONTINUITY
MB5*	M5	CONTINUITY
MB5*	B5	OPEN CIRCUIT
T1*	LN2-P4	CONTINUITY
R1*	LN1-P3	CONTINUITY
R*	M2	CONTINUITY
R	B	OPEN CIRCUIT
V_{BB1}	ON-V_{BB}	CONTINUITY
BL	GRD	CONTINUITY

* Not affected by the operation of K2.

TABLE F
CONTINUITY TEST ON RELAY BOARD WITH K1 AND K2 RESTORED

FROM TERMINAL	TO TERMINAL	EXPECTED RESULT
AG	GRD	OPEN CIRCUIT
AG	LK1	CONTINUITY
LK1	ON	OPEN CIRCUIT
LK1	OFF	OPEN CIRCUIT
MB5	M5	OPEN CIRCUIT
MB5	B5	CONTINUITY
T1	LN2-P4	OPEN CIRCUIT
R1	LN1-P3	OPEN CIRCUIT
R	M2	OPEN CIRCUIT
R	B	CONTINUITY
B2	GRD	OPEN CIRCUIT
V_{BB1}	ON-V_{BB}	SEE NOTE

Note: Reset VOM to measure V_{BB} across these terminals.

6. PRINTED CIRCUIT BOARD TESTS AND ADJUSTMENTS

6.01 Tests and adjustments for Printed Circuit Boards (PCB) are carried out with the PCB removed from the hands-free units (4.05 H). To avoid damage to integrated circuits and discrete components, the PCB should be supported in a Bench Vice (Fig. 23), during the entire course of the tests. These tests, which consist of a number of electrical tests and adjustment procedures, are present in Chart form as follows:

(a) Power Supply Adjustment and Voltage Tests, Chart 6.

(b) Variolosser Balance Adjustment, Chart 7.

(c) Receive Threshold Adjustment, Chart 9.

(d) Receive Channel Tests, Chart 11.

(e) Transmit Channel Tests, Chart 13.

6.02 All tests and adjustments are carried out with the PCB initially connected to ancillary equipment which replaces the speaker, microphone and LED circuits. (Disconnected upon removal of the PCB from the HFU.) Test equipment is then removed or added to the basic setup, as required by the individual test or adjustment. These connection arrangements are depicted for each Chart by Fig. 24 through 29.

6.03 During the course of the tests, settings for critical controls are specified when required. These controls must be set exactly as described, otherwise the test results will be incorrect.

6.04 If the results of any test or adjustment is unsatisfactory, note the test and step number and the significant primary components and continue with the tests until all have been performed. If during the performance of these tests, unsatisfactory results are noted, refer to the "Defective Component, Isolation and Replacement" procedure, Part 7. These procedures will aid in locating the defective part. When the defective part has been replaced, repeat the tests.

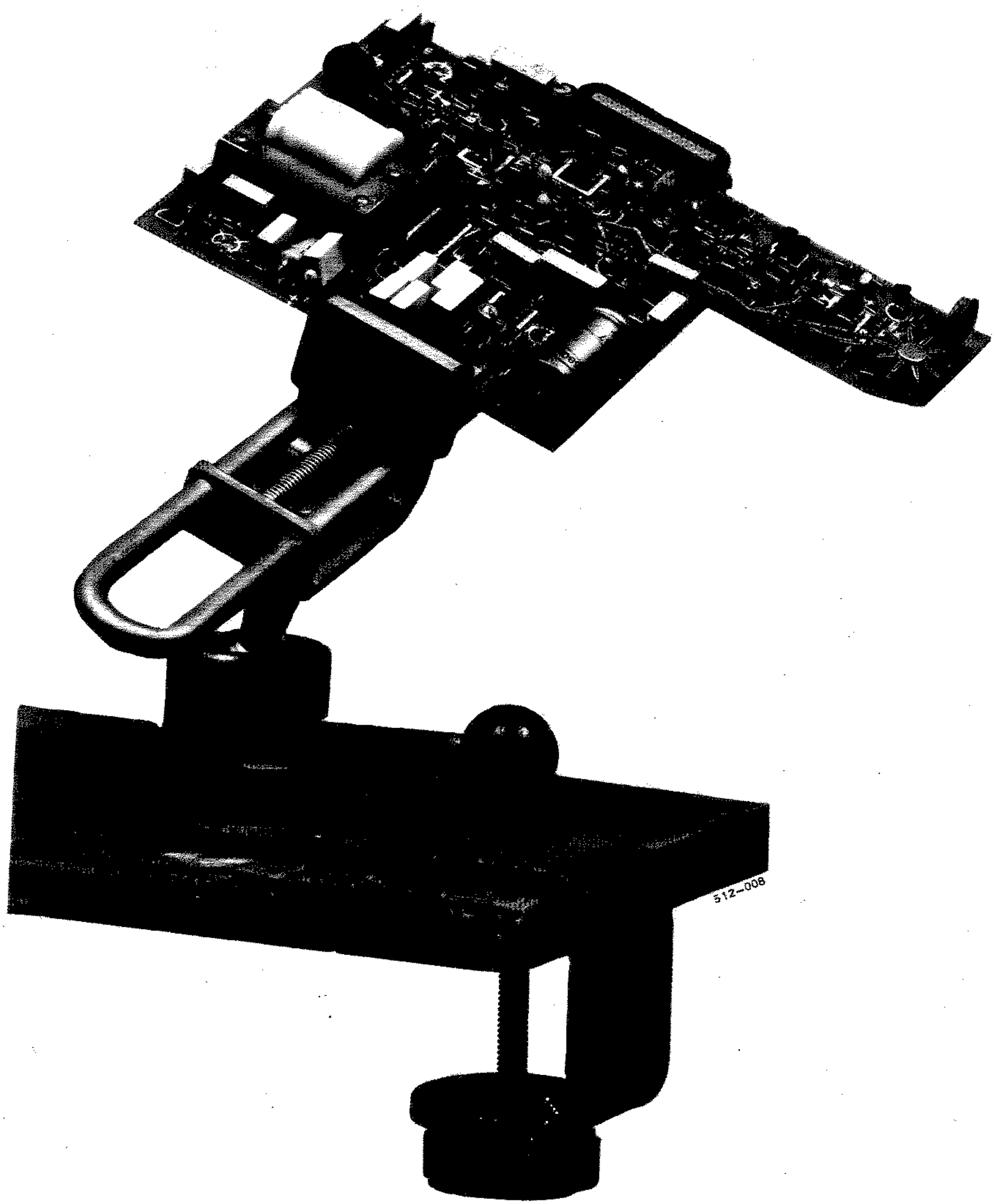


Fig. 23 — PCB Prepared for Testing

CHART 6 – POWER SUPPLY ADJUSTMENT AND VOLTAGE CHECKS

EQUIPMENT REQUIRED:

51 ohm resistor, 600 ohm resistor, 50 K ohm potentiometer, transformer, LED, VOM, and 3 Jumper Wires.

Note 1: Required voltages at primary components are listed in Table H.

Note 2: Use Table L and Fig. 38 to locate TP and components.

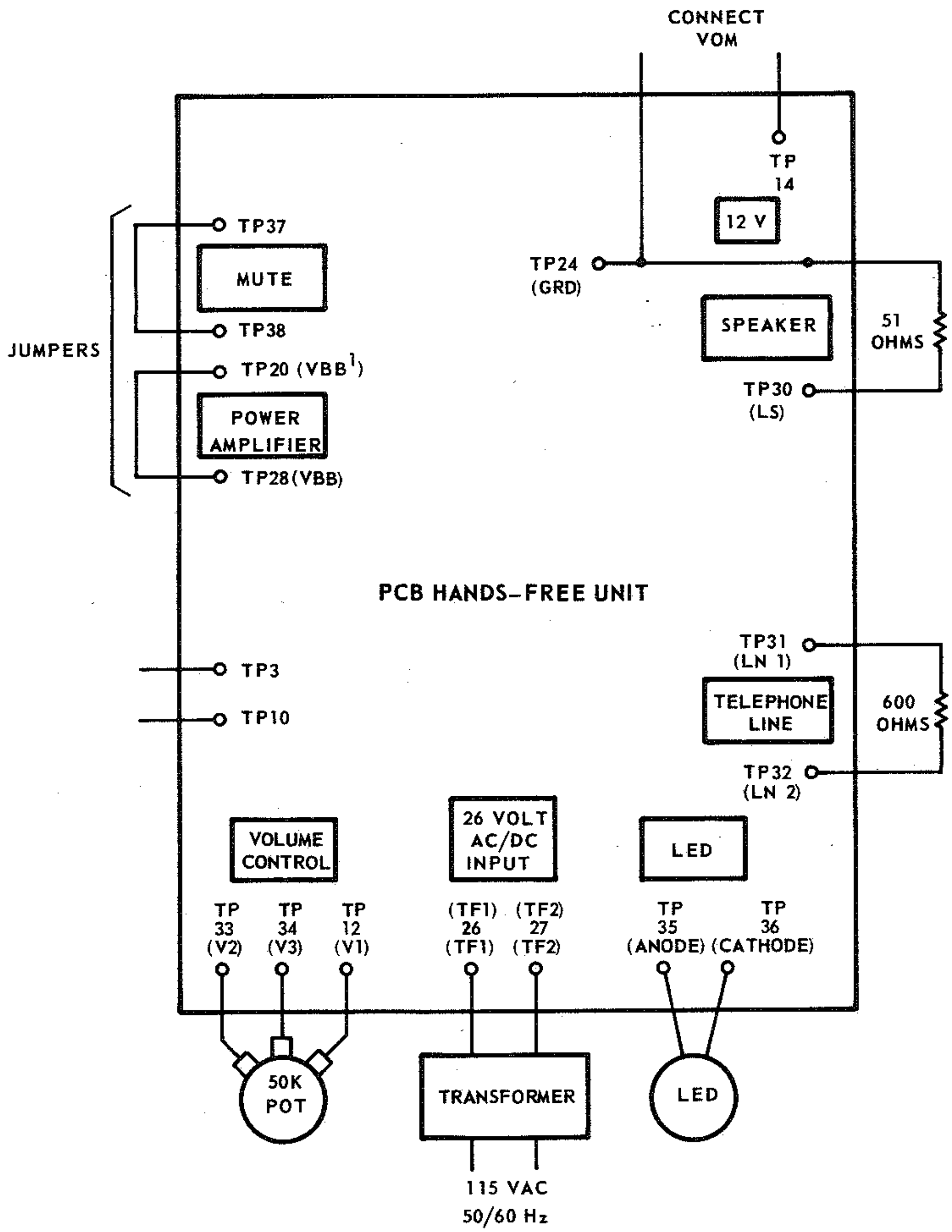
STEP	PROCEDURE	INDICATION	PRIMARY SUSPECT COMPONENTS OR ACTION
1	Connect the PCB as shown in Fig. 24. Set the VOM to the 30 volt dc range and place the leads across TP14 (positive) and TP24 (negative). Adjust R98, on the PCB.	VOM reading to be 12 V dc ±0.1 volts.	MC7
2	Disconnect the VOM and turn R71 fully counterclockwise and then slowly clockwise until the LED indicator lights.	LED is lit.	If LED does not light refer to Chart 9, Receive Threshold Adjustment
3	Remove jumper from between TP20 and TP28.	LED goes out.	
4	Replace jumper across TP20 and TP28.	LED is lit.	
5	Set the VOM to the 30 volt dc range and measure the voltages between TP listed in Table G.	VOM readings for each measurement taken should be within the ranges shown in Table G.	See Table G.
6	Set the VOM to a millivolt dc range. Connect a jumper across TP10 and TP12 and place the VOM leads across TP3 (+) and TP10 (–).	VOM reading should be less than 50 mV.	MC5

CHART 6 (Cont) – POWER SUPPLY ADJUSTMENT AND VOLTAGE CHECKS

STEP	PROCEDURE	INDICATION	PRIMARY SUSPECT COMPONENTS OR ACTION
7	Remove the jumper from TP10 and TP12. Rotate R71, on the PCB counter-clockwise until the LED turns off.	LED not lit.	If LED stays lit refer to Chart 9, Receive Threshold Adjustment
8	Set the VOM to the millivolt dc range. Measure the voltage across TP16 (+) and TP3 (–).	Voltage reading should be less than 100 mV.	MC5

TABLE G
VOLTAGES AT TEST POINTS

TP NO.		VOLTAGE	
+	–	MIN.	MAX.
15	24	7.800	8.200
15	16	0.161	0.175
16	10	1.500	1.730
10	18	0.228	0.260
18	24	5.830	6.200
4	24	3.500	4.200
5	6	0.240	0.290
5	24	3.200	4.800
2	24	2.500	7.000
20	24	23.000	27.000
19	24	12.000	14.000
17	24	2.000	2.400
3	10	0.360	0.460
53	13	0.010	0.020



NOTE: SEE FIG 38 FOR LOCATION OF TP

Fig. 24 — PCB Power Supply Adjustment and Voltage Checks — Test Set-Up

CHART 7 – VARIOLOSSER BALANCE ADJUSTMENT

EQUIPMENT REQUIRED:

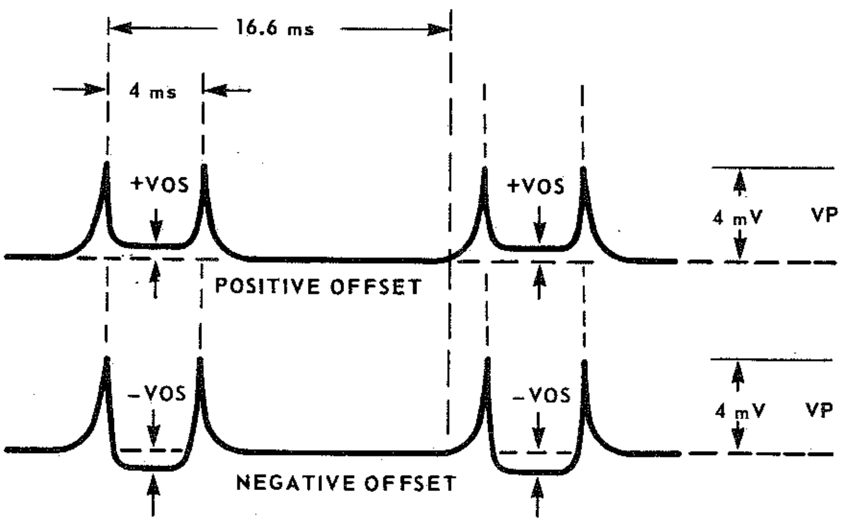
51 ohm resistor, 10 K ohm resistor, 600 ohm resistor, 100 K ohm resistor, 10 K ohm potentiometer, 50 K ohm potentiometer, Transformer, LED, VTVM, Oscilloscope, Signal Generator, Diode and 4 Jumper Wires.

Note: Required voltages at primary components are listed in Table H.

STEP	PROCEDURE	INDICATION	ACTION
1	Connect the PCB as shown in Fig. 25. Set the signal generator to inject 60 Hz at 20 dBV.		
2	Set Channel A to read dc voltages less than 10 mV (5 mV/div. range). Adjust the 10 K potentiometer to center the Channel A trace on the scope screen. Set Channel B to read ac voltage changes between 1 and 2 volts (0.5 V/div.).		
3	For HFU 600 assemblies of the PCB adjust R10, on the PCB until the required waveform is obtained.	(At TP41): The low voltage level between each peak of a pair should be the same as the low voltage level between pairs. The amplitude of the peaks should not exceed 4 mV. The drift allowance is limited to 10 mV total for peaks plus balance.	If the required waveform cannot be obtained see Chart 8.

CHART 7 (Cont) – VARIOLOSSER BALANCE ADJUSTMENT

STEP	PROCEDURE	INDICATION	ACTION
4	For Phase 1 assemblies of the PCB (identified by a "B") no adjustment is provided for transmit variolosser balancing.	(At TP41): The amplitude of the two peaks shall not exceed 10 mV peak to peak.	If the required waveform cannot be obtained see Chart 8.
5	For HFU 600 assemblies of the PCB adjust R33 for minimum variation at TP30.	(At TP30): The peak-to-peak amplitude of the voltage spikes should not exceed 800 mV with the ancillary 50 K pot turned fully clockwise. The drift allowance for this setting of R33 shall not exceed a peak-to-peak amplitude of 1.5 volts.	
6	For Phase 1 assemblies of the PCB no adjustment is provided for receive variolosser balancing.	(At TP30): The amplitude of the two peaks shall not exceed a peak-to-peak amplitude of 1.5 V at TP30 with the ancilliary 50 K potentiometer turned fully clockwise.	



DC Offset – Variolosser Balance Adjustments

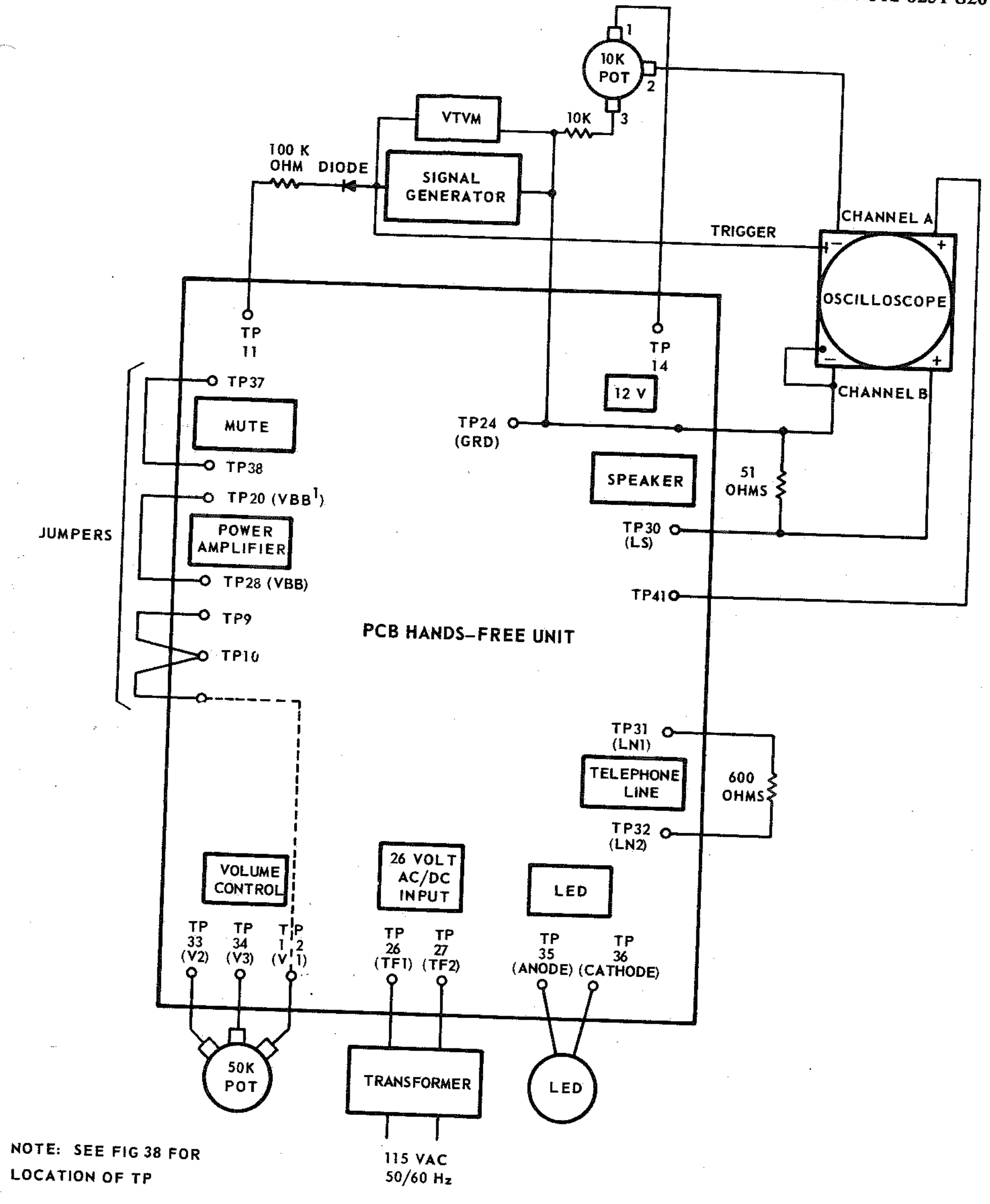


Fig. 25 — Variolosser Balance Adjustment

CHART 8 – VARIOLOSSER BALANCE ADJUSTMENT – FAULT CLEARING

If there is no output from the variolossers with a 60 Hz, 20 dBV signal applied to the base of Q16 (TP11), check with the oscilloscope for the following voltages and waveforms.

TEST POINT	AC VOLTAGE	WAVEFORM
Q16, Base Q17, Base	2.4 V	
MC5, Pin 5 MC5, Pin 7	1.7 V	
MC8, Pin 8 MC8, Pin 10	380 mV 220 mV	
MC8, Pin 12	8 mV	
MC9, Pin 8 MC9, Pin 10	200 mV 275 mV	
MC9, Pin 12	800 mV	

CHART 9 – RECEIVE THRESHOLD ADJUSTMENT

EQUIPMENT REQUIRED:

Signal Generator, VTVM, 51 ohm resistor, 600 ohm resistor, LED, 50 K ohm potentiometer and 2 jumpers.

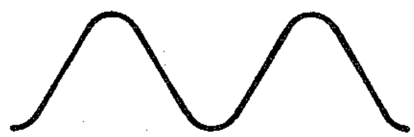
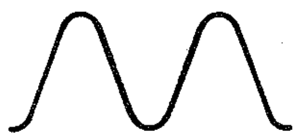
Note: Required voltages at primary components are listed in Table H.

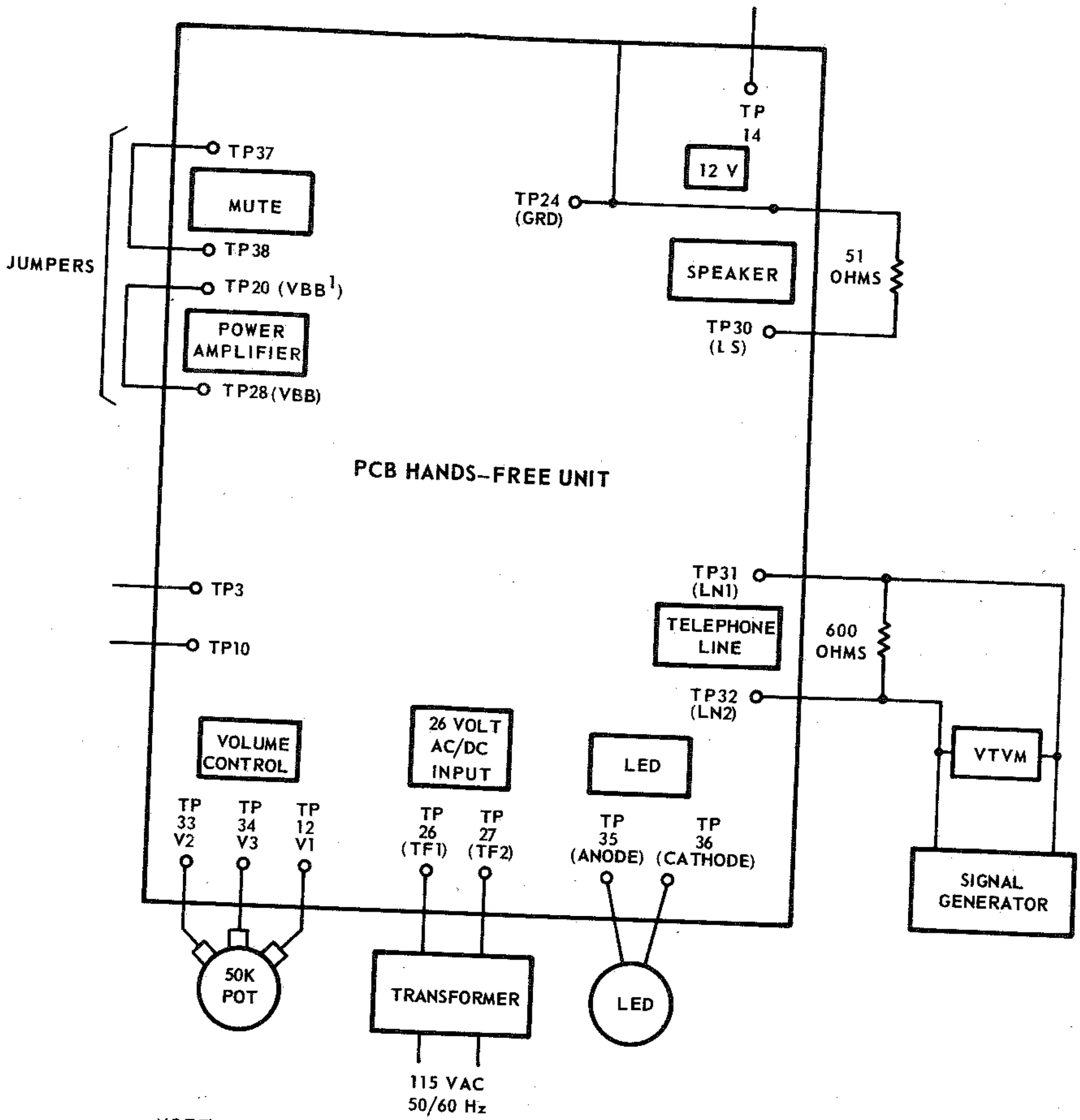
STEP	PROCEDURE	INDICATION	ACTION
1	Connect the PCB as shown on Fig. 26. Turn R71, on the PCB, fully counter-clockwise. Adjust signal generator for a 1 kHz −57 dBV signal.		If a procedure does produce the required result see Chart 10.
2	Slowly advance R71, clockwise, until LED comes on.	LED stays on (illuminated).	
3	Back-off R71 (counter-clockwise) until LED flashes.	LED will alternate between on and off.	
4	Decrease signal level to −58 dBV.	LED goes out.	
5	Increase signal level to −56 dBV.	LED comes on.	

CHART 10 – RECEIVE THRESHOLD ADJUSTMENT – FAULT CLEARING

A receive threshold fault can be found using the test set-up in Fig. 26 and checking the waveforms at the following test points.

The dc voltages given can be used as a guide, but are not necessarily exact. The dc voltages have ground reference.

TEST POINT	AC VOLTAGE	DC VOLTAGE	WAVEFORM
Q3, Emitter Q3, Collector Q4, Base Q4, Emitter Q5, Collector Q10, Base Q10, Emitter C14-R56	3 mV 3 mV 3 mV 3 mV 6 mV 6 mV 6 mV 6 mV	3 V 11.7 V 3 V 2.6 V 5.2 V 4.9 V 3.8 V	
R56-CR8	3 mV		
MC2, Pin 7	800 mV	3.7 V	
CR9-R58	5 mV		
MC9, Pin 3 MC9, Pin 4 MC9, Pin 12 MC6, Pin 1 MC6, Pin 5 MC6, Pin 6 MC6, Pin 2 MC6, Pin 3	5 mV 5 mV 4 mV 200 mV 200 mV 200 mV 3 mV 3 mV	2.2 V 2.2 V 9 V 13 V 13 V 13 V 13 V 13 V	



NOTE: SEE FIG 38 FOR ACTUAL LOCATION OF TEST POINTS

Fig. 26 – Receiver Threshold Adjustments – Test Set-Up

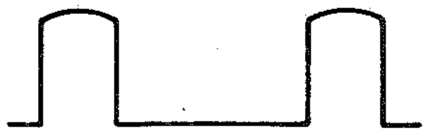
CHART 10 (Cont) – RECEIVE THRESHOLD ADJUSTMENT – FAULT CLEARING			
TEST POINT	AC VOLTAGE	DC VOLTAGE	WAVEFORM
MC6, Pin 7	1.5 V	13 V	
TP30	200 mV		

CHART 11 – RECEIVE CHANNEL TESTS

EQUIPMENT REQUIRED:

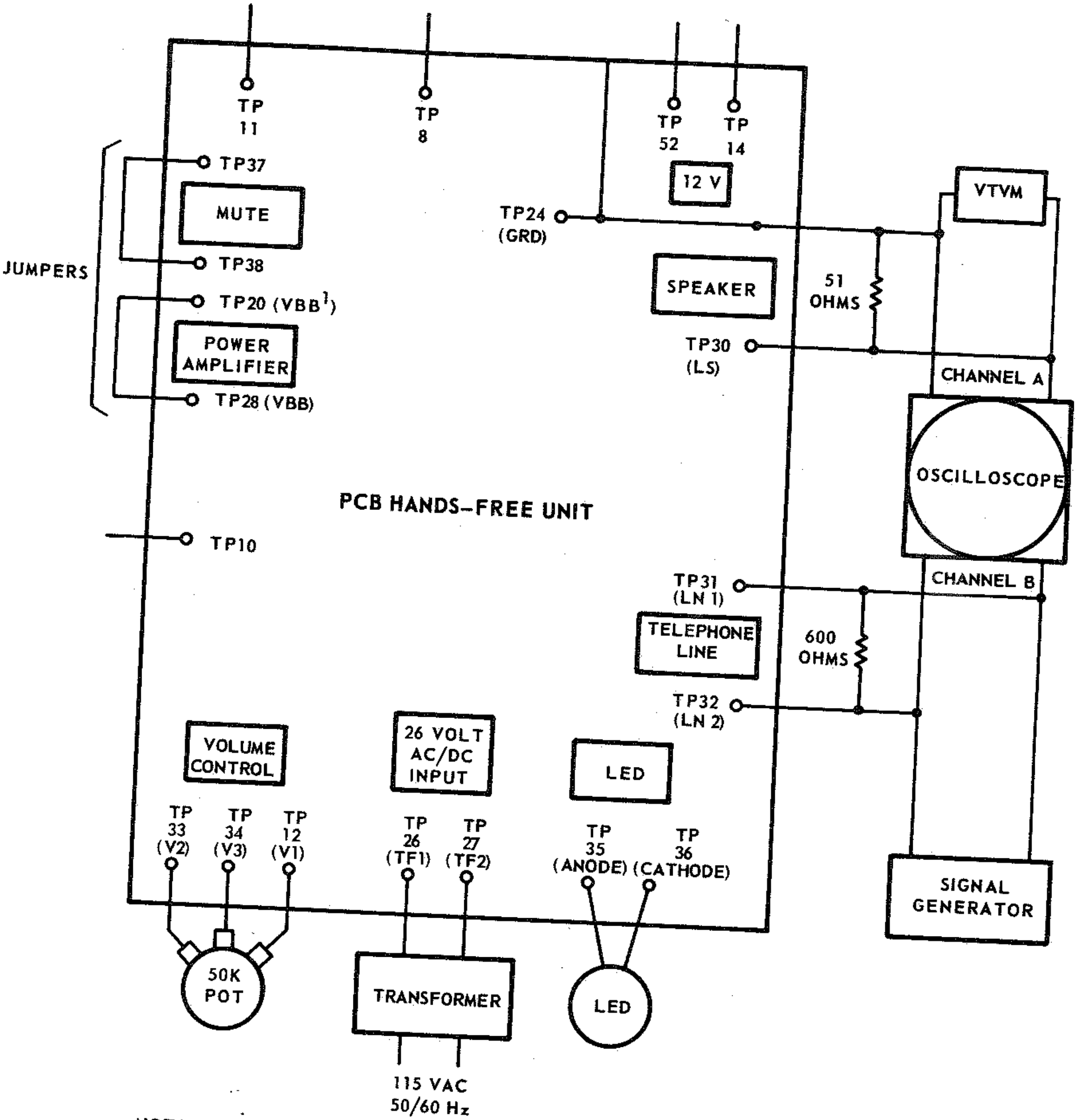
51 ohm resistor, 600 ohm resistor, 4.7 K ohm resistor, 10 K ohm resistor, 100 K ohm resistor, 50 K ohm potentiometer, Signal Generator, LED, Transformer, Oscilloscope, VTVM, and 3 Jumper wires.

STEP	PROCEDURE	INDICATION	ACTION
1	Connect the PCB as shown in Fig. 27. Set signal generator at 1 kHz, –0 dBV.		
GAIN AND FREQUENCY RESPONSE			
2	Lower the frequency, (maintain level at –40 dBV) until the LED turns on.	LED turns on at a frequency greater than 100 Hz.	If a procedure does not produce the required result see Chart 12, Step 1.
3	Reset frequency to 1 kHz and increase level to –30 dBV.	Signal level between TP30 and TP24 is +4±2 dBV.	
4	Adjust oscillator level.	Level steady at +4 dBV.	
5	Decrease frequency to 300 Hz while maintaining level obtained in Step 4.	Signal level between TP30 and TP24 decreases to between +1 and +3 dBV.	
6	Increase frequency to 3 kHz while maintaining level obtained in Step 4.	Signal level between TP30 and TP24 decreases to between +1 dBV and +4 dBV.	
CLIPPING LEVEL			
7	Reset frequency to 1 kHz and increase amplitude until signal at oscilloscope is just below clipping. Measure peak-to-peak voltage at this stage.	Peak-to-peak voltage exceeds 12 Volts (approximately 12.3 dBV).	
8	Set the signal to –22 dBV at 1 kHz.	Signal level between TP30 and TP24 is +12±2 dBV.	

CHART 11 (Cont) – RECEIVE CHANNEL TESTS

SWITCHED LOSS

STEP	PROCEDURE	INDICATION	ACTION
9	Reset oscillator level to give +12 dBV between TP30 and TP24. Connect a 4.7 K ohm resistor between TP8 and TP24 and a jumper between TP10 and TP12. Note the signal level at TP30 and TP24 and record for comparison if the Transmit Channel Switched Loss test should be performed.	Signal level between TP30 and TP24 decreases to between −37 dBV and −41.5 dBV. (This is equivalent to a switched loss of 49 to 53.5 dB).	If test cannot be performed see Chart 12, Step 2.
10	Remove the 4.7 K ohm resistor from between TP8 and TP24 and the jumper from between TP10 and TP12.	Signal level between TP30 and TP24 is +12 dBV.	
11	Rotate the 50 K ohm potentiometer to the fully counterclockwise position.	Signal level between TP30 and TP24 decreases to between −21 B and −31 dB.	If test requirement cannot be met see Chart 12, Step 3.
NOISE			
12	Remove the oscilloscope, the 600 ohm resistor and the signal generator from between TP31 and TP32. Place a jumper across TP31 and TP32 and a 10 K ohm resistor between TP52 and TP24. Rotate the 50 K ohm potentiometer to the fully clockwise position.	The noise level between TP30 and TP24 is less than 40 dB.	If test requirement cannot be met see Chart 12, Step 4.

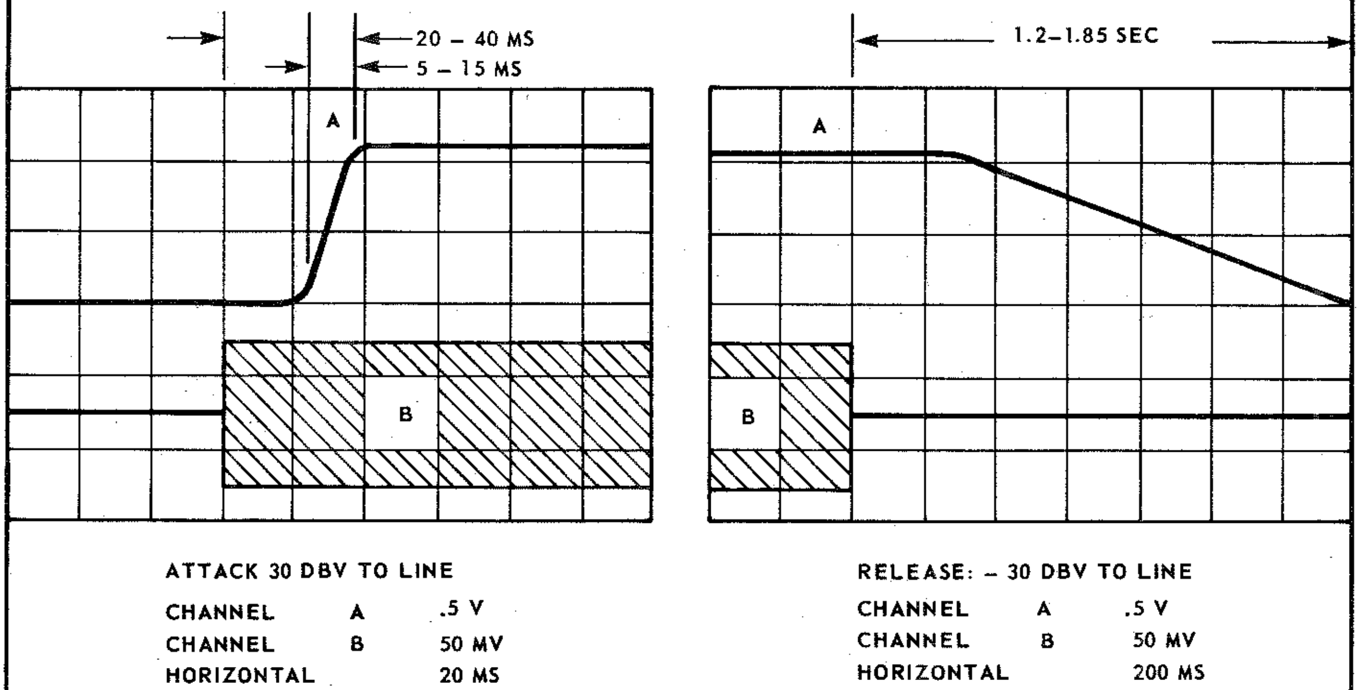


NOTE: SEE FIG 38 FOR LOCATION OF TP

Fig. 27 – Receive Channel Tests, Test Set-Up

CHART 11 (Cont) – RECEIVE CHANNEL TESTS

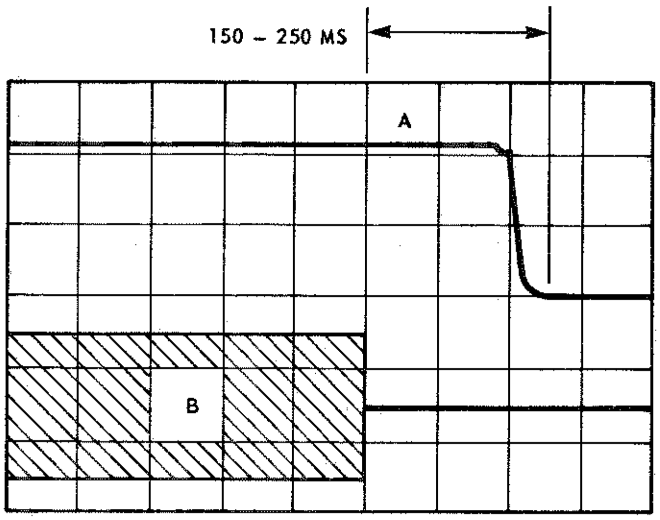
STEP	PROCEDURE	INDICATION	ACTION
SWITCHING TIMES			
13	Adjust the test setup for the PCB as shown in Fig. 28. Use the differential inputs of the oscilloscope and set the controls to measure dc voltage changes between 0 and 3 volts across the control circuit (TP3 and TP18).		
14	Briefly apply −30 dBV signal at 1 kHz (minimum duration 500 ms). Measure the attack and release times of the control circuit (TP3 and TP18) referred to the applied signal.	Attack Time: 30±10 ms. Release time 1.2 to 1.85 s.	If test requirement cannot be met see Chart 12, Step 5.



Attack and Release Times at −30 dBV – Receive Channel Tests

CHART 11 (Cont) – RECEIVE CHANNEL TESTS

STEP	PROCEDURE	INDICATION	ACTION
15	Connect a 100 K ohm resistor between TP53 and TP14. Briefly apply a –30 dBV signal at 1 kHz and measure the release time as the circuit switches from receive to full transmit.	Release Time: 200±50 ms.	If test requirement cannot be met see Chart 12, Step 6.

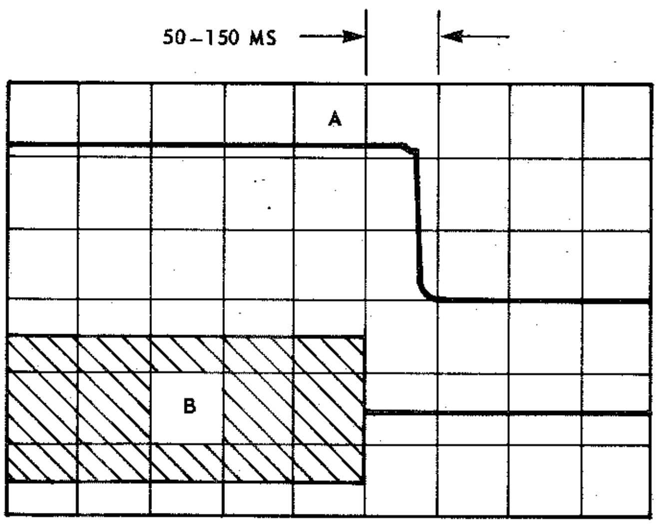


FAST RELEASE: –30 DBV TO LINE

CHANNEL	A	.5 V
CHANNEL	B	50 MV
HORIZONTAL		100 MS

Fast Release Times at –30 dBV – Receive Channel Tests

STEP	PROCEDURE	INDICATION	ACTION
16	Repeat Step 15 with a –50 dBV signal.	Release Time: 100±50 ms.	



FAST RELEASE: –50 DBV TO LINE

CHANNEL	A	.5 V
CHANNEL	B	5 MV
HORIZONTAL		100 MS

Fast Release Times at –50 dBV – Receive Channel Tests

CHART 12 — RECEIVE CHANNEL TESTS — FAULT CLEARING

STEP 1

A receive channel fault can be found using the test set-up in Fig. 27 and checking the waveforms at the following test points.

The dc voltages given can be used as a guide, but are not necessarily exact. The dc voltages have ground reference.

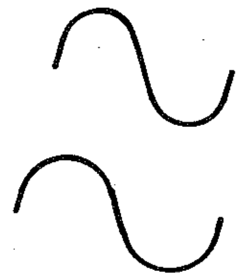
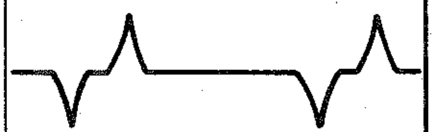
TEST POINT	AC VOLTAGE	DC VOLTAGE	WAVEFORM
Q3, Emitter	58 mV	3 V	
Q3, Base	58 mV	4 V	
Q3, Collector	60 mV	11.7 V	
Q4, Emitter	56 mV	2.6 V	
Q4, Base	56 mV	3 V	
Q5, Collector	116 mV	5.2 V	
Q10, Base	110 mV		
Q10, Emitter	105 mV		
C29-R56	100 mV		
MC2, Pin 6	15 mV		
MC2, Pin 7	1.5 V		
Through CR9	0.1 V		
MC4, Pin 3	7 mV		
MC9, Pin 4	110 mV	2.2 V	
MC9, Pin 12	55 mV	9 V	
MC6, Pin 1	4.2 V	13 V	
MC6, Pin 5	4.2 V	13 V	
MC6, Pin 6	4.2 V	13 V	
MC6, Pin 2	58 mV	13 V	
MC6, Pin 3	58 mV	13 V	
MC6, Pin 7	5.6 V	13 V	

CHART 12 (Cont) – RECEIVE CHANNEL TEST – FAULT CLEARING

STEP 1

TEST POINT	AC VOLTAGE	DC VOLTAGE	WAVEFORM
TP30	4 V		
CR5-Q8	0.5 V		

STEP 2 SWITCHED LOSS

Measure voltage at MC4, Pin 1 (1.9 V) and MC5, Pin 7 (6.2 V). If these voltages are correct check the input (pin 4 and pin 5) and output of MC9 (pin 12 and pin 5). The loss between these points should be –55 to –51 dB. If the loss is less, change MC9 and perform variolosser balance adjustment test (Chart 7) and check switched loss again. If loss is still less than –55 to –51 dB then change C45.

STEP 3 VOLUME CONTROL RANGE

Measure voltage at MC5, Pin 7. This voltage should vary from 7.9 V to 6.6 V with adjusting the volume control. If it does not vary within this range check the switching time (Chart 11, Step 13).

STEP 4 NOISE

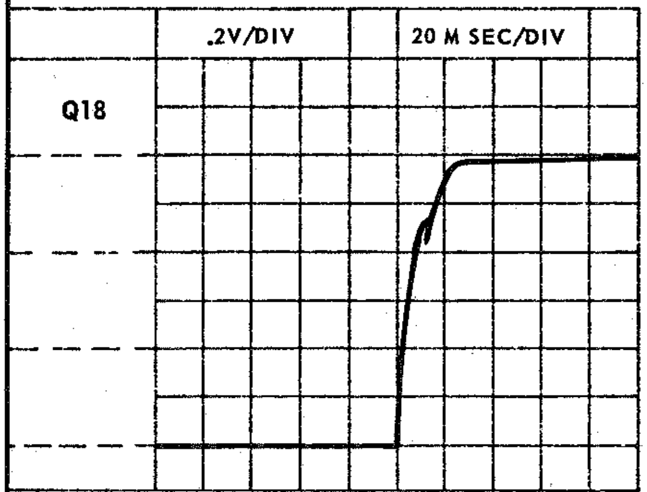
If the noise test does not meet the requirement, disconnect MC9, Pin 12 and check for noise again. If the requirement is still not met the fault is in the power amplifier. (Primary components are MC6, C17, C19.)

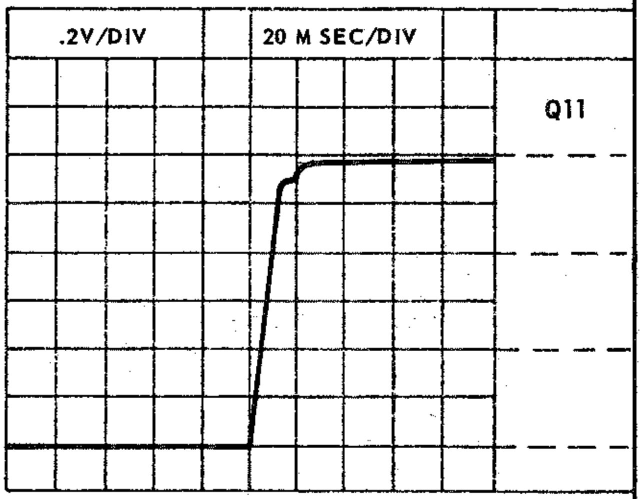
If the noise is within the limits after disconnecting MC9, Pin 12, the fault is in the hybrid or MC9. Trace the noise source back through the circuit by disconnecting one point at a time until the noise is found. (Primary components are MC9, Q2.)

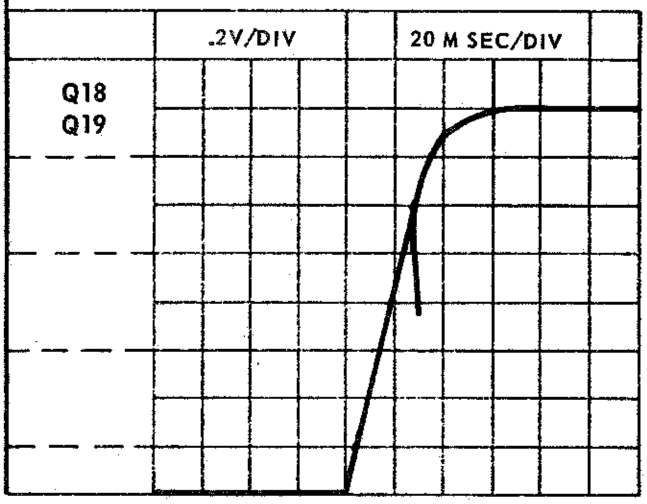
CHART 12 (Cont) – RECEIVE CHANNEL TEST – FAULT CLEARING

STEP 5 **ATTACK TIME**

If the requirements cannot be met compare the oscilloscope waveforms with the following figures. The probable faulty component is shown on each figure.







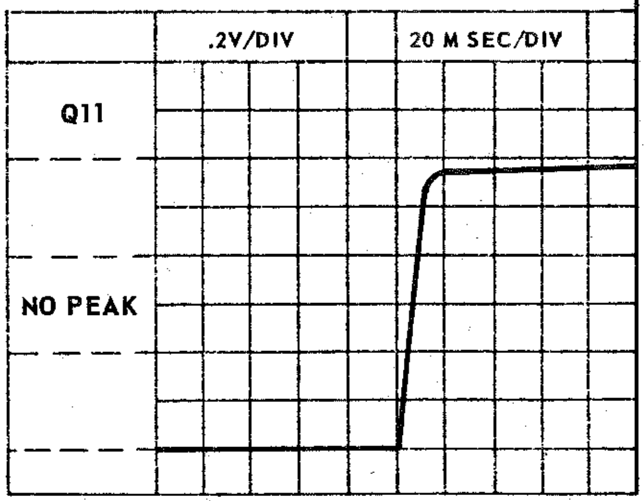


CHART 12 (Cont) — RECEIVE CHANNEL TEST — FAULT CLEARING

STEP 5 (Cont)

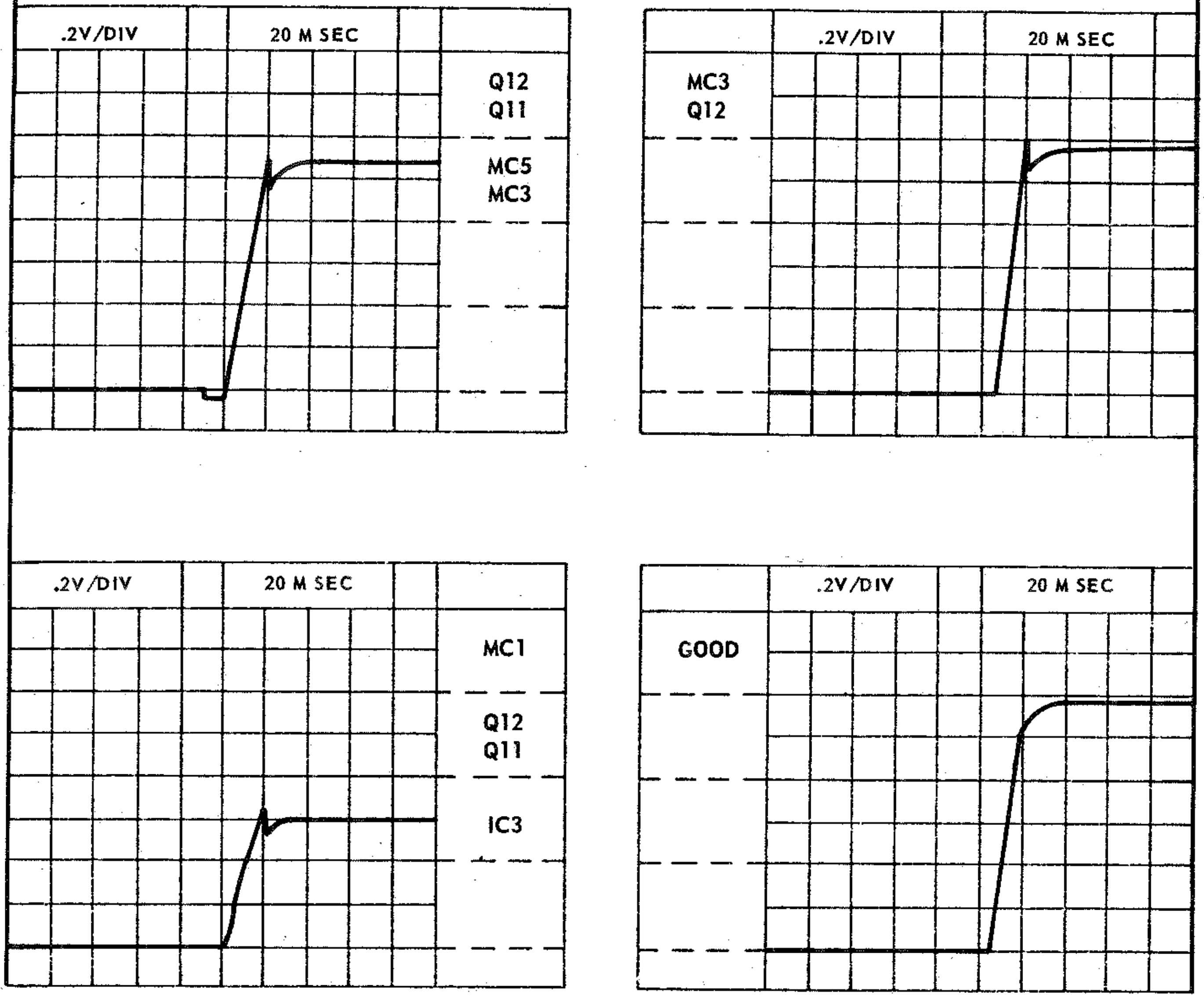
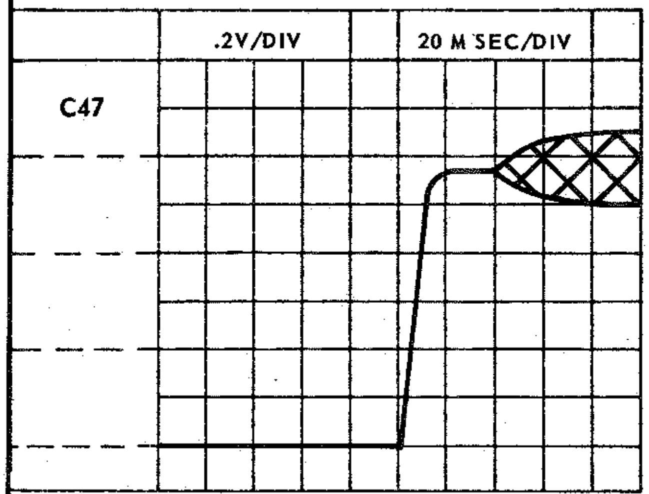
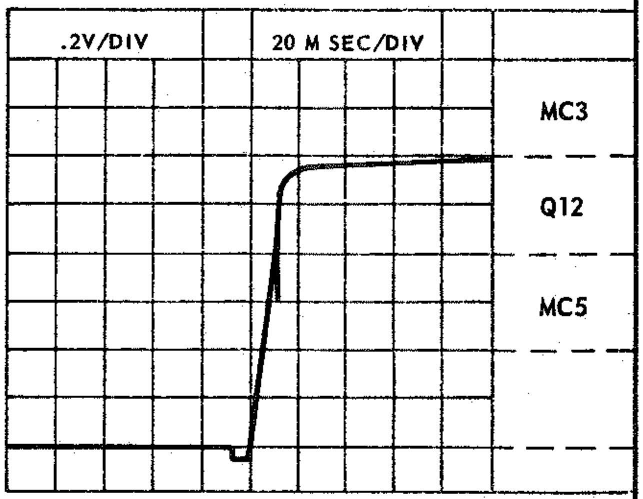
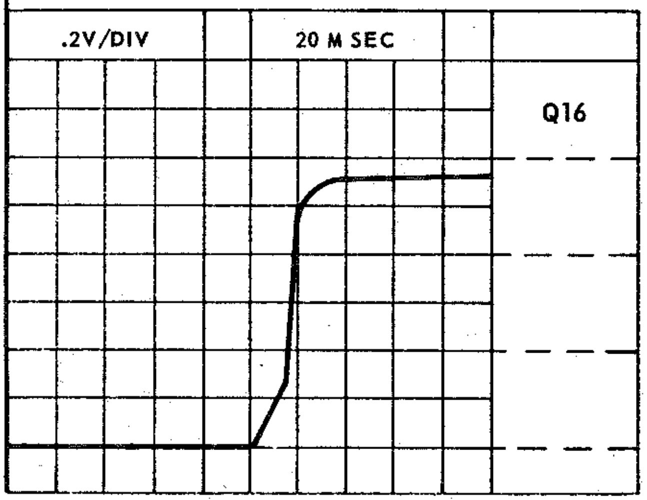


CHART 12 (Cont) – RECEIVE CHANNEL TEST – FAULT CLEARING

STEP 5 (Cont)







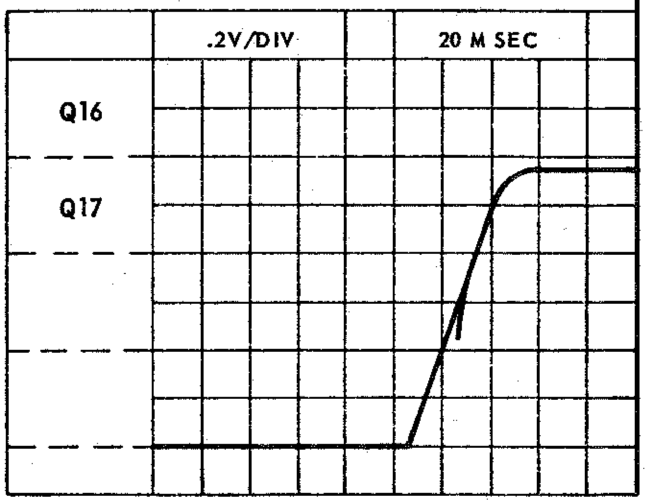
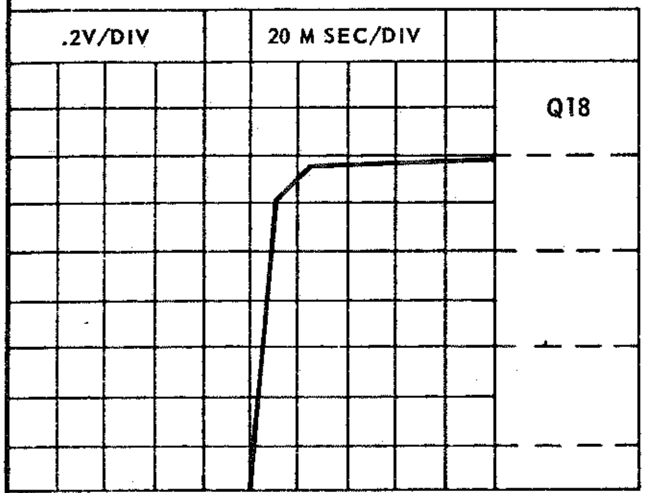
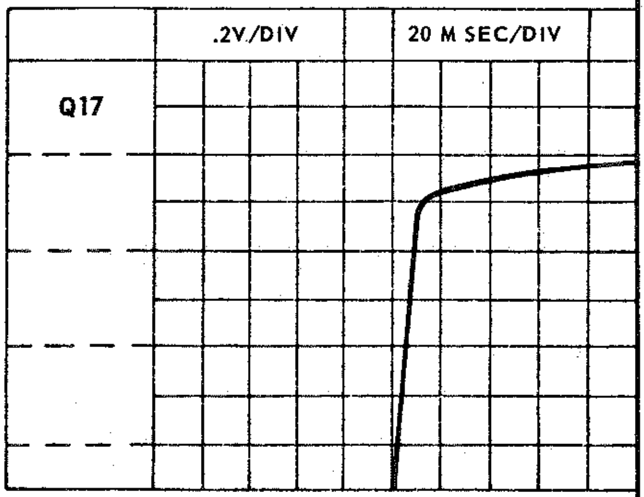


CHART 12 (Cont) – RECEIVE CHANNEL TEST – FAULT CLEARING

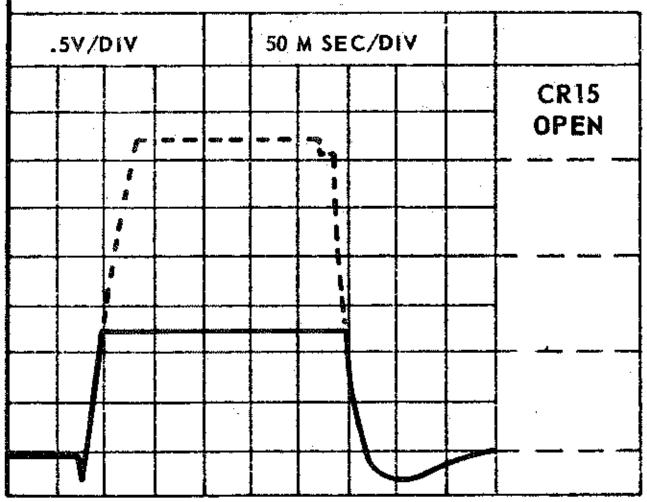
STEP 5 (Cont)

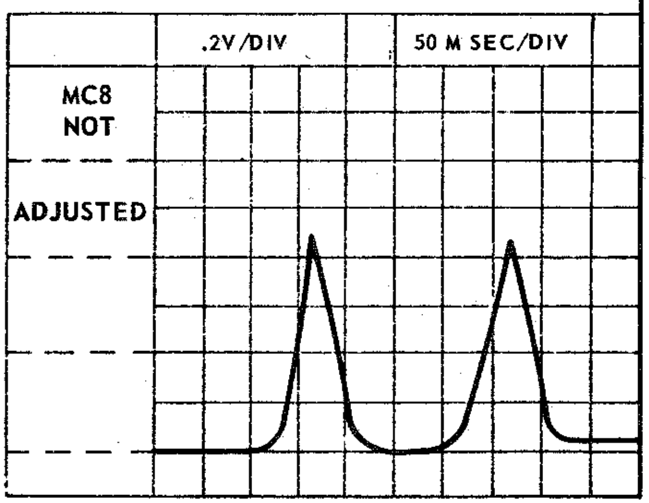




STEP 6 The release time can be put out of limits by Q16 or C38. If the release is fast (60 ms) rather than 1.5 s, check MC5, Pin 1. This should be 11 V. If it is 1.9 V check the noise circuit. If the release is still fast check Q17 and Q19.

The waveform for the switching time for Transmit – Receive – Transmit should be compared with the following figures. The probable faulty component is shown on each waveform.





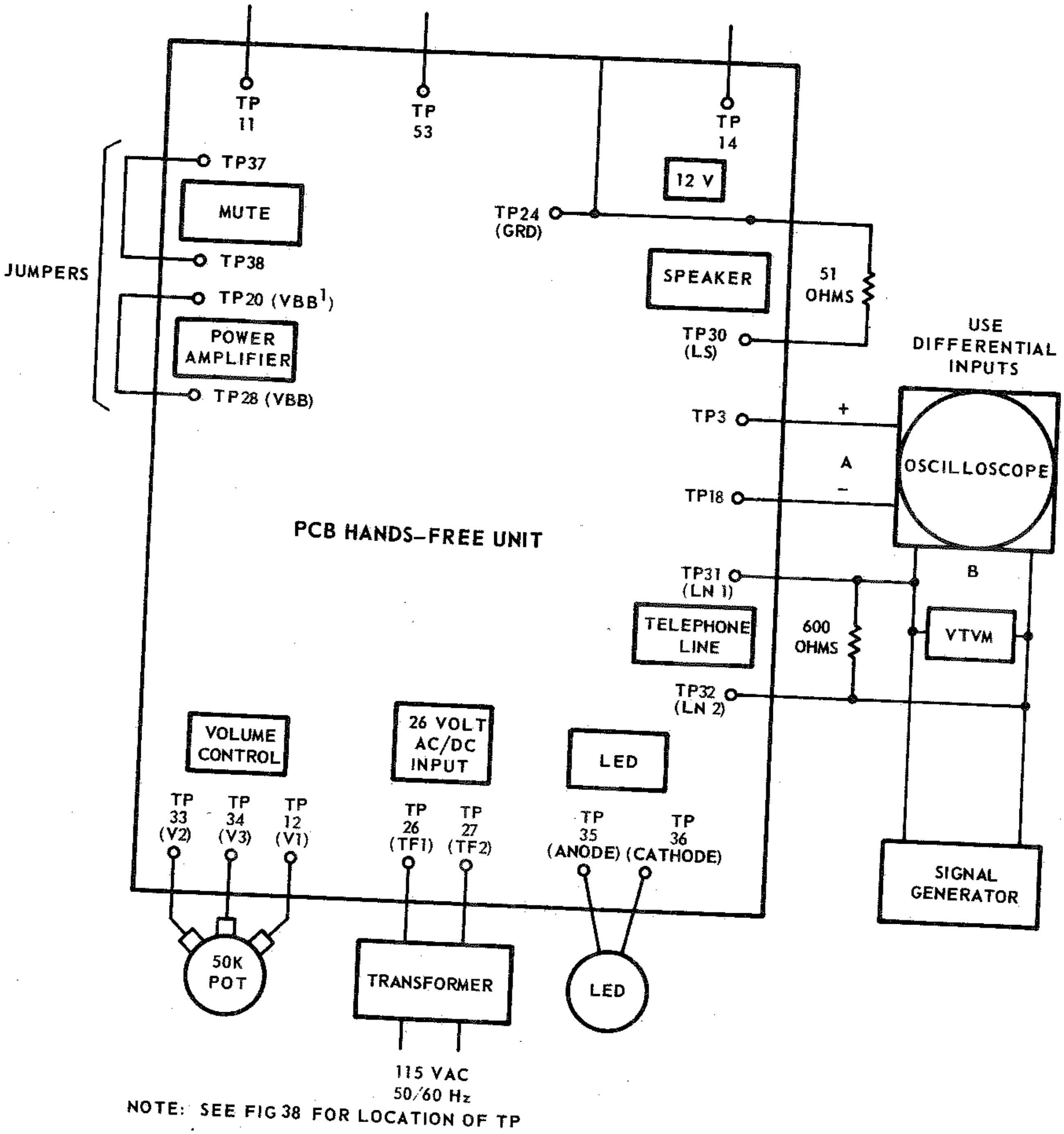
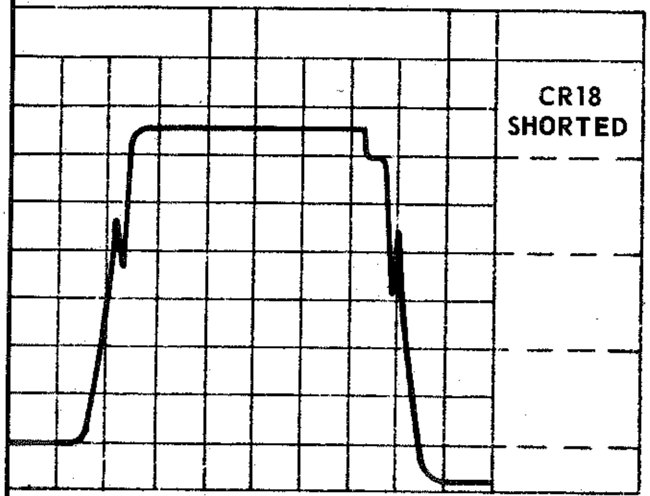
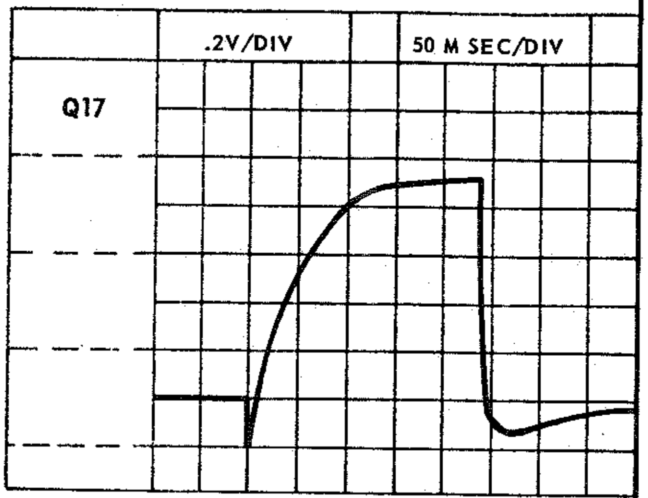


Fig. 28 – Receive Channel Time Tests – Test Set-Up

CHART 12 (Cont) – RECEIVE CHANNEL TEST – FAULT CLEARING

STEP 6 (Cont)





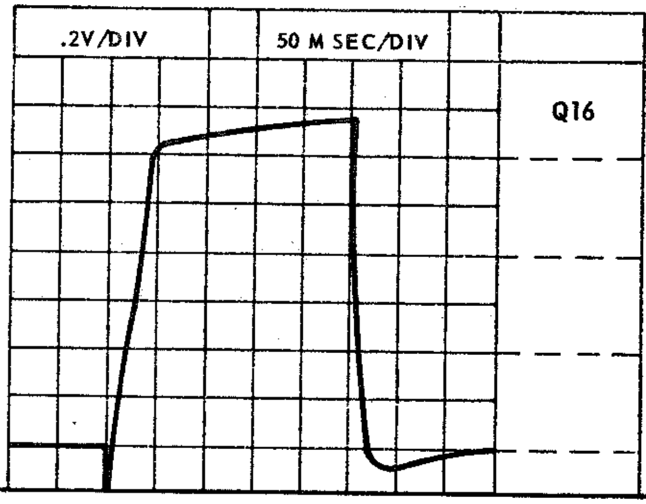


CHART 13 – TRANSMIT CHANNEL TESTS

EQUIPMENT REQUIRED:

51 ohm resistor, 600 ohm resistor, 100 K ohm resistor, 10 K ohm resistor, 50 K ohm potentiometer, Transformer, LED, Oscilloscope, Signal Generator, VTVM, and 5 Jumper Wires.

STEP	PROCEDURE	INDICATION	ACTION
1	Connect the PCB as shown in Fig. 29. Set the signal generator to inject a signal of 1 kHz at a level of –20 dBV.	The signal level at TP31 and TP32 is +21±2 dBV.	If a test requirement cannot be met see Chart 14, Step 1.
2	Adjust the signal input for –21 dBV at TP31 and TP32.	As required.	
GAIN AND FREQUENCY RESPONSE			
3	Maintain the signal level of Step 2, but decrease the frequency to 300 Hz.	The signal level at TP31 and TP32 is 23 (+1; –2) dBV.	
4	Maintain the signal level of Step 2 but increase the frequency to 3 kHz.	The signal level at TP31 and TP32 remains at 23 (+1; –2) dBV.	
5	Connect the VTVM across TP2 and TP24. With the 600 ohm resistor still connected across TP31 and TP32, note the signal level.	The signal level at TP2 and TP24 should be 32.5 (+2.5; –5.0) dBV.	
6	Remove the 600 ohm resistor from across TP31 and TP32. Note the signal level.	The signal level at TP2 and TP24 should be 22±2 dBV.	
7	Place a jumper across TP31 and TP32. Note the signal level.	The signal level at TP2 and TP24 should be –19±2 dBV.	

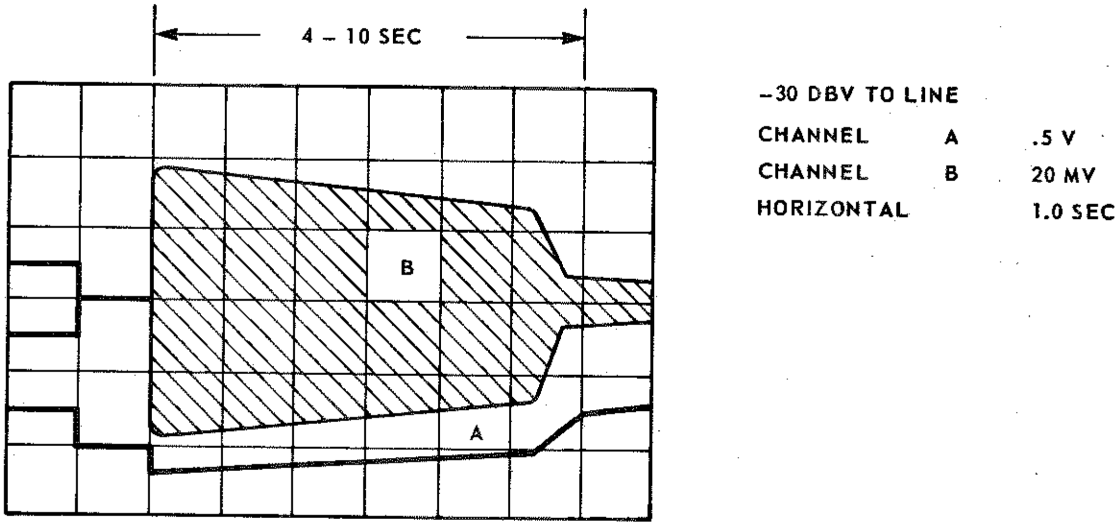
CHART 13 (Cont) – TRANSMIT CHANNEL TESTS

STEP	PROCEDURE	INDICATION	ACTION
SWITCHED LOSS			
8	Remove the jumper from TP31 and TP32. Disconnect the VTVM from TP2 and TP24. Connect the VTVM across the 600 ohm resistor at TP31 and TP32. Adjust the signal generator to deliver –6 dBV at 1 kHz between TP31 and TP32.	The signal level at TP31 and TP32 should be –6±0.5 dBV.	If a test requirement cannot be met see Chart 14, Step 2.
9	Connect a 10 K ohm resistor across TP52 and TP24. Note the signal level at TP31 and TP32.	The signal level at TP31 and TP32 should drop to between –55 dBV and –59 dBV. This represents a switched loss of between –49 and –53.5 dB. (If a Receive Channel Test has been performed, compare with the loss recorded in Step 9 of Chart 11. The recorded results should be within 1 dB of each other.)	
10	Remove the 10 K ohm resistor from across TP52 and TP24. Note the level at TP31 and TP32.	The signal level at TP31 and TP32 should be –6±0.5 dBV.	
STANDBY			
11	Remove the jumper from across TP10 and TP12.	The signal level at TP31 and TP32 should drop to –17±2 dBV.	If the signal level does not drop see Chart 14, Step 3.

CHART 13 (Cont) – TRANSMIT CHANNEL TESTS			
STEP	PROCEDURE	INDICATION	ACTION
NOISE			
12	Replace the jumper across TP10 and TP12 and disconnect the signal generator and 100 K ohm resistor from across TP29 and TP24. Reconnect the 100 K ohm resistor only across TP29 and TP24.	The noise level, as measured across TP31 and TP32, should be less than –69 dBV.	If the noise exceeds –69 dBV see Chart 14, Step 4.
NOISE CIRCUIT			
13	Remove the 100 K ohm resistor from across TP29 and TP24 and reconnect the signal generator and the 100 K ohm resistor across TP29 and TP24 as shown on Fig. 29. Set the injected signal to –33 dBV at 1 kHz.	The signal level at TP31 and TP32 should be –34±2 dBV.	If a test requirement cannot be met see Chart 14, Step 5.
14	Remove the jumper from across TP10 and TP12. Record the value obtained.	The signal level at TP31 and TP32 should be 11±2 dB below the level of Step 13.	
15	Remove the jumper from across TP7 and TP14.	The signal level at TP31 and TP32 decreases 7±2 dB below the level recorded in Step 14.	

CHART 13 (Cont) – TRANSMIT CHANNEL TESTS

STEP	PROCEDURE	INDICATION	ACTION
16	Briefly remove the signal at TP29 and then reapply. Check signal and control voltage waveform on the oscilloscope.	The signal level should decrease from an initial −34±2 dBV to −23±4 dBV within a minimum of 4 and a maximum of 10 s.	



Noise Circuit-Transition to Standby – Transmit Channel Tests

STEP	PROCEDURE	INDICATION	ACTION
17	Replace the jumper across TP10 and TP12 and across TP7 and TP14.	The signal level at TP31 and TP32 should be −34±2 dBV.	

CHART 13 (Cont) — TRANSMIT CHANNEL TESTS			
STEP	PROCEDURE	INDICATION	ACTION
SWITCHING TIMES			
18	Disconnect Channel B of the oscilloscope from TP31 and TP32. Connect Channel A across the signal generator with the + lead between the 100 K resistor and the signal generator. Set the controls for Channel B to measure dc voltage differences up to 0.5 volts.	Attack time is 50±20 ms (see Fig. 33). Release time is 0.6±0.2 s.	If a test requirement cannot be met see Chart 14, Step 6.
19	Briefly apply a −36 dBV signal at 1 kHz. Measure the attack and release times at the voltage between TP3 and TP18.		

CHART 14 – TRANSMIT CHANNEL TESTS – FAULT CLEARING

STEP 1

A transmit channel fault can be found using the test set-up in Fig. 29 and checking the waveforms at the following test points.

The dc voltages given can be used as a guide, but are not necessarily exact.

TEST POINT	AC VOLTAGE	DC VOLTAGE	WAVEFORM
MC1, Pin 1	270 mV	6 V	
MC1, Pin 6	30 mV	3.8 V	
MC1, Pin 7	2.4 V	3.8 V	
MC3, Pin 1	8 V	10 V	
MC3, Pin 3	20 mV		
MC8, Pin 4	250 mV	2.2 V	
MC8, Pin 12	150 mV	9 V	

CHART 14 (Cont) – TRANSMIT CHANNEL TESTS – FAULT CLEARING

STEP 1 (Cont)	TEST POINT	AC VOLTAGE	DC VOLTAGE	WAVEFORM
	Q1, Emitter	140 mV	7.8 V	
	Q1, Base	150 mV	9 V	
	R47-C24	40 mV		
	MC2, Pin 1	4 V	3.8 V	
	MC2, Pin 7	1.4 V	3.9 V	
	C30+	50 mV		
	C31+	5 mV		

CHART 14 (Cont) – TRANSMIT CHANNEL TESTS – FAULT CLEARING

STEP 1 (Cont)	TEST POINT	AC VOLTAGE	DC VOLTAGE	WAVEFORM
	Q2, Emitter	4 mV	1.9 V	
	Q2, Base	2 mV	2.4 V	
	Q3, Emitter	270 mV	3 V	
	Q3, Base	250 mV	4 V	
	Q3, Collector	380 mV	11 V	
	Q4, Emitter	40 mV	2.6 V	
	Q4, Base	40 mV	3 V	
	Q4, Collector	1 mV	11.4 V	
	Q5, Collector	80 mV	5.2 V	
	MC9, Pin 4	80 mV	2.2 V	
	Q10, Base	75 mV	4.9 V	
	Line	290 mV		

STEP 2 SWITCHED LOSS

If the signal level at TP31 and TP32 does not drop at all check the switching time. The unit probably does not go into receive. Check the voltage at MC5, Pin 7. This voltage should go to 7.9 volts.

If MC5, Pin 7 is 7.9 volts and the signal level does not drop, replace MC8. After replacing MC8 perform the variolosser balance test (Chart 7).

STEP 3 STANDBY TEST

If the signal level does not drop, check MC5, Pin 1. This output should be high (11.7 V). Check the output from MC5, Pin 7 (6.66 V). If MC5, Pin 1 is low (1.9 V), check the noise circuit (MC3 and MC1). If MC5, Pin 1 is high but MC5, Pin 7 is 6.2 V, check CR19 and Q18.

STEP 4 NOISE

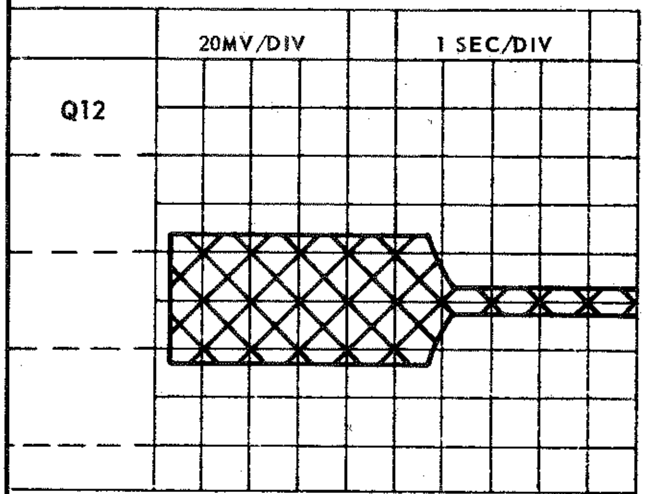
If the noise exceeds −69 dBV, close the mute switch, which eliminates the noise created before the preamplifier. If the noise level goes down more than 4 dB at the line, change R2 and R3 and check MC1. If the noise level does not go down more than 4 dB when the mute switch is closed, change MC8 and/or Q2.

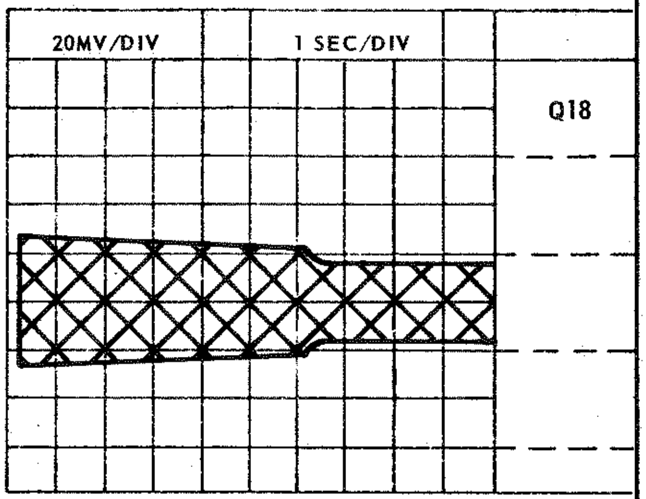
CHART 14 (Cont) – TRANSMIT CHANNEL TESTS – FAULT CLEARING

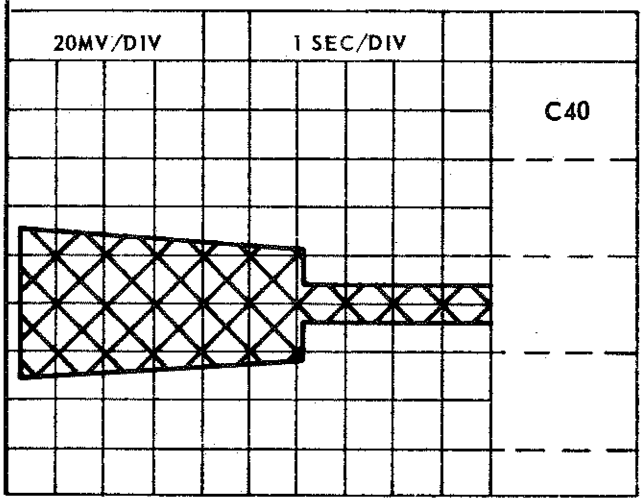
STEP 5 — **NOISE CIRCUIT**

Compare the oscilloscope waveform from Chart 13, Step 13 with the following figures. The probable faulty component is shown on each figure.

The time required before the noise circuit starts operating is dependent on C35 and R65. If C35 must be replaced, power up the board for 10 minutes before retesting.







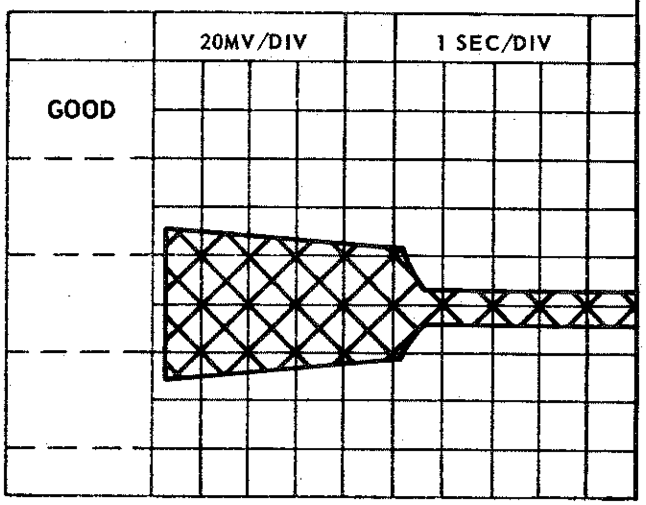
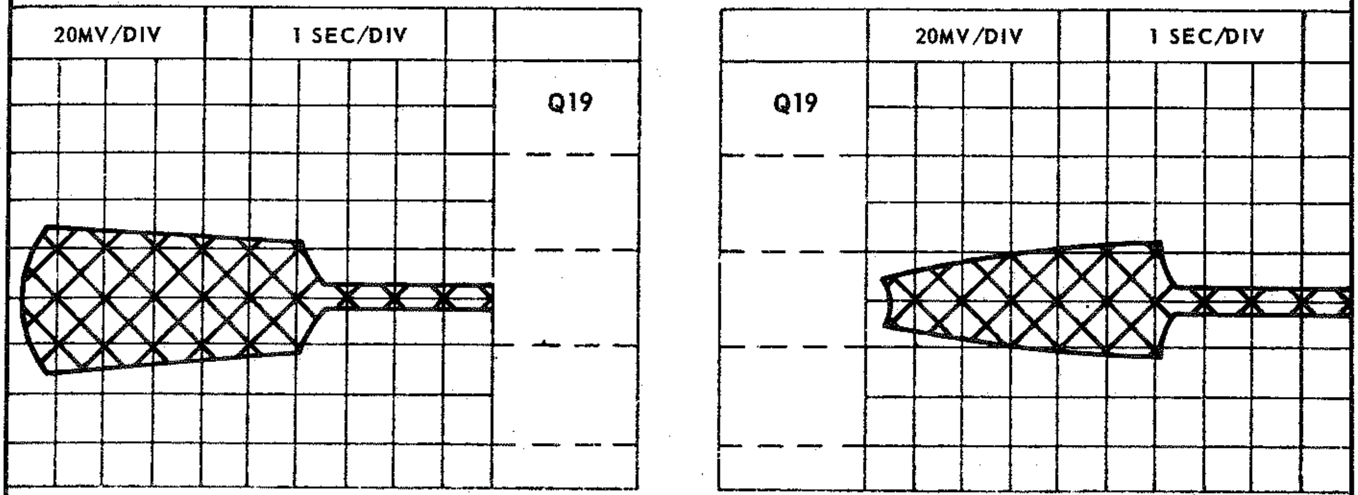


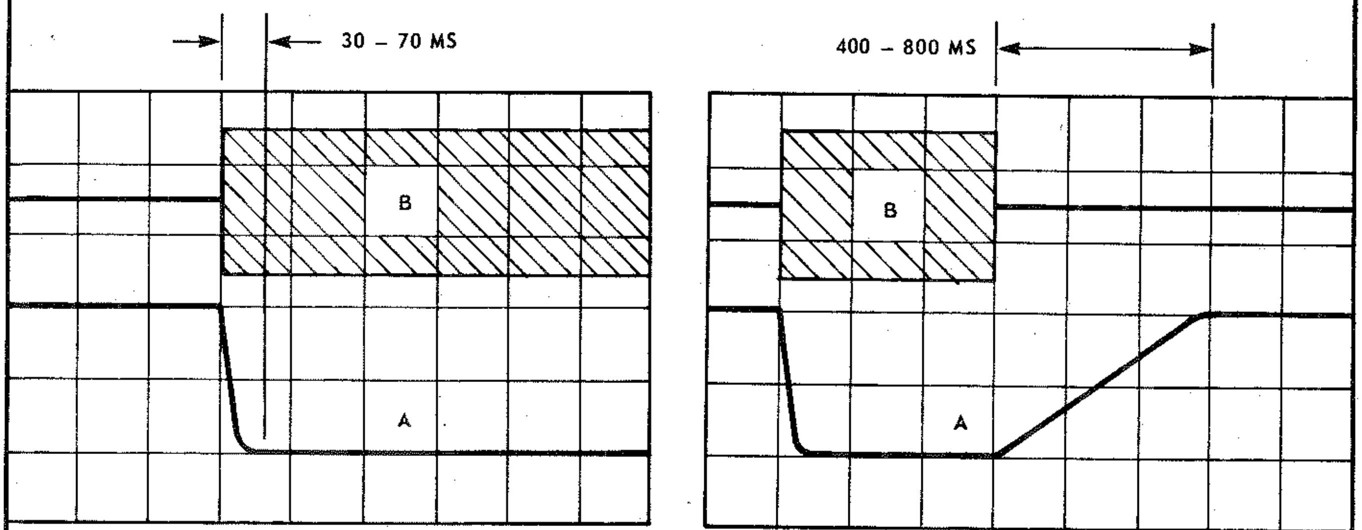
CHART 14 (Cont) – TRANSMIT CHANNEL TESTS – FAULT CLEARING

STEP 5 (Cont)



STEP 6 | **SWITCHING TIME**

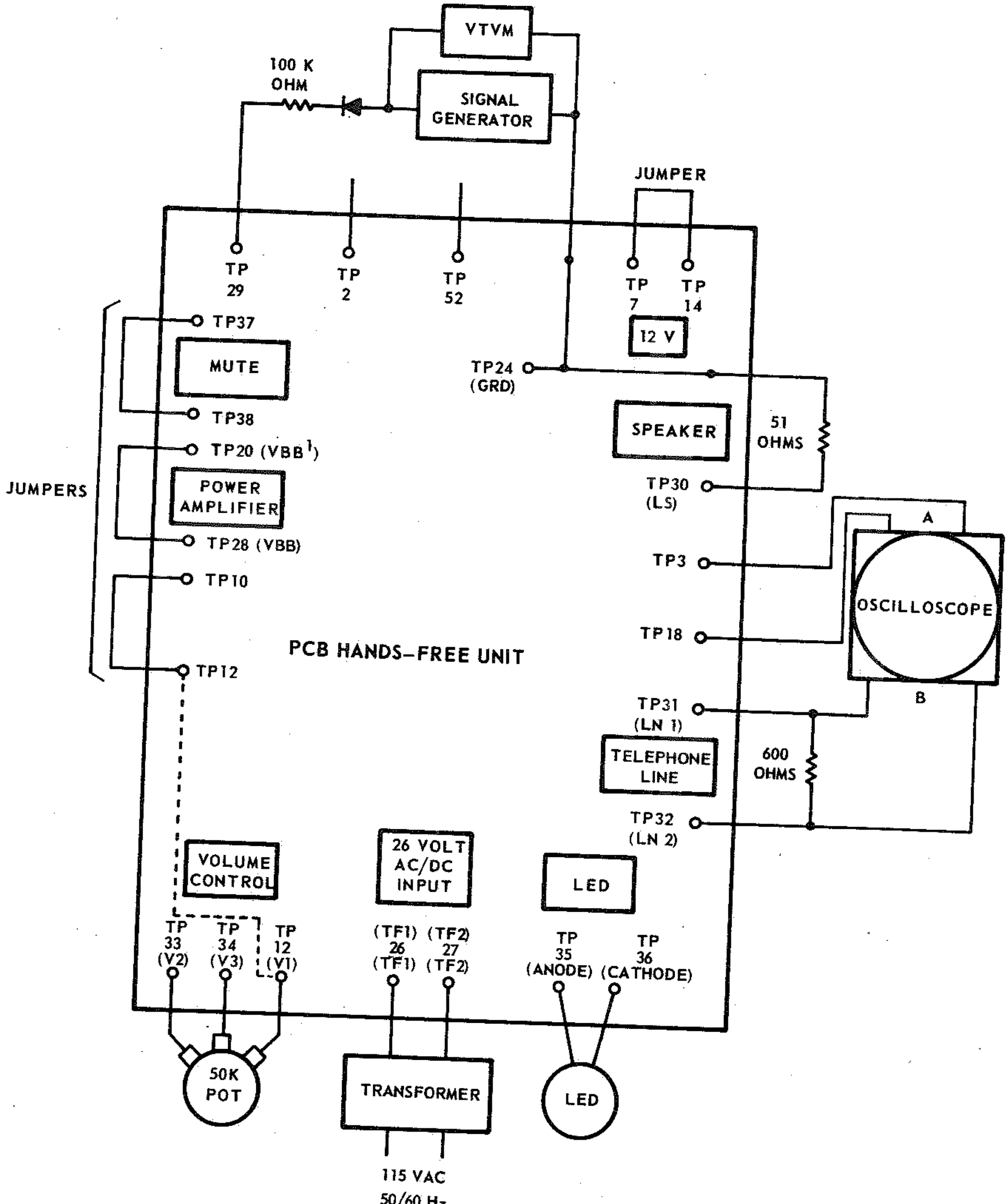
The switching times show changes in voltage at MC5, Pin 7 (TP3). With the test set-up in Chart 13, Step 18 the waveform should look like the figures below.



ATTACK: –36 DBV TO MK		
CHANNEL	A	.2 V
CHANNEL	B	20 MV
HORIZONTAL		50 MS

RELEASE: –36 DBV TO MK		
CHANNEL	A	2 V
CHANNEL	B	20 MV
HORIZONTAL		.2 SEC

Attack and Release Times at –36 dBV – Transmit Channel Tests



NOTE: SEE FIG 38 FOR LOCATION OF TP

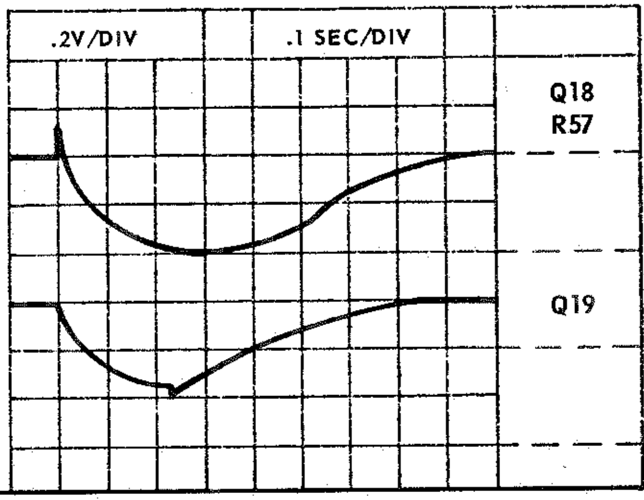
Fig. 29 — Transmit Channel Tests — Test Set-Up

CHART 14 (Cont) – TRANSMIT CHANNEL TESTS – FAULT CLEARING

STEP 6 (Cont)

The attack time is dependent on C40 and R88 and the release time on C40 and R87. If there is no attack time at all, while performing the test, check MC5, Pin 1 which should be high, going low for 400 ms±, and returning high again. If MC5, Pin 1 does not go low check the noise circuit.

Possible failures are shown in the figure below.



7. DEFECTIVE COMPONENTS, ISOLATION AND REPLACEMENT PROCEDURE

7.01 If a test cannot be completed, then a voltage analysis should be performed. This consists of checking for correct voltages at selected locations on the PCB, in accordance with the test under progress. Voltage analysis is performed using Table H.

7.02 Table H lists the primary components of the PCB. The general function of each of these components and the required voltage at the component terminals is listed in the table.

7.03 It would be impractical for this shop repair practice to attempt to cover every discrete component on the PCB. The voltage analysis information contained herein is used to isolate a fault to a specific area by checking the input/output voltages of the primary component related to a specific function. If an incorrect reading is obtained at any point then further checks, of the related components in that area, are performed (refer to the schematic diagram, Fig. 18 and the PCB description, Part 3) until the fault is localized. Removal of the faulty component is detailed in 7.07.

VOLTAGE ANALYSIS

7.04 To perform dc voltage analysis tests, prepare the PCB as shown in Fig. 30.

7.05 Set the VOM to the 30 V dc range and place the positive lead on TP14 and the negative lead on TP24. Adjust R98, on the PCB, until a reading of 12 volts is obtained.

7.06 Use a digital voltmeter to check for the voltages listed in Table H.

REMOVAL OF COMPONENTS FROM PCB

7.07 Ensure that the PCB is firmly secured in a bench vice (Fig. 23) with the solder side upwards. The use of a suction type soldering iron is recommended, failing this "solder-wick" may be used. In some instances it may be necessary to pry the component loose while the solder is molten. When leads are accessible, precutting will facilitate removal.

> ***Caution:** Heat may have to be applied for several seconds while removing component. This may damage a component which was otherwise serviceable. Therefore, do not return removed components to the PCB, but replace with new components.*

ASSEMBLY OF NEW COMPONENTS TO PCB

7.08 Before installing the new component on the PCB ensure that all connection holes are free of solder. Cut leads to length and dress to fit exactly into connection holes. Secure component temporarily to the underside of the board, using masking tape if required. Carry out soldering operation expeditiously to avoid transmitting heat to the component. Ensure that no bridges are formed by excess solder flows. Remove masking tape, if used, when soldering operations are completed. After a component is replaced the PCB must be retested.

TABLE H
SUSPECTED FAULTY COMPONENT VOLTAGE ANALYSIS

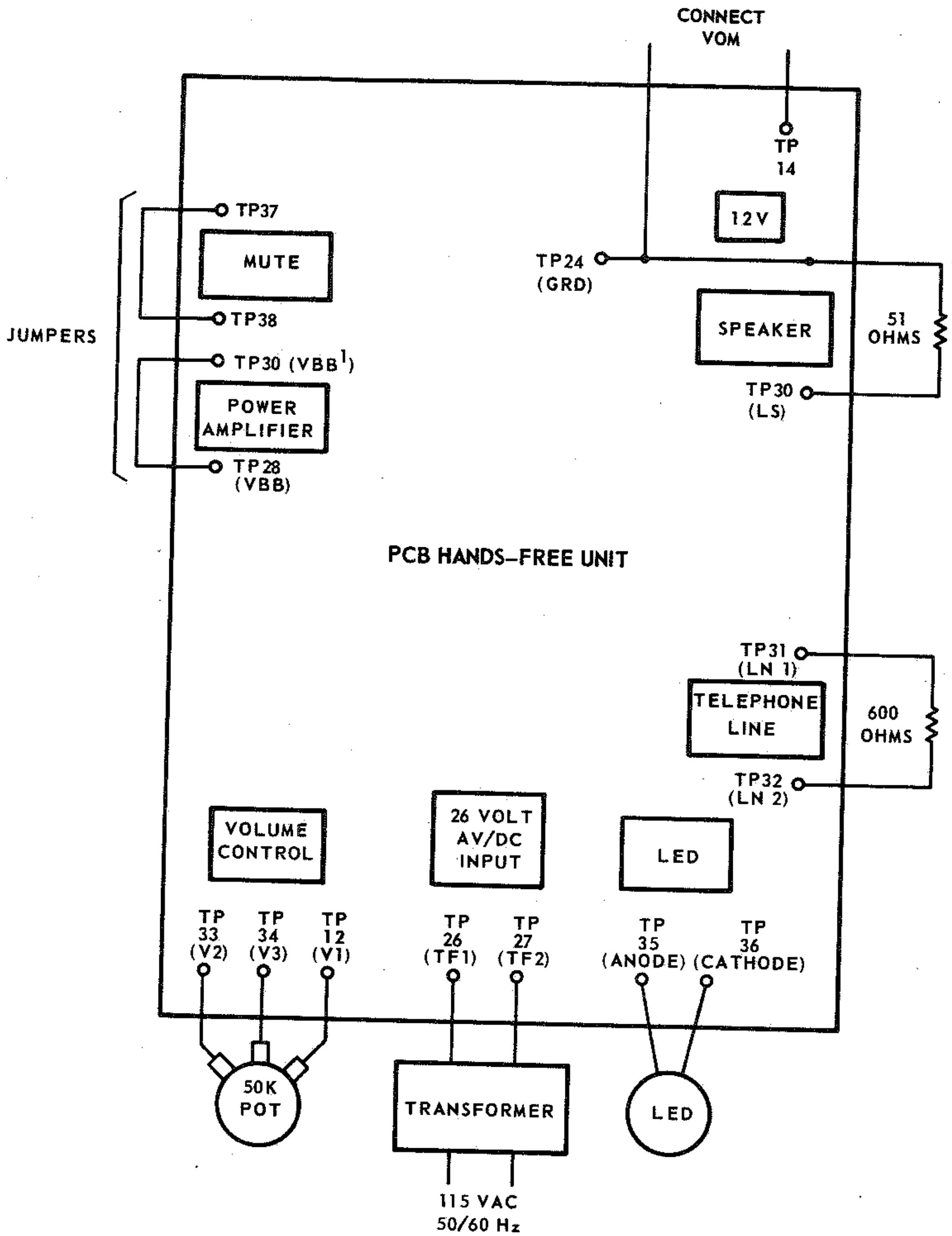
COMPONENT		FUNCTION OF COMPONENT	TESTING POINT	REQUIRED VOLTAGE (DC)
AR1	Pin 1	Transmit Variolosser (for Phase 1 configuration only)	TP17	2.20±0.2
	Pin 2		TP3	6.15±0.01
	Pin 3		Pin 3	9.00—1.00+0.5
	Pin 4		TP39	2.20±0.2
	Pin 6		TP14	12.00±0.01
	Pin 7		TP18	5.90±0.01
AR2	Pin 1	Receive Variolosser (for Phase 1 configuration only)	TP17	2.20±0.2
	Pin 2		TP3	6.15±0.01
	Pin 3		TP45	9.00—1.00+0.5
	Pin 4		TP43	2.20±0.2
	Pin 6		TP14	12.00±0.01
	Pin 7		TP15	7.97±0.01
Bias Network R59, R60, R61, R48, R49, R100, R101, R102, R103, R104, R105, and R106.		Supplies correct voltages for the operation of the components of the circuit	See Table G	See Table G
MC1	Pin 1	Transmit and Receive Rectifier and Amplifier	Pin 1	6.03±0.5
	Pin 2		Pin 2	6.04±0.5
	Pin 3		TP4	6.03±0.5
	Pin 6		Pin 6	3.86±0.78
	Pin 7		Pin 7	3.75±0.16
MC2	Pin 1	Transmit and Receive Rectifier and Amplifier	Pin 1	3.49±0.15
	Pin 2		Pin 2	3.86±0.78
	Pin 3		TP4	3.86±0.78
	Pin 6		Pin 6	3.83±0.78
	Pin 7		Pin 7	3.74±0.16
MC3	Pin 2	Noise Control	Pin 2	3.75
	Pin 3		TP48	3.75
	Pin 5		Pin 5	3.72
	Pin 6		Pin 6	3.60
	Pin 7		Pin 7	3.59
MC4	Pin 1	Main Comparator	TP50	1.91±0.18
MC5	Pin 1	Noise Comparator	TP51	11.32±0.11
	Pin 7		TP3	6.57±0.23

TABLE H (Cont)
SUSPECTED FAULTY COMPONENT VOLTAGE ANALYSIS

COMPONENT		FUNCTION OF COMPONENT	TESTING POINT	REQUIRED VOLTAGE (DC)
MC6	Pin 1	Power Amplifier	Pin 1	12.96±0.73
	Pin 3		Pin 3	12.47±0.51
	Pin 7		Pin 7	12.93±0.84
MC7	Pin 2	Voltage Regulator	Pin 2	7.06±0.18
	Pin 10		Pin 10	13.32±0.12
MC8	Pin 1	Transmit Variolosser (for HFU 600 configuration only)	TP40	2.16±0.12
	Pin 2		Pin 2	1.51±0.11
	Pin 3		Pin 3	1.51±0.11
	Pin 4		TP39	2.16±0.12
	Pin 6		TP14	12.00±0.10
	Pin 10		TP18	6.01±0.69
	Pin 12		TP41	9.00±0.25
MC9	Pin 1	Receive Variolosser (for HFU 600 configuration only)	TP44	2.16±0.12
	Pin 2		Pin 2	1.52±0.17
	Pin 3		Pin 3	1.52±0.17
	Pin 4		TP43	2.16±0.12
	Pin 6		TP14	12.00±0.10
	Pin 10		Pin 10	7.84±0.10
	Pin 12		TP45	8.99±0.92
Q1	Base (b)	Transmit Amplifier	Q1-b	9.00−1.00+0.5
	Emitter (e)		TP41	7.65
	Collector (c)		TP14	12.00±0.10
Q2	Base (b)	Hybrid	TP23	2.40±0.15
	Emitter (e)		TP43	1.90±0.12
	Collector (c)		Q2-c	4.06±0.66
Q3	Base (b)		Q2-c	4.06±0.66
	Emitter (e)		TP23	2.95±0.75
	Collector (c)		TP21	11.73±0.26
Q4	Base (b)	Receive Amplifier	Q4-b	2.87±0.72
	Emitter (e)		Q4-e	2.50±0.60
	Collector (c)		Q4-c	11.90±0.60
Q5	Base (b)		Q5-b	11.90±0.60
	Emitter (e)		TP14	12.03±0.25
	Collector (c)		TP2	5.00±1.20
Q6	Base (b)	Light Emitting Diode Control	Q6-b	0.25±0.05
	Collector (c)		TP35	2.60±0.03
Q7	Collector (c)		TP36	0.036±0.016

TABLE H (Cont)
SUSPECTED FAULTY COMPONENT VOLTAGE ANALYSIS

COMPONENT		FUNCTION OF COMPONENT	TESTING POINT	REQUIRED VOLTAGE (DC)
Q8	Base (b)	Power Amplifier	Q8-b	12.94±0.64
	Emitter (e)		TP19	13.54±0.64
	Collector (c)		Q8-c	25.00±1.28
Q9	Base (b)		Q9-b	12.94±0.65
	Emitter (e)		TP19	13.54±0.64
	Collector (c)		TP24	Chassis Ground
Q10	Base (b)	Twin T Notch Filter	Q10-b	4.90±0.75
	Emitter (e)		Q10-e	3.74±0.16
	Collector (c)		TP14	12.00±0.10
Q11	Base (b)	Current Noise Gate	Q11-b	11.57±0.07
	Emitter (e)		TP14	12.03±0.25
	Collector (c)		TP7	6.34±0.12
Q15	Base (b)		TP9	5.39±0.47
	Emitter (e)		Q15-e	4.01±0.47
	Collector (c)		Q15-c	11.57±0.07
Q12	Collector (c)	Noise Control	Q12-c	6.34±0.12
Q13	Collector (c)	Low Level Booster	Q13-c	3.76±0.20
Q14	Base (b)	Switch Timing	Q14-b	10.85±0.05
	Emitter (e)		Q14-e	5.59±0.47
	Collector (c)		TP10	6.20±0.12
Q16	Base (b)	Transmit to Receive Switch	TP11	5.59±0.47
Q17	Base (b)	Control Switching	TP11	5.59±0.47
	Emitter (e)		Q17-e	7.77±0.13
	Collector (c)		TP16	7.87±0.13
Q18	Base (b)		Q18-b	8.31±0.13
	Emitter (e)		Q18-e	7.77±0.13
	Collector (c)		TP16	7.87±0.13
Q19	Base (b)	Noise Timing	Q19-b	10.85±0.17
	Emitter (e)		Q19-e	8.31±0.09
	Collector (c)		TP10	6.20±0.12



NOTE: SEE FIG 38 FOR LOCATION OF TP

Fig. 30 — Preparation of PCB for Detailed Voltage Checks

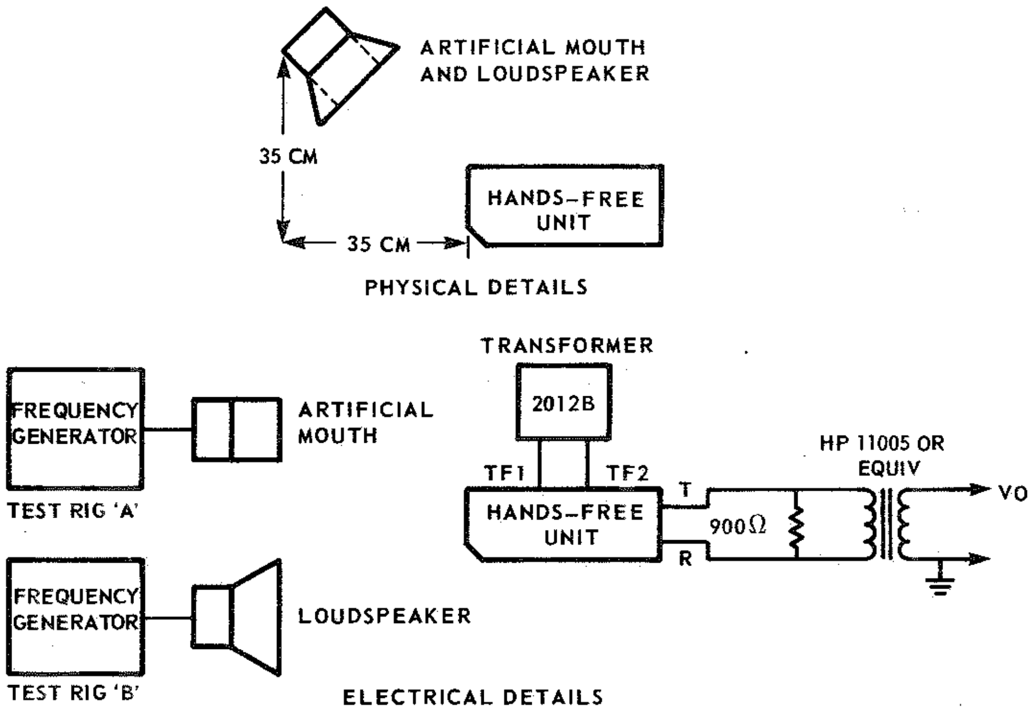


Fig. 31 — Acoustical Testing of Transmit Function

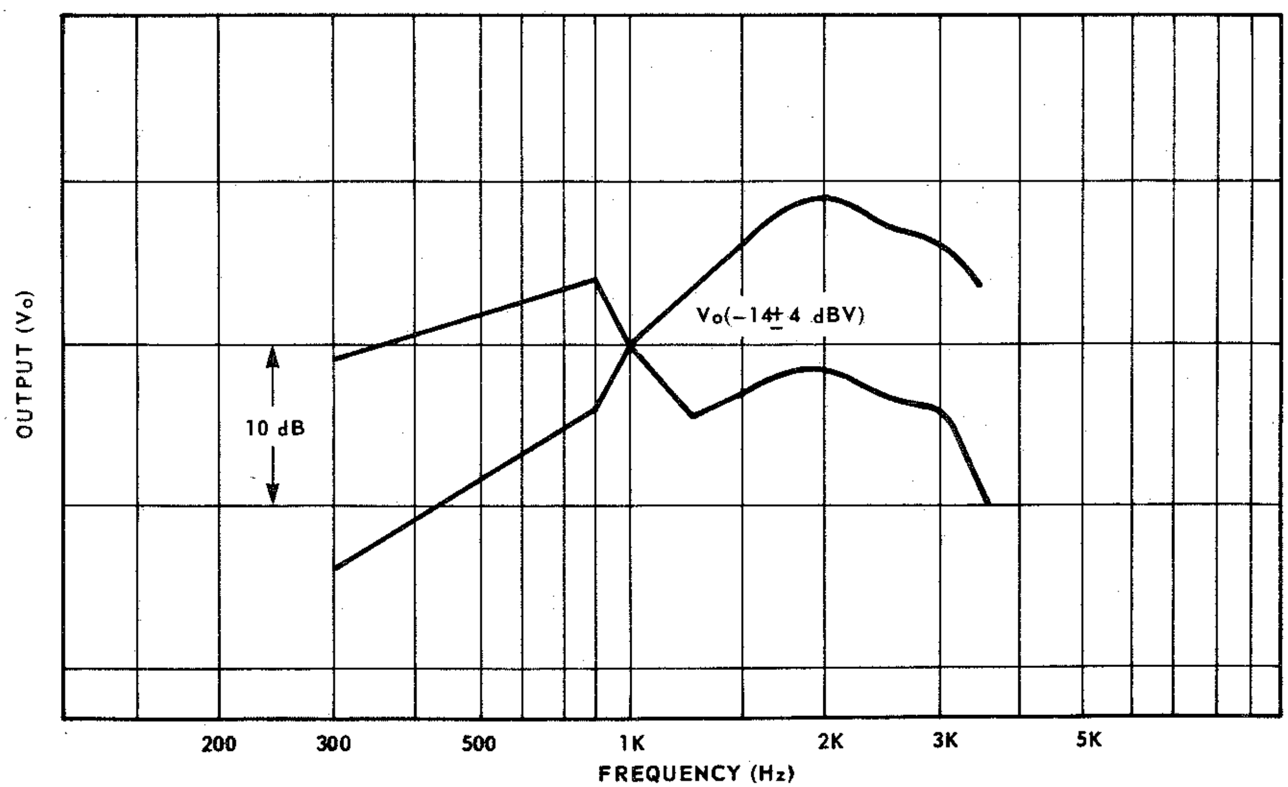


Fig. 32 — Sending Frequency Response

8. ACOUSTIC TESTS

8.01 Acoustic tests are performed upon completion of all other tests, after replacement of faulty components and following reassembly of the HFU. The tests are designed to prove the effectiveness of the acoustic foam pad inserts and the acoustic sealing of the cover and case. In the course of carrying out acoustic tests the following tests are performed.

- Microphone and speaker — dynamically tested
- Transmitter and receiver sensitivity
- Frequency response
- Performance in the presence of background noise
- Speed of switching from standby to transmit mode

8.02 The acoustic tests shall be performed in an environment free of echoes or reverberation with an ambient sound level of less than 40 dBA. (These conditions may be obtained in an Anechoic chamber similar to that listed in Table B.) The unit shall be placed on an open grid of nonsound reflecting material.

8.03 The transmitter acoustic tests are described in Chart 15, Fig. 31, and Fig. 32.

8.04 The receiving acoustic tests are described in Chart 16, Fig. 33, Fig. 34, and Fig. 35.

CHART 15 — ACOUSTIC TEST — TRANSMITTING

EQUIPMENT REQUIRED:

Artificial Mouth, 2 Frequency Generators, Anechoic Chamber, Loudspeaker, NE-2012B Transformer, HP11005 (or equivalent) Transformer and 90 ohm resistor.

STEP	PROCEDURE	INDICATION
1	Arrange the HFU and Test equipment in the physical and electrical configuration as shown in Fig. 31. *Note:* Because of the action of the noise compensating circuit, it is necessary to pulse the input signal for sending tests. The maximum duration of the ON time should be 400 ms and the minimum duration of the OFF time should be 200 ms.	N/A
1 KHZ SENSITIVITY		
2	Using only the Test Rig "A" (Fig. 31) adjust the free field sound pressure to 74 dB (at 1 kHz) relative to 20 μ Pa.	Vo output should be −14±4 dBV.

CHART 15 (Cont) — ACOUSTIC TEST — TRANSMITTING		
STEP	**PROCEDURE**	**INDICATION**
FREQUENCY RESPONSE		
3	Maintain the sound pressure of Step 2. Check the output at any frequency, relative to the response at 1 kHz.	Output shall be within the limit lines shown in Fig. 32.
NOISE CIRCUIT		
4	Use both Test Rig "A" and Test Rig "B" (Fig. 31) to give a continuous 700 Hz free field, sound pressure level of 57 dBA at the test position.	The pulsed output shall be -7 ± 2 dB less than that measured in Step 2.
5	Disable the Test Rig "B".	Output at Vo should be similar to Step 2.
6	Commence with the pulsed sound pressure at "0" and slowly increase the sound pressure until a sudden jump at output level is observed. Note the free field sound pressure level at this point.	Free field sound pressure level shall be 50 ± 5 dB relative to 20 μPa.

CHART 16 — ACOUSTIC TESTS — RECEIVER		
EQUIPMENT REQUIRED: Free field microphone, frequency response tracer, microphone amplifier, NE-2012B and HP11005A transformers and oscillator.		
STEP	**PROCEDURE**	**INDICATION**
1	Arrange the HFU and test equipment in the physical and electrical configuration as shown in Fig. 33. *Note:* It is not necessary to use a pulsed signal for receiving tests.	N/A
1 KHZ SENSITIVITY		
2	Adjust the open circuit voltage of the oscillator to -15 dBV. Check the output at 1 kHz at the amplifier.	Po should be 81 ± 4 dB relative to 20 μ Pa for COMPANION 1 and COMPANION 2 HFU and 84 ± 4 dB relative to 20 μ Pa for LOGIC HFU.

CHART 16 (Cont) – ACOUSTIC TESTS – RECEIVER

STEP	PROCEDURE	INDICATION
FREQUENCY RESPONSE		
3	Check the frequency response relative to the response at 1 kHz.	Response should fall within the limit lines shown in Fig. 34 and 35.
SWITCHING POINT		
4	Set the oscillator to 1 kHz and reduce output to zero. Slowly increase the oscillator output until a sudden jump in output occurs.	The oscillator open circuit voltage should be -45 ± 5 dBV.

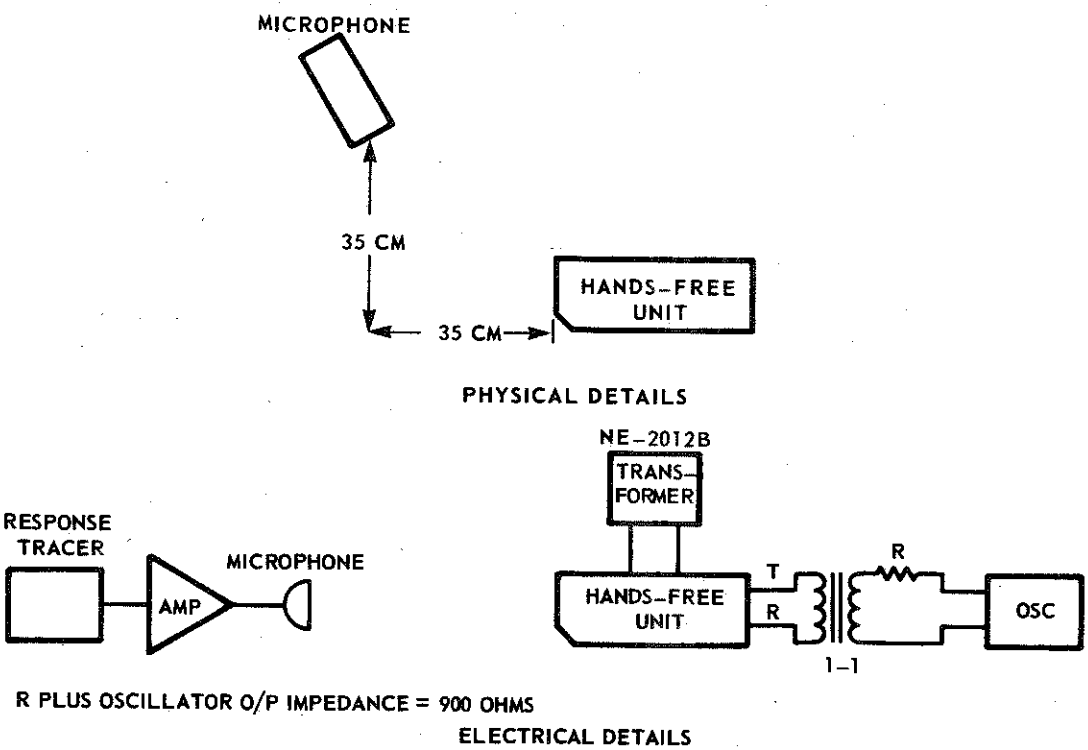


Fig. 33 – Acoustic Set-Up – Receiver

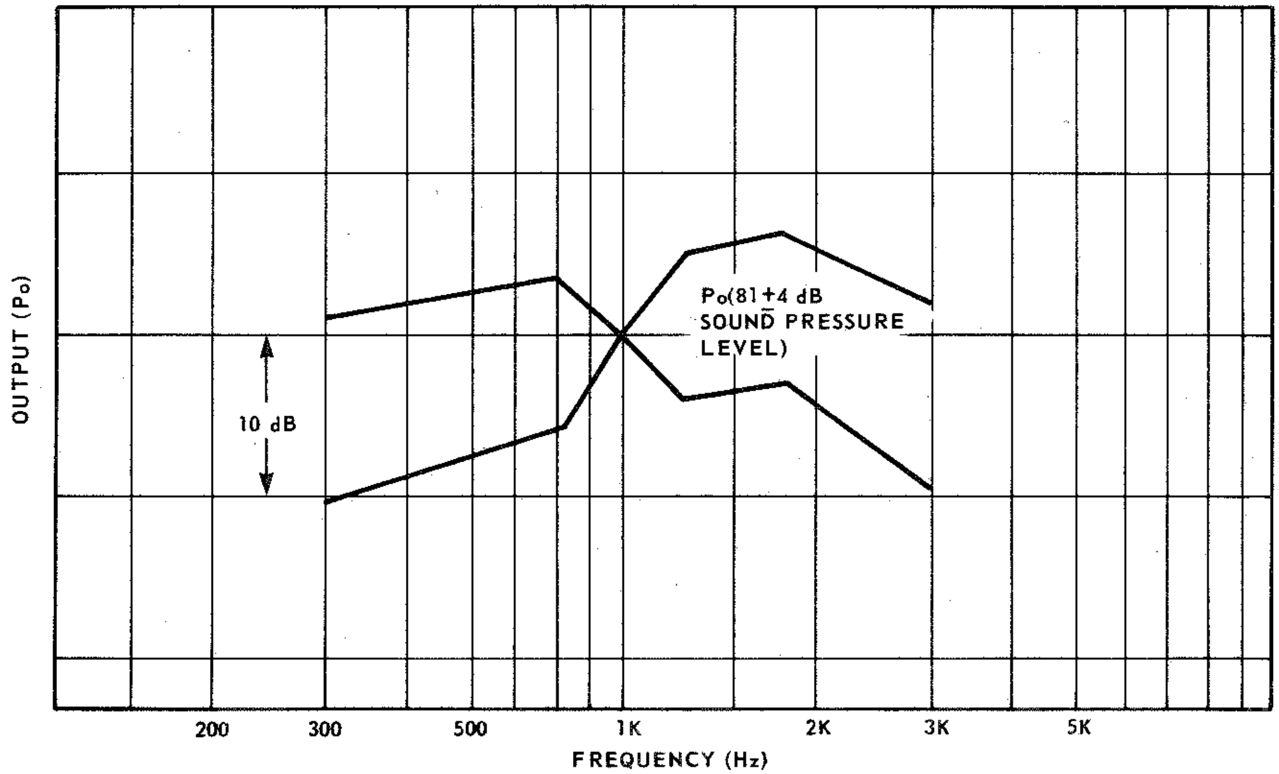


Fig. 34 — Receiving Frequency Response COMPANION 1 and COMPANION 2 HFU

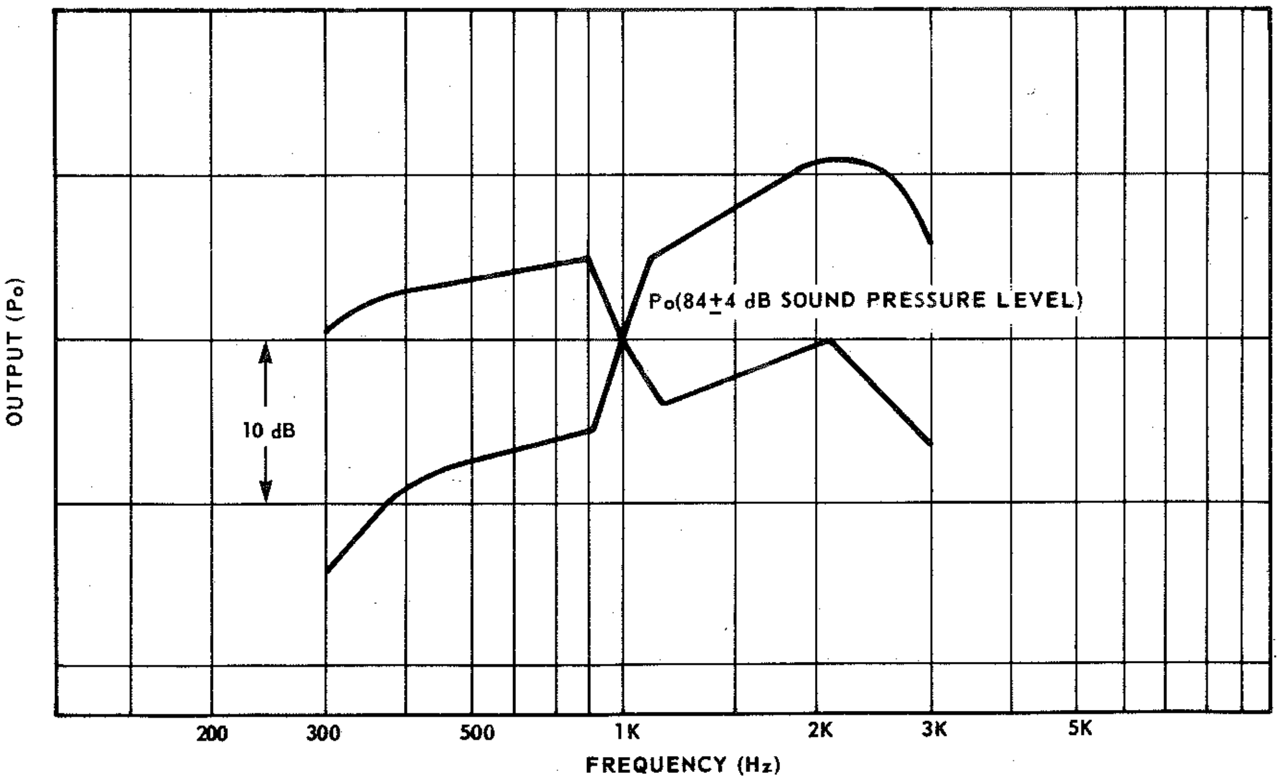


Fig. 35 — Receiving Frequency Response LOGIC HFU

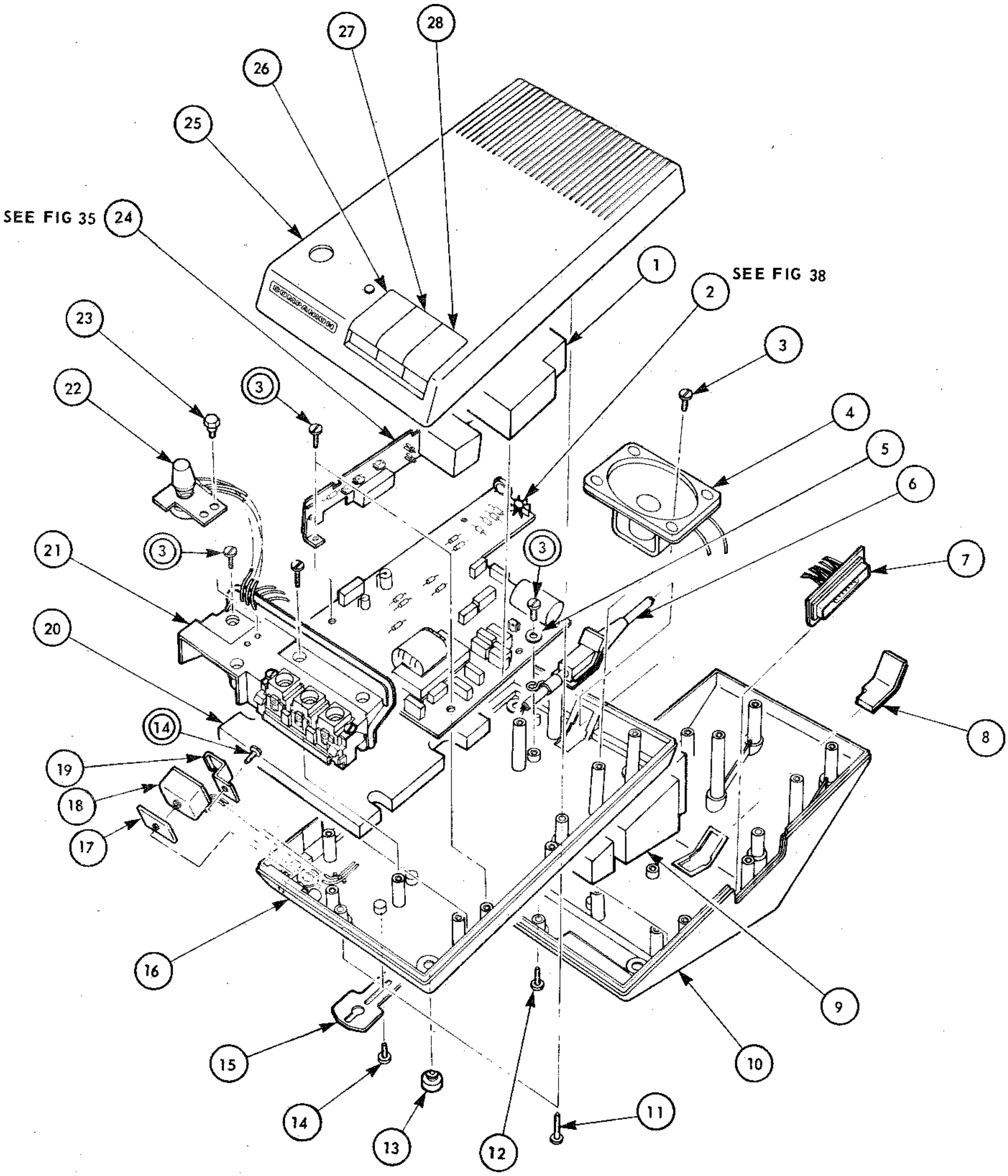


Fig. 36 — Exploded View of QUS1A, QUS1B and QUS1C HFU

9. ORDERING INFORMATION AND ASSEMBLY IDENTIFICATION

9.01 An exploded view, depicting both COMPANION and LOGIC configurations of the hands-free unit is provided in Fig. 36. An associated parts identification list which identifies specific QUS1A, QUS1B, or QUS1C HFU parts, is given in Table J.

9.02 Item 2 (Printed Circuit Board Assembly) and Item 23 (Relay Board Assembly) are further broken down by Fig. 37 and Fig. 38. Table K refers to the Relay Board and Table L refers to the PCB.

TABLE J
HFU PARTS LIST

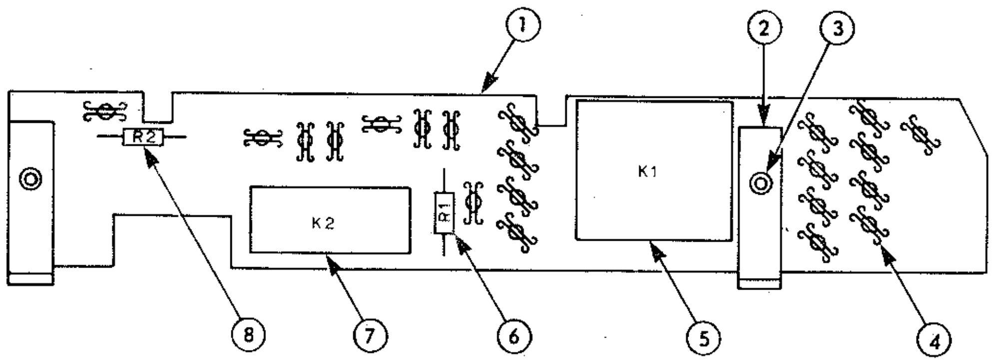
ITEM FIG. 36	PART NUMBER	NOTES	DESCRIPTION	QUANTITY		
				1A	1B	1C
1	P0523447		Foam Pad	1	1	1
2	P0517220	1,2	Printed Circuit Board Assy	1	1	1
2	P0532399	1,3	Printed Circuit Board Assy	1	1	1
3	P099M372		Screw	14	14	12
4	P0514730		Speaker Assembly	1	1	1
5	P0284145		Washer	1	1	—
6	NE-D16QC		Cord	—	1	—
6	NE-D4QD		Cord	1	—	—
7	P0517900-999	4	Interconnect Assembly	—	—	1
8	P0518000-099		Seal	—	—	1
9	P0523348		Foam Pad	—	—	1
10	P0517800-899		Base and Insert Assembly	—	—	1
11	P0517295		Screw	3	3	2
12	P099U569		Screw	—	—	1
13	P096D326		Foot	4	4	4
14	P0511317		Screw	3	3	1
15	P0517284		Bracket	1	1	—
16	P0517000-099		Base	1	1	—
17	P0514755		Pad	1	1	1
18	QUX1A		Electret Microphone	1	1	1
19	P0517213		Bracket	1	1	1
20	P0523346		Foam Pad	1	1	—
21	P0514744		Mounting Frame Assembly	—	1	1
22	P0514736		Volume Control Assembly	1	1	1
23	P0471904		Screw	2	2	2
24	P0517219	5	Relay Board Assembly	—	1	1
25	P0517600-699		Cover Assembly	1	—	—
25	P0518100-199		Cover Assembly	—	1	1
26	P0517209	6	"MUTE" Key	—	1	1
27	P0517207	6	"ON" Key	—	1	1
27	P0517210	6	"ON" Key	1	—	—
28	P0517208	6	"OFF" Key	1	1	1
29	P0525725	7	LEAD (O-R)	—	1	1
30	P096C216	7	LEAD (R-O)	—	1	1
31	P0525724	7	LEAD (BL-BK)	—	1	1
32	P013E182	7	LEAD (R-G)	—	1	1
33	P013E771	7	LEAD (G)	—	1	1

Notes:

1. See Fig. 38.
2. HF 600 only.
3. Phase 1 only.
4. Available in Chameleon Gray (–35) and Warm White (–20).
5. See Fig. 37.
6. Part of Item 25, Cover Assembly.
7. Lead Assembly not shown on Fig. 36, refer to Fig. 6.

TABLE K
RELAY BOARD ASSEMBLY PARTS LIST

ITEM FIG. 37	PART NUMBER	DESCRIPTION	QTY. REQ'D.
1	P0517286	Printed Circuit Board	1
2	P0517272	Bracket	2
3	P043A120	Rivet	2
4	P0532360 or P096B583	Connector	21
5	NE-MB5	Relay (K1)	1
6	RC03Y510J	Resistor (R1)	1
7	See List 1 of Fig. 37	Relay K2	1
8	See List 1 of Fig. 37	Resistor R2	1



LIST 1

RELAY K2 (BNR SPEC 156/2)		RESISTOR R2	
PART NUMBER	NOMINAL COIL RESISTANCE	PART NUMBER	RESISTANCE
QRK11B–1	460 OHMS	RC01Y271J	270 OHMS
QRK11B–2	620 OHMS	RC01Y111J	110 OHMS
QRK11B–3	620 OHMS	RC01Y111J	110 OHMS
QRK11B–4	620 OHMS	RC01Y111J	110 OHMS

Fig. 37 — Relay Board Assembly

TABLE L
PCB PARTS LIST

REF DESIG-NATION	PART NUMBER	DESCRIPTION	LOCATION ON FIG. 38
AR1	QMS1A	Hybrid Microcircuit Transmit Variolosser (Note 2)	H3
AR2	QMS2A	Hybrid Microcircuit Receive Variolosser (Note 2)	K8
C1	C0023494	Capacitor 0.1 μF	C3
C2	C0035740	Capacitor 220 pF	C4
C3	C0023494	Capacitor 0.1 μF	F3
C4	C0035749	Capacitor 1 μF 35 V	K3
C5	C0035796	Capacitor 1500 pF	H5
C6	C0035745	Capacitor 0.047 μF	N3
C7	C0026302	Capacitor 0.005 μF	Q4
C8	C0035752	Capacitor 4.7 μF 10 V	Q8
C9	C0023635	Capacitor 0.22 μF	N5
C10	C0035745	Capacitor 0.047 μF	P6
C11	C0035789	Capacitor 0.001 μF	P7
C12	C0035742	Capacitor 0.01 μF	N6
C13	C0035799	Capacitor 0.680 μF	P6
C14	C0023494	Capacitor 0.1 μF	M10
C15	C0035749	Capacitor 1 μF 35 V	H9
C16	C0035715	Capacitor 22 μF 25 V	N12
C17	C0023494	Capacitor 0.1 μF	K11
C18	C0035796	Capacitor 1500 pF	L11
C19	C0023693	Capacitor 0.47 μF	K13
C20		NOT USED	
C21	C0035742	Capacitor 0.01 μF	M14
C22	C0023494	Capacitor 0.1 μF	J15
C23	C0035715	Capacitor 22 μF 25 V	K14
C24	C0035751	Capacitor 2.2 μF 20 V	G7
C25	C0035745	Capacitor 0.047 μF	N10
C26	C0035745	Capacitor 0.047 μF	P8
C27	C0035745	Capacitor 0.047 μF	P10
C28	C0033745	Capacitor 0.047 μF	P10
C29	C0023693	Capacitor 0.47 μF	N11
C30	C0035752	Capacitor 4.7 μF 10 V	G11
C31	C0035752	Capacitor 4.7 μF 10 V	F10
C32	C0035715	Capacitor 22 μF 25 V	D7
C33	C0023693	Capacitor 0.47 μF	C7
C34	C0035751	Capacitor 2.2 μF 20 V	D11
C35	C0035712	Capacitor 100 μF 25 V	D9
C36	C0035739	Capacitor 100 pF	E15
C37	C0035749	Capacitor 1 μF 35 V	F12
C38	C0035749	Capacitor 1 μF 35 V	H15
C39	C0035745	Capacitor 0.047 μF	H15

TABLE L (Cont)
PCB PARTS LIST

REF DESIG-NATION	PART NUMBER	DESCRIPTION	LOCATION ON FIG. 38
C40	C0035750	Capacitor 1.5 μF 35 V	C19
C41	C0035719	Capacitor 680 μF 40 V	N15
C42	C0035739	Capacitor 100 pF	F20
C43	C0035749	Capacitor 1 μF 35 V	C21
C44	C0035797	Capacitor 15 μF 16 V	F14
C45	C0035791	Capacitor 100 μF 4V	H5
C46	C0022475	Capacitor 330 pF	E16
C47	C0035778	Capacitor 1000 pF	D20
C48	C0035796	Capacitor 1500 pF	F19
C49	C0035795	Capacitor .022 μF (Note 1)	K9
CR1	C0098188	Diode 1N4002	P8
CR2	C0098188	Diode 1N4002	P8
CR3	C0098188	Diode 1N4002	P9
CR4	C0098188	Diode 1N4002	P9
CR5	C0098188	Diode 1N4002	N14
CR6	C0037336	Diode 1N4148	G9
CR7	C0037336	Diode 1N4148	F8
CR8	C0037336	Diode 1N4148	E9
CR9	C0037336	Diode 1N4148	E9
CR10	C0037336	Diode 1N4148	C8
CR11	C0037336	Diode 1N4148	D6
CR12	C0037336	Diode 1N4148	D14
CR13	C0037336	Diode 1N4148	D13
CR14	C0037336	Diode 1N4148	E16
CR15	C0037336	Diode 1N4148	G13
CR16	C0037336	Diode 1N4148	G15
CR17	C0037336	Diode 1N4148	G14
CR18	C0037336	Diode 1N4148	G14
CR19	C0037336	Diode 1N4148	D17
CR20	C0037336	Diode 1N4148	D19
CR21	C0037336	Diode 1N4148	D20
CR22	C0098188	Diode 1N4002	P14
CR23	C0098188	Diode 1N4002	E20
CR24	C0098188	Diode 1N4002	M14
CR25	C0098188	Diode 1N4002	M16
MC1	C0035762	Micro Circuit 1458	D4
MC2	C0035762	Micro Circuit 1458	F8
MC3	C0035762	Micro Circuit 1458	D14
MC4	C0035762	Micro Circuit 1458	E10
MC5	C0035762	Micro Circuit 1458	E19
MC6	C0035762	Micro Circuit 1458	L12
MC7	C0035764	Micro Circuit 723C	F22
MC8	C0035776	Micro Circuit 1496L (Note 1)	H3
MC9	C0035776	Micro Circuit 1496L (Note 1)	K9

TABLE L (Cont)
PCB PARTS LIST

REF DESIG-NATION	PART NUMBER	DESCRIPTION	LOCATION ON FIG. 38
Q1	C0035760	Transistor MPSA13	K3
Q2	C0035759	Transistor 2N5449	N3
Q3	C0035760	Transistor MPSA13	P3
Q4	C0035759	Transistor 2N5449	M8
Q5	C0098481	Transistor 2N5447	M9
Q6	C0035759	Transistor 2N5449	H12
Q7	C0035759	Transistor 2N5449	H11
Q8	C0035759	Transistor 2N5449	L14
Q9	C0098481	Transistor 2N5447	M13
Q10	C0035760	Transistor MPSA13	Q11
Q11	C0098481	Transistor 2N5447	F14
Q12	C0035759	Transistor 2N5449	E14
Q13	C0035759	Transistor 2N5449	E12
Q14	C0098481	Transistor 2N5447	H14
Q15	C0035759	Transistor 2N5449	F15
Q16	QTW14A	Transistor 2N5449	F17
Q17	QTW14A	Transistor 2N5449	C16
Q18	QTW14A	Transistor 2N5449	C17
Q19	C0098481	Transistor 2N5447	C20
R1	RCO1Y103J	Resistor 10 K ohm	C3
R2	RCO1Y103J	Resistor 10 K ohm	D3
R3	RCO1Y103J	Resistor 10 K ohm	E4
R4	RCO1Y104J	Resistor 100 K ohm	D4
R5	RFO5AX1002G	Resistor 10 K ohm 2% (Note 1)	F4
R6	RFO5AX8201G	Resistor 8.2 K ohm 2% (Note 1)	H6
R7	RFO5AX1001G	Resistor 1 K ohm 2% (Note 1)	J5
R8	RFO5AX1002G	Resistor 10 K ohm 2% (Note 1)	G5
R9	RFO5AX9101G	Resistor 9.1 K ohm 2% (Note 1)	F5
R10	C0035798	Resistor Variable 2.5 K ohm (Note 1)	G4
R11	RFO5AX1002G	Resistor 10 K ohm (Note 1)	G4
R12	RCO1Y102J	Resistor 1 K ohm	L3
R13	RCO1Y203J	Resistor 20 K ohm	K3
R14	RCO1Y302J	Resistor 3 K ohm	H4
R15	RCO1Y393J	Resistor 39 K ohm	N4
R16	RFO5AQ2003G	Resistor 200 K ohm 2%	P4
R17	RFO5AQ5102G	Resistor 51 K ohm 2%	P3
R18	RFO5AQ1803G	Resistor 180 K ohm 2%	N6
R19	RFO5AQ4702G	Resistor 47 K ohm 2%	P5
R20	RCO1Y431J	Resistor 430 ohm	M5
R21	RCO1Y432J	Resistor 4.3 K ohm	N4
R22	RCO1Y153J	Resistor 15 K ohm	N7
R23	RCO1Y822J	Resistor 8.2 K ohm	Q5
R24	RCO1Y203J	Resistor 20 K ohm	Q6
R25	RCO1Y204J	Resistor 200 K ohm	P7

TABLE L (Cont)
PCB PARTS LIST

REF DESIG-NATION	PART NUMBER	DESCRIPTION	LOCATION ON FIG. 38
R26	RCO1Y472J	Resistor 4.7 K ohm	M10
R27	RCO1Y472J	Resistor 4.7 K ohm	L9
R28	RFO5AX1002G	Resistor 10 K ohm 2% (Note 1)	G7
R29	RFO5AX1001G	Resistor 1 K ohm 2% (Note 1)	K10
R30	RFO5AX8201G	Resistor 8.2 K ohm 2% (Note 1)	J9
R31	RFO5AX1002G	Resistor 10 K ohm 2% (Note 1)	H6
R32	RFO5AX9101G	Resistor 9.1 K ohm 2% (Note 1)	H6
R33	C0035798	Resistor Variable 2.5 K ohm (Note 1)	J8
R34	RCO1Y102J	Resistor 1 K ohm	K10
R35	RCO1Y203J	Resistor 20 K ohm	J10
R36	RFO5AX1002G	Resistor 10 K ohm (Note 1)	G6
R37	RCO1Y302J	Resistor 3 K ohm	H11
R38	RCO1Y203J	Resistor 20 K ohm	G12
R39	RCO1Y472J	Resistor 4.7 K ohm (Note 1)	J12
R40	RCO1Y392J	Resistor 3.9 K ohm	J14
R41	RCO1Y183J	Resistor 18 K ohm	N13
R42	RCO1Y304J	Resistor 300 K ohm	M11
R43	RCO1Y203J	Resistor 20 K ohm	M13
R44	RCO1Y392J	Resistor 3.9 K ohm	K13
R45	RCO1Y304J	Resistor 300 K ohm	L12
R46	RCO1Y100J	Resistor 10 ohm	K15
R47	RCO1Y201J	Resistor 200 ohm	J6
R48	RCO1Y103J	Resistor 10 K ohm	E6
R49	RCO1Y472J	Resistor 4.7 K ohm	E6
R50	RCO1Y103J	Resistor 10 K ohm	G9
R51	RCO1Y271J	Resistor 270 ohm	G10
R52	RCO1Y563	Resistor 56 K ohm	N9
R53	RCO1Y563	Resistor 56 K ohm	P9
R54	RCO1Y273J	Resistor 27 K ohm	M9
R55	RCO1Y152J	Resistor 1.5 K ohm	P11
R56	RCO1Y102J	Resistor 1 K ohm	K10
R57	RCO1Y103J	Resistor 10 K ohm	F9
R58	RCO1Y331J	Resistor 330 ohm	F9
R59	RCO1Y103J	Resistor 10 K ohm	E8
R60	RCO1Y331J	Resistor 330 ohm	E6
R61	RCO1Y472J	Resistor 4.7 K ohm	E4
R62	RCO1Y102J	Resistor 1 K ohm	C7
R63	RCO1Y103J	Resistor 10 K ohm	C9
R64	RCO1Y202J	Resistor 2 K ohm	C11
R65	RCO1Y104J	Resistor 100 K ohm	C11
R66	RCO1Y100J	Resistor 10 ohm	D10
R67	RCO1Y104J	Resistor 100K	D15
R68	RCO1Y105J	Resistor 1 Meg ohm	E15
R69	RCO1Y754J	Resistor 750 K ohm	E15

TABLE L (Cont)
PCB PARTS LIST

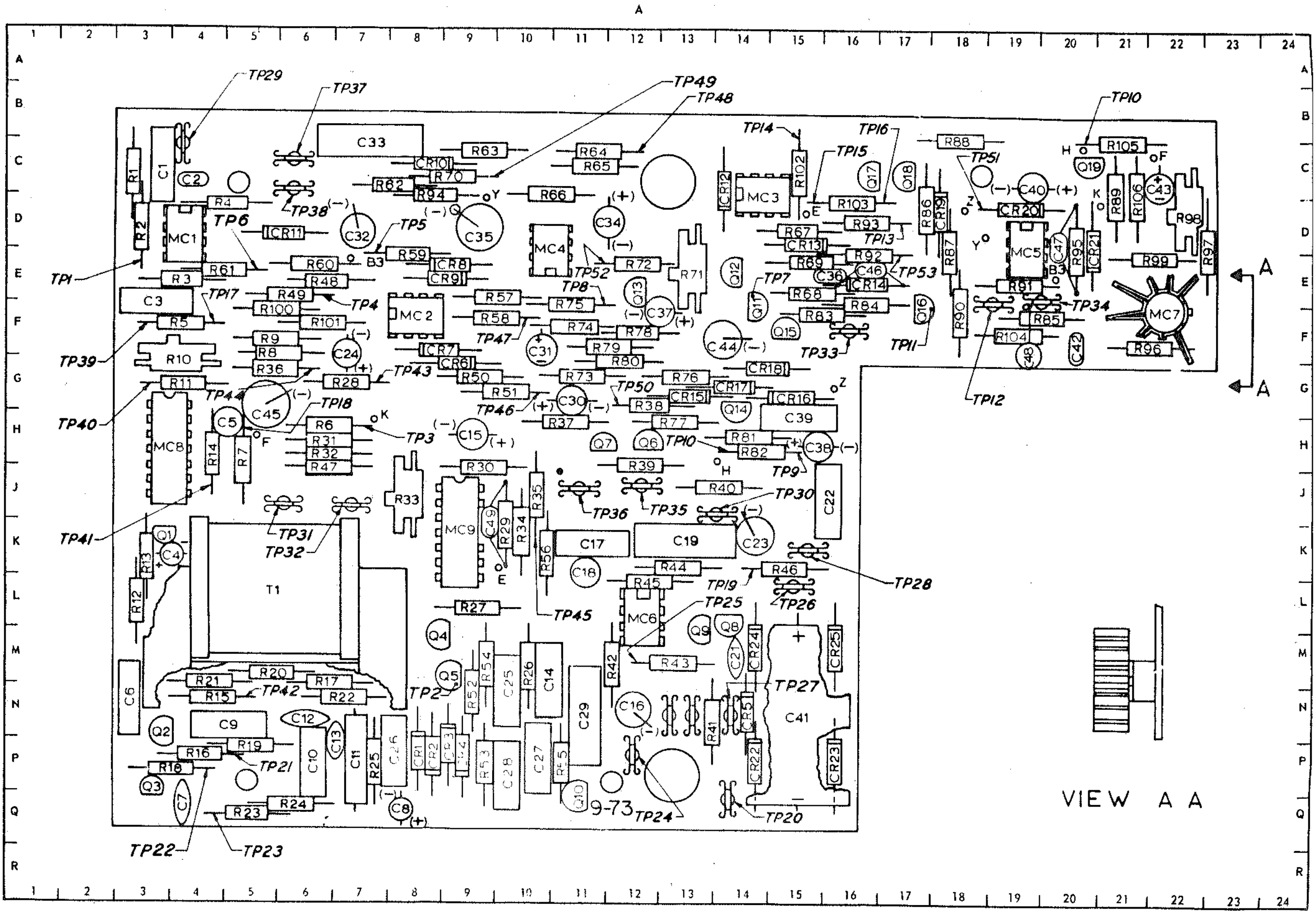
REF DESIG-NATION	PART NUMBER	DESCRIPTION	LOCATION ON FIG. 38
R70	RFO5AX7502G	Resistor 75 K ohm	C9
R71	C0035737	Resistor, Variable 50 K ohm	E13
R72	RCO1Y105J	Resistor, 1 Meg ohm	E12
R73	RCO1Y103J	Resistor 10 K ohm	G11
R74	RCO1Y103J	Resistor 10 K ohm	F11
R75	RCO1Y105J	Resistor 1 Meg ohm	F11
R76	RCO1Y333J	Resistor 33 K ohm	G13
R77	RCO1Y104J	Resistor 100 K ohm	H13
R78	RCO1Y473J	Resistor 47 K ohm	F12
R79	RCO1Y103J	Resistor 10 K ohm	F11
R80	RCO1Y204J	Resistor 200 K ohm	G12
R81	RCO1Y103J	Resistor 10 K ohm	H14
R82	RCO1Y105J	Resistor 1 Meg ohm	H14
R83	RCO1Y304J	Resistor 300 K ohm	F15
R84	RCO1Y104J	Resistor 100 K ohm	F16
R85	RCO1Y332J	Resistor 3.3 K ohm	F19
R86	RCO1Y103J	Resistor 10 K ohm	D17
R87	RCO1Y564J	Resistor 560 K ohm	E18
R88	RCO1Y472J	Resistor 4.7 K ohm	C18
R89	RCO1Y104J	Resistor 100 K ohm	D21
R90	RCO14225J	Resistor 2.2 Meg ohm	F18
R91	RCO1Y105J	Resistor 1 Meg ohm	E19
R92	RCO1Y563	Resistor 56 K ohm	E16
R93	RCO1Y124J	Resistor 120 K ohm	D16
R94	RCO1Y104J	Resistor 100 K ohm	D8
R95	RCO1Y104J	Resistor 100 K ohm	E20
R96	RCO1Y100J	Resistor 10 ohm	F21
R97	RCO1Y202J	Resistor 2 K ohm	E22
R98	C0035736	Resistor, Variable 1 K ohm	D22
R99	RCO1Y302J	Resistor 3 K ohm	E21
R100	RFO5AX4302G	Resistor 43 K ohm 2%	F5
R101	RFO5AX1002G	Resistor 10 K ohm 2%	F6
R102	RFO5AX1001F	Resistor 1 K ohm 1%	C15
R103	RFO5AQ43R0G	Resistor 43 ohm 2%	D16
R104	RFO5AX4320F	Resistor 432 ohm 1%	F19
R105	RFO5AQ62R0G	Resistor 62 ohm 2%	C21
R106	RFO5AX1501F	Resistor 1.5 K ohm 1%	D21
T1	QTK152A	Transformer	L5

TABLE L (Cont)
PCB PARTS LIST

REF DESIG-NATION	PART NUMBER	DESCRIPTION	LOCATION ON FIG. 38
MISCELLANEOUS			
—	P0514742	Printed Circuit Board (Note 3)	—
—	P096Q593	Spacer (see View A-A)	M21
TP29	P096B583	Connector (Note 4)	C4
TP37	P096B583	Connector (Note 4)	C6
TP38	P096B583	Connector (Note 4)	D6
TP12	P096B583	Connector (Note 4)	F18
TP34	P096B583	Connector (Note 4)	F19
TP33	P096B583	Connector (Note 4)	F16
TP30	P096B583	Connector (Note 4)	J13
TP35	P096B583	Connector (Note 4)	J12
TP36	P096B583	Connector (Note 4)	J11
TP28	P096B583	Connector (Note 4)	K15
TP26	P096B583	Connector (Note 4)	L15
TP31	P096B583	Connector (Note 4)	J6
TP32	P096B583	Connector (Note 4)	J7
TP20	P096B583	Connector (Note 4)	Q14
TP24	P096B583	Connector (Note 4)	P12
TP27	P096B583	Connector (Note 4)	N14
—	C0035768	Heat Sink (see View A-A)	M20
—	P0525897	Tubing (As required)	—
BL-3R	P096T991	Lead	—
BR-W	P0892549	Lead	—
BR-2R	P097M825	Lead	—
G-2W	P096T990	Lead	—
G-2BK	P096R830	Lead	—
S-2BK	P097M90B	Lead	—
BK	P096V012	Lead	—
—	P0535399	Bracket (Note 2)	G3
—	P0535354	Post	

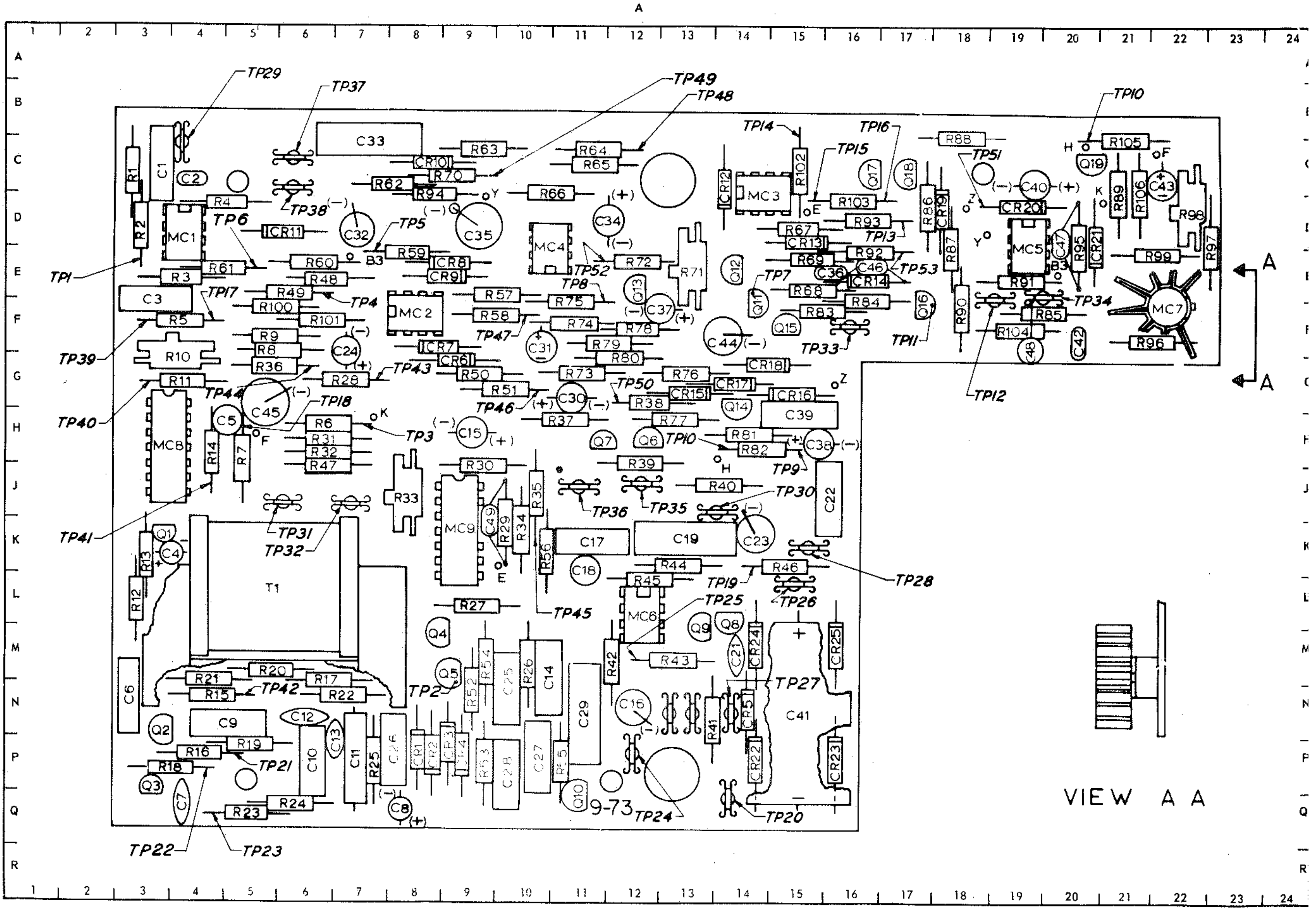
Notes:

1. Used on HFU 600 configuration only (Fig. 38 Sheet 1).
2. Used on Phase 1 configuration only (Fig. 38 Sheet 2).
3. Printed Circuit Board Base mounts all components of the PCB assembly.
4. Part No. P0532360 may be substituted if P096B583 not obtainable.



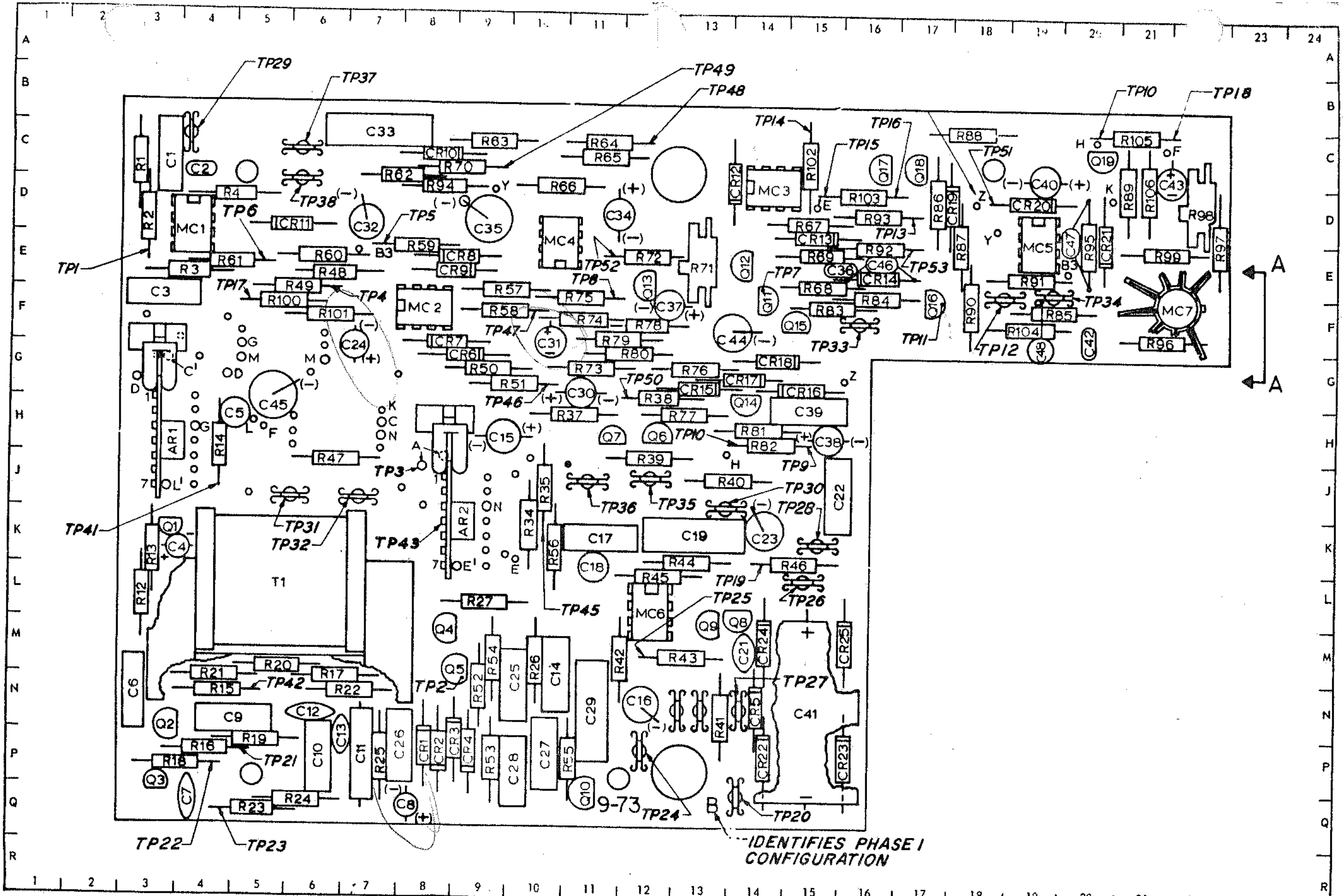
HFU 600 CONFIGURATION

Fig. 38 — P(Assembly



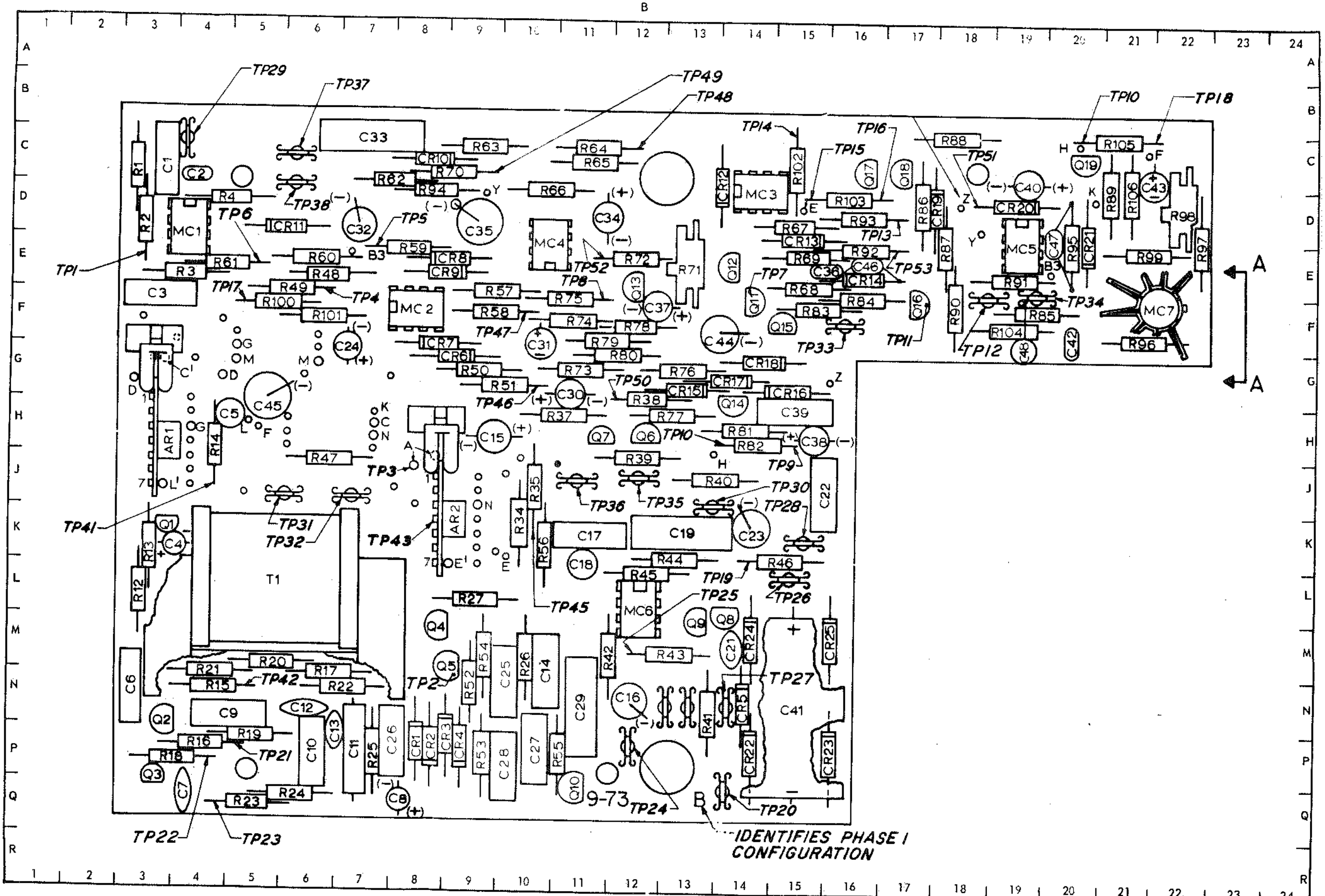
HFU 600 CONFIGURATION

Fig. 38 — P(ssembly



PHASE 1 CONFIGURATION

Fig. 38 — PCB Assembly
(Sheet 2 of 2)



PHASE 1 CONFIGURATION

Fig. 38 – PCB Assembly
(Sheet 2 of 2)