Errata

Title & Document Type: **4937A Transmission Impairment Measuring Set Operating and Service Manual**

Manual Part Number: **04937-90021**

Revision Date: **May 1986**

About this Manual

We've added this manual to the Agilent website in an effort to help you support your product. This manual provides the best information we could find. It may be incomplete or contain dated information, and the scan quality may not be ideal. If we find a better copy in the future, we will add it to the Agilent website.

HP References in this Manual

This manual may contain references to HP or Hewlett-Packard. Please note that Hewlett-Packard's former test and measurement, life sciences, and chemical analysis businesses are now part of Agilent Technologies. The HP XXXX referred to in this document is now the Agilent XXXX. For example, model number HP8648A is now model number Agilent 8648A. We have made no changes to this manual copy.

Support for Your Product

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Search for the model number of this product, and the resulting product page will guide you to any available information. Our service centers may be able to perform calibration if no repair parts are needed, but no other support from Agilent is available.

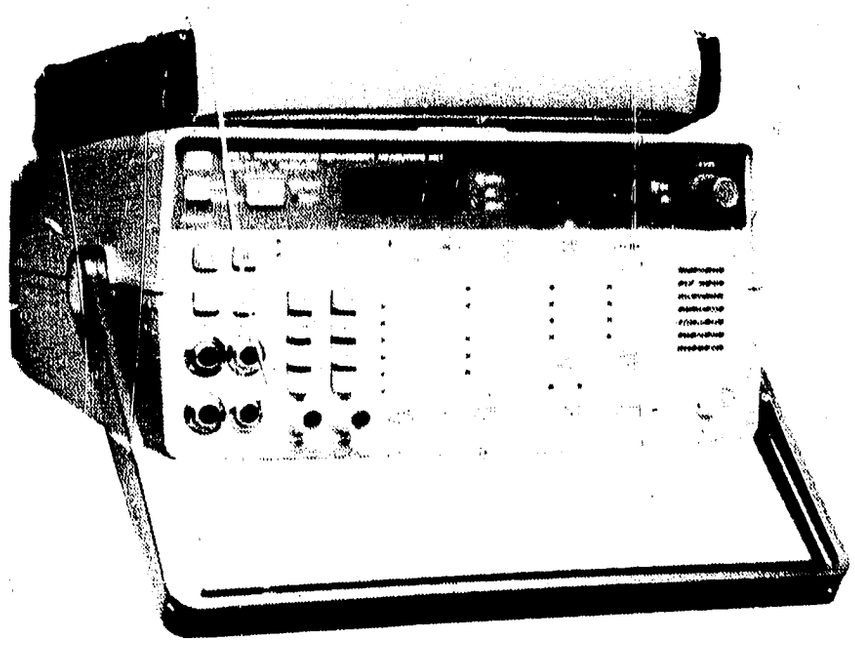
Agilent Technologies

HP 4937A

OPERATING AND SERVICE MANUAL

4937A

TRANSMISSION IMPAIRMENT MEASURING SET



HEWLETT PACKARD

HP 4937A

SAFETY

This product has been designed and tested according to International Safety Requirements. To ensure safe operation and to keep the product safe, the information, cautions, and warnings in this manual must be heeded. Refer to Section I for general safety considerations applicable to this product.

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other international Standards Organization members.

WARRANTY

This Hewlett-Packard instrument product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, HP will, at its options, either repair or replace products which prove to be defective.

For Warranty service or repair, this product must be returned to a service facility designated by HP. Buyer shall prepay shipping charges to HP and HP shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to HP from another country.

HP warrants that its software and firmware designed by HP for use with an instrument will execute its programming instructions when properly installed on that instrument. HP does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance. No other warranty is expressed or implied. HP specifically disclaims the implied warranties of merchantability and fitness for a particular purpose.

EXCLUSIVE REMEDIES

The remedies provided herein are buyer's sole and exclusive remedies. HP shall not be liable for any direct, indirect, special, incidental, or consequential damages, whether based on contract, tort, or any other legal theory.

ASSISTANCE

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products. For any assistance, contact your nearest Hewlett-Packard Sales and Service Office.

CW&A 4/84

OPERATING AND SERVICE MANUAL

HEWLETT PACKARD

HEWLETT-PACKARD MODEL 4937A

Transmission Impairment Measuring Set

(Including Options 001 and 002)

SERIAL NUMBERS

This manual applies directly to instruments with serial numbers prefixed 2546A.

With changes described in Section VII, this manual also applies to instruments with serial numbers prefixed 2418A, 2440A, and 2523A.

For additional important information about serial numbers, see INSTRUMENTS COVERED BY MANUAL in Section 1.

MANUAL PART NO. 04937-90021
MICROFICHE PART NO. 04937-90022

Printed May 1986
PRINTED IN U.S.A.

WARNING

SAFETY

If this instrument is to be energized via an autotransformer for voltage reduction, make sure the common terminal is connected to the earthed pole of the power source.

BEFORE SWITCHING ON THIS INSTRUMENT, the protective earth terminals of this instrument must be connected to the protective conductor of the (mains) power cord. The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action must not be negated by use of an extension cord (power cable) without a protective conductor (grounding).

Make sure that only fuses with the required rated current and of the specified type (normal blow, time delay, etc.) are used for replacement. The use of repaired fuses and the short-circuiting of fuse holders must be avoided.

Whenever it is likely that the protection offered by fuses has been impaired, the instrument must be made inoperative and be secured against any unintended operation.

GROUNDING

Any interruption of the protective (grounding) conductor (inside or outside the instrument) or disconnecting the protective earth terminal can make this instrument dangerous. Intentional interruption is prohibited.

HIGH VOLTAGE

Any adjustment, maintenance, and repair of the opened instrument under voltage should be avoided as much as possible and, when inevitable, should be carried out only by a skilled person who is aware of the hazard involved.

Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.

Adjustments and service described herein are performed with power supplied to the instrument while protective covers are removed. Energy available at many points, if contacted, result in personal injury.

CAUTION

LINE VOLTAGE

BEFORE SWITCHING ON THIS INSTRUMENT, make sure instrument requirements match the voltage of the power source.

GROUNDING

BEFORE SWITCHING ON THIS INSTRUMENT, ensure that all devices connected to this instrument are connected to the protective (earth) ground.

BEFORE SWITCHING ON THIS INSTRUMENT, ensure that the line power (mains) plug is connected to a three-conductor line power outlet that has a protective (earth) ground. (Grounding one conductor of a two-conductor outlet is not sufficient.)

IEC SYMBOLS

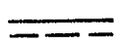
The following is a list of key IEC symbols used by Hewlett-Packard. All symbols are normally applied adjacent to the device requiring the symbol. They shall not be placed on removable parts likely to be detached or lost.

Instruction Manual symbol: If necessary, to preserve the apparatus from damage it is necessary for the user to refer to the instruction manual, then shall the apparatus be marked with this symbol (IEC 348;16a).

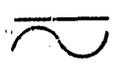
Terminal devices fed from the interior by live voltages that may be dangerous when connecting to or disconnecting from those devices shall be marked with the flash shown when the voltage exceeds 1 KV: The flash shall be red (IEC 348;18c).

Earth Terminals. If the use of this symbol for the protective earth terminal is not permitted by National Standards, it may be modified, for example, by being placed inside a circle (IEC 348,18a).

AC current (IEC 117-1, symbol No. 3).



DC current (IEC 117-1, symbol No. 2).



AC or DC current (IEC 117-1, symbol No. 8).

Frame or chassis connection. The hatching may be completely or partly omitted if there is no ambiguity. If the hatching is omitted, the line representing the frame or chassis shall be thicker (IEC 117-1, symbol No. 87).

A — Ampere (IEC 117-4, symbol No. 356).

V — Volt (IEC 117-4, symbol No. 357).

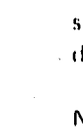
VA — Voltampere (IEC 117-4, symbol No. 358).

W — Watt (IEC 117-4, symbol No. 360).

Wh — Watthour (IEC 117-4, symbol No. 361).

VAh — Voltamperehour (IEC 117-4, symbol No. 362).

Hz — Hertz (IEC 117-4, symbol No. 365).



Contactor, normally closed. In order to avoid confusion with the symbol for a capacitor, the distance between the horizontal (as drawn here) lines should be at least equal to the length of those lines (IEC 117-3, symbol No. 215.2).

In addition the following describes the use of Warnings, Cautions and Notes used in HP Automatic Test System Manuals.

Warnings, cautions and notes. (All) Warnings and cautions shall precede the text to which each applies but notes may precede or follow applicable text depending on the material to be highlighted. Warnings, cautions, and notes shall not contain procedural steps nor shall they be numbered. When a warning, caution, or note consists of two or more paragraphs, the heading WARNING, CAUTION, NOTE, shall not be repeated above each paragraph. If it is ever necessary to precede a paragraph by both a warning and a note, or a caution and a note, etc, they shall appear in the sequence as noted, namely, warnings, cautions, notes. Such inserts in the text shall be short and concise and be used to emphasize important and critical instructions.

WARNING

An operating procedure, practice, etc, which, if not correctly followed, could result in personal injury or loss of life.

CAUTION

An operating procedure, practice, etc. which, if not strictly observed, could result in damage to, or destruction of, equipment.

NOTE: An operating procedure, condition, etc. which it is essential to highlight.

Health hazards precaution data. (All) When hazardous chemicals or adverse health factors, in the environment or use of the equipment cannot be eliminated, appropriate precautionary requirements shall be included

Table of Contents

Table of Contents (con't)

Table of Contents (con't)

Table of Contents (con't)

Table of Contents (con't)

List of Illustrations

List of Illustrations (con't)

List of Tables

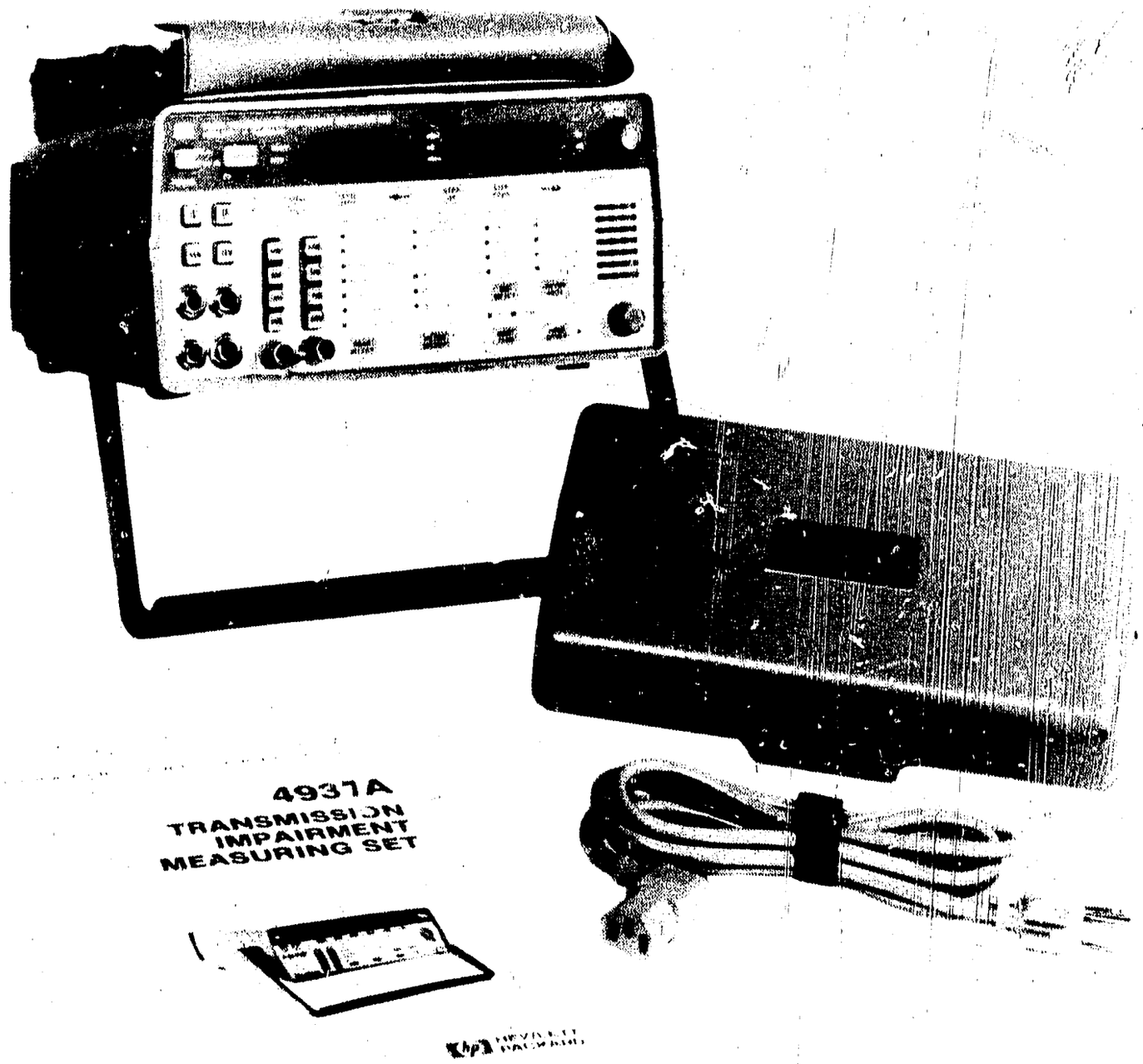


Figure 1-1. *Model 4937A Transmission Impairment Measuring Set*

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION

1-2. This Operating and Service Manual contains information required to install, operate, test, adjust, and service the Hewlett-Packard Model 4937A Transmission Impairment Measuring Set. Figure 1-1 shows the instrument and accessories supplied. Throughout the remainder of this manual the Model 4937A will be referred to as HP 4937A or the instrument.

1-3. The Manual part number is listed on the title page. Also listed on the title page of this manual is a Microfiche part number. This number can be used to order 4 X 6 inch microfilm transparencies of the manual. Each microfiche contains up to 96 photo-duplicates of the manual pages. The microfiche package also includes the latest Manual Changes supplement as well as pertinent Service Notes.

1-4. SPECIFICATIONS

1-5. Instrument specifications are listed in table 1-1. These specifications are the performance standards or limits against which the instrument is tested. Supplemental characteristics are shown in the shaded areas or in italics and are intended to provide information useful in the application of the instrument. These specifications are not warranted performance parameters. Performance tests are listed in Section IV of this manual.

1-6. SAFETY CONSIDERATIONS

1-7. This product is a Safety Class 1 instrument (provided with a protective earth terminal). The instrument and manual should be reviewed for safety markings and instructions before operation.

1-8. INSTRUMENTS COVERED BY THIS MANUAL

1-9. Attached to the instrument is a serial number plate. The serial number is in the form: 0000A00000. It is in two parts; the first four digits and the letter are the serial prefix and the last five digits are the suffix. The prefix is the same for all identical instruments; it changes only when a change is made to the instrument. The suffix however, is assigned sequentially and is different for each instrument. The contents of this manual apply to the instruments with the serial number prefix(s) listed under SERIAL NUMBERS on the title page.

1-10. An instrument manufactured after the printing of this manual may have a serial number prefix that is not listed on the title page. This unlisted serial number prefix indicates the instrument is different from those described in this manual. The manual for this newer number is accompanied by a yellow Changes Sheet supplement. This supplement contains "change information" that explains how to adapt the manual to the newer instrument.

1-11. For information concerning a serial number prefix that is not listed on the title page or in the Manual Changes supplement, contact your nearest Hewlett-Packard sales office.

1-12. DESCRIPTION

1-13. The HP 4937A is a voice band Transmission Impairment Measurement Set that also incorporates signaling capability. These features, combined with the instruments light weight, provides a portable field service tool for fast, accurate network access testing. The HP 4937A signaling feature can be used to verify the proper installation of PBX systems.

1-14. The transmission impairment measurements that can be made using the HP 4937A are listed below:

1. Level and Frequency
2. Noise
3. Noise with Tone
4. Signal to Noise
5. Noise to Ground
6. Return Loss

1-15. The procedures for using supervisory signaling, and for making the transmission impairment measurements, are described in Section III of this manual.

1-16. Supervisory signaling is used to detect or change the state or condition of a subscriber or network line. There are two supervisory conditions; on-hook and off-hook. The on-hook condition is when the telephone is idle. That is the handset is resting on the cradle and the grounding switch is open.

1-17. Off-hook condition is when the telephone is active. That is when the handset is removed from the cradle and the grounding switch is closed.

1-18. These on-hook and off-hook conditions provide circuit indications such as circuit idle, circuit busy, seizure, and disconnect.

1-19. The HP 4937A can perform the following supervisory signaling functions:

1. Loop start signaling
2. Ground start signaling
3. Loop reverse battery signaling
4. E/M signaling Types I, II, and III
5. Wink

1-20. OPTIONS

The following options are available:

1. Option 001 adds a rechargeable battery pack.
2. Option 002 deletes 900 ohm and adds 150 ohm impedance.
3. Option 910 includes an additional Operating and Service Manual.

1-21. WARRANTY

Instrument warranty is as listed inside of the front cover.

1-22. ACCESSORIES AVAILABLE

1. Test Cord w/ 310 male to alligator clips, 60 inches, HP P/N 18182A
2. Test Cord w/ 310 male at both ends, 36 inches, HP P/N 15513A
3. Standard 19-inch rack mounting kit, HP P/N 18132A
4. Ladder bracket, HP P/N 18161A

1-23. RECOMMENDED TEST EQUIPMENT

1-24. Equipment required to maintain the Model 4937A is listed in table 1-2. Other equipment may be substituted if it meets or exceeds the critical specifications listed in the table.

1-25. BATTERY OPERATION (Option 001)

1-26. Instruments with Option 001 have nickel-cadmium batteries that enable the HP 4937A to operate from internal power when in areas where ac power is not available. Typical operating time is 5 hours when the batteries are fully charged. The batteries are trickle charged whenever the instrument is connected to an ac power source and the POWER switch is in the STBY position.

1-27. Regular discharge/charge cycles are recommended to maintain maximum battery capacity. The instrument should be operated until the batteries are discharged (when LOW BATTERY indicator is displayed in the left display) then recharged, at least every 30 days. Normal recharge time is about 14 hours. Typical battery life under normal operating conditions should be at least 100 charge/discharge cycles.

Note
Batteries do not charge when the HP 4937A is operating from an ac source.

1-28. Charging the Batteries

1-29. The internal battery consists of one 15-volt rechargeable battery pack. To recharge the batteries, connect the HP 4937A to an ac power source and press the power switch to STBY (the batteries will not charge with the power switch in the ON position). Normal recharge time is about 14 hours.

1-30. Charging Temperature

1-31. The batteries may be charged at temperatures between +5 degrees C and +40 degrees C (+41 degrees F and +104 degrees F), but will have greater charge capacity if charged between +5 degrees C and +25 degrees C (+41 degrees F and +77 degrees F). At temperatures above +25 degress C the charge acceptance falls off as shown in figure 1-2. For example, a cell charged at +45 degrees C accepts about 60 to 70 percent of its rated capacity. Temperatures below +5 degrees C cause pressure to build up within the cell as it is charged, which could result in venting of the cell. This can result in permanent degradation of the battery capacity due to loss of electrolyte.

1-32. Operating Temperature

1-33. Normal operating temperature of the HP 4937A with batteries should be between 0 degrees C and +40 degrees C (+32 degrees F and +104 degrees F). However, there will be a loss of capacity when operating at the extremes. At low temperatures, the batteries cannot fully discharge even though they were fully charged at room temperature. At high temperatures the same effect takes place, but to a lesser degree, in addition to charge acceptance previously mentioned. Figure 1-2 illustrates this effect.

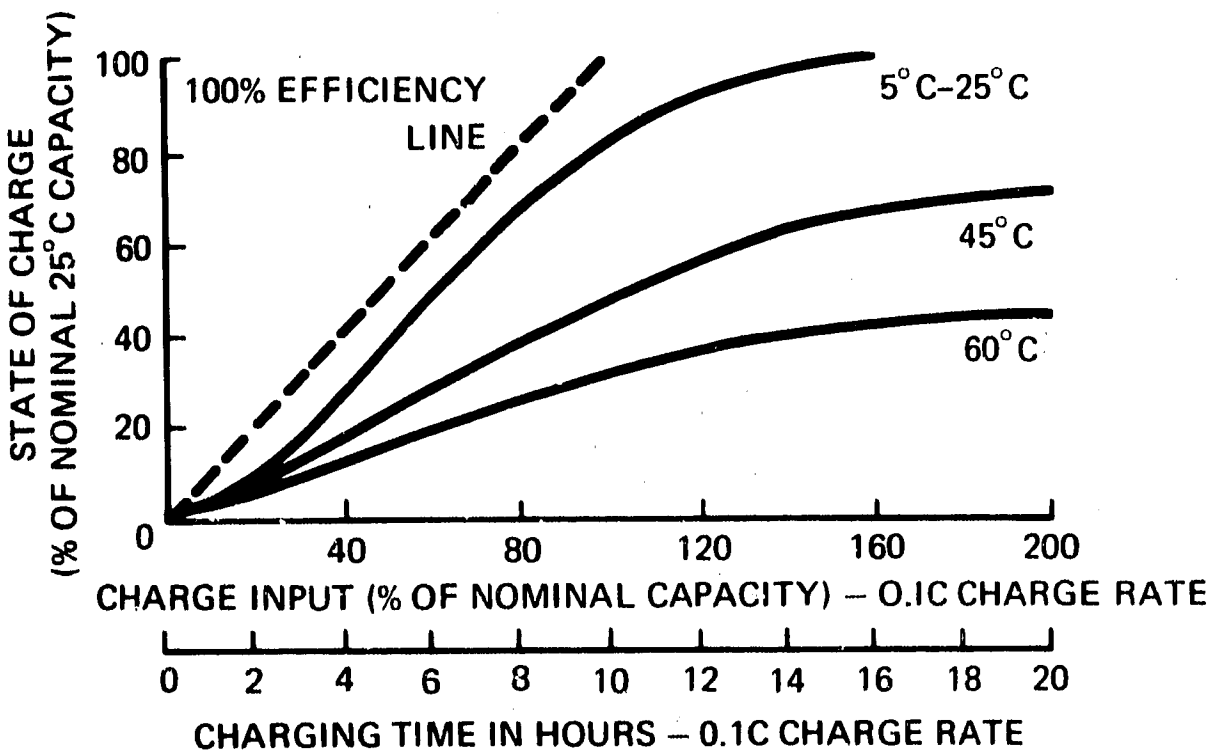


Figure 1-2. *Charge Acceptance at Various Temperatures*

Table 1-1. *Specifications*

LEVEL/FREQUENCY

Transmitter

Frequency:
Range: 20 Hz to 9999 Hz
Resolution: 1 Hz
Accuracy: +/-0.005% of output frequency

Preprogrammed functions:
SF Skip: skips the frequency band from 2450-2750 Hz
Frequencies: at power up 404 Hz, 1004 Hz, 2804 Hz, and 2713 Hz

Level:
Range: -40 to +13 dBm
Resolution: 0.1 dB
Accuracy (@ 1004 Hz, -19 dBm to 0 dBm), +/-0.1 **dBm** (elsewhere) +/-0.2 **dBm**

Flatness (referenced to 1 kHz, in **dBm**)

Frequency (Hz)

Level (**dBm**)	20	200	4000	9999
+13	+.5,-3.0	+/-0.2	+/-0.2	
+10	+/-1.0	+/-0.2	+/-0.2	
-40				

Distortion (in dB from fundamental)

Note: (Includes harmonics, spurious, and background noise within a 3 dB bandwidth of 4 kHz or 4 X f_o whichever is greater.)

Frequency (Hz)

Level (**dBm**)	40	100	4000	9999
+13	-20	-45	-45	
+10	-30	-55	-55	
0	-40	-50	-50	
-40				

Note: At 1004 Hz, 0 dBm, threshold is more than 65 dB down when using a 4-kHz filter.

Table 1-1. *Specifcations (con't)*

Receiver

Frequency:
Range: 20 Hz to 9999 Hz
Resolution: 1 Hz
Accuracy: +/-1.0 Hz

Level:
Range: -60 to +13 dBm
Resolution: 0.1 dB
Accuracy: (in dB)

	Frequency (Hz)				
	20	50	200	4000	9999
Level (dBm) +13	+/-1.0	+/-0.5	+/-0.2	+/-0.2	
-40	+/-1.0	+/-0.6	+/-0.4	+/-0.4	
-60					

Note: Receiver accuracy not specified below 500 Hz when using 150 ohm termination. (Instruments with option 002.)

Note: At 1004 Hz accuracy is +/-0.1 dB from -20 to +13 dBm.

Cross Talk: >78 dB isolation @ 4 kHz, decreasing 6 dB per octave above 4 kHz.

Preprogrammed Functions:
Range Hold: Inhibits the autorange from changing from its present setting.

MESSAGE CIRCUIT NOISE

Transmitter: quiet terminated

Receiver:
Range: 0 to 99 dBrn; 150 ohms, lower limit is 7 dB higher (Option 002 instruments only)
Resolution: 1 dB
Accuracy: +/-1 dB from 10 to 99 dBrn
+/-2 dB from 0 to 10 dBrn
Weighting Filters: C-message, and 3 kHz Flat

Table 1-1. *Specifications (con't)*

NOISE WITH TONE

Transmitter:
Frequency: 1004 Hz fixed tone (for other specifications, see Transmitter Frequency)

Receiver:
Notch Filter: >50 dB rejection from 995- to 1025-Hz
Weighting Filters: C-message, and 3 kHz flat
Range: 10 to 99 dBrn (600, 900, and 1200)
Resolution: 1 db
Accuracy: +/-1 dB from 20 to 99 dBrn
+/-3 dB from 10 to 20 dBrn

SIGNAL-TO-NOISE RATIO

Transmitter:
Frequency: 1004 Hz fixed tone (for other specifications, see Level and Frequency)

Receiver:
Signal Level Range: -40 to +13 dBm
Ratio Range: 10 to 45 dB
Resolution: 1 dB
Accuracy: +/-1 dB

NOISE-TO-GROUND

Transmitter: quiet terminated

Receiver:
Weighting Filters: C-message, and 3 kHz flat
Range: 50 to 99 dBrn (600, 900, and 1200 ohms)
Resolution: 1 dB
Accuracy: +/-1.5 dB

RETURN LOSS

2-wire: 600 and 900 ohms only (600 ohms Option 002)

Transmitter:
Level Range: -26 dBm to -2 dBm
Resolution: 0.1 dB
Transmitter Spectra:
Echo, singing return loss low, and singing return loss high spectra all meet the specifications of IEEE standard P743 and Bell System Publication 41009.

Table 1-1. *Specifications (con't)*

RETURN LOSS 2-wire: (con't)

Receiver:
Range: 0 to 40 dB
Resolution: 0.1 dB
Internal Hybrid Impedance: 600 ohms (+/-0.1%) or 900 ohms (+/-0.1%) in series with 2.16 microfarads (+/-1%)

4-Wire: 600 and 900 ohms only (600 ohms Option 002)

Transmitter:
Level Range: -26 dBm to -2 dBm
Resolution: 0.1 dB
Transmitter Spectra:
Echo, singing return loss low, and singing return loss high spectra all meet the specifications of IEEE standard P743 and Bell System Publication 41009.

Receiver:
Range: 0 to 50 dB
Resolution: 0.1 dB
Accuracy: +/-0.5 dB overall
Transhybrid Loss Compensation: -29.9 dB to +29.9 dB in 0.1 dB steps

Table 1-1. *Specifications (con't)*

SUPERVISORY SIGNALING

E/M Signaling

Types: Type I, II, and III (both originate and terminate) Battery: -48 Vdc current limited to 29 mA

Supervision Sensors Threshold Voltages:

	E Lead	M Lead
Voltage:	<-16V = on hook	>-16V = on hook
	>-16V = off hook	<-16V = off hook

	On-Hook	Off-Hook
Type I	open	gnd
Type II	open	SG
Type III	open	gnd

	On-Hook	Off-Hook
Type I	gnd	batt
Type II	open	SB
Type III	SG	SB

Loop Signaling

Types: Loop Start, Ground Start, and Loop Reverse Battery (both originate and terminate)

Hold Circuits: 2, each drawing 27 milliamps at a minimum voltage of 8.5 Vdc
Battery: -48 Vdc with 340 ohms in series, current limited to 29 milliamps

Bridging Loss of Battery:
<0.5 dB from 200 Hz to 500 Hz
<0.3 dB from 500 Hz to 10 kHz

WINK

Idle: 100 msec (nominal)
Off Hook: 200 msec (nominal)

Status indication of on-Hook and off-Hook for both originate and terminate ends of the trunk, except Loop Start which only indicates originate end.

Table 1-1. *Specifications (con't)*

GENERAL

Maximum DC Blocking: 200 Volts

Impedances: 600, 900, and 1200 ohms, BRIDGE. TRMT and RCV impedances independently selectable

Bridging Loss to 10 kHz: <0.2 dB

Receiver Return Loss: >30 dB from 50 Hz to 4 kHz at 600, 900, and 1200 ohms
>30 dB from 800 Hz to 10 kHz at 150 ohms (option 002)

Longitudinal Balance: >80 dB at 60 Hz; >70 dB at 540 Hz; >60 dB up to 4 kHz decreasing 6 dB per octave to 10 kHz.

Power Requirements: 100 V, 120 V, 220 V, and 240 Vac +5%, -10%, 48-66 Hz

Battery Supply (option): Typically >5.0 hours of continuous operation at 25 C. Complete recharging in 14 hours with unit in STBY.

Temperature Range: 0 C to +55 C, (+32 F to +131 F); 0 C to+ 40 C with batteries (+32 F to +110 F)

Warm up time @ 20 C for stated accuracy: 5 minutes

Dimensions: 279 mm x 127 mm x 381 mm (5 in. x 11 in. x 15 in.)

Weight: 5.3 kg (12 lbs)
7.6 kg (17 lbs) with batteries

Options

001: Adds rechargeable battery pack
002: Deletes 900-ohm impedance and adds 150-ohm impedance
910: Includes extra Operating and Service Manual

Table 1-2. *Recommended Test Equipment*

Instrument	Critical Specifications	Recommended Model	Use
Ac Calibrator	Output: 1mV to 10V Freq: 20Hz to 4 kHz Accy: 0.02%	Fluke 5200A	P,T
Ac Voltmeter	6 1/2 digit, 0.1%	HP 3456A	P,T
Multimeter	dc current	HP 3468A	P,T
Oscilloscope	Dual Chan: 5mV/div	HP 1740A	P,A
Signature Analyzer	CMOS levels Qualifer	HP 5005A	T
Audio Analyzer	20 Hz to 4 kHz	HP 8903A	P,A
Counter	10 kHz	HP 5315A	P
Power Supply	50 volt	HP 6218B	P
Service brackets		HP P/N 1531-0211	
DIP switch		HP P/N 1251-7158	
Resistor, 398 ohm 1%		HP P/N 0698-9100	
Resistor, 600 ohm 1%		HP P/N 0698-7408	
Resistor, 900 ohm 1%		HP P/N 0698-6344	

Note: A=Adjustments
P=Performance Test
T=Troubleshooting

SECTION II

INSTALLATION

2-1. INTRODUCTION

2-2. This section provides installation instructions for the Model 4937A TIMS. This section also includes information about initial inspection and damage claims, preparation for use, power requirements, storage and shipment.

2-3. INITIAL INSPECTION

2-4. Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the instrument has been checked mechanically and electrically. The contents of the shipment should be as shown in figure 1-1. The procedures for checking electrical performance are given in Section IV. If the contents are incomplete, if there is mechanical damage or defect, or if the instrument does not pass the performance tests, notify the nearest Hewlett-Packard sales and support office. If the shipping container is damaged, or the cushioning material shows signs of stress, notify the carrier as well as the Hewlett-Packard sales and support office.

2-5. PREPARATION FOR USE

CAUTION

Before connecting this instrument to an ac power source, be sure that the rear panel line module is set to the same voltage as the ac source and that the correct fuse for that ac voltage is installed.

2-6. Power Requirements

2-7. This instrument requires a power source of 100-, 120-, 220-, or 240-Vac, +5% or -10%. Single phase 48 - to 66-Hz

2-8. Option 001 instruments have a battery power supply. The battery pack provides up to 5 hours of continuous operation at 25 degrees C. Complete recharging in 14 hours with unit in STBY mode.

2-9. Line Voltage Selection

2-10. Figure 2-1 provides instruction for line voltage and fuse selection. The line voltage selection and fuse are factory set for 120 Vac operation.

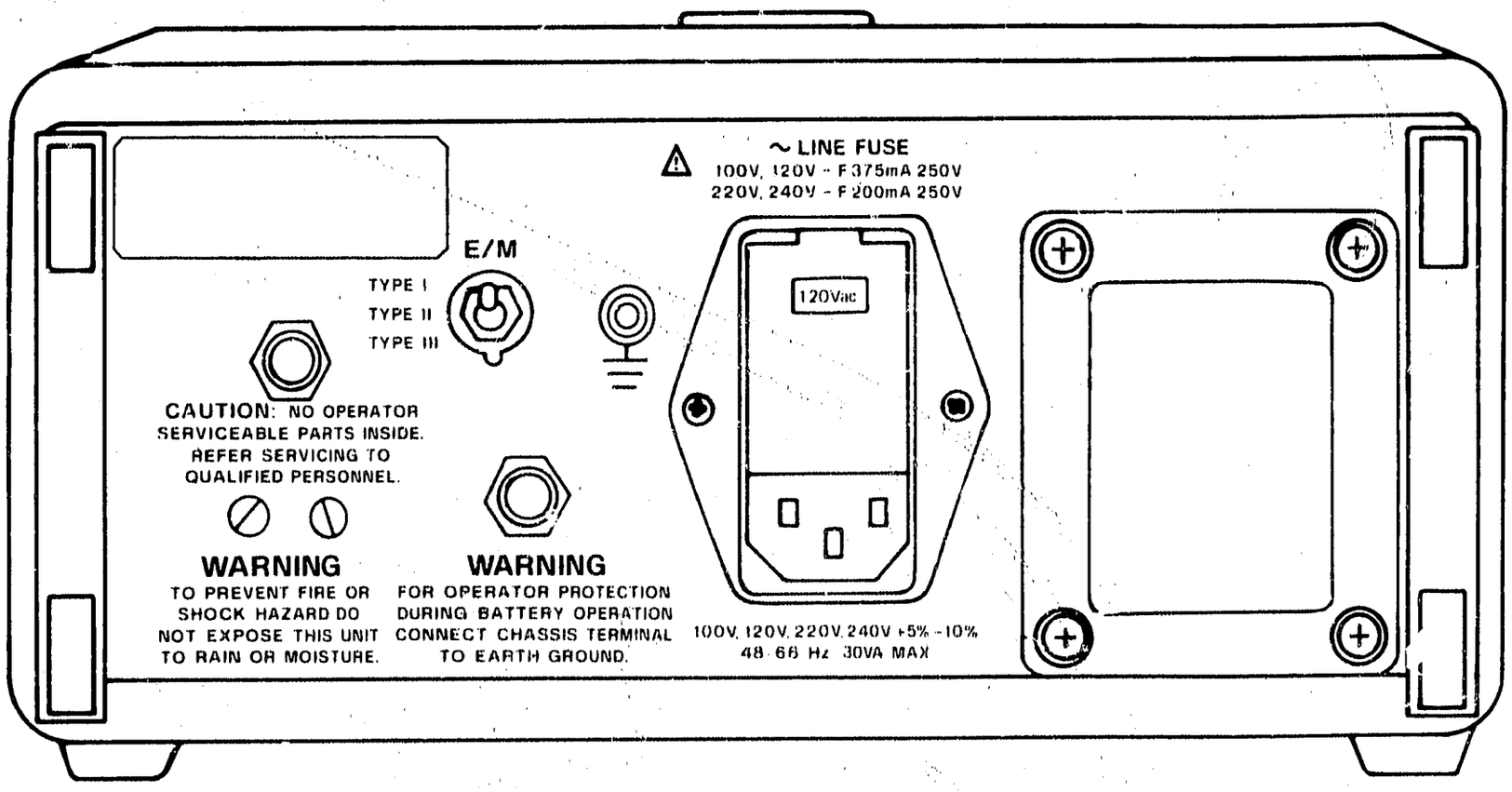


Figure 2-1. *Line Voltage Selection*

2-11. Power Cable

WARNING

Any interruption of the protective (grounding) conductor (inside or outside the instrument) or disconnecting the protective earth terminal can make this instrument dangerous to electrical shock.

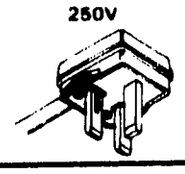
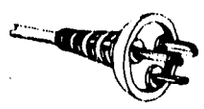
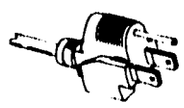
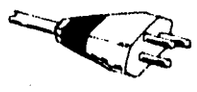
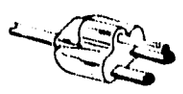
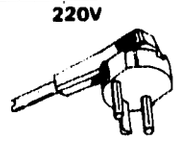
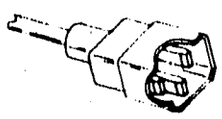
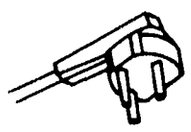
2-12. This instrument is supplied with a three-wire power cable. When connected to an appropriate three-wire ac power receptacle, the cable grounds the instrument. See table 2-1 for available power cables.

2-13. OPERATING ENVIRONMENT

2-14. Temperature

2-15. This instrument may be operated in temperatures from 0 degrees C to +55 degress C (+32 degrees F to +131 degrees F). Temperature range for instruments with batteries is 0 degrees C to +40 degrees C (+32 degrees F to +104 degrees F).

Table 2-1. *Power Cables Available*

Plug Type	Cable HP Part Number	C D	Plug Description	Cable Length (inches)	Cable Color	For Use In Country
250V 	8120-1351 8120-1703	0 6	Straight *BS1363A 90°	90 90	Mint Gray Mint Gray	United Kingdom, Cyprus, Nigeria, Rhodesia, Singapore
250V 	8120-1369 8120-0696	0 4	Straight *NZSS198/ASC112 90°	79 87	Gray Gray	Australia, New Zealand
250V 	8120-1689 8120-1692	7 2	Straight *CEE7-Y11 90°	79 79	Mint Gray Mint Gray	East and West Europe, Saudi Arabia, Egypt, So Africa, India (unpolarized in many nations)
125V 	8120-1348 8120-1398 8120-1754 8120-1378 8120-1521 8120-1676	5 5 7 1 6 2	Straight *NEMA5 15P 90° Straight *NEMA5-15P Straight *NEMA5-15P 90° Straight *NEMA5-15P	80 80 36 80 80 36	Black Black Black Jade Gray Jade Gray Jade Gray	United States, Canada, Japan (100V or 200V), Mexico, Philippines, Taiwan
250V 	8120-2104	3	Straight *SEV1011 1959-24507 Type 12	79	Gray	Switzerland
250V 	8120-0698	6	Straight *NEMA6-15P			United States Canada
220V 	8120-1957 8120-2956	2 3	Straight *DHCK 107 90°	79 79	Gray Gray	Denmark
250V 	8120-1860	6	Straight *CEE22-VI (Systems Cabinet use)			
250V 	8120-4600 8120-4211	d 7	Straight BS 546/SABS 164 90°	98 98	Black Black	So Africa, India

*Part number shown for plug is industry identifier for plug only. Number shown for cable is HP Part Number for complete cable including plug.
E = Earth Ground, L = Line, N = Neutral

2-16. Humidity

2-17. This instrument may be operated in environments with humidity from 5 percent to 95 percent relative humidity at +40 degrees C (+104 degrees F). However, the instrument should be protected from temperature extremes that can cause condensation within the instrument.

2-18. STORAGE AND SHIPMENT

2-19. Environment

2-20. The instrument may be stored and shipped within the following environmental limits:

- Temperature..... -20 to +65 degrees C (-4 to +149 degrees F)
- Humidity..... Up to 90% Relative at +65 degrees C (+149 degrees F)

2-21. Packaging

2-22. Tagging for Service.--If the instrument is being returned to Hewlett- Packard for service, please complete one of the blue repair tags located at the back of this manual and attach it to the instrument.

2-23. Original Packaging.--Containers and materials identical to those used in factory packaging are available through Hewlett-Packard sales and support offices. If the instrument is being returned for servicing, attach a tag indicating the type of service required, return address, model number, and full serial number. Also mark the container FRAGILE to ensure careful handling. In any correspondence, refer to the instrument by model number and full serial number.

2-24. Other Packaging.--The following general instructions should be used for repacking with commerically available materials:

a. Wrap the instrument in heavy paper or plastic. (If shipping to Hewlett- Packard office or service center, attach a tag indicating type of service required, return address, model number, and full serial number.)

b. Use strong shipping container. A double-walled carton made of 350-pound test material is adequate.

c. Use a layer of shock-absorbing material 70- to 100-mm (3- to 4-inches) thick around all sides of the instrument to provide firm cushioning and to prevent movement inside the container. Protect the control panel with cardboard.

d. Seal the shipping container securely.

e. Mark shipping container FRAGILE to ensure careful handling.

f. In any correspondence, refer to instrument by model number and full serial number.

SECTION III
OPERATION

3-1. INTRODUCTION

3-2. This section contains information on front and rear panel features, self check procedures, and error codes. It also describes typical operating modes. The principles of operation of the measurements are explained in Appendix A of this manual.

3-3. OPERATING CHARACTERISTICS

3-4. The HP 4937A provides two types of functions: Transmission Impairment Measurements and Supervisory Signaling.

The transmission impairment measurements that can be made with the HP 4937A are:

- Level and Frequency
- Noise
- Noise with Tone
- Signal to Noise
- Noise to Ground
- Return Loss

Signaling capabilities of the HP 4937A are:

- Supervisory signaling simulation
- Establishing talk condition for transmission testing
- Ability to hold two 2-wire circuits for testing

The types of supervisory signaling simulation are:

- Loop Start
- Ground Start
- Loop Reverse Battery
- E/M signaling Types I, II, and III
- Wink

3-5. PANEL FEATURES

3-6. Figure 3-1 identifies the front and rear panel features and includes a brief description as to the function of each feature.

3-7. SELF CHECK

3-8. The HP 4937A has two types of self checks. These are a power on self check and an extended self check. The power on self check procedure is performed automatically at power-up by the instrument. It checks most of the major circuits and should identify major problems. The error message table listed below indicates which tests are in power on self check and which are in extended self check. To perform the extended self check, externally jumper the E/M jack and the SG/SB jack together, and then press the SHIFT key and the FILTER select key. Failure of the instrument to pass any self check procedure indicates a malfunction that can possibly affect other measurements.

3-9. ERROR MESSAGES

3-10. The HP 4937A gives two types of error messages. The two types of messages are either a functional error in one of the self check modes or an operational error. The errors are listed below.

3-11. Operational Errors:

Err 01--This error indicates that the receive level is greater than the upper limit for the selected measurement.

Err 02--Indicates that the receive level is under the lower limit for the selected measurement.

Err 07--This error signifies the loss of the 1004 Hz hold tone.

Err 09--Indicates that the level measurement currently being made needs to auto range and the Range Hold mode is set.

Err 10--Indicates that 1200 ohms impedance is selected in two wire return loss. Only 600 ohms and 900 ohms are available.

Err 30--Wink is illegal setup for Loop Start and Loop Reverse Battery Originate.

Err 31--In Loop Originate the incomming battery has negative on the tip.

3-12. Power On Self Check Errors:

Err 11--Indicates that the power up self test failed the ROM checksum.

Err 12--Indicates that the power up self test failed the RAM check.

Err 13--The magnitude of the cal level for the voltage to frequency converter is out of range.

Err 14--Power up self check failed to measure a frequency of 1004 Hz.

Err 15--Measurement of the hold tone frequency is not 1004 Hz.

Err 16--Power up self check failed to measure a proper level of +13.0 dBm.

Err 17--Level measured through the C-message filter is not the proper amplitude.

Err 18--Level measured through the 3-kHz flat filter is not the proper amplitude.

Err 19--Level measured through the 60-Hz reject filter is not the proper amplitude.

Err 20--Level measured through the QRMS detector is not the proper amplitude.

Err 21--Level measured through the Return Loss detector is not the proper amplitude.

3-13. Extended Self Check Errors:

Err 50--Level of the Echo return loss waveform is not the proper amplitude.

Err 51--Level of the Singing High return loss waveform is not the proper amplitude.

Err 52--Level of the Singing Lo return loss waveform is not the proper amplitude.

Err 53--The measured depth of the notch filter is too small. This test will fail if the level is too low. The transmit level must be greater than -40 dBm to pass this test.

Err 54--The TIPPOS detector did not pass the test to detect the presense of 48 volt supply.

Err 55--The TIPPOS detector did not pass the test to detect the absence of the 48 volt supply.

Err 56--The TIPNEG detector did not pass the test to detect the presense of 48 volt supply.

Err 57--The TIPNEG detector did not pass the test to detect the absence of the 48 volt supply.

Err 58--The GNDCUR detector did not pass the test to detect the presense of current from the 48 volt supply.

Err 59--The GNDCUR detector did not pass the test to detect the absence of current from the 48 volt supply.

Err 60--The TERMCUR detector did not pass the test to detect the presense of current from the 48 volt supply.

Err 61--The TERMCUR detector did not pass the test to detect the absence of current from the 48 volt supply.

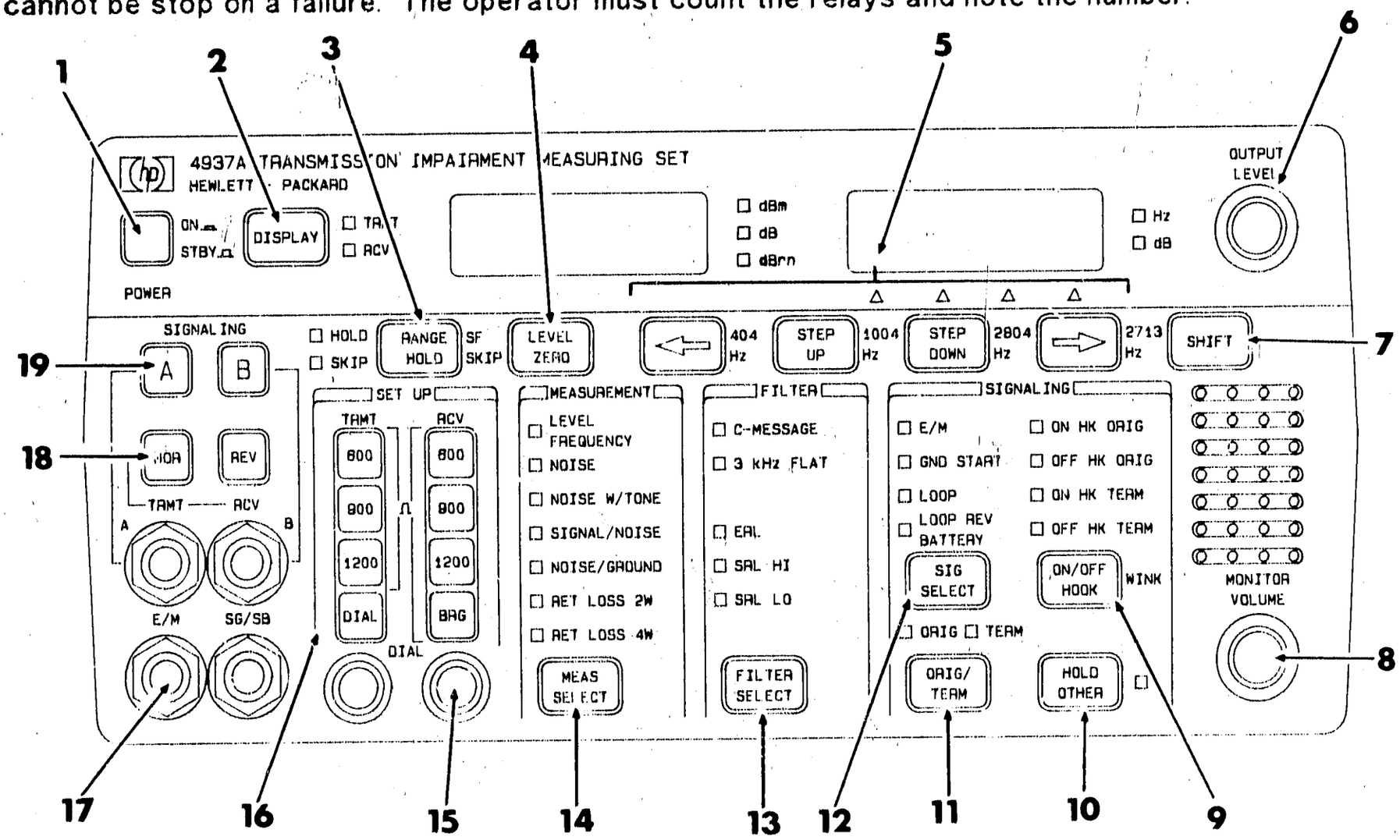
Err 62--The E lead detector did not sense the presence of the M lead. The E/M jack must be connected to the SB/SG jack to pass this test.

Err 63--The E lead detector did not sense the absence of the M lead. The E/M jack must be connected to the SB/SG jack to pass this test.

Err 64--The M lead detector did not sense the presence of the E lead. The E/M jack must be connected to the SB/SG jack to pass this test.

Err 65--The M lead detector did not sense the absence of the E lead. The E/M jack must be connected to the SB/SG jack to pass this test.

3-14. The Relay Step Check is the last extended self check to be done. In this check each relay is set, a tone is sounded for about 100 msec, then the relay is reset. This is done for each relay in sequence at about a 2-Hz rate. If the relay is not heard on both ends of the tone it will be noticable to the ear. Since this test relies on the operator to actually detect a missing relay closure, the test cannot be stop on a failure. The operator must count the relays and note the number.



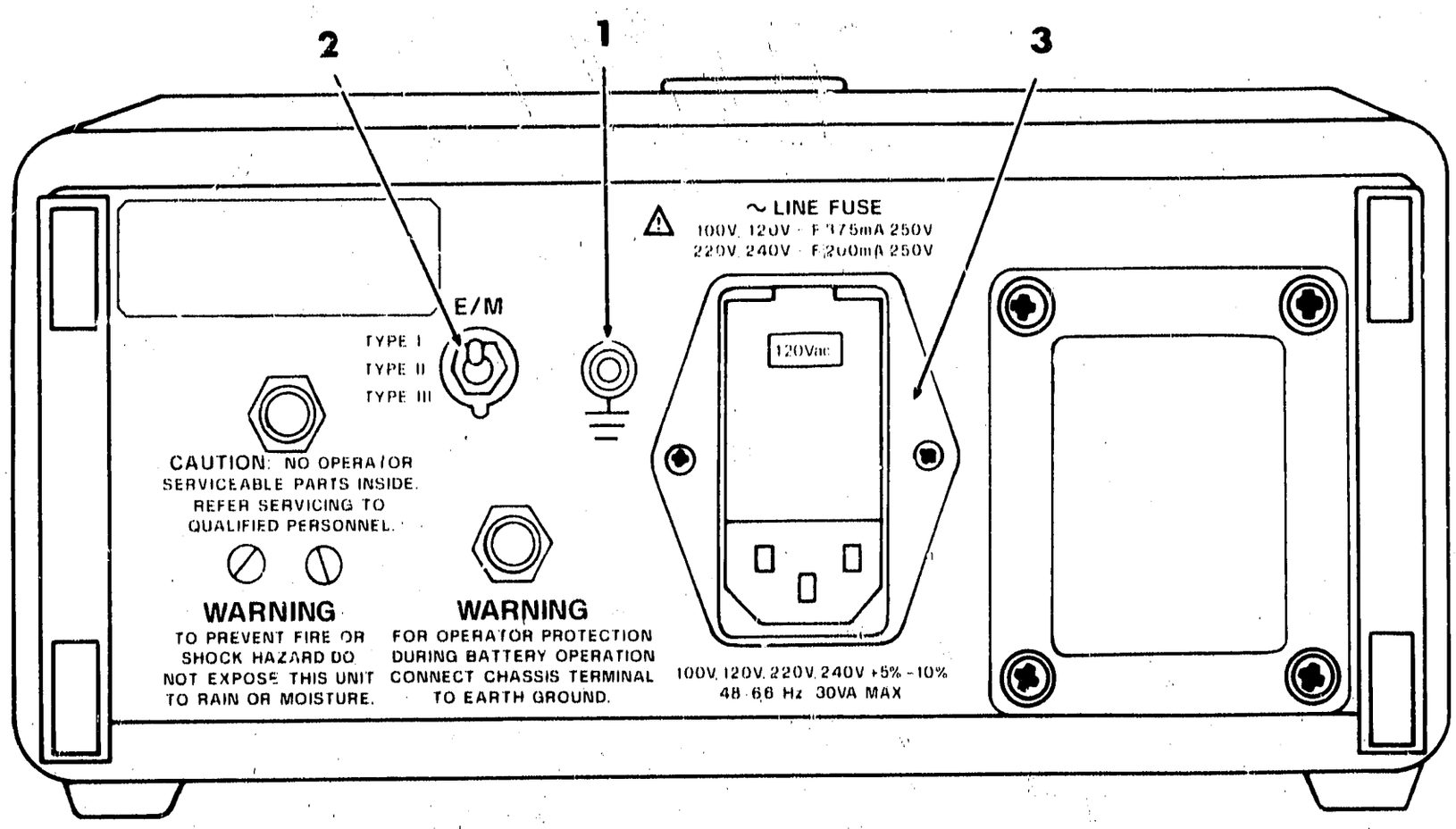


Figure 3-1. *Front and Rear Panel Controls, Connectors, and Indicators.*

3-15. CONTROLS, CONNECTORS, and INDICATORS

FRONT PANEL

1. Power Switch--Switches power to the instrument when in the ON position. In the STBY position power is still applied to some circuits. If the unit has the battery (Option 001) there will still be power available to some internal circuits even in STBY position and the batteries are charged in this position. There are separate battery operation and low battery indicators. These indicators are located in the left hand display.

2. DISPLAY key--Selects either the TRMT (transmit) or the RCV (receive) signal to be displayed. The corresponding LED will be lighted.

3. RANGE HOLD and SF SKIP key

   RANGE HOLD--Prevents the autorange from changing from its present setting during a measuremen

   SF Skip--Prevents the transmitter from transmitting within +/-150 Hz (300 Hz band) of 2600 Hz. This feature eliminates accidentally being disconnected by SF signaling units on dial-up lines. Operates only in LEVEL/FREQUENCY.

4. LEVEL ZERO key--Sets a 0 dB reference in RCV LEVEL/FREQUENCY mode. All subsequent measurements will be made in dB relative to this reference. dB LED in center of the front panel will light. A - (minus) dB reading indicates levels higher than the reference level per the telephone industry convention.

   In 4-wire return loss and RCV mode, the LEVEL ZERO key enters a 0 dB return loss in the left display and calculates the transhybrid loss (THL) which is displayed in the right hand display.

5. STEP UP, STEP DOWN, <- and -> keys--In TRMT Mode (right display) and LEVEL FREQUENCY; <- or -> selects the position of digit to be increased or decreased. Lighted cursor indicates one-of-four digit positions. Digit value is incremented by pressing STEP UP and decremented by pressing STEP DOWN. Pressing and holding the STEP UP or STEP DOWN key causes the action to repeat. Also, with the SHIFT key sets the output frequency to 404 Hz, 1004 Hz, 2804 Hz, and 2713 Hz in LEVEL FREQUENCY mode.

   In 4-wire return loss and RCV mode, these keys are used to enter the THL of the circuit.

6. OUTPUT LEVEL Control--Adjusts the transmitter output level continously from -40 dBm to +13 dBm. Output level is displayed on the left display.

7. SHIFT key--Used to activate any of the functions labeled in blue.

8. MONITOR VOLUME Control and Speaker--Permits adjustable volume for listening to the circuit under test or to the Test Set Transmitter.

3-15. CONTROLS, CONNECTORS, and INDICATORS (con't)

9. ON/OFF HOOK key--When the instrument is selected to be the ORIGINATE end, the ON/OFF HOOK key simulates the on-hook or off-hook condition of the originate end. When the instrument is the TERMINATE end the ON/OFF HOOK key simulates the on-hook or off-hook condition of the terminate end.

   STATUS LEDs--There are four status LEDs that indicate the status of both the originate and terminating ends of the line. The status lights are:

   ON HK ORIG (on-hook originate)

   OFF HK ORIG (off-hook originate)

   ON HK TERM (on-hook terminate)

   OFF HK TERM (off-hook terminate)

10. HOLD OTHER--Puts an auxillary hold circuit on the B jack if the A signaling key is pressed. The auxillary hold circuit will be placed on the A jack if the B signaling key is pressed. (used to seize a second 2-wire circuit for testing)

11. ORIG/TERM key--Selects whether the type of signaling is originate or terminate.

12. SIG SELECT key--Selects one of the following signaling modes. Lighted LED indicates selected signaling.

    E/M (E and M)

    GND START (ground start)

    LOOP (loop start)

    LOOP REV BATTERY (loop reverse battery)

13. FILTER SELECT key--Selects desired weighting filter for noise measurements and the type of spectrum for return loss measurement.

14. MEAS SELECT key--Selects one of the following measurements. Lighted LED indicates selected measurement.

    LEVEL FREQUENCY

    NOISE

    NOISE W/TONE (noise with tone)

    SIGNAL/NOISE (signal to noise)

    NOISE TO GROUND

    RET LOSS 2W (return loss 2 wire)

    RET LOSS 4W (return loss 4 wire)

3-15. CONTROLS, CONNECTORS, and INDICATORS (con't)

15. DIAL binding posts--A handset can be connected to the binding posts to dial-up a line.

16. SET UP switches

TRMT

600, 900, 1200 ohms--Provides terminating impedance to match the characteristic impedance of the line.

150, 600, 1200 ohms (Option 002)--Provides terminating impedance to match the characteristic impedance of the line.

DIAL--Connects the dial jack to the line that is connected to the A or B jack. This inturn connects the DIAL jack to signaling module. The dial jack is routed to the appropriate place determined by the signaling mode.

RCV

600, 900, 1200 ohms--Provides terminating impedance to match the characteristic impedance of the line.

150, 600, 1200 ohms (Option 002)--Provides terminating impedance to match the characteristic impedance of the line.

BRG--Sets the receiver to a high impedance when the HP 4937A is bridging the circuit under test instead of terminating the line.

17. E/M and SB/SG Jacks--These jacks are used for E/M type signaling. For the three different types of E/M signaling (Type I, II, & III) the appropriate connections are made to the two jacks. Selection of the three types of E/M signaling is made using a switch on the rear panel.

18. NOR and REV switches--The NOR switch connects the A 310 jack to the transmitter and the B 310 jack to the receiver. The REV switch connects the A 310 jack to the receiver and the B 310 jack to the transmitter. When the NOR and REV switches are either both out or both pressed in, the transmitter and receiver are internally looped.

19. A and B SIGNALING switches--The A switch connects the A 310 jack to the loop signaling module and an auxillary hold circuit is available on the B 310 jack. The B switch connects the B 310 jack to the loop signaling module and moves the auxillary hold circuit to the A jack.

REAR PANEL

1. GROUND Jack--Used to connect the HP 4937A to earth ground.

2. E/M SELECTION Switch--Used to select one of the three types of E/M signaling An audible beep denotes which type of signaling was selected with a corresponding 1, 2, or 3 beeps.

3. Voltage Select--Allows selection of proper line voltage.

3-16. OPERATING INSTRUCTIONS

3-17. POWER ON AND SET UP

3-18. Ac Power On

1. Connect power cord to the rear line module on which the correct line voltage has been selected. See Section II for procedure to select line voltage.

WARNING

Always connect power cord to a properly grounded 3-wire power outlet. Any interuption of the protective earth grounding will cause a potential shock hazard that could result in personal injury.

2. Press POWER ON pushbutton. The HP 4937A will automatically do a self check.

3-19. Battery Power On (Option 001 only)

WARNING

For operator protection during battery operation, connect the chassis termination on the rear panel to earth ground.

1. Disconnect power cord

2. Press POWER ON pushbutton. When switching between battery and ac power, cycle the POWER pushbutton from ON to STBY to ON.

3-20. Set Up

CAUTION

Do not connect more than 200 Vdc or 10V rms at 60 Hz to the 310 jacks.

1. Connect circuit under test to the 310 jacks.

2. Press the NOR pushbutton to connect the left 310 jack to the transmitter and the right 310 jack to the receiver.

3. To reverse the direction of the test press the REV pushbutton.

4. Press the SET UP TRMT pushbutton that corresponds to the circuit impedances on the transmitter side (150, 600, 900, or 1200).

5. Press the SET UP RCV pushbutton that corresponds to the circuit impedance on the receiver side (150, 600, 900, or 1200).

3-21. SIGNALING

3-22 This section describes the signaling function of the HP 4937A and gives detailed procedures for seizing the line for testing. The HP 4937A measuring circuits are disconnected from the line under test until both ends of the line have been seized.

3-23. Signaling notifies the switch (central office, PBX, etc.) that a subscriber desires service. Signaling also is used to notify the subscriber of incomming calls. Then, with the necessary data to identify the distant subscriber, the switch will properly route the call.

3-24. The terms on-hook (open switch) and off-hook (closed switch) are used throughout this section to describe the state of signaling equipment regardless of the actual type of signaling used. To identify the circuits, the terms originate equipment and terminate equipment are used. These terms refer only to the hardware configuration and not with the action of initiating the call. The terminate equipment supplies the operating power and current detect circuitry. The originate equipment provides a dc current path via a switch.

3-25. Supervisory signaling deals with the circuits that monitor the status of a subscriber loop or a trunk line. The four types of supervisory signaling that are commonly used are: loop start, ground start, loop reverse battery, and E/M.

3-26. The signaling procedures that follow are arranged in a manner to configure the HP 4937A first as the Originate End equipment, and then as the Terminate End equipment. Procedures to establish talk conditions using the HP 4937A are also included.

3-27. LOOP START SIGNALING

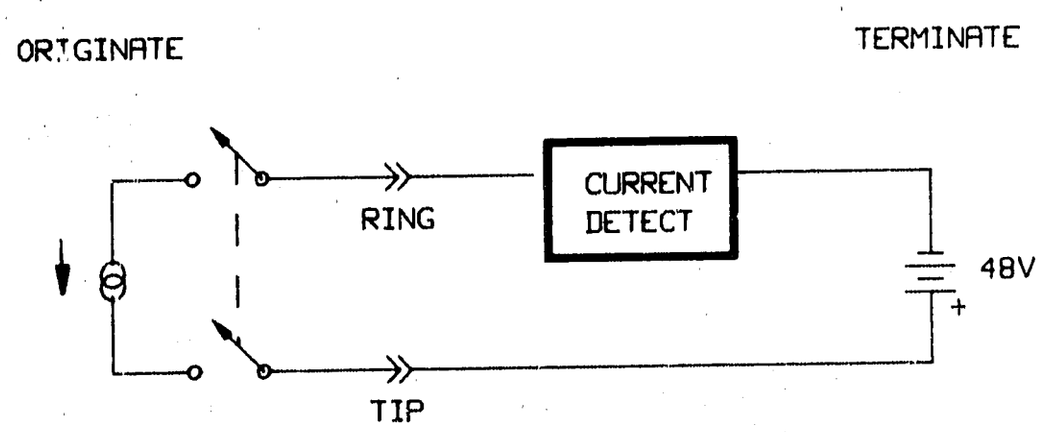
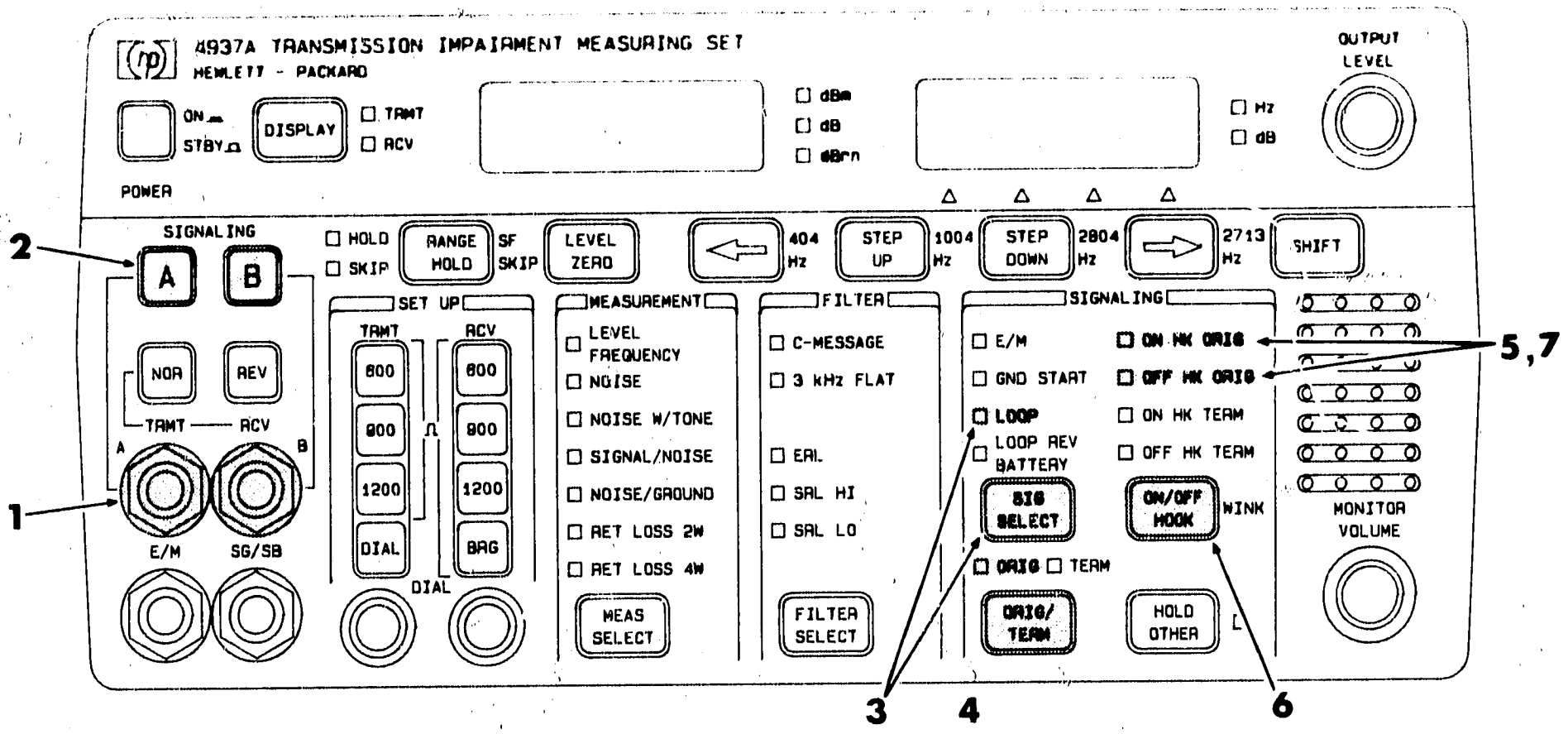


Figure 3-2. *Loop Start Signaling*

3-28. Loop start signaling is used with the circuits that monitor the status of a subscriber loop (see figure 3-2) The signaling starts with the line in an idle state. When the telephone is off-hook the central office detects the current flow and responds with a dial tone. The dial tone is the central office's off-hook state. The HP 4937A can be either the originate end (telephone) or the terminate end (central office).



Seizing The Line--Loop Start Originate End

To configure the HP 4937A as the Originate End proceed as follows:

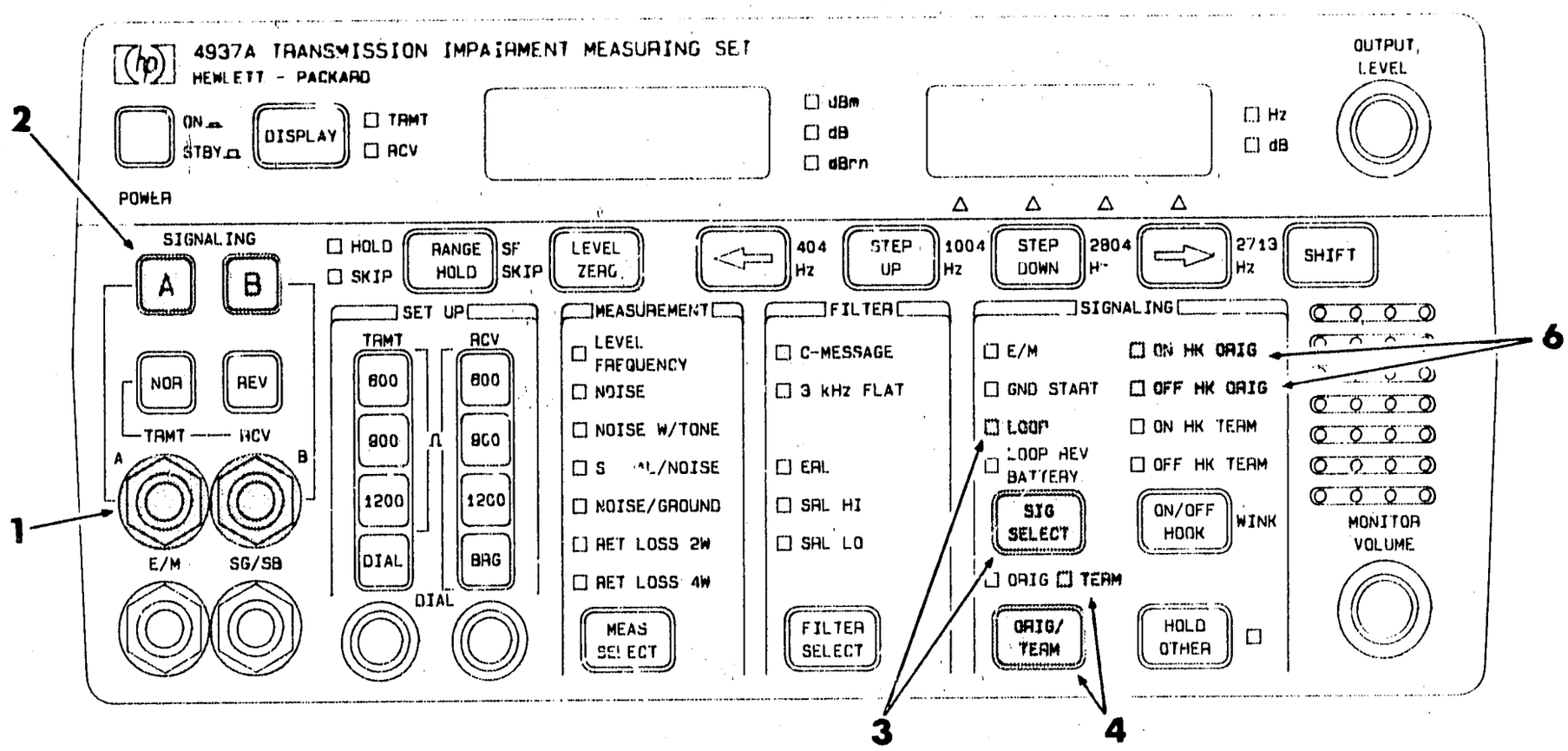
1. Connect the line under test to either 310-jack A or B.
2. Select SIGNALING A if the line under test is connected to 310-jack A or SIGNALING B if the line is connected to 310-jack B.
3. Using SIG SELECT key select Loop Start signaling mode. The LOOP LED should be lighted.
4. Using ORIG/TERM key select ORIG. The ORIG LED should be lighted.
5. Verify the following LEDs:
   - ON HK ORIG - lighted
   - OFF HK ORIG - off
6. To seize the line under test press ON/OFF HOOK key.
7. Verify the following LEDs:
   - ON HK ORIG - off
   - OFF HK ORIG - lighted
8. The line under test is seized. You can now proceed to one of the following:
   - Establish talk condition
   - Conduct transmission impairment measurements
   - Release the line

Establishing Talk Condition

1. Seize the line as described in the previous section Loop start Originate End
2. Connect lineman's handset (butt-in) to DIAL jacks located on the front panel.
3. Press DIAL key. OFF HK ORIG LED should be lighted and a tone should be heard on the handset.
4. The line is now ready to accept dial pulses, tones, or voice.
5. To perform transmission impairment measurements, release DIAL key (an internal hold coil will continue to hold the line).
6. Perform desired measurement as described in the Measurements Section.

Releasing The Line

1. Press ON/OFF HOOK key and verify the following LEDS:
   - ON HK ORIG - lighted
   - OFF HK ORIG - off
2. Pressing the ON/OFF HOOK key again will re-seize the line.



Seizing The Line--Loop Start Terminate End

To configure the HP 4937A as the Terminate End proceed as follows:

1. Connect the line under test to either 310-jack A or B.

2. Select SIGNALING A if the line under test is connected to 310-jack A or SIGNALING B if the line is connected to 310-jack B.

3. Using SIG SELECT key select Loop Start signaling mode. The LOOP LED should be lighted.

4. Using ORIG/TERM key select TERM. The TERM LED should be lighted.

5. Office battery is now provided on the line.

6. The status LEDs indicate the condition of the far end (originate) of the line. When the originate end goes off-hook, then verify the following LEDs:

   - ON HK ORIG - off
   - OFF HK ORIG - lighted

7. The line under test is seized. You can now proceed to one of the following:

   - Establish talk condition
   - Conduct transmission impairment measurements
   - Release the line

Establishing Talk Condition

1. Seize the line as described in the previous section, Loop Start Terminate End.
2. Connect lineman's handset (butt-in) to DIAL jacks located on the front panel.
3. Press DIAL key. The HP 4937A will provide talk battery and will ac couple lineman's handset to the line under test.
4. The line is now ready to accept tones or voice.
5. To perform transmission impairment measurements, release the DIAL key.
6. Perform desired measurement as described in the Measurements Section.

Releasing The Line

1. Loop start terminate always provides office battery. To remove battery, use SIG SELECT key to turn off signaling.

3-29. GROUND START SIGNALING

3-30. Ground start signaling is commonly used on trunk lines between a PBX and a central office. The PBX is usually the originate end and the central office is the terminate end. Either end can seize the trunk by providing a current path to ground. When both ends are off-hook, the line looks very similar to Loop Start signaling.

3-31. The HP 4937A can function as either the originate end (PBX) or the terminate end (central office). As the originate end, the HP 4937A begins the loop closure by grounding the ring (goes off hook closing S-1) which causes a current to flow through the line (see figure 3-3).

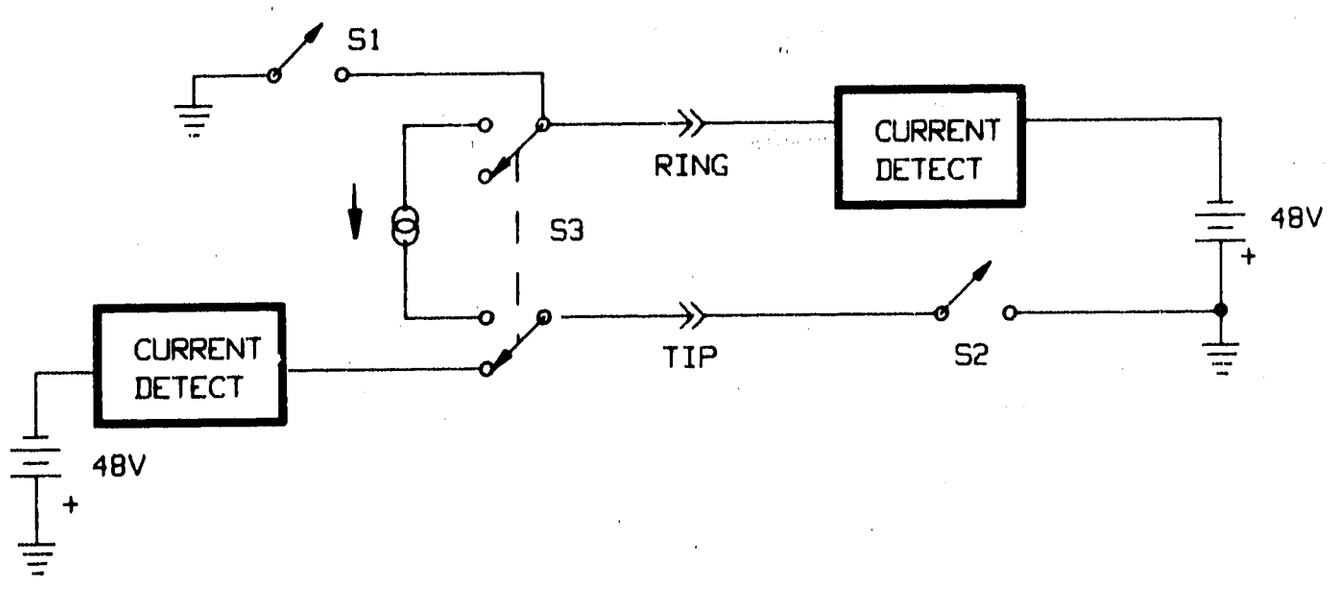
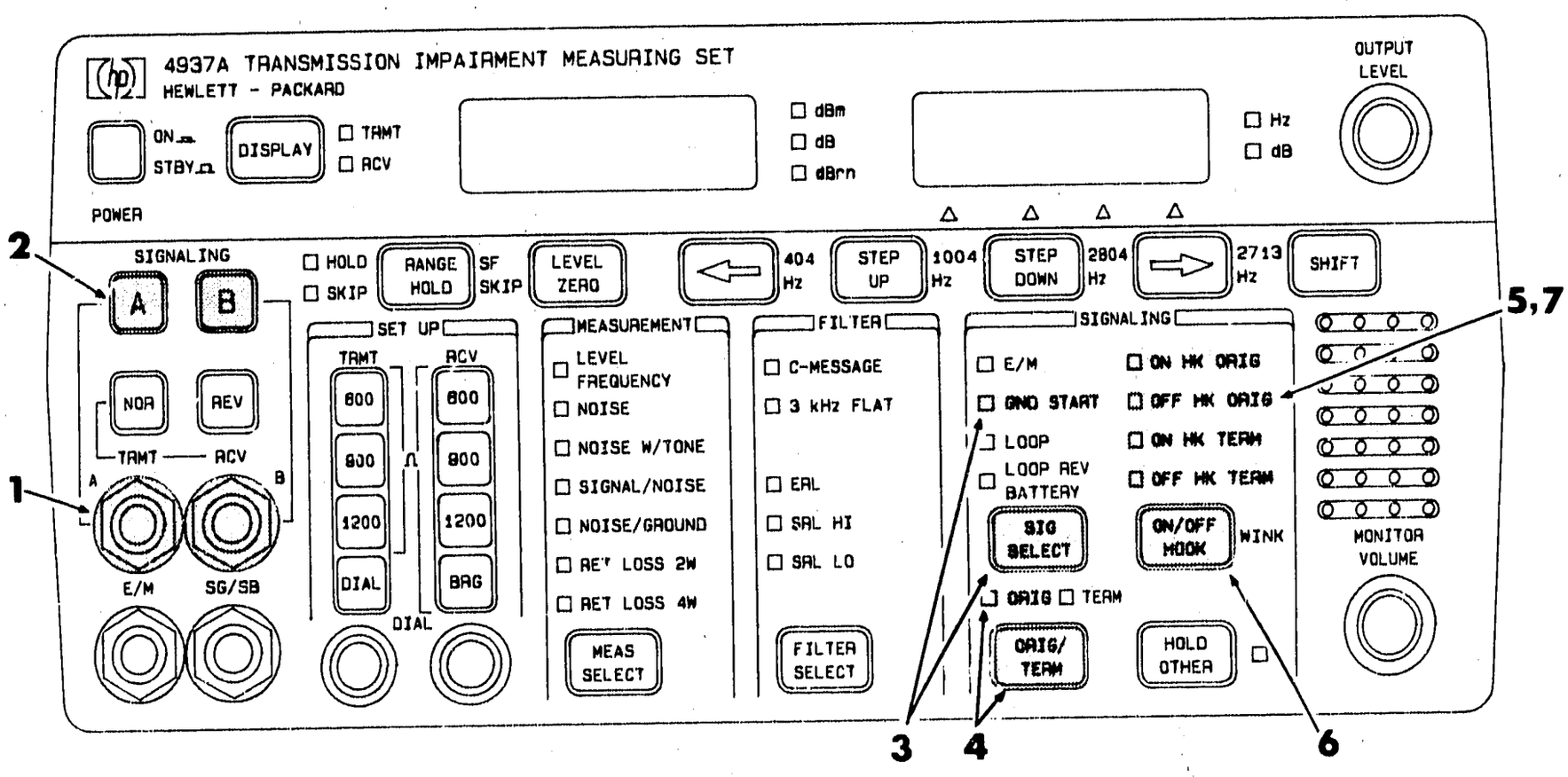


Figure 3-3. *Ground Start Signaling Circuit*

3-32. The terminate equipment senses this current flow and interprets it as a request for the trunk. The terminate equipment acknowledges the request by grounding the tip (goes off hook closing S-2) side of the line. This causes a current to flow through the tip side of the line from the originate end to the terminate end.

3-33. The HP 4937A will recognize the current through the tip side of the circuit and will: remove the ground from the ring (opening S-1), remove the 48 volts from the tip, and at the same time place a hold coil (current sink) between tip and ring (closing S-3) causing the current to flow from the terminate equipment to the HP 4937A and back to the terminate equipment. The loop is now closed (seized) and the terminate equipment responds with a dial tone.



Seizing The Line--Ground Start Originate End

To configure the HP 4937A as the Originate End proceed as follows:

1. Connect the line under test to either 310-jack A or B.
2. Select SIGNALING A if the line under test is connected to 310-jack A or SIGNALING B if the line is connected to 310-jack B.
3. Using SIG SELECT key select Ground Start signaling mode. The GND START LED should be lighted.
4. Using ORIG/TERM key select ORIG. The ORIG LED should be lighted.
5. Verify the following LEDs :
   - ON HK ORIG - lighted
   - OFF HK ORIG - off
   - ON HK TERM - lighted
   - OFF HK TERM - off
6. To seize the line under test press ON/OFF HOOK key.
7. The line under test is seized when the LEDs indicate the following:
   - ON HK ORIG - off
   - OFF HK ORIG - lighted
   - ON HK TERM - off
   - OFF HK TERM - lighted

8. You can now proceed to perform one of the following:

   - Establish talk conditions
   - Conduct transmission impairment measurements
   - Release the line

Establishing Talk Condition

1. Seize the line as described in the previous section, Ground Start Originate End.

2. Connect lineman's handset (butt-in) to DIAL jacks located on the front panel.

3. Press DIAL key. OFF HK ORIG LED should be lighted and a tone should be heard in the handset.

4. When the terminate end responds by going off-hook, the line is ready to accept dial pulses, tones, or voice.

5. To perform transmission impairment measurements, release DIAL key (an internal hold coil will continue to hold the line).

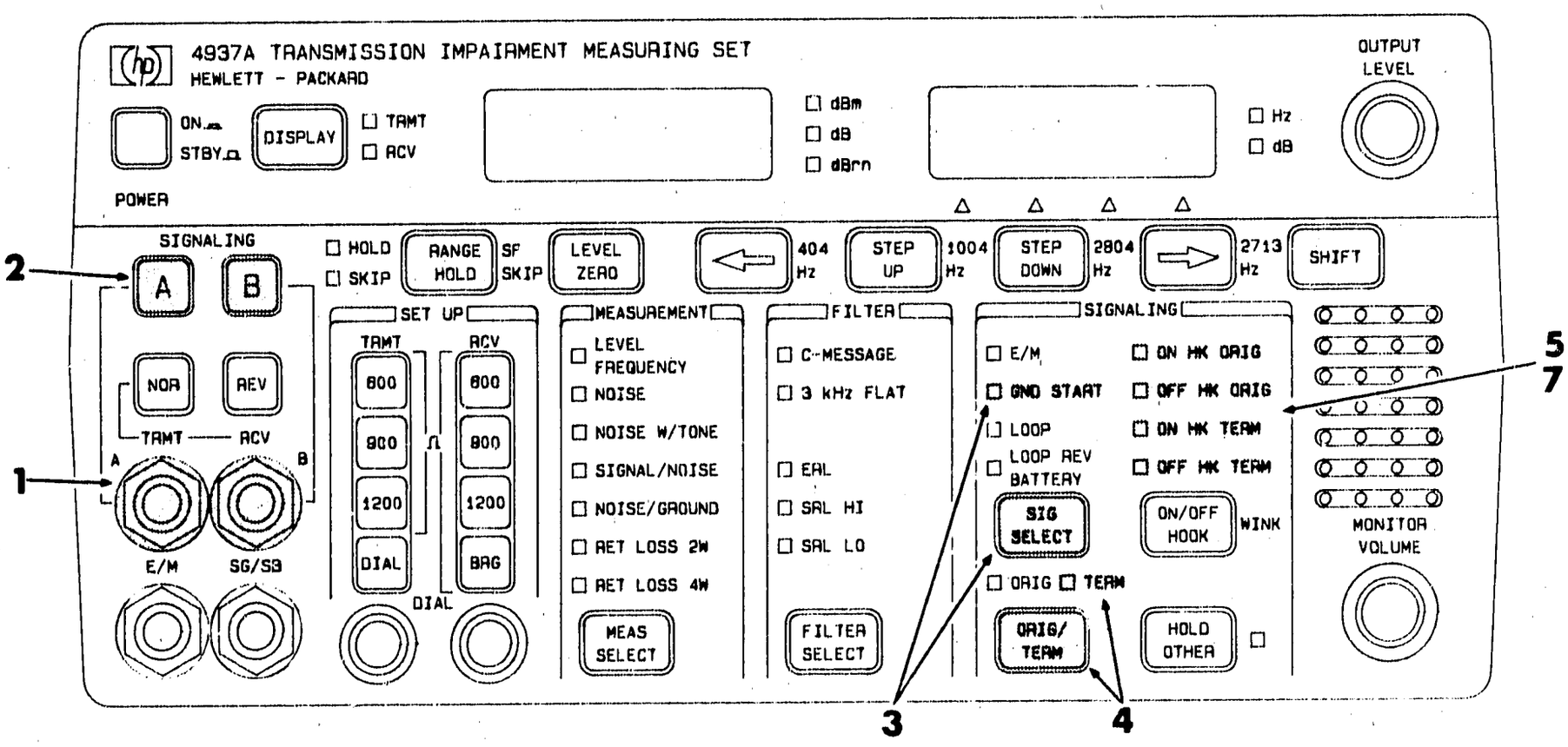
6. Perform desired measurement as described in the Measurements Section.

Releasing The Line

1. Press ON/OFF HOOK key and verify the following LEDS:

   - ON HK ORIG - lighted
   - OFF HK ORIG - off

2. Pressing the ON/OFF HOOK key again will re-seize the line.



Seizing The Line--Ground Start Terminate End

To configure the HP 4937A as the Terminate End proceed as follows:

1. Connect the line under test to either 310-jack A or B.
2. Select SIGNALING A if the line under test is connected to 310-jack A or SIGNALING B if the line is connected to 310-jack B.
3. Using SIG SELECT key select Ground Start signaling mode. The GND START LED should be lighted.
4. Using ORIG/TERM key select TERM. The TERM LED should be lighted.
5. Verify the following LEDs :
   - ON HK ORIG - lighted
   - OFF HK ORIG - off
   - ON HK TERM - lighted
   - OFF HK TERM - off
6. To seize the line under test press ON/OFF HOOK key.
7. The line under test is seized when the LEDs indicate the following:
   - ON HK ORIG - off
   - OFF HK ORIG - lighted
   - ON HK TERM - off
   - OFF HK TERM - lighted

8. You can now proceed to perform one of the following:

   - Establish talk conditions
   - Conduct transmission impairment measurements
   - Release the line

Establishing Talk Condition

1. Seize the line as described in the previous section, Ground Start Terminate End.

2. Connect lineman's handset (butt-in) to DIAL jacks located on the front panel.

3. Press DIAL key. The HP 4937A will provide talk battery and will ac couple lineman's handset to the line under test.

4. The line is now ready to accept tones or voice.

5. To perform transmission impairment measurements, release DIAL key.

6. Perform desired measurement as described in the Measurements Section.

Releasing The Line

1. Press ON/OFF HOOK key and verify the following LEDS:

   - ON HK TERM - lighted
   - OFF HK TERM - off

2. Pressing the ON/OFF HOOK key again will re-seize the line.

3-34. LOOP REVERSE BATTERY SIGNALING

3-35. Loop reverse battery is used to signal one way trunks. This is most often used in PBXs for direct inward dial (DID) lines. Direct inward dialing permits an outside call to be dialed directly to a PBX subscriber loop without operator assistance. The on-hook and off-hook states at the terminate end are indicated by reversing the battery polarity (see figure 3-4).

3-36. The term one-way trunk refers to only the signaling characteristics of the trunk and not to the direction of communications. The call can be initiated by only the originate end of the trunk. Once the signaling is complete, the trunk will carry normal two-way communications. The HP 4937A can be used as either the originate end (outside call) or the terminate end (PBX).

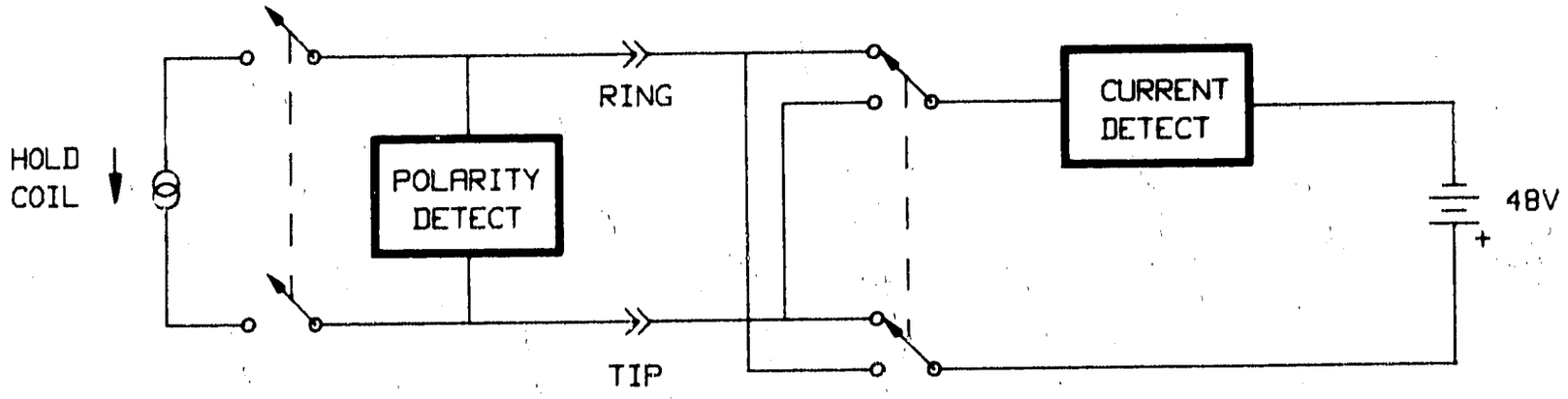
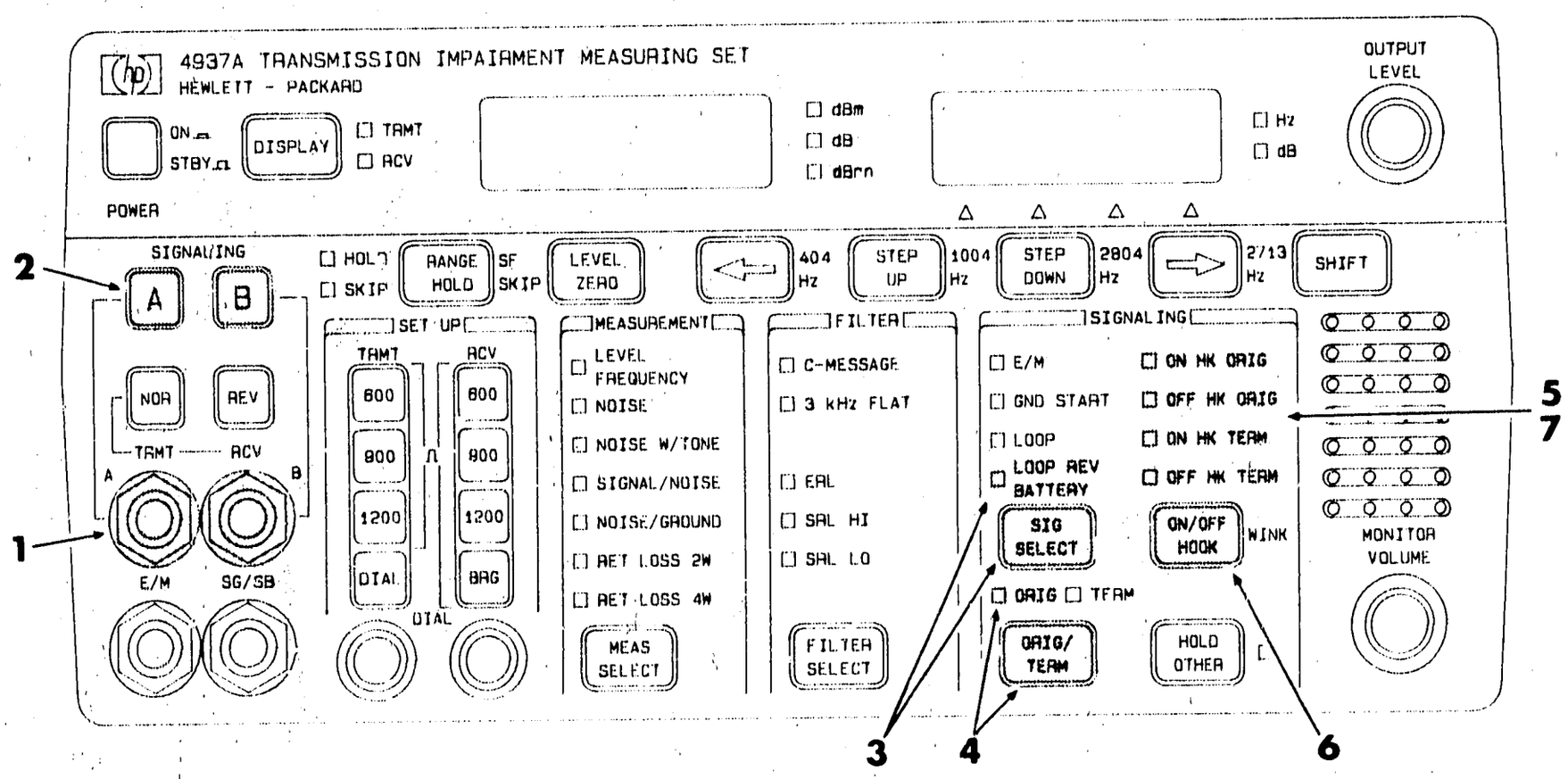


Figure 3-4. *Loop Reverse Battery Signaling*

MODEL 4937A
LOOP REVERSE BATT



Seizing The Line--Loop Reverse Battery Originate End

To configure the HP 4937A as the Originate End proceed as follows:

1. Connect the line under test to either 310-jack A or B.
2. Select SIGNALING A if the line under test is connected to 310-jack A or SIGNALING B if the line is connected to 310-jack B.
3. Using SIG SELECT key select Loop Reverse Battery signaling mode. The LOOP REV BATTERY LED should be lighted.
4. Using ORIG/TERM key select ORIG. The ORIG LED should be lighted.
5. Verify the following LEDs:
   - ON HK ORIG - lighted
   - OFF HK ORIG - off
   - ON HK TERM - lighted
   - OFF HK TERM - off
6. To seize the line under test press ON/OFF HOOK key.
7. The line under test is seized when the LEDs indicate the following:
   - ON HK ORIG - off
   - OFF HK ORIG - lighted
   - ON HK TERM - off
   - OFF HK TERM - lighted

8. You can now proceed to perform one of the following:

   - Establish talk conditions
   - Conduct transmission impairment measurements
   - Release the line

Establishing Talk Condition

1. Seize the line as described in the previous section, Loop Reverse Battery Originate End.

2. Connect lineman's handset (butt-in) to DIAL jacks located on the front panel.

Note

A tone will be heard immediately, but the handset is not actually connected to the line until after the DIAL key is pressed.

3. Press DIAL key. OFF HK ORIG LED should be lighted and a tone should be heard on the handset.

4. The line is now ready to accept dial pulses, tones, or voice.

5. To perform transmission impairment measurements, release DIAL key (an internal hold coil will continue to hold the line).

6. Perform desired measurement as described in the Measurements Section.

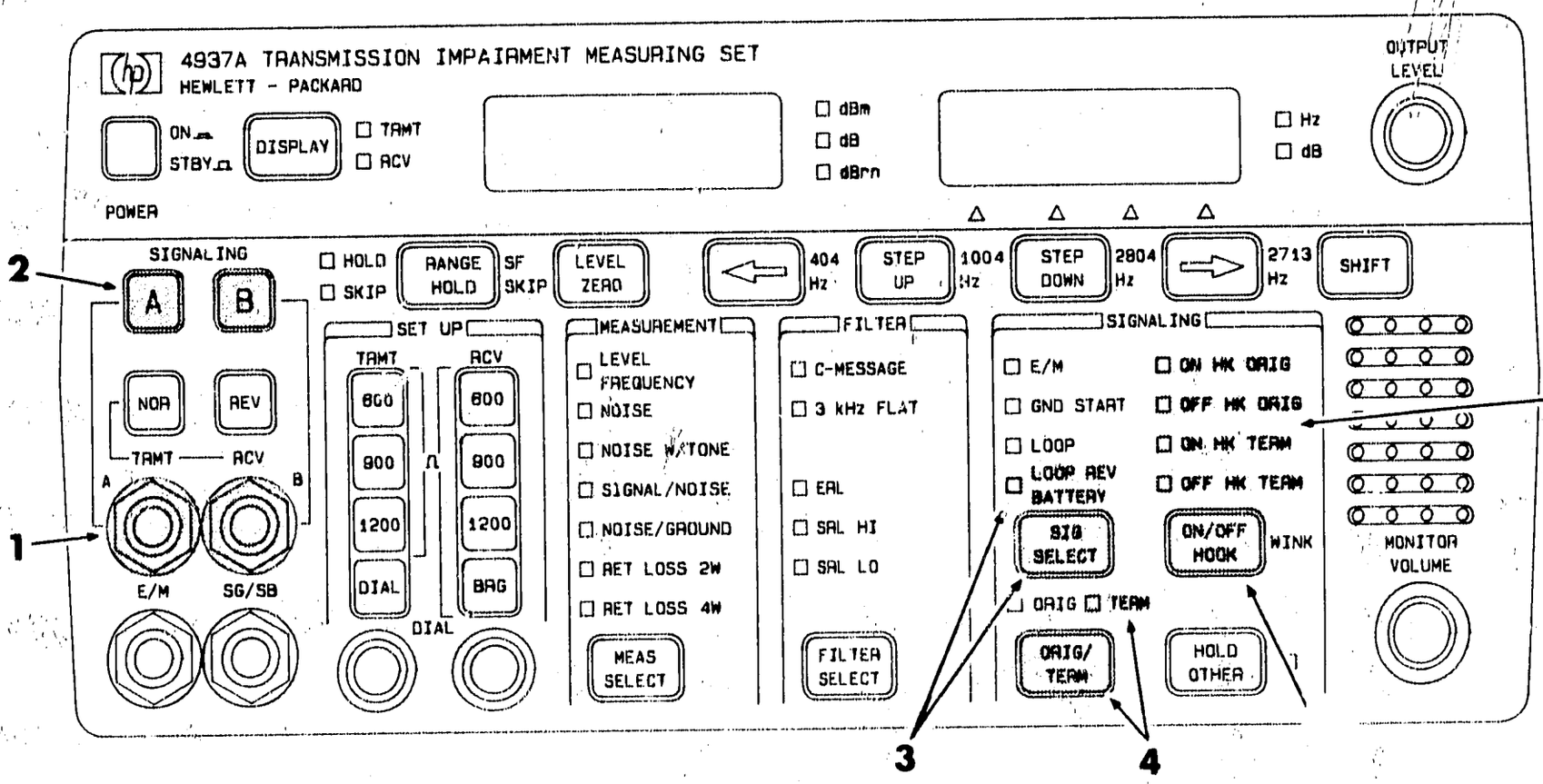
Releasing The Line

1. Press ON/OFF HOOK key and verify the following LEDS:

   - ON HK ORIG - lighted
   - OFF HK ORIG - off

2. Pressing the ON/OFF HOOK key again will re-seize the line.

MODEL 4937A
LOOP REVERSE BATT



Seizing The Line--Loop Reverse Battery Terminate End

To configure the HP 4937A as the Terminate End proceed as follows:

1. Connect the line under test to either 310-jack A or B.

2. Select SIGNALING A if the line under test is connected to 310-jack A or SIGNALING B if the line is connected to 310-jack B.

3. Using SIG SELECT key select Loop Reverse Battery signaling mode. The LOOP REV BATTERY LED should be lighted.

4. Using ORIG/TERM key select TERM. The TERM LED should be lighted.

5. Verify the following LEDs :

   - ON HK ORIG - lighted
   - OFF HK ORIG - off
   - ON HK TERM - lighted
   - OFF HK TERM - off

6. To seize the line under test press ON/OFF HOOK key. (Technically, the terminate end of Loop Reverse Battery cannot seize the line, it can only respond to a request for seizure from the originate end.)

7. The line under test is seized when the LEDs indicate the following:

   - ON HK ORIG - off
   - OFF HK ORIG - lighted
   - ON HK TERM - off
   - OFF HK TERM - lighted

8. You can now proceed to perform one of the following:

   - Establish talk conditions
   - Conduct transmission impairment measurements
   - Release the line

Establishing Talk Condition

1. Seize the line as described in the previous section, Loop Reverse Battery Terminate End.

2. Connect lineman's handset (butt-in) to DIAL jacks located on the front panel.

3. Press DIAL key. The HP 4937A will provide talk battery and will ac couple lineman's handset to the line under test.

4. The line is now ready to accept tones or voice.

5. To perform transmission impairment measurements, release DIAL key.

6. Perform desired measurement as described in the Measurements Section.

Releasing The Line

1. Press ON/OFF HOOK key and verify the following LEDS:

   - ON HK TERM - lighted
   - OFF HK TERM - off

2. Pressing the ON/OFF HOOK key again will re-seize the line.

3-37. E/M SIGNALING

3-38. E/M signaling is used primarily to signal the internal switching of the PBX or shorthaul trunks between two PBXs. E/M signaling uses a separate wire pair to send signaling information (E lead and M lead) from the pair used to send voiceband information (tip and ring). In addition, E/M Types II and III use sense ground (SG) and sense battery (SB) leads to improve signaling performance. (see figures 3-5, 3-6, and 3-7)

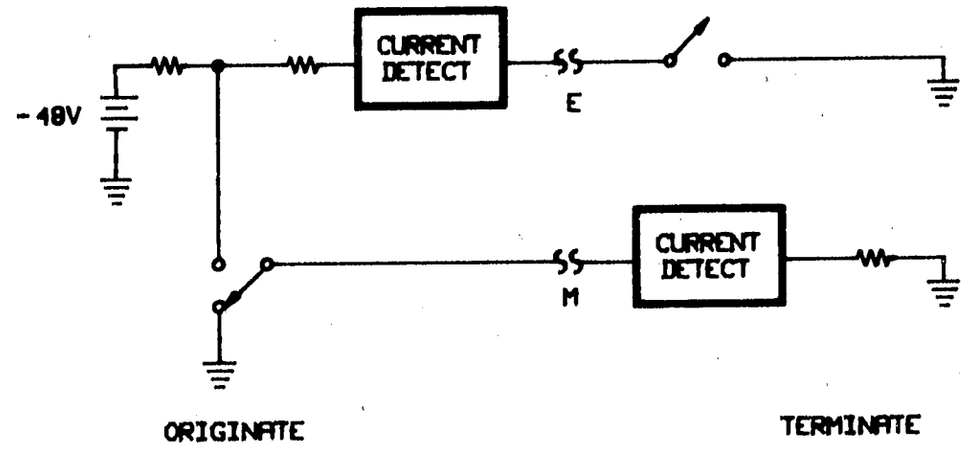


Figure 3-5. *E/M Type I Signaling*

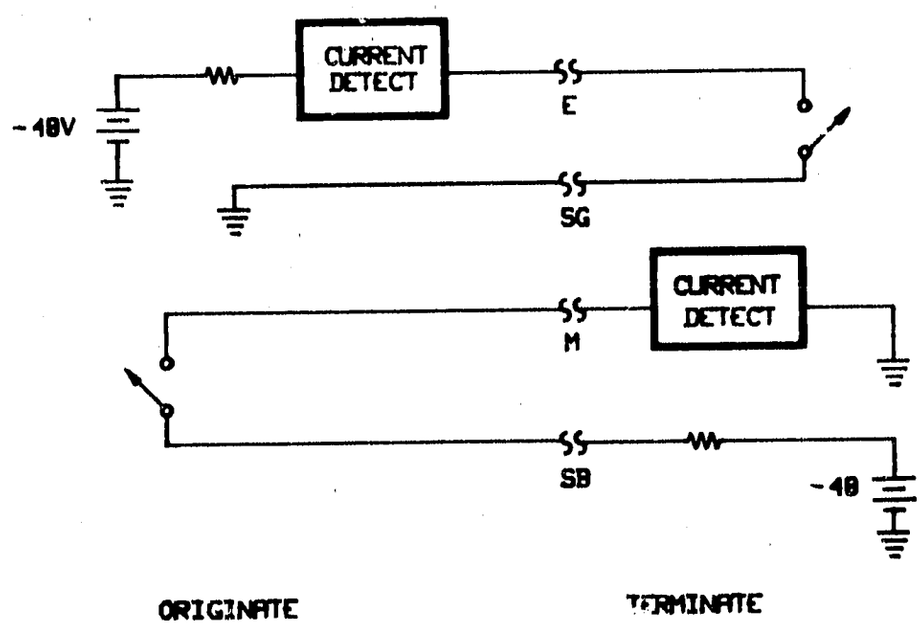


Figure 3-6. *E/M Type II Signaling*

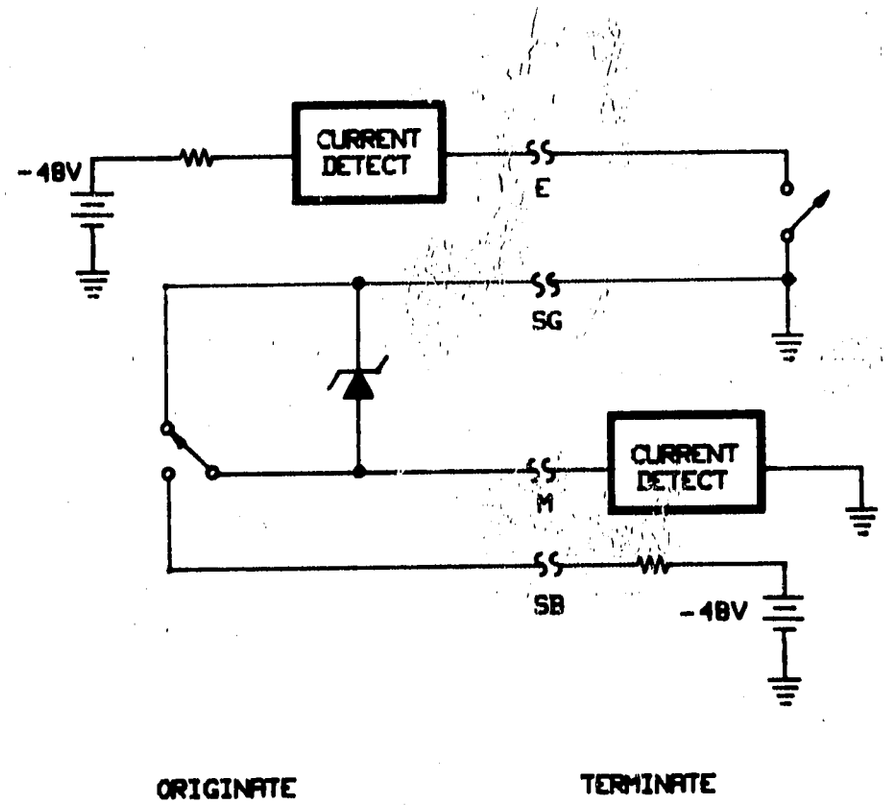
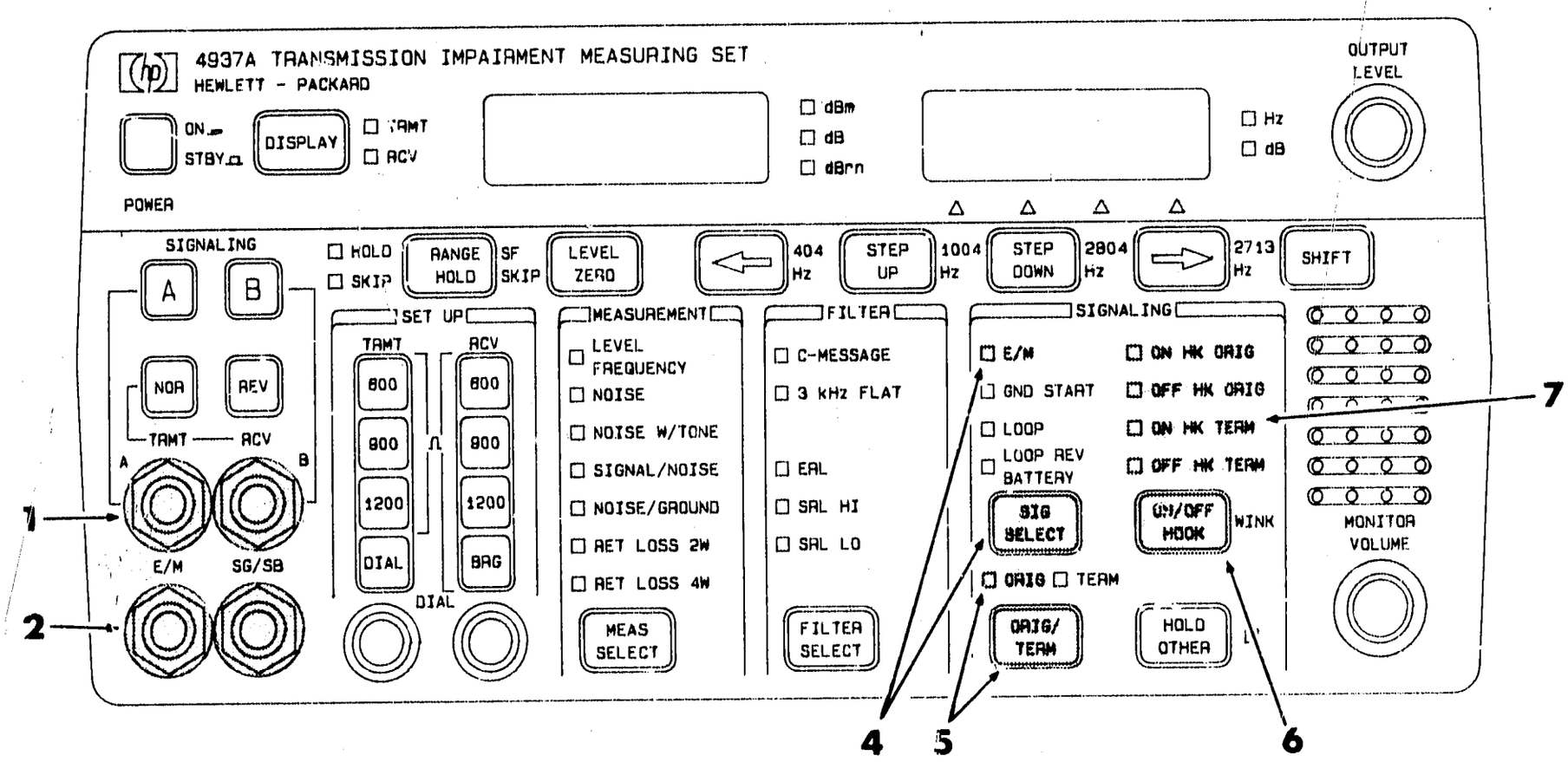


Figure 3-7. *E/M Type III Signaling*



Seizing The Line--E/M Signaling Types I, II, and III Originate End

To configure the HP 4937A as the Originate End, proceed as follows:

1. Connect the line (or lines if 4-wire) under test to 310-jack A or B.

2. Connect E/M leads (for E/M Types II and III connect SG/SB leads also).

3. Set E/M toggle switch (located on rear panel) to desired signal type. E/M type must be selected before E/M is selected on front panel.

4. Using SIG SELECT key select E/M signaling mode. The HP 4937A will beep one, two, or three times to indicate the type E/M selected. The E/M LED should be lighted.

5. Using ORIG/TERM key select ORIG. The ORIG LED should be lighted.

6. To seize the line under test press ON/OFF HOOK key.

7. The line is seized when the LEDs indicate the following:

   - ON HK ORIG - off
   - OFF HK ORIG - lighted
   - ON HK TERM - off
   - OFF HK TERM - lighted

8. You can now proceed to perform one of the following:

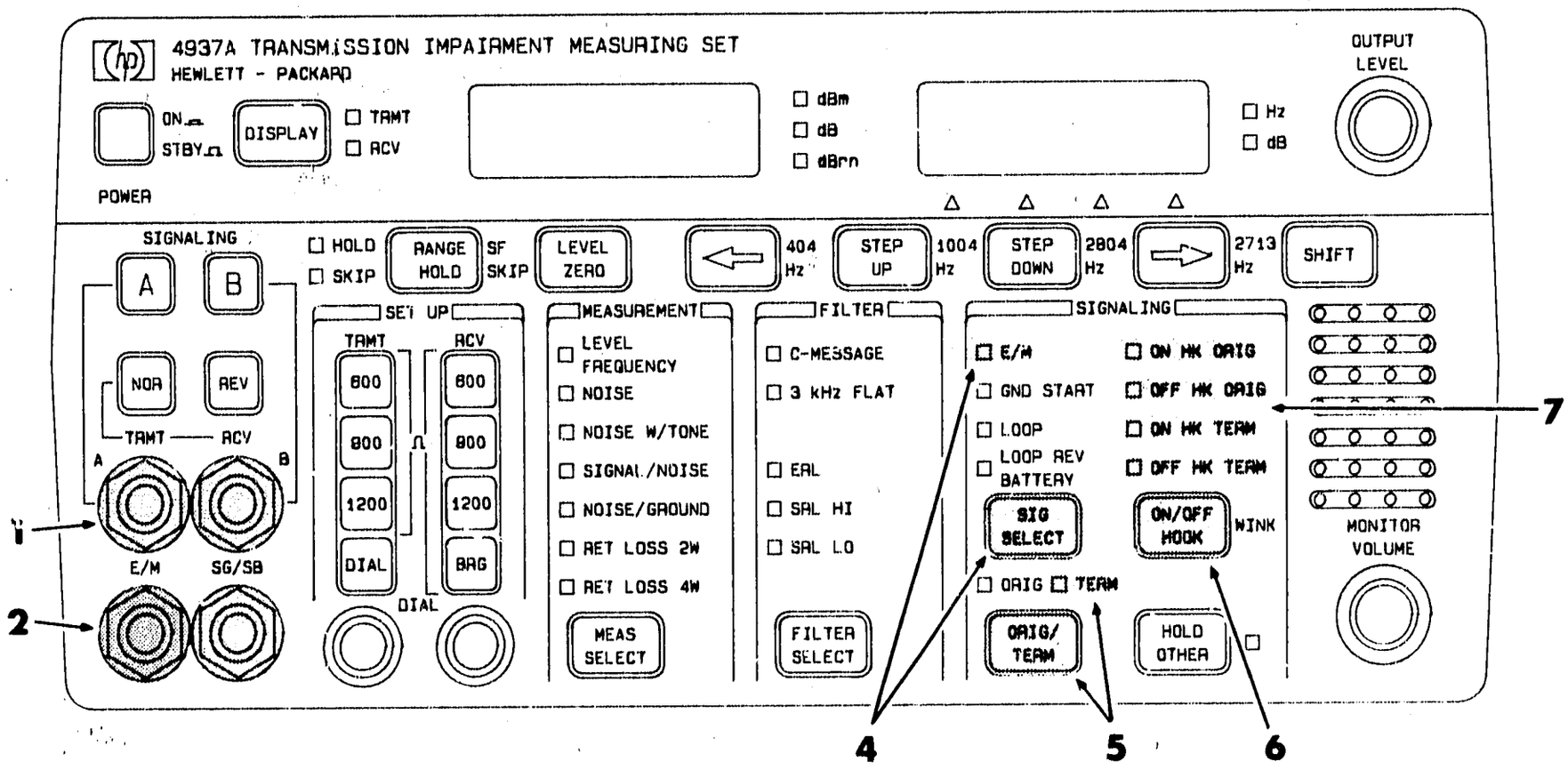
   - Establish talk conditions
   - Conduct transmission impairment measurements
   - Release the line

Establishing Talk Condition

1. Seize the line as described in the previous section, E/M Signaling Types I, II, and III Originate End.
2. Connect lineman's handset (butt-in) to DIAL jacks located on the front panel.
3. Select SIGNALING A if the line under test is connected to 310 jack A or to SIGNALING B if connected to 310 jack B.
4. Press DIAL key. The HP 4937A will provide talk battery to the linemen's handset. Tones and voice will be coupled to the line under test. Dial pulses will be connected to the M lead.
5. The line is now ready to accept dial pulses, tones, or voice.
6. To perform transmission impairment measurements, release DIAL key.
7. Perform desired measurement as described in the Measurements Section.

Releasing The Line

1. Press ON/OFF HOOK key and verify the following LEDS:
   - ON HK TERM - lighted
   - OFF HK TERM - off
2. Pressing the ON/OFF HOOK key again will re-seize the line.



Seizing The Line--E/M Signaling Types I, II, and III Terminate End

To configure the HP 4937A as the Terminate End, proceed as follows:

1. Connect the line (or lines if 4-wire) under test to 310-jack A or B.

2. Connect E/M leads (for E/M Types II and III connect SG/SB leads also).

3. Set E/M toggle switch (located on rear panel) to desired signal type. E/M type must be selected before E/M is selected on front panel.

4. Using SIG SELECT key select E/M signaling mode. The HP 4937A will beep one, two, or three times to indicate the type E/M selected. The E/M LED should be lighted.

5. Using ORIG/TERM key select TERM. The TERM LED should be lighted.

6. To seize the line under test press ON/OFF HOOK key.

7. The line is seized when the LEDs indicate the following:

   - ON HK ORIG - lighted
   - OFF HK ORIG - off
   - ON HK TERM - lighted
   - OFF HK TERM - off

8. You can now proceed to perform one of the following:

   - Establish talk conditions
   - Conduct transmission impairment measurements
   - Release the line

Establishing Talk Condition

1. Seize the line as described in the previous section, E/M Signaling Types I, II, and III Treminate End.
2. Connect lineman's handset (butt-in) to DIAL jacks located on the front panel.
3. Select SIGNALING A if the line under test is connected to 310 jack A or to SIGNALING B if connected to 310 jack B.
4. Press DIAL key. The HP 4937A will provide talk battery to the linemen's handset. Tones and voice will be coupled to the line under test. Dial pulses will be connected to the E lead.
5. The line is now ready to accept dial pulses, tones, or voice.
6. To perform transmission impairment measurements, release DIAL key.
7. Perform desired measurement as described in the Measurements Section.

Releasing The Line

1. Press ON/OFF HOOK key and verify the following LEDS:
   - ON HK TERM - lighted
   - OFF HK TERM - off
2. Pressing the ON/OFF HOOK key again will re-seize the line.

3-39. WINK

3-40. Wink is a signaling technique used to pass address information down a trunk line. It is a momentary on-hook to off-hook to on-hook transition that signals the far end to begin sending address digits (see figure 3-8).

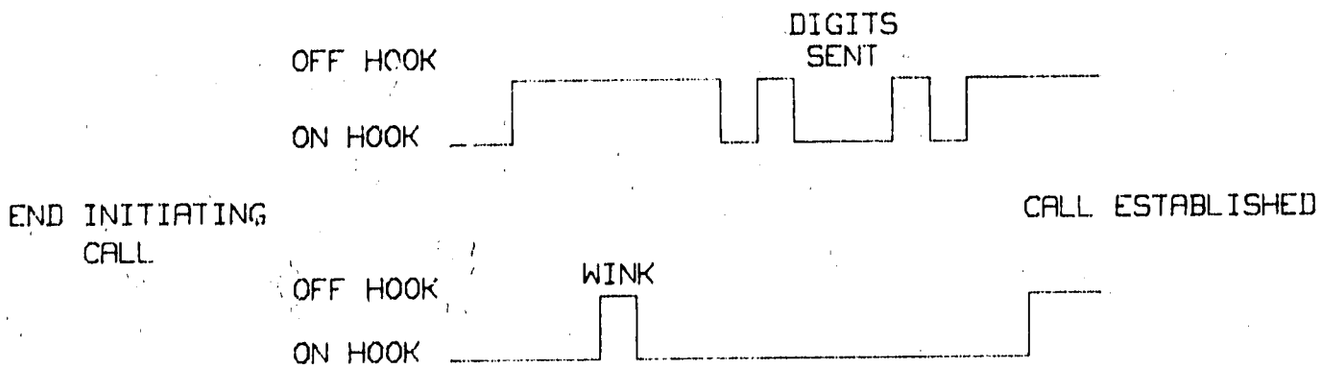


Figure 3-8. *Wink Signaling Technique*

3-41. The initiating end begins the process by going off-hook. The receiving end when ready, answers with a wink. The initiating end then sends the digits to the receiving end. Once the receiving end has received all the digits and completes the connection, it ends the sequence by going off-hook.

3-42. The HP 4937A is capable of providing Wink for E/M, Ground Start, and Loop Reverse Battery terminate. The Wink times are specified in figure 3-9. The address digits sent to the HP 4937A are not stored and cannot be displayed.

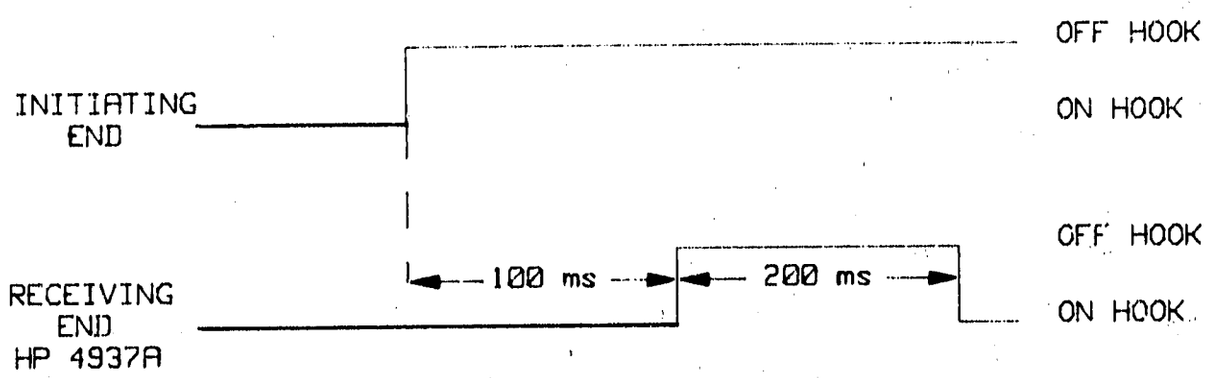
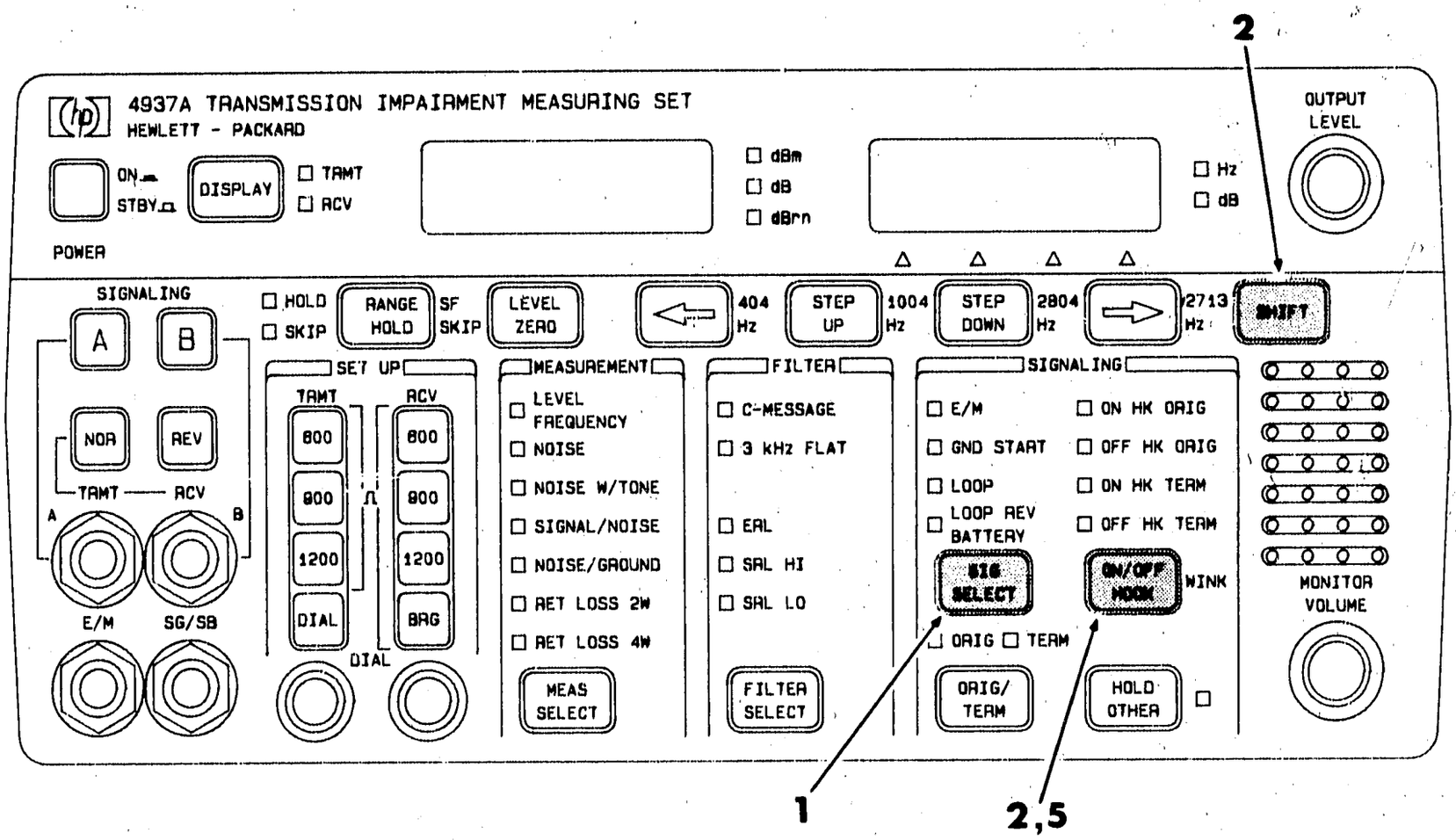


Figure 3-9. *Wink Times*



Using Wink Signaling

1. Configure the HP 4937A to the signaling mode desired.

2. Press the SHIFT key followed by the ON/OFF HOOK key.

Note

Err 30 will be displayed if wink is used with an illegal signaling mode or if both ends of the line are not in the off-hook state.

3. The appropriate status LED will blink rapidly. This indicates the wink is armed and in a ready state. Wink can be disarmed by pressing any key.

4. When the far end goes off-hook, the HP 4937A will respond with rapid off-hook and on-hook transitions.

5. After the digits have been received, place the HP 4937A in the off-hook state by pressing the ON/OFF HOOK key.

6. The line is now seized and you can proceed to perform one of the following:

   - Establish talk condition
   - Conduct transmission impairment measurements
   - Release the line

Establishing Talk Condition

1. Seize the line as described in the previous section, Using Wink Signaling.

2. Connect lineman's handset (butt-in) to DIAL jacks located on the front panel.

3. Press DIAL key. OFF HK ORIG LED should be lighted and a tone should be heard on the handset.

4. The line is now ready to accept dial pulses, tones, or voice.

5. To perform transmission impairment measurements, release DIAL key (an internal hold coil will continue to hold the line).

6. Perform desired measurement as described in the Measurements Section.

Releasing The Line

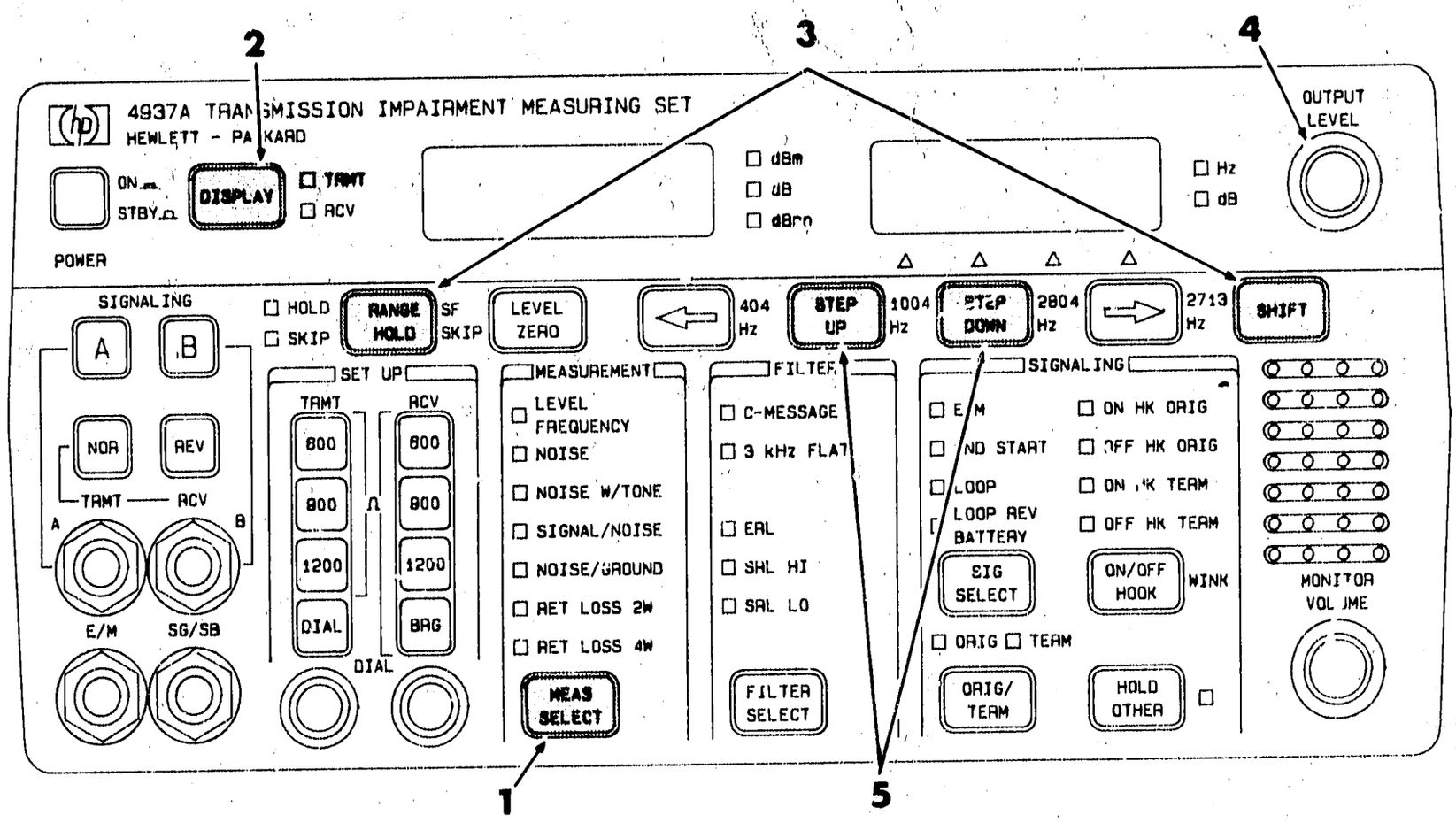
1. Press ON/OFF HOOK key and verify the following LEDS:

   - ON HK ORIG - lighted
   - OFF HK ORIG - off

2. Pressing the ON/OFF HOOK key again will re-seize the line.

3-43. MEASUREMENTS

3-44. Level and Frequency



TRANSMITTER

1. Using the MEAS SELECT key select LEVEL FREQUENCY.

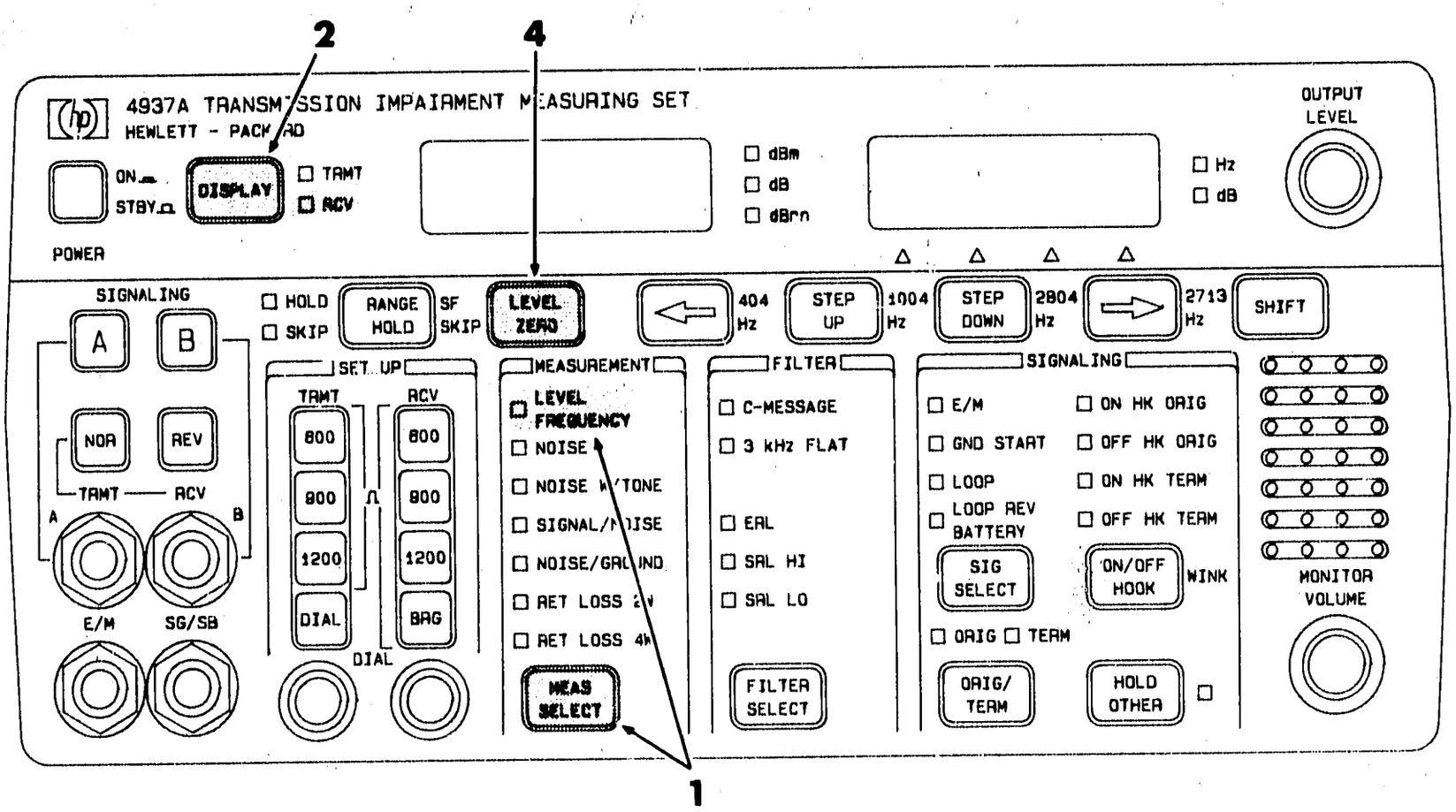
2. Press DISPLAY-TRMT key to display the transmitted signal. TRMT indicator will light. Level can be read in the left display and frequency can be read in the right display.

3. If SF signaling units are used on the circuit under test, press SHIFT key, then RANGE HOLD key to select SF SKIP which blanks the frequency from 2450 Hz to 2750 Hz.

4. Turn OUTPUT LEVEL knob to adjust the level of the transmitted signal to data level, which is usually 13 dB below the transmitted level point (TLP). An Err 01 displayed indicates the level is >+16 dBm. An Err 02 displayed indicates the level is <-70 dBm.

5. Use the STEP UP and STEP DOWN keys to select the desired output frequency. To select one of the preset frequencies (404 Hz, 1004 Hz, 2804 Hz, or 2713 Hz) press the SHIFT key and then press the desired frequency key.

3-44. Level and Frequency (con't)



RECEIVER

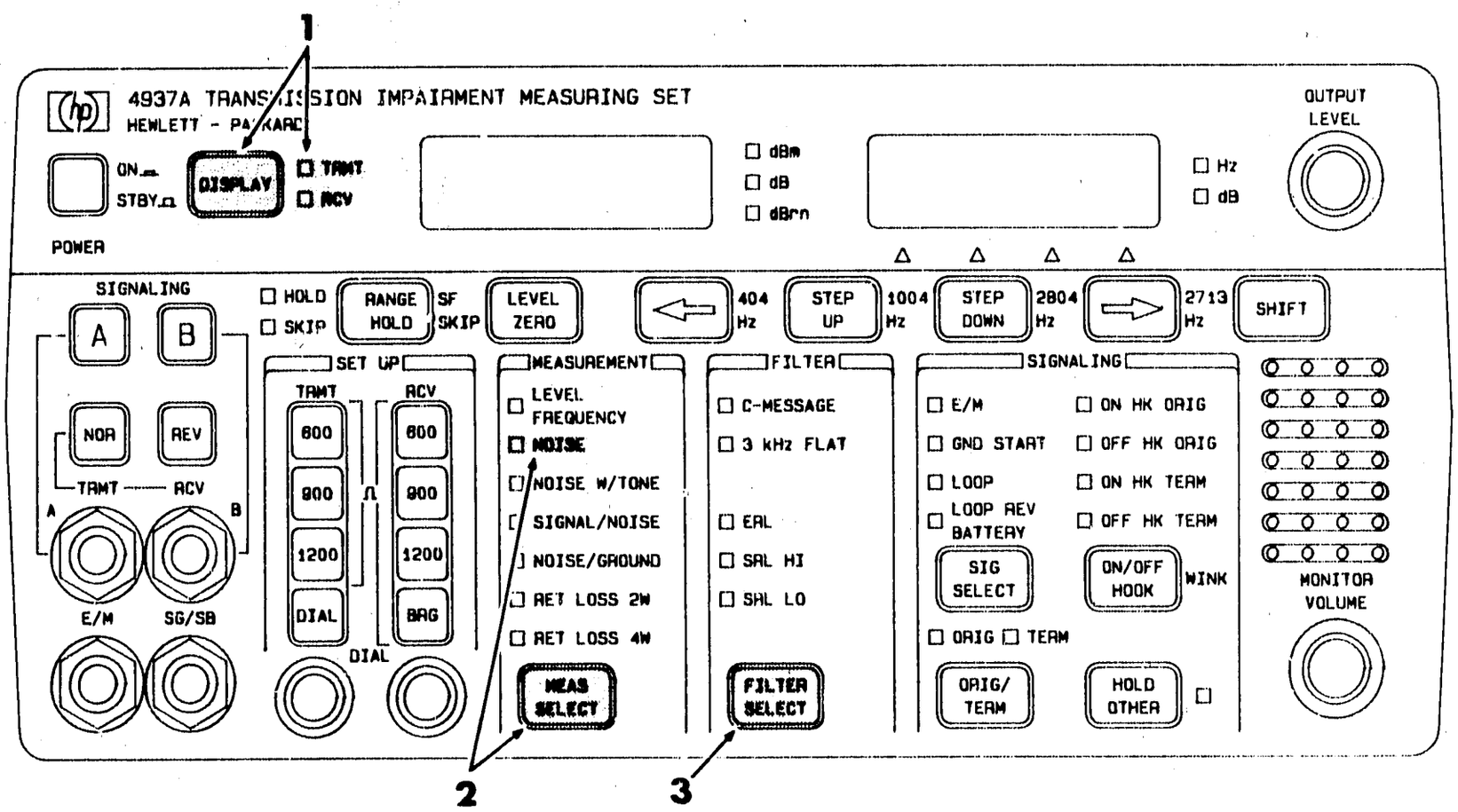
1. Using the MEAS SELECT key select LEVEL FREQUENCY.

2. Press DISPLAY-RCV key to display the received signal. RCV indicator will light. Level can be read in the left display.

3. An Err 01 displayed indicates the signal is >+16 dBm. An Err 02 displayed indicates the signal is <-70 dBm.

4. For attenuation distortion measurments press LEVEL ZERO key to set the received level at 0 dB. All subsequent level measurements will be made relative to this point. Pressing the LEVEL ZERO key a second time reverts the level to absolute units (dBm) instead of relative units (dB). A negative reading indicates levels higher than the reference level per the telephone industry convention.

3-45. NOISE



TRANSMITTER

1. Press DISPLAY-TRMT key to display the transmitted signal. TRMT indicator will light.
2. Press MEAS SELECT key to select NOISE.

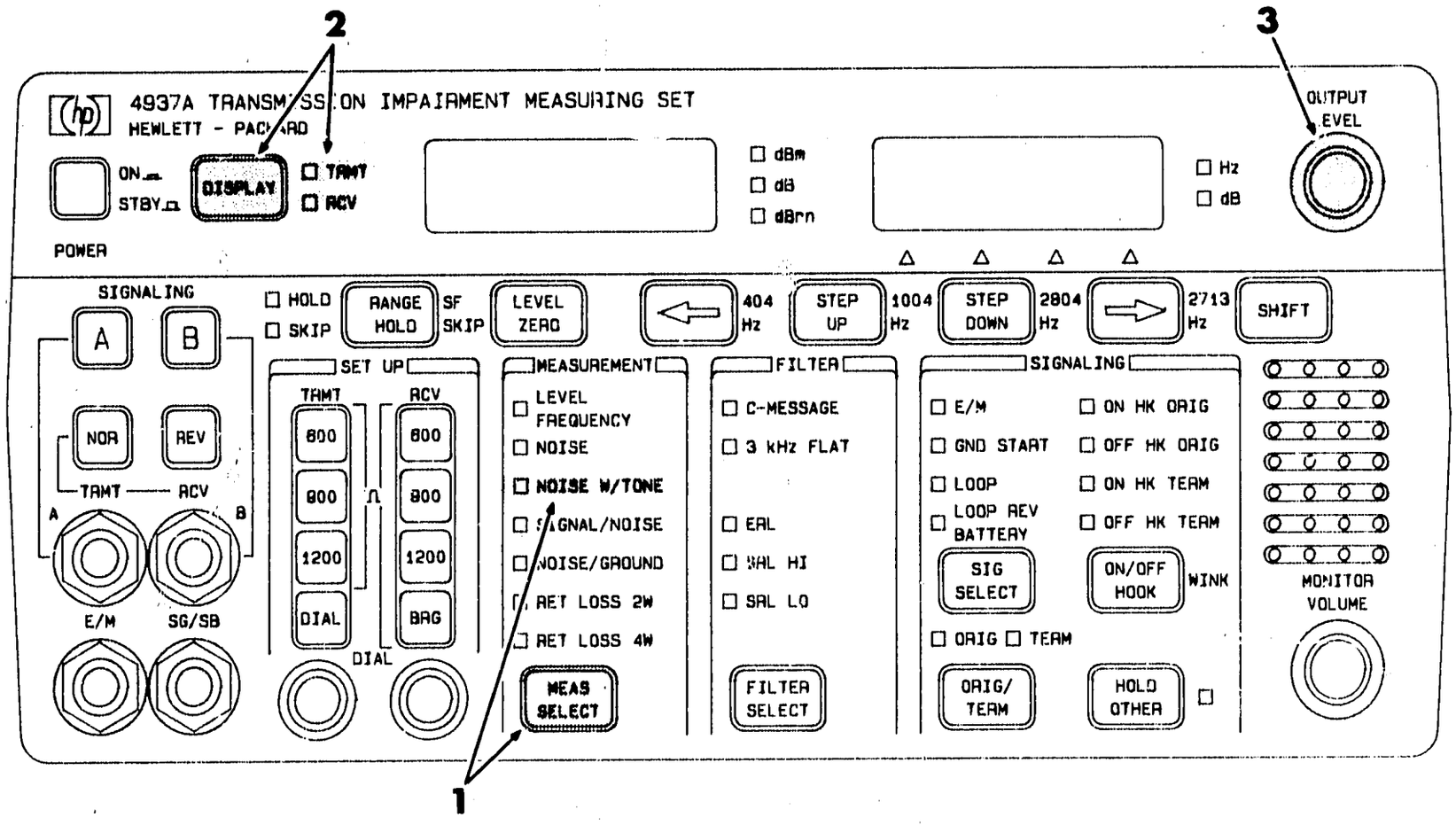
Note

There will be no values displayed because in this configuration the transmitter is turned off and a quiet termination is supplied to the TRMT jack.

RECEIVER

1. Press DISPLAY-RCV key to display the received signal. RCV indicator will light.
2. Press MEAS SELECT key to select NOISE.
3. Press FILTER key and select the desired filter.
4. Read the dBrn noise level in the left display. An Err 02 in the left display indicates underrange (<0 dBrn).

3-46. NOISE WITH TONE



TRANSMITTER

1. Press MEAS SELECT key to select NOISE W/TONE.

2. Press DISPLAY TRMT-RCV key to display the transmitted signal. TRMT indicator will be on and 1004 Hz will be in the right display.

3. Adjust OUTPUT LEVEL control to change 1004 Hz signal to data level in left display (usually 13 dB below the transmitted level point).

RECEIVER

1. Press MEAS SELECT key to select NOISE W/TONE.

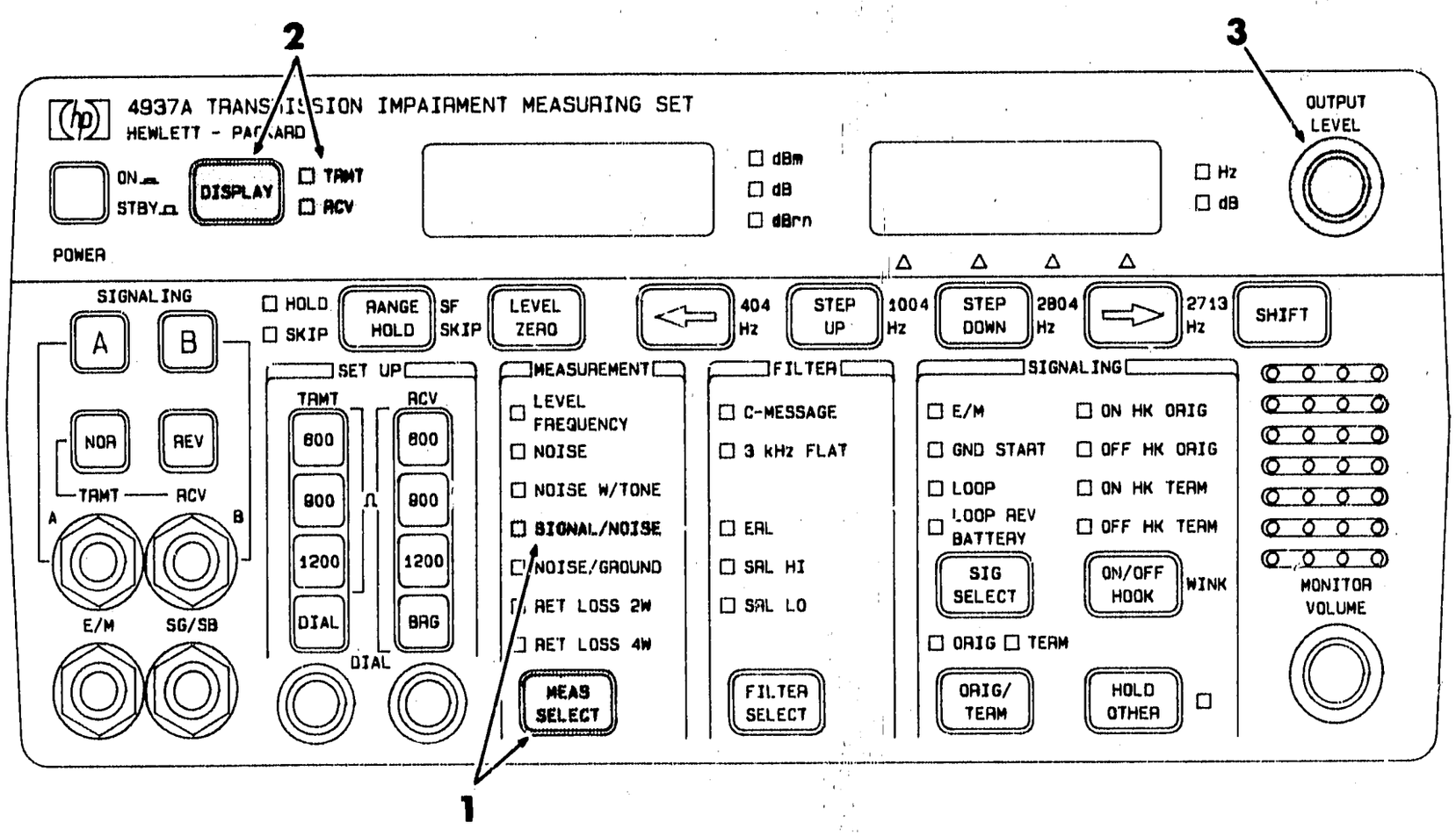
2. Press DISPLAY TRMT-RCV key to display the received signal. RCV indicator will be on.

3. Read dBrn in left display.

Note

Err 07 in right display indicates the received 1004 Hz tone has dropped below -46 dBm or exceeded +16 dBm.

3-47. SIGNAL TO NOISE



TRANSMITTER

1. Press MEAS SELECT key to select SIGNAL/NOISE.
2. Press DISPLAY-TRMT to display the transmitted signal. TRMT indicator will be on.
3. Adjust OUTPUT LEVEL control to change the 1004 Hz signal to data level (usually 13 dB below the transmitted level point).

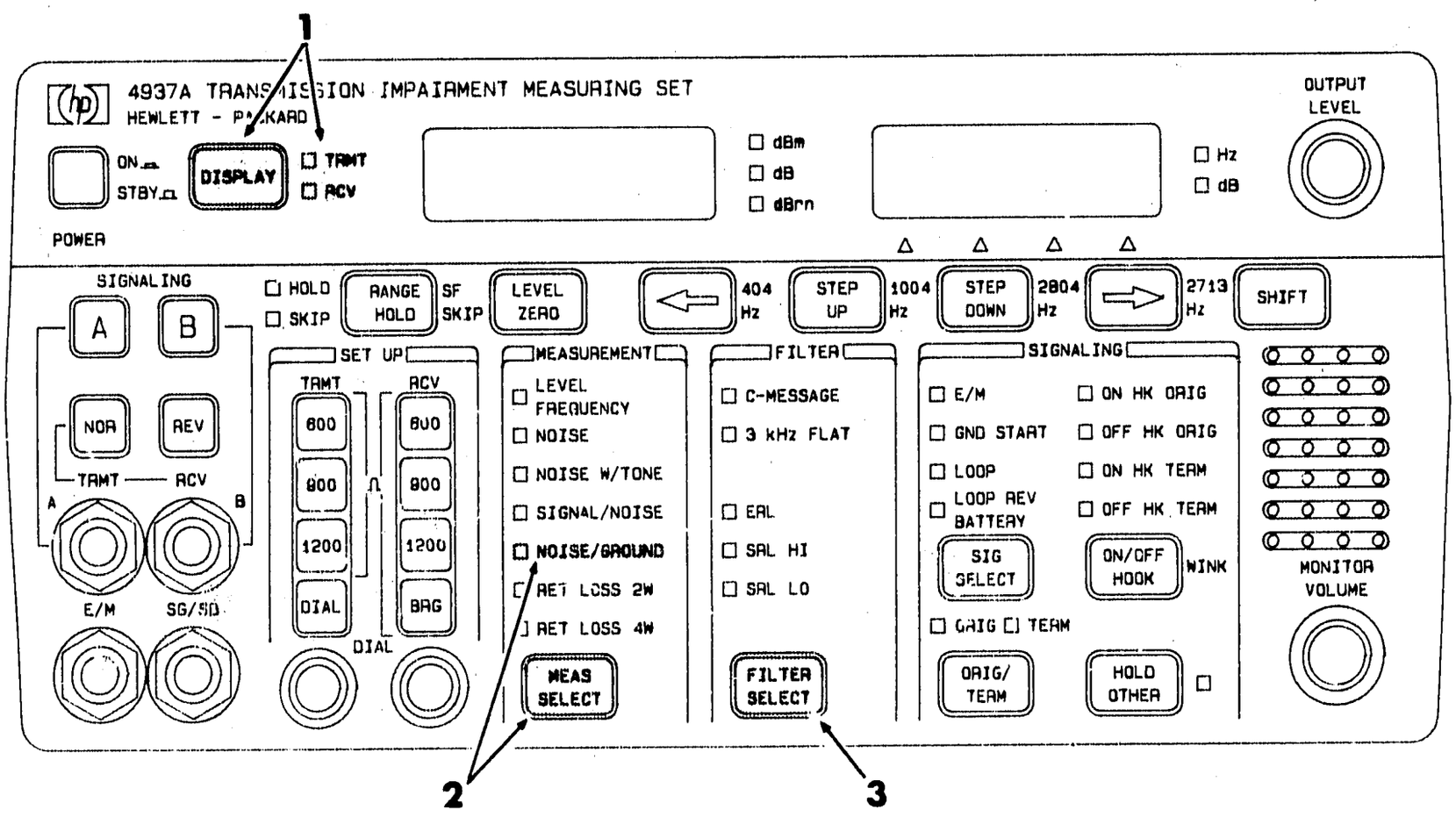
RECEIVER

1. Press MEAS SELECT key to select SIGNAL/NOISE.
2. Press DISPLAY-RCV to display the received signal. RCV indicator will be on.
3. Read the signal to noise ratio as dB in the right display. The received level is displayed in the left display.

Note

Err 07 indicates the received 1004 Hz tone has dropped below -46 dBm or exceeded +16 dBm.

3-48. NOISE TO GROUND



TRANSMITTER

1. Press DISPLAY–TRMT key to display the transmitted signal. TRMT indicator will be on.

2. Press MEAS SELECT key to select NOISE/GROUND. This provides a quiet termination to the TRMT jack.

Note

There will be no values displayed because in this configuration the transmitter is turned off and a quiet termination is supplied to the TRMT jack.

RECEIVER

Note

For valid noise to ground measurements the test set must be properly grounded. Connect the rear panel chassis ground post to a known ground.

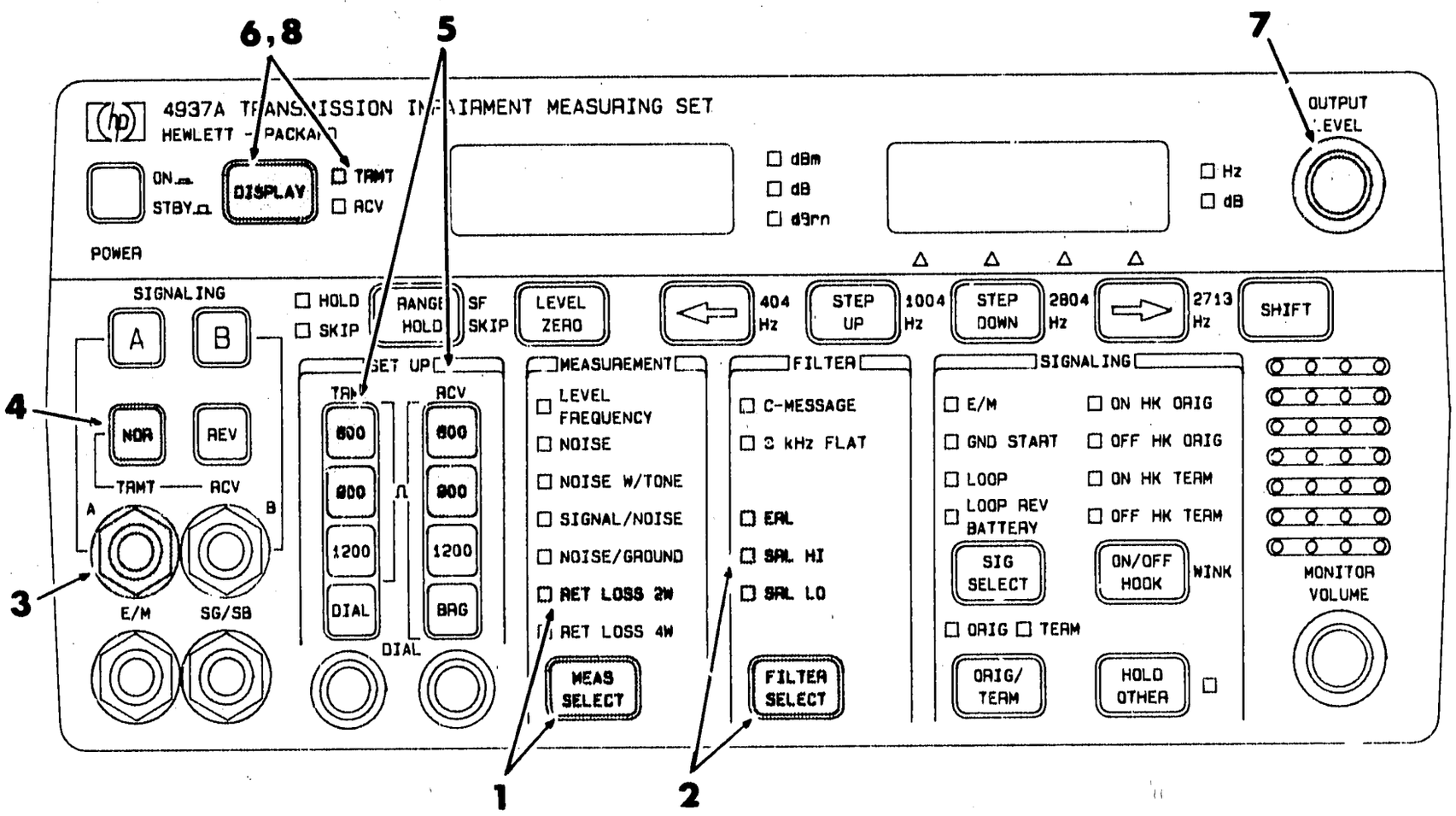
1. Press DISPLAY–RCV key to display the received signal. RCV indicator will be on.

2. Press MEAS SELECT key to select NOISE/GROUND.

3. Use FILTER SELECT key to select the desired filter.

4. Read dBrn noise level in the left display.

3-49. RETURN LOSS 2-WIRE



1. Press MEAS SELECT key to select RET LOSS 2W.

2. Press FILTER SELECT key to select one of the following:

   - ERL (echo return loss--middle band).
   - SRL HI (singing return loss--upper band).
   - SRL LO (singing return loss--lower band).

3. Connect the line under test to the A 310-jack.

4. Press NOR key.

5. Select TRMT and RCV impedance of either 600 or 900 ohms (600 ohms for Option 002). Return loss cannot be measured at 1200 ohms.

6. Press DISPLAY to select TRMT mode.

Note

The HP 4937A must be in the transmit mode before adjusting the output level.

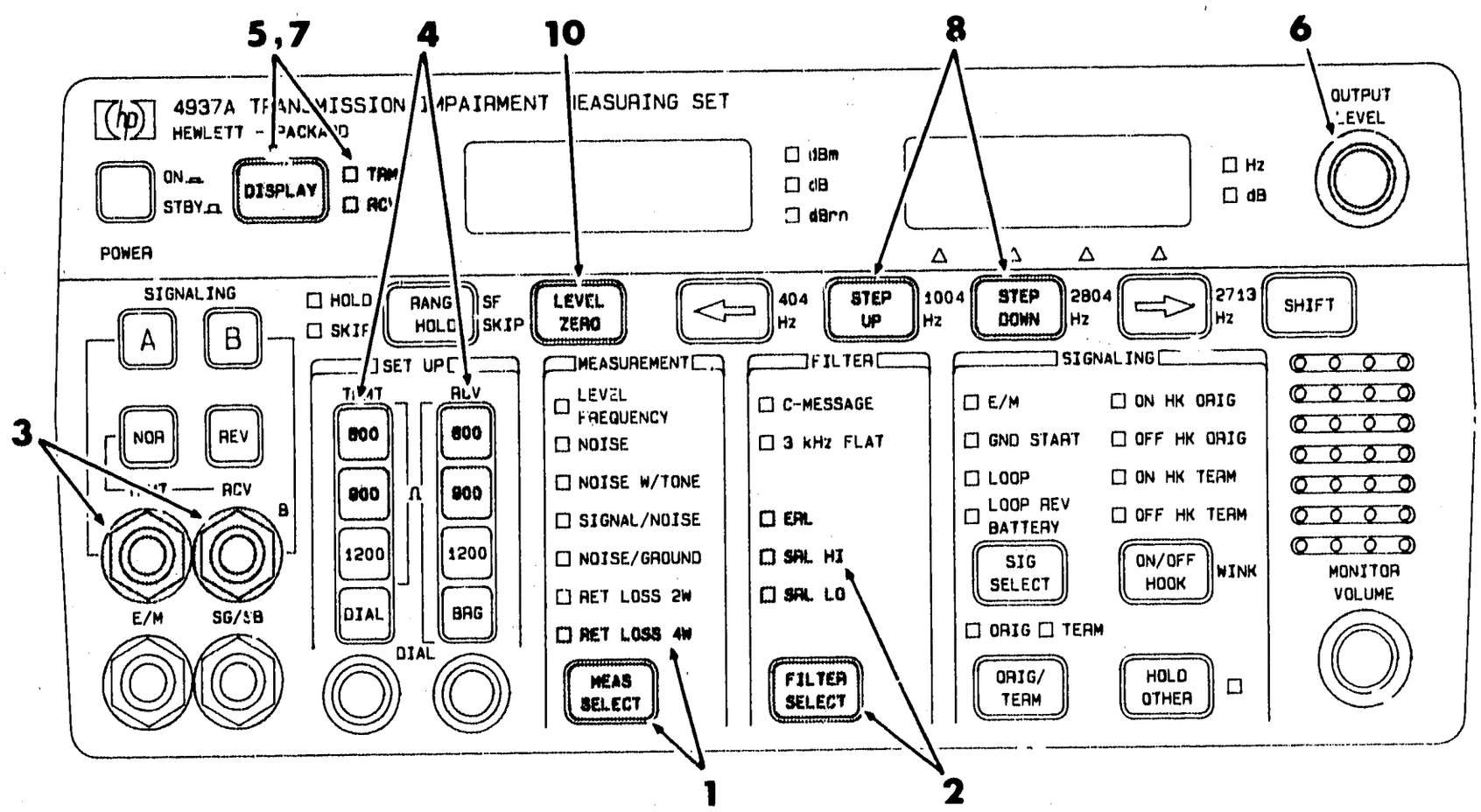
3-49. RETURN LOSS 2-WIRE (con't)

7. Using OUTPUT LEVEL control adjust the transmit level to desired level.

8. Press DISPLAY key to view results. Return loss is shown in dB on the left display.

9. Using FILTER SELECT key select the remaining test as listed in step 2.

3-50. RETURN LOSS 4-WIRE



1. Press MEAS SELECT key to select RET LOSS 4W.

2. Press FILTER SELECT key to select one of the following:

   - ERL (echo return loss--middle band).
   - SRL HI (singing return loss--upper band).
   - SRL LO (singing return loss--lower band).

3. Connect the 4-wire circuit to the transmit and receive jacks.

4. Select TRMT and RCV impedance of either 600 or 900 ohms (600 ohms for Option 002). Return loss cannot be measured at 1200 ohms.

5. Press DISPLAY key to select TRMT mode.

Note

The HP 4937A must be in the transmit mode before adjusting the output level.

6. Using OUTPUT LEVEL control adjust the transmit level to desired level.

7. Press DISPLAY key to select RCV mode.

3-50. RETURN LOSS 4-WIRE (con't)

8. Enter the transhybrid loss correction factor using the STEP UP and STEP DOWN arrow keys.

Note

If the transhybrid loss factor is not known perform steps 9 through 13. The HP 4937A will measure the value.

9. Short the 2-wire side of the hybrid.

10. Press LEVEL ZERO key to measure the loss. It will be shown in the right display.

11. Disconnect the short on the 2-wire side of the hybrid.

12. Return loss is shown in the left display.

13. Using FILTER SELECT key select the remaining test as listed in step 2.

SECTION IV
PERFORMANCE TESTS

4-1. INTRODUCTION

4-2. The procedures in this section test the instrument's electrical performance using the specifications in table 1-1 as the performance standards. All tests can be performed without access to the interior of the instrument. These tests can be used for incoming inspection verification. If the instrument should fail any test refer to Section VIII of this manual.

4-3. EQUIPMENT REQUIRED

4-4. Equipment required for the performance tests is listed in the Recommended Test Equipment table in Section I. Any equipment that satisfies the critical specifications given in the table may be substituted for the recommended model(s).

4-5. TEST RECORD

4-6. Results of the performance test may be tabulated on the Test Record at the end of the procedures. The Test Record lists all of the tested specifications and their acceptable limits. The results recorded at incoming inspection can be used for comparison in periodic maintenance and troubleshooting and after repair or adjustment.

4-7. SELF CHECK

4-8. A self check is automatically done each time the instrument is powered up. Some circuits and filters are tested in addition to all front panel LEDs and alpha-numeric indicators.

4-9. CALIBRATION CYCLE

4-10. This instrument requires periodic verification of performance. Depending on the use and environmental conditions, the instrument should be checked using the performance test every six months. Performance tests should also be made following repair or adjustment.

4-11. ABBREVIATED PERFORMANCE TEST

4-12. The abbreviated performance test, along with the power up and the extended self test, will verify to a 90 percent confidence level that the HP 4937A meets its published specifications. If a more thorough verification is required perform the complete performance tests.

4-13. If the HP 4937A fails to pass any of the abbreviated performance test, perform the equivalent complete performance test before troubleshooting. The HP 4937A may fail the abbreviated test, but still be within published specifications. The abbreviated tests are located at the back of this Section.

4-14. PERFORMANCE TESTS

4-15. Transmitter Flatness at +10 dBm

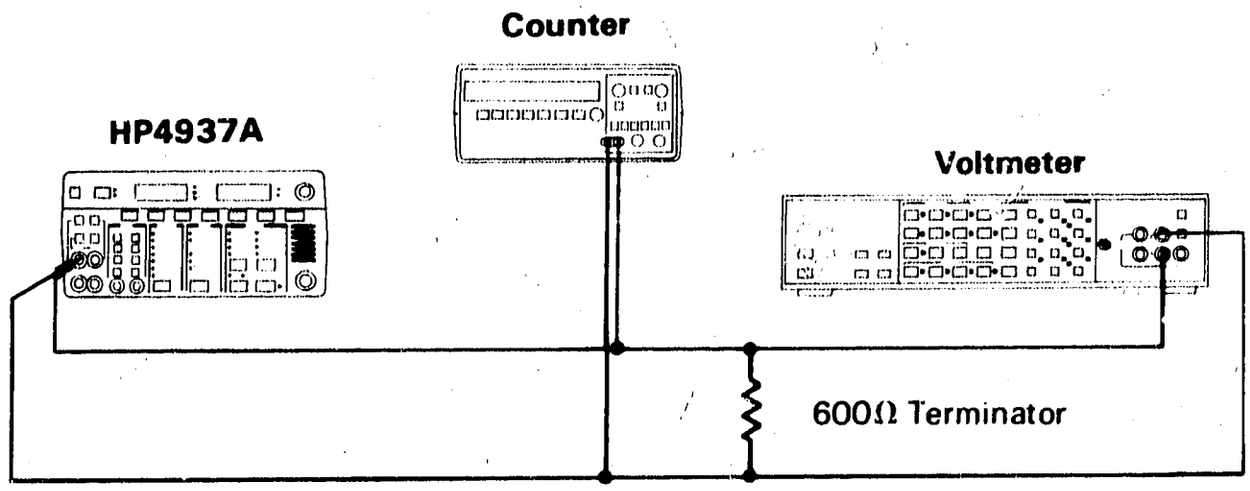


Figure 4-1. *Transmitter Flatness Test at +10 dBm*

EQUIPMENT:

Counter
Voltmeter (HP 3456A)
600-ohm termination

1. Connect equipment as shown in figure 4-1.

2. On the HP 4937A set:

DISPLAY	TRMT
SET UP TERM	600
MEASUREMENT	LEVEL FREQUENCY
OUTPUT	1004 Hz
SELECT A	NORMAL

3. Adjust HP 4937A OUTPUT LEVEL until 0.775 Vrms (0.0 dBm into 600 ohms) appears on the voltmeter. HP 4937A must be set at a frequency of 1004 Hz.

4. Set the HP 3456A into dB Relative Mode by pressing Store Y(8), Math 20 Log X/Y (9).

5. Check the HP 4937A transmitter flatness at the frequencies listed in table 4-1.

4-15. Transmitter Flatness at +10 dBm (con't)

6. Check that the frequencies are within + or - 0.005% tolerance.

Table 4-1. *Transmitter Flatness at +10 dBm*

HP 4937A OUTPUT	HP 4937A START	HP 4937A STOP	STEP SIZE	HP 3456A MIN	HP 3456A MAX
+13 dBm	20 Hz	200 Hz	10 Hz	10dB	13.50 dB
+13 dBm	200 Hz	4000 Hz	100 Hz	12.80 dB	13.20 dB
+13 dBm	4000 Hz	9999 Hz	1000 Hz	12.80 dB	13.20 dB
+10 dBm	20 Hz	200 Hz	10 Hz	7.00 dB	10.50 dB
+10 dBm	200 Hz	4000 Hz	100 Hz	9.80 dB	10.20 dB
+10 dBm	4000 Hz	9999 Hz	1000 Hz	9.80 dB	10.20 dB

4-16. Transmitter Flatness at -40 dBm

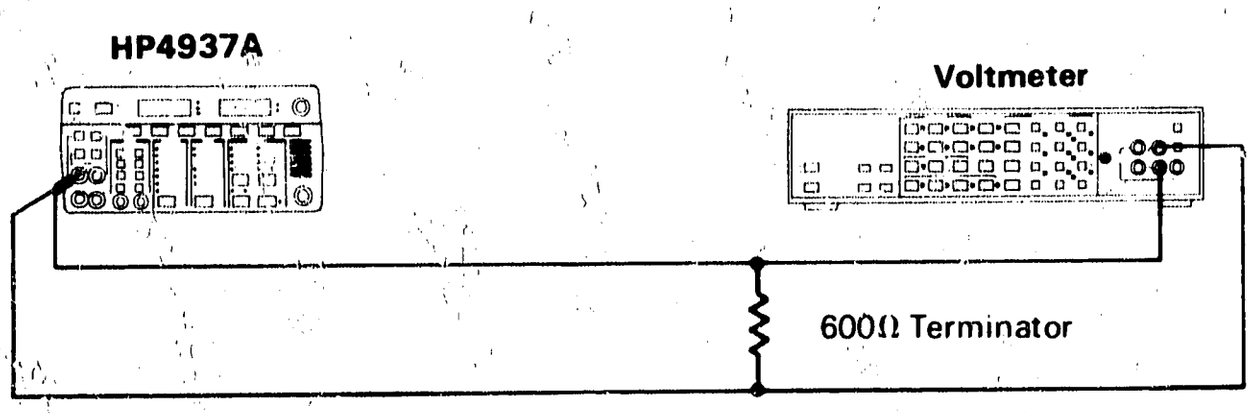


Figure 4-2. *Transmitter Flatness Test at -40 dBm*

EQUIPMENT:

Voltmeter
600-ohm termination

1. Connect equipment as shown in figure 4-2.

2. On the HP 4937A set:

SELECT A	NORMAL
DISPLAY	TRMT
SET UP TRMT	600
MEASUREMENT	LEVEL FREQUENCY
OUTPUT	1004 Hz

3. Adjust the HP 4937A output level until .00775 +/- 5 counts (-40 dBm into 600 ohms) is displayed on the voltmeter. The HP 4937A must be set at a frequency of 1004 Hz.

4. Set the HP 3456A into dB Relative Mode by pressing Store Y(8), Math 20 Log X/Y (9).

5. Check the HP 4937A transmitter flatness at the frequencies listed in table 4-2.

4-16. Transmitter Flatness at -40 dBm (con't)

6. Check that the frequencies are within +/- .005% tolerance.

Note

The +20 dB amplifier (P/N 04935-60018) provides a 600 ohm termination. If a high impedance amplifier is used instead, a 600 ohm termination must be added to the amplifier input. See Figure 4-2A for a schematic of the Filter Circuits and Table 4-2A for a parts list.

Table 4-2. *Transmitter Flatness*

HP 4937A Output	HP 4937A Start	HP 4937A Stop	Step Size	HP 3456A Min	HP 3456A Max
-40 dBm	20 Hz	200 Hz	10 Hz	-1.00 dB	+1.00 dB
-40 dBm	200 Hz	4000 Hz	200 Hz	-0.20 dB	+0.20 dB
-40 dBm	4000 Hz	9999 Hz	1000 Hz	-0.20 dB	+0.20 dB

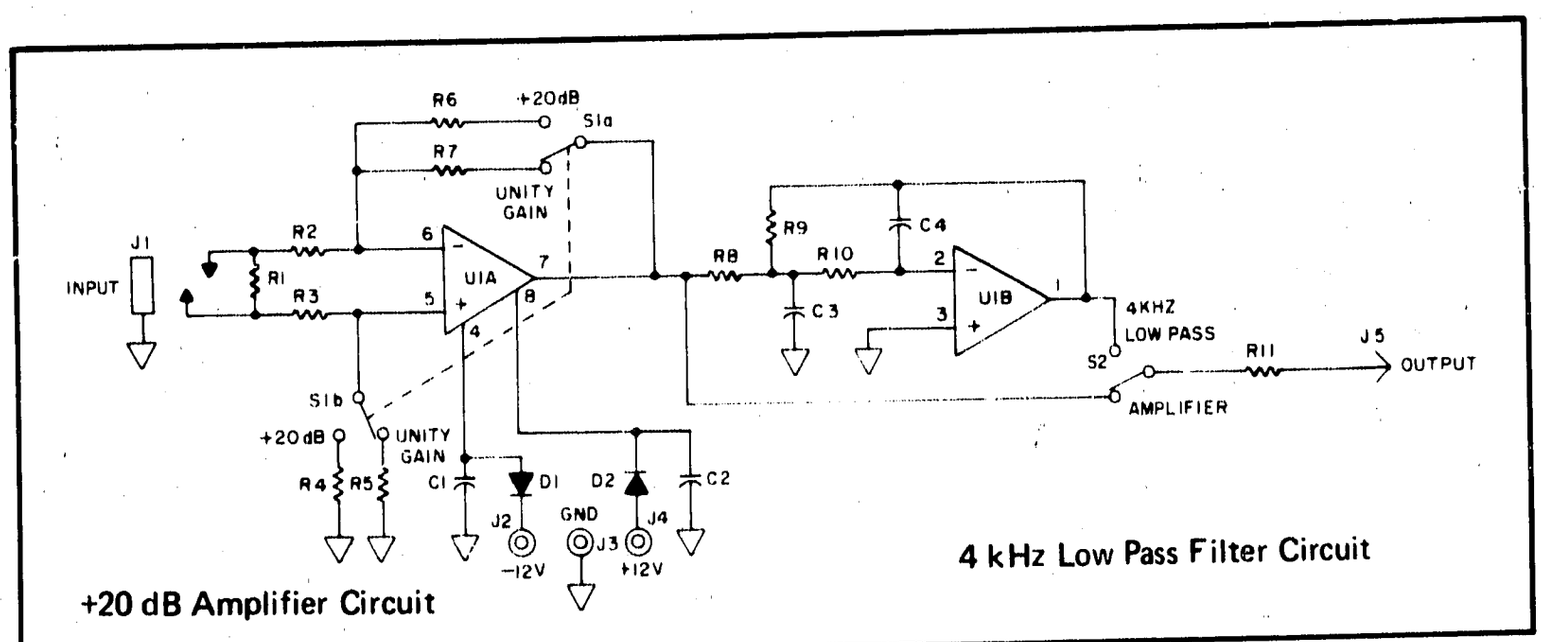


Figure 4-2A. *Filter Circuits*

Table 4-2A. *Filter Circuits Parts List*

REFERENCE DESIGNATOR	HP PART NO.	DESCRIPTION
C1	0160-3468	0.12uf +5%
C2	0160-3468	0.12uf +5%
C3	0160-6405	10K pf +1%
C4	0160-6185	1K pf +1%
D1	1901-0040	Diode
D2	1901-0040	Diode
R1	0698-7408	600ohm +0.1%
R2	0757-0442	10Kohm +1%
R3	0757-0442	10Kohm +1%
R4	0757-0465	100Kohm +1%
R5	0757-0442	10Kohm +1%
R6	0757-0465	100Kohm +1%
R7	0757-0442	10Kohm +1%
R8	0698-3450	42.2Kohm +1%
R9	0698-3450	42.2Kohm +1%
R10	0698-3151	2.87Kohm +1%
R11	0698-7408	600ohm +0.1%
U1	1826-0712	IC OP Amp
S1	3101-0973	DPDT Switch
S2	3101-0973	DPDT Switch
J1	1251-3677	310 Jack
J2	1510-0076	Binding Post
J3	1510-0076	Binding Post
J4	1510-0076	Binding Post
J5	1251-1780	BNC Connector

***The Diagnostic Service Kit (HP 04935-60014) contains a test board with this circuit.**

4-17. Distortion Test

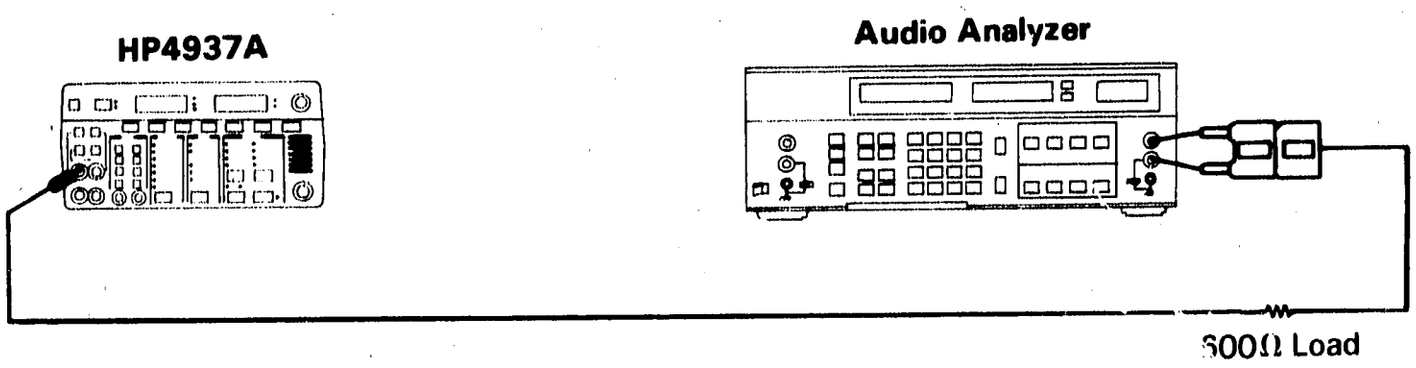


Figure 4-3. *Distortion Test*

EQUIPMENT:

Dual Output Power Supply
Audio Analyzer
20 dB Amplifier
600 ohm load

1. Connect the equipment as shown in figure 4-3.

2. On the HP 4937A set:

DISPLAY	TRMT
NOR	PRESSED IN
SET UP TRMT	600
MEASUREMENT	LEVEL FREQUENCY

3. Set the audio analyzer to measure distortion in dB. This input should be floating.

4. Enable the 30 kHz low pass filter on the audio analyzer.

5. Measure the distortion at the frequencies listed in table 4-3.

4-17. Distortion Test (con't)

Table 4-3. *Distortion Test +13 dBm to 0 dBm*

Frequency	Output Level	Distortion
40 Hz	+13 dBm	<= -20 dB
100 Hz	+13 dBm	<= -45 dB
1004 Hz	+13 dBm	<= -45 dB
4000 Hz	+13 dBm	<= -45 dB
9999 Hz	+13 dBm	<= -45 dB
40 Hz	+10 dBm	<= -30 dB
100 Hz	+10 dBm	<= -55 dB
1004 Hz	+10 dBm	<= -55 dB
4000 Hz	+10 dBm	<= -55 dB
9992 Hz	+10 dBm	<= -55 dB
40 Hz	0 dBm	<= -30 dB
100 Hz	0 dBm	<= -55 dB
1004 Hz	0 dBm	<= -55 dB
8191 Hz	0 dBm	<= -55 dB
8192 Hz	0 dBm	<= -55 dB
9999 Hz	0 dBm	<= -55 dB

6. Connect equipment as shown in figure 4-4.

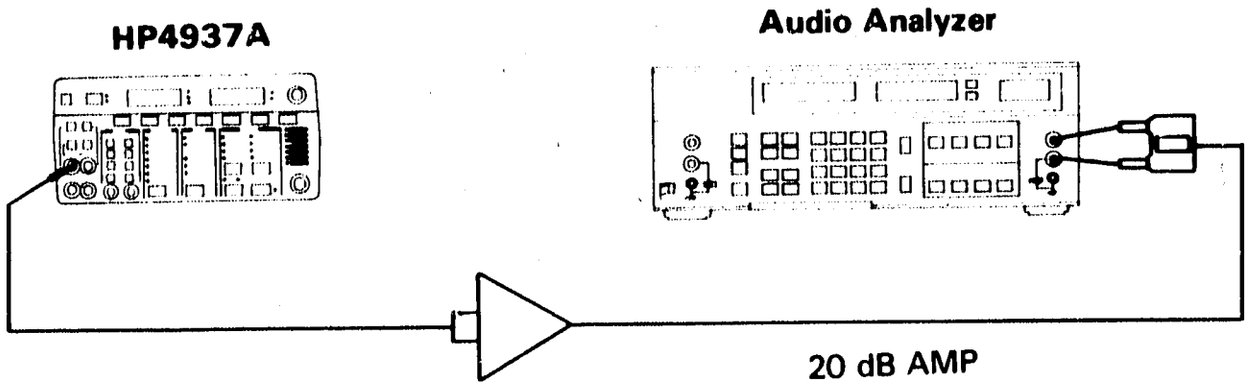


Figure 4-4. *-40 dBm Distortion Test*

4-17. Distortion Test (con't)

7. Measure the distortion at the frequencies listed in Table 4-4.

Table 4-4. *-40 dBm Distortion Test*

Frequency	Output Level	Distortion
40 Hz	-40 dBm	<= -40 dB
100 Hz	-40 dBm	<= -50 dB
1004 Hz	-40 dBm	<= -50 dB
4000 Hz	-40 dBm	<= -50 dB
9999 Hz	-40 dBm	<= -50 dB

8. Change the +20 dB amplifier to unity gain and switch in the 4-kHz low pass filter.

9. Measure the distortion frequencies listed in Table 4-5.

Table 4-5. *-40 dBm Distortion Test*

Frequency	Output Level	Distortion
1004 Hz	0 dBm	<= 65 dB

4-18. Receiver Accuracy at +11 dBm and -40 dBm and -60 dBm.

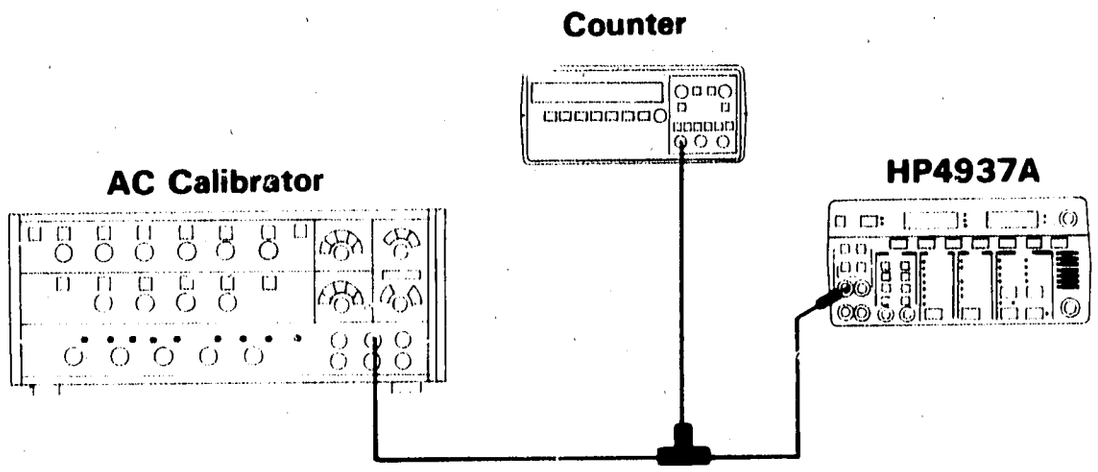


Figure 4-5. *Receiver Test at +11 dBm , -40 dBm, and -60 dBm*

EQUIPMENT:

AC Calibrator
Counter

1. Connect equipment as shown in figure 4-5.

2. On the HP 4937A set:

DISPLAY	RCV
REV	pressed in
SET UP RCV	600
MEASUREMENT	LEVEL FREQUENCY

RECEIVER ACCURACY AT +11 dBm

1. Set ac calibrator to 2.733 V (+10.95 dBm into 600 ohms). The 0.05 dB offset checks for round off errors in the HP 4937A.

2. Test the HP 4937A at each frequency shown in table 4-6.

4-18. Receiver Accuracy at +11dBm, -40 dBm, and -60 dBm (con't)

RECEIVER ACCURACY AT -40 dBm

1. Set the ac calibrator output to 7.702 mV (-40.05 dBm into 600 ohms).
2. Test the HP 4937A at each frequency shown in table 4-6.

RECEIVER ACCURACY AT -60 dBm.

1. Set the ac calibrator output to 775 mV (-60 dBm into 600 ohms).
2. Test the HP 4937A at each frequency shown in Table 4-6.

Table 4-6. *Receiver Accuracy Test Table*

COUNTER FREQUENCY	FREQUENCY TOLERANCE	+11 dBm	-40 dBm	-60 dBm
20 Hz	+/-1 Hz	10.0 to 11.9	-41.0 to -39.1	-61.0 to -59.0
50 Hz	+/-1 Hz	10.5 to 11.4	-40.5 to -39.6	-60.6 to -59.4
200 Hz	+/-1 Hz	10.8 to 11.1	-40.2 to -39.9	-60.4 to -59.6
1000 Hz	+/-1 Hz	10.9 to 11.0	-40.2 to -39.9	-60.4 to -59.6
4000 Hz	+/-1 Hz	10.8 to 11.1	-40.2 to -39.9	-60.4 to -59.6

4-19. Detector Linearity Test

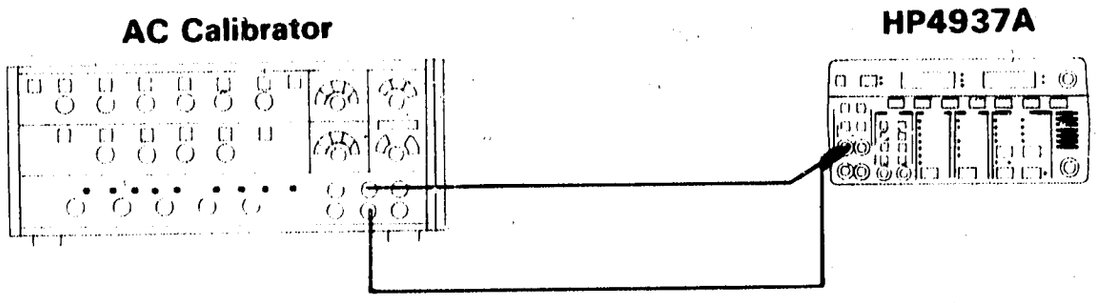


Figure 4-5A. *Detector Linearity Test*

EQUIPMENT:

Ac calibrator

1. Connect equipment as shown in figure 4-5A.
2. Set the HP 4937A set:

REV	pressed in
DISPLAY	RCV
SET UP RCV	600
MEASUREMENT	LEVEL FREQUENCY

3. Set ac calibrator for an output of 775 mV and 1000 Hz.
4. Step the ac calibrator voltage down until E-02 appears in the right hand display of the HP 4937A.
5. Set the ac calibrator for an output of 1.0 Volts at 1000 Hz.

4-19. Detector Linearity Test (con't)

6. Step the ac calibrator voltage up until E-01 appears in the right hand display of the HP 4937A.

7. Connect an HP 3336B to an HP 4937A in place of the AC calibrator.

8. On the HP 4937A set:

MEASUREMENT	NOISE
FILTER SELECT	3 KHZ FLAT

9. For each voltage listed in table 4-7 verify that the display is within the limits listed.

Table 4-7. *QRMS Detector Linearity*

HP 3336B FREQUENCY	HP 3336B POWER LEVEL	HP 4937A DISPLAY
200 HZ	+7 DBM	96 to 97 DBRN
200 HZ	0 DBM	89 to 91 DBRN
200 HZ	-10 DBM	79 to 81 DBRN
200 HZ	-20 DBM	69 to 71 DBRN
200 HZ	-30 DBM	59 TO 51 DBRN
200 HZ	-40 DBM	49 TO 51 DBRN
200 HZ	-50 DBM	39 TO 41 DBRN
200 HZ	-60 DBM	29 TO 31 DBRN
200 HZ	-70 DBM	19 TO 21 DBRN
2000 HZ	+7 DBM	96 TO 97 DBRN
2000 HZ	0 DBM	89 TO 91 DBRN
2000 HZ	-10 DBM	79 TO 81 DBRN
2000 HZ	-20 DBM	69 TO 71 DBRN
2000 HZ	-30 DBM	59 TO 61 DBRN
2000 HZ	-40 DBM	49 TO 51 DBRN
2000 HZ	-50 DBM	39 TO 41 DBRN
2000 HZ	-60 DBM	29 TO 31 DBRN
2000 HZ	-70 DBM	19 TO 21 DBRN

4-20. Filter Tests

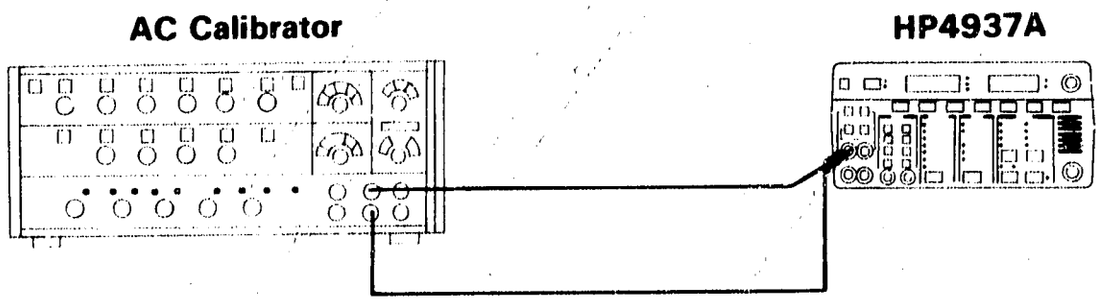


Figure 4-6. *Filter Tests*

EQUIPMENT:

Ac calibrator

1. Connect equipment as shown in figure 4-6.
2. On the HP 4937A set:

MEASUREMENT	AS SPECIFIED

3. Set ac calibrator to .775 V (0.0 dBm across 600 ohms).

C-MESSAGE FILTER

1. On the HP 4937A set:

MEASUREMENT	NOISE
FILTER	C-MESSAGE

2. Check the response at each frequency in table 4-8. The HP 4937A should be within the range given.

4-20. Filter Test (con't)

Table 4-8. *C-Message Test*

FREQUENCY (ac calibrator)	RECEIVED LEVEL (dBrn) (HP 4937A display)
200	62 to 67
500	81 to 83
2000	87 to 89
5000	58 to 64
9999	<56

3-kHz FLAT FILTER TEST

1. Using FILTER SELECT key on HP 4937A select 3 kHz FLAT filter.
2. Check the response at each frequency in table 4-9. The HP 4937A should be within the range given.

Table 4-9. *3-kHz Flat Filter*

FREQUENCY (HZ) (ac calibrator)	RECEIVED LEVEL (dBrn) (HP 4937A display)
60	89 to 91
400	89 to 91
1000	89 to 91
2000	89 to 91
3000	85 to 88
6000	74 to 80

NOTCH FILTER

1. Select the 3 kHz filter.
2. Select NOISE W/TONE measurement.
3. Check the response at each frequency in table 4-10. The display should be within the range given.

Table 4-10. *Notch Filter Test*

FREQUENCY (HZ) (ac calibrator)	RECEIVED LEVEL (dBrn) (HP 4937A display)
60	88 to 90
400	87 to 90
862	87 to 90
995	<40
1025	<40
1182	87 to 90
1700	87 to 90

4-20. Filter Test (con't)

60-Hz REJECT FILTER

1. Set ac calibrator frequency to 1000 Hz.
2. Using MEAS SELECT key on HP 4937A select RET LOSS 4W.
3. Turn the OUTPUT LEVEL control fully clockwise.
4. Using DISPLAY key on HP 4937A select RCV.
5. Allow the display to settle, then press LEVEL ZERO key on the HP 4937A.
6. Check the response (left display) at each frequency listed in table 4-11.

Table 4-11. *60-Hz Reject Filter Test*

FREQUENCY (ac calibrator)	LEFT DISPLAY READING (HP 4937A display)
400 Hz	<=0.1 dB
200 Hz	<=0.5 dB
60 Hz	>=20 dB

4-21. Hold Tone Dropout Detector Test

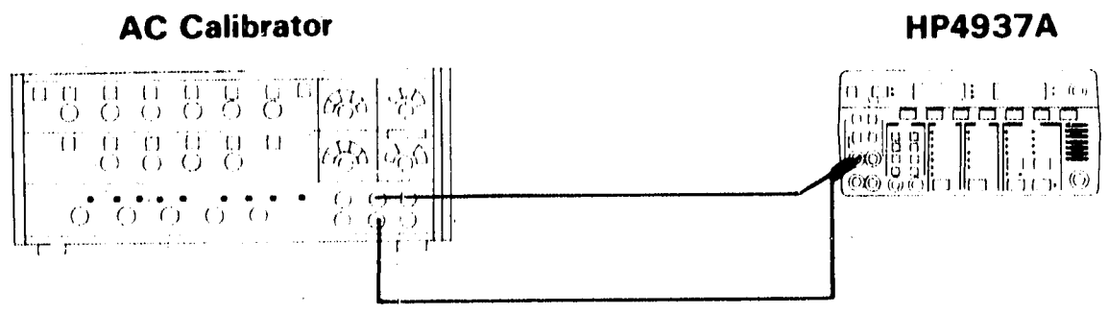


Figure 4-7. *Hold Tone Dropout Detector Test*

EQUIPMENT:

Ac calibrator

1. Connect equipment as shown in figure 4-7.

2. On the HP 4937A set:

DISPLAY	RCV
REC	pressed in
SET UP RCV	600
MEASUREMENT	NOISE WITH TONE
FILTER	C-MESSAGE

3. Set ac calibrator to 9 mV at 1004 Hz.

4. Lower the ac calibrator level (between 3 and 4 mV rms) until E-07 appears on the HP 4937A display.

5. On HP 4937A select RECEIVE LEVEL FREQUENCY and read the signal level from the display. It should be -46 dBm +/-2 dBm.

4-22. Noise to Ground Test

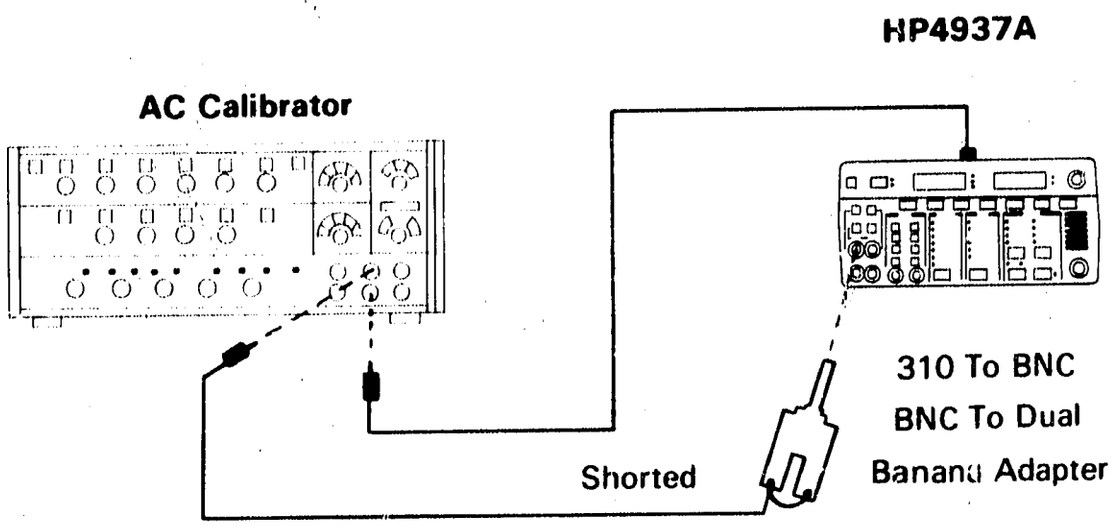


Figure 4-8. *Noise to Ground Test*

EQUIPMENT:

Ac calibrator

1. Connect equipment as shown in figure 4-8.

2. On the HP 4937A set:

DISPLAY	RCV
MEASUREMENT	NOISE/GROUND

3. Connect ac calibrator low to ground lug on HP 4937A rear panel.

4. Short HP 4937A input (tip and ring) and connect to the ac calibrator HIGH.

5. Set ac calibrator output to .7746 Vrms at 1000 Hz. The HP 4937A should display between 88 and 91 dBrn.

4-23. Termination Impedance Test

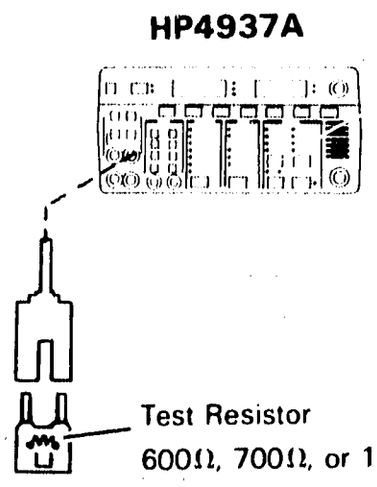


Figure 4-9. *Termination Impedance Test*

EQUIPMENT:

Multimeter
Resistors 600-, 900-, and 1200-ohm

1. Disconnect HP 4937A from ac power.

2. Measure the resistance across the transmitter and receiver jacks. Both measurements should be greater than 1M ohm.

Note

As the dc blocking capacitors charge, the measured resistance may slowly rise. Set the multimeter to the lowest resistance and increase the resistance as the meter overranges.

3. Connect equipment as shown in figure 4-9.

4. On the HP 4937A set:

NOR and REV	press simultaneously	*on OPTION 002 set:
SET UP RCV	900	600
SET UP TRMT	900	600
DISPLAY	RCV	
MEASUREMENT	LEVEL FREQUENCY	
OUTPUT LEVEL	adjust to 0.0 dBm	

4-23. Termination Impedance Test (con't)

5. Repeat the following test three times. The procedure and the expected results remain the same. The termination impedance selected and the value of the resistor placed across the receive jack will change. Use the 900- ohm resistor first, the 600-ohm resistor second, and then the 1200-ohm resistor.

   a. Select equal TRMT and RCV termination impedance.

   b. The display should read 0.0 dBm.

   c. Press the BRG pushbutton.

   d. The display should read 6.1 dBm +/-.1 dBm.

   e. Connect the first resistor externally across the right jack. The resistance should be the same as the impedance selected for TRMT and RCV.

   f. The display should read 0.0 dBm +/- .1 dBm.

   g. Release the BRG pushbutton and remove the resistor.

   h. Repeat steps a through g for the other resistors.

4-24. 2-Wire Return Loss (See table 1-1 in Section I for Range and Resolution)

EQUIPMENT:

600-ohm resistor, 0.1%
900-ohm resistor, 0.1% (except Option 002)

1. Connect the 600-ohm resistor across the TRMT jack.

2. On the HP 4937A set:

TRMT	NOR
MEASUREMENT	RET LOSS 2W
DISPLAY	TRMT
SET UP TRMT	600
SET UP RCV	600
FILTER	ERL
OUTPUT LEVEL	-2 dBm

3. Set the HP 4937A DISPLAY to RCV.

4. The return loss as measured by the HP 4937A should be approximately 24.5 dB +/- 0.1 dB.

5. Using the FILTER SELECT key select SRL HI.

6. The return loss as measured by the HP 4937A should be approximately 32.9 dB +/- 0.1 dB.

7. Using the FILTER SELECT key select SRL LO.

8. The return loss as measured by the HP 4937A should be approximately 15.6 dB +/- 0.1 dB.

9. Remove the 600-ohm resistor and connect the 900-ohm resistor across the TRMT jack.

Note

Steps 10 through 16 do not apply to Option 002.

10. On the HP 4937A set:

DISPLAY	TRMT
SET UP TRMT	900
SET UP RCV	900
FILTER	ERL
OUTPUT LEVEL	-2 dBm

11. Set the HP 4937A DISPLAY to RCV.

4-24. 2-Wire Return Loss (con't)

12. The return loss as measured by the HP 4937A should be approximately 28.3 dB +/- 0.1 dB.

13. Using the FILTER SELECT key select SRL HI.

14. The return loss as measured by the HP 4937A should be approximately 36.6 dB +/- 0.1 dB.

15. Using the FILTER SELECT key select SRL LO.

16. The return loss as measured by the HP 4937A should be approximately 18.9 dB +/- 0.1 dB.

17. Remove the 900-ohm resistor. The return loss as measured by the HP 4937A should be approximately 0.0 dB for all three measurements.

4-25. 4-Wire Return Loss Test

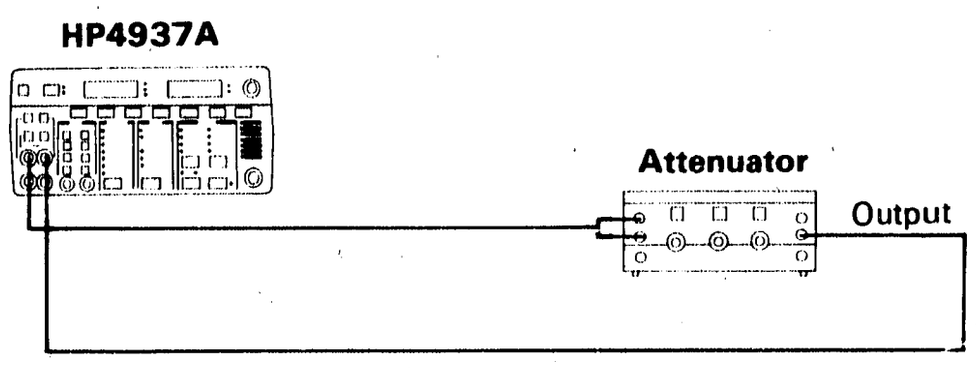


Figure 4-10. *4-Wire Return Loss Test*

EQUIPMENT:

Attenuator (600 ohms)

1. Connect equipment as shown in figure 4-10.
2. On the HP 4937A set:

MEASUREMENT	RET LOSS 4W
DISPLAY	TRMT
SET UP TRMT	600
SET UP RCV	600
NOR	pressed in
FILTER	ERL

3. Set attenuator to 0.0 dB.
4. Set OUTPUT LEVEL to -2.0 dBm.
5. Set DISPLAY to RCV.
6. Set the attenuator as listed in table 4-12 and verify return loss is within limits shown.

Table 4-12. *Return Loss Measurements*

ATTENUATOR	RETURN LOSS
0	-0.5 to +0.5 dB
10	+9.5 to +10.5 dB
20	+19.5 to +20.5 dB
30	+29.5 to +30.5 dB
40	+39.5 to +40.5 dB
50	+49.5 to +50.5 dB

4-25. 4-Wire Return Loss Test (con't)

7. Using FILTER SELECT key select SRL LO.

8. Repeat step 6 for SRL LO.

9. Using FILTER SELECT key select SRL HI.

10. Repeat step 6 for SRL HI.

11. Change the HP 4937A display to TRMT and set HP 4937A OUTPUT LEVEL to -26 dBm.

12. Repeat steps 5 through 10.

4-26. Signaling Voltage Test

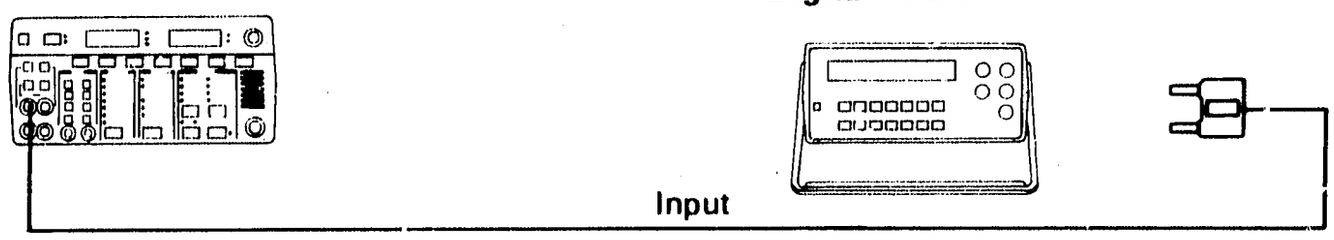


Figure 4-11. *Signaling Voltage Test*

EQUIPMENT:

Multimeter

1. Connect equipment as shown in figure 4-11.
2. On the HP 4937A set:

SIGNALING	A
SIG SELECT	LOOP
ORIG/TERM	TERM

3. Using multimeter set to DC VOLTS, the measured voltage should be 45.6 volts +/- 0.5 volt.
4. Change the multimeter to measure current. The current should be >100 mA.

4-27. Battery Bridging Loss Test

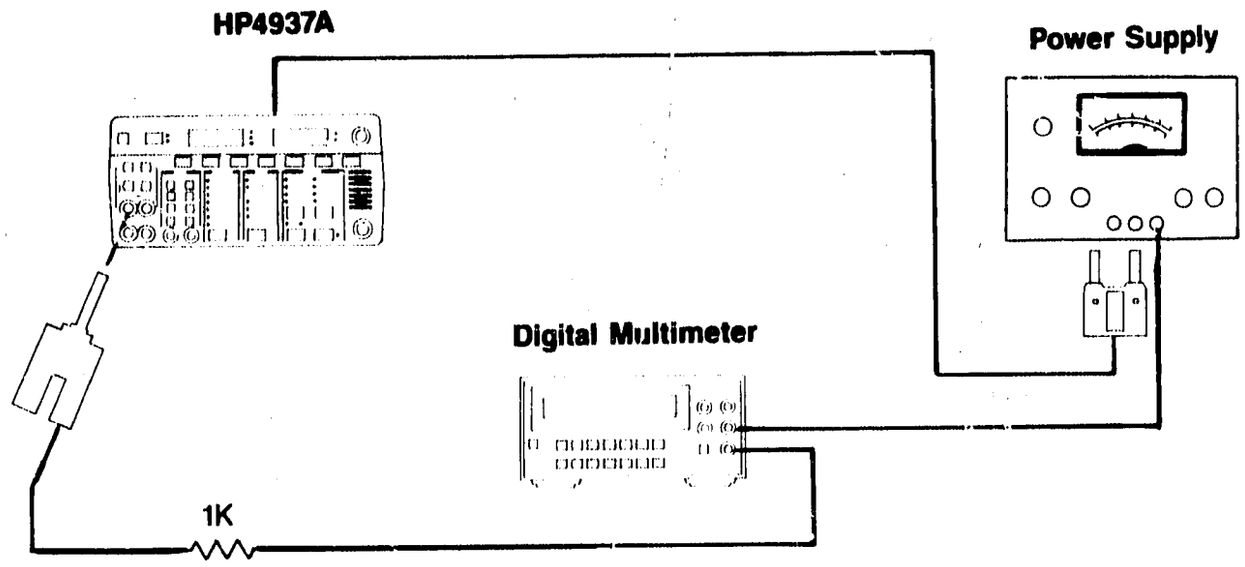


Figure 4-12. *Battery Bridging Loss Test*

EQUIPMENT:

Digital voltmeter
Multimeter
Power supply
1k ohm resister (P/N 0764-0016)

1. On the HP 4937A set:

SIGNALING	LOOP ORIG
SET UP	TRMT DIAL
SIG A/B	A

2. Put 1k ohm resistor across the dial jacks.

3. Connect the equipment as shown in Figure 4-12 (The HP 4937A ground connection is on the rear panel).

NOTE

On a 310 to dual banana connector, the ring is the negative side and the tip is the positive side.

4. Set the power supply to 48 volts.

5. Put the HP 4937A signaling to OFF HOOK. The HP 3478A should read 30-40 MA DC for approximately one second, then drop to 0.0 MA DC.

6. Press the Dial button in. The HP 3478A should continue to read 0.0 MA DC.

7. Press the Dial button out. The HP 3478A should continue to read 0.0 MA DC.

4-27. Battery Bridging Loss Test (con't)

9. Connect the equipment as shown in Figure 4-13. Put the 1K ohm resistor across the dial jacks.

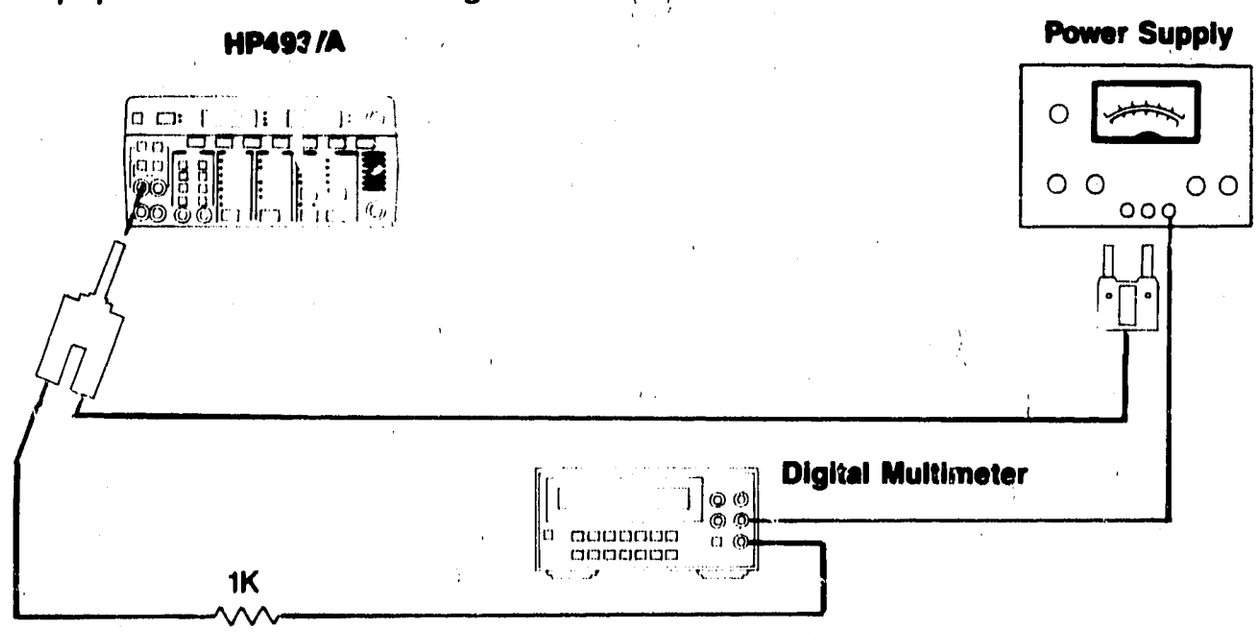


Figure 4-13. *Battery Bridging Loss Test*

10. Push the dial button in and the OFF HOOK ORIG LED should come on. Connect the HP 3456A across the dial terminals. The voltmeter should read between 20 and 24 volts.

11. Press the ON/OFF button. The ON HOOK ORIG LED should come on. The voltage on the voltmeter should read 0.0 volts +/- 25 mV.

12. Release the Dial push button and disconnect all connections to the HP 4937A.

13. Connect the transmitter to the receiver with a 310 test cable. Connect the voltmeter across the tip and ring.

14. The HP 4937A should be in Level/Frequency Transmit with Signaling and Hold Other off.

15. Set the HP 4937A to 0.0 dBm and 9999 Hz.

16. Put the voltmeter into AC Volts dB relative mode by pressing Store Y(8) and Math Log (X/Y)(9).

17. Put the HP 4937A into the Loop Start Signaling Term Mode and Hold Other.

18. Check that the HP 3456A Display is within the tolerance given for each frequency in Table 4-13.

Table 4-13. *Battery Bridging Loss*

HP 4937A Frequency	HP 3456A Reading
9999 Hz	<0.6 dB
500 Hz	<0.2 dB
200 Hz	<0.2 dB

4-28. Hold Current Test

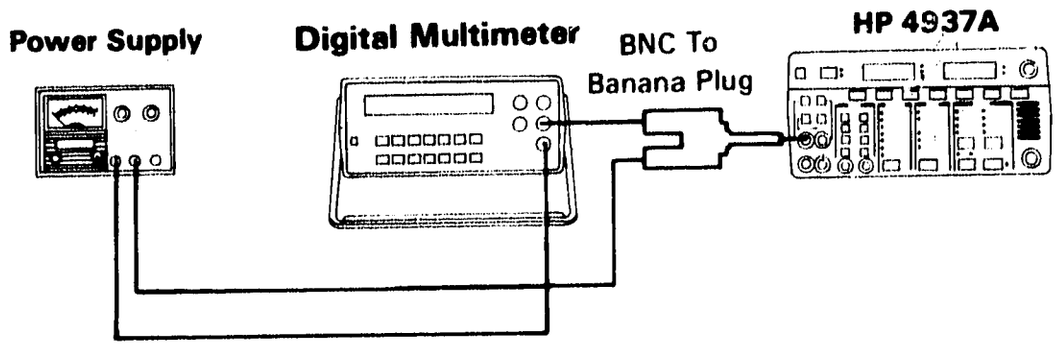


Figure 4-14. *Hold Current Test*

EQUIPMENT:

Multimeter
Power Supply

1. Connect equipment as shown in figure 4-14.

2. Adjust the power supply output for 19.5V +/- 0.1V.

3. On the HP 4937A set:

REV	pressed out
SIGNALING	B
DISPLAY	RCV
NOR	pressed out
MEASUREMENT	LEVEL FREQUENCY

4. Set the multimeter range to 200 mA.

5. Adjust the HP 4937A frequency to 1004 Hz at 0.0 dBm.

6. Press HOLD OTHER key. The current displayed on the multimeter should be 21 mA +/- 1 mA. The HP 4937A should read 0.0 dB.

4-28. Hold Current Test (con't)

7. Increase the power supply voltage to 50 volts. The current reading on the multimeter should read <29 mA.

8. On the HP 4937A set:

SIGNALING	A
SIG SELECT	LOOP
ORIG/TERM	ORIG
ON/OFF HOOK	OFF HOOK ORIG

9. Set the power supply to 19.5 volts.

10. The current displayed on the multimeter should be 21 mA +/- 1 mA.

11. Increase the power supply to 50 volts. The current should be <29 mA.

4-29. E/M Signaling Type I

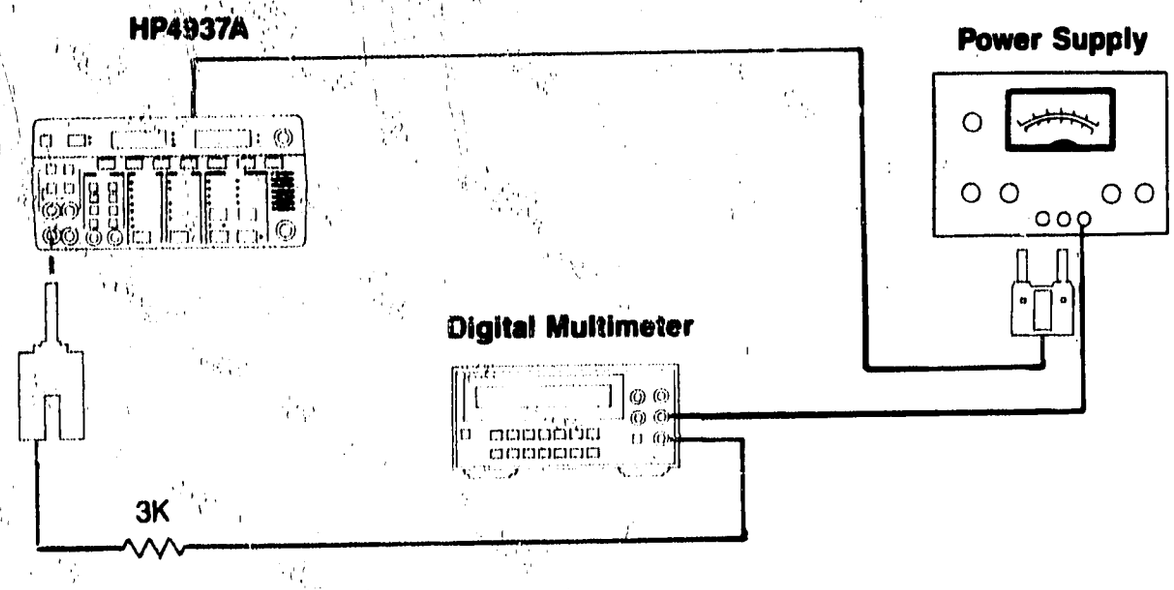


Figure 4-15. *E/M Signaling* Type I

EQUIPMENT:

Power supply
Multimeter
Voltmeter
2-resistors, 3k ohms (P/N 0698-3338)

1. On the HP 4937A set:

DISPLAY	RCV
SIGNALING TYPE	TYPE 1
SIGNALING	E/M
	ORIG
NOR REV	OUT
TRANSMIT LEVEL	13 DBM

2. The ON HK LED should be on.

3. Ground the E Lead. The ON HK TERM LED should go off and the OFF HOOK TERM LED should come on.

4. Connect the voltmeter from the M Lead to GND (the GND connection is on the rear panel of the HP 4937A). The voltage should be 0 volts dc +/-25 mV.

5. Press the ON/OFF hook button. The OFF HK ORIG LED should come on and the voltage should be -44 to -52 volts dc.

4-29. E/M Signaling Type I (con't)

6. Press the ORIG/TERM Button. The HP 4935A should be in the TERM mode.

7. Connect the equipment as shown in Figure 4-15.

8. The ON HOOK TERM should be on.

9. The multimeter should read <0.1 mA.

10. Press the ON/OFF HOOK button. The HP 4937A should now indicate OFF HK TERM.

11. The multimeter should read >13 mA.

12. Ground the M lead. The ON HK ORIG LED should stay on.

13. Remove the ground from the M lead. The OFF HK ORIG LED should come on.

4-30. E/M Signaling Type II

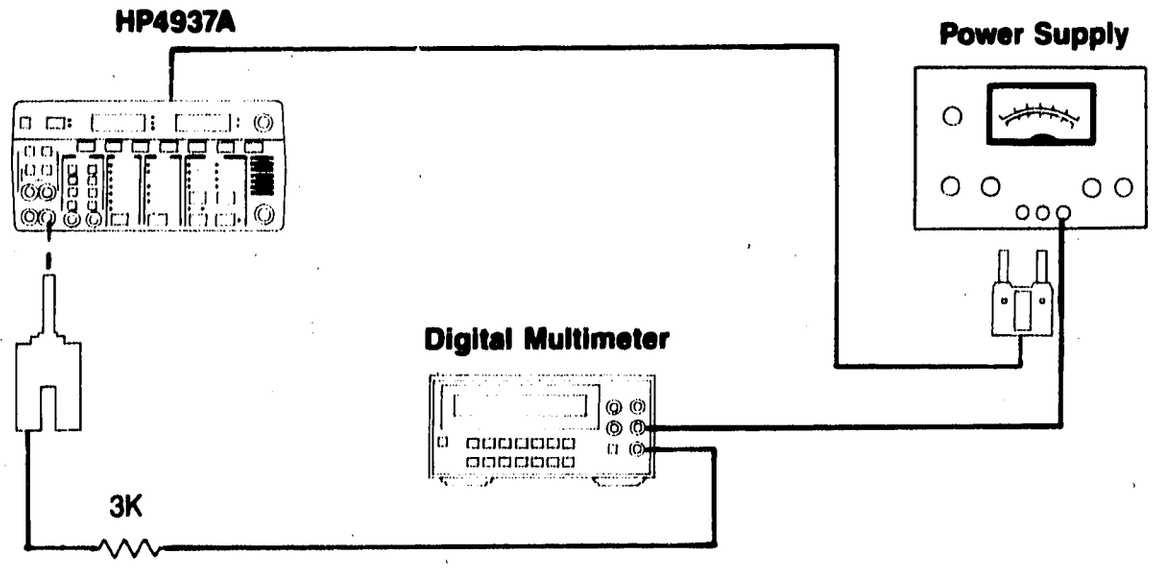


Figure 4-16. *E/M Signaling Type II*

EQUIPMENT:

Power Supply
Multimeter
Two 3k ohm resistors (P/N 0698-3338)

1. On the HP 4937A set:

SIGNALING TYPE	TYPE II
SIGNALING	E/M
	ORIG

2. Connect the equipment as shown in Figure 4-16 (The ground connection on the HP 4937A is on the rear panel).

NOTE

"SG" is the tip, or positive side, of the connector.

3. Set the power supply to 48 volts +/- 0.2 volts.

4. Measure the voltage to ground at the SG lead with the multimeter. The reading should be 0 volts +/- 25 mV.

4-30. E/M Signaling Type II (con't)

5. Connect the multimeter from the M lead to the SB lead. Change the function to 2-wire resistance. When the ON HK ORIG LED is on, the resistance should be infinite.

6. Press the ON/OFF HOOK button. When OFF HK ORIG LED is on the resistance should be <10 ohms.

7. Press the ORIG/TERM button. The HP 4937A should be in the TERMINATE mode.

8. Connect the multimeter from the E lead to the SG lead. The reading should be infinite with the ON HK TERM LED on.

9. Press the ON/OFF HOOK button. When the OFF HK TERM LED is on, the resistance should be <10 ohms.

10. Set the voltmeter to read DC volts. Connect the multimeter leads from the SB lead to ground. The reading should be between 44 and 52 volts.

4-31. E/M Signaling Type III

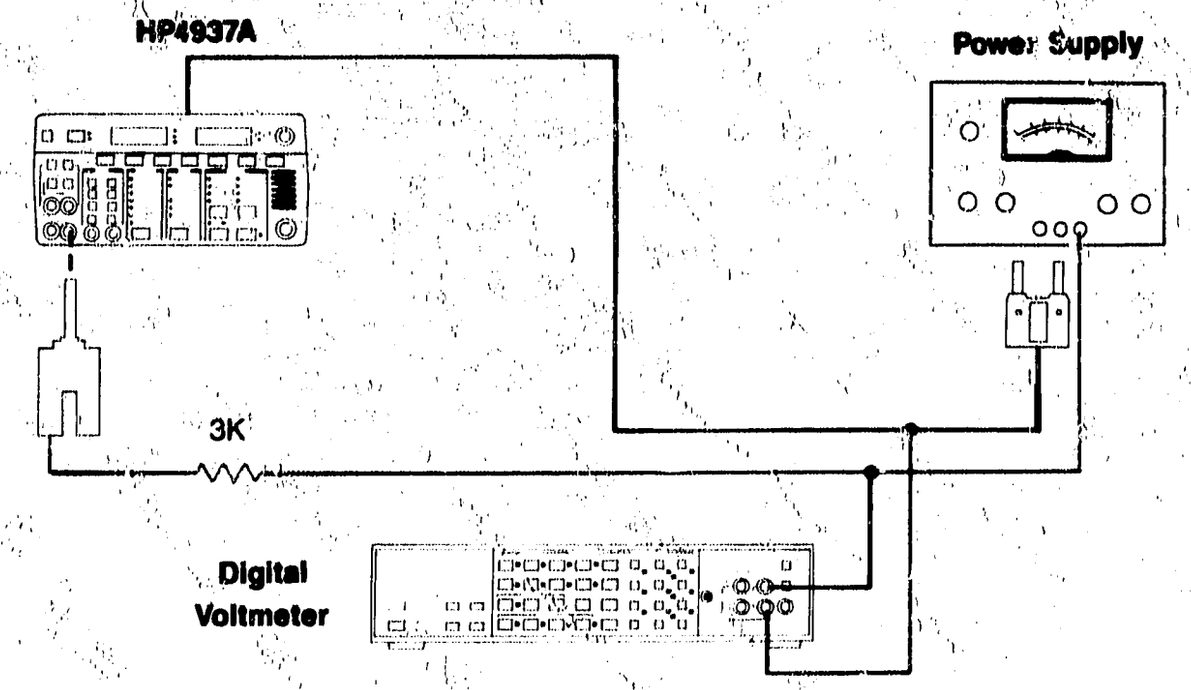


Figure 4-17A. *E/M Signaling Type III*

EQUIPMENT:

Power Supply
Voltmeter
Multimeter
Two 3k ohm resistors (P/N 0698-3338)

1. On the HP 4937A set:

SIGNALING TYPE	TYPE III
SIGNALING	E/M
	ORIG

2. Ground the SG connection and apply -48 +/- 0.2 volts to the SB connection.

3. Connect the voltmeter between M and GND (the GND connection is on the rear panel of the HP 4937A). When the ON HK ORIG LED is on the voltage should be 0 volts +/- 25 mV.

4. Press the ON/OFF HOOK button. When the OFF ORIG TERM LED is on, the voltage should be -48 volts +/- 0.2 volts.

5. Press the ORIG/TERM button. The HP 4937A should be in TERMINATE mode.

6. Connect the equipment as shown in Figure 4-17A. (The HP 4937A ground connection is on the rear panel.)

7. Set the power supply to 48 volts +/- 25 mV.

8. Measure the voltage from SG to GND with the voltmeter. The reading should be 0 volts +/- 25 mV.

4-31. E/M Signaling Type III (con't)

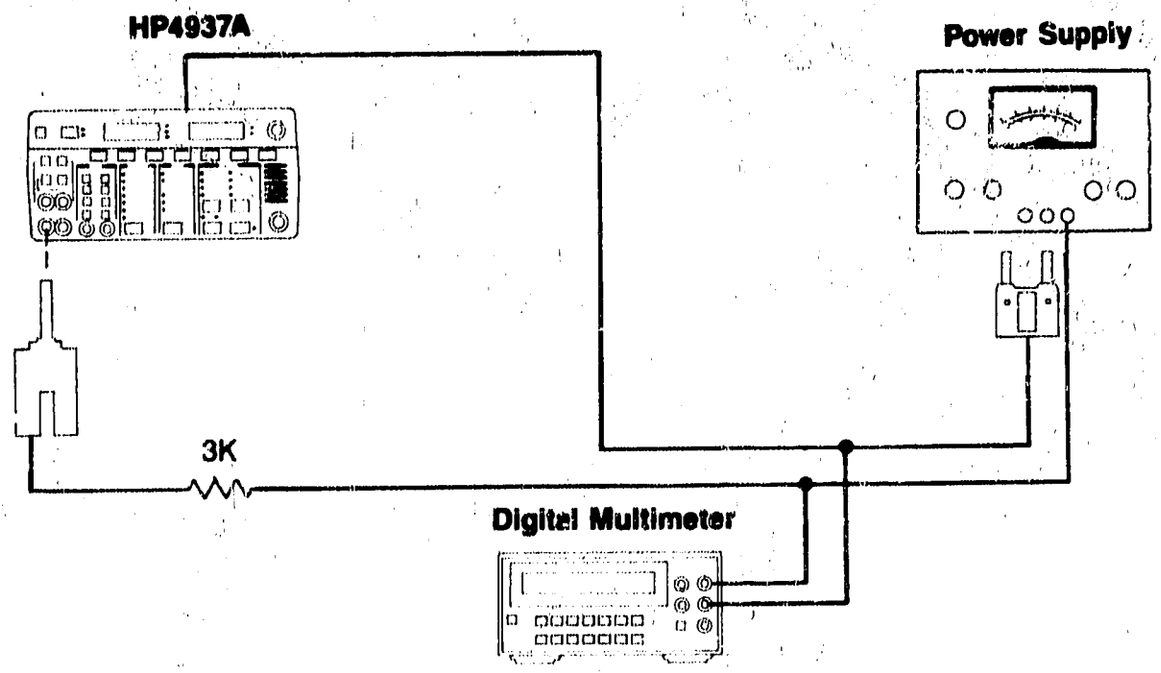


Figure 4-17B. *E/M Signaling Type III*

9. Connect the equipment as shown in Figure 4-17B. (The ground connection of the HP 4937A is on the rear panel.)

10. Set the power supply to 48 volts +/- 0.2 volts.

11. Measure the voltage from the E lead to GND with the multimeter. The reading should be -48 volts +/- 0.2 volts, with the ON HK TERM LED on.

12. Press the ON/OFF HOOK button. When the OFF HK TERM LED is on, the voltage should be 0 volts +/- 25 mV.

4-32. Ground Start

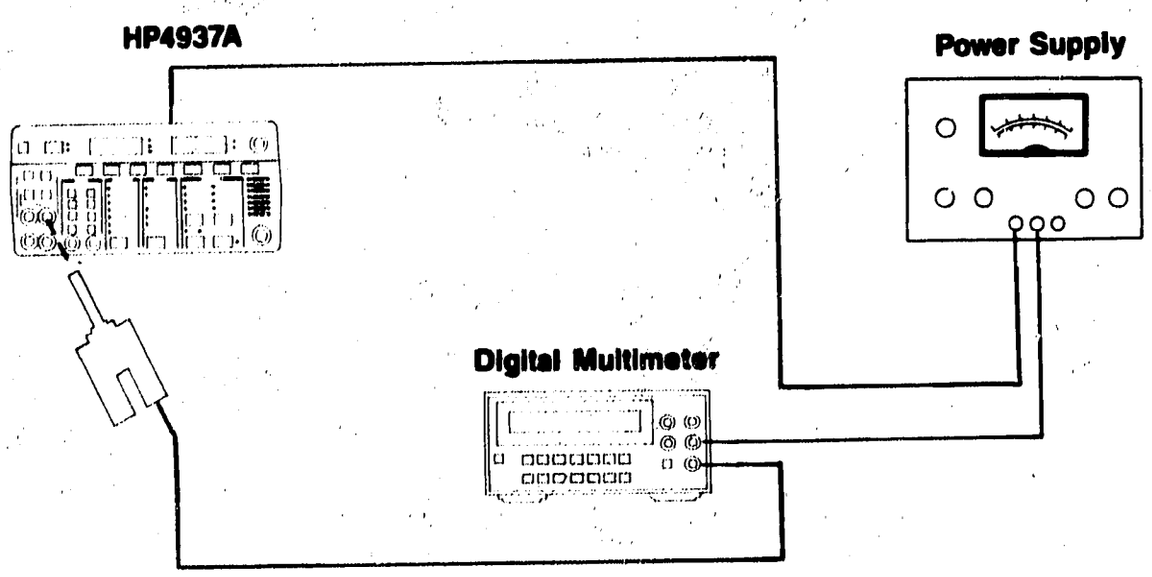


Figure 4-18A. *Ground Start*

Equipment:

Multimeter
Power Supply
Two 1K ohm resistors (P/N 0764-0016)

1. On the Hp 4937A set:

DISPLAY	RCV
SIGNALING	GROUND START
	ORIG

2. Connect the equipment as shown in Figure 4-18A. (The ground connection of the HP 4937A is on the rear panel.)

3. Set the power supply to 48 volts.

4. Connect a 1K ohm resistor across the dial jacks.

5. When the ON HK ORIG LED is on, the current should be less than 0.1 mA.

6. Press the DIAL button. When the OFF HK ORIG LED is on, the current should be >32.6 mA.

7. Ground the Tip. With the DIAL button out, the current should be >21 +/- .1 mA.

8. Press the ORIG TERM button. The HP 4937A should now be in Terminate mode.

4-32. Ground Start (con't)

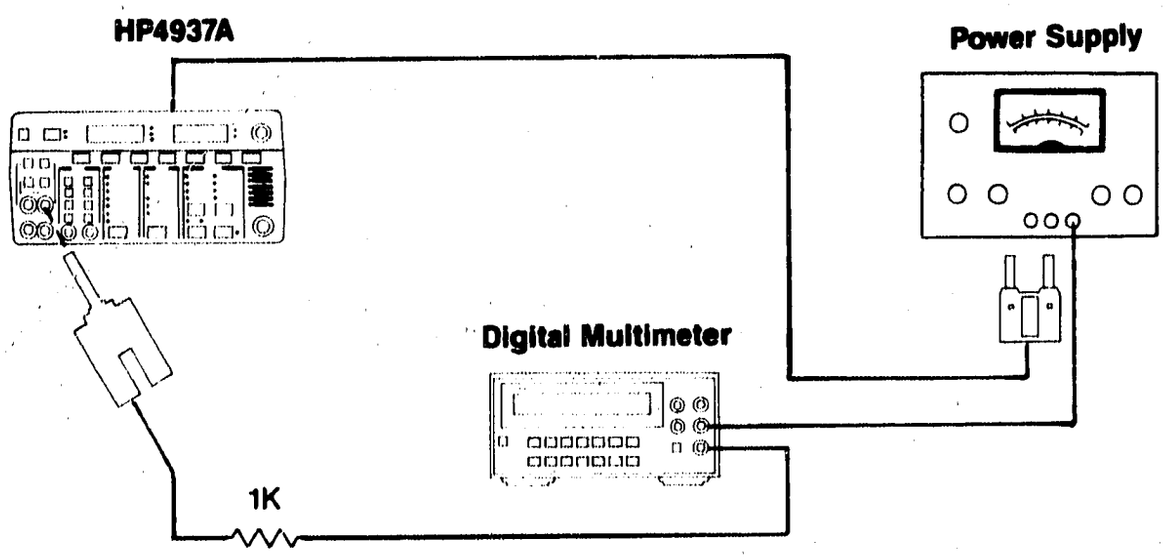


Figure 4-18B. *Ground Start*

9. Connect the equipment as shown in Figure 4-18B. (The ground connection of the HP 4937A is on the rear panel.)

10. The ON HOOK TERM LED should be on. The multimeter should read <0.1 mA.

11. Press the ON/OFF HOOK button. When the OFF HK TERM LED is on the multimeter should read >39 mA.

4-33. Loop Reverse Battery

Equipment

Storage Oscilloscope
Power Supply
Two 3K ohm resistors (P/N 0698-3338)

1. On the HP 4937A set:

SIGNALING	LOOP REVERSE BATTERY
	ORIG
	"A"

2. Connect the positive side of the power supply to the Tip and the negative side to the Ring. Set the power supply to 6.3 volts. The HP 4937A on HK TERM LED should be on.

3. Reverse the polarity on the Tip and Ring. The OFF HOOK TERM LED should be on.

4. Press the ORIG TERM button. The HP 4937A should be in Terminate mode. The OFFHK ORIG LED and the ON HK TERM LED should be on.

5. Remove the power supply and put a 3k ohm resistor from the Tip to Ring. The OFF HK ORIG LED should be on.

6. Press the ON/OFF HOOK button. The OFF HK TERM LED should come on.

7. Press the ON/OFF HOOK button. The ON HK TERM LED should come on.

8. Remove the 3k ohm resistor.

4-33. Loop Reverse Battery (con't)

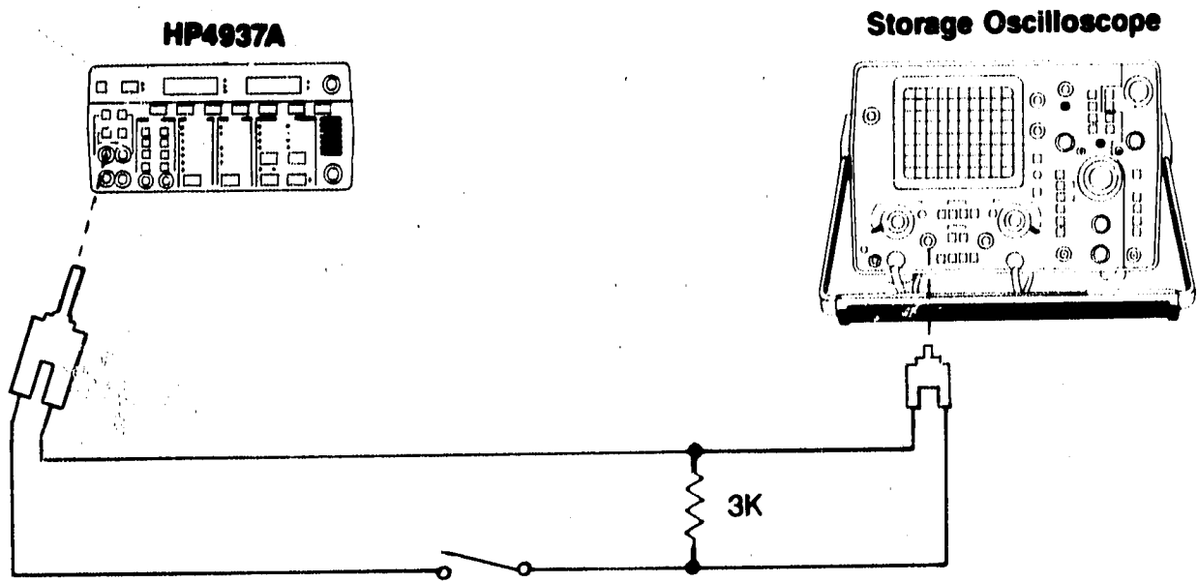


Figure 4-19. *Loop Reverse Battery*

9. Connect the equipment as shown in Figure 4-19.

10. The HP 4937A should be in Loop Reverse Battery and Terminate mode of signaling. Press SHIFT ON-OFF HOOK. This is the Wink mode. The ON HK TERM LED should be flashing.

11. Set up the storage oscilloscope: The AUTO STORE LED should be on. Press the WRITE button on the storage display then press the ERASE button on the Persistence Knob.

12. Close the contact switch.

13. The positive pulse should be 100 msec +/- 10 msec. The negative pulse should follow the 100 msec of the positive pulse and be 200 msec +/- 10 msec. The pulse should then go positive again and stay positive.

4-34. ABBREVIATED PERFORMANCE TEST

4-35. Transmitter Test

1. On the HP 4937A set:

MEASUREMENT	LEVEL FREQUENCY
OUTPUT LEVEL	fully clockwise
FREQUENCY	1004 Hz
DISPLAY	TRMT

2. Externally loop the transmitter to the receiver (jack A and jack B). The DISPLAY should read 13.0 dBm +/-0.1 dBm.

3. Change DISPLAY to RCV. The DISPLAY should read 13.0 dBm +/-0.1 dBm.

4. Change the FREQUENCY to 20 Hz. The DISPLAY should read 10-13 dBm.

5. Change the FREQUENCY to 8191 Hz. The DISPLAY should read 13 dBm +/-0.2 dBm.

6. Increase the frequency by 1 Hz. Verify that the right display reads 8192 Hz.

7. Change the MEASUREMENT to SIGNAL/NOISE and select C-message filter. The right DISPLAY should read >55 dB.

8. Select the 3 kHz FLAT filter. The right DISPLAY should read >55 dB.

4-36. Receiver Accuracy Test

See Figure 4-3

EQUIPMENT:

Ac Calibrator

1. Use the test setup shown in figure 4-3.
2. Set the ac calibrator to 0.7791 V (-0.05 dBm into 600 ohms).
3. Test the HP 4937A at each frequency given in table 4-16.

Table 4-14. *Abbreviated Receiver Accuracy Test Table*

FREQUENCY (ac calibrator)	LEVEL (0.7791 V) (4937A display)
20 Hz +/-1 Hz	-1.0 to +0.9 dBm
50 Hz +/-1 Hz	-0.5 to +0.4 dBm
200 Hz +/-1 Hz	-0.2 to +0.1 dBm
4 kHz +/-.01 kHz	-0.2 to +0.1 dBm

4-37. Tone Dropout Test

1. On the HP 4937A set:

MEASUREMENT	NOISE/TONE
DISPLAY	TRMT

2. Externally loop the transmitter to the receiver (jack A and jack B).

3. Set the transmit level to -47 dBm.

4. Change the HP 4937A DISPLAY to RCV. E-02 should be DISPLAYED.

4-38. Termination Impedance Test

1. On the HP 4937A set:

POWER	ON
DISPLAY	RCV
NOR and REV	press simultaneously
SET UP RCV	600
SET UP TRMT	600
MEASUREMENT	LEVEL FREQUENCY
OUTPUT LEVEL	adjust to 0.0 dBm

2. Press the BRG pushbutton. The display should read 6.1 dBm +/-0.1 dBm.

3 Release the BRG pushbutton.

4. Press in both 1200 pushbuttons. The display should read 0.0 +/-0.1 dBm.

5. Press in both 900 pushbuttons (150 for option 002 instruments). The display should read 0.0 dBm +/-0.1 dBm.

4-39. Return Loss

Note

Steps 1 through 4 are not applicable to the option 002 instruments.

1. Connect the 900-ohm resistor across the TRMT jack.

2. On the HP 4937A set:

NOR	pressed in
DISPLAY	TRMT
SET UP TRMT	900
SET UP RCV	900
MEASUREMENT	RET LOSS 2W
FILTER	ERL
OUTPUT LEVEL	-2 dBm

3. Set the HP 4937A DISPLAY to RCV.

4. The return loss as measured by the HP 4937A should be approximately 28.3 dB +/- 0.1 dB.

5. Connect a 600-ohm resistor across the TRMT jack.

6. On the HP 4937A set:

MEASUREMENT	RET LOSS 2W
DISPLAY	TRMT
SET UP TRMT	600
SET UP RCV	600
FILTER	ERL
OUTPUT LEVEL	-2 dBm

7. Set the HP 4937A DISPLAY to RCV.

8. The return loss as measured by the HP 4937A should be approximately 24.5 dB +/- 0.1 dB.

9. Loop the TRMT jack to the RCV jack with the 600-ohm resistor still connected across the TRMT jack.

4-39. Return Loss (con't)

10. On the HP 4937A set:

MEASUREMENT	RET LOSS 4W
DISPLAY	TRMT
SET UP TRMT	600
SET UP RCV	600
FILTER	ERL
OUTPUT LEVEL	-2 dBm

11. Set the HP 4937A DISPLAY to RCV. The return loss should be approximately 3.5 dB +/- 0.1 dB.

4-40. Hold Current Test

EQUIPMENT:

Ac/dc voltmeter
Digital multimeter
Power supply (HP 6218A)

1. Connect the equipment as shown in figure 4-15.

2. Adjust the power supply output for 8.5V +/- 0.1V.

3. On the HP 4937A set:

REV	pressed in
SIGNALING	A
SIG SELECT	LOOP
ORIG/TERM	ORIG
ON/OFF HOOK	OFF HOOK ORIG

4. The current displayed on the multimeter should be 21 mA +/- 1 mA.

5. On the HP 4937A set:

SIGNALING	B
HOLD OTHER	on

6. The current displayed on the multimeter should be 21 mA +/- 1 mA.

4-41. Dial Test

EQUIPMENT:

none

1. Using the SIG SELECT key select E/M.
2. Press DIAL pushbutton. An audible click (energize relay) should be heard.
3. Short the DIAL jacks. An audible click (energize relay) should be heard.
4. Remove short from the DIAL jacks. An audible click should be heard when relay is de-energized.

Table 4-15. Performance Test Record

Hewlett-Packard Model 4937A Transmission Impairment Measuring Set

Serial No.

Tested By Date

Repair Order No.

Recommended Calibration Interval 6 Month Interval

DESCRIPTION	Results PASS	FAIL
Transmitter Flatness at +10 dBm	———	———
Transmitter Flatness at -40 dBm	———	———
Distortion Test	———	———
Receiver Accuracy at +11 dBm and -40 dBm and -60 dBm	———	———
Detector Linearity Test	———	———
Filter Tests	———	———
Hold Tone Dropout Detector Test	———	———
Noise to Ground Test	———	———
Termination Impedance Test	———	———
2-Wire Return Loss	———	———
4-Wire Return Loss	———	———
Signaling Voltage Test	———	———
Battery Bridging Loss Test	———	———
Hold Current Test	———	———
E/M Signaling Type I	———	———
E/M Signaling Type II	———	———
E/M Signaling Type III	———	———
Ground Start	———	———
Loop Reverse Battery	———	———

SECTION V
ADJUSTMENTS

5-1. INTRODUCTION

5-2. This section describes the adjustments to the instrument that are necessary to bring the instrument into specification after repair or when a performance test has failed.

5-3. SAFETY CONSIDERATIONS

5-4. Listed warnings and cautions must be followed for your protection and to avoid damage to the equipment. Whenever internal instrument circuits are exposed, caution must be exercised. When using ac powered test equipment, the test equipment chassis should be connected to earth ground. With the HP 4937A in STBY(standby) ac power is still applied to the instrument and some dc voltages are still present. To completely power down the instrument, disconnect the instrument from the power source. For instruments with batteries (Option 001), disconnect the batteries also.

WARNING

The power switch does not turn off ac power and some dc power circuits.

5-5. EQUIPMENT REQUIRED

5-6. Test equipment needed for adjustments are listed in table 1-2. Test equipment with equivalent specifications may be substituted.

5-7. ADJUSTMENT LOCATIONS

5-8. Adjustment locations are shown on the component locators and service sheets in Section VIII.

5-9. ADJUSTMENT PROCEDURES

5-10. Adjustments should be done in the sequence given.

5-11. A2 Output Level and Transmit Monitor Loop Adjustments

REFERENCE:
A2 Transmitter Assembly

EQUIPMENT:
600 ohm resistor
voltmeter (HP 3456A)

PROCEDURE:

1. Connect the 600 ohm load load across the transmitter output and measure the level with the HP 3456A.
2. On the HP 4937A set:

DISPLAY	TRMT
MEASUREMENT	LEVEL FREQUENCY
FREQUENCY	1004 HZ
OUTPUT LEVEL	FULLY CLOCKWISE

3. Adjust A2R312, OUTPUT LEVEL, until 3.460V +/-2 mV is displayed on the HP 3456A.
4. Adjust the front panel OUTPUT LEVEL control until 775 mV +/-5 mV is displayed on the HP 3456A.
5. Connect the HP 3456A to A2TP7 (autorange output).
6. Adjust A2R322, LOOP ADJUST, until the HP 3456A reads 775 mV +/- 5 mV.
7. Remove the 600 ohm load.

5-12. A3 Offset Adjustment

REFERENCE:
A3 Receiver Assembly

EQUIPMENT:
Ac/dc Voltmeter (HP 3456A)

PROCEDURE:

1. On the HP 4937A set:

DISPLAY	TRMT
MEASUREMENT	NOISE

2. Short A3TP1 to A3TP2.
3. Short A3TP3 to A3TP4.
4. Measure the voltage at A3TP6. Adjust A3R208, OFFSET, until voltage reading is 0.0 +/-.3 mV dc.
5. Remove shorts placed in step 2a and 2b.

5-13. A3 Gain Adjustments

REFERENCE:
A3 Receiver Assembly

EQUIPMENT:

Synthesizer/Level Generator (HP 3336B)
Digital Voltmeter (HP 3456A)

PROCEDURE:

1. Connect the HP 3456A to the 600 ohm output of the HP 3336B.
2. Set the HP 3336B for an output of 3.53 dBm.
3. Adjust the HP 3336B to 1.166 VRMS +/-1 mV on the HP 3456A (connect a 600 ohm resistor across the input jacks of the HP 3456A).
4. On the HP 4937A set:

DISPLAY	RCV
MEASUREMENT	LEVEL FREQUENCY
SET UP TRMT	600 ohms
SET UP RCV	600 ohms

5. Move the HP 3456A from the HP 3336B to the HP 4937A, A3TP7.
6. Adjust A3R508, RCVR GAIN, until 1.66 VRMS is displayed on the HP 3456A.

5-14. A3 Average Detector Adjustment

REFERENCE:
A3 Receiver Assembly

EQUIPMENT:
Voltmeter (HP 3456A)
Synthesizer/Level Generator (HP 3336B)

1. Connect the HP 3456A to the 600 ohm output of the HP 3336B and adjust the output of the HP 3336B until 1.166 VRMS +/- 1mV is displayed on the HP 3456A.

2. On the HP 4937A set:

MEASUREMENT	LEVEL FREQUENCY
DISPLAY	RCV
SET UP	600 ohms

3. Connect the HP 3456A to A3TP5 and change the mode to DC volts.

4. Adjust A3R106, AVG DET, until 2.145 volts +/-1 mV is displayed by the HP 3456A.

5. The HP 4937A should display 3.5 dBm to 3.6 dBm.

5-15. A3 QRMS Detector Adjustment

Equipment:
Voltmeter (HP 3456A)
Synthesizer/Level Generator (HP 3336B)

1. Connect the HP 3456A to the 600 ohm output of the HP 3336B and adjust the output to 1.166 VRMS +/-1mV.

2. On the HP 4937A set:

MEASUREMENT	NOISE
FILTER	3 kHz
SET UP	600 OHMS
DISPLAY	RCV

3. Connect the HP 3456A to the 600 ohm output jack of the HP 3336B. Adjust the output of the HP 3336B until the HP 3456A reads 1.166 VRMS +/-1 mV.

4. Connect the HP 3456A to A3TP5 of the HP 4937A and change the mode of the HP 3456A to DC volts.

5. Adjust A3R102 (QRMS) until 2.099 volts +/- 1 mV is displayed on the HP 3456A.

5-16. A3 Notch Filter Adjustment

REFERENCE:
A3 Receiver Assembly

EQUIPMENT:
Oscilloscope (HP 1741A)
Synthesizer/Level Generator (HP 3336B)

PROCEDURE:

1. Connect the 600 ohm output of the HP 3336B to the receive input of the HP 4937A. Set the output of the HP 3336B to +7 dBm.

2. On the HP 4937A set:

MEASUREMENT	LEVEL FREQUENCY
DISPLAY	RCV
SET UP	600 OHMS

3. Move A3J609 jumper to the right, shorting pins 5 to 12, 6 to 11, 7 to 10, and 8 to 9.

4. Connect the oscilloscope to A3TP15.

5. Set the HP 3336B frequency to 995 Hz.

6. Adjust A3R706 (995 Hz) for a minimum ac signal on the oscilloscope.

7. Connect the oscilloscope probe to A3TP14.

8. Set the HP 3336B frequency to 1010 Hz.

9. Adjust A3R610, 1010 Hz, for a minimum ac signal on the oscilloscope.

10. Connect the oscilloscope probe to A3TP17.

11. Change the frequency on the HP 4937A to 1025 Hz.

13. Adjust A3R711, 1025 Hz, for a minimum signal on the oscilloscope.

14. Move the A3J609 shorting bar to the left, shorting pins 1 to 16, 2 to 15, 3 to 14, and 4 to 13.

5-17. A3 C-message Filter Adjustments

REFERENCE:
A3 Receiver Assembly

EQUIPMENT:
Digital voltmeter (HP 3456A)
Synthesizer/Level Generator (HP 3336B)

PROCEDURE:

1. Connect the HP 3336B 600 ohm output to the HP 4937A. Set the HP 3336B to 1000 Hz at +7 dBm.

2. On the HP 4937A set:

MEASUREMENT	LEVEL FREQUENCY
DISPLAY	RCV
SET UP	600 OHMS

3. Connect the HP 3456A to A3TP3-5. Measure the ac voltage at A3TP8-5. Store this in the Y Register by pressing Store and then 8. Put the HP 3456A into the dB mode by pressing Math, 9.

4. Connect the voltmeter to A3TP8-3.

6. Adjust A3R309, C-MESS GAIN, until the voltage at A3TP8-3 is 0.0 to -0.07 dB.

5-18. Receiver Bandwidth

EQUIPMENT:
Synthesizer/Level Generator (HP 3336B)

1. Connect the 600 ohm output of the HP 3336B to the receiver of the HP 4937A. Set the HP 3336B output to 1000 Hz at 0 dB.

2. On the HP 4937A set:

MEASUREMENT	LEVEL FREQUENCY
DISPLAY	RCV
SET UP	600 OHMS

3. When the HP 4937A recognizes the 1000 Hz, 0 dBm signal, press the level zero button.

4. Change the frequency on the HP 3336B to 18 KHz. The power loss read by the HP 4937A should be 3 dB +/- 0.5 dB.

5-19. 48 Volt Supply Adjustment

EQUIPMENT:
Voltmeter (HP 3456A)

1. On the HP 4937A set:

MEASUREMENT	NOISE
DISPLAY	TRMT
SIGNALING	LOOP
ORIG/TERM	TERM
HOLD OTHER	ON
OFF HK ORIG	ON

2. Connect the negative lead of the HP 3456A to A2TP602 on the HP 4937A and the positive lead of the HP 3456A to GND.

3. Adjust A2R603 until the voltage is 45.0 volts +/-100 mV.

5-20 A2 Hold Circuit Adjustments

REFERENCE:
A2 Transmitter Assembly

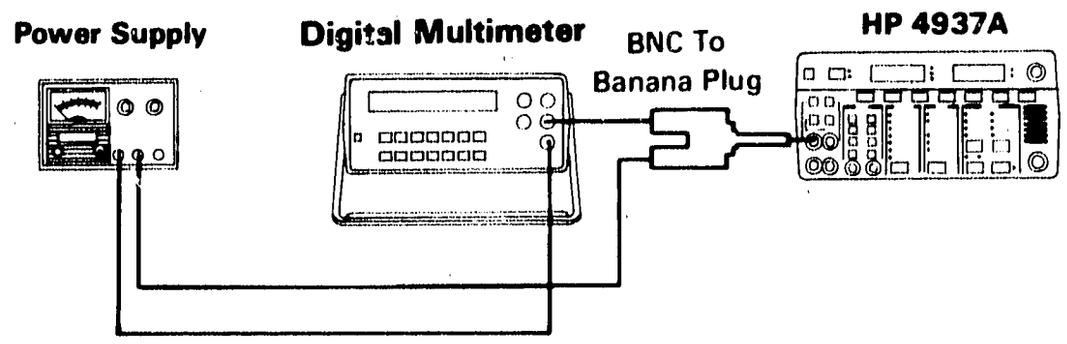


Figure 5-1. *Hold Circuit Adjustment*

EQUIPMENT:
Digital multimeter (HP 3478A)
Power supply (HP 6034A)

PROCEDURE:

1. Connect equipment as shown in figure 5-1.

2. Adjust the power supply output for 8.5 V +/-0.1 V.

3. On the HP 4937A set:

MEASUREMENT	NOISE
DISPLAY	TRMT
SIGNALING	B SELECTED
SET UP	600 OHMS
HOLD OTHER	ON

4. Adjust A2R448, HOLD CURRENT, to a dc current reading of 21.0 mA +/- 0.1 mA on the HP 3478A.

5. On the HP4937A set:

SIGNALING	NOR, A SELECTED
HOLD OTHER	OFF
SIGNALING	LOOP, ORIG
ON/OFF HOOK	OFF HOOK

6. Adjust A2R468, HOLD CIRCUIT, to a dc current reading of 21.0 mA +/- 0.1 mA on the HP 3478A.

5-21. Charging Circuit Test

EQUIPMENT:
Multimeter (HP 3478A)

1. Turn off the power of the HP 4937A and remove the battery pack from the A2J6 connector.
2. Connect the HP 3478A between A2J6 pins 1 and 2. The reading should be >17 volts DC.
3. Change the HP 3478A to DC current. The reading should be between 365 and 390 mA.
4. Remove the HP 3478A and reconnect the battery pack to A2J6.

5-22. Selecting a Capacitor for SRH 900 Ohms

NOTE

A2C360 is factory selected. Use this procedure if C360 must be changed from the A2 board.

EQUIPMENT:
- 900 ohm resistor
- Oscilloscope (HP 1741A)
- Decade Capacitor (HP 4440B)

PROCEDURE:

1. On the HP 4937A set:

DISPLAY	TRMT
SIGNALING	A/NOR
SET UP	600 OHMS
DIAL	OFF
BRIDGE	OFF
MEASUREMENT	RET LOSS 2W
FILTER	ERL

2. Set the level on the HP 4937A to -2 dBm.
3. Set the switch on the HP 4937A to 900 ohms.
4. Put the 900 ohm resistor across the transmit jack of the HP 4937A.
5. Set the display on the HP 4937A to RCV.
6. Set the filter on the HP 4937A to SRL-HI.
7. If the display on the HP 4937A reads less than 36.2 dB the capacitor will have to be added. Connect the decade capacitor from ground to the eyelet next to the transformer's output.
8. Connect a scope from ground to pin 2 of the receiver input transformer.
9. Adjust the decade capacitor until the waveform on the scope is a minimum.

5-22. Selecting a Capacitor for SRH 900 Ohms (con't)

10. The HP 4937A display should read 36.5 to 36.6 dB.

11. Add 30 pf to the capacitance measured with the decade capacitor and install a cap of that value between the test pin and the ground eyelet.

Note

C360 must have a 5% tolerance and be between 80 pf and 300 pf, in 10 pf increments.

Suggested Parts:

100 pf	0140-0193
120 pf	0160-2205
130 pf	0140-0195
140 pf	0140-0217
150 pf	0140-0196
160 pf	0160-2206
180 pf	0140-0197
200 pf	0140-0198
220 pf	0160-0134
240 pf	0140-0199
270 pf	0140-0210
300 pf	0160-2207

SECTION VI

REPLACEABLE PARTS

6-1. INTRODUCTION

6-2. This section contains information for ordering parts. Table 6-1 lists the abbreviations used in table 6-3, table 6-2 is the Manufacturer's Code List, and table 6-3 lists the replaceable parts. Figures 6-1 and 6-2 are illustrated parts breakdown.

6-3. REPLACEABLE PARTS LIST

6-4. Table 6-3 lists the replaceable parts in alphanumerical order. Included is the description, quantity (total number used in the instrument), the HP Part Number and the manufacturer's part number.

6-5. ORDERING INFORMATION

6-6. To order a part listed in the replaceable parts table, quote the Hewlett- Packard part number, indicate the quantity required, and address the order to the nearest Hewlett-Packard Sales Office.

Table 6-1. *Reference Designations and Abbreviations*

REFERENCE DESIGNATIONS

A = assembly	J = electrical connector (stationary portion); jack	TB = terminal board
B = fan; motor	L = coil; inductor	TP = test point
BT = battery	MP = misc. mechanical part	U = integrated circuit; microcircuit
C = capacitor	P = electrical connector (movable portion); plug	V = electron tube; glow lamp
CR = diode; diode thyristor; varactor	Q = transistor; SCR; triode thyristor	VR = voltage regulator; breakdown diode
DL = delay line	R = resistor	W = cable
DS = annunciator; lamp; LED	RT = thermistor	X = socket
E = misc electrical part	S = switch; jumper	Y = crystal unit (piezo-electric or quartz)
F = fuse	T = transformer	
FL = filter		
H = hardware		

ABBREVIATIONS

A = amperes	DIA = diameter	K = kilo (10^3), kilohm
AC = alternating current	DIP = dual in-line package	
ADD = address	DPDT = double-pole, double-throw	LED = light emitting diode
ADJ = adjust, adjustment	DPST = double-pole, single-throw	LFT = left
AL = aluminum	DR = drive	LG = long
AR = as required	DRVR = driver	LH = lefthand
ASM = algorithmic state machine	DSPL = display	LKWR = lockwasher
ASSY = assembly	DTL = diode-transistor logic	LP = low pass
		LS = low power Schottky
B = base	E = emitter	LSB = least significant bit
BCD = binary coded decimal	ECL = emitter-coupled logic	
BeCu = beryllium copper	ELECT = electrolytic	M = milli (10^{-3}), male, mega (10^6), megohm
BIN = binary	ENCAP = encapsulated	MET FLM = metal film
BLK = black	EXT = external	MET OX. = metal oxide
BLU = blue	EXTR = extractor	MHZ = megahertz
BP = band pass		MFR = manufacturer
BRN = brown	F = female, farads	MINTR = miniature
BRS = brass	FF = flip-flop	MISC = miscellaneous
BTU = British thermal unit	FLM = film	MOM = momentary
	FRNT = front	MOS = metal oxide semiconductor
C = collector	FXD = fixed	MSB = most significant bit
CATH = cathode		MTCHD = matched
CCW = counterclockwise	G = giga (10^9)	MTG = mounting
CD PL = cadmium plate	GE = germanium	MTLC = metallic
CER = ceramic	GL = glass	
CERMET = ceramic met flm	GND = ground(ed)	N = nano (10^{-9})
CKTS = circuits	GP = General Purpose	N.C. = normally closed, no connection
C FLM = carbon film	GRA = gray	NE = neon
CLK = clock	GRN = green	NO. = number
CLR = clear		N.O. = normally open
CMOS = complementary metal oxide semiconductor logic	H = henries	NP = No Polarity
	HDW = hardware	NPN = negative-positive-negative
COM = common	HEX = hexagon, hexagonal, six	NPO = negative-positive zero (zero temperature coefficient)
COML = commercial	HP = high pass	NRFR = not recommended for field replacement
COMP = composition	HR = hour(s)	NS = normally shorting, nanosecond
COMPL = complete	HZ = Hertz	NSR = not separately replaceable
COND = conductor		NYL = nylon
CONN = connector	IC = integrated circuit	
CONT = contact	ID = inside diameter	OBD = order by description
CPRSN = compression	IF = intermediate frequency	OD = outside diameter
CTL = complementary-transistor logic	IN. = inch, inches	ORN = orange
	INCAND = incandescent	
CW = clockwise	INCL = include(s)	
	INSUL = insulation, insulated	
D = diameter	INT = internal	
DC = direct current	INTL = internal	
DEPC = deposited carbon		

Table 6-1. *Reference Designations and Abbreviations (Continued)*

ABBREVIATIONS

P = pico (10^{-12})	RVT = rivet	TRN = turn
PC = printed circuit	RWV = reverse working voltage	TTL = transistor-transistor logic
PCA = printed-circuit assembly		TYP = typical
PF = picofarad	S = second	
PIV = Peak Inverse Voltage	SB = slow blow	U (μ) = micro (10^{-6})
PK = peak	SCR = silicon controlled rectifier	UF = microfarad
PNL = panel	SE = selenium	US = microseconds
PNP = positive-negative-positive	SGL = single	
P-P = peak-to-peak	SI = silicon	V = volt(s)
PPM = parts per million	SHK = shank	VAR = variable
POLYC = polycarbonate	SIP = single in-line package	VCO = voltage controlled oscillator
POLYE = polyethylene	SKT = socket	
POLYSTY = polystyrene	SLDR = solder	VDCW = direct current working volts
PORC = porcelain	SPCG = spacing	VIO = violet
POSN = position(s)	SPDT = single-pole, double-throw	VNP = no polarity voltage
POZI = pozidrive	SPST = single-pole, single-throw	
PRV = peak reverse voltage	SST = stainless-steel	W = watts
PWV = peak working voltage	STL = steel	WT = weight
P/O = part of	SZ = size	WW = wirewound
		WHT = white
R = ring	T = tip	WIP = wiper
RAM = random access memory	TA = tantalum	WIV = working inverse voltage
ROM = read only memory	TEL = telephone	WSHR = washer
RECT = rectifier	T.C. = Temp. Compensated, temp. coefficient	X = times, multiple
RF = radio frequency		
RH = right hand	THKNS = thickness	YEL = yellow
RMS = root-mean-square	TI = titanium	
RND = round	TGL = toggle	ZNR = zener
RT = right hand	THD = thread	
RTL = resistor-transistor logic	THK = thick	ϕ = phi, phase
RTNT = retainer	TOL = tolerance	
RTRY = rotary	TRMR = trimmer	

Table 6-2. *Manufacturer Code List*

MFR NO.	MANUFACTURER NAME	ADDRESS		ZIP CODE
00000	ANY SATISFACTORY SUPPLIER			
01121	ALLEN-BRADLEY CO	MILWAUKEE	WI	53204
01295	TEXAS INSTR INC SEMICOND CMPNT DIV	DALLAS	TX	75222
03888	K D I PYROFILM CORP	WHIPPANY	NJ	07981
04713	MOTOROLA SEMICONDUCTOR PRODUCTS	PHOENIX	AZ	85008
06383	PANDUIT CORP	TINLEY PARK	IL	60477
07716	TRW INC BURLINGTON DIV	BURLINGTON	IA	52601
12969	UNITRODE CORP	WATERTOWN	MA	02172
13103	THERMALLOY CO	DALLAS	TX	75234
17856	SILICONIX INC	SANTA CLARA	CA	95054
19701	MEPCO/ELECTRA CORP	MINERAL WELLS	TX	76067
24355	ANALOG DEVICES INC	NORWOOD	MA	02062
24546	CORNING GLASS WORKS (BRADFORD)	BRADFORD	PA	16701
25088	SIEMENS CORP	ISELIN	NJ	08830
27014	NATIONAL SEMICONDUCTOR CORP	SANTA CLARA	CA	95051
28480	HEWLETT-PACKARD CO CORPORATE HQ	PALO ALTO	CA	94304
3L585	RCA CORP SOLID STATE DIV	SOMERVILLE	NJ	
32293	INTERSIL INC	CUPERTINO	CA	95014
32997	BOURNS INC TRIMPOT PROD DIV	RIVERSIDE	CA	92507
56289	SPRAGUE ELECTRIC CO	NORTH ADAMS	MA	01247
72136	ELECTRO MOTIVE CORP	FLORENCE	SC	06226
75042	TRW INC PHILADELPHIA DIV	PHILADELPHIA	PA	19108
8E175	BURR BROWN CO	TUCSON	AZ	35801
90201	MALLORY CAPACITOR CO	INDIANAPOLIS	IN	46206

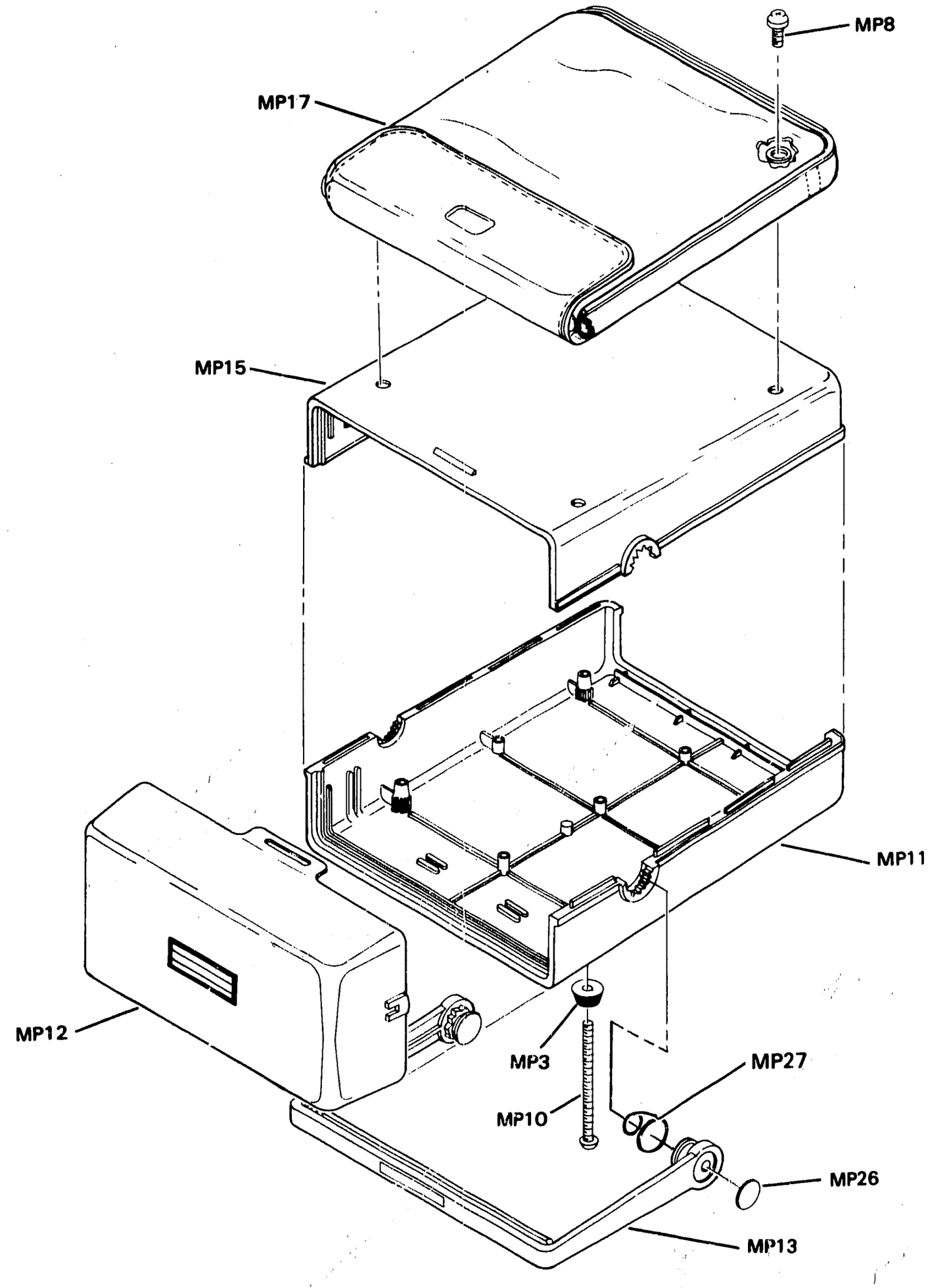
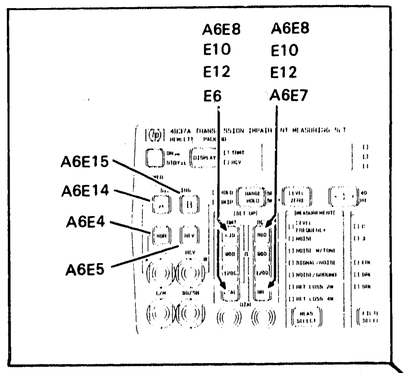


Figure 6-1. *Illustrated Parts Breakdown of Case and Covers*

MODEL 4937A
REPLACEABLE PARTS



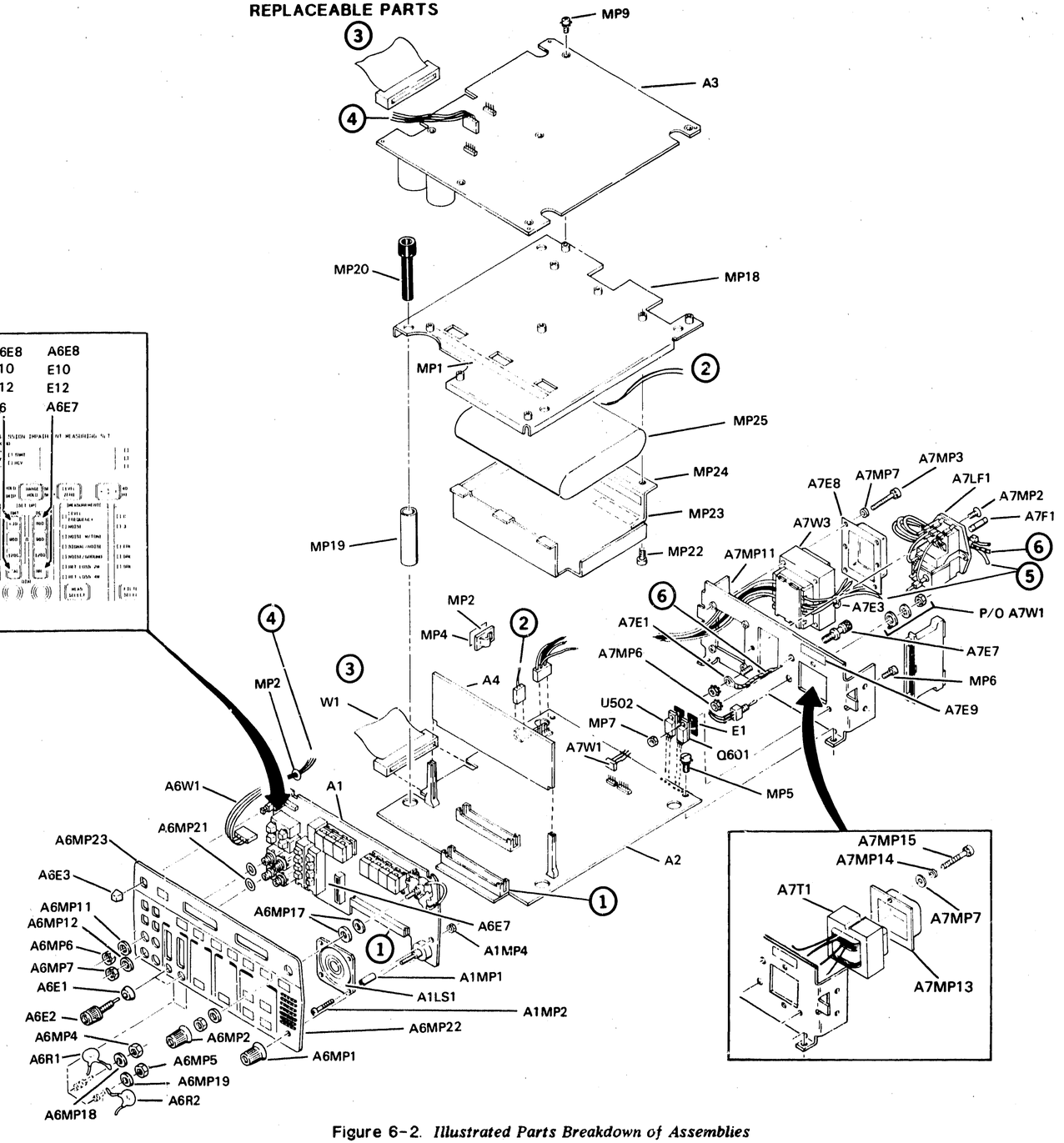


Figure 6-2. *Illustrated Parts Breakdown of Assemblies*

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
				CHASSIS PARTS		
A2	04937-60002	1		TRANSMITTER BRD	28480	04937-60002
A3	04937-60003	1		RECEIVER BRD	28480	04937-60003
A4	04937-60004	1		DCU ASSEMBLY	28480	04937-62601
A7	04937-62606	1		REAR PANEL ASSY	28480	04937-62606
A9	04937-60009	1		SIGNALING HLD ASSY	28480	04937-60009
E1	0340-0949	2		TRANS INSULATOR	28480	0340-0949
E2	2110-0296	1		FUSE 2A 250V	28480	2110-0296
MP1	0460-1027			FOAM ADH-BACKED	28480	0460-1027
MP2	0400-0133	1		GROMMET CHAN	28480	1400-0133
MP3	0403-0414	4		FOOT BUMPER	28480	0403-0414
MP4	0470-1146			ADHESIVE	28480	0470-1146
MP5	2200-0103	2		SCR MCH 4-40 .250	28480	2200-0103
MP6	2200-0704	2		MS 4-40 .375	28480	2200-0704
MP7	0590-0810	2		NUT-HEX-DBL-CHAM	28480	0590-0810
MP8	0624-0485	4		SCR-TPG 8-16	28480	0624-0485
MP9	2360-0117	6		SCR MCH 6-32 .375	28480	2360-0117
MP10	2520-0014	4		MCH SCR 8-32 4IN	28480	2520-0014
MP11	4040-1704	1		CASE BOTTOM HALF	28480	4040-1704
MP12	5040-4469	1		FRONT COVER	28480	5040-4469
MP13	5040-4470	1		HANDLE-CASE	28480	5040-4470
MP14	5040-4471	2		FOOT REAR	28480	5040-4471
MP15	5040-4480	1		CASE TOP HALF	28480	5040-4480
MP16	5060-7159	1		POWER CRD STRAP	28480	5060-7159
MP17	04951-40005	1		POUCH-SOFT CASE	28480	04951-40005
MP18	04937-00002	1		SUPPORT SHIELD	28480	04937-00002
MP19	5040-4467	4		PLASTIC SPCR SHT	28480	5040-4467
MP20	5040-4468	4		PLASTIC SPCR LNG	28480	5040-4468
	04937-90002	1		OPERATING MANUAL	28480	04937-90002
	04937-90004	1		QUICK REF GUIDE	28480	04937-90004
	4937A/001 OPT			ADD BATTERIES		
	4937A/002 OPT			ADD EXTRA MANUAL		
				OPTION 001 ONLY		
MP21	1400-0510	1		CLAMP-CABLE	28480	1400-0510
MP22	2510-0103	3		CSR MCH 8-32 .375	28480	2510-0103
MP23	7120-5635	1		LABEL-WARNING	28480	7120-5635
MP24	04937-00003	1		BATTERY HOLDER	28480	04937-00003
MP25	04937-80006	1		BATTERY PACK	28480	04937-80006
MP26	04937-80004	1		LABEL-HANDLE	28480	04937-80004
MP27	1460-2096	2		SPRINGS,COMPRESSION	28480	1460-2096
Q601	1854-0727	1		XSTR NPN 2N6474	28480	1854-0727
U502	1826-0393	1		IC-LM317T	28480	1826-0393
W1	04937-61604	1		FLAT RIBBON ASSY	28480	04937-61604
W2	8120-1521	1		CA-ASSY 18 AWG (POWER CORD)	28480	8120-1521

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1	04937-60001	3	2	SWITCHBOARD ASSEMBLY (STANDARD)	28480	04937-60001
A1	04937-60006	8	2	SWITCHBOARD ASSEMBLY (OPTION 002)	28480	04937-60006
A1C1	0160-3535	2	1	CAPACITOR-FXD 560PF +-5% 300VDC MICA	28480	0160-3535
A1C2	0160-5881	5	1	CAPACITOR-FXD 2.16UF +-1% 200VDC	28480	0160-5881
A1C3	0160-5332	1	112	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A1C4	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A1C5	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A1C6	0180-2815	1	4	CAPACITOR-FXD 100UF+-20% 10VDC TA	28480	0180-2815
A1C7	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A1C8	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A1C9	0180-2815	1		CAPACITOR-FXD 100UF+-20% 10VDC TA	28480	0180-2815
A1C10	0180-2815	1		CAPACITOR-FXD 100UF+-20% 10VDC TA	28480	0180-2815
A1C11	0160-5371	8	1	CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-5371
A1C12	0160-3508	9	5	CAPACITOR-FXD 1UF +80-20% 50VDC CER	28480	0160-3508
A1C13	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A1C14	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A1CR1	1902-1256	5	4	DIODE-ZNR 10V 10% PD=5W IR=75UA	28480	1902-1256
A1CR2	1901-0731	7	7	DIODE-PWR RECT 400V 1A	28480	1901-0731
A1CR3	1902-1256	5		DIODE-ZNR 10V 10% PD=5W IR=75UA	28480	1902-1256
A1CR4	1901-0731	7		DIODE-PWR RECT 400V 1A	28480	1901-0731
A1CR5	1902-1256	5		DIODE-ZNR 10V 10% PD=5W IR=75UA	28480	1902-1256
A1CR6	1901-0731	7		DIODE-PWR RECT 400V 1A	28480	1901-0731
A1CR7	1902-1256	5		DIODE-ZNR 10V 10% PD=5W IR=75UA	28480	1902-1256
A1CR8	1901-0731	7		DIODE-PWR RECT 400V 1A	28480	1901-0731
A1CR100	1906-0074	1	1	DIODE-ARRAY 50V 400MA	28480	1906-0074
A1DS104	1990-0759	6	1	LED-LIGHT BAR MODULE LUM-INT=3MCD	28480	HLMP-2620
A1DS105	1990-0540	3	7	DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7650
A1DS106	1990-0540	3		DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7650
A1DS107	1990-0540	3		DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7650
A1DS110	1990-0540	3		DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7650
A1DS111	1990-0540	3		DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7650
A1DS112	1990-0540	3		DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7650
A1DS113	1990-0540	3		DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7650
A1J1	1251-5063	9	3	CONNECTOR 6-PIN M POST TYPE	28480	1251-5063
A1J2	1251-8492	4	1	CONN POST TYPE .100-PIN-SPCG 26-CONT	28480	1251-8492
A1J3	1251-7308	9	2	CONN-POST TYPE .100-PIN-SPCG 60-CONT	28480	1251-7308
A1J400	1252-1134	9	4	CONNECTOR-TEL JACK 2-CKT .25-SHK-DIA	28480	1252-1134
A1J401	1252-1134	9		CONNECTOR-TEL JACK 2-CKT .25-SHK-DIA	28480	1252-1134
A1J600	1252-1134	9		CONNECTOR-TEL JACK 2-CKT .25-SHK-DIA	28480	1252-1134
A1J601	1252-1134	9		CONNECTOR-TEL JACK 2-CKT .25-SHK-DIA	28480	1252-1134
A1K100	0490-1383	3	4	RELAY 4C 5VDC-COIL 2A 250VAC	28480	0490-1383
A1K101	0490-1383	3		RELAY 4C 5VDC-COIL 2A 250VAC	28480	0490-1383
A1K103	0490-1383	3		RELAY 4C 5VDC-COIL 2A 250VAC	28480	0490-1383
A1K104	0490-1354	8	17	RELAY 2C 5VDC-COIL 2A 250VAC (STANDARD ONLY)	28480	0490-1354
A1MP1	0380-1013	3	2	SPACER-RND .600-IN-LG .115-IN-ID	00000	ORDER BY DESCRIPTION
A1MP2	2200-0173	6	2	SCREW-MACH 4-40 1-IN-LG 82 DEG	00000	ORDER BY DESCRIPTION
A1MP3	2200-0173	6		SCREW-MACH 4-40 1-IN-LG 82 DEG	00000	ORDER BY DESCRIPTION
A1MP4	2260-0001	5	2	NUT-HEX-DBL-CHAM 4-40-THD .094-IN-THK	28480	2260-0001
A1MP5	2260-0001	5		NUT-HEX-DBL-CHAM 4-40-THD .094-IN-THK	28480	2260-0001
A1MP6	04937-80005	9	1	OVERLAY BATT DIS	28480	04937-80005
A1MP7	04937-80017	3	1	LABEL 002 (OPTION 002)	28480	04937-80017
A1R1	0698-6261	6	4	RESISTOR 600 .25% .25W F TC=0+-50	28480	0698-6261
A1R2	0698-6261	6		RESISTOR 600 .25% .25W F TC=0+-50	28480	0698-6261
A1R3	0699-0657	2	2	RESISTOR 74.8 .25% .5W F TC=0+-50 (OPTION 002)	28480	0699-0657
A1R3	0699-0658	4	2	RESISTOR 450 .25% .5W F TC=0+-50	28480	0699-0658
A1R4	0699-0657	4	2	RESISTOR 300 .25% .5W F TC=0+-50	28480	0699-0657
A1R5	0699-0657	4		RESISTOR 74.8 .25% .5W F TC=0+-50 (OPTION 002)	28480	0699-0657
A1R5	0699-0658	5		RESISTOR 450 .25% .5W F TC=0+-50	28480	0699-0658
A1R6	0699-0657	4		RESISTOR 300 .25% .5W F TC=0+-50	28480	0699-0657
A1R7	2100-3857	7	1	RESISTOR-VAR CONTROL CC 10K 20% SPCL	28480	2100-3857
A1R8	0757-0346	2	2	RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A1R9	0698-4123	5	1	RESISTOR 499 1% .125W F TC=0+-100	24546	C4-1/8-T0-499R-F
A1R10	0698-3450	9	1	RESISTOR 42.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4222-F
A1R11	0698-3132	4	1	RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F
A1R12	0698-3497	4	2	RESISTOR 6.04K 1% .125W F TC=0+-100	24546	C4-1/8-T0-604R-F
A1R13	0757-0442	9	16	RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A1R14	0698-8063	0	2	RESISTOR 1K .1% .5W F TC=0+-50	20480	0698-8063
A1R15	0698-5453	6	1	RESISTOR 900 .1% .125W F TC=0+-50	03888	PME55 T-2-900R-B
A1R16	0698-8063	0		RESISTOR 1K .1% .5W F TC=0+-50	20480	0698-8063

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1R17	0698-6261	6		RESISTOR 600 .25% .25W F TC=0+-50	28480	0698-6261
A1R18	0757-0465	6	10	RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A1R19	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A1R20	2100-3858	8	1	RESISTOR-VAR CONTROL CP 50K 20% 10CW	28480	2100-3858
A1S100	3101-2124	2	1	SWITCH-PB DPDT ALTNG .25A 115VAC	28480	3101-2124
A1S200	3101-2391	5	4	SWITCH-PB 2-STATION 15MM C-C SPACING	28480	3101-2391
A1S201	3101-2391	5		SWITCH-PB 2-STATION 15MM C-C SPACING	28480	3101-2391
A1S300	3101-2391	5		SWITCH-PB 2-STATION 15MM C-C SPACING	28480	3101-2391
A1S301	3101-2391	5		SWITCH-PB 2-STATION 15MM C-C SPACING	28480	3101-2391
A1S302	3101-2682	7	8	SWITCH-PB 4-STATION 10MM C-C SPACING	28480	3101-2682
A1S303	3101-2682	7		SWITCH-PB 4-STATION 10MM C-C SPACING	28480	3101-2682
A1S402	3101-2682	7		SWITCH-PB 4-STATION 10MM C-C SPACING	28480	3101-2682
A1S403	3101-2682	7		SWITCH-PB 4-STATION 10MM C-C SPACING	28480	3101-2682
A1S502	3101-2682	7		SWITCH-PB 4-STATION 10MM C-C SPACING	28480	3101-2682
A1S503	3101-2682	7		SWITCH-PB 4-STATION 10MM C-C SPACING	28480	3101-2682
A1S602	3101-2682	7		SWITCH-PB 4-STATION 10MM C-C SPACING	28480	3101-2682
A1S603	3101-2682	7		SWITCH-PB 4-STATION 10MM C-C SPACING	28480	3101-2682
A1SG1	1970-0078	0	2	TUBE-ELECTRON SURGE V PTCTR	25088	B1-A350/15
A1SG2	1970-0078	0		TUBE-ELECTRON SURGE V PTCTR	25068	B1-A350/15
A1SP1	9160-0273	8	1	LOUDSPEAKER 50 MM SQUARE SPEAKER; IMP=8	28480	9160-0273
A1U209	1820-3165	5	5	IC DRVR CMOS PRPHL GP LATCH INPUT OCTL	28480	1820-3165
A1U210	1820-2132	4	2	IC DRVR CMOS LED DRVR	32293	ICM7218A
A1U212	1820-2132	4		IC DRVR CMOS LED DRVR	32293	ICM7218A
A1U214	1826-0682	7	1	IC AUDIO AMPL PWR 8-DIP-P PKG	27014	LM386N-1
A1U514	1826-0678	1	1	IC OP AMP GP DUAL TO-99 PKG	27014	LM358H
A1XDS1	1200-0915	3	3	SOCKET-DSPL 14-CONT DIP DIP-SLDR	28480	1200-0915
A1XDS2	1200-0915	3		SOCKET-DSPL 14-CONT DIP DIP-SLDR	28480	1200-0915
A1XDS3	1200-0915	3		SOCKET-DSPL 14-CONT DIP DIP-SLDR	28480	1200-0915
A2	04937-60011	5	1	TRANSMITTER BOARD ASSEMBLY (STANDARD)	28480	04937-60011
A2	04937-60012	6	1	TRANSMITTER BOARD ASSEMBLY (OPTION 002)	28480	04937-60012
A2C101	0160-5332	1	29	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A2C201	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A2C202	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A2C203	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A2C204	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A2C205	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A2C301	0180-3226	0	2	CAPACITOR-FXD 100UF 20% 25VDC	28480	0180-3226
A2C302	0160-3420	4	4	CAPACITOR-FXD 7500PF +-1% 100VDC MICA	28480	0160-3420
A2C303	0160-3936	7	3	CAPACITOR-FXD 700PF +-1% 100VDC MICA	28480	0160-3936
A2C304	0160-0218	2	4	CAPACITOR-FXD 2400PF +-1% 300VDC MICA	28480	0160-0218
A2C305	0160-3291	7	5	CAPACITOR-FXD 1200PF +-1% 100VDC MICA	28480	0160-3291
A2C306	0160-3420	4		CAPACITOR-FXD 7500PF +-1% 100VDC MICA	28480	0160-3420
A2C307	0160-3936	7		CAPACITOR-FXD 700PF +-1% 100VDC MICA	28480	0160-3936
A2C308	0160-3420	4		CAPACITOR-FXD 7500PF +-1% 100VDC MICA	28480	0160-3420
A2C309	0160-3936	7		CAPACITOR-FXD 700PF +-1% 100VDC MICA	28480	0160-3936
A2C310	0160-3420	4		CAPACITOR-FXD 7500PF +-1% 100VDC MICA	28480	0160-3420
A2C311	0180-0491	5	1	CAPACITOR-FXD 10UF+-20% 25VDC TA	28480	0180-0491
A2C312	0180-3124	7	2	CAPACITOR-FXD 75UF+100-20% 300VDC AL	28480	0180-3124
A2C351	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A2C352	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A2C353	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A2C354	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A2C355	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A2C356	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A2C357	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A2C401	0160-5769	8	2	CAPACITOR-FXD 4.7UF +-20% 250VDC POLYE	28480	0160-5769
A2C402	0160-5769	8		CAPACITOR-FXD 4.7UF +-20% 250VDC POLYE	28480	0160-5769
A2C403	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A2C404	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A2C405	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A2C406	0160-5298	0	5	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A2C407	0160-5368	3	1	CAPACITOR-FXD .47UF +-10% 50VDC CER	28480	0160-5368
A2C408	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A2C409	0180-0373	2	2	CAPACITOR-FXD .68UF+-10% 35VDC TA	56289	150D684X9035A2
A2C410	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A2C411	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A2C412	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A2C413	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A2C414	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A2C415	0180-1743	2	2	CAPACITOR-FXD .1UF+-10% 35VDC TA	56289	150D104X9035A2
A2C416	0180-1743	2		CAPACITOR-FXD .1UF+-10% 35VDC TA	56289	150D104X9035A2
A2C417	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A2C418	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A2C419	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A2C420	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A2C426	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A2C427	0160-4232	1	1	CAPACITOR-FXD .047UF +-.05 100VDC CER	28480	0160-4232
A2C428	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A2C429	0180-0373	2		CAPACITOR-FXD 0.68UF +-10% 35VDC CER	28480	0180-0373
A2C430	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A2C501	0180-3365	8	1	CAPACITOR-FXD 6800UF +100-10% 35VDC AL	28480	0180-3365
A2C502	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A2C503	0180-3226	0		CAPACITOR-FXD 100UF 20% 25VDC	28480	0180-3226
A2C504	0160-4821	1	2	CAPACITOR-FXD 1200PF +-5% 100VDC CER	28480	0160-4821
A2C505	0160-4835	7	1	CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A2C506	0160-4832	4	1	CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A2C507	0160-3508	9		CAPACITOR-FXD 1UF +80-20% 50VDC CER	28480	0160-3508
A2C508	0160-3508	9		CAPACITOR-FXD 1UF +80-20% 50VDC CER	28480	0160-3508
A2C509	0180-0373	2		CAPACITOR-FXD .68UF+-10% 35VDC TA	56289	150D684X9035A2
A2C510	0160-4821	1		CAPACITOR-FXD 1200PF +-5% 100VDC CER	28480	0160-4821
A2C511	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A2C512	0160-3508	9		CAPACITOR-FXD 1UF +80-20% 50VDC CER	28480	0160-3508
A2C513	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A2C514	0180-2620	6	1	CAPACITOR-FXD 2.2UF+-10% 50VDC TA	25088	D2R2GS1B50K
A2C515	0180-2831	1	1	CAPACITOR-FXD 47UF+-20% 35VDC TA	90201	THF476M035P1G
A2C516	0160-3508	9		CAPACITOR-FXD 1UF +80-20% 50VDC CER	28480	0160-3508
A2C517	0180-3221	5	2	CAPACITOR-FXD 10 UF 100VDC	28480	0180-3221
A2C518	0180-3376	1	2	CAPACITOR-FXD 2200UF+30-10% 25VDC AL	28480	0180-3376
A2C519	0180-3376	1		CAPACITOR-FXD 2200UF+30-10% 25VDC AL	28480	0180-3376
A2C520	0180-3375	0	1	CAPACITOR-FXD 3300UF+30-10% 16VDC AL	28480	0180-3375
A2C521	0180-0553	0	2	CAPACITOR-FXD 22UF+-20% 25VDC TA	28480	0180-0553
A2C521	0180-2815	1		CAPACITOR-FXD 100UF+-20% 10VDC TA	28480	0180-2815
A2C522	0180-0553	0		CAPACITOR-FXD 22UF+-20% 25VDC TA	28480	0180-0553
A2C523	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A2C524	0180-2815	1		CAPACITOR-FXD 100UF+-20% 10VDC TA	28480	0180-2815
A2C603	0180-3221	5		CAPACITOR-FXD 10 UF 100VDC	28480	0180-3221
A2C610	0160-3448	6		CAPACITOR 1000P 250VDC	28480	0160-3448
A2CR301	1901-0033	2	5	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0033
A2CR302	1901-0033	2		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0033
A2CR303	1902-0029	8	2	DIODE-ZNR 12V 5% PD=1W IR=5UA	28480	1902-0029
A2CR304	1902-0029	8		DIODE-ZNR 12V 5% PD=1W IR=5UA	28480	1902-0029
A2CR401	1906-0069	4	3	DIODE-FW BRDG 400V 1A	28480	1906-0069
A2CR402	1826-0774	8	1	IC-VR LM385BZ	28480	1826-0774
A2CR404	1826-0585	9	1	V REF TO-92	27014	LM329DZ
A2CR405	1906-0069	4		DIODE-FW BRDG 400V 1A	28480	1906-0069
A2CR406	1902-0574	8	4	DIODE-ZNR 64.9V 5% DO-15 PD=1W TC=+.083%	28480	1902-0574
A2CR407	1902-0574	8		DIODE-ZNR 64.9V 5% DO-15 PD=1W TC=+.083%	28480	1902-0574
A2CR408	1901-0050	3	15	DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A2CR409	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A2CR410	1902-0574	8		DIODE-ZNR 64.9V 5% DO-15 PD=1W TC=+.083%	28480	1902-0574
A2CR412	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A2CR413	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A2CR414	1906-0069	4		DIODE-FW BRDG 400V 1A	28480	1906-0069
A2CR420	1826-0585	9		IC V RGLTR-V-REF FXD	28480	1826-0585
A2CR501	1906-0243	6	1	DIODE-FW BRDG 100V 2A	28480	1906-0243
A2CR502	1884-0293	8	1	THYRISTOR-SCR	04713	MCR69-2
A2CR503	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A2CR504	1901-0731	7		DIODE-PWR RECT 400V 1A	28480	1901-0731
A2CR505	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A2CR506	1901-0535	9	2	DIODE-SM SIG SCHOTTKY	28480	1901-0535
A2CR507	1901-0535	9		DIODE-SM SIG SCHOTTKY	28480	1901-0535
A2CR508	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A2CR509	1901-0871	6	5	DIODE-PWR RECT 150V 2.5A 25NS	12969	UES1103
A2CR511	1901-1106	2	1	DIODE-POWER RECTIFIER	28480	1901-1106
A2CR512	1901-0871	6		DIODE-PWR RECT 150V 2.5A 25NS	12969	UES1103
A2CR513	1901-0871	6		DIODE-PWR RECT 150V 2.5A 25NS	12969	UES1103
A2CR514	1901-0871	6		DIODE-PWR RECT 150V 2.5A 25NS	12969	UES1103
A2CR515	1901-0871	6		DIODE-PWR RECT 150V 2.5A 25NS	12969	UES1103
A2CR516	1901-0992	2	2	DIODE-SCHOTTKY 1N5822 40V 3A	28480	1901-0992
A2CR517	1901-0992	2		DIODE-SCHOTTKY 1N5822 40V 3A	28480	1901-0992
A2CR518	1902-0574	8		DIODE-ZNR 64.9V 5% DO-15 PD=1W TC=+.083%	28480	1902-0574
A2CR520	1902-0964	0	1	DIODE-ZNR 10V 5% DO-35 PD=.4W TC=+.02%	28480	1902-0964
A2CR526	1901-0731	7		DIODE-PWR RECT 400V 1A	28480	1901-0731
A2CR527	1901-0731	7		DIODE-PWR RECT 400V 1A	28480	1901-0731
A2CR601	1902-0526	0	2	DIODE-CUR RGLTR 1N5305 100V DO-7	04713	1N5305
A2CR602	1901-0732	8	1	DIODE-PWR RECT 1KV 1A	28480	1901-0732
A2CR603	1902-0554	4	2	DIODE-ZNR 10V 5% PD=1W IR=10UA	28480	1902-0554
A2CR604	1902-0554	4		DIODE-ZNR 10V 5% PD=1W IR=10UA	28480	1902-0554
A2CR605	1901-0033	2		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A2CR606	1901-0033	2		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A2CR607	1902-0526	0		DIODE-CUR RGLTR IN5305 100V DO-7	04713	IN5305
A2CR608	1902-0970	8	1	DIODE-ZNR 33V 5% DO-35 PD+.4W TC=+.097%	28480	1902-0970
A2CR610	1901-0732	8		DIODE-PWR RECT KV 1A	28480	1901-0732
A2CR611	1901-0033	2		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A2E1	0340-0949	8	2	INSULATOR-XSTR THRM-CNDCT	28480	0340-0949
A2E2	0340-1072	0	4	INSULATOR WATER-SLBL	28480	0340-1072
A2E3	1200-0173	5	3	INSULATOR-XSTR DAP-GL	28480	1200-0173
A2E4	1205-0376	0	1	HEAT SINK SGL PLSTC-PWR-CS	13103	6072B

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A2F1	2110-0332	8	2	FUSE 3A 125V .25X.27	28480	2110-0332
A2F2	2110-0332	8		FUSE 3A 125V .25X.27	28480	2110-0332
A2J1	1251-7304	5	2	CONN-POST TYPE .100-PIN-SPCG 60-CONT	28480	1251-7304
A2J3	1251-7304	5		CONN-POST TYPE .100-PIN-SPCG 60-CONT	28480	1251-7304
A2J4	1251-7134	9	2	CONNECTOR 4-PIN M POST TYPE	28480	1251-7134
A2J5	1251-3276	2	1	CONNECTOR 6-PIN M POST TYPE	28480	1251-3276
A2J6	1251-3192	1	1	CONNECTOR 3-PIN M POST TYPE	28480	1251-3192
A2J8	1251-7056	4	1	CONNECTOR 14-PIN M POST TYPE	28480	1251-7056
A2J9	1251-4136	5	1	CONNECTOR 6-PIN M POST TYPE	28480	1251-4136
A2JU101	1251-6947	0	24	CONNECTOR-SGL CONT PIN .025-IN-BSC-SZ SQ	28480	1251-6947
A2JU101	1258-0141	8	6	JUMPER-REM	28480	1258-0141
A2JU301	1251-6947	0		CONNECTOR-SGL CONT PIN .025-IN-BSC-SZ SQ	28480	1251-6947
A2JU301	1258-0141	8		JUMPER-REM	28480	1258-0141
A2JU501	1251-6947	0		CONNECTOR-SGL CONT PIN .025-IN-BSC-SZ SQ	28480	1251-6947
A2JU501	1258-0141	8		JUMPER-REM	28480	1258-0141
A2K301	0490-1354	8		RELAY 2C 5VDC-COIL 2A 250VAC	28480	0490-1354
A2K401	0490-1354	8		RELAY 2C 5VDC-COIL 2A 250VAC	28480	0490-1354
A2K402	0490-1354	8		RELAY 2C 5VDC-COIL 2A 250VAC	28480	0490-1354
A2K403	0490-1354	8		RELAY 2C 5VDC-COIL 2A 250VAC	28480	0490-1354
A2K404	0490-1354	8		RELAY 2C 5VDC-COIL 2A 250VAC	28480	0490-1354
A2K405	0490-1354	8		RELAY 2C 5VDC-COIL 2A 250VAC	28480	0490-1354
A2K406	0490-1354	8		RELAY 2C 5VDC-COIL 2A 250VAC	28480	0490-1354
A2K407	0490-1354	8		RELAY 2C 5VDC-COIL 2A 250VAC	28480	0490-1354
A2K409	0490-1354	8		RELAY 2C 5VDC-COIL 2A 250VAC	28480	0490-1354
A2K410	0490-1354	8		RELAY 2C 5VDC-COIL 2A 250VAC	28480	0490-1354
A2K411	0490-1383	3		RELAY 4C 5VDC-COIL 2A 250VAC	28480	0490-1383
A2K412	0490-1354	8		RELAY 2C 5VDC-COIL 2A 250VAC	28480	0490-1354
A2K413	0490-1354	8		RELAY 2C 5VDC-COIL 2A 250VAC	28480	0490-1354
A2K414	0490-1354	8		RELAY 2C 5VDC-COIL 2A 250VAC	28480	0490-1354
A2K415	0490-1354	8		RELAY 2C 5VDC-COIL 2A 250VAC	28480	0490-1354
A2K416	0490-1354	8		RELAY 2C 5VDC-COIL 2A 250VAC	28480	0490-1354
A2K501	0490-1405	0	1	RELAY 2C 12VDC-COIL 2A 250VAC	28480	0490-1405
A2L501	9140-0801	6	1	INDUCTOR 25UH 10% .25WX.62LG	28480	9140-0801
A2L502	04937-8001	7	1	INDUCTOR-COUPLED	28480	04937-80011
A2L503	9100-3560	6	2	INDUCTOR RF-CH-MLD 5.6UH 5% .166DX.385LG	28480	9100-3560
A2L504	9100-3560	6		INDUCTOR RF-CH-MLD 5.6UH 5% .166DX.385LG	28480	9100-3560
A2L601	9140-0138	2	2	INDUCTOR RF-CH-MLD 180UH 5% .166DX.385LG	28480	9140-0138
A2L602	9140-0138	2		INDUCTOR RF-CH-MLD 180UH 5% .166DX.385LG	28480	9140-0138
A2MP1	0403-0294	0	2	SPACER-SNAP-IN .500 IN LG; .280 IN OD	28480	0403-0294
A2MP2	0590-0010	1		NUT-HEX-DBL CHAM 4-40 THD .124-IN THK	00000	ORDER BY DESCRIPTION
A2MP3	5040-0170	6	2	SUPPORT BOARD	28480	5040-0170
A2Q301	1054-0053	5	1	TRANSISTOR NPN 2N2218 SI TO-5 PD=800MW	04713	2N2218
A2Q302	1853-0012	4	1	TRANSISTOR PNP 2N2904A SI TO-39 PD=600MW	01295	2N2904A
A2Q401	1853-0036	2	3	TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A2Q402	1854-0749	6	2	TRANSISTOR NPN SI TO-220AB PD=30W	04713	MJE2361
A2Q403	1854-0215	1	8	TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A2Q404	1853-0281	2		TRANSISTOR PNP 2N2907A	28480	1853-0281
A2Q405	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A2Q406	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A2Q407	1854-0575	6	4	TRANSISTOR NPN SI PD=625MW FT=50MHZ	04713	MPS-A42
A2Q408	1854-0575	6		TRANSISTOR NPN SI PD=625MW FT=50MHZ	04713	MPS-A42
A2Q409	1854-0575	6		TRANSISTOR NPN SI PD=625MW FT=50MHZ	04713	MPS-A42
A2Q410	1854-0071	7	2	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A2Q411	1854-0749	6		TRANSISTOR NPN SI TO-220AB PD=30W	04713	MJE2361
A2Q412	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A2Q413	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A2Q414	1854-0215			TRANSISTOR NPN SI PD=350MW FT=300MHZ	28480	1854-0215
A2Q415	1854-0215			TRANSISTOR NPN SI PD=350MW FT=300MHZ	28480	1854-0215
A2Q416	1854-0575			TRANSISTOR NPN SI PD=625 FT=50MHZ	28480	1854-0575
A2Q420	1854-0575	6		TRANSISTOR NPN SI PD=625MW FT=50MHZ	04713	MPS-A42
A2Q421	1854-0575	6		TRANSISTOR NPN SI PD=625MW FT=50MHZ	04713	MPS-A42
A1Q422	1854-0575	6		TRANSISTOR NPN SI PD=625MW FT=50MHZ	04713	MPS-A42
A2Q423	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200 MHZ	28480	1854-0071
A2Q501	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	2N3904
A2Q502	1855-0402	0	1	TRANSISTOR J-FET 2N5115 P-CHAN D-MODE	17856	2N5115
A2Q503	1855-0526	9	1	TRANSISTOR MOSFET P-CHAN E-MODE SI	28480	1855-0526
A2Q504	1855-0525	8	1	TRANSISTOR MOSFET N-CHAN E-MODE SI	28480	1855-0525
A2Q505	1855-0492	8	1	TRANSISTOR MOSFET N-CHAN E-MODE TO-220	28480	1855-0492
A2Q510	1853-0036	2		TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A2R101	0698-8827	4	4	RESISTOR 1M 1% .125W F TC=0+-100	28480	0698-8827
A2R102	1810-0207	9	1	NETWORK-RES 8-SIP22.0K OHM X 7	01121	208A223
A2R103	0757-0280	3	15	RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A2R301	0757-0291	6	1	RESISTOR 24.9 1% .125W F TC=0+-100	19701	MF4C1/8-T0-2492-F
A2R302	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A2R303	0757-0283	6	3	RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-F
A2R304	0698-3259	6	1	RESISTOR 7.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0 7871 F
A2R305	0698-4435	2	1	RESISTOR 2.49K 1% .125W F TC=0+-100	24546	C4 1/8-T0-2491-F
A2R306	0698-3268	7	1	RESISTOR 11.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1152-F
A2R307	0698-5088	3	1	RESISTOR 12K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1202-F
A2R308	0757-0447	4	1	RESISTOR 16.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1622-F
A2R309	0757-0281	4	1	RESISTOR 2.74K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2741-F
A2R310	0698-4505	7	1	RESISTOR 71.5K 1% .125W F TC=0+-100	24546	C4 1/8-T0-7152-F
A2R311	0698-3154	0	1	RESISTOR 4.22K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4221-F
A2R312	2100-3876	0	1	RESISTOR-TRMR 1K 10% C TOP ADJ 17 TRN	28480	2100-3876
A2R313	0698-4020	1	1	RESISTOR 9.53K 1% .125W F TC=0+-100	24546	C4-1/8-T0-9531-F
A2R314	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A2R315	0757-0441	8	2	RESISTOR 8.25K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8251-F
A2R316	0757-0441	8		RESISTOR 8.25K 1% .125W F TC=0+-100	24546	C4 1/8-T0-8251-F
A2R317	0757-0180	2	2	RESISTOR 31.6 1% .125W F TC=0+-100	28480	0757-0180
A2R318	0757-0180	2		RESISTOR 31.6 1% .125W F TC=0+-100	28480	0757-0180
A2R319	0698-6261	6		RESISTOR 600 .25% .25W F TC=0+-50	28480	0698-6261
A2R320	0698-0084	9	2	RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A2R321	0757-0421	4	1	RESISTOR 825 1% .125W F TC=0+-100	24546	C4 1/8-T0-825R-F
A2R322	2100-3881	7	2	RESISTOR-TRMR 500 10% C TOP ADJ 17 TRN	28480	2100-3881
A2R401	0757-0443	0	2	RESISTOR 11K 1% .125W F TC=0+-100	24546	C4 1/8-T0-1102 F
A2R402	0757-0459	8	1	RESISTOR 56.2K 1% .125W F C=0+-100	24546	C4 1/8-T0-5622 F
A2R403	0757-0798	8	2	RESISTOR 110 1% .5W F TC=0+-100	28480	0757-0798
A2R404	0757-0798	8		RESISTOR 110 1% .5W F TC=0+-100	28480	0757-0798
A2R408	0757-0410	7	6	RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A2R409	0757-0433	8	2	RESISTOR 3.32K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3321-F
A2R410	0757-0433	8		RESISTOR 3.32K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3321-F
A2R411	0698-3572	6	1	RESISTOR 60.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6042-F
A2R412	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A2R413	0698-3157	3	3	RESISTOR 19.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1962-F
A2R414	0698-3515	7	1	RESISTOR 5.9K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5901-F
A2R415	0757-0418	9	3	RESISTOR 619 1% .125W F TC=0+-100	24546	C4 1/8-T0-619R-F
A2R416	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A2R417	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A2R418	0698-3262	1	2	RESISTOR 40.2 1% .125W F TC=0+-100	28480	0698-3262
A2R419	0698-3438	3		RESISTOR 147 1% .125W F TC=0+-100	28480	0698-3438
A2R420	0757-0418	9		RESISTOR 619 1% .125W F TC=0+-100	24546	C4-1/8-T0-619R-F
A2R421	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A2R422	0698-8827	4		RESISTOR 1M 1% .125W F TC=0+-100	28480	0698-8827
A2R423	0698-3540	8	1	RESISTOR 15.4K 1% .125W F TC=0+-100	24546	C4 1/8-T0-1542-F
A2R424	0698-4493	2	1	RESISTOR 34K 1% .125W F TC=0+-100	24546	C4 1/8-T0-3402-F
A2R426	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A2R427	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4 1/8-T0-1003-F
A2R428	0698-3407	6	1	RESISTOR 1.96K 1% .5W CC TC=0+647	28480	0698-340.
A2R430	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A2R432	0698-8827	4		RESISTOR 1M 1% .125W F TC=0+-100	28480	0698-8827
A2R434	0698-4486	3	2	RESISTOR 24.9K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2492-F
A2R435	0698-4486	3		RESISTOR 24.9K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2492-F
A2R436	0698-4574	0	1	RESISTOR 210 1% .25W F TC=0+-100	24546	C5-1/4-T0-210R-F
A2R437	0811-1803	4	1	RESISTOR 1.3K 5% 3W PW TC=0+-20	28480	0811-1803
A2R439	0757-0159	5	2	RESISTOR 1K 1% .5W F TC=0+-100	28480	0757-0159
A2R440	0757-0159	5		RESISTOR 1K 1% .5W F TC=0+-100	28480	0757-0159
A2R441	0698-3453	2	2	RESISTOR 196K 1% .125W F TC=0+-100	24546	C4 1/8-T0-1963-F
A2R442	0698-3459	8	1	RESISTOR 383K 1% .125W F TC=0+-100	28480	0698-3459
A2R443	0757-0401	0	7	RESISTOR 100 1% .125W F TC=0+-100	24546	C4 1/8-T0-101 F
A2R444	0698-8826	3	2	RESISTOR 825K 1% .125W F TC=0+-100	28480	0698-8826
A2R445	0757-0199	3	3	RESISTOR 21.5K 1% .125W F TC=0+-100	24546	C4 1/8-T0-2152-F
A2R446	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4 1/8-T0-101-F
A2R447	0698-3431	6	1	RESISTOR 23.7 1% .125W F TC=0+-100	28480	0698-3431
A2R448	2100-3020	6	1	RESISTOR-TRMR 10 20% C TOP-ADJ 17-TRN	32997	3292W-1-100
A2R449	0757-0466	7	2	RESISTOR 110K 1% .125W F TC=0+-100	24546	C4 1/8-T0-1103-F
A2R450	0757-0466	7		RESISTOR 110K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1103-F
A2R451	0757-0460	1	2	RESISTOR 61.9K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6192-F
A2R452	0757-0283	6		RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-F
A2R453	0757-0460	1		RESISTOR 61.9K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6192-F
A2R454	0757-0283	6		RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-F
A2R455	0698-3437	2		RESISTOR 133 1% .125W F TC=0+-100	24546	C4-1/8-T0-133R-F
A2R461	0698-3453	2		RESISTOR 196K 1% .125W F TC=0+-100	28480	0698-3453
A2R462	0698-3459	8		RESISTOR 383K 1% .125W F TC=0+-100	28480	0698-3459
A2R463	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	28480	0757-0401
A2R464	0698-8826	3		RESISTOR 825K 1% .125W F TC=0+-100	28480	0698-8826
A2R465	0757-0199	3		RESISTOR 21.5K 1% .125W F TC=0+-100	28480	0757-0199
A2R466	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	28480	0757-0401
A2R467	0698-3431	6		RESISTOR 23.7 OHMS 1% .125W F TC=0+-100	28480	0698-3431
A2R468	2100-3020	6		RESISTOR-TRMR 10 20% C TOP-ADJ 17 TRN	28480	0698-3020
A2R470	0767-0001	1		RESISTOR 400 5% 3W MO	28480	0767-0001
A2R471	0764-0016	1		RESISTOR 1K 5% 2W	28480	0764-0016
A2R501	0683-2215	1	1	RESISTOR 220 5% .25W FC TC=-400/+600	01121	CB2215
A2R502	0757-0349	5		RESISTOR 22.6K 1% .125W F TC=0+-100	24546	C4 1/8-T0-2262-F
A2R503	0757-0276	7	1	RESISTOR 61.9 1% .125W F TC=0+-100	24546	C4 1/8-T0-6192-F
A2R504	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4 1/8-T0-1001-F
A2R505	0698-8162	0	1	RESISTOR 11.8K 25% .125W F TC+0+-100	28480	0698-8162

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A2R506	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A2R507	0698-3446	3	2	RESISTOR 383 1% .125W F TC=0+-100	24546	C4-1/8-T0-383R-F
A2R508	0811-1672	5	1	RESISTOR 3.3 5% 2W PW TC=0+-400	75042	BWH2-3R3-J
A2R509	0757-0346	2		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A2R510	0698-3446	3		RESISTOR 383 1% .125W F TC=0+-100	24546	C4-1/8-T0-383R-F
A2R511	0757-0349	5		RESISTOR 22.6K 1% .125W F TC=0+-100	24546	C4 1/8-T0-2262-F
A2R512	0698-3152	8	3	RESISTOR 3.40K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3401-F
A2R513	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A2R514	0698-3454	3	1	RESISTOR 215K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2153-F
A2R515	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A2R516	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A2R517	0757-0444	1	2	RESISTOR 12.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1212-F
A2R518	0757-0420	3	4	RESISTOR 750 1% .125W F TC=0+-100	24546	C4-1/8-T0-751-F
A2R519	0698-3452	1	1	RESISTOR 147K 1% .125W F TC=0+-100	24546	C4 1/8-T0-1473-F
A2R520	0757-0288	1	1	RESISTOR 9.09K 1% .125W F TC=0+-100	19701	MF4C1/8-T0-9091-F
A2R521	0757-0438	3	3	RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4 1/8-T0-5111-F
A2R522	0757-0461	2	1	RESISTOR 60.1K 1% .125W F TC=0+-100	24546	C4 1/8-T0-6012-F
A2R523	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A2R524	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A2R525	0698-3429	2	1	RESISTOR 19.6 1% .125W F TC=0+-100	03888	PME55-1/8-T0-19R6-F
A2R526	0698-8822	9	2	RESISTOR 6.81 1% .125W F TC=0+-100	28480	0698-8822
A2R527	0698-8822	9		RESISTOR 6.81 1% .125W F TC=0+-100	28480	0698-8822
A2R528	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4 1/8-T0 1003-F
A2R529	0110-0179	7	1	WIRE RES .362 OHM/FT .0205 DIA	28480	0110-0179
A2R530	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4 1/8-T0-1001-F
A2R531	0757-0420	3		RESISTOR 750 1% .125W F TC=0+-100	24546	C4 1/8 T0-751 F
A2R532	0698-3158	4	1	RESISTOR 23.7K 1% .125W F TC=0+-100	24546	C4 1/8-T0-2372-F
A2R533	0698-0085	0	1	RESISTOR 2.61K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2611-F
A2R534	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4 1/8-T0-1001-F
A2R535	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A2R536	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4 1/8-T0 101-F
A2R537	0698-8816	1	1	RESISTOR 2.15 1% .125W F TC=0+-100	28480	0698-8816
A2R538	0757-0280	7		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4 1/8-T0 1001-F
A2R602	0698-3460	1	1	RESISTOR 422K 1% .125W F TC=0+-100	28480	0698 3460
A2R603	2100-3252	6	1	RESISTOR-TRMR 5K 10% C TOP ADJ 1 TRN	28480	2100-3252
A2R604	0698-3245	0	1	RESISTOR 20.5K 1% .125W F TC=0+-100	24546	C4 1/8-T0-2052 F
A2R610	0757-0465	6	1	RESISTOR 100K 1% .125W F TC=0+-100	28480	0757-0465
A2R611	0757-0398	4	1	RESISTOR 75 1% .125W F TC=0+-100	28480	0757-0398
A2R612	0764-0016	8	1	RESISTOR 1K 5% 2W F TC=0+-100	28480	0764-0016
A2R613	2100-1431	9	1	RESISTOR-TRMR 10 5% F TC=0+-100	28480	2100-1431
A2R614	0757-0346	2		RESISTOR 10 1% .125W F TC=0+-100	28480	0757-0346
A2T301	04937-80012	8	1	OUTPUT XFMR	28480	04937 80012
A2T301	04937-80018	4	1	OUTPUT XFMR (OPTION 002)	28480	04937-80018
A2T501	04937-80010	6	1	XFORMER-SWITCH	28480	04937-80010
A2TP1	1251-2313	6	4	CONNECTOR-SGL CONT SKT .04 IN-BSC-SZ RND	28480	1251-2313
A2TP501	1251-6947	0		CONNECTOR-SGL CONT PIN .025-IN-BSC-SZ SQ	28480	1251-6947
A2TP601	1251-6947	0		CONNECTOR-SGL CONT PIN .025-IN-BSC-SZ SQ	28480	1251-6947
A2TP602	1251-6947	0		CONNECTOR-SGL CONT PIN .025 IN-BSC-SZ SQ	28480	1251-6947
A2U105	1820-2998	0	3	IC-MC74HC373N	20400	1820-2998
A2U201	1820-3002	5	2	IC MC74HC374N	20480	1820-3002
A2U202	1820-3002	5		IC-MC74HC374N	28480	1820 3002
A2U203	1820-1955	7	5	IC ADDR CMOS FULL ADDER 4 BIT	3L585	CD4008BE
A2U204	1820-1955	7		IC ADDR CMOS FULL ADDER 4-BIT	3L585	CD4008BE
A2U205	1820-1955	7		IC ADDR CMOS FULL ADDER 4-BIT	3L585	CD4008BE
A2U206	1820-1955	7		IC ADDR CMOS FULL ADDER 4-BIT	3L585	CD4008BE
A2U207	1820-1955	7		IC ADDR CMOS FULL ADDER 4 BIT	3L585	CD4008BE
A2U208	1820-3058	5	3	IC FF CMOS/74HC D-M/S POS EDGE-TRIG COM	28480	1820 3058
A2U209	1820-3058	5		IC FF CMOS/74HC D M/S POS EDGE-TRIG COM	28400	1820 3058
A2U210	1820-3058	5		IC FF CMOS/74HC D-M/S POS-EDGE-TRIG COM	28480	1820-3058
A2U211	04937-10001	8	1	ROM WAVE FORM	28480	04937-10001
A2U212	1820-1956	8	6	IC LCH CMOS OCT CLOCK QUAD	3L585	CD4042BE
A2U213	1820-2925	3	1	IC CNTR CMOS/74HC BIN SYNCHRO	28480	1820-2925
A2U214	1820-1112	8	2	IC FF TTL LS D TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A2U215	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE TRIG	01295	SN74LS74AN
A2U216	1820-1730	6	1	IC FF TTL LS D TYPE POS-EDGE-TRIG COM	01295	SN74LS273N
A2U217	1820-1145	7	1	IC BFR CMOS INV HEX 1-INP	3L585	CD4049UBE
A2U301	1826-0508	6	1	IC CONV 10-B-D/A 16-DIP-C PKG	24355	AD561JD
A2U302	1826-0753	3	6	IC OP AMP LOW BIAS H-IMPD QUAD 14-DIP-C	04713	MC34004BL
A2U303	1826-0753	3		IC OP AMP LOW-BIAS-H-IMPD QUAD 14-DIP-C	04713	MC34004BL
A2U304	1826-0962	6	1	IC OP AMP LOW-BIAS H IMPD DUAL 8-DIP-P	20480	1826-0962
A2U305	1826-0779	3	1	IC MULTIPLXR 4-CHAN-ANLG DUAL 16-DIP-P	24355	AD7502JN
A2U401	1990-0732	5	3	OPTO-ISOLATOR LED PDIO/XSTR IF=20MA MAX	20400	HCPL-2731
A2U402	1990-0732	5		OPTO-ISOLATOR LED-PDIO/XSTR IF=20MA MAX	28480	HCPL-2731
A2U403	1820-2213	2	1	IC GATE CMOS OR QUAD 2-INP	27014	MM74C32N
A2U404	1820-2998	0		IC-MC74HC373N	28480	1820-2998
A2U406	1826-0412	1	2	IC COMPARATOR PRCN DUAL 8 DIP P PKG	27014	LM393N
A2U407	1820-3289	4	1	IC DRVR CMOS PRPHL DP LATCH INPUT QUAD	28480	1820 3289
A2U408	1820-3165	5		IC DRVR CMOS PRPHL DP LATCH INPUT OCTL	28480	1820-3165

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A2U409	1820-3165	5		IC DRVR CMOS PRPHL GP LATCH INPUT OCTL	28480	1820-3165
A2U410	1820-3165	5		IC DRVR CMOS PRPHL GP LATCH INPUT OCTL	28480	1820-3165
A2U411	1820-3165	5		IC DRVR CMOS PRPHL GP LATCH INPUT OCTL	28480	1820-3165
A2U412	1820-2924	2	1	IC-MC74HC02N	28480	1820-2924
A2U413	1820-1932	0	1	IC MV CMOS MONOSTBL RETRIG/RESET DUAL	04713	MC14538BCP
A2U414	1990-0732	5		OPTO-ISOLATOR LED-PDIO/XSTR IF=20MA MAX	28480	HCPL-2731
A2U415	1826-0643	0	3	IC V RGLTR-V-REF-ADJ 3/30V TO-92 PKG	28480	1826-0643
A2U501	1826-0468	7	1	IC COMPARATOR GP 8-DIP-P PKG	04713	MC3423P1
A2U503	1826-0275	4	1	IC 78L12A V RGLTR TO-92	04713	MC78L12ACP
A2U504	1826-0412	1		IC COMPARATOR PRCN DUAL 8-DIP-P PKG	27014	LM393N
A2U505	1826-0544	0	1	V REF 8-DIP-C	04713	MC1403U
A2U506	1826-1066	3	1	IC-VOLTAGE REGULATOR 2A PIN PLASTIC PKG.	28480	1826-1066
A2U601	1826-0643	0		IC V RGLTR-V-REF-ADJ 3/30V TO-92 PKG	28480	1826-0643
A2U602	1826-0643	0		IC V RGLTR-V-REF-ADJ 3/30V TO-92 PKG	28480	1826-0643
A2W1	5060-7167	7		CABLE RCVR INPUT	28480	5060-7167
	2200-0728	7	4	SCREW MACH 4-40 .312 IN-LG PAN HD SLT	00000	ORDER BY DESCRIPTION
A3	04937-60003	5	1	RECEIVER BOARD ASSEMBLY	28480	04937-60003
A3C1	0160-5332	1	78	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C2	0180-0374	3	12	CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A3C3	0180-0228	6	1	CAPACITOR-FXD 22UF+-10% 15VDC TA	56289	150D226X9015B2
A3C4	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C5	0180-0374	3		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A3C6	0180-0374	3		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A3C7	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C8	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C9	0180-0374	3		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A3C10	0180-0374	3		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A3C11	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C12	0180-0374	3		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A3C13	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C14	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C15	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C16	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C17	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C18	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C19	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C20	0180-0374	3		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A3C21	0180-0374	3		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A3C22	0180-0374	3		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A3C23	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C24	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C25	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C26	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C27	0160-2225	5	1	CAPACITOR-FXD 2000PF +-5% 300VDC MICA	28480	0160-2225
A3C28	0160-2213	1	2	CAPACITOR-FXD 620PF +-5% 300VDC MICA	28480	0160-2213
A3C29	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C30	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C31	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C32	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C33	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C34	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C35	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C36	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C37	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C38	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C39	0160-0128	3	1	CAPACITOR 2.2UF 50VDC CER	28480	0160-0128
A3C40	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C41	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C42	0180-0374	3		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A3C43	0180-0374	3		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A3C44	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C45	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C46	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C47	0160-2209	5	1	CAPACITOR-FXD 360PF +-5% 300VDC MICA	28480	0160-2209
A3C48	0160-3291	7		CAPACITOR-FXD 1200PF +-1% 100VDC MICA	28480	0160-3291
A3C49	0160-0218	2		CAPACITOR-FXD 2400PF +-1% 300VDC MICA	28480	0160-0218
A3C50	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C51	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C52	0160-2675	9	2	CAPACITOR-FXD 3900PF +-1% 300VDC MICA	28480	0160-2675
A3C53	0160-3291	7		CAPACITOR-FXD 1200PF +-1% 100VDC MICA	28480	0160-3291
A3C54	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C55	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C57	0160-3295	1	4	CAPACITOR-FXD 5100PF +-1% 100VDC MICA	28480	0160-3295
A3C58	0160-2675	9		CAPACITOR-FXD 3900PF +-1% 300VDC MICA	28480	0160-2675
A3C59	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C60	0160-6320	9	2	CAPACITOR-FXD 1700PF +-1% 100VDC MICA	28480	0160-6320
A3C61	0160-3295	1		CAPACITOR-FXD 5100PF +-1% 100VDC MICA	28480	0160-3295
A3C62	0160-3295	1		CAPACITOR-FXD 5100PF +-1% 100VDC MICA	28480	0160-3295

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3C63	0160-5695	9	3	CAPACITOR-FXD .1UF +-1% 200VDC MET-POLYC	28480	0160-5695
A3C64	0160-5695	9		CAPACITOR-FXD .1UF +-1% 200VDC MET-POLYC	28480	0160-5695
A3C65	0160-0218	2		CAPACITOR-FXD 2400PF +-1% 300VDC MICA	28480	0160-0218
A3C66	0160-3291	7		CAPACITOR-FXD 1200PF +-1% 100VDC MICA	28480	0160-3291
A3C67	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C68	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C69	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C70	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C71	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C72	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C73	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C74	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C75	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C76	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C77	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C78	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C79	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C80	0160-5695	9		CAPACITOR-FXD .1UF +-1% 200VDC MET-POLYC	28480	0160-5695
A3C81	0160-6405	1	9	CAPACITOR-FXD .01UF +-1% 100VC MICA	28480	0160-6405
A3C82	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C83	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C84	0160-3295	1		CAPACITOR-FXD 5100PF +-1% 100VDC MICA	28480	0160-3295
A3C85	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C86	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C87	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C88	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C89	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C90	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C91	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C92	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C93	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C94	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C95	0180-1746	5	3	CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A3C96	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A3C97	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A3C98	0140-0190	7	2	CAPACITOR-FXD 39PF +-5% 300VDC MICA	72136	DM15E390J0300WV1CR
A3C99	0140-0190	7		CAPACITOR-FXD 39PF +-5% 300VDC MICA	72136	DM15E390J0300WV1CR
A3C100	0160-0167	0	2	CAPACITOR-FXD .002UF +-10% 200VDC POLYE	28480	0160-0167
A3C101	0160-0167	0		CAPACITOR-FXD .002UF +-10% 200VDC POLYE	28480	0160-0167
A3C102	0180-3124	7		CAPACITOR-FXD 75UF+100-20% 300VDC AL	28480	0180-3124
A3C103	0160-3291	7		CAPACITOR-FXD 1200PF +-1% 100VDC MICA	28480	0160-3291
A3C104	0160-0218	2		CAPACITOR-FXD 2400PF +-1% 300VDC MICA	28480	0160-0218
A3C105	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C106	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C107	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C108	0180-0197	8	4	CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A3C109	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C110	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C111	0160-0290	8	1	CAPACITOR-FXD 1500PF +-10% 200VDC POLYE	28480	0160-0290
A3C112	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A3C113	0160-6405	1		CAPACITOR-FXD .01UF +-1% 100VC MICA	28480	0160-6405
A3C116	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C117	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C118	0160-2213	1		CAPACITOR-FXD 620PF +-5% 300VDC MICA	28480	0160-2213
A3C119	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C120	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C121	0160-6405	1		CAPACITOR-FXD .01UF +-1% 100VC MICA	28480	0160-6405
A3C122	0160-6405	1		CAPACITOR-FXD .01UF +-1% 100VC MICA	28480	0160-6405
A3C123	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A3C124	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C125	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C126	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C127	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C128	0160-6405	1		CAPACITOR-FXD .01UF +-1% 100VC MICA	28480	0160-6405
A3C129	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A3C130	0160-6405	1		CAPACITOR-FXD .01UF +-1% 100VC MICA	28480	0160-6405
A3C131	0160-6405	1		CAPACITOR-FXD .01UF +-1% 100VC MICA	28480	0160-6405
A3C132	0160-6405	1		CAPACITOR-FXD .01UF +-1% 100VC MICA	28480	0160-6405
A3C133	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C134	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C135	0160-6405	1		CAPACITOR-FXD .01UF +-1% 100VC MICA	28480	0160-6405
A3C136	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3C137	0160-6320	9		CAPACITOR-FXD 1700PF +-1% 100VDC MICA	28480	0160-6320
A3C138	0160-4801	7	2	CAPACITOR-FXD 100PF +-5% 100VDC CER	28480	0160-4801
A3C139	0160-4801	7		CAPACITOR-FXD 100PF +-5% 100VDC CER	28480	0160-4801

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3C140	0160-5332	1		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-5332
A3CR1	1901-0518	8	6	DIODE-SM SIG SCHOTTKY	28480	1901-0518
A3CR2	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A3CR3	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A3CR4	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A3CR5	1901-0040	1	3	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A3CR6	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A3CR7	1901-0376	6	4	DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A3CR8	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A3CR9	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A3CR10	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR11	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR12	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR13	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR14	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR15	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A3CR16	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A3CR17	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A3CR18	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A3E1	1200-0173	5		INSULATOR-XSTR DAP-GL	28480	1200-0173
A3E2	1251-4398	1	2	CONNECTOR SHUNT-4 POSITION	28480	1251-4398
A3E3	1251-7158	7	1	SHUNT-DIP 10 POSITION DUAL INLINE	28480	1251-7158
A3J2	1251-7134	9		CONNECTOR 4-PIN M POST TYPE	28480	1251-7134
A3J3	1251-5063	9		CONNECTOR 6-PIN M POST TYPE	28480	1251-5063
A3JU1	1258-0141	8		JUMPER-REM	28480	1258-0141
A3JU2	1258-0141	8		JUMPER-REM	28480	1258-0141
A3JU501	1200-0639	8	2	SOCKET-IC 20-CONT DIP DIP-SLDR	28480	1200-0639
A3JU502	1200-0639	8		SOCKET-IC 20-CONT DIP DIP-SLDR	28480	1200-0639
A3JU609	1200-0607	0	1	SOCKET-IC 16 CONT DIP DIP-SLDR	28480	1200-0607
A3MP1	0380-1157	6	2	SPACER-SNAP-IN .25 IN LG; .31 IN A/F	00000	ORDER BY DESCRIPTION
A3MP2	2260-0002	6	2	NUT-HEX-DBL-CHAM 4-40-THD .062-IN-THK	28480	2260-0002
A3MP3	2260-0002	6		NUT-HEX-DBL-CHAM 4-40-THD .062-IN-THK	28480	2260-0002
A3MP4	2260-0009	3	2	NUT-HEX-W/LKWR 4-40-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
A3MP5	2260-0009	3		NUT-HEX-W/LKWR 4-40-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
A3Q1	1854-0810	2	1	TRANSISTOR NPN SI PD=625MW FT=200MHZ	28480	1854-0810
A3R1	0757-0444	1		RESISTOR 12.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1212-F
A3R2	0698-3155	1	6	RESISTOR 4.64K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4641-F
A3R4	0698-4475	0	1	RESISTOR 9.76K 1% .125W F TC=0+-100	03888	PME55-1/8-T0-9761-F
A3R5	0757-0199	3		RESISTOR 21.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2152-F
A3R6	0757-0199	3		RESISTOR 21.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2152-F
A3R7	0698-3157	3		RESISTOR 19.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1962-F
A3R8	0698-3157	3		RESISTOR 19.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1962-F
A3R9	0757-0420	3		RESISTOR 750 1% .125W F TC=0+-100	24546	C4-1/8-T0-751-F
A3R10	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A3R11	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A3R12	0757-0420	3		RESISTOR 750 1% .125W F TC=0+-100	24546	C4-1/8-T0-751-F
A3R13	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A3R14	0698-6360	6	15	RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A3R15	0698-6320	8	2	RESISTOR 5K .1% .125W F TC=0+-25	03888	PME55-1/8-T9-5001-B
A3R16	0698-3152	8		RESISTOR 3.48K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3481-F
A3R17	0698-3153	9	1	RESISTOR 3.03K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3031-F
A3R18	0698-6320	8		RESISTOR 5K .1% .125W F TC=0+-25	03888	PME55-1/8-T9-5001-B
A3R19	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A3R20	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A3R21	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A3R22	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A3R23	0757-0453	2	1	RESISTOR 30.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3012-F
A3R24	0757-0455	4	1	RESISTOR 36.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3652-F
A3R25	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A3R26	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A3R27	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A3R28	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A3R29	0698-3155	1		RESISTOR 4.64K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4641-F
A3R30	0698-3150	6	1	RESISTOR 2.37K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2371-F
A3R31	0757-0424	7	1	RESISTOR 1.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1101-F
A3R32	0690-7585	9	1	RESISTOR 316.2 .1% .125W F TC=0+-25	19701	MF4C1/8-T9-316R2-B
A3R33	0698-6447	0	1	RESISTOR 603.8 .1% .125W F TC=0+-25	28480	0698-6447
A3R34	0698-6446	9	1	RESISTOR 2.162K .1% .125W F TC=0+-25	28480	0698-6446
A3R35	0698-6445	8	3	RESISTOR 6.830K .1% .125W F TC=0+-25	28480	0698-6445
A3R36	0698-8638	5	2	RESISTOR 3.16K .1% .125W F TC=0+-25	28480	0698-8638
A3R37	0698-6445	8		RESISTOR 6.830K .1% .125W F TC=0+-25	28480	0698-6445
A3R38	0757-0458	7	3	RESISTOR 51.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5112-F
A3R39	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A3R40	0757-0458	7		RESISTOR 51.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5112-F
A3R41	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3R42	0698-3497	4		RESISTOR 6.04K 1% .125W F TC=0+-100	24546	C4-1/8-T0-604R-F
A3R43	0698-3156	2	1	RESISTOR 14.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1472-F
A3R44	0698-3152	6		RESISTOR 3.48K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3481-F
A3R45	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R46	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R47	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A3R48	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A3R49	0757-0279	0	4	RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A3R50	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R51	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A3R52	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R53	0698-3451	0	1	RESISTOR 133K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1333-F
A3R54	0757-0458	7		RESISTOR 51.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5112-F
A3R55	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R56	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A3R57	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A3R58	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A3R59	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R60	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R61	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A3R62	0698-7847	6	3	RESISTOR 1.111K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-1111R-B
A3R63	0698-8638	5		RESISTOR 3.16K .1% .125W F TC=0+-25	28480	0698-8638
A3R64	0698-6445	8		RESISTOR 6.030K .1% .125W F TC=0+-25	28480	0698-6445
A3R65	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A3R66	0698-7847	6		RESISTOR 1.111K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-1111R-B
A3R67	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A3R68	0698-7847	6		RESISTOR 1.111K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-1111R-B
A3R69	0698-4471	6	1	RESISTOR 7.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7151-F
A3R70	0698-4202	1	1	RESISTOR 8.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8871-F
A3R71	0757-1093	8	1	RESISTOR 3K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3001-F
A3R72	0698-3490	5	1	RESISTOR 8.66K 1% .125W F TC=0+-100	24546	C4-1/8-T0-866R-F
A3R73	0698-8850	3	1	RESISTOR 41.9K .1% .125W F TC=0+-25	28480	0698-8850
A3R74	0698-6343	5	1	RESISTOR 9K .1% .125W F TC=0+-25	28480	0698-6343
A3R75	0698-6964	6	1	RESISTOR 49.5K .1% .125W F TC=0+-25	28480	0698-6964
A3R76	0699-1052	5	1	RESISTOR 146K .1% .125W F TC=0+-25	28480	0699-1052
A3R77	0698-8805	8	1	RESISTOR 10.35K .1% .125W F TC=0+-25	28480	0698-8805
A3R78	0698-6625	6	1	RESISTOR 6K .1% .125W F TC=0+-25	28480	0698-6625
A3R79	0699-1051	4	1	RESISTOR 92.8K .1% .125W F TC=0+-25	28480	0699-1051
A3R80	0698-6477	6	1	RESISTOR 59.67K .25% .125W F TC=0+-50	28480	0698-6477
A3R81	0699-1176	4	1	RESISTOR 5.62K .1% .125W F TC=0+-25	28480	0699-1176
A3R82	0699-0722	3	1	RESISTOR 23.7K .1% .125W F TC=0+-25	28480	0699-0722
A3R83	0698-6423	2	2	RESISTOR 31.25K .1% .125W F TC=0+-25	28480	0698-6423
A3R84	0698-6423	2		RESISTOR 31.25K .1% .125W F TC=0+-25	28480	0698-6423
A3R85	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A3R86	0698-3155	1		RESISTOR 4.64K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4641-F
A3R87	0698-3155	1		RESISTOR 4.64K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4641-F
A3R88	0698-3155	1		RESISTOR 4.64K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4641-F
A3R89	0698-3155	1		RESISTOR 4.64K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4641-F
A3R90	0698-6467	4	2	RESISTOR 16.9K 1% .125W F TC=0+-50	28480	0698-6467
A3R91	0698-8799	9	1	RESISTOR 21.5K .1% .125W F TC=0+-25	28480	0698-8799
A3R92	0698-7382	4	1	RESISTOR 103.5K .1% .125W F TC=0+-50	19701	MF4C1/8-T2-10352-B
A3R93	0698-4002	9	1	RESISTOR 5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5001-F
A3R94	0757-0463	4	1	RESISTOR 82.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8252-F
A3R95	0698-7850	1	1	RESISTOR 9.455K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-9455R-B
A3R96	0698-7934	2	1	RESISTOR 12.1K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-1212-B
A3R97	0757-0290	5	1	RESISTOR 6.19K 1% .125W F TC=0+-100	19701	MF4C1/8-T0-6191-F
A3R98	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A3R99	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A3R100	0757-0864	9	2	RESISTOR 301K 1% .5W F TC=0+-100	28480	0757-0864
A3R101	0757-0864	9		RESISTOR 301K 1% .5W F TC=0+-100	28480	0757-0864
A3R102	2100-3882	8	3	RESISTOR-TRMR 2K 10% C TOP ADJ 17-TRN	28480	2100-3882
A3R103	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R104	0757-0278	9	1	RESISTOR 1.78K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1781-F
A3R105	0698-0083	8	1	RESISTOR 1.96K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1961-F
A3R106	2100-3882	8		RESISTOR-TRMR 2K 10% C TOP ADJ 17 TRN	28480	2100-3882
A3R107	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A3R108	0698-0084	9		RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A3R109	0757-0274	5	1	RESISTOR 1.21K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1211-F
A3R110	0698-8850	1	1	RESISTOR 12.4K .1% .125W F TC=0+-25	28480	0698-8850
A3R111	0699-0164	8	1	RESISTOR 738.5 .1% .125W F TC=0+-25	28480	0699-0164
A3R112	0698-4480	7	4	RESISTOR 15.8K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1502-F
A3R113	0698-4480	7		RESISTOR 15.8K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1502-F
A3R114	0698-4480	7		RESISTOR 15.8K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1502-F
A3R115	0698-4480	7		RESISTOR 15.8K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1502-F
A3R116	0698-3440	7	1	RESISTOR 196 1% .125W F TC=0+-100	24546	C4-1/8-T0-196R-F

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3R117	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A3R118	0698-3409	8	1	RESISTOR 2.37K 1% .5W F TC=0+-100	28480	0698-3409
A3R119	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A3R120	0699-0588	0	2	RESISTOR 18.171K .1% .125W F TC=0+-25	28480	0699-0588
A3R121	0699-0587	9	1	RESISTOR 12.918K .1% .125W F TC=0+-25	28480	0699-0587
A3R122	0699-0585	7	1	RESISTOR 240.738K .1% .125W F TC=0+-25	28480	0699-0585
A3R123	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A3R124	0699-0586	8	1	RESISTOR 186.365K .1% .125W F TC=0+-25	28480	0699-0586
A3R125	0698-6467	4		RESISTOR 16.9K 1% .125W F TC=0+-50	28480	0698-6467
A3R126	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A3R127	0699-0588	0		RESISTOR 18.171K .1% .125W F TC=0+-25	28480	0699-0588
A3R128	0699-0589	1	2	RESISTOR 34.334K .1% .125W F TC=0+-25	28480	0699-0589
A3R129	0699-0589	1		RESISTOR 34.334K .1% .125W F TC=0+-25	28480	0699-0589
A3R130	0757-0289	2	1	RESISTOR 13.3K 1% .125W F TC=0+-100	19701	MF4C1/8-T0-1332-F
A3R131	0699-0590	4	3	RESISTOR 15.750K .1% .125W F TC=0+-25	28480	0699-0590
A3R132	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A3R133	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A3R134	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A3R135	0699-0590	4		RESISTOR 15.750K .1% .125W F TC=0+-25	28480	0699-0590
A3R136	0699-0600	7	1	RESISTOR 100.502K .1% .125W F TC=0+-25	28480	0699-0600
A3R137	0699-0592	6	1	RESISTOR 7.741K .1% .125W F TC=0+-25	28480	0699-0592
A3R138	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A3R139	0698-3453	2		RESISTOR 196K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1963-F
A3R140	0699-0593	7	2	RESISTOR 13.665K .1% .125W F TC=0+-25	28480	0699-0593
A3R141	0699-0593	7		RESISTOR 13.665K .1% .125W F TC=0+-25	28480	0699-0593
A3R142	0757-0443	0		RESISTOR 11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1102-F
A3R143	0699-0591	5		RESISTOR 140.158K.1%	28480	0699-0591
A3R144	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A3R208	2100-3883	9	4	RESISTOR-TRMR 5K 10% C TOP-ADJ 17-TRN	28480	2100-3883
A3R309	2100-3882	8		RESISTOR-TRMR 2K 10% C TOP-ADJ 17-TRN	28480	2100-3882
A3R503	1810-0281	9	2	NETWORK-RES 10 SIP100.0K OHM X 9	01121	210A104
A3R508	2100-3881	7		RESISTOR-TRMR 500 10% C TOP-ADJ 17-TRN	28480	2100-3881
A3R610	2100-3883	9		RESISTOR-TRMR 5K 10% C TOP-ADJ 17-TRN	28480	2100-3883
A3R706	2100-3883	9		RESISTOR-TRMR 5K 10% C TOP-ADJ 17-TRN	28480	2100-3883
A3R711	2100-3883	9		RESISTOR-TRMR 5K 10% C TOP-ADJ 17-TRN	28480	2100-3883
A3T1	9100-3489	8	1	TRANSFORMER	28480	9100-3489
A3TP1	1251-6947	0		CONNECTOR-SGL CONT PIN .025-IN-BSC-SZ SQ	28480	1251-6947
A3TP2	1251-6947	0		CONNECTOR-SGL CONT PIN .025-IN-BSC-SZ SQ	28480	1251-6947
A3TP3	1251-6947	0		CONNECTOR-SGL CONT PIN .025-IN-BSC-SZ SQ	28480	1251-6947
A3TP4	1251-6947	0		CONNECTOR-SGL CONT PIN .025-IN-BSC-SZ SQ	28480	1251-6947
A3TP5	1251-6947	0		CONNECTOR-SGL CONT PIN .025-IN-BSC-SZ SQ	28480	1251-6947
A3TP6	1251-6947	0		CONNECTOR-SGL CONT PIN .025-IN-BSC-SZ SQ	28480	1251-6947
A3TP7	1251-6947	0		CONNECTOR-SGL CONT PIN .025-IN-BSC-SZ SQ	28480	1251-6947
A3TP9	1251-6947	0		CONNECTOR-SGL CONT PIN .025-IN-BSC-SZ SQ	28480	1251-6947
A3TP10	1251-6947	0		CONNECTOR-SGL CONT PIN .025-IN-BSC-SZ SQ	28480	1251-6947
A3TP11	1251-6947	0		CONNECTOR-SGL CONT PIN .025-IN-BSC-SZ SQ	28480	1251-6947
A3TP12	1251-6947	0		CONNECTOR-SGL CONT PIN .025-IN-BSC-SZ SQ	28480	1251-6947
A3TP13	1251-6947	0		CONNECTOR-SGL CONT PIN .025-IN-BSC-SZ SQ	28480	1251-6947
A3TP14	1251-6947	0		CONNECTOR-SGL CONT PIN .025-IN-BSC-SZ SQ	28480	1251-6947
A3TP15	1251-6947	0		CONNECTOR-SGL CONT PIN .025-IN-BSC-SZ SQ	28480	1251-6947
A3TP16	1251-6947	0		CONNECTOR-SGL CONT PIN .025-IN-BSC-SZ SQ	28480	1251-6947
A3TP17	1251-6947	0		CONNECTOR-SGL CONT PIN .025-IN-BSC-SZ SQ	28480	1251-6947
A3U100	1820-2326	8	1	IC XLTR CMOS TTL-TO MOS HEX	04713	MC14504BCP
A3U101	1826-0742	0	1	IC V RGLTR-V-REF-FXD 10V TO-5 PKG	28480	1826-0742
A3U103	1826-1071	0	5	IC OP AMP PRCN 8-TO 99 PKG	28480	1826-1071
A3U105	1826-1071	0		IC OP AMP PRCN 8-TO 99 PKG	28480	1826-1071
A3U107	1826-1071	0		IC OP AMP PRCN 8-TO-99 PKG	28480	1826-1071
A3U108	1826-0915	9	7	IC OP AMP LOW-BIAS H-IMPD 8-DIP-C PKG	01295	TL071ACJG (PER HP DWG)
A3U200	1826-1071	0		IC OP AMP PRCN 8-TO-99 PKG	28480	1826-1071
A3U201	1820-1315	3	1	IC MULTIPLXR 8-CHAN-ANLG 16-DIP-P PKG	3L585	CD4051BE
A3U203	1826-1071	0		IC OP AMP PRCN 8 TO 99 PKG	28480	1826-1071
A3U206	1820-1725	9	2	IC MULTIPLXR ANLG 16-DIP-P PKG	17856	DG508CJ
A3U207	1826-0753	3		IC OP AMP LOW BIAS H-IMPD QUAD 14-DIP-C	04713	MC34004BL
A3U300	1826-0624	7	1	IC CONV V/FREQ 14 DIP-P PKG	8E175	VFC32KP
A3U301	1826-0705	1	4	IC OP AMP LOW BIAS H-IMPD DUAL 8 DIP-C	01295	TL072ACJG
A3U303	1826-0130	8	1	IC COMPARATOR GP QUAD 14-DIP-P PKG	01295	LM339N
A3U304	1826-0915	2		IC OP AMP LOW-BIAS-H IMPD 8-DIP-C PKG	01295	TL071ACJG (PER HP DWG)
A3U308	1826-0915	9		IC OP AMP LOW-BIAS-H-IMPD 8-DIP-C PKG	01295	TL071ACJG (PER HP DWG)
A3U401	1826-0705	1		IC OP AMP LOW-BIAS H-IMPD DUAL 8-DIP C	01295	TL072ACJG
A3U402	1820-0939	5	2	IC FF CMOS D-TYPE POS-EDGE-TRIG DUAL	3L585	CD4013BE
A3U403	1820-1241	4	1	IC MUXR/DATA-SEL CMOS 8-TO-1-LINE 8-INP	3L585	CD4512BE
A3U404	1826-0915	9		IC OP AMP LOW-BIAS-H-IMPD 8-DIP-C PKG	01295	TL071ACJG (PER HP DWG)
A3U405	1826-0740	8	4	IC SWITCH ANLG DUAL 16-DIP C PKG	32293	ID5043CDE
A3U406	1826-0208	3	3	IC OP AMP GP 8-DIP-P PKG	27014	LM310N
A3U407	1820-1725	9		IC MULTIPLXR ANLG 16-DIP-P PKG	17856	DG508CJ
A3U409	1826-0753	3		IC OP AMP LOW-BIAS-H-IMPD QUAD 14-DIP-C	04713	MC34004BL
A3U410	1826-0705	1		IC OP AMP LOW-BIAS-H-IMPD DUAL 8-DIP C	01295	TL072ACJG

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3U411	1826-0915	9		IC OP AMP LOW-BIAS-H-IMPD 8-DIP-C PKG	01295	TL071ACJG (PER HP DWG)
A3U503	1820-1956	8		IC LCH CMOS COM CLOCK QUAD	3L585	CD4042BE
A3U504	1820-1956	8		IC LCH CMOS COM CLOCK QUAD	3L585	CD4042BE
A3U505	1820-1956	8		IC LCH CMOS COM CLOCK QUAD	3L585	CD4042BE
A3U506	1820-1956	8		IC LCH CMOS COM CLOCK QUAD	3L585	CD4042BE
A3U507	1820-1956	8		IC LCH CMOS COM CLOCK QUAD	3L585	CD4042BE
A3U508	1826-0208	3		IC OP AMP GP 8-DIP-P PKG	27014	LM310N
A3U509	1826-1047	0	1	IC OP AMP PRCN 8-DIP-C PKG	28480	1826-1047
A3U510	1826-0785	1		IC OP AMP LOW BIAS-H-IMPD DUAL 8-DIP-C	01295	TL072ACJG
A3U605	1826-0208	3		IC OP AMP GP 8-DIP-P PKG	27014	LM310N
A3U606	1826-0740	8		IC SWITCH ANLG DUAL 16-DIP-C PKG	32293	IH5043CDE
A3U607	1826-0740	8		IC SWITCH ANLG DUAL 16-DIP-C PKG	32293	IH5043CDE
A3U608	1826-0915	9		IC OP AMP LOW-BIAS-H-IMPD 8-DIP-C PKG	01295	TL071ACJG (PER HP DWG)
A3U611	1826-0915	9		IC OP AMP LOW-BIAS-H-IMPD 8-DIP-C PKG	01295	TL071ACJG (PER HP DWG)
A3U706	1826-0740	8		IC SWITCH ANLG DUAL 16-DIP-C PKG	32293	IH5043CDE
A3U708	1826-0753	3		IC OP AMP LOW-BIAS-H-IMPD QUAD 14-DIP-C	04713	MC34004BL
A3U710	1826-0753	3		IC OP AMP LOW-BIAS-H-IMPD QUAD 14-DIP-C	04713	MC34004BL
A4	04937-60004	6		DCU ASSEMBLY (STANDARD)	28480	04937-60004
A4	04937-60008	0	1	DCU ASSEMBLY (OPTION 002)	28480	04937-60008
A4C1	0160-4006	2	2	CAPACITOR-FXD 39PF +-5% 100VDC CER 0+-30	28480	0160-4006
A4C2	0160-4006	2		CAPACITOR-FXD 39PF +-5% 100VDC CER 0+-30	28480	0160-4006
A4C4	0180-0374	3		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020D2
A4C5	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A4C6	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A4C7	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A4C8	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A4C9	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A4C10	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A4C11	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A4C12	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A4C13	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A4C14	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A4CR1	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4E1	5000-9043	6	1	EXTRACTOR PIN	28480	5000-9043
A4E2	5040-6843	2	1	EXT-PC BLACK	28480	5040-6843
A4J1	1251-4670	2	1	CONNECTOR 3-PIN M POST TYPE	28480	1251-4670
A4MP1	04937-80019	5	1	LABEL 002 (OPTION 002)	28480	04937-80019
A4R1	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-TC-1003-F
A4R2	0698-0827	4		RESISTOR 1M 1% .125W F TC=0+-100	28480	0698-0827
A4R100	1810-0279	5		NETWORK-RES 10-SIP4.7K OHM X9	01121	210A472
A4R101	1810-0281	9	1	NETWORK-RES 10-SIP100.0K OHM X 9	01121	210A104
A4TP1	1251-6947	0		CONNECTOR-SGL CONT PIN .025-IN-BSC-SZ SQ	28480	1251-6947
A4TP1	1251-7308	9		CONN-POST TYPE .100-PIN SPCG 60-CONT	28480	1251-7308
A4TP2	1251-6947	0		CONNECTOR-SGL CONT PIN .025 IN BSC-SZ SQ	28480	1251-6947
A4U100	1820-3131	5	1	IC 8-BIT,LOW POWER,I-TEMP.RANGE MICRO-P.	28480	1820-3131
A4U101	1820-3551	3	1	NSCB10AN-C-TEMP	28480	1820-3551
A4U102	04937-10010	9	1	ROM-OP SYSTEM 1	28480	04937-10010
A4U102	04937-10012	1	1	RO[illegible] SYSTEM 1 (OPTION 002)	28480	04937-10012
A4U103	1820-2998	9		IC [illegible] IC373N	28480	1820-2998
A4U104	04937-10011	0	1	ROM-OP SYSTEM 2	28480	04937-10011
A4U104	04937-10013	2	1	ROM-OP SYSTEM 2 (OPTION 002)	28480	04937-10013
A4U105	1820-0939	5		IC FF CMOS D-TYPE POS-EDGE-TRIG DUAL	3L585	CD4013BE
A4U106	1820-3079	0	1	IC DCDT CMOS/74HC 3-TO-8-LINE	28480	1820-3079
A4U107	1820-1960	4	1	IC GATE CMOS NAND DUAL 4 INP	04713	MC14012BCP
A4U108	1820-2922	0	1	IC GATE CMOS/74HC NAND QUAD 2-INP	28480	1820-2922
A4U109	1820-3136	0	1	IC DCDR CMOS/74HC BIN 4 TO 16-LINE	28480	1820-3136
A4W1	1258-0141	0		JUMPER-REM	28480	1258-0141
A4Y1	0410-1327	7	1	CRYSTAL-QUARTZ 4.194304 MHZ HC-18/U-HLDR	28480	0410-1327
A4XDS1	1200-0567	1	2	SOCKET-IC 28-CONT DIP DIP SLDR	28480	1200-0567
A6	04937-62601	3	1	FRONT PANEL ASSY	28480	04937-62601
A6A1	04937-60001	3		SWITCHBOARD ASSY	28480	04937-60001
A6A2	04937-60006	8		SWITCHBOARD ASSY (OPTION 002)	28480	04937-60006
A6E1	0340-0732	7	2	INSULATOR-BDG POST POLYC	28480	0340-0732
A6E2	1510-0131	7	2	BINDING POST SGL SGL-TUR JGK	28480	1510-0131
A6E3	5041-0201	6	1	KEYCAP WHITE	28480	5041-0201
A6E4	5041-1931	1	1	KEYCAP NOR	28480	5041-1931
A6E5	5041-1932	2	1	KEYCAP REV	28480	5041-1932

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A6E6	5041-1933	3	1	KEYCAP DIAL	28480	5041-1933
A6E7	5041-1935	5	1	KEYCAP BRDG	28480	5041-1935
A6E8	5041-1938	8	2	KEYCAP 600	28480	5041-1938
A6E9	5041-1938	8		KEYCAP 600	28480	5041-1938
A6E10	5041-1939	9	2	KEYCAP 900 (STANDARD ONLY)	28480	5041-1939
A6E10	5041-1937	7	2	KEYCAP 150 (OPTION 002)	28480	5041-1937
A6E11	5041-1939	9		KEYCAP 900 (STANDARD ONLY)	28480	5041-1939
A6E11	5041-1937	7		KEYCAP 150 (OPTION 002)	28480	5041-1937
A6E12	5041-2022	3	2	KEYCAP 1200	28480	5041-2022
A6E13	5041-2022	3		KEYCAP 1200	28480	5041-2022
A6E14	5041-2813	0	1	KEYCAP A	28480	5041-2813
A6E15	5041-2814	1	1	KEYCAP B	28480	5041-2814
A6MP1	0370-1089	2	1	KNOB BASE 1/2 JGK .125-IN-ID	28480	0370-1089
A6MP2	0370-1095	0	1	KNOB BASE 1/2 ODP .25-IN-ID	28480	0370-1095
A6MP3	0890-0344	2	1	TUBING-FLEX .04-ID TFE .012-WALL	00000	ORDER BY DESCRIPTION
A6MP4	2420-0023	1	2	NUT-HEX-W/LKWR 6-32-THD .109-IN-THK	28480	2420-0023
A6MP5	2420-0023	1		NUT-HEX-W/LKWR 6-32-THD .109-IN THK	28480	2420-0023
A6MP6	2950-0001	8	4	NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
A6MP7	2950-0001	8		NUT-HEX-DBL-CHAM 3/8-32 THD .094 IN THK	00000	ORDER BY DESCRIPTION
A6MP8	2950-0001	8		NUT-HEX-DBL-CHAM 3/8-32 THD .094-IN-THK	00000	ORDER BY DESCRIPTION
A6MP9	2950-0001	8		NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
A6MP10	2950-0043	8	1	NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
A6MP11	3050-0067	9	7	WASHER-FL MTLC 5/16 IN .375-IN-ID	28480	3050-0067
A6MP12	3050-0067	9		WASHER-FL MTLC 5/16 IN .375-IN-ID	28480	3050-0067
A6MP13	3050-0067	9		WASHER-FL MTLC 5/16 IN .375-IN-ID	28480	3050-0067
A6MP14	3050-0067	9		WASHER-FL MTLC 5/16 IN .375-IN-ID	28480	3050-0067
A6MP15	3050-0067	9		WASHER-FL MTLC 5/16 IN .375-IN-ID	28480	3050-0067
A6MP16	3050-0067	9		WASHER-FL MTLC 5/16 IN .375-IN-ID	28480	3050-0067
A6MP17	3050-0067	9		WASHER-FL MTLC 5/16 IN .375-IN-ID	28480	3050-0067
A6MP18	3050-0100	1	2	WASHER-FL MTLC NO. 6 .147-IN-ID	28480	3050-0100
A6MP19	3050-0100	1		WASHER-FL MTLC NO. 6 .147-IN-ID	28480	3050-0100
A6MP20	7154-0394	9	1	STAINLESS STEEL SCREEN .0042IN 1.1IN	28480	7154-0394
A6MP21	0160-0464	8	4	CNDCT O-RING	28480	0160-0464
A6MP22	04937-80001	5	1	FRONT PANEL	28480	04937-80001
A6R1	0837-0116	4	2	VARISTOR VIN=250FAC ENERGY=20JOULES	28480	0837-0116
A6R2	0837-0116	4		VARISTOR VIN=250FAC ENERGY=20JOULES	28480	0837-0116
A6W1	5060-7167	/		RCVR INPUT CABLE ASSY	28480	5060-7167
A7	04937-62602	4	1	REAR PANEL ASSY	28480	04937-62602
A7E1	0360-0370	1	1	TERMINAL-SLDR LUG LK-MTG FOR #6-SCR	28480	0360-0370
A7E2	0890-0311	3	1	TUBING-DIS .125-D/.062-RCVD .02-WALL	28480	0890-0311
A7E3	1400-0249	0	4	CABLE TIE .062-.625-DIA .091-WD NYL	06383	PLT1M-8
A7E4	1400-0249	0		CABLE TIE .062-.625-DIA .091-WD NYL	06383	PLT1M-8
A7E5	1400-0249	0		CABLE TIE .062-.625-DIA .091-WD NYL	06383	PLT1M-8
A7E6	1400-0249	0	1	CABLE TIE .062-.625-DIA .091-WD NYL	06383	PLT1M-8
A7E7	1510-0038	8	1	BINDING POST ASSY SGL THD-STUD	28480	1510-0038
A7E8	7100-0389	9	1	TRANSFORMER COVER .62-DP	28480	7100-0389
A7E9	7120-1155	1	1	LABEL-WARNING .625-IN-WD 1.5-IN-LG PVC	28480	7120-1155
A7F1	2110-0065	4		FUSE .375A 250V NT 1.25X .25 UL	28480	2110-0065
A7LF1	9135-0224	6	1	POWER LINE FILTER	28480	9135-0224
A7MP1	2190-0027	6	1	WASHER-LK INTL T 1/4 IN .256-IN-ID	28480	2190-0027
A7MP1	2200-0167	8	2	SCREW-MACH 4-40 .375-IN-LG 82 DEG	28480	2200-0167
A7MP1	2360-0242	8	4	SCREW MACH 6-32 1.25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A7MP2	2200-0167	8		SCREW-MACH 4-40 .375-IN-LG 82 DEG	28480	2200-0167
A7MP2	2360-0242	8		SCREW-MACH 6-32 1.25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A7MP3	2360-0242	8		SCREW-MACH 6-32 1.25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A7MP4	2360-0242	8		SCREW-MACH 6-32 1.25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A7MP5	2420-0003	7	1	NUT-HEX-DBL-CHAM 6-32-THD .094-IN-THK	28480	2420-0003
A7MP6	2950-0006	3	1	NUT-HEX-DBL-CHAM 1/4-32-THD .094 IN THK	00000	ORDER BY DESCRIPTION
A7MP7	3050-0066	8	6	WASHER-FL MTLC NO. 6 .147-IN-ID	28480	3050-0066
A7MP8	3050-0066	8		WASHER-FL MTLC NO. 6 .147-IN-ID	28480	3050-0066
A7MP9	3050-0066	8		WASHER-FL MTLC NO. 6 .147-IN-ID	28480	3050-0066
A7MP10	3050-0066	8		WASHER-FL MTLC NO. 6 .147-IN-ID	28480	3050-0066
A7MP11	04937-00006	2	1	REAR PANEL	28480	04937-00006
A7MP12	04937-80003	7	1	IDENT LABEL	28480	04937-80003
A7MP13	7100-1292	2	1	TRANSFORMER COVER	28480	7100-1292
A7MP13	2190-0018	5		WASHER SPLIT #6	28480	2190-0018
A7MP13	2360-0131	4		SCREW-MACH 6-32 1.125	28480	2360-0131
A7MP14	1290-0018	5	2	WASHER LOCK	28480	2190-0018
A7MP15	2360-0131	4	2	SCREW-MACH 6-32 1.125	28480	2360-0131
A7T1	9100-4482	3	1	TRANSFORMER	28480	9100-4482
A7TP1	1251-7832	4	3	CONNECTOR-SGL CONT QDISC-FEM	28480	1251-7832
A7TP2	1251-7832	4		CONNECTOR-SGL CONT QDISC-FEM	28480	1251-7832
A7TP3	1251-7832	4		CONNECTOR-SGL CONT QDISC-FEM	28480	1251-7832
A7W1	04937-61601	1	1	E/M CABLE	28480	04937-61601
A7W3	04937-61603	1	1	CBL ASSY XMR	28480	04937-61603

SECTION VII
MANUAL CHANGES

7-1. INTRODUCTION

7-2. This section contains information to backdate this manual for instruments with serial prefixes lower than the Serial Prefix shown on the Title Page. It may also contain information about compatibility with other Protocol Analyzer software.

7-3. MANUAL CHANGES

7-4. To adapt this manual to your HP 4937A make the changes listed in Table 7-1. Changes are listed by serial prefix number. The sequence of change should be performed in the order shown.

Table 7-1. *Manual Changes*

If your HP 4937A has serial prefix or serial number:	Make these changes to your manual:
2418A	4, 3, 2, 1
2537A	3, 2, 1
2440A	3, 2
2523A	3

CHANGE 1

Section IV, Page 4-29, Hold Current Test

Change Step 6 to read as follows:

6. Press HOLD OTHER key. The current displayed on the multimeter should be 27 mA +/- 0.5 mA. The HP 4937A should read 0.0 dB.

Section IV, Page 4-30, Hold Current Test (con't)

Change Step 10 to read as follows:

10. The current displayed on the multimeter should be 27 mA +/- 0.5 mA. The HP 4937A display should be 0.0 dB.

CHANGE 1 (con't)

Section V, Page 5-8, A2 Hold Circuit Adjustments

Change Step 4 to read as follows:

4. Adjust A2R448, HOLD CURRENT, to a dc current of 26.3 mA +/- 0.1 mA.

Section VI, Table 6-3, Page 6-12, Replaceable Parts

Change: A2R407 to HP Part No. 6698-8009; Qty 1; RESISTOR 95, 1%, 1W, TC=0+-15; Mfr Code 07716; Mfr Part Number MAR5-1/10 TO 95R0-D.

Change: A2R447 to HP Part No. 0757-0302; Qty 1; RESISTOR 16.2, 1%, .125W, F TC=0+-100; Mfr Code 19701; Mfr Part Number MF4C1/8-TO 16R2-F.

Section VI, Table 6-3, Page 6-19, Replaceable Parts

Change the following part numbers:

A4U102: change part number to 04937-10002
A4U102: change part number to 04937-10004 (option 002)
A4U104: change part number to 04937-10003
A4U104; change part number to 04937-10005 (option 002)

Section VIII, Figure 8-11, Page 8-39

Change: A2R407 from 118 to 95

Section VIII, Figure 8-12, Page 8-41

Change: A2R447 from 23.7 to 16.2

Section VIII, Paragraph 8-125, page 8-24

Replace with page 7-9 Signatures

CHANGE 2

Section V, page 5-8

Change PROCEDURE instructions in paragraph 5-16, Hold Circuit Adjustments, to read as follows:

PROCEDURE:

1. Connect equipment as shown in figure 5-1.

2. Adjust the power supply output for 8.5V +/- 0.1V.

3. On the HP 4937A set:

```
REV pressed in
SIGNALING B
HOLD OTHER ON
```

4. Adjust A2R448, HOLD CURRENT, to a dc current reading of 26.3 mA, +/- 0.1 mA.

CHANGE 2 (con't)

Section VI Table 6-3, Page 6-7 Replaceable Parts

Delete: A9 HP Part No. 04937-60009, SIGNALING HLD ASSY.

Change: A7 to HP Part No. 04937-62602, description same.

Section VI Table 6-3, Page 6-10 Replaceable Parts

Delete: A2C610, A2CR610, A2CR611.

Change: A2CR605 to HP Part No. 1901-0050, DIODE SWITCHING 80V 200MA 2NS, Mfr. Code 28480, Mfr. Part No. 1901-0050.

A2CR606 to HP Part No. 1901-0050, DIODE SWITCHING 80V 200MA 2NS, Mfr. Code 28480, Mfr. Part No. 1901-0050.

Add: A2C602 HP Part No. 0160-0161, CAPACITOR-FXD .01UF +/- 10%, 200VDC POLYE, Mfr. Code 28480, Mfr. Part No. 0160-0161.

Section VI Table 6-3, Page 6-10 Replaceable Parts (con't)

Add: A2C604 HP Part No. 0180-3186, CAPACITOR-FXD 100UF +/- 20% 100VDC, Mfr. Code 28480, Mfr. Part No. 0180-3186.

Section VI Table 6-3, Page 6-11 Replaceable Parts

Change: A2Q404 to HP Part No. 1853-0036, TRANSISTOR PNP SI PD=310MW FT=250MHZ, Mfr. Code 28480, Mfr. Part No. 1853-0036.

Add: A2J7 HP Part No. 1200-0666, SOCKET-XSTR 3-CONT, Mfr. Code 28480, Mfr. Part No. 1200-0666.

A2J10 HP Part No. 1200-0666, SOCKET-XSTR 3 CONT, Mfr. Code 28480, Mfr. Part No. 1200-0666.

A2K601 HP Part No. 0490-1354, RELAY 2C 5VDC-COIL 2A 250VAC, Mfr. Code 28480, Mfr. Part No. 0490-1354.

CHANGE 2 (con't)

Section VI Table 6-3, Page 6-12 Replaceable Parts

Change: A2R418 to HP Part No. 0698-3437, RESISTOR 133 1% .125W F, Mfr. Code 24546, Mfr. Part No. C4-1/8-TO-133R-F.

A2R419 to HP Part No. 0757-0418, RESISTOR 619 1% .125W F, Mfr. Code 24546, Mfr. Part No. C4-1/8-TO-619R-F.

A2R428 to HP Part No. 0689-3025, RESISTOR 3K 5% 1W CC, Mfr. Code 01121, Mfr. Part No. GB3025.

Add: A2R405 HP Part No. 0757-0349, RESISTOR 22.6K 1% .125W F, Mfr. Code 24546, Mfr. Part No. C4-1/8-TO-2262-F.

A2R406 HP Part No. 0757-0349, RESISTOR 22.6K 1% .125W F, Mfr. Code 24546, Mfr. Part No. C4-1/8-TO-2262-F.

A2R407 HP Part No. 0698-4407, RESISTOR 118 1% 1W F, Mfr. Code 28480, Mfr. Part No. 0698-4407.

Section VI Table 6-3, Page 6-13 Replaceable Parts

Delete: A2R610, A2R611, A2R612.

Add: A2R601 HP Part No. 0698-5397, RESISTOR 84.5 1% .125W F, Mft. Code 24546, Mfr. Part No. C4-1/8-TO-84R5-F.

Section VI Table 6-3, Page 6-14 Replaceable Parts

Delete: A2W1.

Section VI Table 6-3, Pages 6-20/6-21 Replaceable Parts

Delete: A7MP13, A7T1, A9 and all associated parts.

Add: A7L1 HP Part No. 04937-80013, INDUCTOR-POT COR, Mfr. Code 28480, Mfr. Part No. 04937-80013.

A7L2 HP Part No. 04937-80013, INDUCTOR-POT COR, Mfr. Code 28480, Mfr. Part No. 04937-80013.

A7W2 Hp Part No. 04937-61602, INDUCT CABL ASSY, Mfr. Code 28480, Mfr. Part No. 04937-61602.

Section VIII Service

Replace: Page 8-31/8-32 with page 7-11/7-12.
Page 8-33/8-34 with page 7-13/7-14.
Page 8-39/8-40 with page 7-15/7-16.

MODEL 4937A
MANUAL CHANGES

CHANGE 3

Section 1 Table 1-1

Replace: Page 1-5 with page 7-17.
Page 1-6 with page 7-18.

Change: Page 1-9 Loop Signaling, Hold Circuits
Change 21 mA to 27 rnA.

Section III Operation

Replace: Page 3-24/3-25 with page 7-19.

Section V Page 5-8, paragraph 5-16

Change step 4 under PROCEDURE to read:

4. Adjust A9R468, Hold Circuit, to a dc current reading of 21.0 mA +/- 0.1 mA.

Section VI Table 6-3, Page 6-7 Replaceable Parts

Change: A2 to HP Part No. 04937-60002, TRANSMITTER BRD, Mfr. Code 28480, Mfr. Part No. 04937-60002.

Add: A9 HP Part No.s 04937-60009, SIGNALING HLD ASSY, Mfr. Code 28480, Mfr. Part No. 04937-60009.

Section VI Table 6-3, Page 6-9/6-10 Replaceable Parts

Delete: A2C426, A2C427, A2C428, A2C429, A2C430, A2CR420.

Section VI Table 6-3, Page 6-11 Replaceable Parts

Delete: A2Q420, A2Q421, A2Q422, A2Q423.

Section VI Table 6-3, Page 6-12 Replaceable Parts

Delete: A2R461, A2R462, A2R463, A2R464, A2R465, A2R466, A2R467, A2R468.

Section VI Table 6-3, Page 6-14 Replaceable Parts

Add: A2W1 HP Part. No. 5060-7167, CABLE RCVR INPUT, Mfr. Code 28480, Mfr. Part No. 5060-7167.

Section VI Replaceable Parts

Replace: Page 6-5 with page 7-20.
Page 6-6 with page 7-21.
Page 6-19 with page 7-22.
Page 6-20 with page 7-23.

CHANGE 3 (con't)

NOTE

Any HP 4937A with one transformer on the rear panel must have the following Performance Tests added.

Section IV Performance Tests

Add: Page 7-25/7-26, Battery Bridging Loss Test.
Page 7-27, E/M and Originate Current Detector Test

Section VIII Service

Replace: Page 8-29 with page 7-24.
Page 8-31/8-32 with page 7-25/7-26.
Page 8-33/8-34 with page 7-27/7-28.
Page 8-35 with page 7-29.
Page 8-37 with page 7-30.
Page 8-39/8-40 with page 7-31/7-32.
Page 8-41 with page 7-33.
Page 8-43 with page 7-34.
Page 8-45 with page 7-35.
Page 8-47 with page 7-36.

Change 4

Section VI Table 6-3, Page 6-19 Replaceable Parts

Change: A4U102 part number to 04937-10006.
A4U102 part number to 04937-10008 (option 002).
A4U104 part number to 04937-10007.
A4U104 part number to 04937-10009 (option 002).

8-125. SIGNATURES

Loop: Waveform Generator

PCA: A2 Transmitter Board

Test Condition: Frequency set to 1024 Hz. If no frequency is displayed, move the frequency cursor to the ten's position and press STEP UP twice. Check that the frequency at A2U208 pin 2 is 2024 Hz.

Signature analyzer connections:

START +	U208 pin 2	A2 Transmitter Board
STOP +	U208 pin 2	A2 Transmitter Board
CLOCK +	U208 pin 9	A2 Transmitter Board

Reference: Vh = CC34

U211

11 = 589N
12 = UH15
13 = 91A0
15 = 8795
16 = 1C4F
17 = 66PU
18 = 307U
19 = 6PCP

U214

2 = 6PCP
3 = CC34
5 = 01F9
11 = CC34
12 = 307N

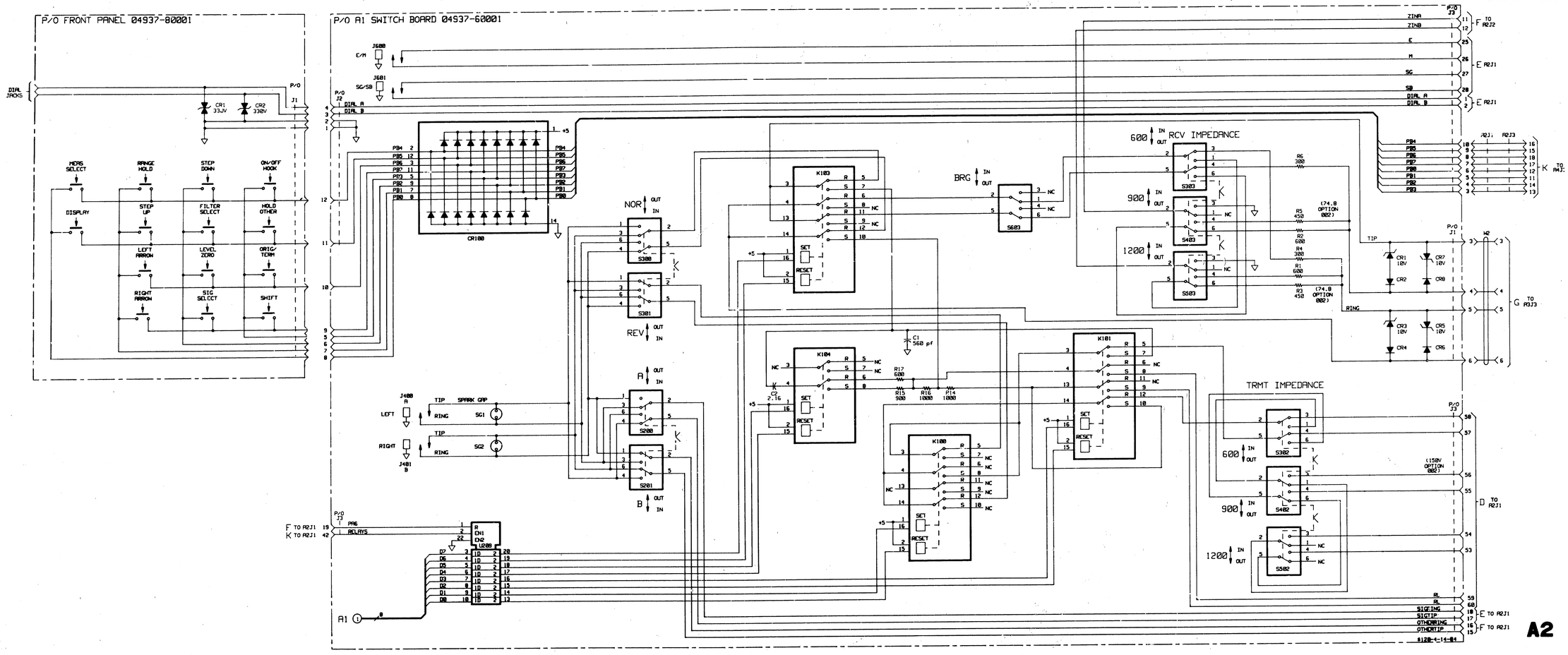


Figure 8-6. *A1 Switch Board Schematic (Sheet 2 of 2)*

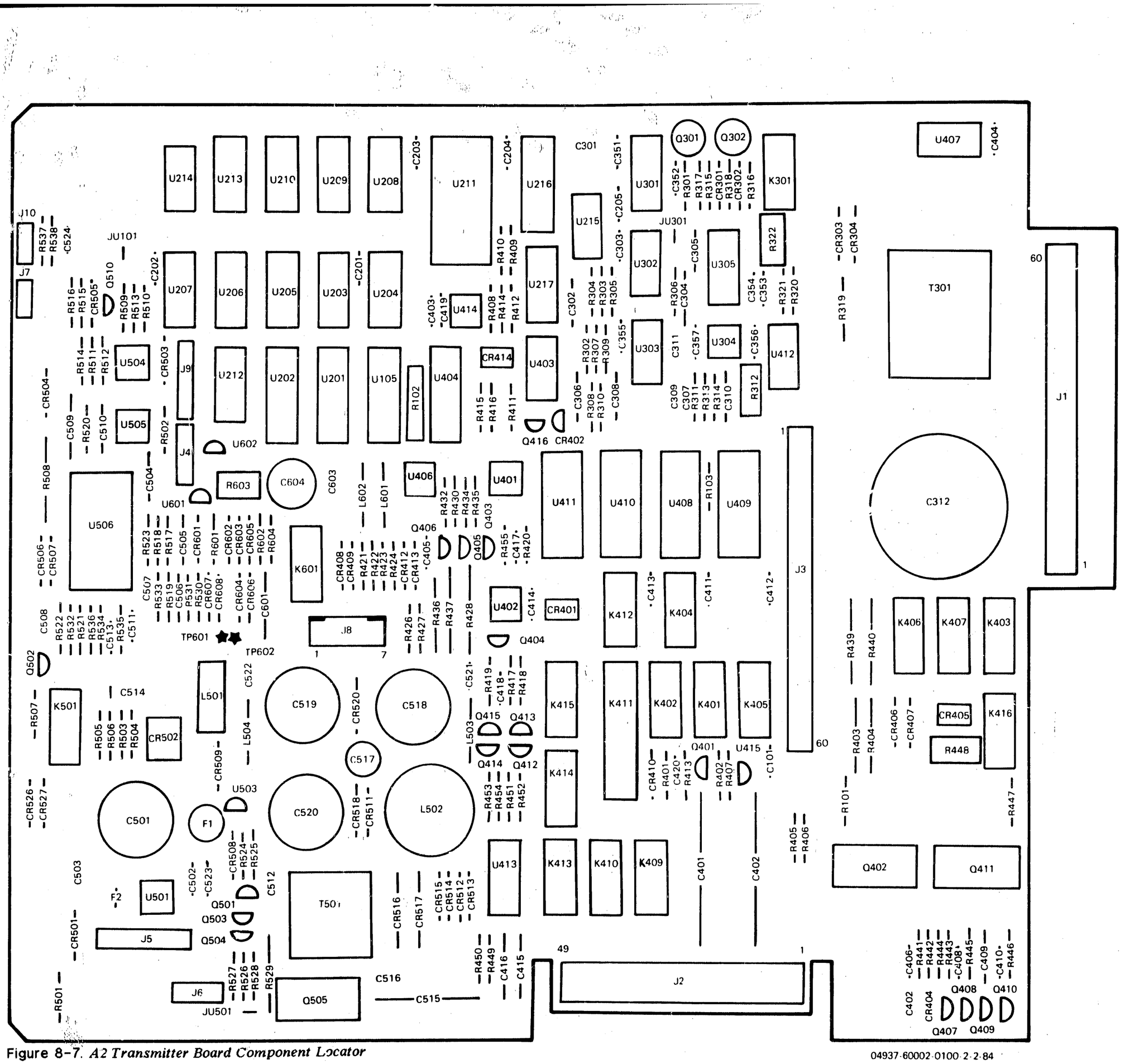
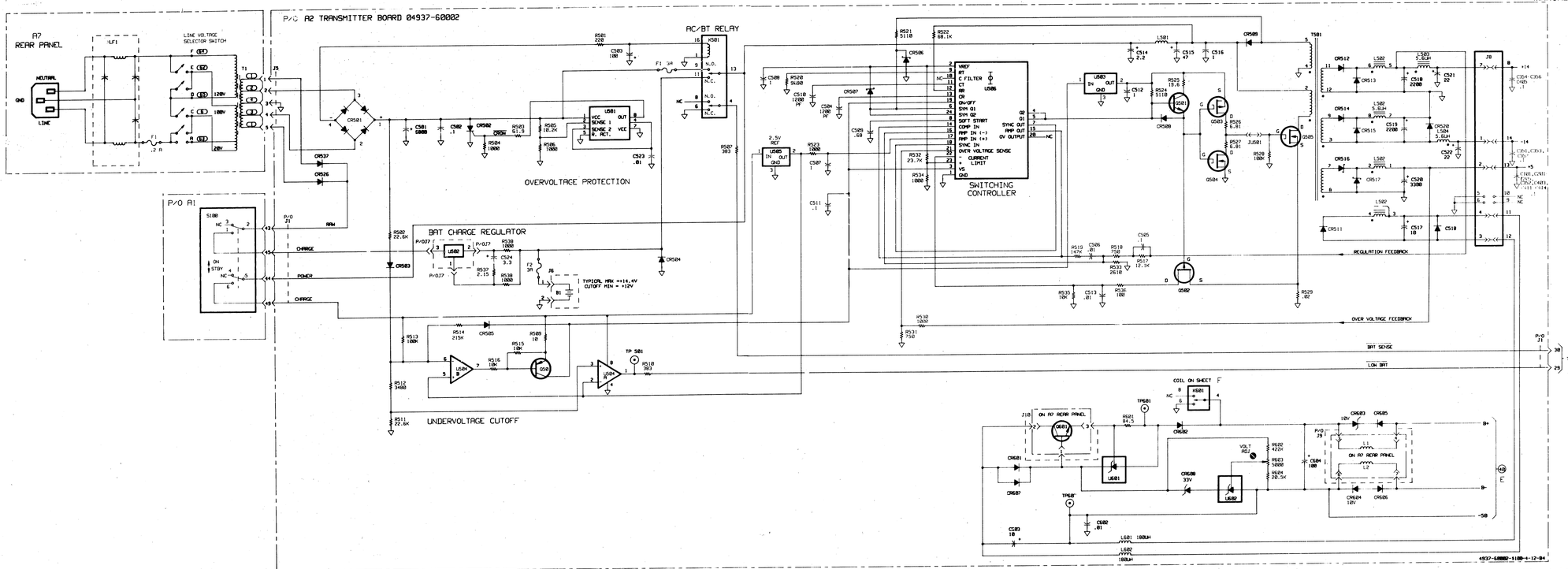


Figure 8-7. *A2 Transmitter Board Component Locator*

04937-60002-0100-2-2-84



B

Figure 8-8 *A2 Transmitter Board Schematic (Sheet 1 of 5)*

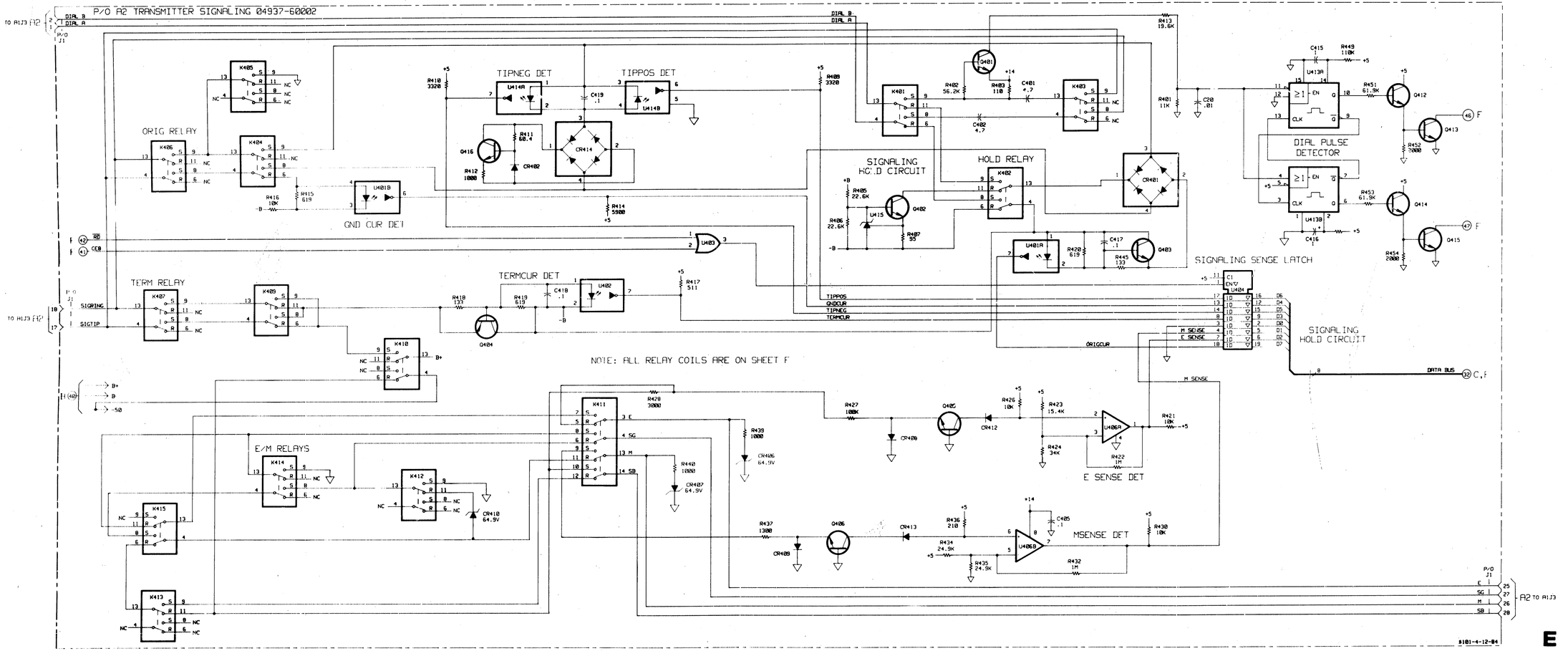


Figure 8-11. *A2 Transmitter Board Schematic (Sheet 4 of 5)*

Table 1-1. *Specifications*

LEVEL/FREQUENCY

Transmitter

Frequency:
Range: 20 Hz to 9999 Hz
Resolution: 1 Hz
Accuracy: +/-0.005% of output frequency

Preprogrammed functions:
SF Skip: skips the frequency band from 2450-2750 Hz
Frequencies: at power up 404 Hz, 1004 Hz, 2804 Hz, and 2713 Hz

Level:
Range: -40 to +13 dBm
Resolution: 0.1 dB
Accuracy (@ 1004 Hz, -19 dBm to 0 dBm), +/-0.1 dB; (elsewhere) +/-0.2 dB

Flatness (referenced to 1 kHz, in dB)

Level (dB)	Frequency (Hz) 20	200	4000	9999
+13	+.5,-3.0	+/-0.2	+/-0.2	
+10	+/-1.0	+/-0.2	+/-0.2	
-40				

Distortion (in dB from fundamental)

Note: (Includes harmonics, spurious, and background noise within a 3 dB bandwidth of 4 kHz or 4 X f_o whichever is greater.)

Level (dB)	Frequency (Hz) 40	100	4000	9999
+13	-20	-45	-45	
+10	-30	-55	-55	
0	-40	-50	-50	
-40				

Note: At 1004 Hz, 0 dBm, threshold is more than 65 dB down when using a 4-kHz filter.

Table 1-1. *Specifcations (con't)*

Receiver

Frequency:
Range: 20 Hz to 9999 Hz
Resolution: 1 Hz
Accuracy: +/-1.0 Hz

Level:
Range: -60 to +13 dBm
Resolution: 0.1 dB
Accuracy: (in dB)

Level	Frequency (Hz) 20	50	200	4000	9999
+13 to -40	+/-1.0	+/-0.5	+/-0.2	+/-0.2	
-40 to -60	+/-1.0	+/-0.6	+/-0.4	+/-0.4	

Note: Receiver accuracy not specified below 500 Hz when using 150 ohm termination. (Instruments with option 002.)

Note: At 1004 Hz accuracy is +/-0.1 dB from -20 to +13 dBm.

Cross Talk: >78 dB isolation @ 4 kHz, decreasing 6 dB per octave above 4 kHz.

Preprogrammed Functions:
Range Hold: Inhibits the autorange from changing from its present setting.

MESSAGE CIRCUIT NOISE

Transmitter: quiet terminated

Receiver:
Range: 0 to 99 dBrn; 150 ohms, lower limit is 7 dB higher (Option C02 instruments only)
Resolution: 1 dB
Accuracy: +/-1 dB from 10 to 99 dBrn
+/-2 dB from 0 to 10 dBrn
Weighting Filters: C-message, and 3 kHz Flat

3-37. E/M SIGNALING

3-38. E/M signaling is used primarily to signal the internal switching of the PBX or shorthaul trunks between two PBXs. E/M signaling uses a separate wire pair to send signaling information (E lead and M lead) from the pair used to send voiceband information (tip and ring). In addition, E/M Types II and III use sense ground (SG) and sense battery (SB) leads to improve signaling performance. (see figures 3-5, 3-6, and 3-7)

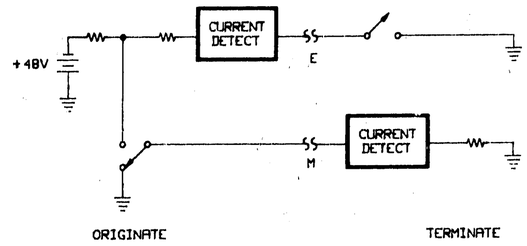


Figure 3-5. *E/M Type I Signaling*

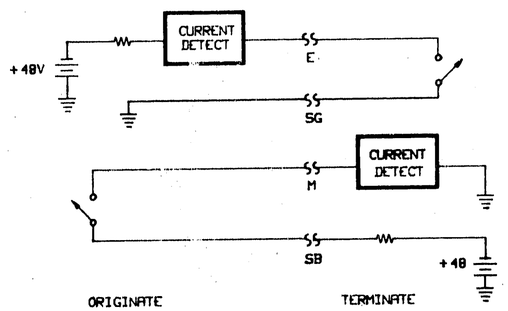


Figure 3-6. *E/M Type II Signaling*

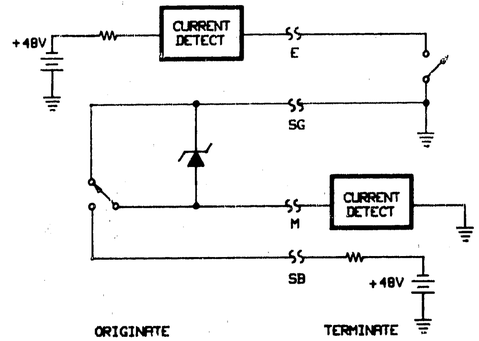


Figure 3-7. *E/M Type III Signaling*

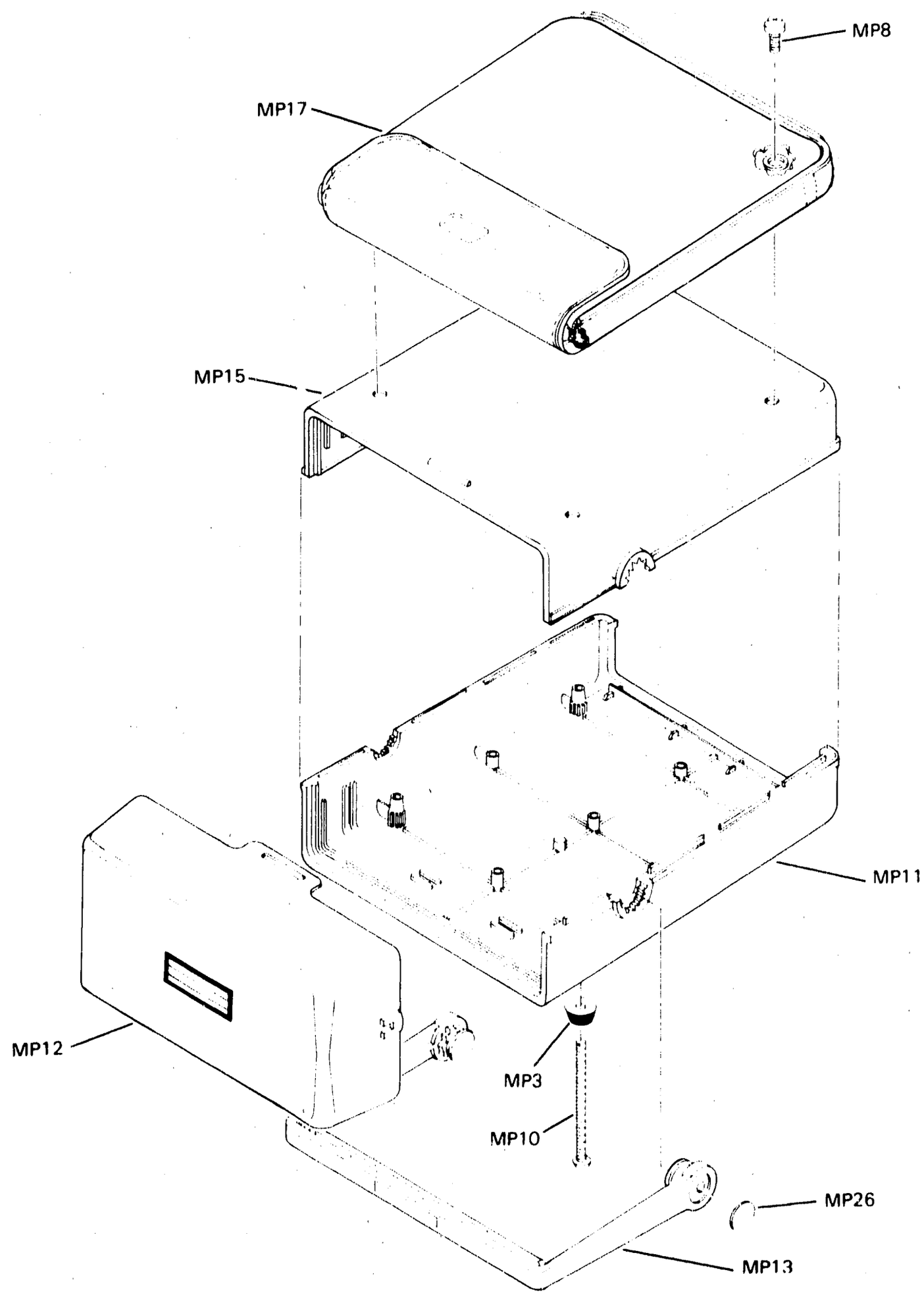


Figure 6-1. *Illustrated Parts Breakdown of Case and Covers*

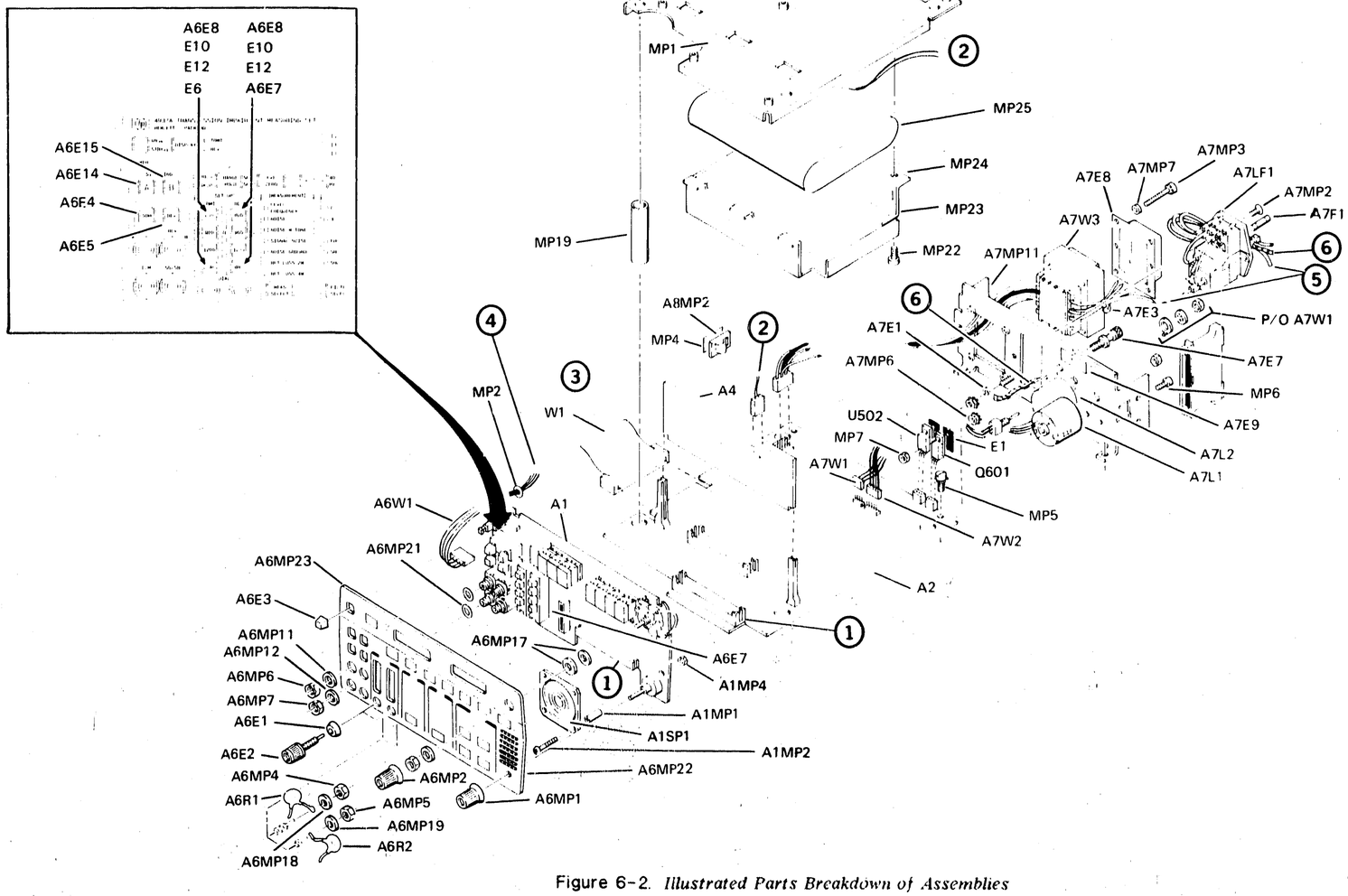


Figure 6-2. *Illustrated Parts Breakdown of Assemblies*

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3U411	1826-0915	9		IC OP AMP LOW-BIAS-H-IMPD 8 DIP-C PKG	01295	TL071ACJG (PER HP DWG)
A3U503	1820-1956	8		IC LCH CMOS COM CLOCK QUAD	3L585	CD4042BE
A3U504	1820-1956	8		IC LCH CMOS COM CLOCK QUAD	3L585	CD4042BE
A3U505	1820-1956	8		IC LCH CMOS COM CLOCK QUAD	3L585	CD4042BE
A3U506	1820-1956	8		IC LCH CMOS COM CLOCK QUAD	3L585	CD4042BE
A3U507	1820-1956	8		IC LCH CMOS COM CLOCK QUAD	3L585	CD4042BE
A3U508	1826-0208	3		IC OP AMP GP 8-DIP-P PKG	27014	LM310N
A3U509	1826-1047	0	1	IC OP AMP PRCN 8-DIP-C PKG	28480	1826-1047
A3U510	1826-0705	1		IC OP AMP LOW BIAS-H IMPD DUAL 8 DIP-C	01295	TL072ACJG
A3U605	1826-0208	3		IC OP AMP GP 8-DIP-P PKG	27014	LM310N
A3U606	1826-0740	8		IC SWITCH ANLG DUAL 16 DIP C PKG	32293	IH5043CDE
A3U607	1826-0740	8		IC SWITCH ANLG DUAL 16 DIP C PKG	32293	IH5043CDE
A3U608	1826-0915	9		IC OP AMP LOW BIAS H IMPD 8 DIP C PKG	01295	TL071ACJG (PER HP DWG)
A3U611	1826-0915	9		IC OP AMP LOW-BIAS-H IMPD 8 DIP-C PKG	01295	TL071ACJG (PER HP DWG)
A3U706	1826-0740	8		IC SWITCH ANLG DUAL 16 DIP C PKG	32293	IH5043CDE
A3U708	1826-0753	3		IC OP AMP LOW-BIAS-H IMPD QUAD 14-DIP-C	04713	MC34004DL
A3U710	1826-0753	3		IC OP AMP LOW-BIAS-H IMPD QUAD 14-DIP-C	04713	MC34004DL
A4	04937-60004	6		DCU ASSEMBLY (STANDARD)	28480	04937-60004
A4	04937-60008	0	1	DCU ASSEMBLY (OPTION 002)	28480	04937-60008
A4C1	0160-4006	2	2	CAPACITOR-FXD 39PF +-5% 100VDC CER 01-30	28480	0160-4006
A4C2	0160-4006	2		CAPACITOR-FXD 39PF +-5% 100VDC CER 01-30	28480	0160-4006
A4C4	0180-0374	3		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A4C5	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A4C6	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A4C7	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A4C8	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A4C9	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A4C10	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A4C11	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A4C12	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A4C13	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A4C14	0160-5298	8		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-5298
A4CR1	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4E1	5000-9043	6	1	EXTRACTOR-PIN	28480	5000-9043
A4E2	5040-6043	2	1	EXT-PC BLACK	28480	5040-6043
A4J1	1251-4670	2	1	CONNECTOR 3-PIN M POST TYPE	28480	1251-4670
A4MP1	04937-00019	5	1	LABEL 002 (OPTION 002)	28480	04937-00019
A4R1	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1003-F
A4R2	0698-0827	4		RESISTOR 1M 1% .125W F TC=0+-100	28480	0698-0827
A4R100	1810-0201	9		NETWORK-RES 10 SIP100.0K OHM X 9	01121	210A104
A4R101	1810-0279	5	1	NETWORK-RES 10 SIP4.7K OHM X 9	01121	210A472
A4TP1	1251-6947	0		CONNECTOR-SGL CONT PIN .025" IN DSC-SZ SQ	28480	1251-6947
A4TP1	1251-7308	9		CONN POST TYPE .100-PIN 1-PCC 60 CONT	28480	1251-7308
A4TP2	1251-6947	0		CONNECTOR-SGL CONT PIN .025" IN DSC-SZ SQ	28480	1251-6947
A4U100	1820-3131	5	1	IC D-BIT,LOW POWER,I-TEMP.RANGE MICRO-P	28480	1820-3131
A4U101	1820-3551	3	1	NSC810AN-C TEMP	28480	1820-3551
A4U102	04937-10002	9	1	ROM OP SYSTEM 1	28480	04937-10002
A4U102	04937-10004	1	1	ROM OP SYSTEM 2 (OPTION 002)	28480	04937-10004
A4U103	1820-2998	9		IC MC74HC373N	28480	1820-2998
A4U104	04937-10003	0	1	ROM OP SYSTEM 2	28480	04937-10003
A4U104	04937-10005	2	1	ROM OP SYSTEM 2 (OPTION 002)	28480	04937-10005
A4U105	1820-0939	5		IC FF CMOS D TYPE POS EDGE-TRIG DUAL	3L585	CD4013BE
A4U106	1820-3079	0	1	IC DCDR CMOS/74HC 3 TO 8-LINE	28480	1820-3079
A4U107	1820-1960	4	1	IC GATE CMOS NAND DUAL 4 INP	04713	MC14012BCP
A4U108	1820-2922	0	1	IC GATE CMOS/74HC NAND QUAD 2 INP	28480	1820-2922
A4U109	1820-3136	0	1	IC DCDR CMOS/74HC BIN 4 TO 16 LINE	28480	1820-3136
A4W1	1250-0141	0		JUMPER-REM	28480	1250-0141
A4X1	0410-1307	7	1	CRYSTAL-QUARTZ 4.194304 MHZ HC-18/U HLDR	28480	0410-1307
A4XD51	1200-0567	1	2	SOCKET IC 28-CONT DIP DIP SLDR	28480	1200-0567
A6	04937-62601	3	1	FRONT PANEL ASSY	28480	04937-62601
A6A1	04937-60001	3		SWITCHBOARD ASSY	28480	04937-60001
A6A2	04937-60006	8		SWITCHBOARD ASSY (OPTION 002)	28480	04937-60006
A6E1	0340-0732	7	2	INSULATOR-BDG POST POLYC	28480	0340-0732
A6E2	1510-0076	4	2	BINDING POST SGL SGL TRM JCK	28480	1510-0076
A6E3	5041-0201	6	1	KEYCAP WHITE	28480	5041-0201
A6E4	5041-1931	1	1	KEYCAP NOR	28480	5041-1931
A6E5	5041-1932	2	1	KEYCAP REV	28480	5041-1932

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A6E6	5041-1933	3	1	KEYCAP DIAL	28480	5041-1933
A6E7	5041-1935	5	1	KEYCAP BRDG	28480	5041-1935
A6E8	5041-1938	8	2	KEYCAP 600	28480	5041-1938
A6E9	5041-1938	8		KEYCAP 600	28480	5041-1938
A6E10	5041-1939	9	2	KEYCAP 900 (STANDARD ONLY)	28480	5041-1939
A6E10	5041-1937	7	2	KEYCAP 150 (OPTION 002)	28480	5041-1937
A6E11	5041-1939	9		KEYCAP 900 (STANDARD ONLY)	28480	5041-1939
A6E11	5041-1937	7		KEYCAP 150 (OPTION 002)	28480	5041-1937
A6E12	5041-2022	3	2	KEYCAP 1200	28480	5041-2022
A6E13	5041-2022	3		KEYCAP 1200	28480	5041-2022
A6E14	5041-2013	0	1	KEYCAP A	28480	5041-2013
A6E15	5041-2014	1	1	KEYCAP B	28480	5041-2014
A6MP1	0370-1089	2	1	KNOB BASE 1/2 DIA .125-IN ID	28480	0370-1089
A6MP2	0370-1095	0	1	KNOB BASE 1/2 DIA .25-IN-ID	28480	0370-1095
A6MP3	0890-0344	2	1	TUBING-FLEX .04 ID TFE .012 WALL	00000	ORDER BY DESCRIPTION
A6MP4	2420-0023	1	2	NUT-HEX-W/LKWR 6-32-THD .109-IN-THK	28480	2420-0023
A6MP5	2420-0023	1		NUT HEX W/LKWR 6-32-THD .109 IN THK	28480	2420-0023
A6MP6	2950-0001	8	4	NUT-HEX-DBL-CHAM 3/8-32 THD .094 IN-THK	00000	ORDER BY DESCRIPTION
A6MP7	2950-0001	8		NUT HEX DBL CHAM 3/8-32 THD .094 IN THK	00000	ORDER BY DESCRIPTION
A6MP8	2950-0001	8		NUT-HEX-DBL-CHAM 3/8-32 THD .094 IN-THK	00000	ORDER BY DESCRIPTION
A6MP9	2950-0001	8		NUT-HEX DBL CHAM 3/8-32 THD .094 IN THK	00000	ORDER BY DESCRIPTION
A6MP10	2950-0043	8	1	NUT-HEX-DBL-CHAM 3/8-32-THD .094 IN-THK	00000	ORDER BY DESCRIPTION
A6MP11	3050-0067	9	7	WASHER FL MTLC 5/16 IN .375-IN ID	28480	3050-0067
A6MP12	3050-0067	9		WASHER-FL MTLC 5/16 IN .375-IN ID	28480	3050-0067
A6MP13	3050-0067	9		WASHER FL MTLC 5/16 IN .375 IN ID	28480	3050-0067
A6MP14	3050-0067	9		WASHER-FL MTLC 5/16 IN .375-IN ID	28480	3050-0067
A6MP15	3050-0067	9		WASHER FL MTLC 5/16 IN .375-IN ID	28480	3050-0067
A6MP16	3050-0067	9		WASHER-FL MTLC 5/16 IN .375 IN-ID	28480	3050-0067
A6MP17	3050-0067	9		WASHER FL MTLC 5/16 IN .375 IN ID	28480	3050-0067
A6MP18	3050-0100	1	2	WASHER FL MTLC NO. 6 .147 IN ID	28480	3050-0100
A6MP19	3050-0100	1		WASHER FL MTLC NO. 6 .147 IN-ID	28480	3050-0100
A6MP20	7154-0394	9	1	STAINLESS STEEL SCREEN .004IN 1.11IN	28480	7154-0394
A6MP21	8160-0464	8	4	CNDCT O-RING	28480	8160-0464
A6MP22	04937-00001	5	1	FRONT PANEL	28480	04937-00001
A6R1	0837-0116	4	2	VARISTOR VIN 250IAC ENERGY 20JOULES	28480	0837-0116
A6R2	0837-0116	4		VARISTOR VIN 250IAC ENERGY 20JOULES	28480	0837-0116
A7	04937-62602	4	1	REAR PANEL ASSY	28480	04937-62602
A7E1	0360-0370	1	1	TERMINAL-SLDR LUG LK MTG FOR #6-SCR	28480	0360-0370
A7E2	0890-0311	3	1	TUBING-NS .115 OZ/.062-RCVD .02 WALL	28480	0890-0311
A7E3	1400-0249	0	4	CABLE TIE .062 .62-DIA .091 WD NYL	06383	PLT1M-0
A7E4	1400-0249	0		CABLE TIE .062 .625 DIA .091 WD NYL	06383	PLT1M 0
A7E5	1400-0249	0		CABLE TIE .062 .62-DIA .091-WD NYL	06383	PLT1M 0
A7E6	1400-0249	0		CABLE TIE .062 .625 DIA .091 WD NYL	06383	PLT1M 0
A7E7	1510-0030	8	1	BINDING POST ASSY SGL THD-STUD	28480	1510-0030
A7E8	7100-0302	9	1	TRANSFORMER COVER .62 DP	28480	7100-0302
A7E9	7120-1155	1	1	LABEL-WARNING .62"-IN-WD 1.5-IN-LG PVC	28480	7120-1155
A7F1	2110-0065	4	1	FUSE .375A 250V NTD 1.25X.25 UL	28480	2110-0065
A7L1	04937-80013	9	2	INDUCTOR POT COR	28480	04937-80013
A7L2	04937-80013	9		INDUCTOR POT COR	28480	04937-80013
A7LF1	9135-0224	6	1	POWER LINE FILTER	28480	9135-0224
A7MP1	2190-0027	6	1	WASHER LK INTL T 1/4 IN .256-IN ID	28480	2190-0027
A7MP1	2200-0167	8	2	SCREW MACH 4-40 .375-IN-LG 82 DEG	28480	2200-0167
A7MP1	2360-0242	0	4	SCREW MACH 6-32 1.25-IN LG PAN HD POZI	00000	ORDER BY DESCRIPTION
A7MP2	2200-0167	8		SCREW MACH 4-40 .375-IN-LG 82 DEG	28480	2200-0167
A7MP2	2360-0242	0		SCREW MACH 6-32 1.25 IN LG PAN HD POZI	00000	ORDER BY DESCRIPTION
A7MP3	2360-0242	0		SCREW MACH 6-32 1.25 IN-LG PAN HD POZI	00000	ORDER BY DESCRIPTION
A7MP4	2360-0242	0		SCREW MACH 6-32 1.25 IN-LG PAN HD POZI	00000	ORDER BY DESCRIPTION
A7MP5	2420-0003	7	1	NUT-HEX-DBL-CHAM 6-32-THD .094 IN-THK	28480	2420-0003
A7MP6	2950-0006	3	1	NUT-HEX DBL CHAM 1/4-32 THD .094 IN THK	00000	ORDER BY DESCRIPTION
A7MP7	3050-0066	8	4	WASHER-FL MTLC NO. 6 .147 IN ID	28480	3050-0066
A7MP8	3050-0066	8		WASHER-FL MTLC NO. 6 .147 IN ID	28480	3050-0066
A7MP9	3050-0066	8		WASHER-FL MTLC NO. 6 .147 IN-ID	28480	3050-0066
A7MP10	3050-0066	8		WASHER FL MTLC NO. 6 .147 IN-ID	28480	3050-0066
A7MP11	04937-00001	7	1	REAR PANEL	28480	04937-00001
A7MP12	04937-80003	7	1	IDENT LABEL	28480	04937-80003
A7TP1	1251-7832	4	3	CONNECTOR-SGL CONT QDISC PIN	28480	1251-7832
A7TP2	1251-7832	4		CONNECTOR SGL CONT QDISC PIN	28480	1251-7832
A7TP3	1251-7832	4		CONNECTOR-SGL CONT QDISC PIN	28480	1251-7832
A7W1	04937-61601	1	1	E/M CABLE ASSY	28480	04937-61601
A7W2	04937-61602	2	1	INDUCT CABL ASSY	28480	04937-61602
A7W3	04937-61603	3	1	CBL ASSY XFMR	28480	04937-61603

PERFORMANCE TEST

4-28. Battery Bridging Loss Test

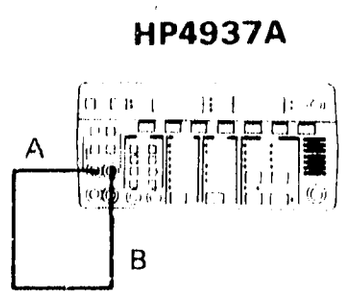


Figure 4-14. *Battery Bridging Loss Test*

EQUIPMENT:

none

1. On the HP 4937A set:

```
DISPLAY..................... RCV
SIGNALING................... A
NOR......................... pressed in
SIGNALING................... press SIG SELECT key until all LEDs are off
SET UP RCV.................. 1200
SET UP TRMT................. 1200
```

2. Externally connect (loop) the TRMT and RCV.

3. Rotate the OUTPUT LEVEL knob completely clockwise and set the frequency for 1004 Hz (press SHIFT key then 1004 Hz key).

4. Press the LEVEL ZERO key.

5. Using SIG SELECT key select LOOP.

6. Using ORIG/TERM key select TERM.

7. Press HOLD OTHER key on.

PERFORMANCE TEST

4-28. Battery Bridging Loss Test (con't)

8. Check that the HP 4937A display is within the tolerance given for each frequency in table 4-15.

Table 4-15. *Battery Bridging Loss*

FREQUENCY	TOLERANCE
199	+/- 0.7 dB
499	+/- 0.5 dB
4999	+/- 0.5 dB
9999	+/- 0.5 dB

PERFORMANCE TEST

4-30. E/M and Originate Current Detector Test

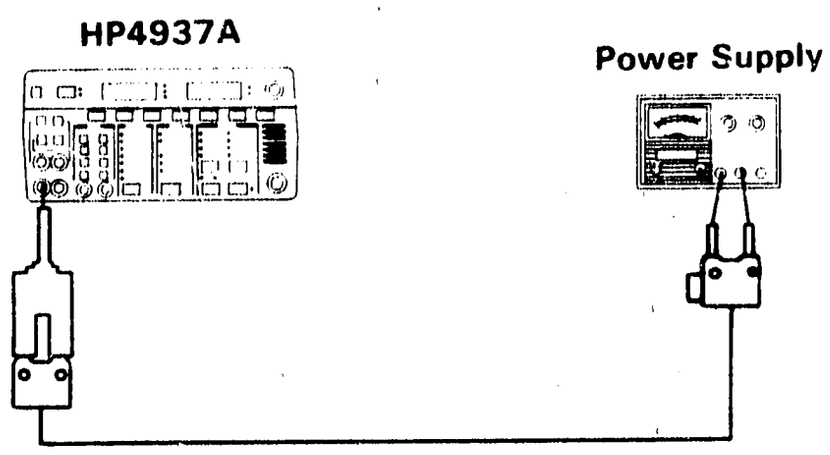


Figure 4-16. *E/M and Originate Current Detector Test*

EQUIPMENT:

Power supply

1. Connect equipment as shown in figure 4-16 with + side of power supply output to the neutral side of the cable.

2. On the HP 4937A set:

```
SIG SELECT..............  E/M
ORIG/TERM...............  ORIG
ON/OFF HOOK.............  ON HK ORIG
```

3. Set power supply for an output of 10.0 volts.

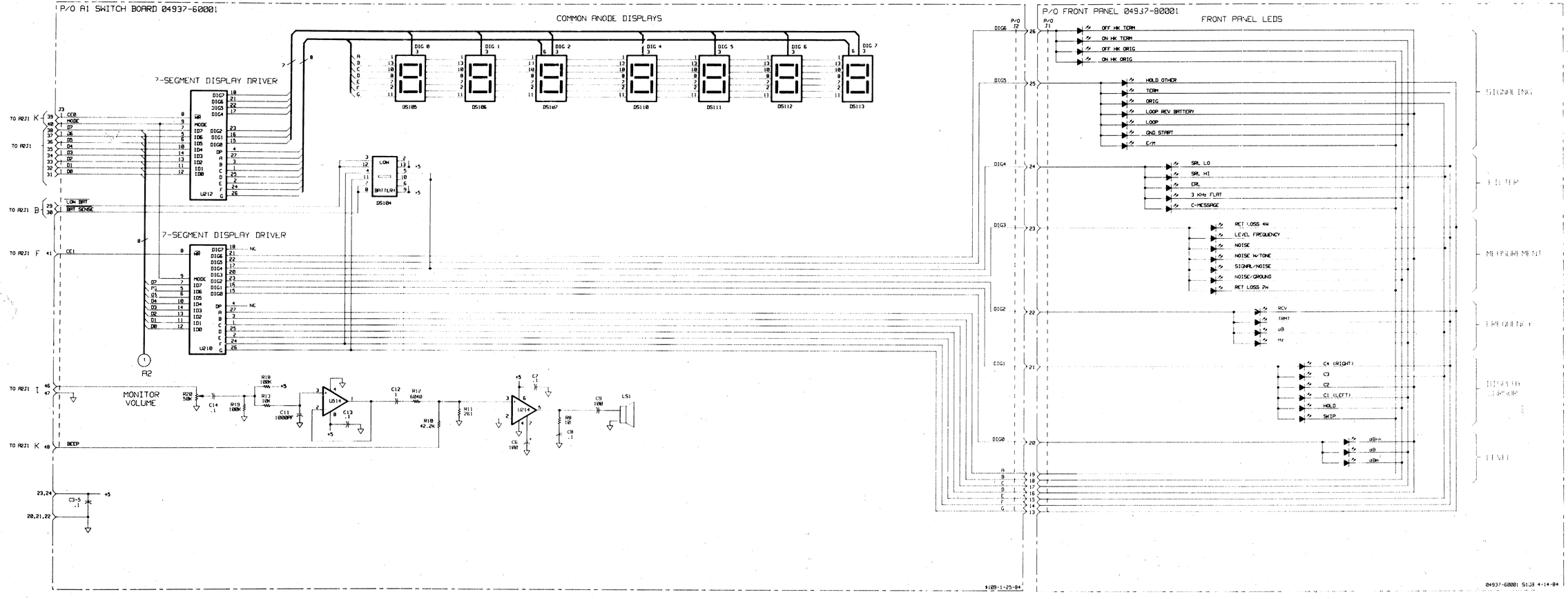
4. Slowly increase the voltage until the ON HK TERM LED is lighted. The trip voltage should be 16 volts +/-2 volts.

5. Reverse the polarity of the power supply voltage.

6. On the HP 4937A set:

```
ORIG/TERM...............  TERM
ON/OFF HOOK.............  OFF HK TERM
```

7. Slowly increase the voltage until the OFF HK ORIG LED is lighted. The trip voltage should be 16 volts +/-2 volts.



A1

Figure 8-5. *A1 Switch Board Schematic (Sheet 1 of 2)*

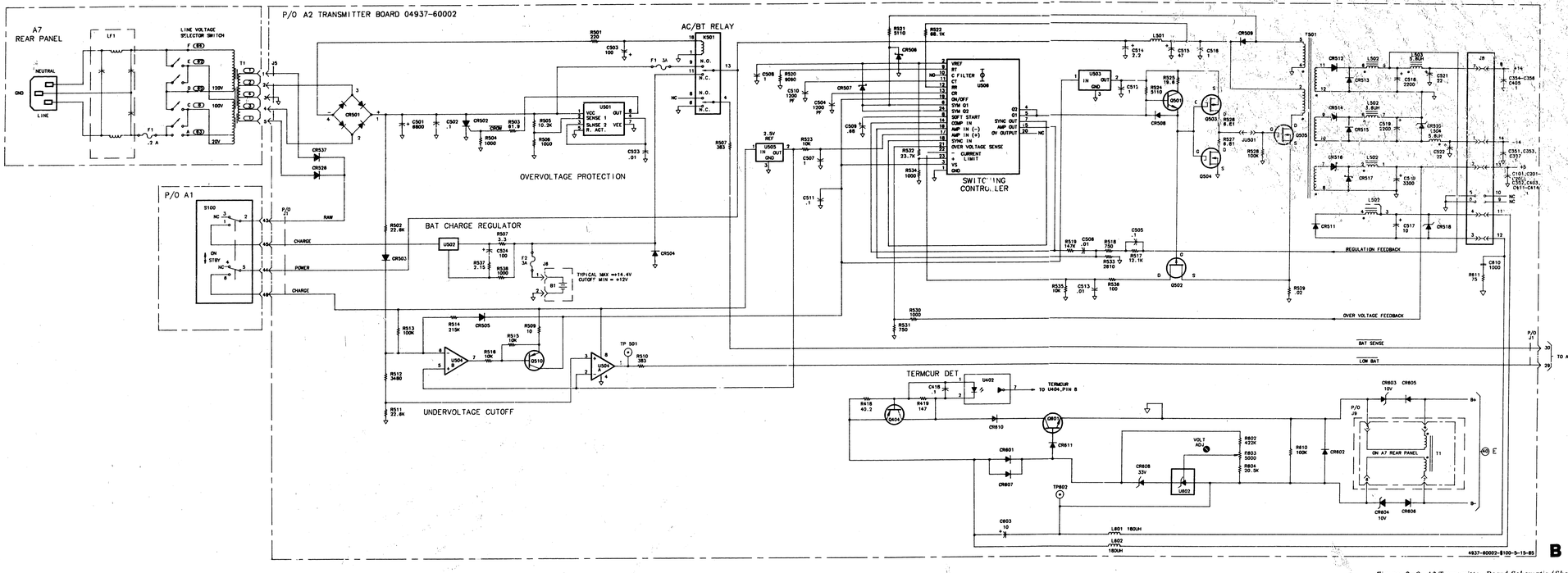


Figure 8-8. *A2 Transmitter Board Schematic (Sheet 1 of 5)*

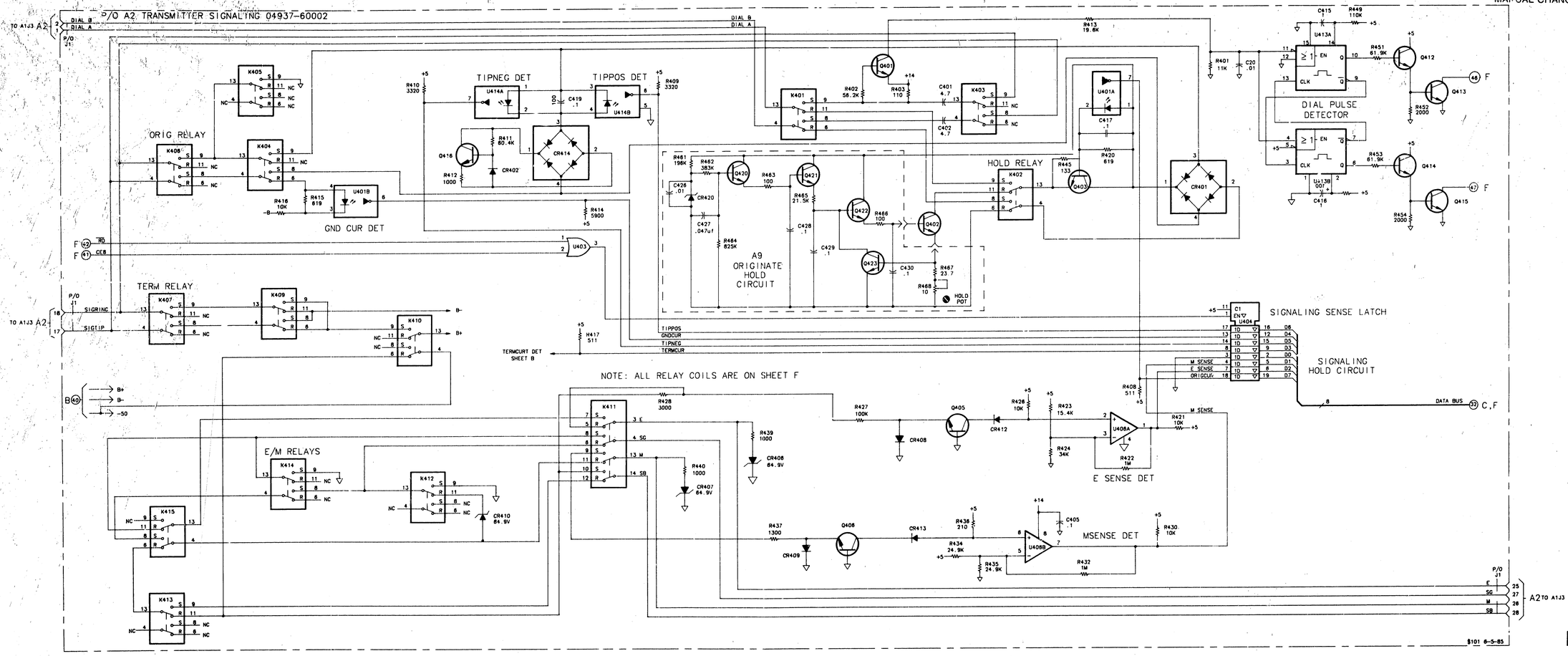
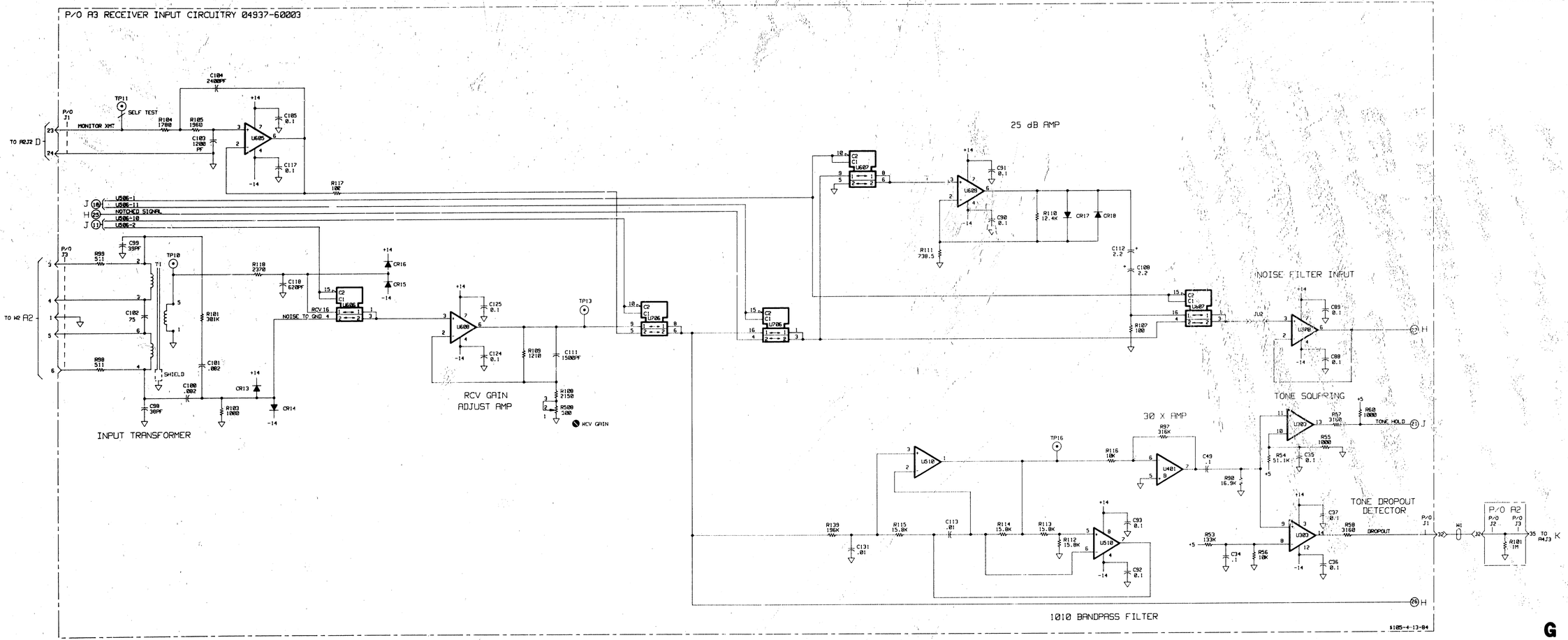
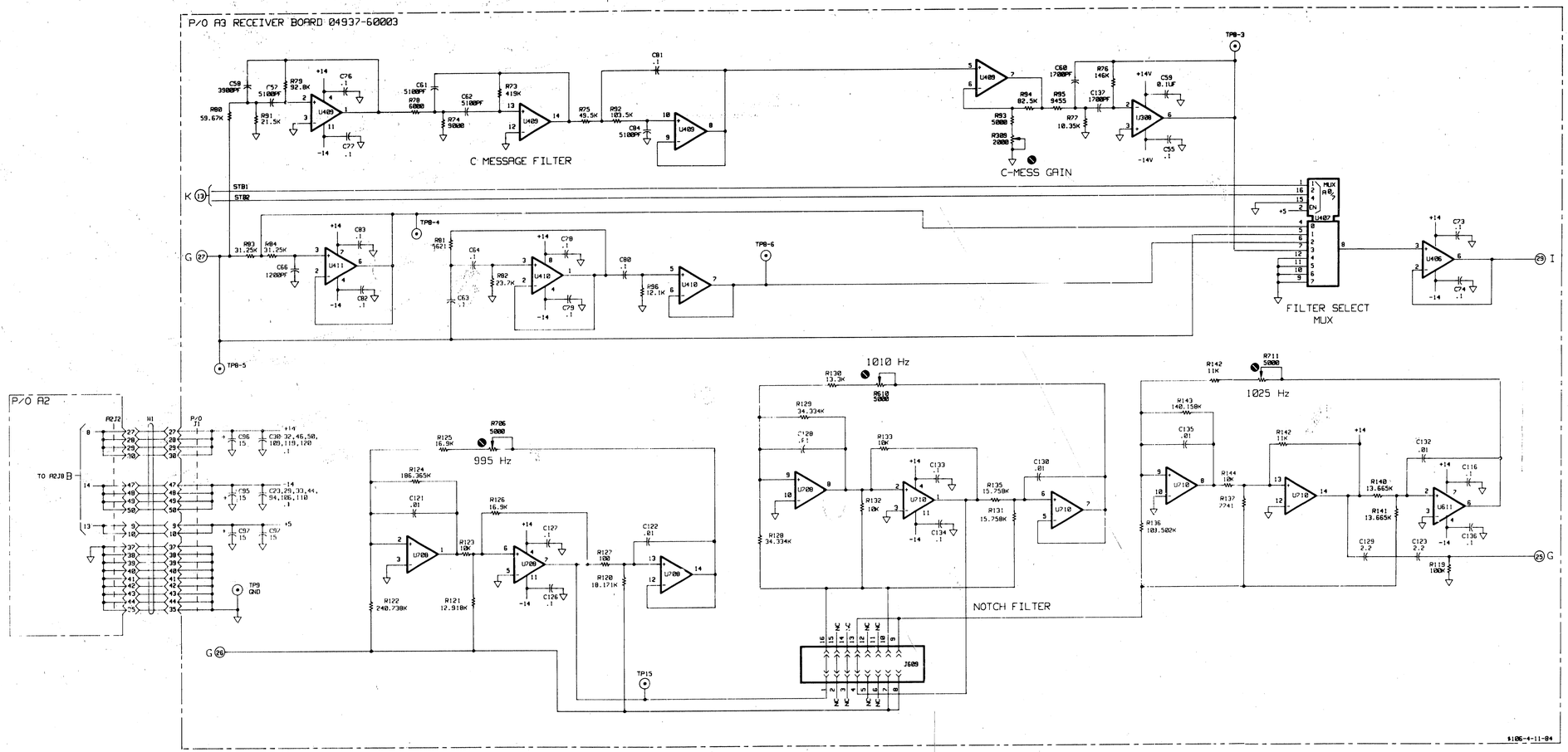


Figure 8-11. *A2 Transmitter Board Schematic (Sheet 4 of 5)*



G

Figure 8-14. *A3 Receiver Board Schematic (Sheet 1 of 4)*



H

Figure 8-15. *A3 Receiver Board Schematic (Sheet 2 of 4)*

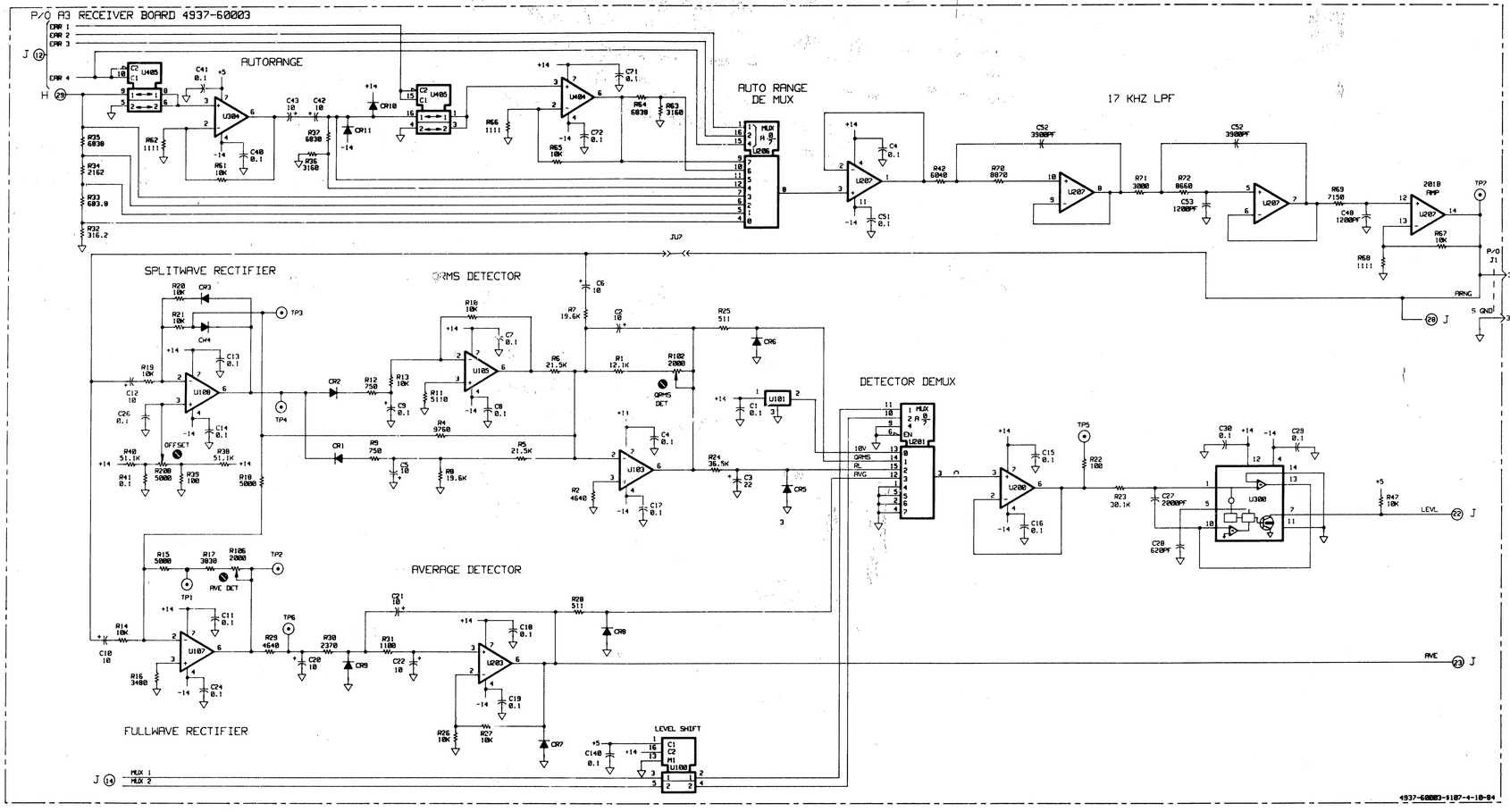


Figure 8-16. *A3 Receiver Board Schematic (Sheet 3 of 4)*

SECTION VIII
SERVICE

8-1. INTRODUCTION

8-2. This section contains service information for the HP 4937A TIMS. Included are the theory of operation, circuit description, troubleshooting and repair, and schematics.

8-3. SAFETY CONSIDERATIONS

8-4. This section contains warnings and cautions that must be followed for your protection and to avoid damage to the equipment.

8-5. Before any repair is completed, ensure that all safety features are intact and functioning, and that all necessary parts are connected to their protective grounding means. Safety markings displayed inside the instrument must be adhered to.

8-6. CIRCUIT DESCRIPTION

8-7. The HP 4937A is a Transmission Impairment Measurement Set that provides both the test signals and measurement capabilities required for testing the transmission characteristics of communication lines and can implement both the PBX and the central office signaling functions. Functionally the HP 4937A consists of six parts:

- The microprocessor/controller circuitry processes data from the receiver and controls the counting functions and general operation of the instrument.
- The receiver circuitry collects and processes test signals
- The transmitter circuitry generates test signals for making measurements
- The switchboard/display interfaces with communication lines and the operator.
- The power supply provides operating power for the HP 4937A
- The signaling circuitry that simulates the PBX or the central office

8-8. The microprocessor board is the main component of the HP 4937A. It provides control and sequencing functions for all measurements.

8-9. The receiver circuitry takes an ac voltage input from the switch board, or from the transmitter board and then filters, autoranges, and detects the fullwave average or rms level of the signal. A pulse stream whose frequency is proportional to the detected level is sent to the microprocessor and the counting section. The receiver section also provides the microprocessor and counting section with a dc voltage detect level and ac signals used to monitor the frequency of the input voltage.

8-10. The transmitter block takes frequency and signal-type information from the microprocessor, synthesizes the appropriate waveform and sends it to the switchboard. In several measurement modes the transmitter has no output signal but is quiet terminated.

8-11. The switch and display section has six major functions:

- Connects the front panel jacks to the transmitter and receiver after selection of the proper impedances. The selected receiver termination information is routed to the microprocessor and control section.
- Provides the dial connections and connection of the front panel jacks to the signaling circuitry after the proper routing of the signal.
- Provides data storage and driver for the segment display and annunciator LEDs.
- Connects the front panel membrane switches to the microprocessor circuit.
- Provides an audio amplifier and speaker to monitor the received signal and to output the beep signal.
- Provides relays that configure the input circuitry so that return loss measurements can be made.

8-12. The power supply provides +5 volts, +14 volts, -14 volts, and 47 volts floating.

8-13. The signaling circuitry provides voltage sources, current sinks, current detectors, and relays to perform supervisory signaling functions.

8-14. Level and Frequency Mode

8-15. **DISPLAY TRMT**--The transmitter provides a sine wave output with the frequency selected by the front panel switches and the level set by the OUTPUT LEVEL control. The level measurement is made by the receiver through the loop- around path. The wide-band low pass filter(LPF) is selected.

8-16. **DISPLAY RCV**--The receiver measures the level and frequency of the balanced input signal from the front panel RCV 310 jack. The receiver signal path is as follows:

- Balanced input through the input transformer. Notch filter is out.
- 25 dB amplifier and autorange on automatic.
- Flat path through the noise filter circuitry.
- Average detector selected.
- Loop-around path is grounded.

8-17. DESCRIPTION OF MEASUREMENT CIRCUITS

8-18. This section describes how the circuitry makes the measurement and the conditions that can be expected during normal operation. Table 8-1 summarizes this information.

Table 8-1. *Measurements Summary*

Measurement	Input Source Selected	Notch Filter	Dectector Used	Receiver Filter	Transmit Filter
Level/Freq:					
TRMT Display	Xmit Monitor	Out	AVE	None	Wideband LPF
RCV Display	Input Xformer	Out	AVG	None	Wideband LPF
Noise:					
TRMT Display	Gnd(no measurement being made quiet termination)				
RCV Display	Input Xformer	Out	QRMS	C-message 3 kHz	Gnd
Noise w/Tone:					
TRMT Display	Xmit Monitor	Out	AVG	C-message 3 kHz	Wideband LPF
RCV Display	Input Xformer	In	QRMS	C-message 3 kHz	Wideband LPF
Signal-Noise					
TRMT Display	Xmit Monitor	Out	AVG	C-message 3 kHz	Wideband LPF
RCV Display	Input Xformer	In	AVG/QRMS	C-message 3-kHz	Wideband LPF
Noise-Ground:					
TRMT	Gnd (no measurement being made quiet termination)				
RCV	Signal-Ground	Out	QRMS	C-message 3 kHz	Gnd
Return Loss:					
2-wire					
Transmit	2-to 4-Wire Bridge	Out	QRMS	60 Hz Rej	Rtn Loss Filter
Receiver	2-to 4-Wire Bridge	Out	QRMS	60 Hz Rej	Rtn Loss Filter
4-wire					
Transmit	Xmit Monitor	Out	QRMS	60 Hz Rej	Rtn Loss Filter
Receiver	Input Xformer	Out	QRMS	60 Hz Rej	Rtn Loss Filter

8-19. Noise Mode

8-20. **DISPLAY TRMT**--The transmitter provides a quiet termination for the line.The input to the power amplifier is grounded (no output current through the transmit transformer) while the loop-around path monitors the wideband low pass filter. The synthesis of the ouput wave is stopped by setting the phase-set latches to zero.

8-21. **DISPLAY RCV**--The receiver measures the level (not frequency) of the input to the front panel RCV jacks. The receiver path is as follows:

- Balanced input through input transformer.
- Notch filter is out.
- 25 dB amplifier and autorange on automatic.
- Noise filter subblock selected from and displayed on the front panel.
- QRMS detector selected.
- Loop around path is grounded.

8-22. Noise With Tone Mode

8-23. **DISPLAY TRMT**--The transmiter synthesizes a 1004 Hz signal whose level is set by the output of the OUTPUT LEVEL control. The wideband LPF is selected and the loop-around path monitors the output of the power amplifier in DISPLAY TRMT.

8-24. **DISPLAY RCV**--The input level is measured with the 1004 Hz tone notched out. Frequency is measured through the 1010 Hz bandpass filter. The signal path is as follows:

- Balanced input through the input transformer.
- Notch filter is in.
- 25 dB amplifier and autorange on automatic.
- Noise filter is selected from the front panel.
- QRMS detector selected.
- Loop-around path input grounded.

8-25. Signal-to-Noise Mode

8-26. **DISPLAY TRMT**--The transmitter synthesizes a 1004 Hz sine wave whose level is set by the front panel OUTPUT LEVEL control. The wideband LPF is selected and the loop-around path monitors the output of the power amplifier in DISPLAY TRMT.

8-27. DISPLAY RCV--The HP 4937A measures the signal-to-noise ratio of the input signal to the front panel RCV jack (1004 Hz). The receiver does this by first measuring the level of the entire signal and then measuring the remaining noise with the QRMS detector through the selected noise filter. The microprocessor then calculates the signal-to-noise ratio and displays the signal, plus noise level on the left display and the signal-to-noise ratio on the right display. The receiver signal path is as follows:

- Balanced input through the input transformer.
- 25 dB amplifier and autorange on automatic.
- Noise filter is selected by the microprocessor, out for entire signal and in for remainding noise.
- QRMS or AVG detector selected as needed.
- Loop-around path grounded in RCV display mode.

8-28. Noise-to-Ground Mode

8-29. DISPLAY TRMT--The transmitter provides a quiet termination for the line. Input to the power amplifier is grounded.

8-30. DISPLAY RCV--The receiver measures the common mode (to ground) input signal from the front panel RCV 310 jacks. The receiver input (in RCV display) is from the noise-to-ground input source. With the exception of the input source selected, noise-to-ground mode works in the same way as the noise measurement mode.

8-31. Frequency Measurement

8-32. Two counters are used to measure level and frequency. These are the two counters T0 and T1 in the A4U101. The counters are used in the gated mode, where the gate is the BEGIN signal. The measurement cycle is completely controlled by the A4U100 through the A4U101 counters.

8-33. Counter T1 contains the number of 262-kHz clock transitions detected during the gating or open interval. Frequency is the number of complete cycles in a unit time interval, such as 10 cycles in 60 msec would be 10/.06 sec=167 Hz. The time interval is calculated from the number of counts in counter T1 by calculating N/262,144 which is the amount of time it takes to accumulate N counts of 262,144 Hz square wave. Let events be the number of frequency cycles, and Counts the number of 262,144 Hz cycles, the frequency is calculated by the microprocessor using the following formula: Events are accumulated in counter T1.

$$\text{Frequency} = \frac{\text{Counts}}{\text{Events}/262{,}144} \text{ Hz}$$

$$= \frac{\text{Counts}}{\text{Events}} \times 262{,}144 \text{ Hz}$$

8-34. The microprocessor will detect an error and blank the frequency display if:

- The 262-kHz signal fails to fill counter T1 to the one-fourth full condition in approximately 63 msec.
- If the Not Open signal fails to toggle within 50 msec, then this indicates that the frequency is not present or is less than 20 Hz.

8-35. Level Measurement

8-36. Level measurement is gated by timer T0 in the A4U101. The interval is accurately controlled by the microprocessor by programming the A4U101.

8-37. There is no need to calculate the voltage-to-frequency converter output from the gated count since the ratio of count is equal to the ratio of frequencies. The microprocessor reads the level counts. All 10-volt counts for the same 70 milliseconds will be 1800 X .070 = 1260 counts.

8-38. OPERATOR TO MICROPROCESSOR

8-39. The receiver impedance selected on the front panel setup switches is sensed through the MISC SENSE latch, A2U105. The microprocessor uses the receiver impedance to compute the power level of the input signal.

8-40. When the HP 4937A is in the BRG receive impedance mode, the receiver has a high impedance input. The received level however, is still computed from the input voltage and the received impedance selected on the setup switches. For the correct level measurement, the proper receive impedance must be selected.

8-41. MICROPROCESSOR TO OPERATOR

8-42. The microprocessor sends information to the operator through the front panel numeric displays and annunicators. The display and annunicators are driven by display chips on the switchboard that provide all the multiplexing and drive requirements. The display or the annunicator chips are selected by the chip enable decoder outputs DISP (CE0) or ANNUN (CE1).

8-43. The beep circuit located in the microprocessor provides audio feedback to alert the operator when a membrane switch closure has been sensed. Whenever a front panel membrane switch is pressed the keyboard interrupt circuitry provides an interrupt for the microprocessor. The microprocessor executes a routine to program timer T1 to provide a square wave that causes an audible beep through the speaker.

8-44. INSTRUMENT TO OPERATOR

8-45. An audio amplifier and speaker are provided to monitor the test signal being measured by the HP 4937A receiver. The monitor amplifier takes its input from the output of the receiver autorange circuit. The monitor amplifier, monitor volume control, and speaker are located on the switchboard.

8-46. OPERATOR TO INSTRUMENT

8-47. There are several operator commands which cannot be sensed by the microprocessor; the input NORM-REV pushbuttons, the TRMT selec' impedance, the BRG pushbutton, the SIGNALING A/B pushbuttons, the OUTPUT LEVEL control, and the MONITOR VOLUME control.

8-48. THEORY OF OPERATION

8-49. Receiver

8-50. The HP 4937A receiver can be divided into the following major circuits: (see figure 8-1)

- Input circuitry--I/O Switching and termination
- Input Select--notch filter and 25 dB amplifier
- Filter circuitry
- Autorange amplifier
- Level detectors
- Hold tone circuitry
- Frequency/Level quantizing circuitry

8-51. The A3 receiver assembly contains all the circuits necessary to do level measurements and background noise measurements. All measurements are done by amplification, filtering, and detection of the received signal.

8-52. Input-Output Switching--The HP 4937A and the communication line to be tested are connected through the TRMT/RCV jacks. The NOR/REV switches select either the transmit or the receive function for the A jack and the other function for the B jack. In normal operation only one of these switches is in use at any one time. Pressing or releasing both switches simultaneously will internally connect the A jack to the B jack.

8-53. The input and output impedances are the standard values of 600, 900, or 1200 ohms (150, 600, or 1200 ohms for Option 002). The HP 4937A impedance selected must match the impedance of the circuit under test or incorrect measurement results will be obtained. The impedances on the A and B jacks are independently selectable.

8-54. The receiver input may be internally terminated or bridged across the circuit under test. If the line is terminated externally, the internal termination is switched out of the circuit by pressing in the BRG pushbutton. The bridge mode provides a high impedance receiver input (greater than 50k ohms).

8-55. In two wire return loss mode, a return loss bridge using a reference impedance of 2.16 microfarads in series with either 600 or 900 ohms is used. The instrument is automatically configured with the bridge for the measurement. The A jack is normally the test port, the REV pushbutton can switch it to the B jack.

8-56. In noise-to-ground mode, the receiver measures the common mode (to ground) input signal. The signal on the tip and ring are summed together by an ac coupled resistor network. The instrument is automatically configured with the summation network in this mode.

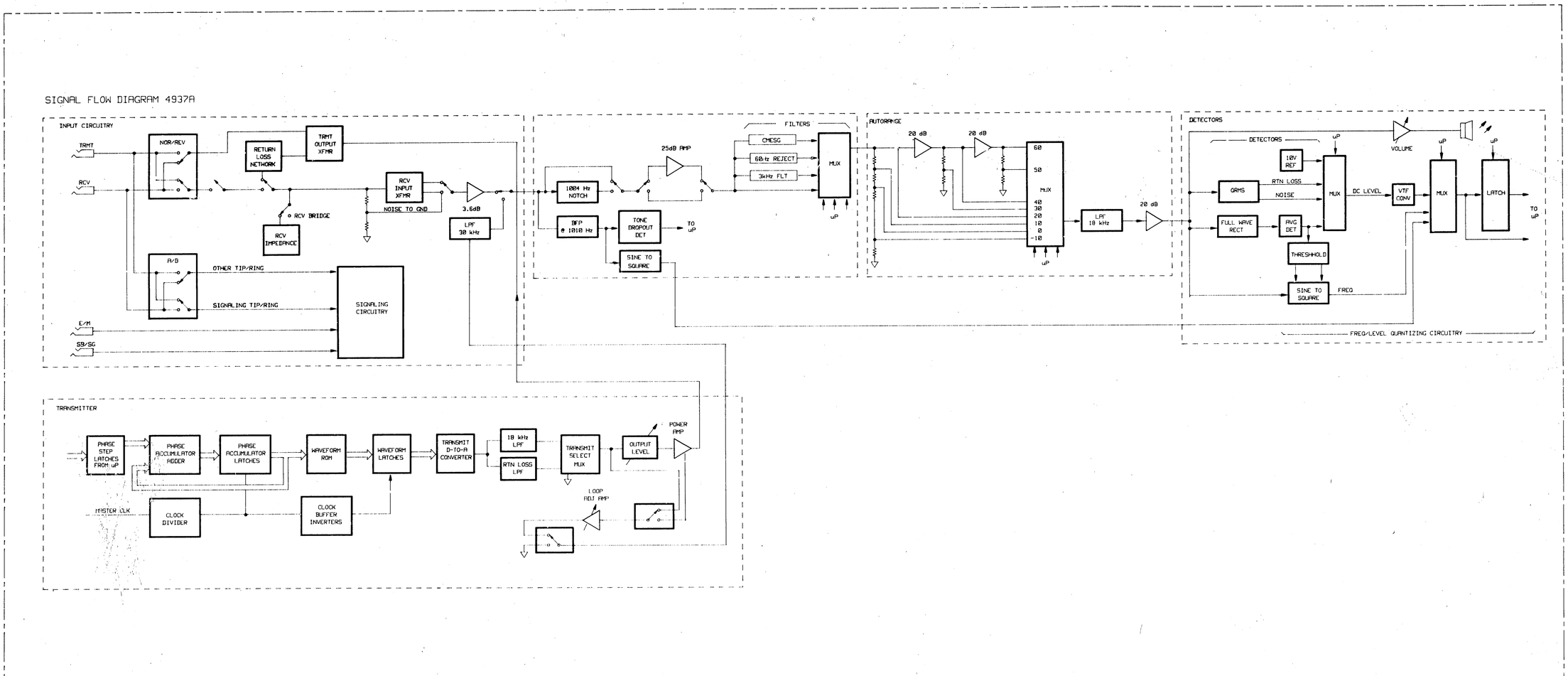


Figure 8-1. *Signal Flow Block Diagram*

8-57. Input/Filter--The HP 4937A receiver can select either of two inputs:

1. The received input from the input circuitry.

2. The transmit monitor path which allows the receiver to measure the transmitted signal.

8-58. An analog switch enables selection of either receiver signal or transmitted signal. Each signal can be routed straight through or via the notch filter. The 25 dB amplifier is dependent on the amplitude of the received signal, and can be bypassed by the microprocessor. A buffer amplifier delivers the signal to the weighting filters.

8-59. The notch filter consists of three, second order biquad notch filters. The first section has the zero located at 995 Hz. The second section has the zero at 1010 Hz. The third section has the zero at 1025 Hz.

8-60. Noise Filter Circuitry

8-61. C-Message Filter--The C-message filter consists of five blocks. The first and second blocks are a bandpass network, the third is a low-pass, the fourth is a gain stage, and the fifth is a bandpass network. Filter gain at 1 kHz is 0 dB.

8-62. 3-kHz Flat Filter--This is a second order Butterworth lowpass filter. The 3 dB frequency is 3 kHz.

8-63. 60 Hz Reject Filter--This is a third order high pass filter. The filter should have at least 20 dB of loss at 60 Hz.

8-64. The microprocessor controls the filter multiplexer's selection of the signal received from the different filter output. The microprocessor also routs the signal through a buffer amplifier to the autorange circuit.

8-65. Autorange

8-66. The autorange circuit can amplify signals up to 60 dB in 10 dB steps, or attenuate them by 10 dB. The various gain states are software controlled. Determination of the correct state is accomplished by measuring the detector output voltage and changing the gain in ten steps until the detector output falls within the dynamic range of the detector.

8-67. After the autorange there is a 5 pole low pass that sets the bandwidth of the HP 4937A. The 3 dB frequency of the filter is 18 kHz.

8-68. Level Detectors

8-69. The detector circuits convert ac input to dc output levels proportional to the input signal level. The HP 4937A uses two different detectors: Fullwave average and QRMS.

1. The full-wave rectifier combines the input ac signal with a half-wave rectified signal of twice the peak amplitude to produce a fullwave rectified signal. The average detector takes the fullwave rectified signal and the lowpass filters to produce a dc level output.

2. The Quasi-RMS detector uses the same technique as the full wave rectifier, but in addition sums in scaled signals from the positive and negative peak detectors. The positive peak detector is inverted before being added so that it will have the same polarity as the other signals being summed together.

8-70. Hold Tone Circuitry

8-71. The 1004 Hz tone dropout and squaring circuitry measures the 1004 Hz frequency tone in noise-with-tone, signal-to-noise, and detects drops in the tone signal below -46 dB. The notch filter removes the 1004 Hz tone before autoranging. The tone signal is intercepted before the notch filter and the amplifier (through a bandpass filter) before being routed to the tone DROP OUT DET and the sine wave to square wave converter.

8-72. To measure the hold tone frequency in noise-with-tone the output of the sine wave to square wave converter is selected in the frequency/level quantizing circuitry. The microprocessor determines if the hold tone is present and above -46 dBm as follows:

- The microprocesor resets the dropout latch through the I/O expander.
- The microprocessor waits for a short time.
- If a tone signal is present and above -46 dBm then the tone dropout detector will set the tone dropout latch.
- The microprocessor reads the tone dropout latch through the I/O expander to determine if the tone dropout latch was set.
- If the tone dropout latch was not reset, the microprocessor writes Err 07 to the right-hand display.

8-73. Freq/Level Quantizer Circuitry

8-74. The Schmitt-trigger circuit is provided to square up the incomming signal when measuring frequency. The hysteresis of the schmitt-trigger is required for good noise rejection. The amount of hysteresis is set proportional to the average detector ouput to provide wider hysteresis for larger signals.

8-75. The V-F converter converts the dc output of the Level Detectors to a frequency that is proportional to the level.

8-76. The microprocessor controls a multiplexer so that it can select the V-F converter, schmitt trigger circuit, or the sine wave to square wave circuits (hold tone frequency) in order to make the approiate measurement.

8-77. Transmitter

8-78. The transmitter circuit is responsible for digitally synthesizing the HP 4937A output signal. It receives inputs from the microprocessor through the data bus, which determines the frequency and type of output waveform. The transmitter circuit supplies outputs through a transformer to the switchboard for the output 310 jacks and to the receiver circuit to internally monitor the transmitted signal through the transmitter monitor loop-around path.

8-79. Sine Waves--If the instantaneous voltage of a sine wave is sampled at many points in time along the wave, a series of numbers representing the wave is obtained. Each number represents the voltage of the sine wave at single point in time. This series of numbers can be saved in ROM and later recalled by stepping through or scanning the ROM. Convert this series of numbers back to a series of voltage levels and the result is a stair step approximation of the original sine wave.

8-80. A difference between the original sine wave and the stair step approximation occurs only at frequencies higher then the original sine-wave frequency. These high frequency distortion components can be eliminated with a filter leaving a very good approximation of the original sine wave.

8-81. This principle is used in the HP 4937A. A series of binary numbers in ROM represents a sine wave. The instrument scans the ROM and converts the number to voltage levels, filters out the high frequency distortion components, and amplifies the resulting waveform to provide the desired test signal.

8-82. Phase Address Generator--The phase-step latches hold the binary value of the frequency. This value changes only if the frequency is changed. The adders add the phase-step size (the binary frequency value) to the old phase address to get a new phase address which is latched into the phase address latch. This is done on the positive going transition of the SYSCLK line. The output of the phase address generator is a series of ROM addresses.

8-83. ROM and Latches--The ROM and latches take the series of address from the phase address generator and converts them into a series of binary voltage values representing the output waveform. These values are held in the voltage value latches. This section unpacks the 8 most significant bits and the 2 least significant bits of voltage data so that the D-to-A converter can get the entire 10 bits at one time.

8-84. Digital to Analog Conversion--The digital to analog conversion circuit takes the binary voltage sequence from the voltage value and converts it to a series of step voltages approximating the output waveform. Both the D-to-A converter and the current-to-voltage converter are in this circuit. The current-to-voltage converter converts the output of the D-to-A converter to a series of voltage values.

8-85. Filter and Signal Select--The output of the digital to analog conversion circuit is only an approximation of the desired output. Unwanted high frequency components are introduced by the step nature of the waveform. These high frequency components must be filtered. The output select multiplexer selects the appropriate filter as the input to the power amplifier.

8-86. Loop-Around Circuit-- The loop-around circuit provides a signal path used by the HP 4937A receiver to monitor the transmitted signal in the display transmit mode. The circuit has two signal paths. The first is from the power amplifier output stage, through the loop adjust amplifier, and the loop select multiplexer to the receiver board. The second signal path comes from the filter output multiplexer and goes directly through the multiplexer to connector J1 and the receiver board.

8-87. To suppress the loop-around signal, the transmit line is grounded through the loop select multiplexer. The loop select lines are the same as the output select multiplexer address lines. With quiet termination, the noise should be below 20 mV.

8-88. Output Amplifier Circuit--The output power amplifier is an operational amplifier driven complementary-symmetry output stage, which provides the amplification necessary for a +13 dBm output level. The OUTPUT LEVEL control provides a full dynamic range of -40 dBm to +13 dBm. The display will show the error code Err 01 to indicate the signal level is too high (overrange).

8-89. Transmit Impedance/Output Routing--The output amplifier circuit drives a transformer with balanced outputs for each of the three impedances. The proper transmitter impedance is set from the front panel SET UP TRMT switches.

8-90. The transmitter signal is routed to the front panel 310 jack that was selected by the NOR/REV switches.

8-91. Power Supply

8-92. The HP 4937A power supply (see figure 8-2) is powered by an ac line or by a rechargeable battery (Option 001). The power supply provides output voltages of: regulated +5 V, +/-14.5 V, and a floating 47 V. A crowbar circuit is used for protection from over voltage if the instrument is plugged into the wrong line voltage.

8-93. The input to the DC/DC converter is from either a 12 cell ni-cad battery or an unregulated 60 Hz transformer and diode. The input voltage can range from 12 V on battery to a high of 26 V on the ac line. All the outputs are short circuit protected and the +5 V output is also overvoltage protected. The converter is also undervoltage protected. That is if the input voltage is too low it will shut down and prevent the battery from being deep discharged.

8-94. The A2U506 switching regulator controller contains the necessary functions for controlling the power supply. The voltage regulation feedback is taken off the +14 volt supply. The current limit is sensed in the source of A2Q505. Overvoltage is sensed off the +5 volt output.

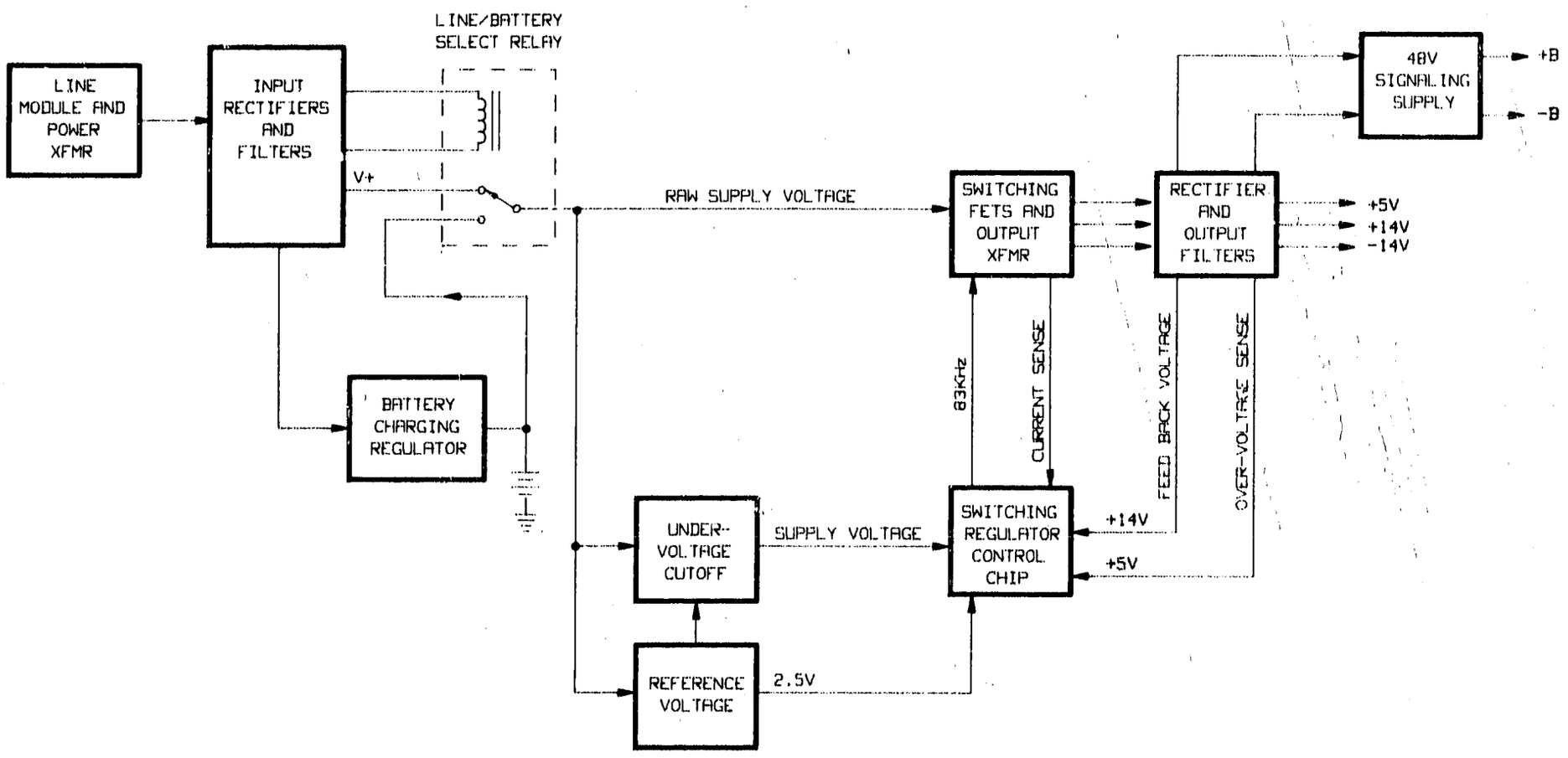


Figure 8-2. *Power Supply Block Diagram*

8-95. SIGNALING

8-96. The signaling circuit block diagram is shown in figure 8-3. The loop type signaling block (originate relays K404 and K405, and terminate relays K409 and K410) and the E/M relays implement the supervisory signaling functions via the E/M and SB/SG jacks on the front panel. The dial circuitry provides an interface to an external lineman's handset (butt-in) and controls either the loop type signaling or the E/M signaling, depending on the type signaling curently being used.

8-97. **E/M Signaling**--The E/M circuit is basically a switching and detecting circuit for use with telephone lines that use E and M pairs for signaling. The circuit can switch into six different configurations; Type I, II, or III, in either originate or terminate modes. Signaling in the form of on-hook and off-hook switching, can be applied to the lines from the microprocessor or from an external handset. Two voltage detectors test the E lead and the M lead to determine the state of the lines for use by the microprocessor.

8-98. E/M Type I signaling consists of a single pair E/M. Type II and III each have two pairs; E and SG, and M and SB.

8-99. Voltage on the E and M leads is detected with two voltage comparators. A common base stage provides isolation and converts a 0 volt to -48 volt signal to a 5 volt to 0 volt signal. This signal is compared against a reference voltage such that the switch point is at a line potential of 16 volts. The output of the comparator is sent to the DCU board via a latch. A 1k ohm resistor and a 65-volt zener diode provide transient protection.

8-100. **Loop Signaling**--The 4937A can simulate either the battery (terminate end) or hold coil (originate end). The dial jacks can be used in either mode and are connected directly in originate and are ac coupled (with talk battery) in terminate. Loop type signaling can be divided into originate circuitry and terminate circuitry.

8-101. The terminate circuitry consists of a 47-volt floating power supply, a current detector, and several relays. The relays can connect or disconnect the 48 volt supply, disconnect the tip lead, and reverse the battery polarity. The DCU controls the state of each relay and configures them according to the desired signaling mode. The current detector trips when the battery current exceeds 3 mA. This sets a flag that can be read by the DCU.

8-102. The originate circuitry consists of a constant current sink (hold coil), a current detector, a tip ground detector, a tip/ring polarity detector and configuration relays. The constant current sink is used in common by all three signaling types. The current detector and tip ground detector are both used in ground start and can be read by the DCU. The polarity detector is used to detect battery reversal in both loop start and loop reverse battery, and can also be read by the DCU. The relays configure these elements as required for different signaling modes, and also makes avaliable a ring to ground path used in ground start.

8-103. **Hold Other Coil**--The hold other coil is a passive circuit that sinks a constant current of 27 mA from 8.5 volts to 53 volts. This permits a dc path while maintaining a high ac impedance.

8-104. **A/B switching**--The A/B switching circuitry consists of two front panel pushbutton switches. When the A key is pressed the loop type signaling circuitry is connected to the A jack. The hold other coil is connected to the B jack to hold the other line while signaling is in progress on the A jack. Pressing the B key reverses the above procedure and places the signaling on the B jack and the hold other coil on the A jack.

8-105. Dial Circuitry--The dial circuitry provides an interface between an external handset and the internal signaling circuitry. In the originate mode of loop type signaling the handset is substituted for the internal hold coil. In the terminate mode a current limited 14 volt talk battery is provided and the voiceband signals are capacitively coupled to the line. In all E/M modes the talk battery is provide along with dial pulse detection circuitry. The dial pulses are sense and used to control the on/off hook relay so the pulses are passed on to the E/M leads.

8-106. The dial pulses are pulled off the talk battery with a transistor inverter. The inverter responds to the change in voltage on the dial jacks corresponding to an off-hook, on-hook, off-hook dial pulse with a 5 volt, 0 volt, 5 volt pulse that can be used as digital signals. The pulse is placed on either the E line (terminating mode) or the M line (originating mode).

8-107. Dial pulses are input to the two one shots, such that the rising edge triggers a pulse 10 msec in duration causing the latch drivers to activate the latching relay to switch to off hook and the falling edge, to switch to on hook.

8-108. Digital Control Unit (DCU)--The DCU consists of CPU (A4U100) running at 2.097 MHz, with 24K bytes of ROM and 128 bytes of RAM. The A4U101 supplies 22 I/O lines and two programmable 16-bit timers. The 128 bytes of RAM in A4U101 is used as system RAM for system variables and the stack.

8-109. Octal latch, A4U103, de-multiplexes the A4U100 address/data bus. Only the A4U101 uses the multiplexed bus. The address bus, except for line A12, does not leave the CPU board. Line A12 is used as the mode select line on the display drivers.

8-110. A4U106 and A4U109 decode the memory blocks for the respective memory sockets and the chip enables for the I/O mapped external latches used for programming the instrument.

8-111. The keyboard is interfaced to the CPU through port B of A4U101 and is interrupt driven using the RST A input to the CPU.

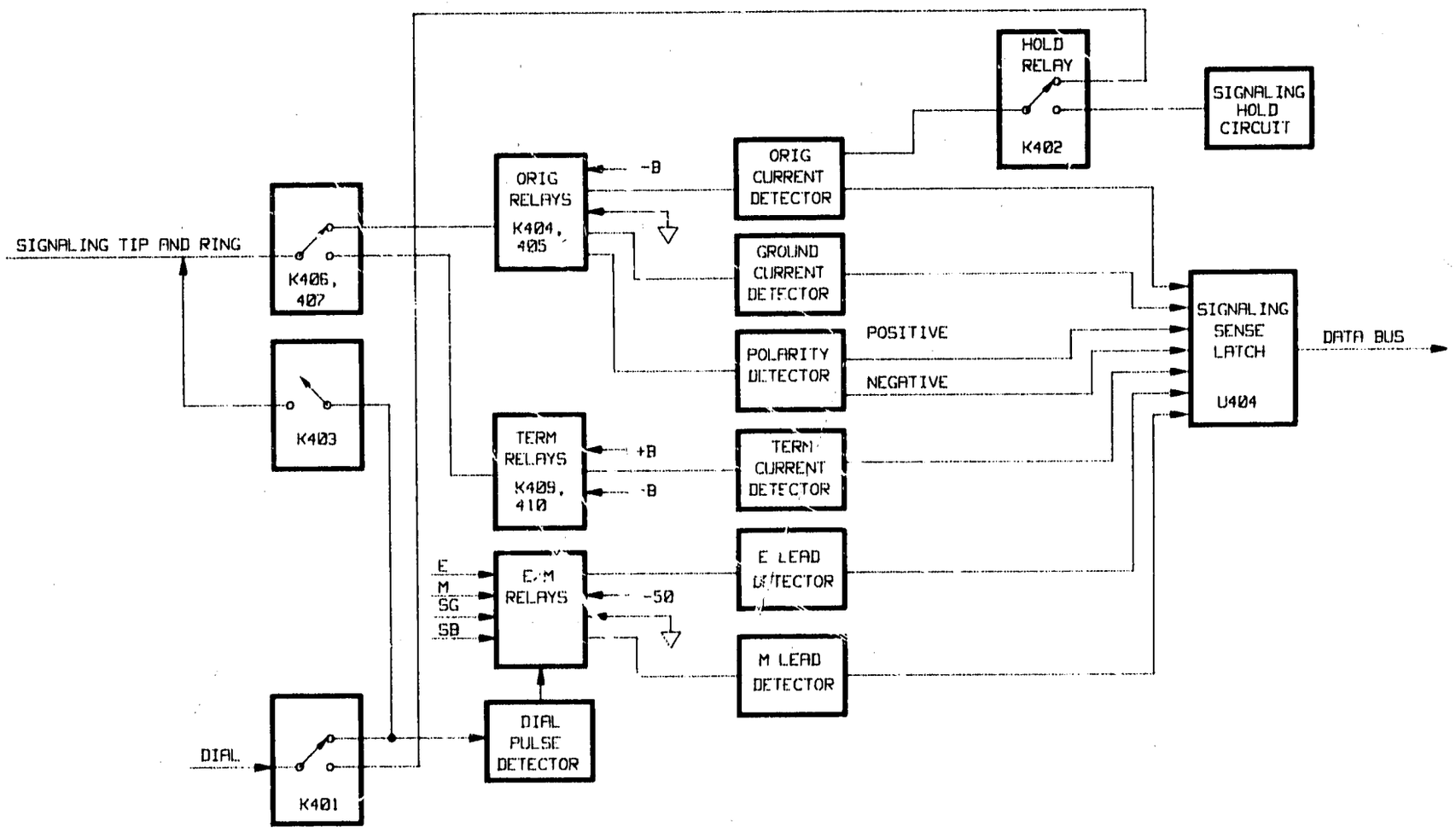


Figure 8-3. *Signaling Block Diagram*

8-112. TROUBLESHOOTING

8-113. SELF TEST

8-114. A self test is automatically done each time the instrument is powered up. Should any test fail, an error code will be displayed. These error codes (11 through 21 listed below) identify the test being made, the test parameters, and the possible cause of the test failure.

8-115. Power Up Self Test

8-116. Troubleshooting

ERROR CODE	TEST DESCRIPTION	TEST FAILS IF:	These troubleshooting hints assume that no errors occured prior to the one being investigated
11	The uP computes a checksum for ROMS A4U102 and A4U104	The computed checksum is incorrect	ROMS A4U102 and A4U104
12	The uP test the RAM in A4U101	A bit of RAM is stuck	A4U101
13	The magnitude of the 10 V reference is measured	The measured value is not 10 volts +/-2 volts	The 10-volt reference (A3U101) and the VFC (A3U300). If error code 14 and 15 are also displayed, troubleshoot A3U403, A3U402, and A4U101
14	The frequency of the self check signal is measured	The measured frequency is not 1004 Hz	If error codes 15 and 16 also occured check transmitter output. If error 16 occured but 15 did not, check the receiver signal path from A3TP12 to A3TP7. If neither error occured check the Schmitt trigger circuit.
15	The frequency of the hold tone is measured	The measured frequency is not 1004 Hz	The 1010 band pass filter and the hold tone signal path.
16	The level of the self check signal is measured through the average detector	The measured level is not 13 dBm +/-0.5 dBm	Set 4937A to DISPLAY TRMT and OUTPUT LEVEl control fully clockwise. Check the signal at A3TP7 for 3 V p-p, if it is not, troubleshoot the receiver signal path from the transmitter monitor buffer A3U605 through the auto range. If the signal at A3TP7 is correct, troubleshoot the AVE detector.
17	The level of the self check signal is measured through the C-meassage filter	The measured level is not 13 dBm +/-0.5 dBm	C-meassage filter
18	The level of the self check signal is measured through the 3-kHz low pass filter	The measured level is not 13 dBm +/-0.5 dBm	3-kHz low pass filter
19	The level of the self check signal is measured through the 60-Hz reject filter	The measured level is not 13 dBm +/-0.5 dBm	60-Hz reject filter
20	The level of the self check signal is measured through the QRMS detector	The measured level is not 13 dBm +/-0.5 dBm	QRMS detector
21	The level of the self check signal is measured through the return loss detector	The measured level is not 13 dBm +/-0.5 dBm	Return loss detector

8-117. EXTENDED SELF TEST

8-118. The extended self test verifies additional circuitry not checked by the Power Up self test. To initiate the extended self test perform the following steps:

1. Externally loop the E/M jack to the SB/SG jack.

2. Press the SHIFT key.

3. Press the FILTER SELECT key.

8-119. The extended self test will execute automatically and display error codes for any tests that fail.

8-120. Relay Test

8-121. After the functional tests of extended self test are completed the HP 4937A sequentially sets and resets each relay. A tone is sounded only as each relay is set and reset so that non-functioning relays can be detected by the absence of the set-click/reset-click. The relays are tested in the following order:

Seg No	Relay No	Seg No	Relay No
1.	A1K100	12.	A2K407
2.	A1K101	13.	A2K409
3.	A1K103	14.	A2K410
4.	A1K104	15.	A2K411
5.	A2K301	16.	A2K412
6.	A2K401	17.	A2K413
7.	A2K402	18.	A2K414
8.	A2K403	19.	A2K415
9.	A2K404	20.	A2K416
10.	A2K405	21.	A2K601
11.	A2K406		

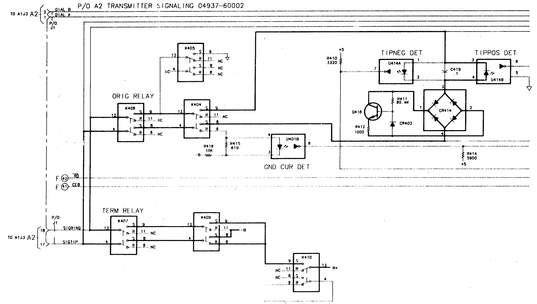


Figure A. *Error Codes 54, 55, 56, and 57 (P/O Figure 8-11)*

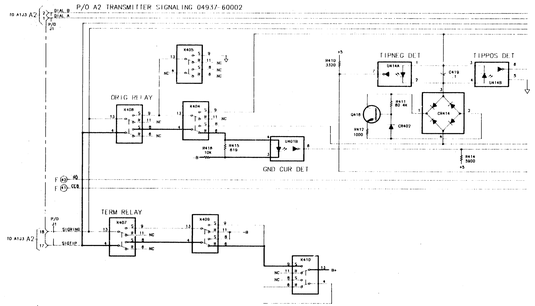


Figure B. *Error Codes 58 and 59 (P/O Figure 8-11)*

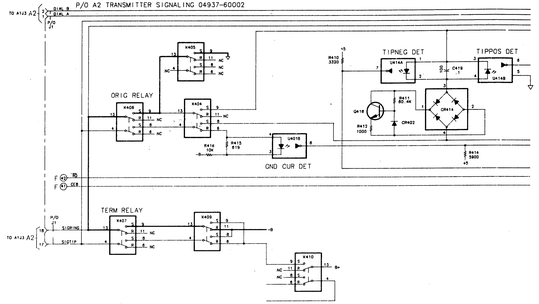


Figure C. *Error Codes 60 and 61 (P/O Figure 8-11)*

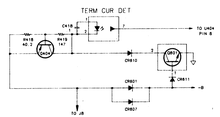


Figure C. *Error Codes 60 and 61 (P/O Figure 8-11) Con't*

8-122. Extended Self Test

ERROR CODE	TEST DESCRIPTION	TEST FAILS IF:
50	The level of the echo return loss waveform is measured by the QRMS detector	The level measured is not 1.45 Vrms +/-0.10 V
51	The level of the singing high return return loss waveform is measured by the QRMS detector	The level measured is not 1.44 Vrms +/-0.10 V
52	The level of the singing low return return loss waveform is measured by the QRMS detector	The level measured is not 1.45 Vrms +/-0.10 V
53	The amplitude of the self test sine wave is measured after going through the notch filter	The self test signal is not attenuated by at least 53 dB
54	The signal path shown in figure A is tested by reading the TIPPOS detector	The output of the TIPPOS detector is not low
55	The current direction shown in figure A is reversed by setting A1K409 and the TIPPOS detector output to read	The output of the TIPPOS detector is not high
56	The current direction shown in figure A is reversed by setting A1K409 and the TIPNEG detector output to read	The output of the TIPNEG detector is not low
57	The signal path shown in figure A is set and the ouput of the TIPNEG detector is read	The output of the TIPNEG detector is not high
58	The signal path shown in figure B is tested by reading the output of the GNDCUR detector	The output of the GNDCUR detector is not low
59	The signal path shown in figure B is broken by resetting A1K407 and the GNDCUR detector output is read	The output of the GNDCUR detector is not high
60	The signal path shown in figure C is tested by reading the output of the TERMCUR detector	The output of the TERMCUR detector is not low
61	The signal path shown in figure C is broken by resetting A1K405 and the TERMCUR detector output is read	The output of the TERMCUR detector is not high

8-123. Troubleshooting

These troubleshooting hints assume that no errors occured prior to the one being investigated.

A2 transmitter and return loss filter and waveform

A2 transmiter and return loss filter and waveform

A2 transmitter and return loss filter and waveform

A3 receiver notch filter, then check transmit signal for distortion

Check that the E/M jack has been looped to the SB/SG jack. Remove jumper A2J101 and restart the extended self test. The 4937A will lockup on the first signal failure that it detects in the relay configuration for that test. Refer to Table 8-2 and verify the signal path and detector output of the signal under test.

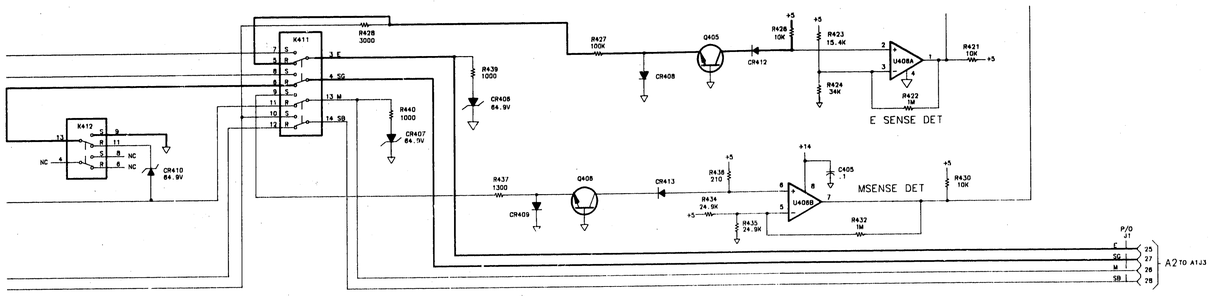


Figure D. *Error Codes 62 and 65 (P/O Figure 8-11)*

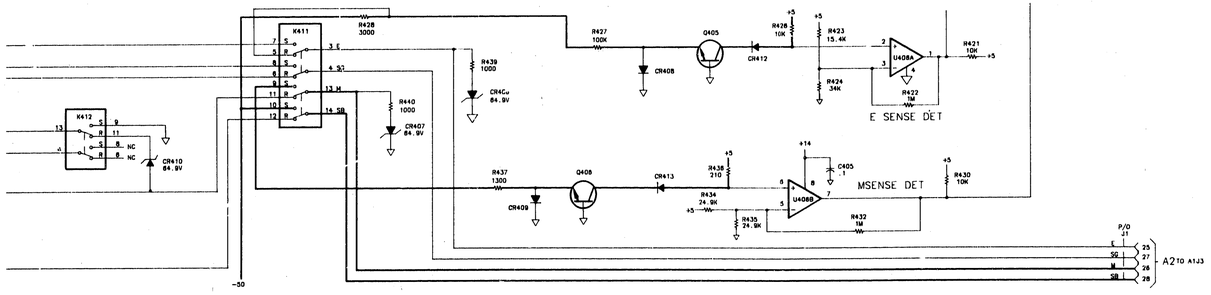


Figure E. *Error Codes 63 and 64 (P/O Figure 8-11)*

8-122. Extended Self Test (con't)

ERROR CODE	TEST DESCRIPTION	TEST FAILS IF:
62	The signal path shown in figure D is tested by reading the output of the ESENSE detector	The output of the ESENSE detector is not low
63	Signal path 1 shown in figure E is tested by reading the output of the ESENSE detector	The output of the ESENSE detector is not high
64	Signal path 2 shown in figure E is tested by reading the output of the MSENSE detector	The output of the MSENSE detector is not high
65	Relay A2K411 is reset as shown in figure D and the output of the MSENSE detector is read	The output of the MSENSE detector is not low

8-123. Troubleshooting (con't)

These troubleshooting hints assume that no errors occured prior to the one being investigated.

Check that the E/M jack has been looped to the SB/SG jack. Remove jumper A2JX and restart the extended self test. The HP 4937A will lockup on the first signal failure that it detects in the relay configuration for that test. Refer to Table 8-2 and verify the signal path and detector output of the signal under test.

Table 8-2. *Error Codes*

RELAY	54/57	55/56	58	59	60	61	62/65	63/64
A2K401	S	S	R	R	R	R	R	R
A2K402	S	S	R	R	R	R	R	R
A2K404	S	S	R	R	S	S	R	R
A2K405	R	R	R	R	S	R	R	R
A2K406	S	S	S	S	S	S	R	R
A2K407	S	S	S	R	S	S	R	R
A2K409	R	S	R	R	R	R	R	R
A2K410	S	S	S	S	R	R	R	S
A2K411	R	R	R	R	R	R	R	R
A2K412	R	R	R	R	R	R	S	R
A2K413	R	R	R	R	R	R	R	R
A2K414	R	R	R	R	R	R	R	R
A2K415	R	R	R	R	R	R	S	S

Note: R = Reset
S = Set

1. Turn the HP 4937A OFF then ON again. The microprocessor programs the waveform generator to 1004 Hz on powerup.

2. Check the input to the waveform ROM A2U211.

Pin	Inputs
2	Low
3	8.03 kHz
4	16.1 kHz
3	2.1 kHz
6	64.3 kHz
7	128.5 kHz
8	5.12 kHz
9	10.2 kHz
10	20.5 kHz
21	1004.0 Hz
23	262.1 kHz
24	2.01 kHz
25	4.02 kHz
26	Low

3. If the above values are correct, go to the waveform generator signature analysis paragraph.

4. Check the output of the phase step latch A2U201 and A2U202. The following outputs should be high, with the remaining outputs low:

512 Hz	A2U201 pin 5
256 Hz	A2U201 pin 2
128 Hz	A2U202 pin 19
64 Hz	A2U202 pin 16
32 Hz	A2U202 pin 15
8 Hz	A2U202 pin 9
4 Hz	A2U202 pin 6

5. Check the frequency of the system clock.

   A2U213 pin 12 = 262 kHz

6. Check the frequency of the phase adders.

	PIN 10	PIN 11	PIN 12	PIN 13	PIN 14
U207			HIGH	LOW	LOW
U206	131.0k	65.5k	98.3k	81.90k	81.9k
U205	65.5k	24.6k	10.2k	5.12k	5.12k
U204	134.0k	66.8k	33.4k	16.70k	16.40k
U203	16.4k	8.19k	4.10k	1.04k	

8-125. SIGNATURES

Loop: Waveform Generator

PCA: A2 Transmitter Board

Test Condition: Frequency set to 32 Hz. Check that the frequency at A2U208 pin 2 is 32 Hz.

Signature analyzer connections:

START +	U208 pin 2	A2 Transmitter Board
STOP +	U208 pin 2	A2 Transmitter Board
CLOCK +	U208 pin 9	A2 Transmitter Board

Reference: Vh = P254

U203
- 10 = 3PCH
- 11 = 55CU
- 12 = PFFA
- 13 = P688

U204
- 10 = 8HC7
- 11 = FC75
- 12 = 15U7
- 13 = 2482
- 14 = 21P3

U205
- 10 = 9422
- 11 = 7CU5
- 12 = 25P1
- 13 = 6U4A
- 14 = FC6F

U206
- 13 = CF67
- 14 = 5P33
- 15 = HIGH

U211
- 11 = 6UF1
- 12 = H26H
- 13 = PP9U
- 15 = U002
- 16 = 6F0U
- 17 = 3C1U
- 18 = 4424
- 19 = 6P1U

U214
- 5 = 283A
- 9 = F7P4

U215
- 5 = 141H
- 9 = 708F

U211
- 11 = 6UF1
- 12 = H26H
- 13 = PP9U
- 15 = U002
- 16 = 6F0U
- 17 = 3C1U

Loop: uP Test

PCA: A4 Processor Board

Test Condition: Remove A4 Board and ROMS U102 and U104.

Signature Analyzer Connections:

START +U100 Pin 8 A4 uP Board
STOP +U100 Pin 8 A4 uP Board
CLOCK +U100 Pin 31 A4 uP Board

A4 TP1 to +5 volts
A4 TP2 to ground

Reference: Vh= 0001

U100

1 = HC88
2 = 2H71
3 = HPP1
4 = 1292
5 = HAP6
6 = 3C97
7 = 3826
8 = 755P
12 = UUUP
13 = 0000
14 = 0000
15 = UUUP
16 = UUUP
17 = UUUP
18 = 0000
19 = 0000

U103

2 = UUUP
5 = 5554
6 = CCCA
9 = 7F7H
12 = 5H20
15 = 0AFC
16 = UPFF
19 = 52F9

Loop: I/O Test-Setup A

PCA: A4 Processor Board

Test Condition: Move J1 to SA position Remove A4 Board EPROMS installed Power up

Signature Analyzer Connections: Normal

START	+U106	Pin 10	A4 Up Board
STOP	-U106	Pin 10	A4 Up Board
CLOCK	-U106	Pin 3	A4 Up Board

A4 TP1 to +5 volts
A4 TP2 to ground

Reference: Vh=65C8

U101

1 = 8333
2 = 8287
3 = 1CH4
5 = 143U
21 = 7P6F
22 = 8333
23 = 9C1H
24 = H8PF

26 = U4A4
27 = H9U3
28 = U4A4
29 = PA67
30 = 052A
31 = 0A55
32 = 14AA
33 = 2954
34 = 52A9
35 = A552
36 = 4AA5
37 = 7UC8
38 = UHF1
39 = PP0A

U106

1 = 0000
2 = 9CFC
3 = 65C8
4 = 9CFC
14 = 65C8
15 = 65C8

U109

18 = 65C8
19 = 9CFC
20 = UP8H
21 = 67H4
22 = 9C77
23 = 6455

Loop: I/O Test- Setup B

PCA: A4 Processor Board

Test Condition: Move J1 to SA position. Power up.

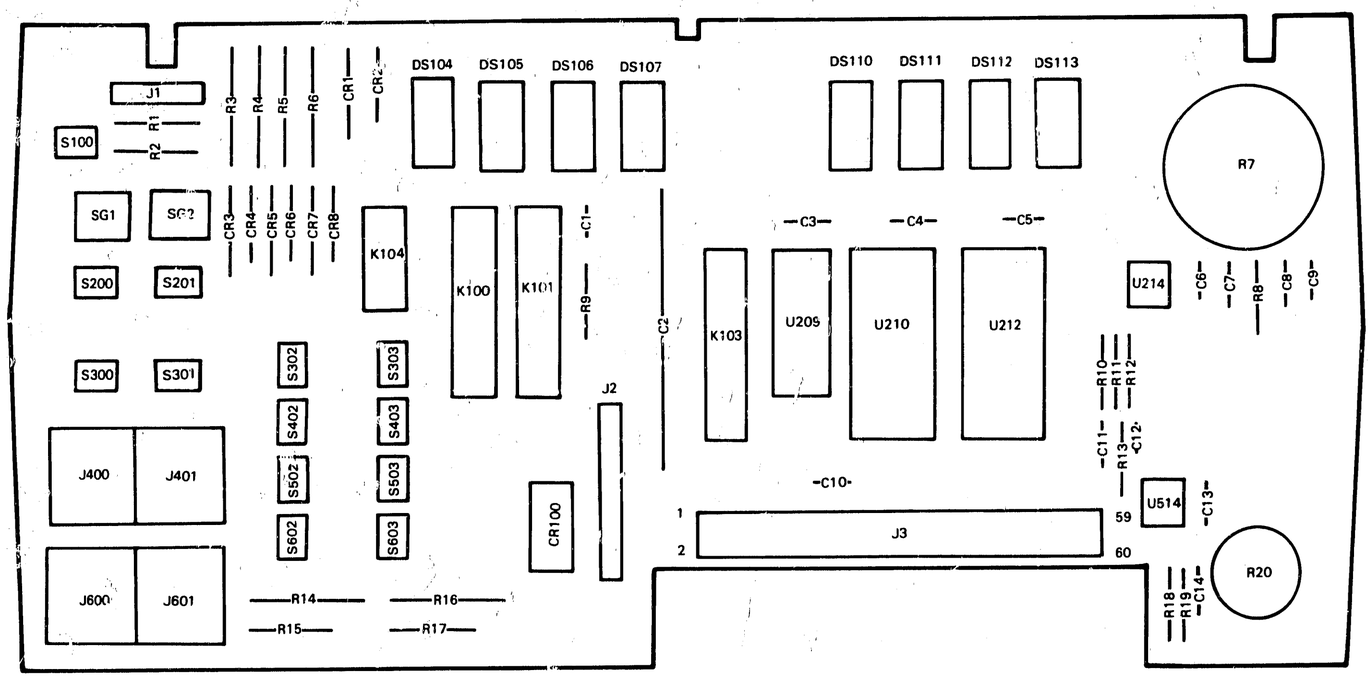
Signature Analyzer Connections: Normal

START	+U106	Pin 10	A4 Up Board
STOP	-U106	Pin 10	A4 Up Board
CLOCK	+U109	Pin 18	A4 Up Board

Reference: Vh 1H43

U109

1 = 1H53
2 = 1557
3 = 1716
4 = 37H4
5 = 56C0
6 = P4C6
7 = P7U8
8 = 40UP
9 = F3H2
10 = 55PH
11 = 4A27
13 = AU6P
14 = 0CAH
15 = 6A2A
16 = A9U0
17 = 44A3



04937-60001-0102-2-2-84

Figure 8-4. *A1 Switch Board Component Locator*

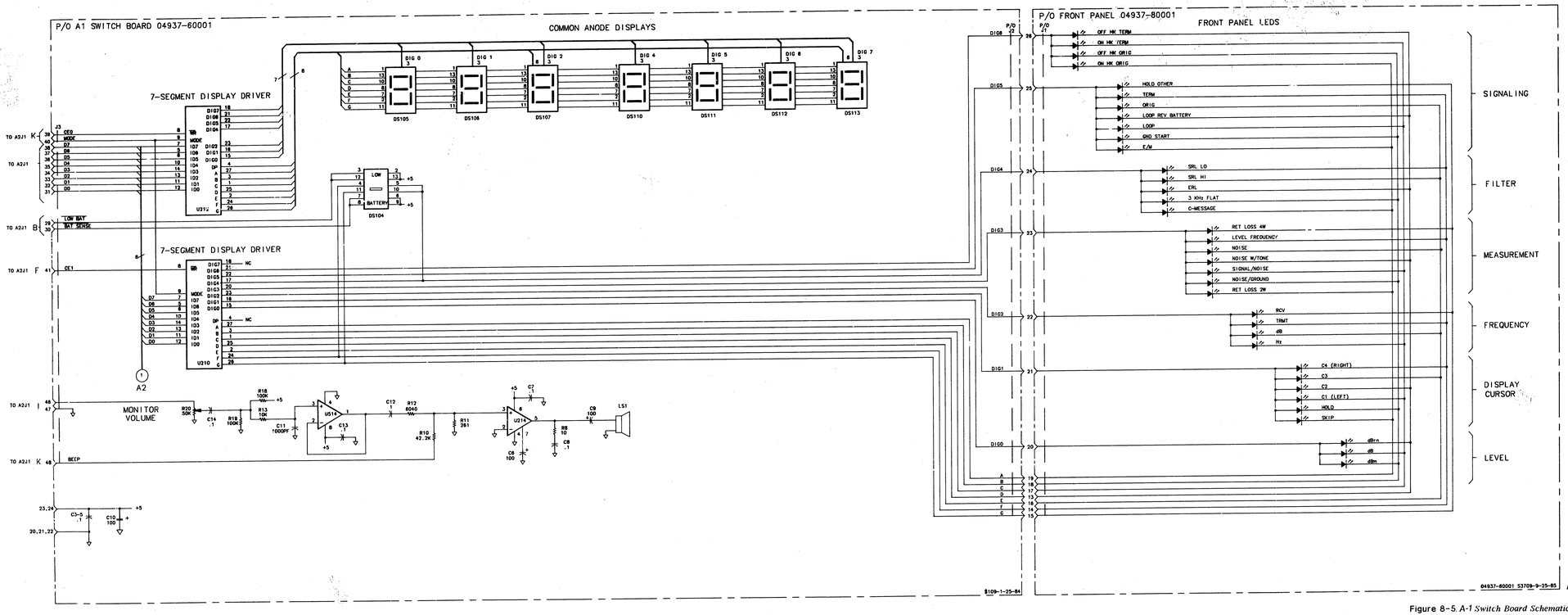


Figure 8-5. *A-1 Switch Board Schematic (Sheet 1 of 2)*

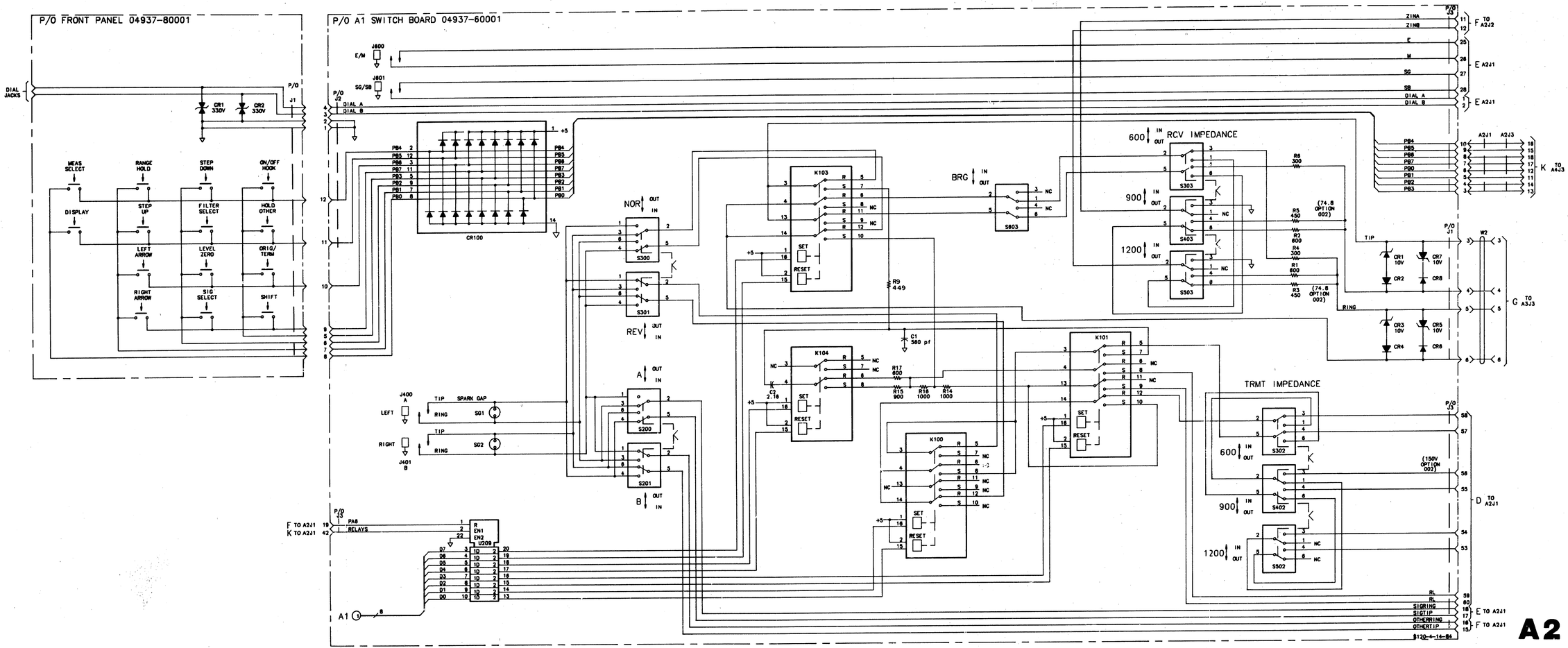


Figure 8-6. *A1 Switch Board Schematic (Sheet 2 of 2)*

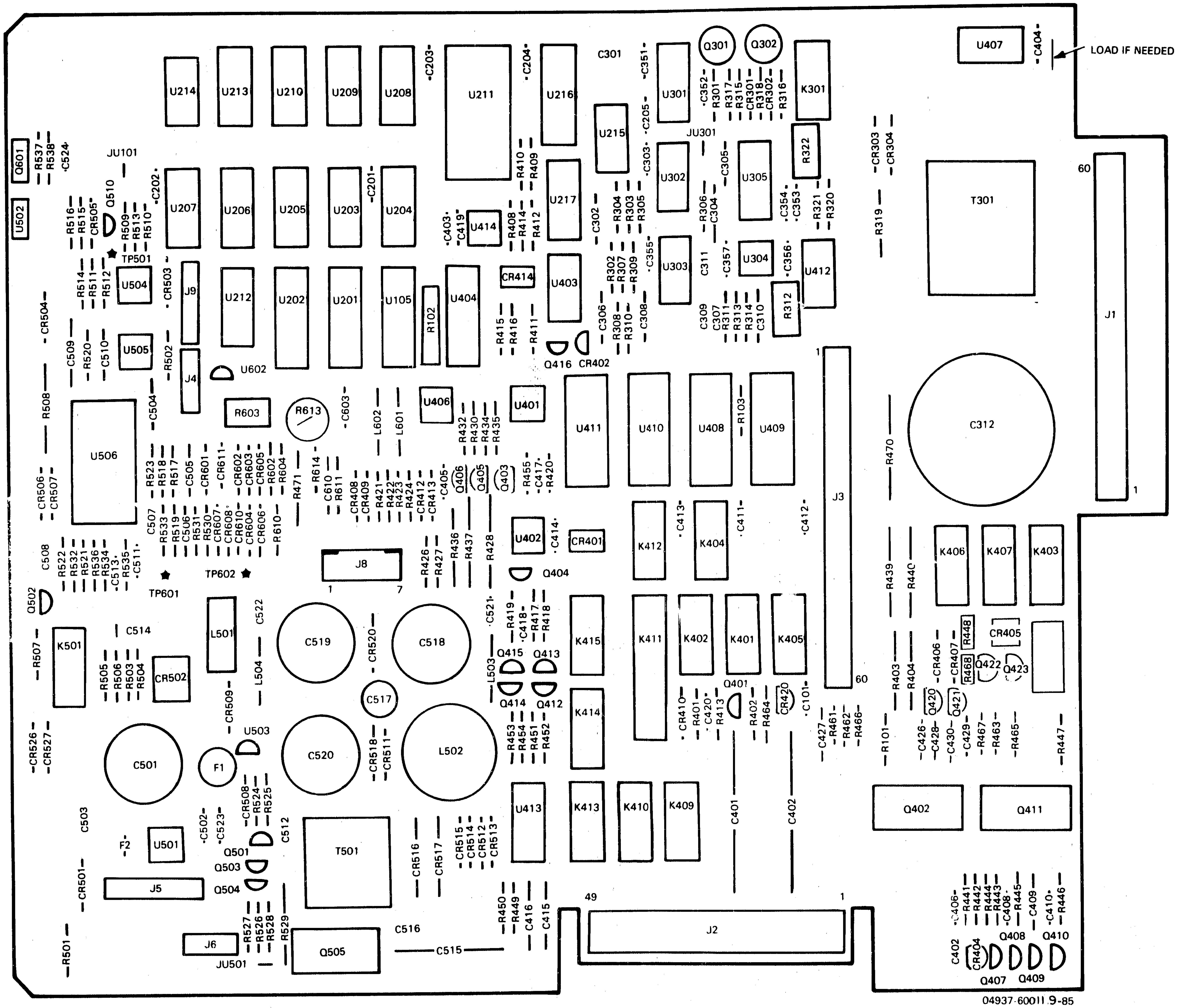
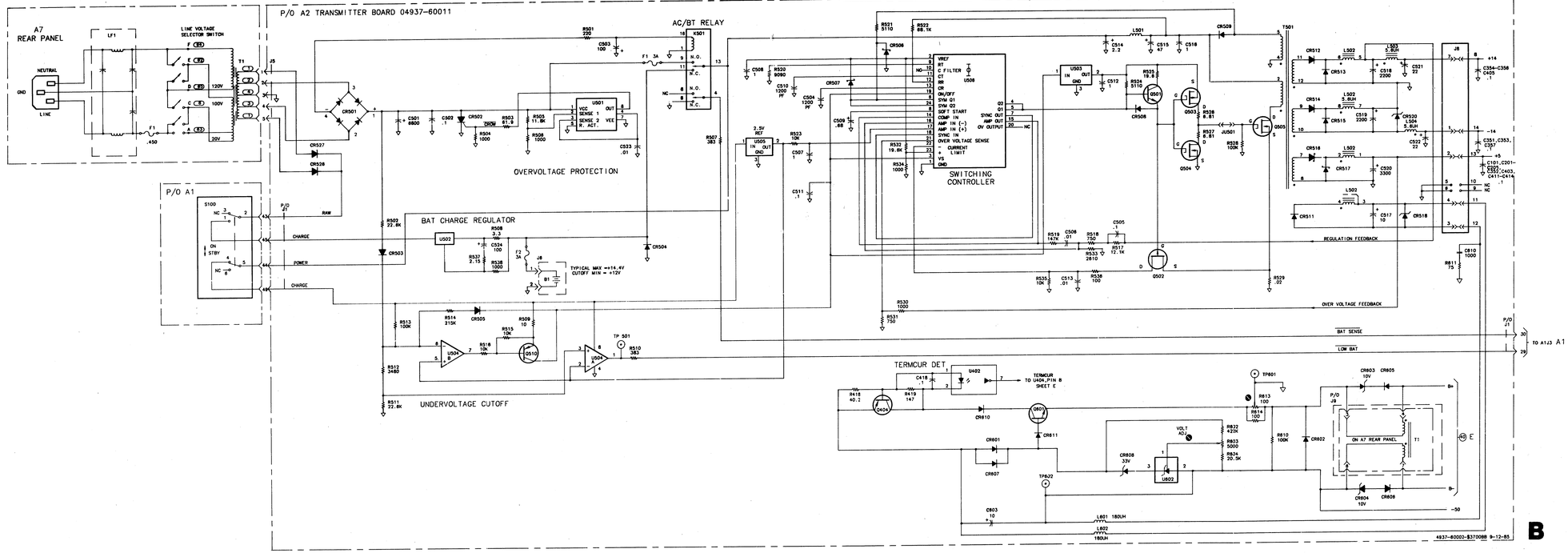


Figure 8-7. *A2 Transmitter Board Component Locator*



B

Figure 8-8. *A2 Transmitter Board Schematic (Sheet 1 of 5)*

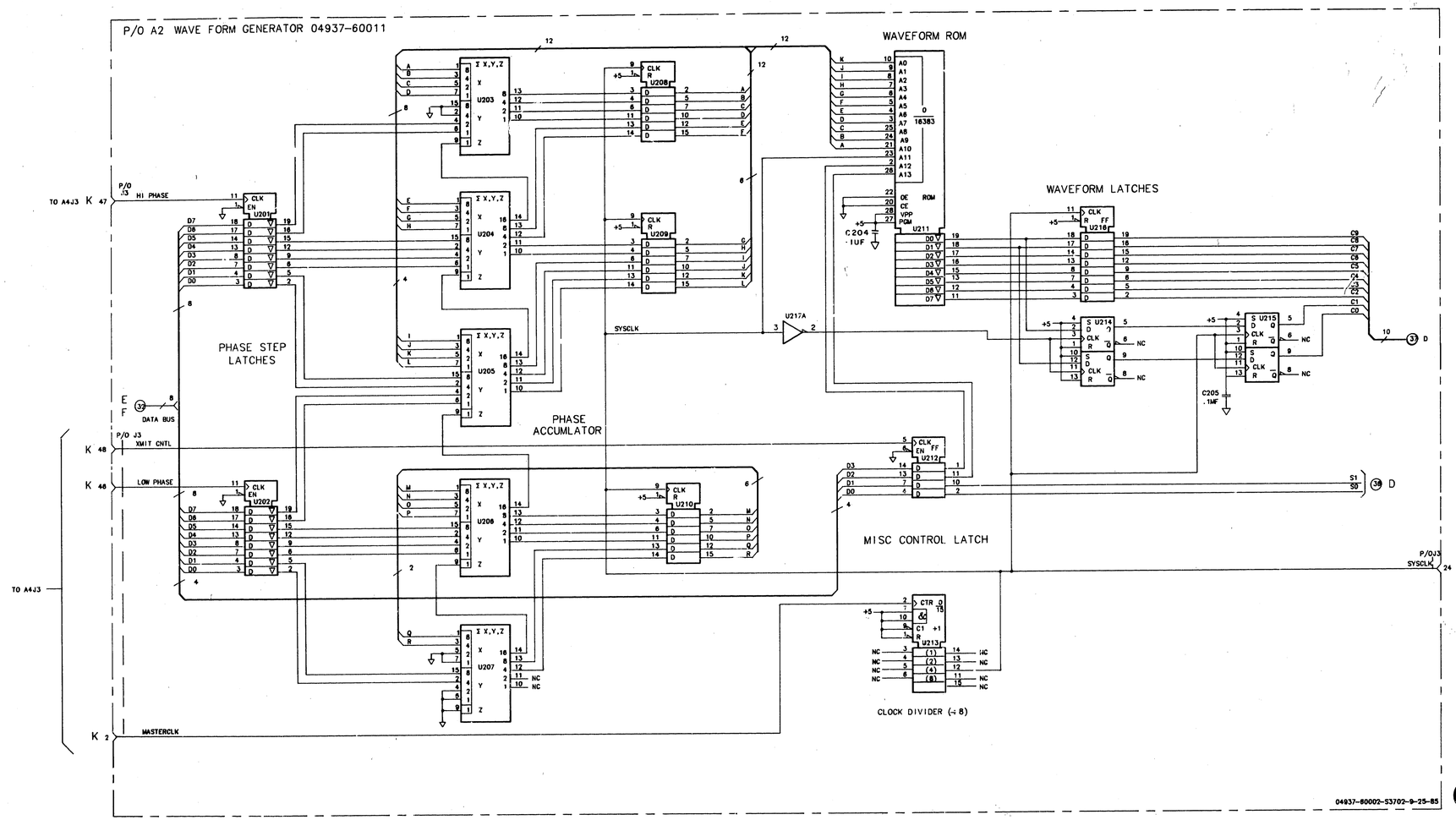


Figure 8-9. *A2 Transmitter Board Schematic (Sheet 2 of 5)*

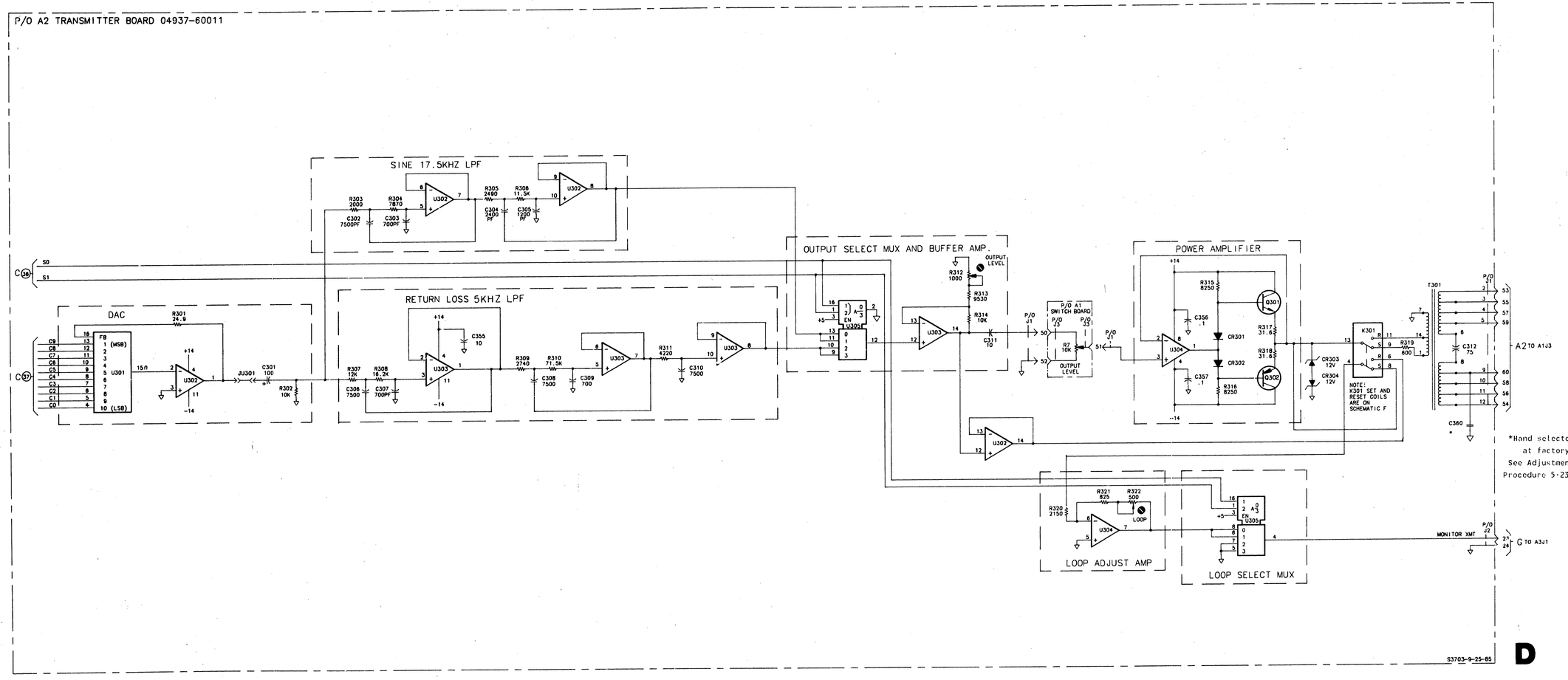


Figure 8-10. *A2 Transmitter Board Schematic (Sheet 3 of 5)*

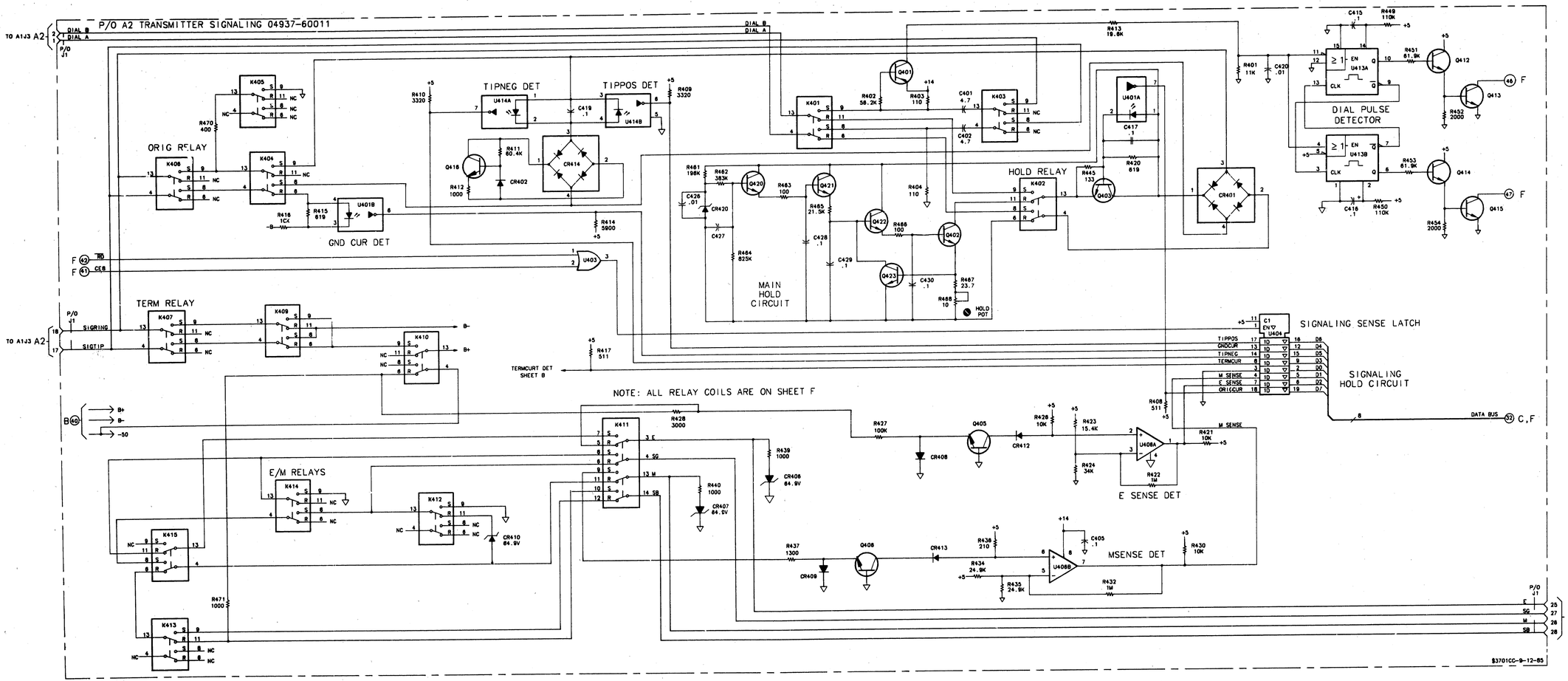


Figure 8-11. *A2 Transmitter Board Schematic (Sheet 4 of 5)*

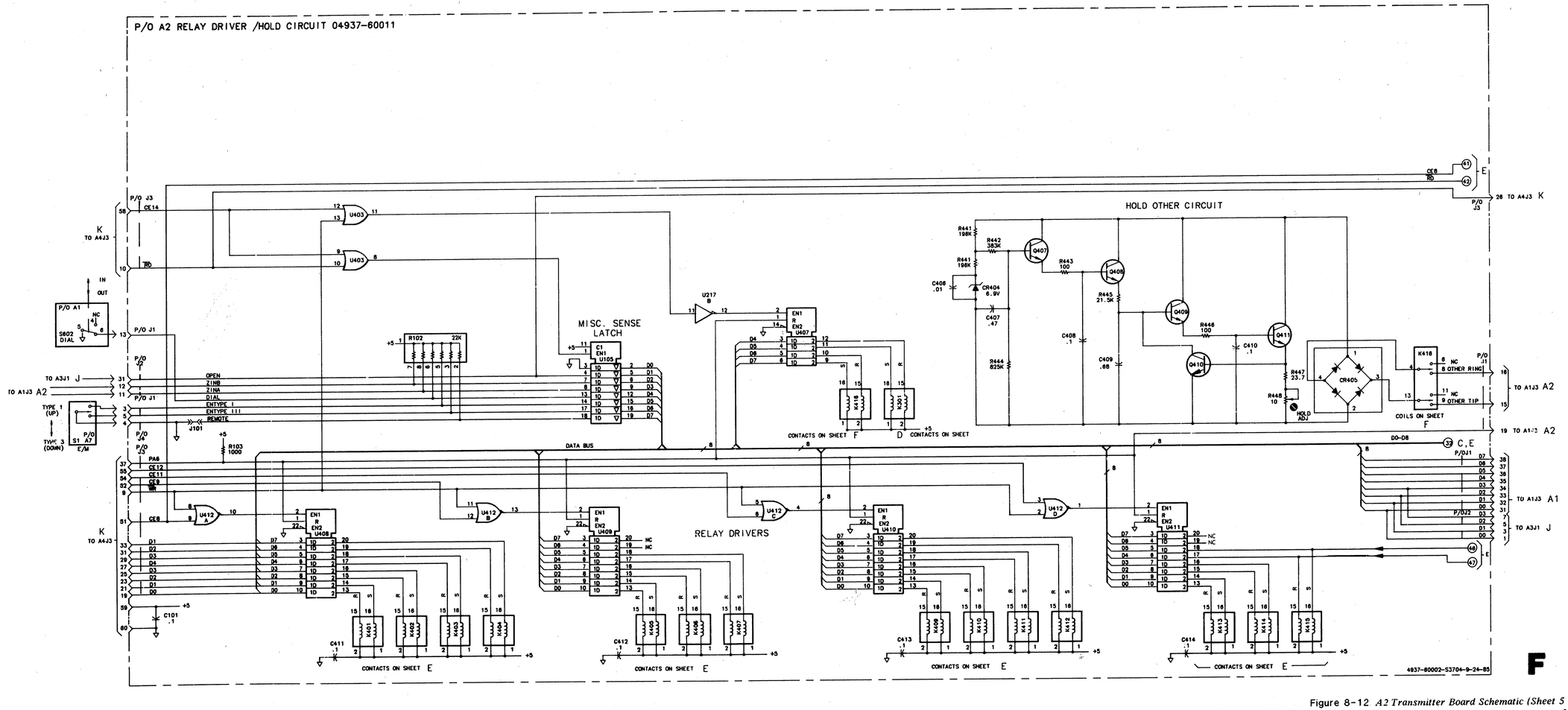


Figure 8-12 *A2 Transmitter Board Schematic (Sheet 5 of 5*

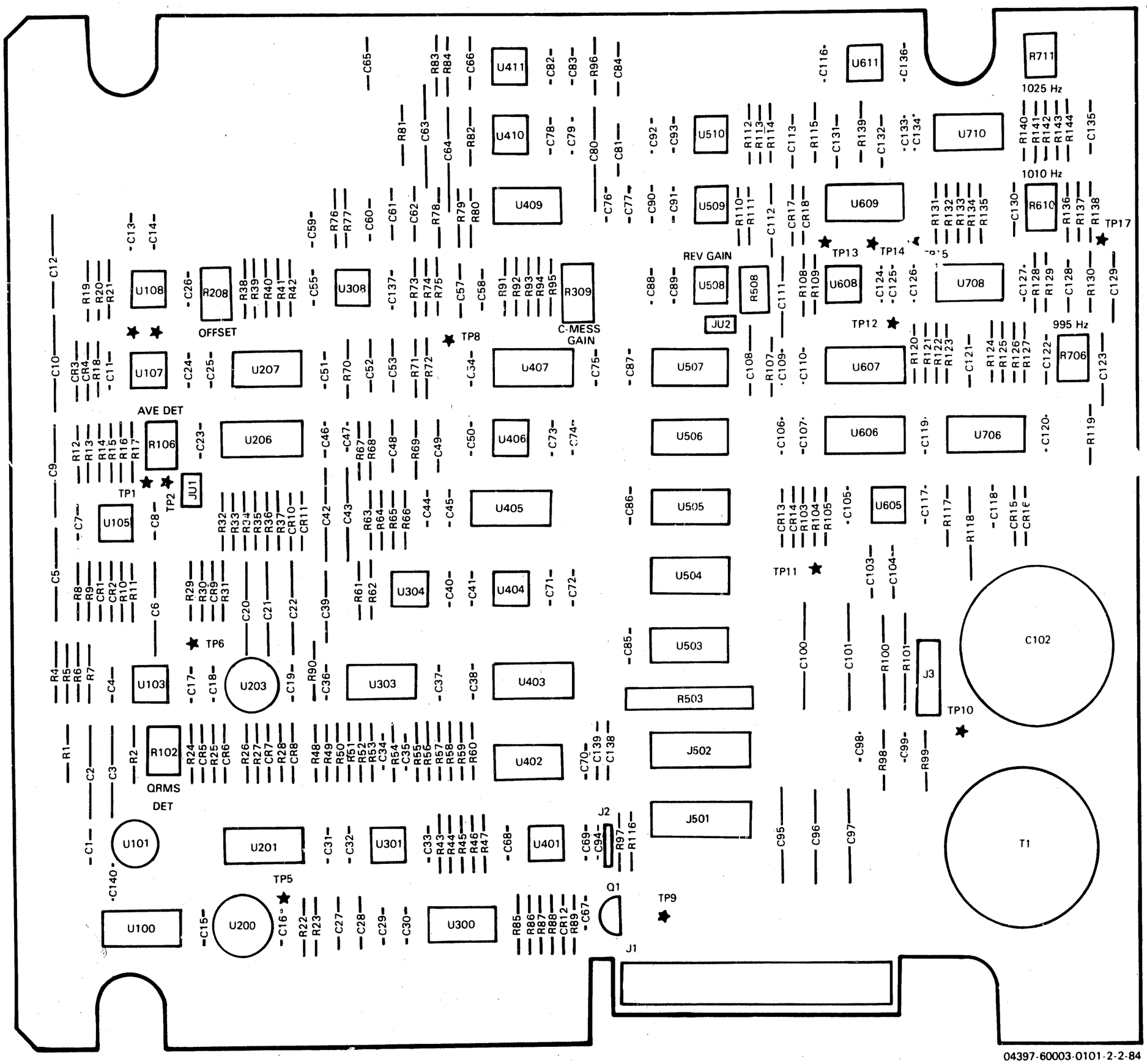


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Figure 8-13. *A3 Receiver Board Component Locator*

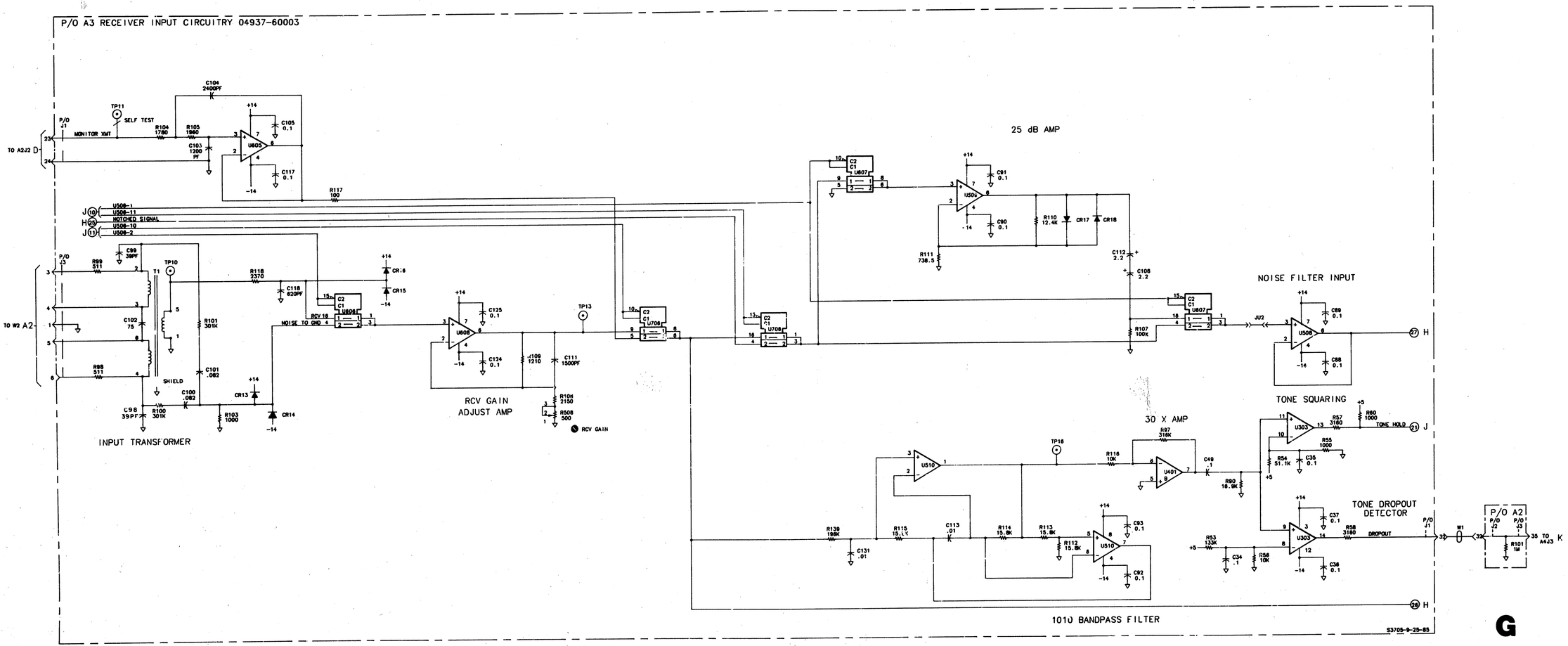

Figure 8-14. *A3 Receiver Board Schematic (Sheet 1 of 4)*

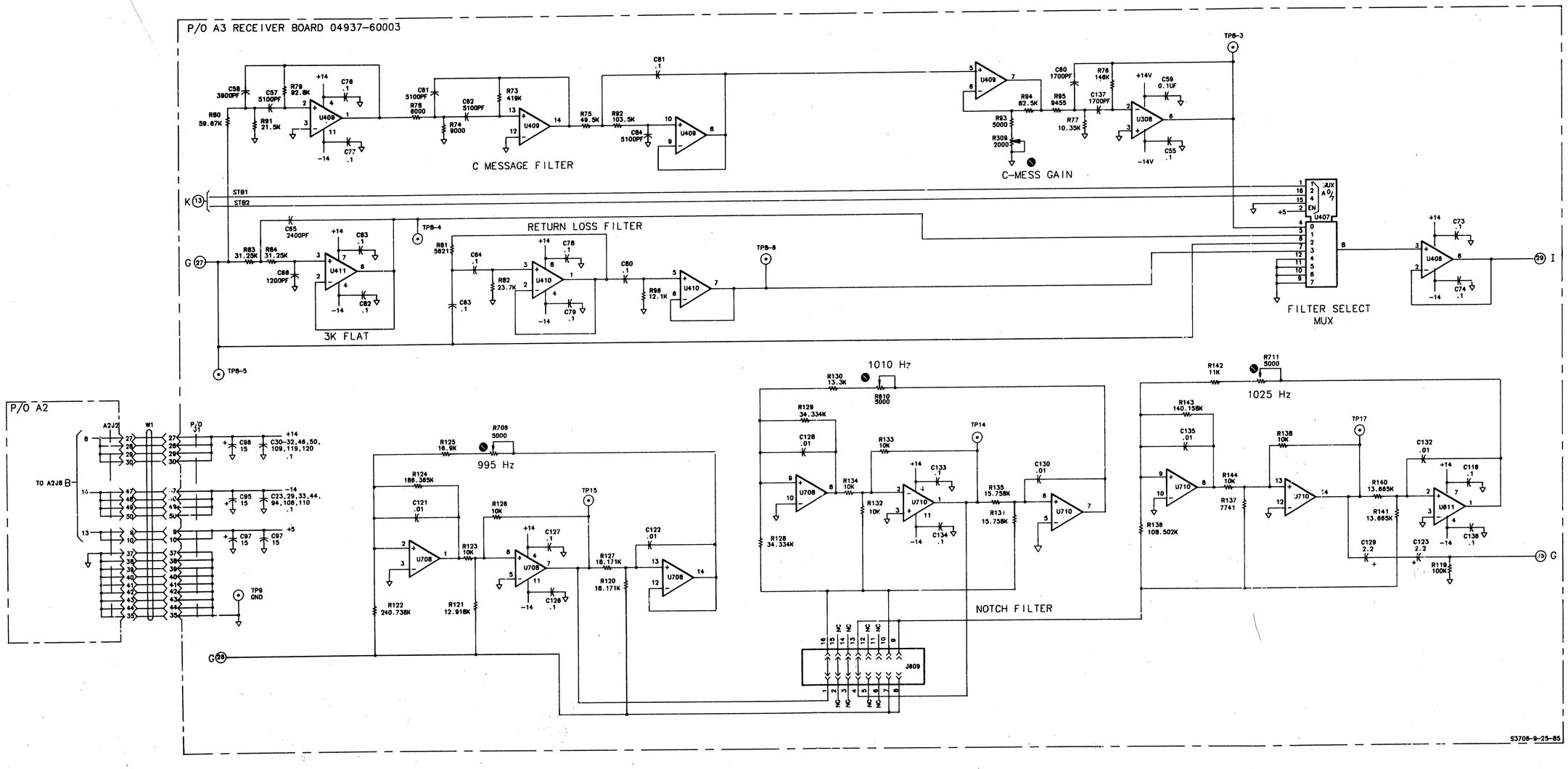

Figure 8-15. *A3 Receiver Board Schematic (Sheet 2 of 4)*

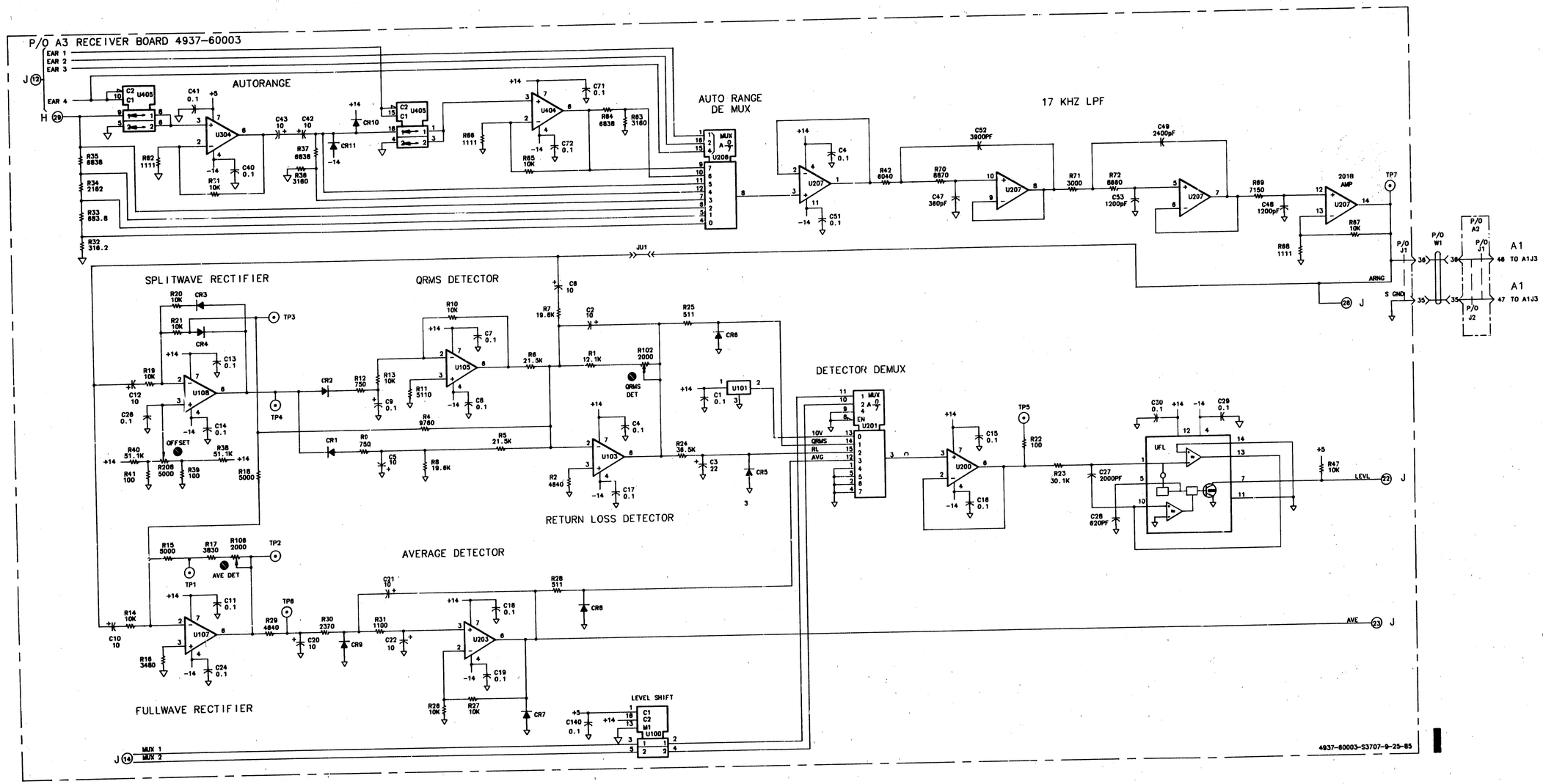

Figure 8-16. *A3 Receiver Board Schematic (Sheet 3 of 4)*

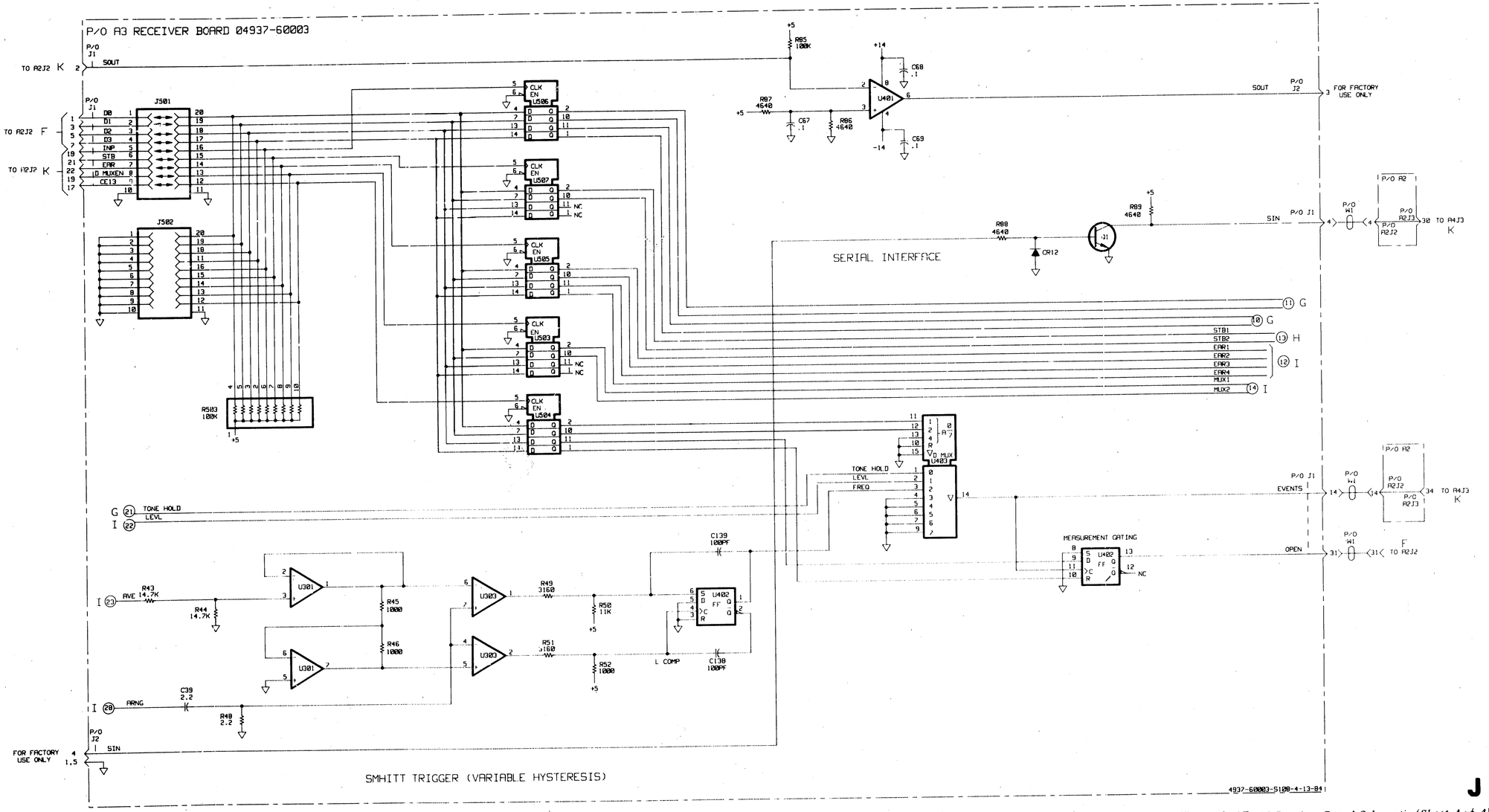

Figure 8-17. *A3 Receiver Board Schematic (Sheet 4 of 4)*

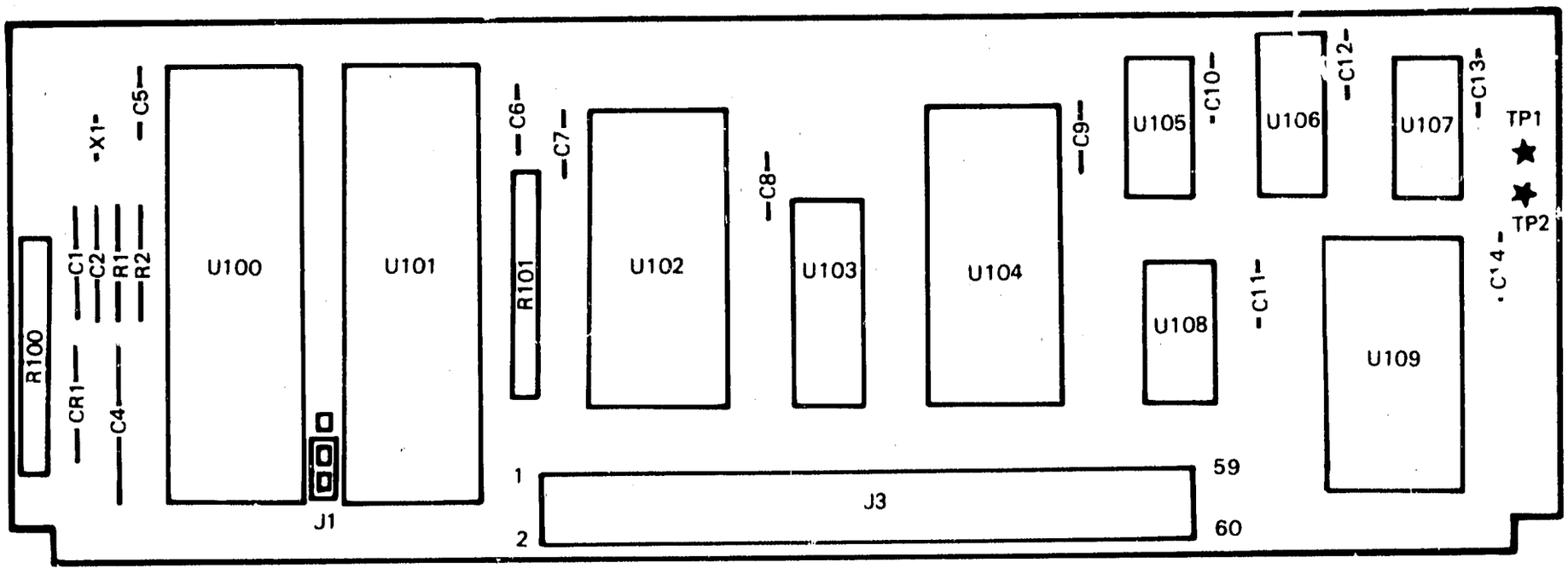

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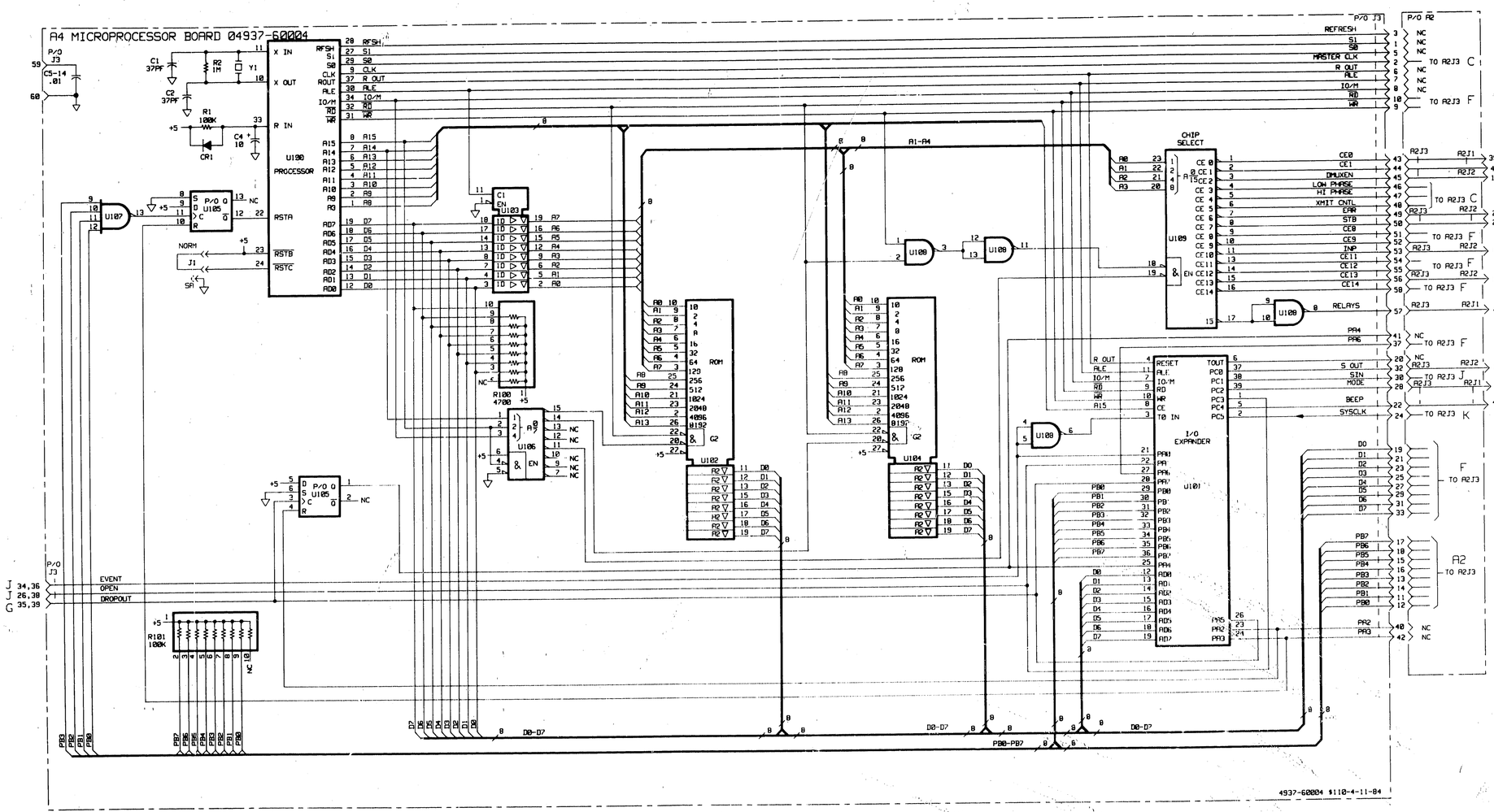
Figure 8-18. *A4 Microprocessor Board Component Locator*



K

Figure 8-19. *A4 Microprocessor Board Schematic*

APPENDIX A

MEASUREMENT and SIGNALING PRINCIPLES

A-1. INTRODUCTION

A-2. The HP 4937A input and output circuits are balanced to match standard voice channel lines. A balanced line is electrically symmetrical; the two sides of the line have equal series resistance, series inductance, shunt capacitance, and leakage to ground.

A-3. To allow dialing, talking, and listening on the circuit under test, the lineman may plug his handset into the handset terminals (binding posts). Either a pulse (rotary) or DTMF handsets may be used.

A-4. INPUT/OUTPUT AND SIGNALING SWITCHING

A-5. The A and B 310 jacks provide connection between the HP 4937A and the circuit under test. Pressing in the NOR pushbutton selects the transmit function for the A jack. The B jack simultaneously performs the receive function. If the REV pushbutton is pressed in, the opposite is true as shown in figure A-1.

A-6. Pressing the A pushbutton allows the HP 4937A to do loop signaling on the A jack. Simultaneously a hold circuit (HOLD OTHER) can be activated on the B jack. If the B pushbutton is pressed in, the opposite is true as shown in figure A-1. E/M signaling can be performed by using the E/M and SG/SB jacks.

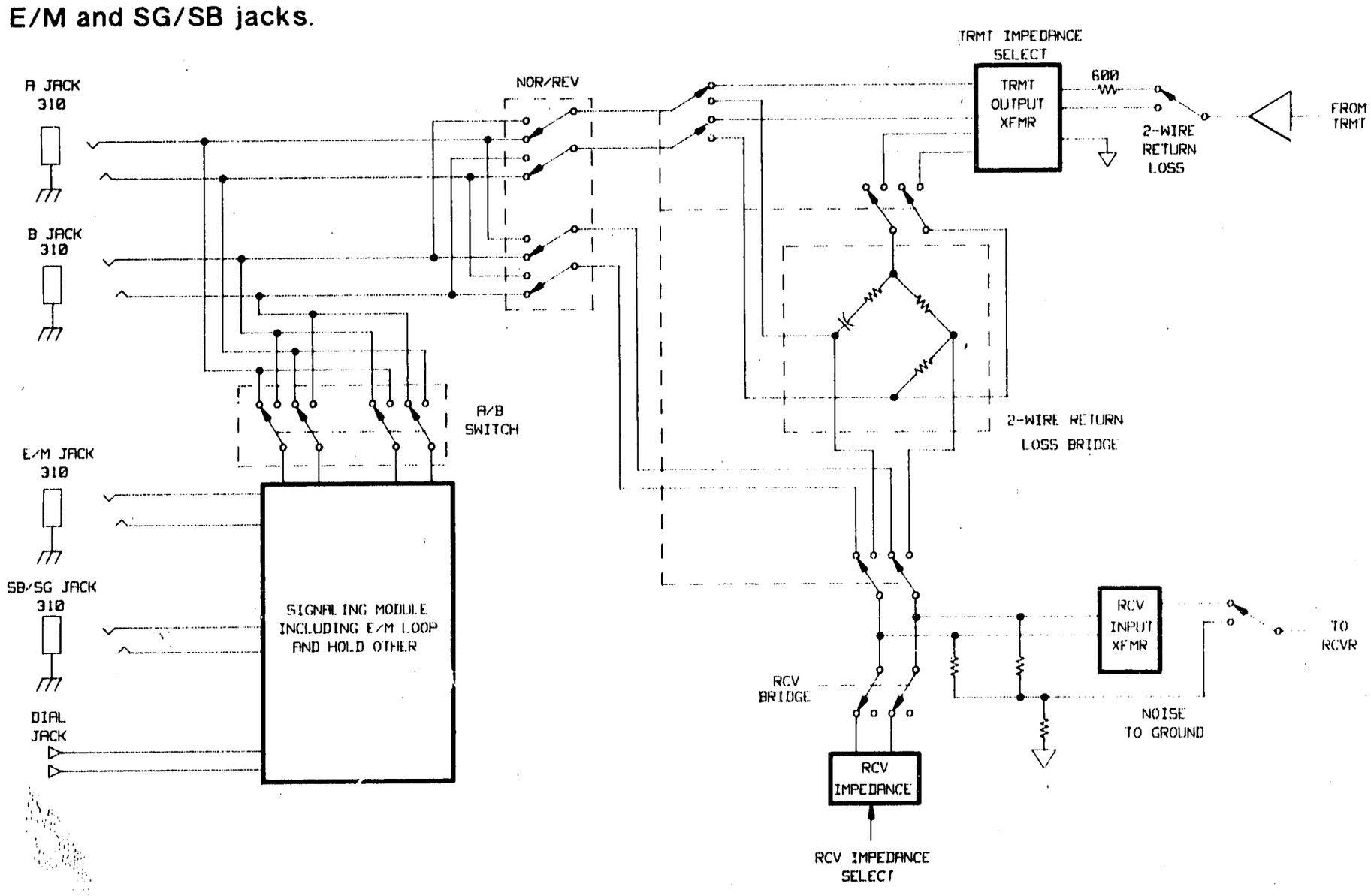


Figure A-1. *Input/Output and Signaling Switching*

A-7. The input and output impedances are the standard values of 600, 900, or 1200 ohms. The HP 4937A impedance selected must match the impedance of the circuit under test or incorrect measurement results will be obtained. The impedances on the A and B jacks are independently selectable.

A-8. The receiver input may be internally terminated or bridged across the circuit under test. If the line is terminated externally, the internal termination is switched out of the circuit by pressing in the BRG pushbutton. The bridge mode provides a high impedance receiver input (greater than 50k ohms).

A-9. LEVEL AND FREQUENCY MEASUREMENTS

A-10. The LEVEL FREQUENCY measurement, measures the amplitude versus frequency response of a voice channel. Frequency shifts, 1000 Hz loss, and attenuation distortion can be measured. The setup as shown in figure A-2 is used for all three measurements.

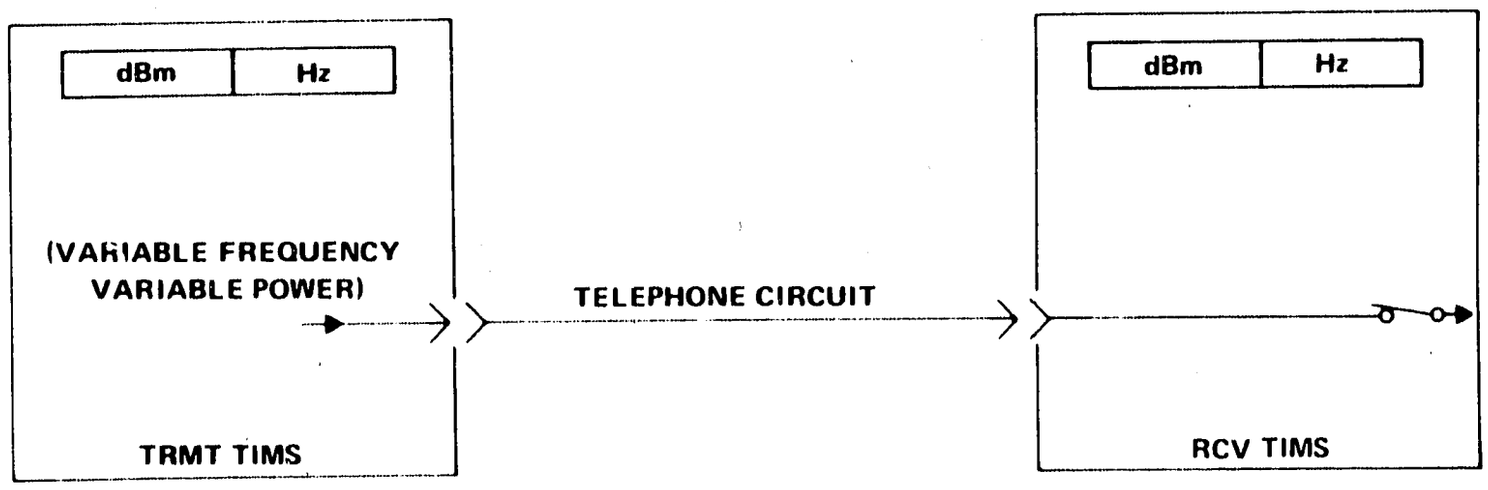


Figure A-2. *Level Frequency Measurement.*

A-11. 1004 Hz Loss

A-12. The 1004 Hz loss measurement determines the point-to-point loss (or gain) of a 1004 Hz test tone transmitted over a voice channel. To make this measurement, a 1004 Hz test frequency is transmitted at the data level. At the receiving HP 4937A, the received loss or gain is measured (in dBm).

A-13. The wake up transmit frequency is actually 1004 Hz (not 1000 Hz), to prevent errors over certain circuits. This 4 Hz offset avoids measurement errors caused by test frequencies which are submultiples of the 8 kHz *T-carrier* sampling rate. The other preset frequencies 404 Hz and 2804 Hz are offset for the same reason. A 2713 Hz is also provided as a fixed output frequency for use with certain channel terminating equipment.

A-14. Frequency Shift

A-15. The frequency shift measurement checks for any difference in the received frequency with reference to the transmitted frequency (frequency translation) as caused by carrier facilities. To make this measurement, a test tone of known frequency is transmitted. At the receiving end, the received frequency is observed and compared with the transmitted frequency. Any difference between transmitted and received frequencies indicates a frequency shift in the test signal. This measurement is not valid when measured on looped-around carrier facilities, since the frequency shift in one direction (near end to far end) may be canceled by the frequency shift in the other direction (far end to near end).

A-16. Attenuation Distortion

A-17. The attenuation distortion measurement checks the amplitude versus frequency characteristics of a circuit using a discrete frequency measurement technique and defines the circuit's usable bandwidth. To make the measurement, a 1004-Hz test frequency is transmitted at a given level At the receiving HP 4937A the power is recorded as the reference level at 1004 Hz. Frequencies between 20 Hz and 9999 Hz can be transmitted. The different power readings may be compared to the 1004 Hz reference on a relative basis to obtain the frequency attenuation characteristics of a voice channel in dBm.

A-18. To obtain loss deviations relative to 1004 Hz, the LEVEL ZERO key is pressed during reception of the 1004 Hz reference signal. The received power level is stored (in dBm) and simultaneously displayed as 0 dB. Level readings taken at other frequencies are compared to the 1004 Hz reference and displayed in dB. The 1004 Hz reference level will not have to be subtracted from levels at other frequencies to obtain dB readings.

A-19. According to telephone industry convention, attenuation is defined as a change in loss of a telephone circuit, compared to the loss of a nominal 1000 Hz signal on that circuit. For example, a circuit with 6 dB more loss at 2800 Hz would have an attenuation distortion of +6 dB. The gain slope measurement is a simplified version of the attenuation distortion measurement. It is measured at only three reference frequencies and is facilitated by the 404 Hz, 1004 Hz, and 2804 Hz fixed frequency transmit keys.

A-20. SF SKIP

A-21. SF Skip (single frequency skip) automatically prevents the HP 4937A from transmitting frequencies in the 2450 Hz to 2750 Hz range. This feature is used when transmitting over a dial-up network with single frequency signaling units.

A-22. MESSAGE CIRCUIT NOISE MEASUREMENTS

A-23. The message circuit noise measurements determine the effects of background noise and tones. Figure A-3 illustrates the basic setup for these measurements.

A-24. The message circuit measurement is obtained by measuring the noise present on a line with a quiet termination on one end (supplied by the transmitting HP 4937A) and a frequency weighted measuring device on the other end (receiving HP 4937A).

A-25. The C-message filter measures noise signals that annoy the typical telephone service subscriber. C-message weighting is also used to evaluate the effects of noise on voice-grade data circuits. C-message weighting is useful for data transmission since the response characteristic has been correlated with the disrupting effects of noise on data transmission (600 to 3000 Hz, see figure A-4).

A-26. The 3 kHz flat filter has a response that provides much less attenuation to the low frequencies (60 Hz to 500 Hz) than the C-message filter. By comparing a 3 kHz flat noise measurement to a C-message noise measurement, the relative influence of low frequency noise (60 Hz commercial power, 20 Hz ringing etc.) can be determined (see figure A-5).

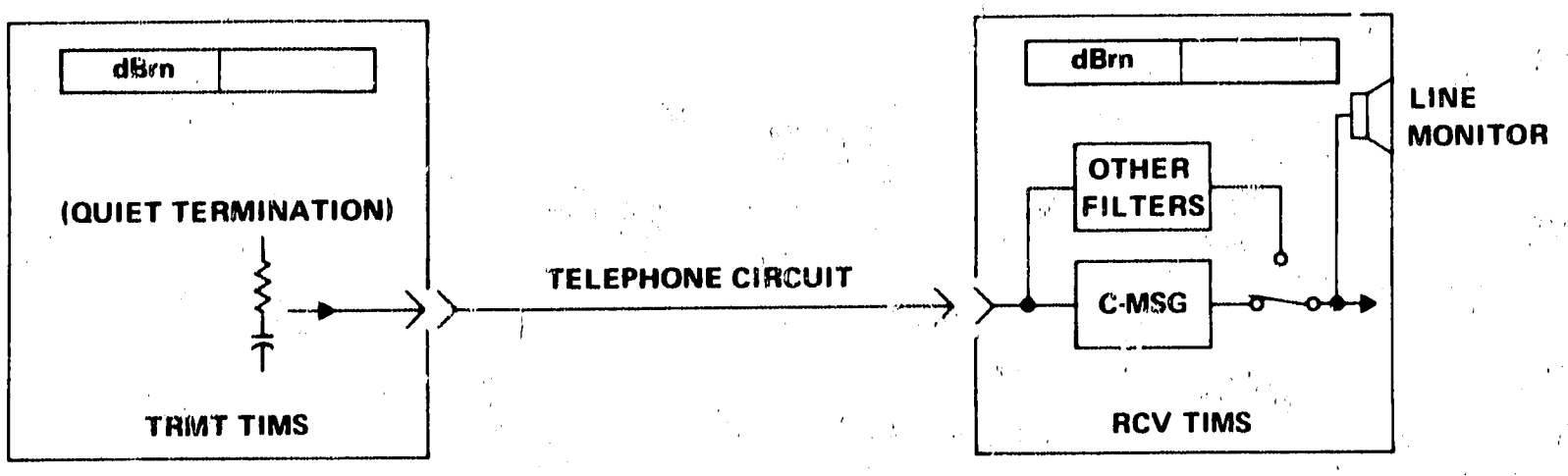


Figure A-3. *Message Circuit Noise Measurement.*

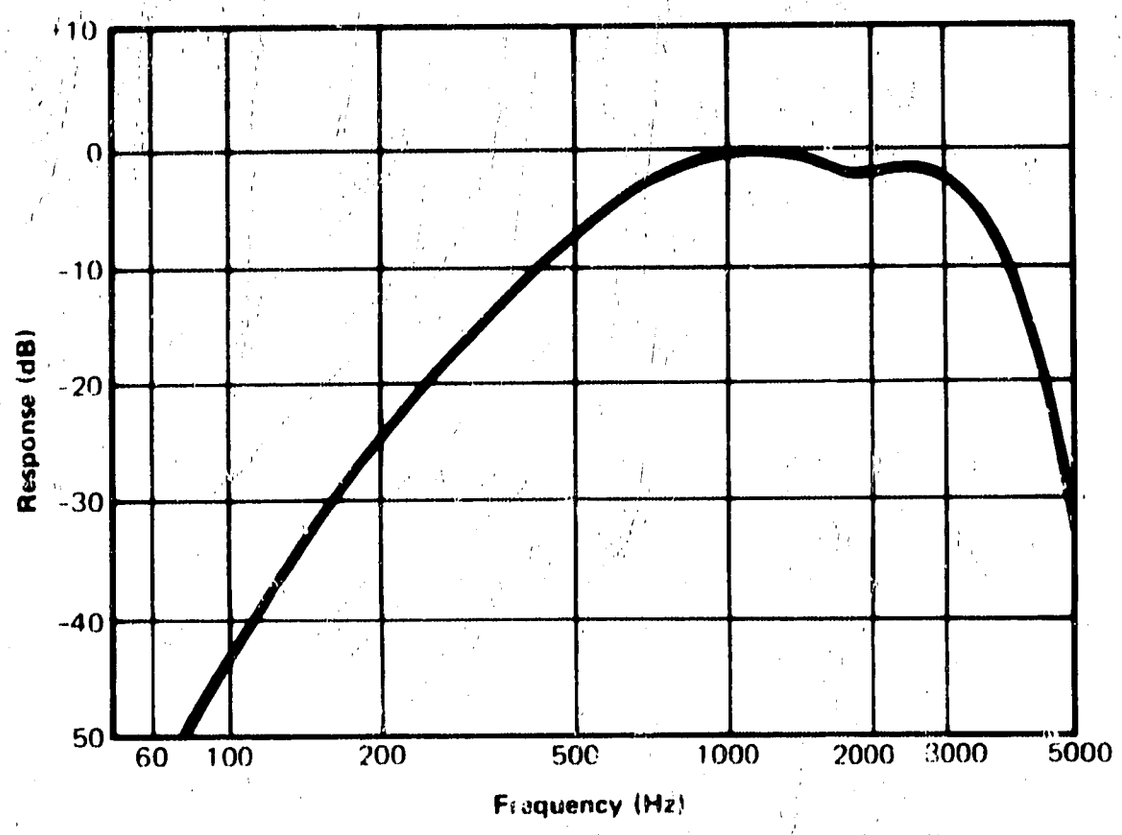


Figure A-4. *C-Message Weighting Characteristic*

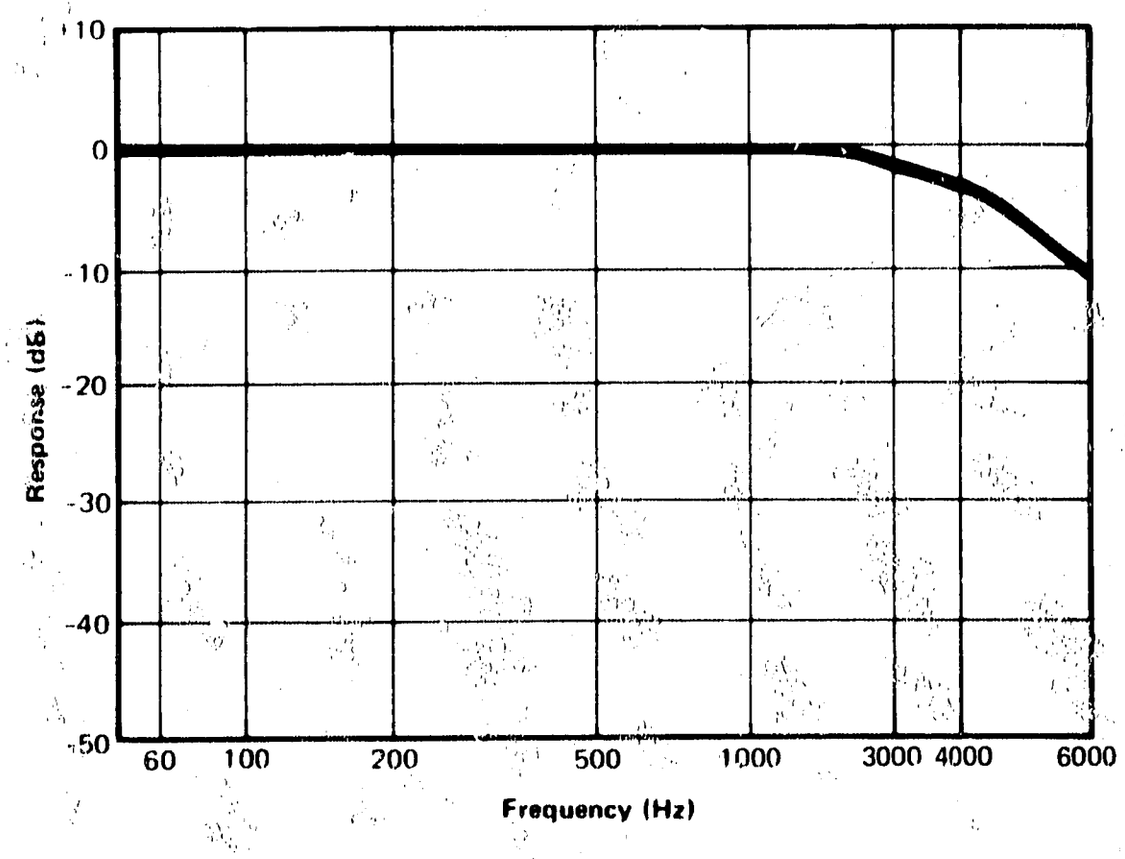


Figure A-5. *3-kHz Flat Weighting Characteristic*

A-27. NOISE MEASUREMENTS

A-28. Received noise levels are displayed in units of dBrn, or dB with respect to reference noise (1000 Hz tone at -90 dBm). For example, a noise reading of 20 dBrn has an RMS power of -70 dBm (20-90=-70). When the C-message filter is selected, readings are displayed in units of dBrn C. The C indicates the noise level was measured with a C-message weighted device.

A-29. Noise-With-Tone (Notched Noise)

A-30. The noise-with-tone measurement technique is used to condition compandors and/or quantizers in the transmission system to their normal operating levels for continuous data signals. Therefore, noise levels are received which duplicate levels present under operating conditions.

A-31. To make this measurement, a 1004 Hz test frequency (holding tone) is transmitted at data level. At the receiving HP 4937A, the 1004 Hz holding tone is selectively attenuated by 50 dB using a notch filter (all frequencies between 995 Hz and 1025 Hz are attenuated by 50 dB or more). The remaining received signal (noise) is passed through a weighting filter for measurement. The received noise level is displayed in units of dBrn. Figure A-6 illustrates the combination of the C-message weighting and notch filter characteristics. The HP 4937A combines the notch with the two weighting filters.

A-32. Signal-To-Noise Measurement

A-33. The signal-to-noise mode allows measurement of the ratio of received signal-plus-noise power to noise power (S+N/N).

A-34. To make this measurement, a 1004 Hz test frequency is transmitted over the line. At the receiving HP 4937A, the 1004 Hz signal is selectively attenuated by 50 dB in the notch filter, usually C-message weighted. The remaining received signal (noise) is then compared with the original signal- plus-noise signal. The computed signal-to-noise ratio is displayed in units of dB. Figure A-7 illustrates this measurement. This is one of the most important parameters for determining the quality of a line.

A-35. Noise-To-Ground Measurement

A-36. The HP 4937A uses noise-to-ground to mea[illegible] the longitudinal noise present on a telephone circuit with reference to ground. The transmitting HP [illegible]37A provides a quiet termination at one end of the voice channel, and the receiving HP 4937A provi[illegible] a frequency weighted filter and detector at the other end. The basic measurement technique used for the noise-to-ground measurement is very similar to the message circuit noise measurement; the main difference lies in the use of a ground reference. Figure A-8 illustrates this difference.

A-37. Noise-to-ground measurements are usually made for troubleshooting purposes: to measure the magnitude of longitudinal signals, which may indicate the susceptibility of a cable pair to electrical coupling from external sources. These measurements are also made to coordinate new installations with power companies, to minimize power line coupling.

A-38. The relative line balance of an end loop can be calculated by subtracting the measured noise-to-ground (Ng) value from the measured message circuit noise (Nm) value. This calculation is only valid if the measurements are made on a twisted pair and it is assumed that the message circuit noise is caused by longitudinal noise converted to message circuit noise by line imbalance. It is recommended that both message circuit noise and noise-to-ground be measured with the 3 kHz flat weighted filter to include the effects of power line related noise.

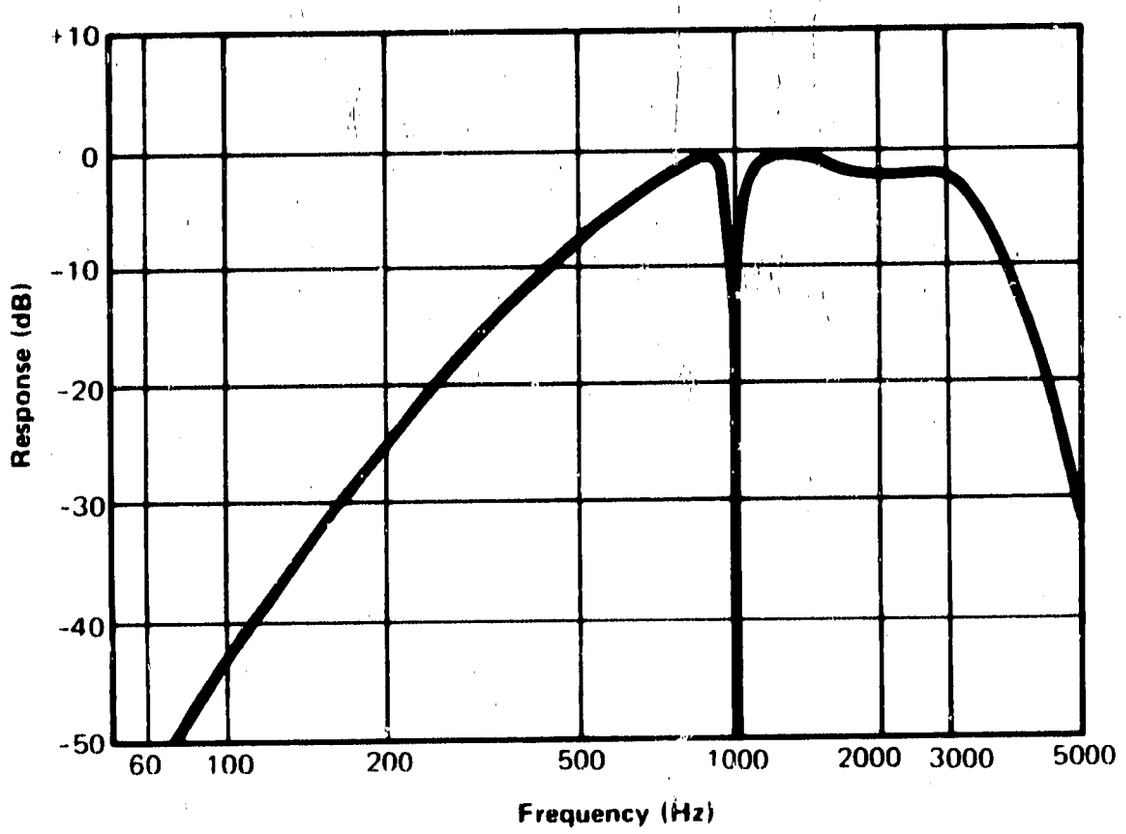
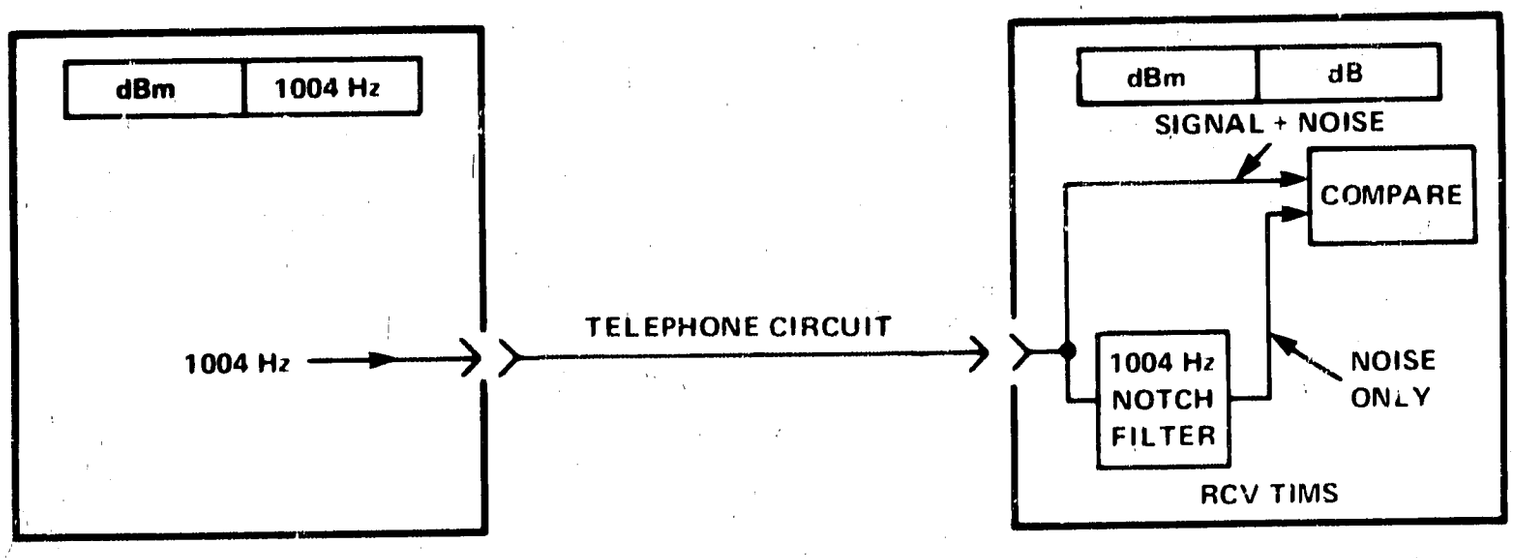


Figure A-6. *C-Message Weighting with Notch*



$$\text{S-T-N RATIO} = 10 \log \frac{P_{SIGNAL} + P_{NOISE}}{P_{NOISE}}$$

Figure A-7. *Signal to Noise Measurement*

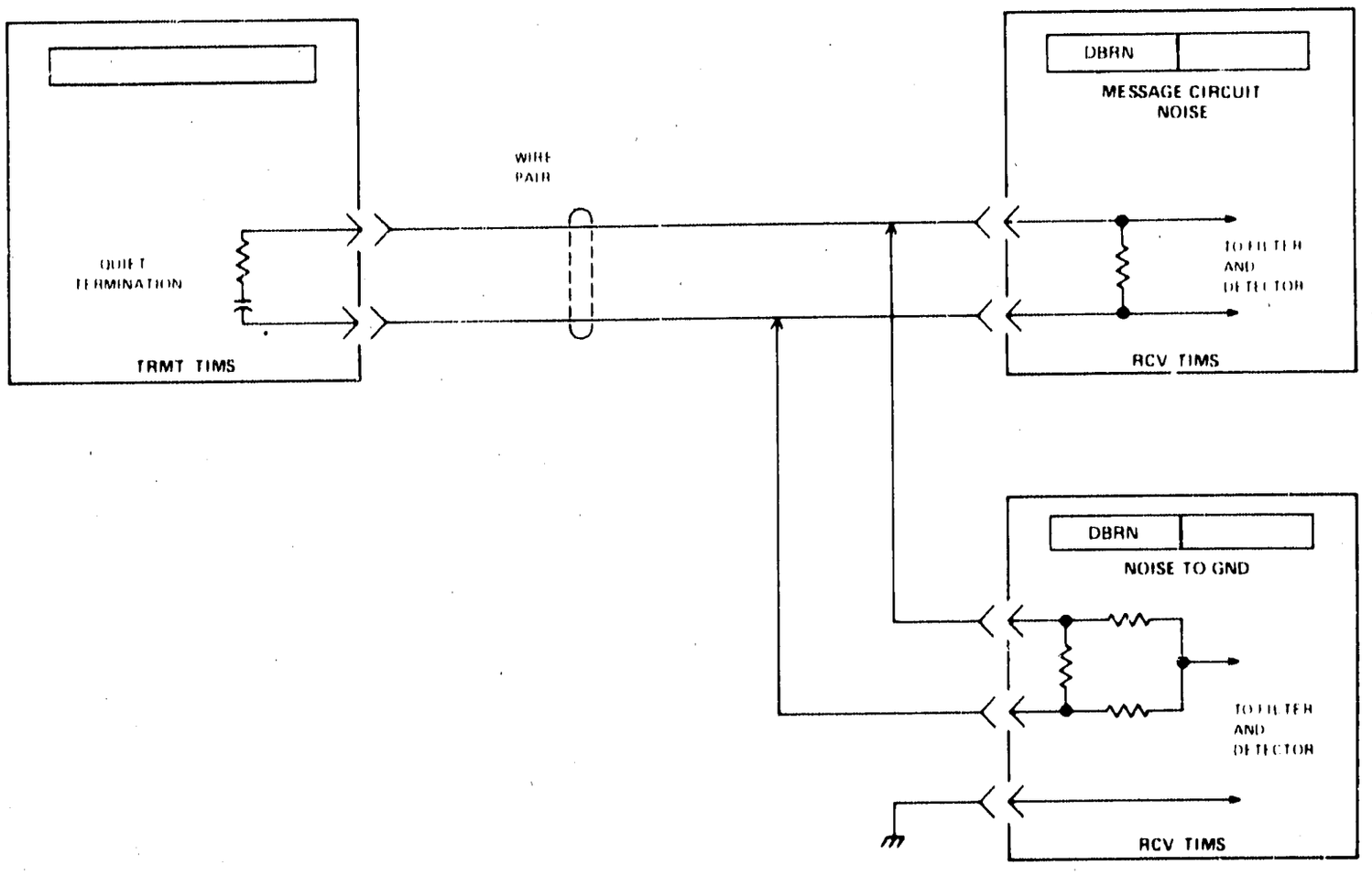


Figure A-8. *Noise to Ground Related to Message Circuit Noise.*

A-39. RETURN LOSS

A-40. Echos or reflections on a telephone line can cause transmission impairments. This occurs when the level of the echo is great enough to be heard and the delay is greater than 600 milliseconds. When the reflections occur such that the talker's signal is returned to him, it is called talker echo. If the talker echo is again reflected and is heard by the listener, it is called listener echo.

A-41. In the frequency bands of 250 to 500 Hz and 2500 to 3000 Hz the return loss is usually degraded. This causes multiple echos which can lead to singing (oscillations) or near-singing conditions. This will cause voice transmission to have a *hollow* sound or *rain-barrel* effect.

A-42. Return loss is used to measure the performance of the telephone line to ensure these impairments do not occur. There are three types of return loss measurements that can be made. These are: Echo, Singing Hi, and Singing Lo. Each of the three types makes a return loss measurement over a different band of frequencies. The output spectrum of the different return loss measurements can be seen in figure A-9.

A-43. In the measurement selection area of the instrument either 2- or 4-wire return loss can be selected. This is done by pressing the MEAS SELECT key. In the filter selection area the selection of the three types of return loss measurement can be made. This is done by pressing the FILTER SELECT key.

A-44. In a four wire circuit, the return loss measurement can be made at either 600, 900, or 1200 ohms. The set up for the measurement is shown in figure A-10. When in the receive mode the THL (transhybrid loss) compensation can be entered via the STEP-UP or STEP-DOWN keys, or by pressing the LEVEL ZERO key the HP 4937A will measure the loss.

A-45. In a two wire circuit, the return loss bridge uses a reference impedance of 2.16 microfarads in series with either 600 or 900 ohms. The instrument is automatically configured with the bridge for the measurement. The set up is shown in figure A-11. The A jack is normally the test port, the REV pushbutton can switch it to the B jack.

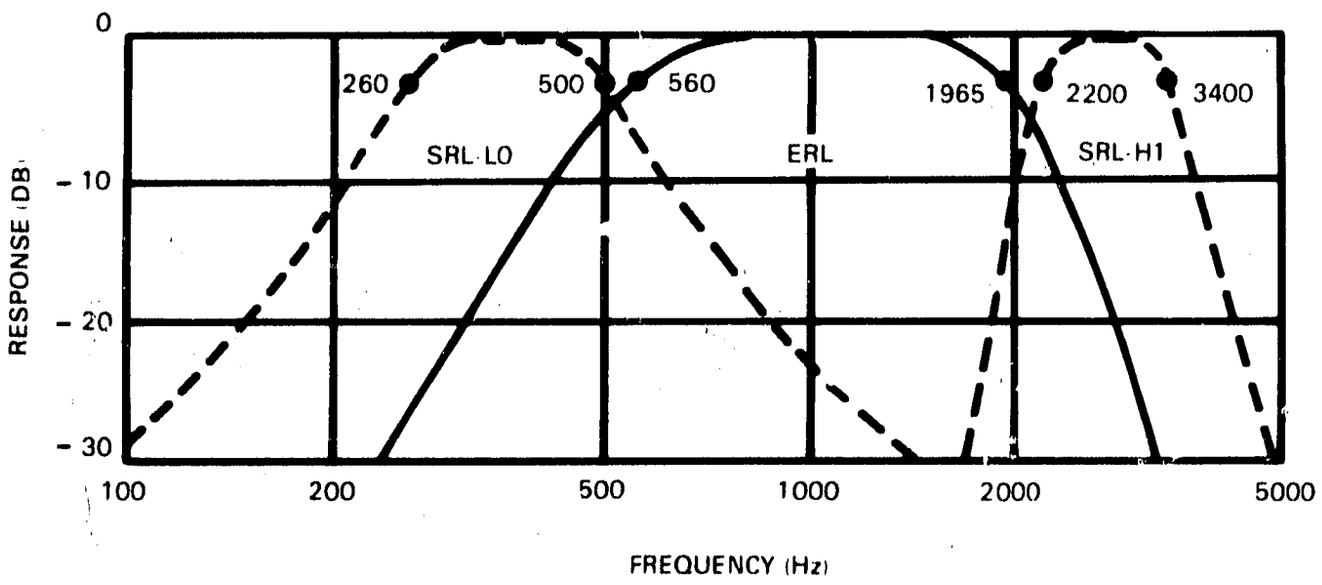


Figure A-9. *Filter Shapes for ERL, SRL Low, SRL High.*

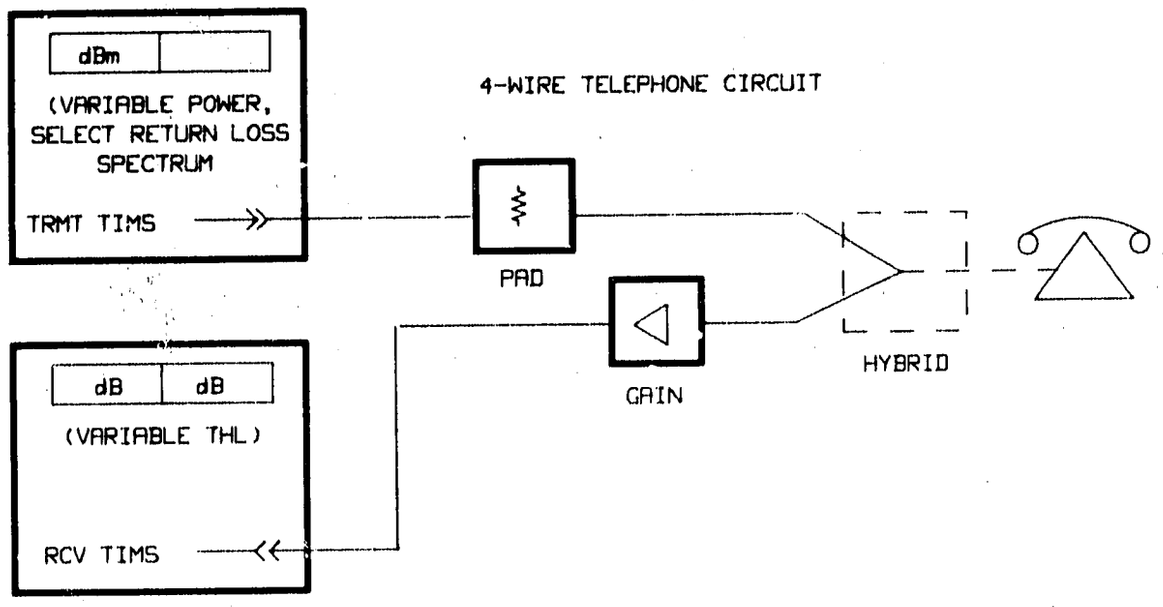


Figure A-10. *4-wire Return Loss.*

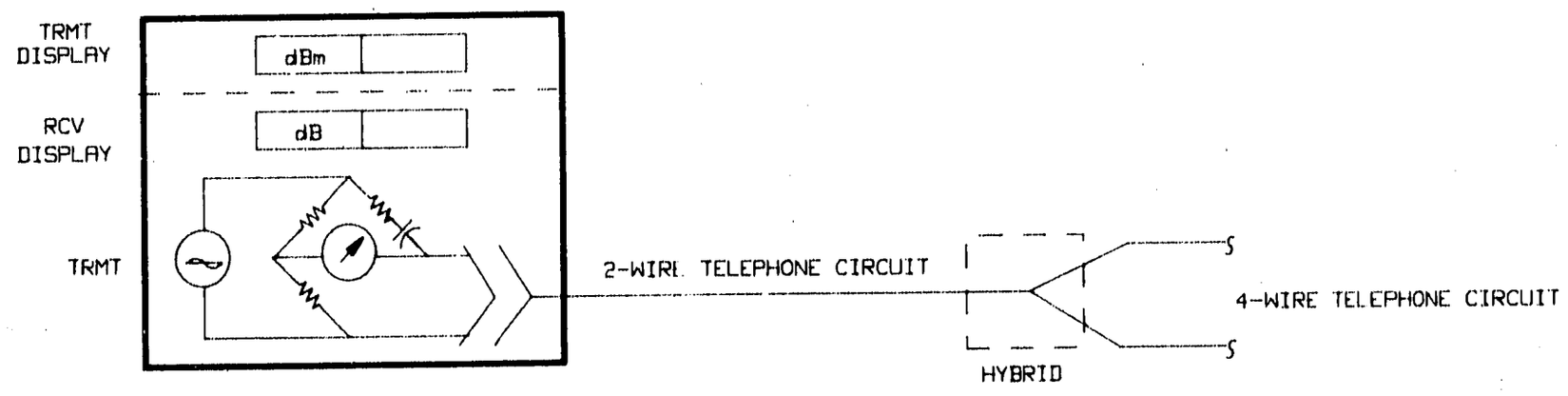


Figure A-11. *2-wire Return Loss*

A-46. SIGNALING

A-47. Signaling conveys the information needed for one subscriber to interconnect with any other subscriber in a switched telephone network. Signaling tells the switch (central office, PBX) that a subscriber desires service. Then given the necessary data to identify the distant subscriber, the switch will properly route the call. There are three functional areas of signaling. These are: supervisory, address, and alerting.

A-48. Supervisory signaling conveys information on whether a cicruit is in use or not. It informs the switch that the calling party is either on-hook or off- hook and whether the called party is on-hook or off-hook. On-hook and off-hook were derived from the positon of a telephone receiver. On-hook being that the receiver was on the switch hook of the telephone and off-hook being that the receiver was picked up.

A-49. The general operation of the signaling function is as follows: First use the A or B signaling keys to select which line the loop signaling is to be performed on. The SELECT and ORIG/TERM keys are then used to choose the type of signaling desired. The ON/OFF HOOK key would then be pressed to start or stop the signaling. The status area always indicates the status of the originate and terminate ends as needed per the signaling mode. The function diagrams for both Loop and E/M signaling are shown in figures A-12 and A-13 respectively. The types of signaling available are:

1. E/M Types I, II, III
2. Ground Start
3. Loop Start
4. Loop Reverse Battery
5. Wink

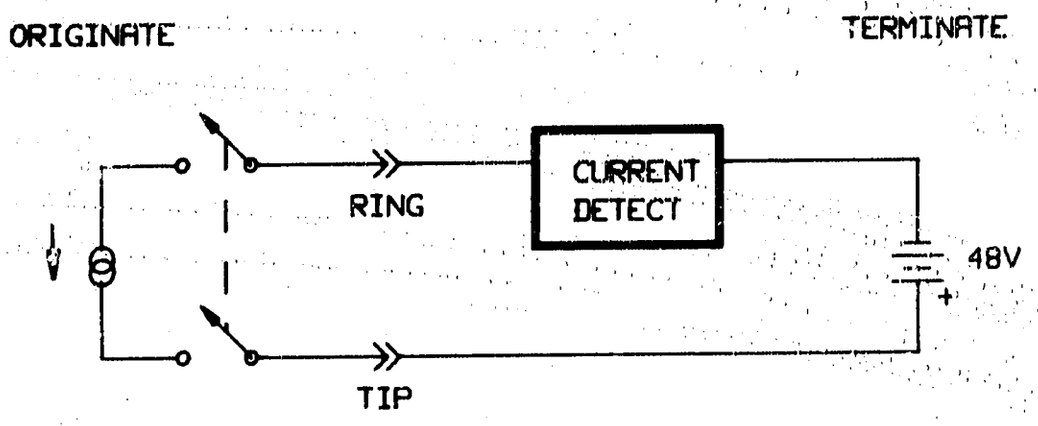
A-50. E/M Signaling

A-51. There are five types of E/M signaling. Those are Types I, II, III, IV, and V. The HP 4937A will provide three of the five types: I, II, and III. The three different type of E/M signaling are accomplished with the E/M and SB/SG jacks on the front panel. For E/M Type I only the E/M jack is used, and for E/M Types II and III both the E/M and SB/SG jacks are used. SB and SG stand for sense battery and sense ground respectively and are used to reduce noise in E/M signaling.

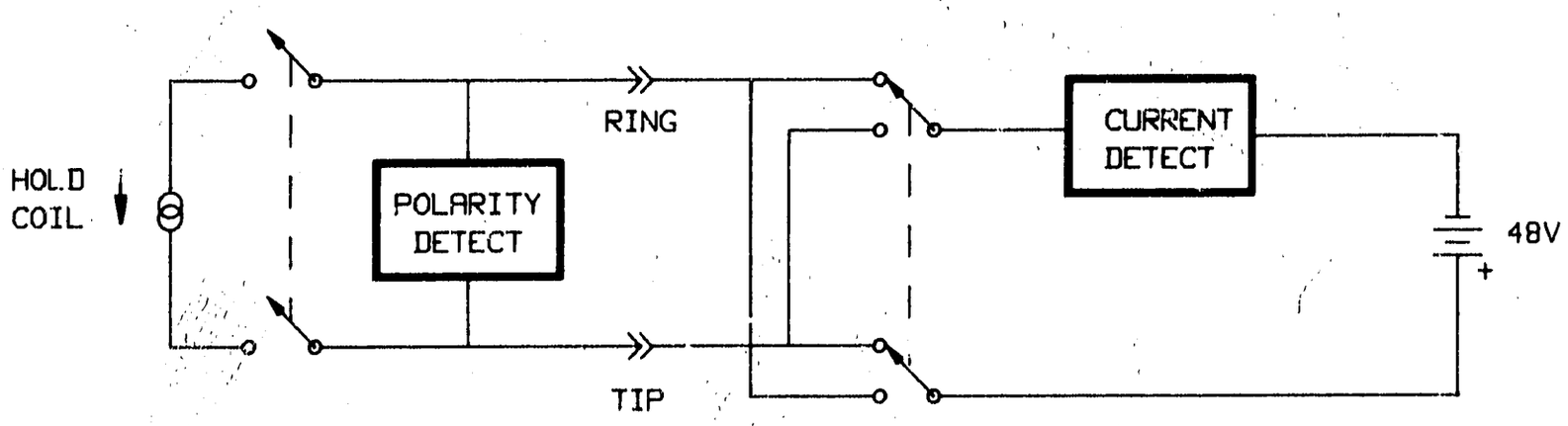
A-52. The HP 4937A can simulate both originate and terminate ends (either the central office or the PBX) for the three types of E/M signaling. The flow chart in figure A-14 describes the operation for E/M originate and terminate.

A-53. Ground Start Signaling

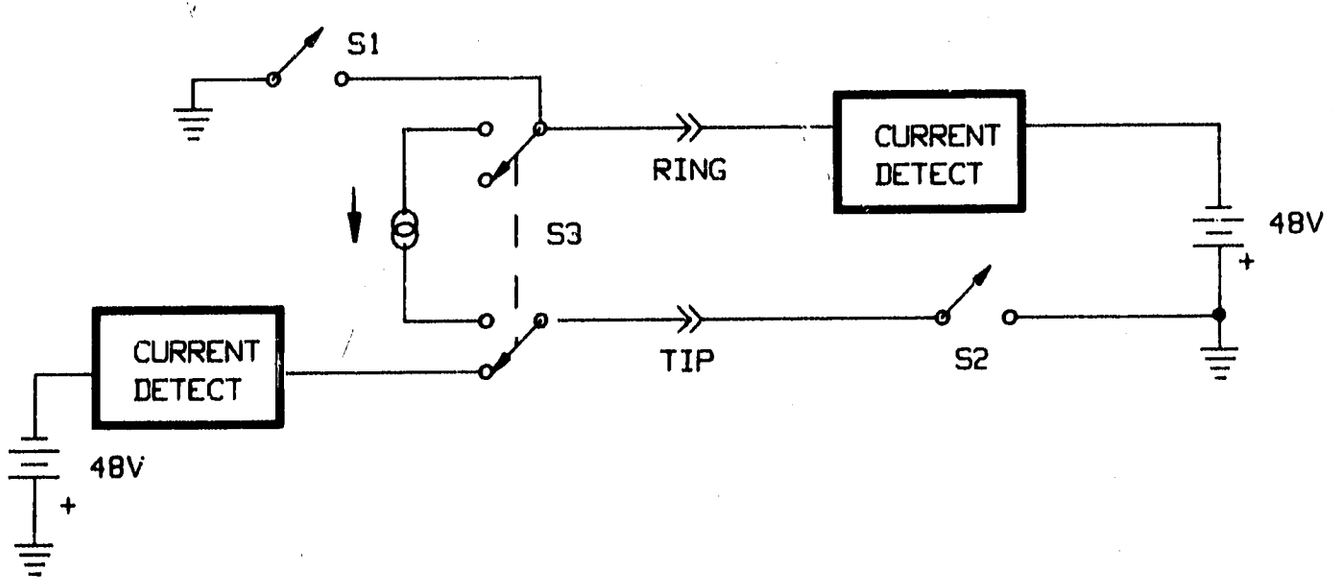
A-54. The HP 4937A is able to simulate ground start for both originate and terminate ends of the line. In ground start originate the user can select either the dial or hold circuit to be connected to the line. When dial is selected the dial binding posts are connected to the line so that dialing can be done using a handset. If the dial jack was not selected the HP 4937A will automatically select the hold circuit. The status lights will show the condition of both the originate and terminate ends of the line.



a) *Loop Start*

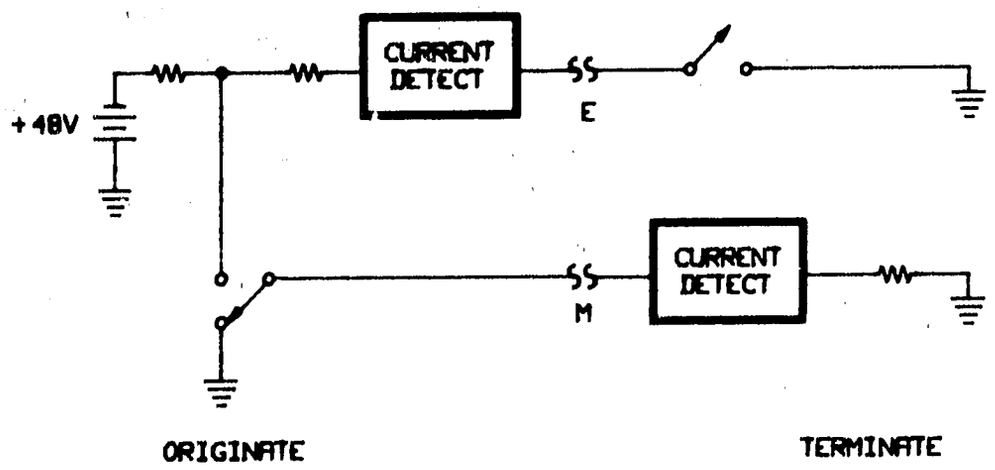


b) *Ground Start*

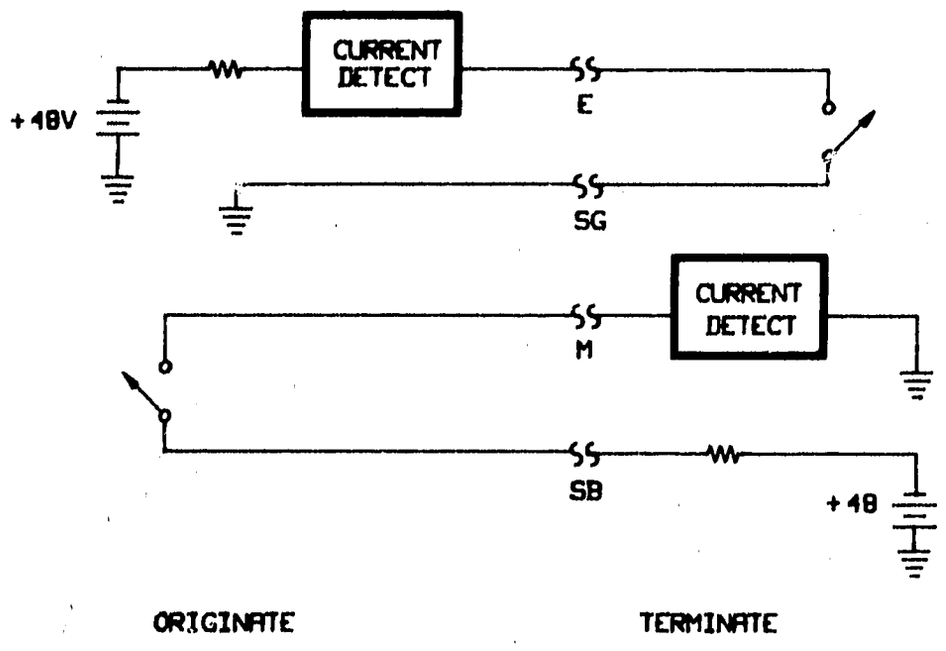


c) *Loop Reverse Battery Start*

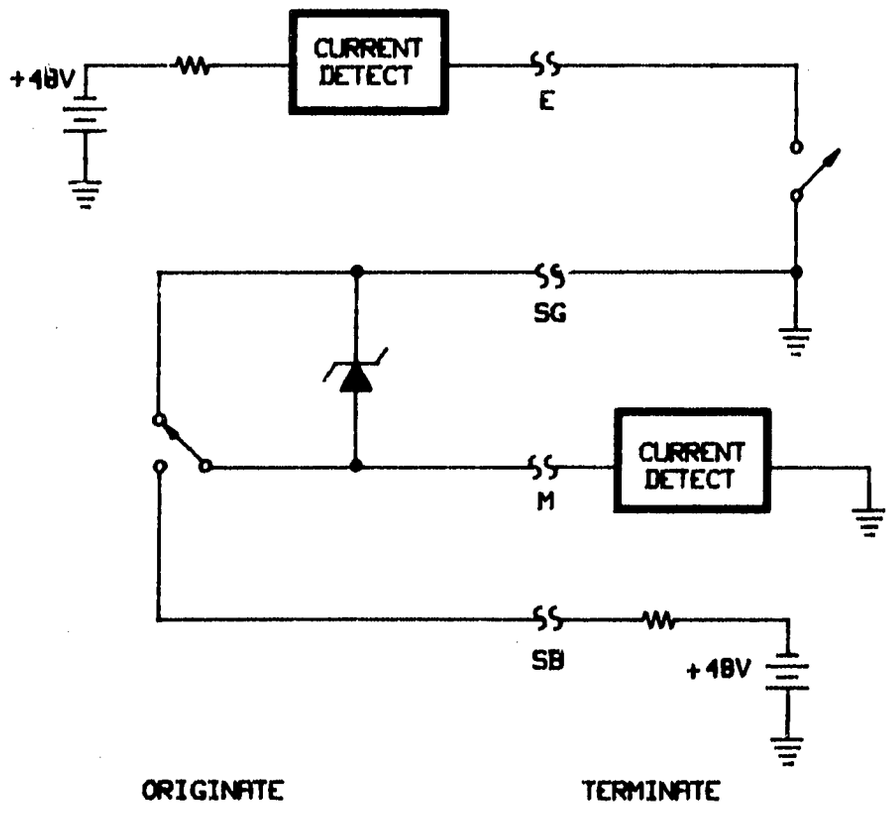
Figure A-12. *Loop Signaling*



a) *Type I*



b) *Type II*



c) *Type III*

Figure A-13. *E/M Signaling*

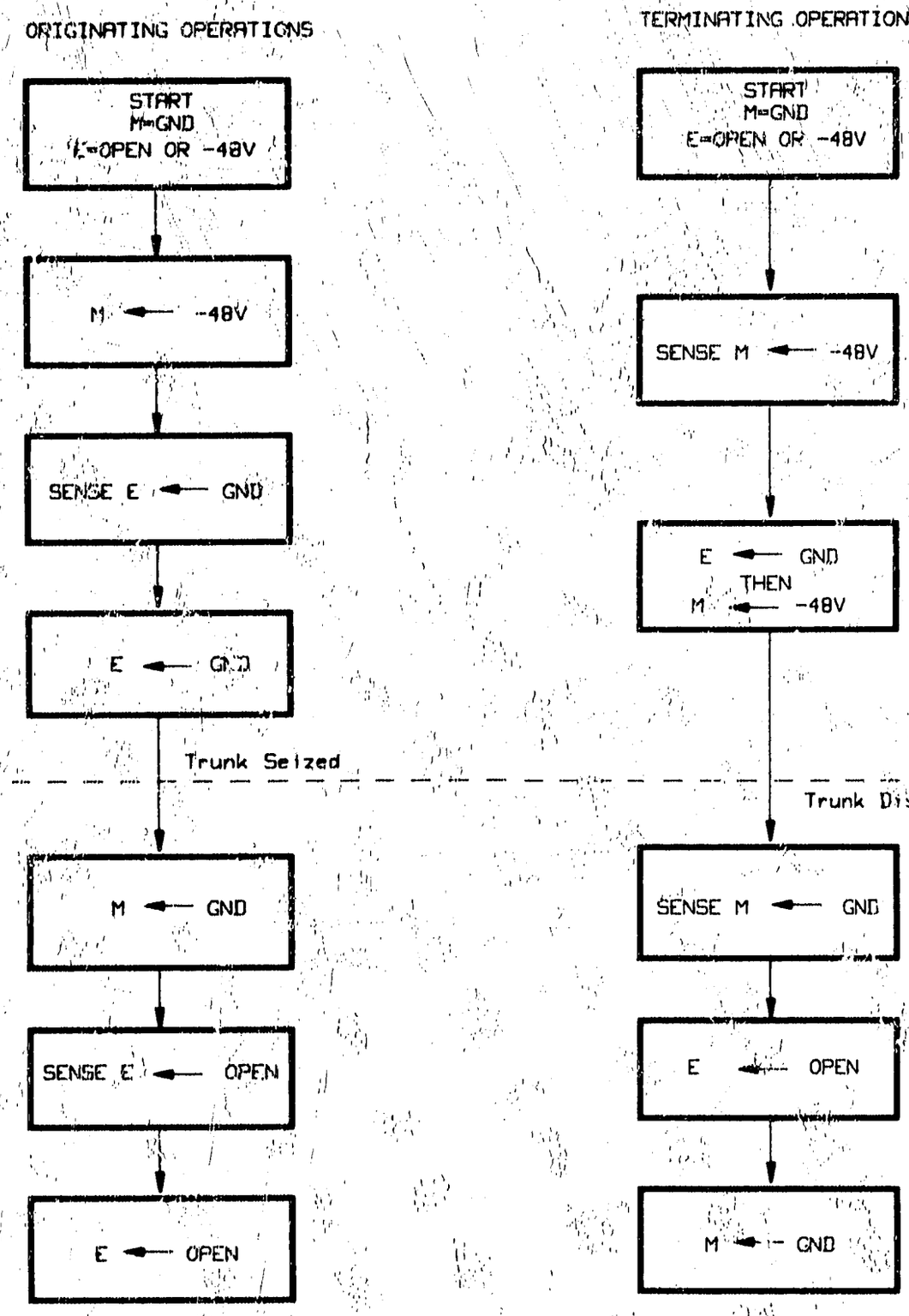


Figure A-14. *E/M Signaling Flow Chart*

A-55. Loop Start Signaling

A-56. The HP 4937A can simulate loop start for both originate and terminate ends of the line. Basically loop start originate puts a hold circuit on the line. In loop start originate the user can select either the dial or hold circuit to be connected to the line. When dial is selected the dial binding posts will be connected to the line so that dialing can be done using a handset. If the dial jack was not selected the HP 4937A will automatically apply the hold circuit.

A-57. In loop start terminate, voltage is continuously applied to the line. A -48 volts is on the ring and ground is on the tip. The voltage across the tip and ring can vary from -42.5 to -52.5 volts. The off-hook condition is detected by current flowing in the loop. The status lights will only show the condition of the orginate end.

A-58. Loop Reverse Battery Signaling

A-59. The HP 4937A can simulate loop reverse battery for both originate and terminate ends of the line. In the originate mode either a hold circuit or the dial jacks will be connected to the line. The on-off hook condition will be determined by the direction of current flow.

A-60. In the terminate mode, the on-hook condition is defined to be -48 volts on tip and ground on ring. The off-hook conditions would be ground on tip and -48 volts on ring. A unit in an idle mode would have both ends of the line on-hook, i.e. both status lights showing on-hook. When the HP 4937A senses a current flow (the originate end going from on-hook to off-hook), it will indicate the originate end when off-hook. Then the ON/OFF HOOK switch can be pressed to cause the terminating end (HP 4937A) to go off-hook to complete the response.

A-61. Hold Other

A-62. This mode of signaling simply puts a standard hold circuit on the line. This also corresponses to loop start orginate. By pushing the hold key the user could connect a hold circuit to the line connected to the B 310 jack. If the B SIGNALING key is pressed in, the hold circuit will be connected to the A jack.

A-63. Wink

A-64. A wink is used with DID (direct inward dial) trunks and all interoffice trunks. A wink is a response to the other end requesting the trunk. When the other end wants the trunk the winking end goes off-hook momentarily then returns to the on-hook state. The wink is used to inform the caller or equipment that dialing information can be received. The dialing information is then transmitted. After receiving the dialing information, the ON/OFF HOOK key can be used to seize the trunk. The HP 4937A will simulate the Wink, but will not store the dialing information.