

217A SQUARE WAVE GENERATOR

OPERATING AND SERVICE MANUAL

HEWLETT  PACKARD

MANUAL CHANGES

MODEL 217 A

SQUARE WAVE GENERATOR

Manual Serial Prefixed: 737-
Manual Printed: NOV. 1967

To adapt this manual to instruments with other serial prefixes check for errata below, and make changes shown in tables.

Instrument Serial Prefixes	Make Manual Changes
G-737- and above	

ERRATA: In Section VI, Replaceable Parts and pertaining Schematics:

Change:	A1	Attenuator Assembly to	-hp- Stock No.
	A2C21	C:fxd., Dipped Mica to 30pF, +5% the following components to factory selected value (*): A2C19, A2R4, A2R13, A2R21, A2R27, A2R43, A2R48.	00211-63401 0160-0181
	F1	Fuse - cartridge, slow-blow, 1/2 Ampere (115V Operation) to	2110-0008
	S1	Switch Push Button Lighted SPDT to	3101-0100
	S2	Switch Slide DPDT Non Shorting to	3101-0033
Add:	to F1	Fuse - cartridge, slow-blow, 1/4 Ampere (230V Operation)	2110-0004
	Under Miscellaneous:		
Change:	Heat Dissipator for TC-18 to		1205-0037
	On Figure 7-6, Output and Trigger Circuit Schematic Diagram: Delete asterisk from R40.		

CERTIFICATION

Hewlett-Packard certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

WARRANTY AND ASSISTANCE

All Hewlett-Packard products are warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed in the operating manual, for the specified period. We will repair or replace products which prove to be defective during the warranty period. No other warranty is expressed or implied. We are not liable for consequential damages.

For any assistance contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.



OPERATING AND SERVICE MANUAL

MODEL 217A

SQUARE WAVE GENERATOR

SERIALS PREFIXED: G 737

COPYRIGHT HEWLETT - PACKARD GMBH 1967
BÖBLINGEN, WEST GERMANY

MANUFACTURED BY HEWLETT - PACKARD GMBH BÖBLINGEN

TABLE OF CONTENTS

Section	Page	Section	Page
I GENERAL INFORMATION.....	1-1	4-16. Trigger Output Circuit	4-3
1-1. Description	1-1	4-17. Output Amplifier.....	4-3
1-4. Manual Identification	1-1	4-18. Power Supply.....	4-3
II INSTALLATION	2-1	V MAINTENANCE	5-1
2-1. Initial Inspection	2-1	5-1. Introduction.....	5-1
2-4. Claims and Repacking.....	2-1	5-3. Test Equipment	5-1
2-7. Preparation for Use	2-1	5-5. Instrument Cover Removal	5-1
2-8. Power Source Requirements.....	2-1	5-7. Performance Check	5-1
2-10. Installation	2-1	5-9. Repetition Rate	5-1
2-12. Rack Mounting	2-1	5-10. Symmetry Control Check	5-3
2-14. Combining Case	2-2	5-11. Output Pulse Characteristics.....	5-3
2-15. Adapter Frame	2-2	5-13. Square Wave Output	5-4
III OPERATION	3-1	5-16. Trigger Output	5-4
3-1. Introduction.....	3-1	5-18. Troubleshooting	5-5
3-3. Duty Cycle.....	3-1	5-20. Repair and Replacement	5-5
3-6. Operating Procedures.....	3-1	5-22. Component Identification	5-5
3-8. Trigger Output.....	3-1	5-25. Servicing Etched Circuit.	
IV PRINCIPLES OF OPERATION.....	4-1	Boards	5-5
4-1. Introduction.....	4-1	5-28. Adjustments	5-5
4-3. General Description	4-1	5-29. Power Supply	5-5
4-9. Schematic Theory	4-2	5-30. Frequency	5-6
4-10. Frequency Control Network	4-2	VI REPLACEABLE PARTS.....	6-1
4-12. Current Source.....	4-2	6-1. Introduction.....	6-1
4-13. Switching Circuit.....	4-2	6-4. Ordering Information	6-1
4-14. Ramp Capacitor Amplifier.....	4-2	VII CIRCUIT DIAGRAMS.....	7-1
4-15. Schmitt Trigger.....	4-3	7-1. Introduction.....	7-1

LIST OF ILLUSTRATIONS

Number	Title	Page	Number	Title	Page
1-1.	Model 217A Square Wave Generator	1-1	5-1.	Definition of Output Pulse Characteristics ..	5-1
2-1.	The Combining Case.....	2-0	5-2.	Frequency Accuracy Check.....	5-3
2-2.	Steps to Place Instrument in Combining Case	2-0	5-3.	Square Wave Output Check	5-4
2-3.	Adapter Frame Instrument Combinations ..	2-1	5-4.	Trigger Output Pulse Check	5-4
2-4.	Two Half Modules in Rack Adapter.....	2-2	5-5.	Trouble shooting chart.....	5-7
3-1.	Determining Duty Cycle.....	3-1	7-1.	Test Point Waveforms	7-0
3-2.	Front Panel Description	3-2	7-2.	Component Location top view.....	7-2
4-1.	Basic Block Diagram	4-1	7-3.	Component Location bottom view.....	7-3
4-2.	Simplified Current Source Operation	4-2	7-4.	Component Location on A2 Board	7-4
4-3.	Ramp Capacitor Amplifier Block Diagram ..	4-3	7-5.	Repetition Rate Schematic Diagram ...	7-5/7-6
			7-6.	Output and Trigger Circuits Schematic Diagram	7-7/7-8
			7-7.	Power Supply Schematic Diagram	7-9

LIST OF TABLES

Number	Title	Page	Number	Title	Page
1-1.	Model 217A Specifications.....	1-0	6-1.	Reference Designation Index.....	6-2
5-1.	Required Test Equipment	5-2	6-2.	Replaceable Parts.....	6-8
5-2.	Frequency Accuracy.....	5-3			
5-3.	Trouble Shooting Procedure	5-7	7-1.	Schematic Diagram Notes	7-1

Table 1-1. Specifications

SQUARE WAVE OUTPUT

REPETITION RATE:

1Hz to 10MHz, 7 ranges

VERNIER: Provides continuous adjustment between ranges.

PERIOD JITTER: < 0.2% at any duty cycle and repetition rate setting.

MAXIMUM OUTPUT: 5 V across 50 Ω , 10V across an open circuit. Output circuit protected, can not be damaged by shorting.

ATTENUATOR: Provides 7 steps from 0.05V to 5V in a 1, 2.5, 5 sequence.

VERNIER: Provides continuous adjustment between ranges, minimum output less than 0.02V across 50 Ω . Rotating vernier to minimum (ccw) may increase preshoot to 10 %.

SYMMETRY: Duty cycle continuously variable from 25% to 75% for 1Hz - 1MHz
30% to 70% for 1MHz - 10MHz

POLARITY: Negative

SOURCE IMPEDANCE: 50 Ω $\pm$ 3% shunted by 20pF.

PULSE SHAPE: (Measured at 5 V across 50 Ω)

RISE AND FALL TIMES: < 5ns

OVERSHOOT AND RINGING: < 5% peak of pulse

PRESHOOT: < 5%

TRIGGER OUTPUT PULSE

WIDTH: 10 ($\pm$ 5) ns at 50% points.

AMPLITUDE: At least 2 V across 50 Ω .

TIMING: Coincident with leading edge of the square wave.

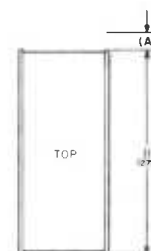
POLARITY: Positive

GENERAL

POWER: 115V or 230V +10%, -15%, 50Hz to 400Hz, 15VA.

DIMENSIONS:

NOTE
DIMENSIONS IN INCHES AND (MILLIMETERS)
(A) FOR TOTAL LENGTH INCLUDING KNOBS
ADD 1 IN (25 MM)
(B) FOR HEIGHT INCLUDING FEET
ADD 7/8 IN (22 MM)



WEIGHT: Net 5 1/2 lbs (2.5 kg)
Shipping 7 1/2 lbs (3.3 kg)

SECTION I

GENERAL INFORMATION

1-1. DESCRIPTION.

1-2. The -hp-Model 217A Square Wave Generator (shown in Figure 1-1) is a compact, general purpose instrument providing negative pulses of variable frequency, duty ratio and amplitude. Complete specifications of performance are given in Table 1-1. The 50 Ω source supplies pulses with 5ns rise and fall times and a peak output of 5V across 50 Ω . An open circuit voltage of 10V is available. The amplitude is continuously controllable from 0.05 to 5V. The frequency range of the instrument, 1Hz to 10MHz, is covered in 7 decade ranges with a vernier control for continuous adjustment on all positions.

1-3. Trigger output pulses, for synchronizing external circuits or instruments, have a pulse width of less than 20ns and an amplitude of at least 2V across 50 Ω . The trigger output is coincident with the leading

edge of the square wave.

1-4. MANUAL IDENTIFICATION.

1-5. Information in this manual applies directly to Model 217A instruments with serial prefix of G-737. The serial prefix is the first three digits of the eight-digit serial number (e.g. 000-00000) used to identify each -hp- instrument. If the serial prefix of a Model 217A is not G-737, a manual change sheet, supplied with the manual, will define the differences between that Model 217A and the one described in this manual, or a different manual, will provide correct information. Corrections to this manual, due to errors that existed when it was printed, are called Errata and appear only on the change sheet supplied. To obtain correct manual information for any instrument, contact the nearest Hewlett-Packard Company Sales/Service Office and always specify the model number and serial number.



Figure 1-1. Model 217A Square Wave Generator

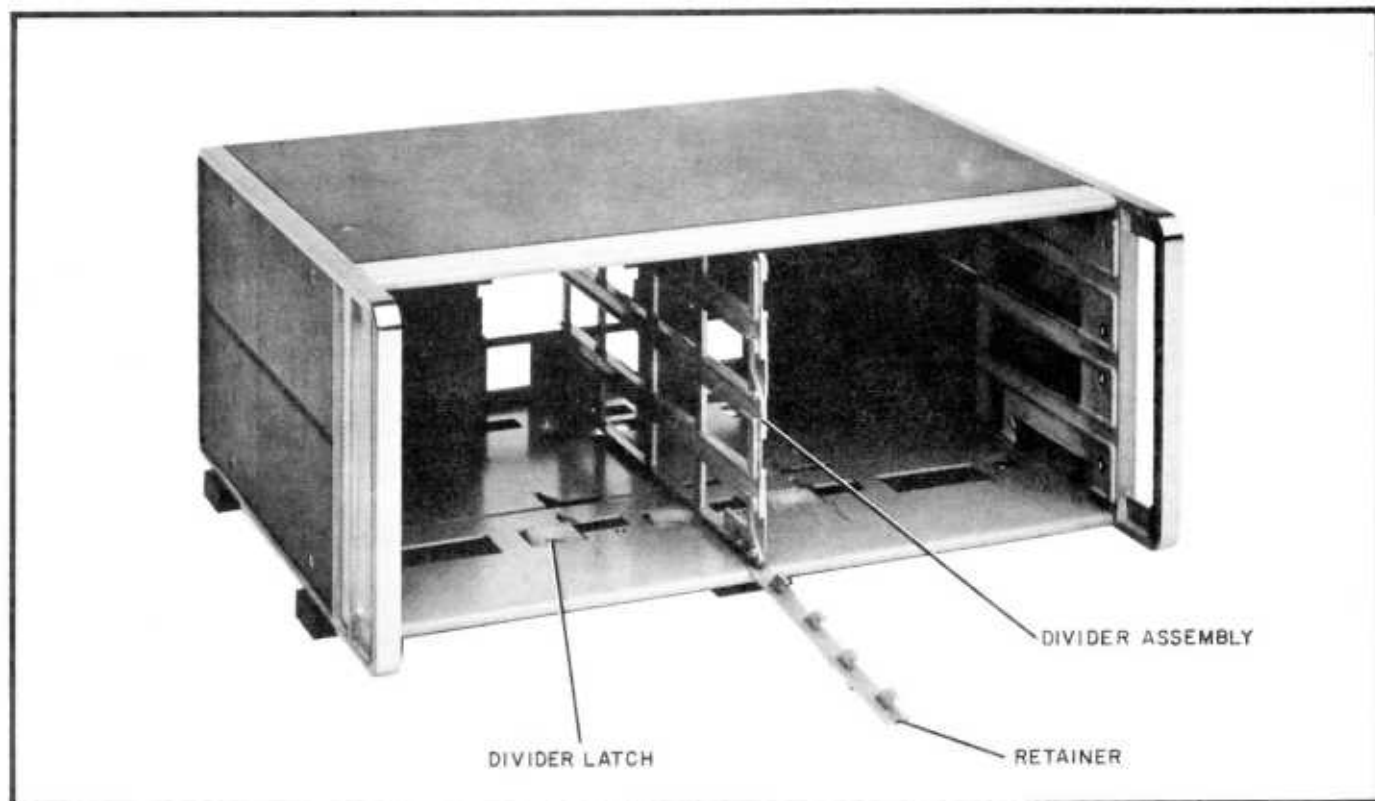


Figure 2-1 The Combining Case

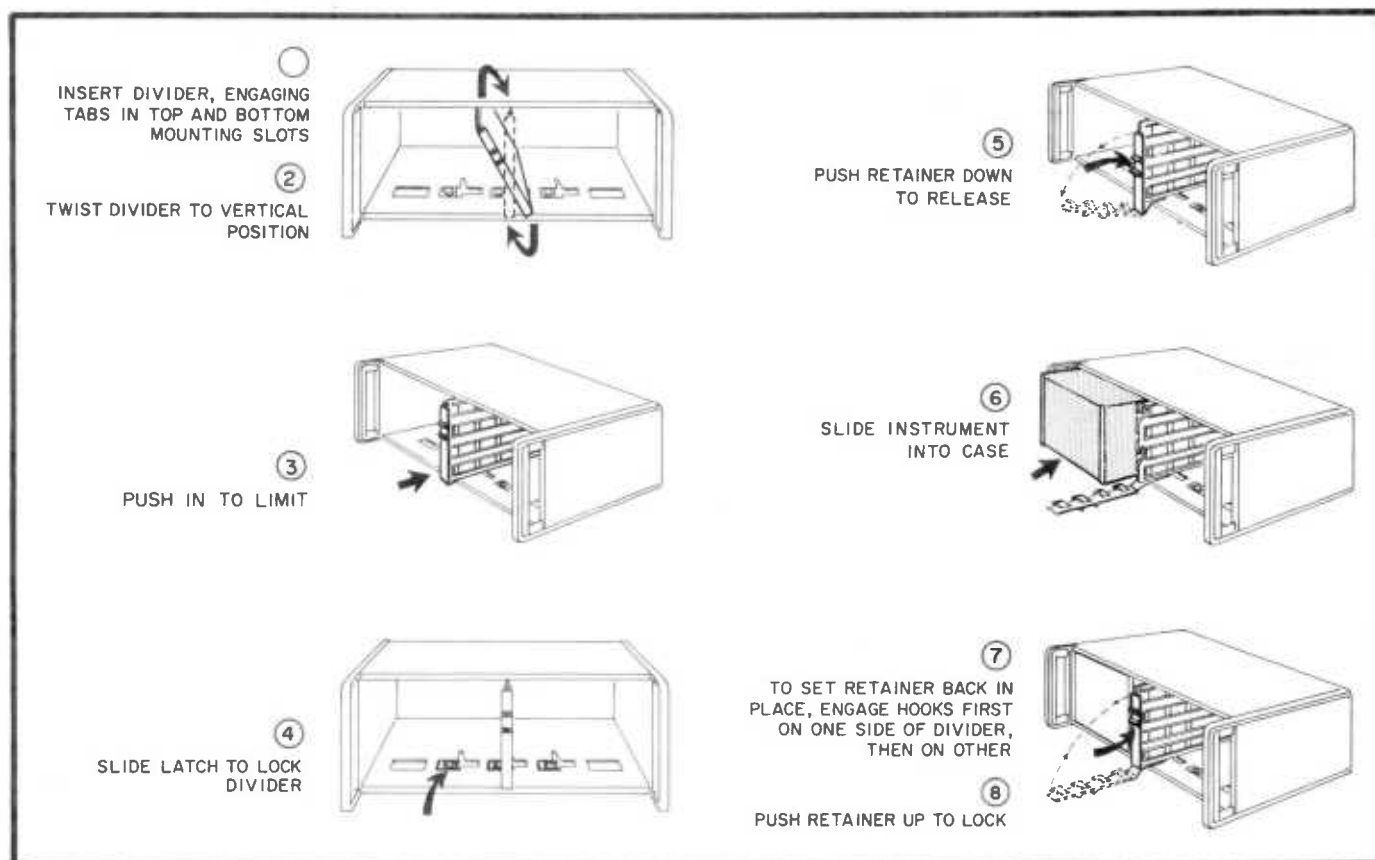


Figure 2-2 Steps to Place Instrument in Combining Case

SECTION II

INSTALLATION

2-1. INITIAL INSPECTION.

2-2. MECHANICAL INSPECTION. If external damage to the shipping carton is evident, ask the carrier's agent to be present when the instrument is unpacked. Check the instrument for external damage, such as broken controls or connectors and dents or scratches, on the panel surfaces. If damage is evident, see Paragraph 2-4 for recommended claim procedure and repackaging information. If the shipping carton is not damaged, check the cushioning material and note any signs of severe stress as an indication of rough handling in transit. If the instrument appears undamaged, perform the electrical check given in the following paragraph.

2-3. ELECTRICAL CHECK. Check the electrical performance of the Model 217A as soon as possible after receipt. Paragraphs 5-7 through 5-17 contain a performance check procedure which will verify instrument operation within the specifications listed in Table 1-1. This check is also suitable for incoming quality control inspection. If the Model 217A does not perform within the specifications when received, refer to Paragraph 2-4 for recommended claim procedure and repacking information.

2-4. CLAIMS AND REPACKING.

2-5. If physical damage is evident or if the instrument does not meet specifications when received, notify the carrier and the nearest Hewlett-Packard Sales/Service Office (see list at rear of this manual). Refer to inside front cover of this manual for the warranty statement applicable to all Hewlett-Packard instruments and products. The Sales/Service Office will arrange for repair or replacement of the instrument without waiting for settlement of the claim against the carrier.

2-6. The original shipping carton and packing material, with the exception of the accordion-pleated pads, should be used for reshipment. The accordion-pleated pads are fatigued with one use and are not reusable. The Hewlett-Packard Sales/Service Office will also provide information and recommendations on materials to be used if the original packing material is not available or is not reusable. Materials used should include: (1) a double-walled carton (check with a freight carrier for test strength required), (2) heavy paper or sheets of cardboard to protect all instrument surfaces: use extra material around projecting parts of the instrument, (3) at least four inches of tightly-packed shock-absorbing material surrounding the instrument. Close the carton securely with heavy paper tape. If the instrument is to be shipped to a Hewlett-Packard Sales/Service Office for repair, attach a tag showing owner, model, serial number and repairs required.

2-7. PREPARATION FOR USE.

2-8. POWER SOURCE REQUIREMENTS. The Model 217A may be operated from an ac source of 115 or 230 V (+10% to -15%) at 50 to 400Hz. Power dissipation is approximately 15 watts. With the instrument power cord disconnected, move the slide switch (located on the rear panel) until the number indicated on the switch corresponds to the available line voltage. A narrow-blade screwdriver is recommended to operate the slide switch. The instrument power line fuse (located at the rear of the instrument above the power cord receptacle) is a 0.5 ampere slow-blow type for 115 V operation and a 0.25 ampere slow-blow type for 230 V operation.

2-9. THREE CONDUCTOR POWER CABLE. To protect operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that the instrument and cabinet be grounded. The center pin on the power cable is the ground connection. To retain the protection when operating the instrument from a two-contact outlet, use a three-conductor to two-conductor adapter and connect the adapter wire to a suitable ground.

2-10. INSTALLATION.

2-11. The Model 217A is fully transistorized; therefore, no special cooling is required. However, the instrument should not be operated where the ambient temperature exceeds 55°C.

2-12. RACK MOUNTING.

2-13. The Model 217A is a submodular unit that, when used alone, can be bench-mounted only. However, when used in combination with other submodular units, it can be bench and / or rack-mounted. The -hp-combining case and adapter frame are designed specifically for this purpose.

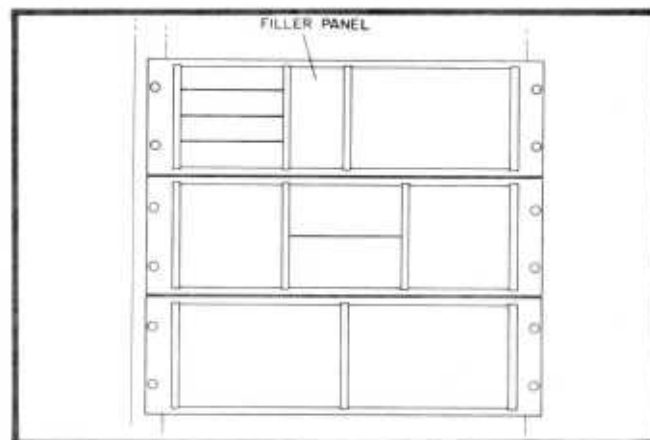


Figure 2-3. Adapter Frame Instrument Combinations

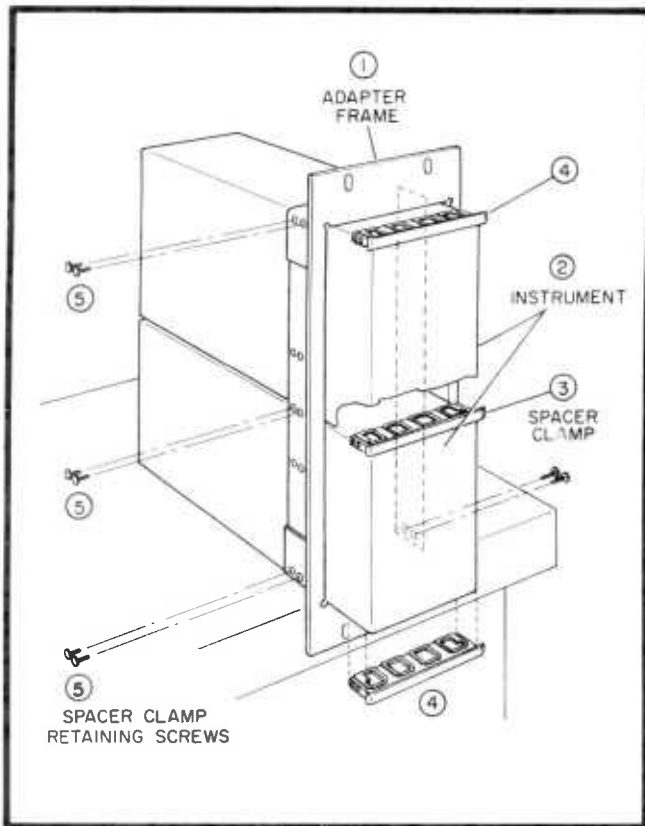


Figure 2-4. Two Half Modules in Rack Adapter

2-14. COMBINING CASE. The combining case shown in Figure 2-4. is a full-module unit which accepts varying combinations of submodule units such as the Model 217A. The combining case can be used as a bench model or it can be rack mounted. Instructions for use of the combining case are given graphically in Figure 2-2 for 1/2-module units. The Model 217A is a 1/3-module unit, therefore it is necessary to use either the right or left divider latch when installing the divider assembly.

2-15. ADAPTER FRAME. The adapter frame is a rack frame that accepts any combination of submodular units. It can be rack-mounted only. An illustration of the adapter frame is given in Figure 2-3. To assemble, refer to Figure 2-4 and proceed as follows:

- a. Place the adapter frame (1) on edge of bench as illustrated.
- b. Stack the submodular units (2) in the frame.
- c. Place the spacer clamps (3) between instruments.
- d. Place the spacer clamps (4) on the two ends of the rack-mounted instruments.
- e. Push the combination into the frame.
- f. Insert screws (5) on both sides of frame and tighten until submodular instruments are secure in frame.
- g. The complete assembly is ready for rack-mounting.

SECTION III
OPERATION

3-1. INTRODUCTION.

3-2. This section contains the operating instructions for the Model 217A Square Wave Generator. This instrument has been designed for general purpose laboratory requirements with the ease-of-use as a prime consideration. Therefore, the operating procedure is quite simple. Figure 3-2 identifies and briefly describes the purpose of each panel control and connector on the instrument.

3-3. DUTY CYCLE.

3-4. Duty cycle is defined as the ratio of duration of pulse (i.e. pulse width) to the total duration of one complete cycle. Figure 3-1 shows the relationship which determines the duty cycle. The time for one cycle is defined as the period, and the period is related to repetition rate by:

$$\text{Period} = \frac{1}{\text{Rep. Rate}}$$

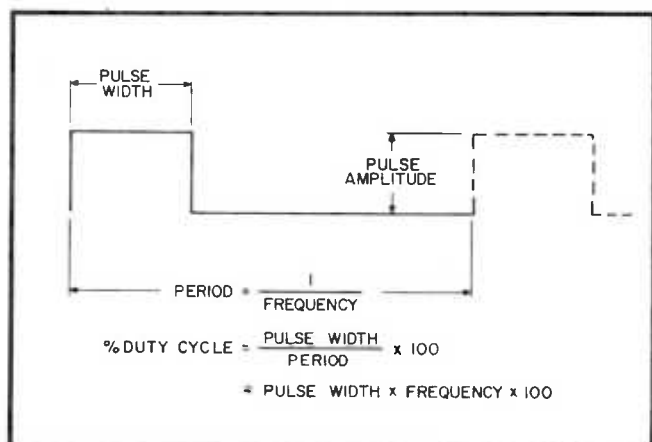


Figure 3-1. Determining Duty Cycle

Thus the product of pulse width and frequency multiplied by 100 determines the duty cycle percentage.

3-5. The SYMMETRY control is responsible for the duty cycle setting; the variability being 25 % - 75 % of the period. (30 % - 70 % in 1 M - 10 M range).

3-6. OPERATING PROCEDURES.

3-7. The Model 217A will generate internally any repetition rate from 1 Hz to 10 MHz. The repetition rate is established by setting the MULTIPLIER selector to one of the seven internal ranges and then adjusting the FREQUENCY (Hz) control to the specific rate desired.

To operate proceed as follows:

- a. Push instrument LINE switch on.
- b. Set MULTIPLIER to desired range and adjust FREQUENCY (Hz) control for the frequency desired.
- c. Adjust SYMMETRY for desired duty cycle.
- d. Square Wave Output. Select AMPLITUDE range and VERNIER setting desired. Note that the clockwise position of the VERNIER yields at least that voltage indicated on the AMPLITUDE selector switch.

3-8. TRIGGER OUTPUT

3-9. Trigger pulses are available at the front panel of the Model 217A. A positive pulse, coincident with the leading edge of the square wave, is available at the trigger output connector.

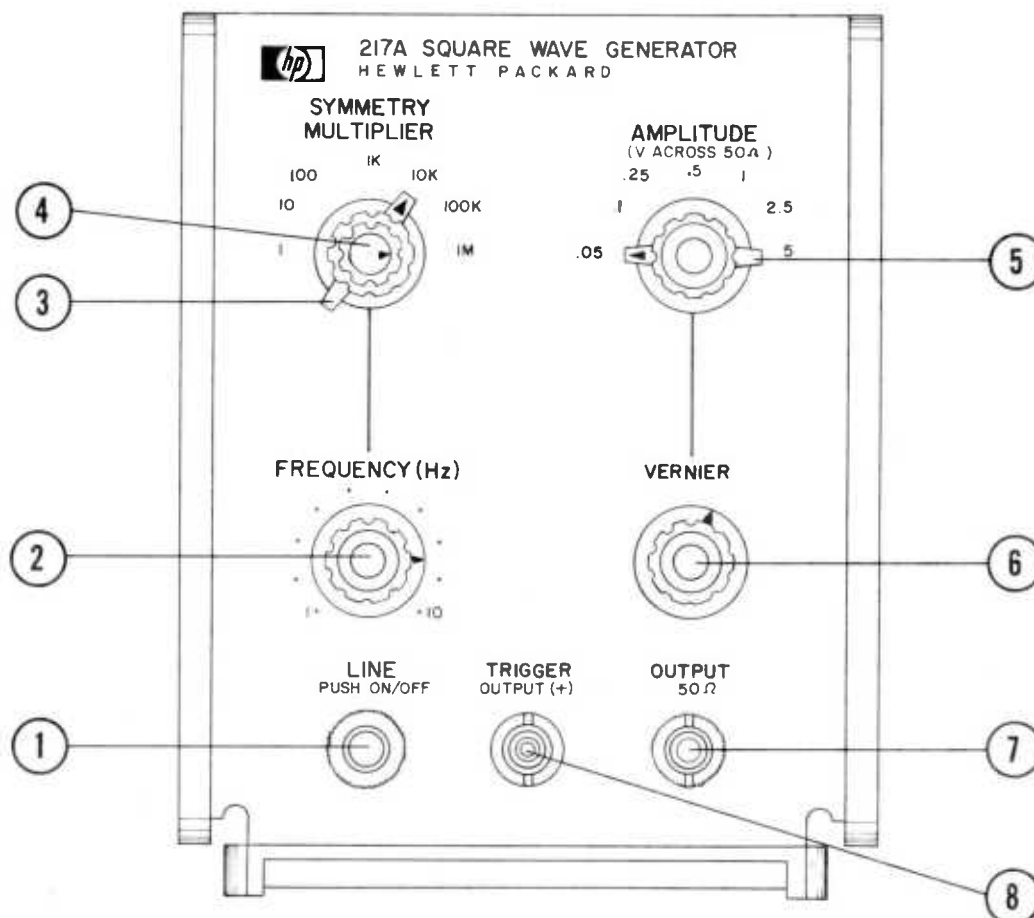


Figure 3-2. Front Panel Description

- | | |
|--|--|
| <p>1. LINE switch. Controls AC power to instrument and indicates ON position by glowing red.</p> <p>2. FREQUENCY control. Provides continuous control of the output frequency within the range determined by the MULTIPLIER setting.</p> <p>3. MULTIPLIER switch. Selects the operating range of the FREQUENCY control.</p> <p>4. SYMMETRY control. Provides adjustment of duty cycle of output pulse.</p> | <p>5. AMPLITUDE selector switch. Selects amplitude range of the square wave output.</p> <p>6. VERNIER control. Provides continuous adjustment of the square wave between settings of the AMPLITUDE selector switch. Maximum cw position gives at least the voltage shown on the AMPLITUDE selector switch.</p> <p>7. OUTPUT 50 Ω connector. Supplies square wave output.</p> <p>8. TRIGGER OUTPUT connector. Supplies trigger pulse.</p> |
|--|--|

SECTION IV

PRINCIPLES OF OPERATION

4-1. INTRODUCTION.

4-2. This section contains a description of the theory of operation of the -hp- Model 217A Square Wave Generator.

4-3. GENERAL DESCRIPTION.

4-4. The Model 217A comprises a frequency control network, two current sources, a ramp capacitor network, a Schmitt trigger, a trigger output circuit and a 50 Ω output amplifier. The complete block diagram is shown in Figure 4-1.

4-5. The Schmitt trigger, the current sources, and the ramp capacitor form the basic generating loop. The Schmitt trigger changes state at predetermined limits on the positive and negative slopes of the ramp capacitor output. This change of state controls the switching circuit which, in turn, causes the selected ramp capacitor to be charged or discharged. A cycle is as follows: the upper current source charges the ramp capacitor at a linear rate. When the amplitude of the positive slope of the ramp reaches the upper predetermined limit of the Schmitt

trigger, the trigger circuit changes state. This change of state activates the switching network, cutting off the upper current source. The ramp capacitor begins to discharge. The discharge continues until the amplitude of the negative slope reaches the lower predetermined limit. At this point the Schmitt trigger reverses to its original state, again activating the switching circuit and so completing one cycle.

4-6. The frequency control network, governed by the FREQUENCY (Hz) control, determines total current in both sources which, in turn, varies the frequency. An increase or decrease of input current respectively increases or decreases the rate of charge of the ramp capacitor.

4-7. Operation of the SYMMETRY control varies the ratio between the currents of the upper and lower sources effecting a change in the duty cycle, the frequency remaining constant.

4-8. The Schmitt trigger provides square waves to the 50 Ω output amplifier and for differentiation to the trigger output circuit to produce positive trigger pulses.

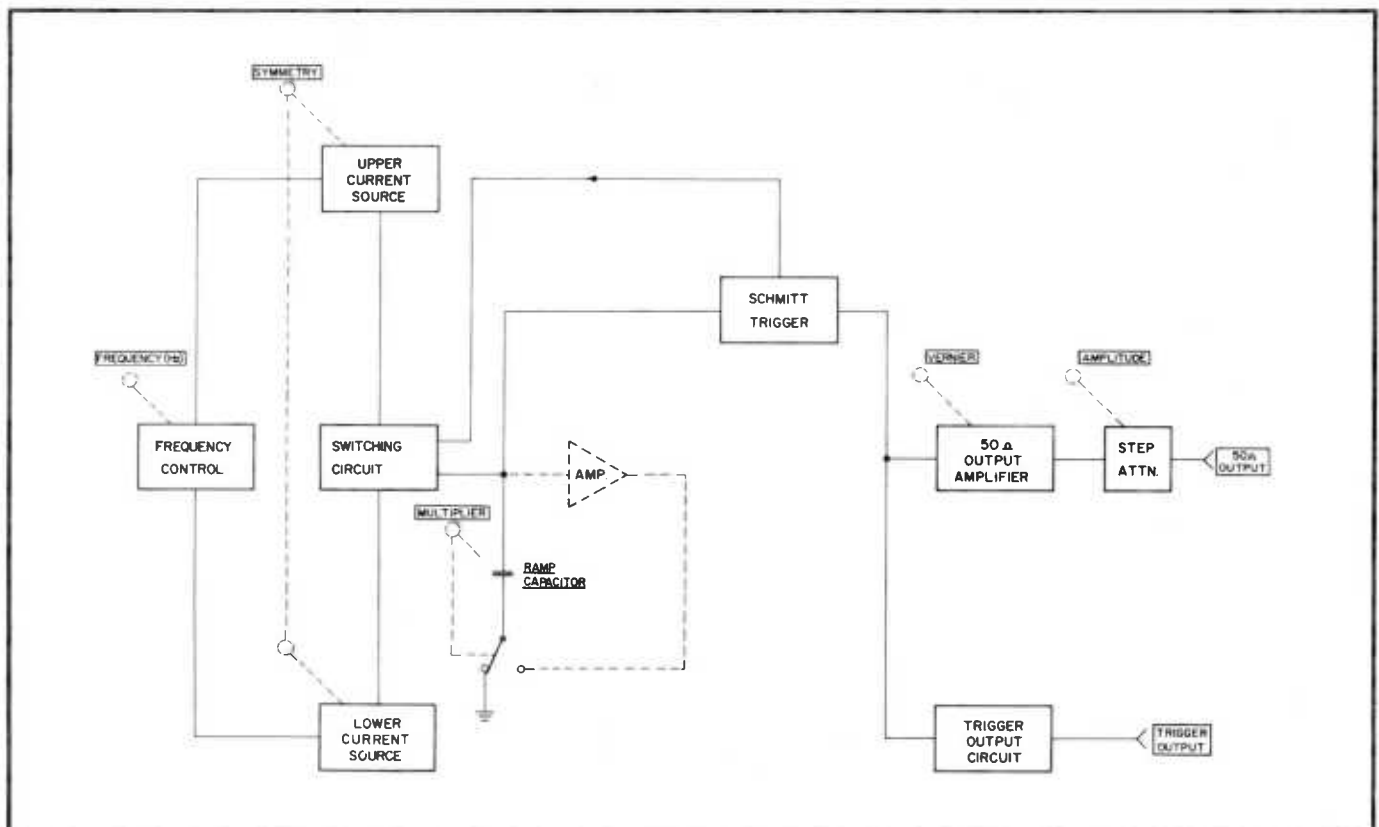


Figure 4-1. Basic Block Diagram

4-9. SCHEMATIC THEORY.

4-10. FREQUENCY CONTROL NETWORK

4-11. The FREQUENCY (Hz) control R2, in conjunction with the MULTIPLIER switch, S3, governs the frequency. The basic frequency equation can be expressed as:

$$f = \frac{1}{Ce} \frac{1}{\frac{1}{i_1} + \frac{1}{i_2}}$$

Where i_1 and i_2 are currents from the two current sources, C is the ramp capacitor and e is the peak to peak voltage of the triangular waveform across the ramp capacitor.

The position of the MULTIPLIER switch selects the ramp capacitor and the FREQUENCY control determines the sum of the currents i_1 and i_2 . The frequency control voltage is applied to the base of current control transistor Q1 which establishes the amount of current available to the ramp capacitor from the current sources Q2 and Q3.

4-12. CURRENT SOURCE (Figure 4-2)

Current source transistors Q2 and Q3 provide a constant current for charging and discharging the ramp capacitor. The ratio of one current to the other of the two current sources is determined by the SYMMETRY control. This enables the charge and discharge rate of the ramp capacitor to be controlled, hence permitting the duty cycle to be varied with no change in

frequency.

4-13. SWITCHING CIRCUIT

Assume Q10 is conducting and Q11 is cut off. This establishes a base voltage on the switching circuit transistors that turns on Q5 and turns off Q4. This action creates two current paths: Current flows through switching transistor Q5 and current source Q3 to the -20 V supply and the ramp capacitor linearly discharges through CR4 and current source Q2. As the voltage at the ramp capacitor is going positive, the base of Q10 is going negative until the Schmitt trigger changes state. This reverses the operation of the switching circuit, Q5 turns off and Q4 turns on. Current now flows through current source Q2 and switching transistor Q4 to the -20 V supply and current source Q3 linearly charges the ramp capacitor through CR5. The base voltage of Q10 will go positive until the Schmitt trigger switches again.

4-14. RAMP CAPACITOR AMPLIFIER

On the upper four ranges the ramp capacitors C5 - C7 and the network, consisting of C2, C3, C4, and R13, are connected to ground. On the lower three ranges, C8 - C10 and the ramp capacitor amplifier form the ramp capacitor circuit. Q8 inverts the phase and amplifies the ramp capacitor signal present at the emitter of Q9. Q7 and Q6 provide a low impedance path between the ramp capacitor and ground. The inverted ramp signal applied to the ramp capacitor increases the charging time as shown in Figure 4-3.

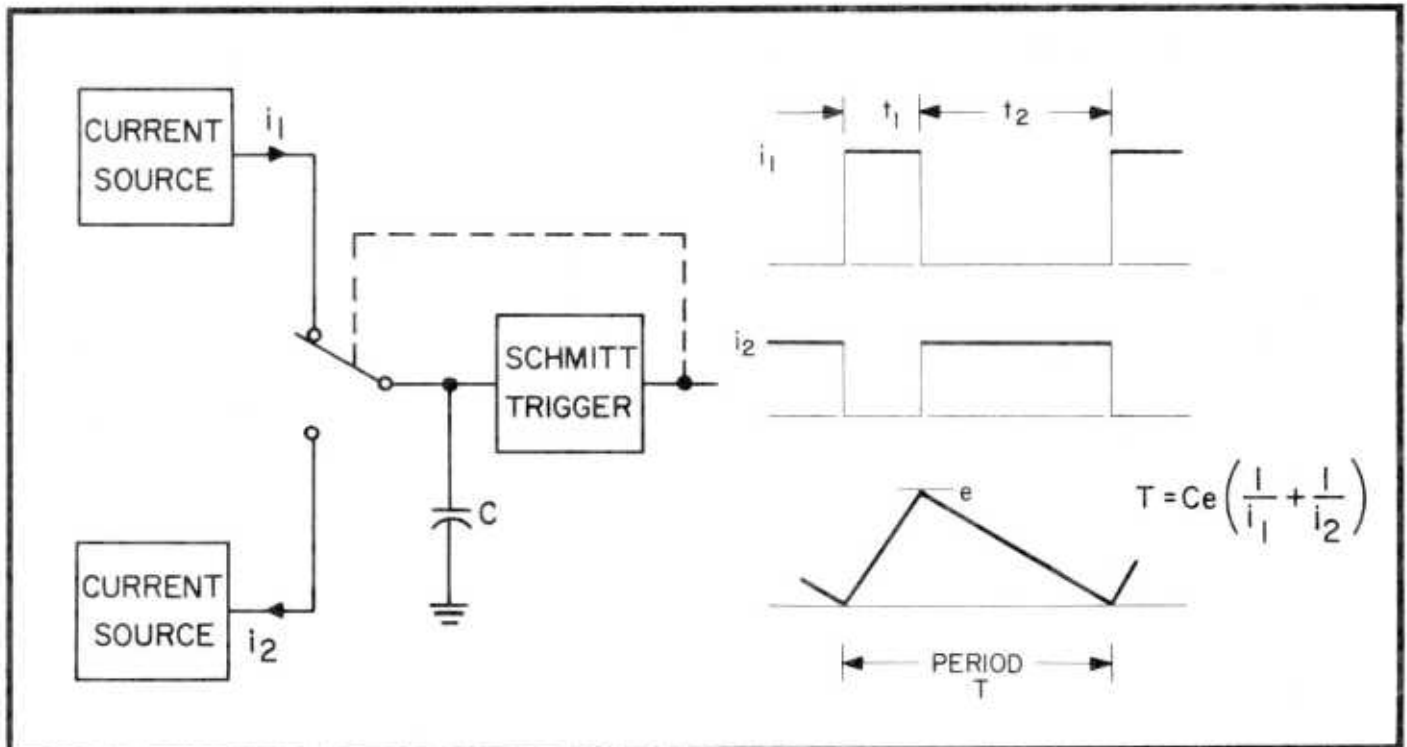


Figure 4-2. Simplified Current Source Operation.

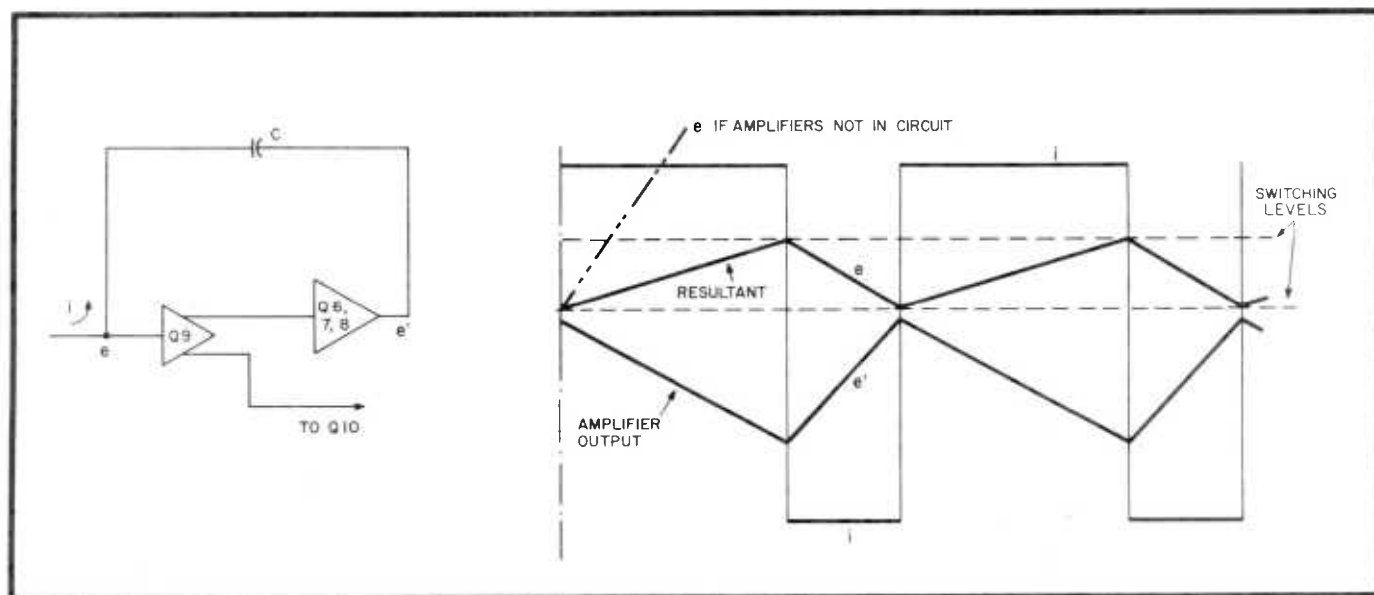


Figure 4-3. Ramp Capacitor Amplifier Block Diagram.

4-15. SCHMITT TRIGGER

The pulse forming circuit consists of inverter Q9, Schmitt trigger Q10/Q11, and impedance converter Q12. Initially Q10 is conducting and the output from Q11 is zero. The ramp capacitor voltage is inverted by Q9 and the negative slope passed to the Schmitt trigger. At a predetermined level (set by circuit components) the Schmitt trigger changes state. The output goes negative, reversing the switching circuit condition, and the ramp capacitor charges. The charge continues until the positive going slope on the base of Q10 switches the Schmitt trigger back to its original state. The pulse from the Schmitt trigger is passed through Q12 to the trigger output circuit and the 50Ω amplifier.

4-16. TRIGGER OUTPUT CIRCUIT

C21 and R49 differentiate the square wave output of the Schmitt trigger. Q21 amplifies the signal and provides the negative pulse to Q24. Q24 inverts the polarity of the spike to provide the positive output trigger pulse.

4-17. 50Ω AMPLIFIER

The drivers and output amplifiers Q13 through Q18 from the 50Ω output circuit. Voltage source Q19 and Q20 regulate the base potentials of output transistors Q17 and Q18 to provide the AMPLITUDE VERNIER control. Output attenuator A1 consists of 3π sections with attenuation of 2, 5, and 10 which are used individually or connected in series to provide stepped attenuation of the square wave output pulse.

4-18. POWER SUPPLY

The power supply operates from either 115 or 230 V ac which is rectified and regulated to provide a dc output of -20V. Two separate primary windings of transformer T1 are switched by S2, in parallel for 115V operation or in series for 230V operation. The -20V supply operates in the following manner. Error amplifier transistor Q23 senses and amplifies any change in output voltage. The change is applied through the regulator control transistor Q22 to the series regulator Q1, which acts as a variable series resistor in the current path.

11

132

SECTION V

MAINTENANCE

5-1. INTRODUCTION.

5-2. This section provides maintenance and service information for the Model 217A Square Wave Generator. Performance check, adjustment procedures, troubleshooting, and repair and replacement information are the major areas covered in this section. Component location and schematic diagrams are included in Section VII of this manual.

5-3. TEST EQUIPMENT.

5-4. Test equipment required for maintaining and checking the performance of the Model 217A is listed in Table 5-1. Test equipment having characteristics similar to those listed in the table may be substituted for the performance check and adjustments.

5-5. INSTRUMENT COVER REMOVAL.

5-6. The top, bottom, and side covers are separately removable. Each cover is held in place by screws which thread into fasteners attached to the instrument side castings. Removal of the bottom cover provides access to all components and test points on etched circuit boards and to nearly all other components on front panel assemblies. Always remove instrument

covers with the AC power turned off or power cord removed.

5-7. PERFORMANCE CHECK.

5-8. The performance check verifies whether or not the Model 217A is operating within the specifications as stated in Table 1-1. This check may be used as part of an incoming quality control inspection, as a periodic operational check, or after repairs and/or adjustments have been made. Recently calibrated test equipment should be used when performing this check. Performance checks must be carried out in the sequence given below.

5-9. REPETITION RATE

a. Refer to Figure 5-2 and Table 5-1 and connect required equipment.

b. Set Model 217A controls as follows:

MULTIPLIER.....1
FREQUENCY.....CCW
SYMMETRY.....50% duty cycle
AMPLITUDE (V across 50 Ω)...5
VERNIERCW

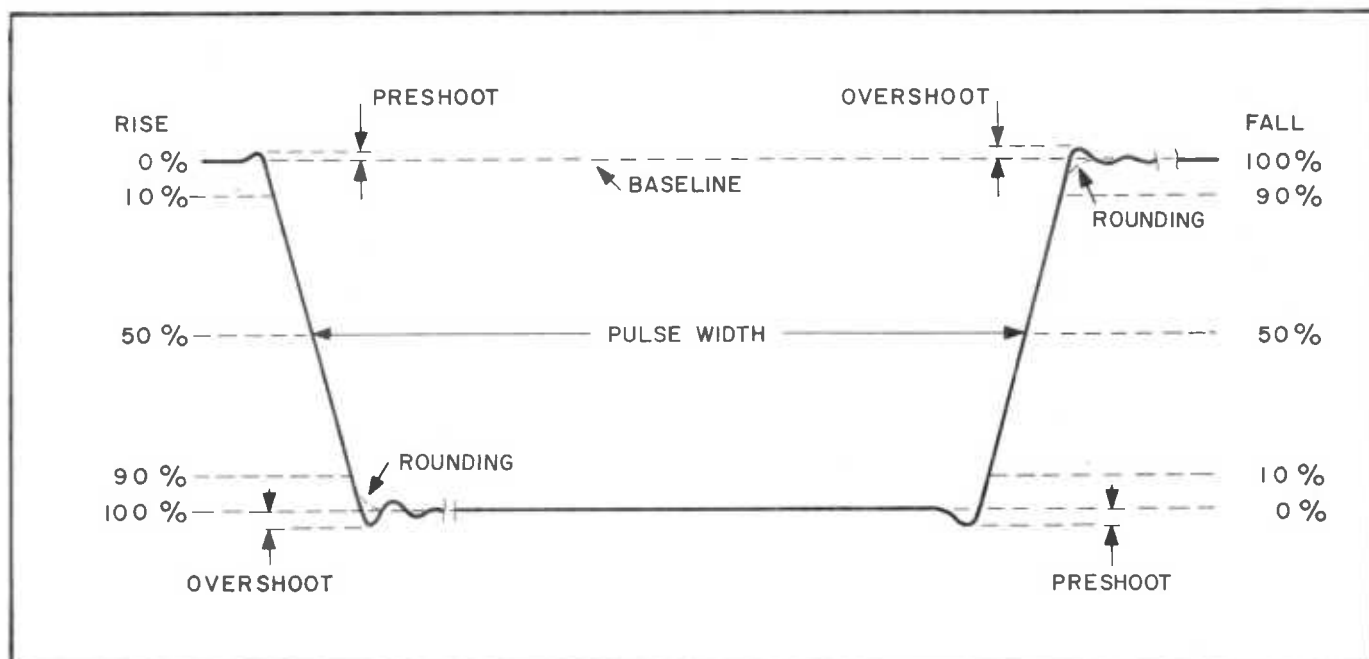


Figure 5-1. Definition of Output Pulse Characteristics

Table 5-1. Required Test Equipment

Recommended Instrument		Required Characteristics	Required for
Type	Model		
Sampling Oscilloscope	hp 185B with 187C	1 GHz Bandwidth	Performance Check
High Frequency Oscilloscope	hp 175A with 1755A and 1781B	50MHz Bandwidth 50mV/cm Sensitivity	Performance Check Adjustments
Frequency Counter	5245L	Period Meter Frequency Counter	Performance Check Adjustments
50 Ω Tee	hp 10221A	1 GHz Bandwidth	Performance Check
20 db - 50 Ω Attenuator	Weinschel Model 50 - 20 - S	Use Recommended Equipment	Performance Check
50 Ω Load	hp 11048B	Feed through Load	Performance Check Adjustments
50 Ω Termination	hp 908A	4 GHz Bandwidth	Performance Check
AC Voltmeter	hp 403B	0.003 V to 0.03 V Voltage Range	Adjustments and Troubleshooting
DC Voltmeter	hp 412A	3 V to 100 V Voltage Range	Adjustments and Troubleshooting
Digital Voltmeter	3440A 3441A Plug-in	$\pm 0.05\%$ Accuracy 4 digit display	Adjustments
Variable Line Voltage Supply		100 - 128 V 200 - 255 V 15VA	Adjustments

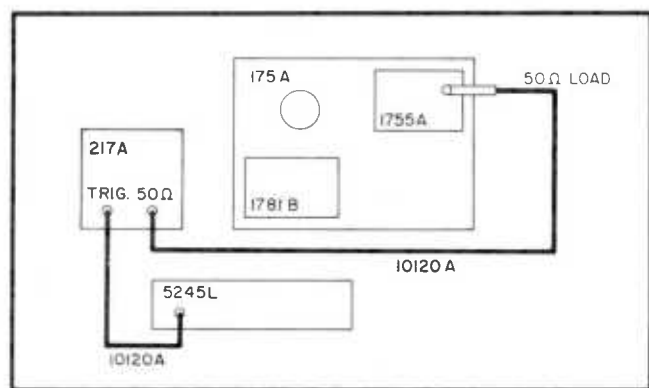


Figure 5-2. Frequency Accuracy Check

c. Set Electronic Counter controls as follows:

SIGNAL INPUT AC
 SENSITIVITY 0.1 V
 TIME BASE 0.1 μ s
 FUNCTION 1 Period Av.

d. Electronic Counter should read more than 1000,000 μ s.

e. Set FREQUENCY control cw, Electronic Counter should read less than 100,000 μ s.

f. Set MULTIPLIER to 10 and FREQUENCY control ccw, Electronic Counter should read more than 100,000 μ s.

g. Set FREQUENCY control cw, Electronic Counter should read less than 10,000 μ s.

h. Set MULTIPLIER to 100 and FREQUENCY control ccw, Electronic Counter should read more than 10,000 μ s.

i. Set FREQUENCY control cw, Electronic Counter should read less than 1,000 μ s.

j. Set Electronic Counter FUNCTION to FREQUENCY and TIME BASE to 1 s.

k. Complete check by setting Square Wave Generator MULTIPLIER switch and FREQUENCY as shown in Table 5-2 columns one and two. The Electronic Counter reading should be as shown in column three.

MULTIPLIER SWITCH	FREQUENCY CONTROL	COUNTER READING
1K	ccw	$\leq$ 1 kHz
1K	cw	$\geq$ 10 kHz
10K	ccw	$\leq$ 10 kHz
10K	cw	$\geq$ 100 kHz
100K	ccw	$\leq$ 100 kHz
100K	cw	$\geq$ 1 MHz
1M	ccw	$\leq$ 1 MHz
1M	cw	$\geq$ 10 MHz

Table 5-2. Frequency Accuracy

5-10. SYMMETRY CONTROL CHECK

a. With Model 217A connected as shown in Figure 5-2, set the controls as follows:

MULTIPLIER 10K
 FREQUENCY CONTROL 1
 SYMMETRY cw
 AMPLITUDE (V across 50 Ω) ... 5
 VERNIER cw

b. Set oscilloscope controls as follows:

TIME SCALE 10 μ s/cm
 TIME SCALE MAGNIFIER. X1
 TRIGGER SOURCE internal
 SWEEP SELECTOR main sweep
 CHANNEL SELECTOR ... channel A
 SENSITIVITY 2 V/cm dc coupled
 POLARITY positive

c. Adjust oscilloscope for a stable display.

d. The "on time" should be greater than 75% of the period.

e. Turn the SYMMETRY control ccw and the "on time" should be less than 25% of the period.

5-11. OUTPUT PULSE CHARACTERISTICS

5-12. Refer to Figure 5-1 for definition of pulse characteristics. Follow these procedures in sequence since each paragraph continues the same equipment connections and front panel settings as in the preceding paragraph. Any required changes in control settings are specified in the procedures.

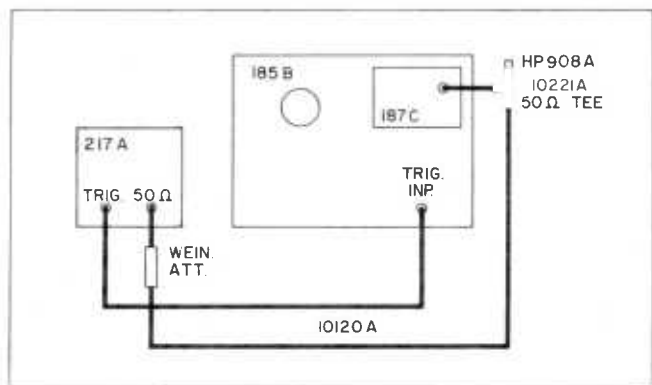


Figure 5-3. 50Ω Output Pulse Check

5-13. 50Ω OUTPUT

5-14. Pulse Amplitude

a. Refer to Figure 5-3 and connect required equipment.

b. Set Model 217A controls as follows:

MULTIPLIER.....1M
FREQUENCY1
SYMMETRY50% duty cycle
AMPLITUDE (V across 50Ω) ...5
VERNIER ccw

c. Set Sampling Oscilloscope controls and plug-in as follows:

TIME SCALE.....200 ns/cm
VERNIERCAL
TIME SCALE MAGNIFIERX1
TRIGGERING.....normal
TRIGGER SLOPEpositive
MODE AND STABILITY.....for stable trace
CHANNEL SELECTORchannel A
SENSITIVITY.....50mV/cm
VERNIERCAL
RESPONSE.....normal

d. The oscilloscope display should be no more than 4 cm (2 V) in amplitude. If 4 cm or less is observed, the ratio between cw and ccw position of the vernier is at least 2.4 to 1. Therefore, at a 0.05 V pulse amplitude setting a minimum of 0.02 V output can be obtained.

e. Turn the 217A vernier control fully clockwise. The deflection should be at least 10 cm (5 V).

5-15. Pulse shape

a. Set Model 217A FREQUENCY control to 5 and adjust VERNIER for a pulse amplitude of 5 V (10 cm).

b. Set the time scale to 50 ns/cm. Change the time scale MAGNIFIER to X20. Move the leading edge of the pulse to the center of the graticule.

c. The following leading edge characteristics should be observed.

Rise Time 10% to 90%...No more than 2 cm (5 ns)
Preshoot.....No more than 5 mm (5%)
Overshoot and Ringing...No more than 5 mm peak (5%)

d. Adjust Oscilloscope DELAY control for display of pulse trailing edge.

e. The following leading edge characteristics should be observed.

Fall Time 10% to 90%...No more than 2 cm (5 ns)
Preshoot.....No more than 5 mm (5%)
Overshoot and Ringing...No more than 5 mm peak (5%)

5-16. TRIGGER OUTPUT

5-17. This procedure verifies the Trigger Output characteristics of the Model 217A. Refer to Figure 5-6 for connection.

a. Set Model 217A controls as follows:

MULTIPLIER.....1M
FREQUENCY5
AMPLITUDE (V across 50Ω) ...5
VERNIERCW

b. Set Sampling Oscilloscope controls as follows:

TIME SCALE20 ns/cm
VERNIERCAL
TIME SCALE MAGNIFIERX2
CHANNEL SELECTORChannel A
SENSITIVITY.....50mV/cm

c. Move the trigger pulse to the center of the CRT. The pulse amplitude should be 2 V (4 cm) or more.

d. Adjust Oscilloscope plug-in sensitivity VERNIER for a full screen picture. Observe the pulse width at 50% amplitude points. The pulse width should be 10 ns $\pm$ 5 ns.

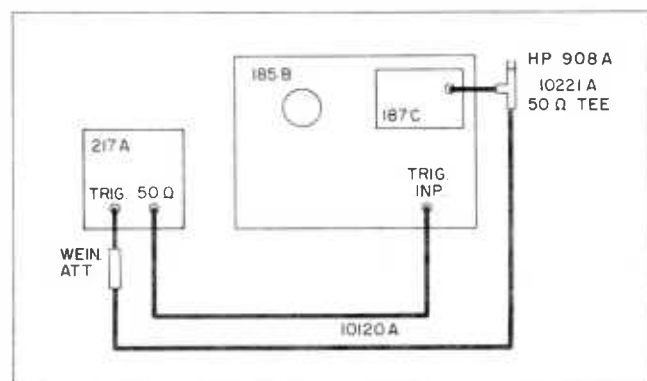


Figure 5-4. Trigger Output Pulse Check

5-18. TROUBLESHOOTING

5-19. To locate trouble in the 217A, start with a thorough visual inspection and then proceed to electrically check out as necessary. During the visual inspection look for burned or loose components, loose wire connections, or any other similar condition which suggests a source of trouble. Repair any faulty component or connection that is isolated during the visual inspection and check instrument performance before continuing to troubleshoot the instrument.

If no obvious fault is located during the visual inspection, proceed with the electrical check out. Use the block diagrams in section IV and the typical waveforms provided to isolate the trouble to a particular circuit. If an improper waveform (or no waveform at all) is detected along the signal path, the trouble will most likely be in that area. If the trouble appears probable in a particular circuit, check the D. C. voltages given in the schematics to further isolate the defective component. Trouble common to several circuits can usually be traced to defective regulated power supplies. In such cases verify and, if necessary, adjust power supply voltages before continuing to troubleshoot. Table 5-3 indicates a few symptoms and their probable cause.

5-20. REPAIR AND REPLACEMENT

5-21. Repair of the Model 217A consists basically of replacing defective components located during troubleshooting. The following paragraphs provide information on the identification and location of all components in the Model 217A and basic considerations when repairing etched circuit boards. If satisfactory operation or repair cannot be accomplished, contact your nearest Hewlett-Packard Sales/Service Office (addresses given at rear of this manual). If shipment of the instrument to the Sales/Service Office for repair is recommended, refer to Paragraph 2-4 for repackaging information. Refer to Section VI for part numbers of replaceable parts and ordering instructions.

5-22. COMPONENT IDENTIFICATION

5-23. All electrical components in the Model 217A are identified on the schematics with a reference designation. Location of components mounted on etched circuit boards or switches is provided in the component location figures. All electrical components not mounted on etched circuit boards or switches are identified in Figure 7-4.

5-24. To help with proper replacement of semiconductors, the emitter or cathode connection is identified by a small dot etched on the circuit board beside the connection point.

5-25. SERVICING ETCHED CIRCUIT BOARDS

5-26. The Model 217A has etched circuit boards which are plated-through type. When servicing this type of board, components may be removed or replaced by unsoldering from either side of the board. When removing large components, such as potentiometers, rotate the soldering iron tip from lead to lead while applying pressure to the part to lift it from the board. Service Note M-20D contains additional information on the repair of etched circuit boards, however, the important considerations are as follows:

- a. Do not apply excessive heat.
- b. Apply heat to component lead and remove lead with a straight pull away from board.
- c. Use toothpick or wooden splinter to clean hole.
- d. Do not force leads of replacement component into holes.

5-27. If the plated metal surface (conductor) lifts from the board, it may be cemented back with a quick-drying acetate base cement (use sparingly) having good insulating properties. An alternate method of repair is to solder a good conducting wire along the damaged area.

5-28. ADJUSTMENTS

These are all factory adjustments and do not normally need readjusting. They should only be readjusted after repair and/or component replacement and even then only if the instrument does not meet the performance tests (5-7 to 5-17). They must be performed in the sequence given below.

5-29. POWER SUPPLY

- a. Use the Digital Voltmeter to measure the voltage at TP-20 V. Adjust R59 to obtain -20 V. Vary the line voltage +10 %, -15 % about the nominal 115 V or 230 V. The -20 V should stay within ± 200 mV.

5-30. FREQUENCY

a. Connect the equipment as shown in Figure 5-2. Set front panel controls as in Paragraph 5-9 b. Measure the amplitude of triangular waveform with 175A at test point TP1 and adjust R26 for an amplitude of 1.8 V. Remove probe.

b. Set FREQUENCY and MULTIPLIER to 10k. Adjust R1 for 100kHz $\pm 2\%$ as indicated on the frequency meter.

c. Set FREQUENCY (Hz) to 1 and adjust R5 for 10 kHz $\pm 1\%$.
Verify b and repeat c and b if necessary,

d. Set FREQUENCY (Hz) to 1 and MULTIPLIER to 1M. Adjust C3 for 1MHz $\pm 1\%$.

e. Set FREQUENCY (Hz) to 10 and check frequency. The frequency should be 10MHz $\pm 4\%$.

f. Set the time base on the 5245L to 0.1 μ s and function to period average 1. Switch 217A MULTIPLIER to 100 and FREQUENCY (Hz) to 10.

g. Adjust R15 for 980 μ s.

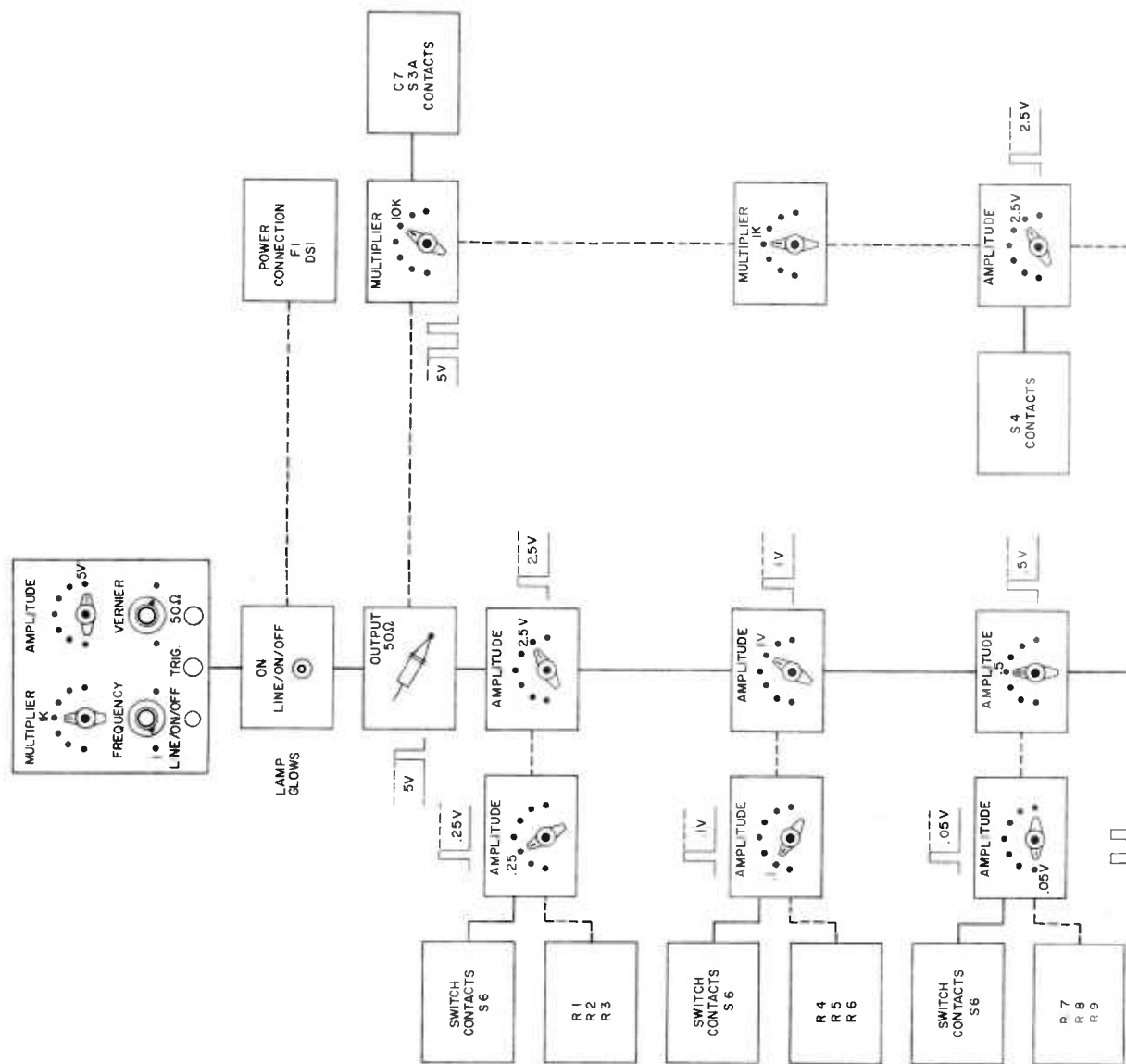
h. Set MULTIPLIER to 10, adjust R16 for 9,800 μ s.

i. Set MULTIPLIER to 1, adjust R17 for 98,000 μ s.

j. Set FREQUENCY (Hz) to 1 and check the 1, 10 and 100 multiplier ranges. The Frequency shall be within $\pm 5\%$ of indicated frequency.

Table 5-3. Trouble Shooting Procedure

SYMPTOM	PROBABLE CAUSE
Pilot lamp does not light	Line fuse open, faulty cable or connection. Defective pilot lamp. Note: Do not replace a blown fuse more than once unless the cause has been determined and eliminated.
No square wave output	Check -20V supply. Defective Q2 and/or Q3, Q11.
No square wave or trigger output	Defective Q20 or Q14.
Square wave rise time too long	Q15 or Q16 defective.
Excessive jitter on one range	Lossy ramp capacitor in that range.
Small amplitude variation of pulse	Dirty or defective R4.
No or very low negative trigger output	Defective Q21.
-20 V high, excessive ripple	Defective Q1.
-20 V low	Defective Q5 and CR13.



TROUBLESHOOTING CHART

Logical troubleshooting requires that the defective circuit or circuits be determined from observing the behavior of the instrument in the different modes and if required by observing the test signals readily available. Indiscriminate removal and replacement of parts and adjustments must be avoided.

The troubleshooting chart is designed to locate the defective circuit or circuits by co-relating automatically the operation or the non-operation of the different controls and hence, the circuits by observing the signals.

To use, start from the initial conditions and change the control settings as shown in the blocks, and look for signals indicated near the block. If the signal (i.e. correct amplitude, or frequency etc.) is present follow the continuous line to the next block and so on. If the signal is not present follow the dotted line until the probable circuit is identified. Then check voltages as shown on the schematics to identify or to confirm the defective component.

INITIAL SETTINGS

Multiplier	1K	Symmetry	Centered
Amplitude (Volts across 50 Ω)	5	Frequency (Hz)	1 (CCW)
Vernier	CW		

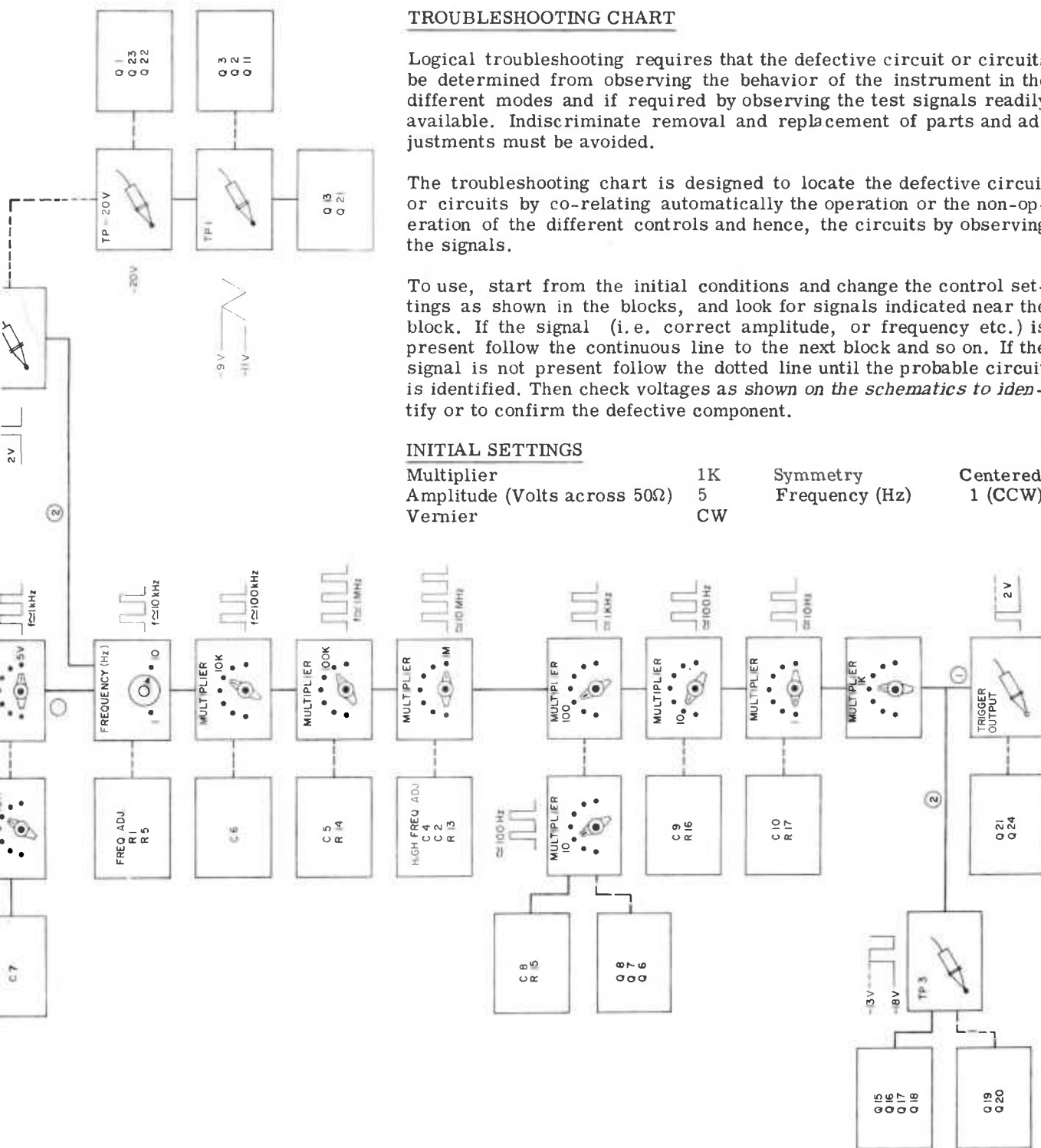


Figure 5-7. Troubleshooting Chart

SECTION VI REPLACEABLE PARTS

6-1 INTRODUCTION

6-2 This section contains information for ordering replacement parts. Table 6-1 lists parts in alpha-numerical order of their reference designators and indicates the description and Φ stock number of each part, together with any applicable notes. Table 6-2 lists parts in alpha-numerical order of their Φ stock numbers and provides the following information on each part:

- a) Description of the part (see list of abbreviations below)
- b) Typical manufacturer of the part in a five-digit code; see list of manufacturers in appendix.
- c) Manufacturer's stock number.
- d) Total quantity used in the instrument (TQ column).
- e) Recommended spare part quantity for complete maintenance (RS column) during one year of isolated service.

6-3 Miscellaneous parts not indexed in table 6-1 are listed at the end of table 6-2.

6-4 ORDERING INFORMATION

6-5 To order a replacement part, address order of inquiry either to your authorized Hewlett-Packard sales representative or to

CUSTOMER SERVICE
Hewlett-Packard Company
395 Page Mill Road
Palo Alto, California

or, in Western Europe, to

Hewlett-Packard S.A.
54 Route des Acacias
Geneva, Switzerland

6-6 Specify the following information for each part:

- a) Model and complete serial number of instrument.
- b) Hewlett-Packard stock number.
- c) Circuit reference designator.
- d) Description

6-7 To order a part not listed in tables 6-1 and 6-2, give a complete description of the part and include its function and location.

REFERENCE DESIGNATORS

A = assembly	F = fuse	P = plug	V = vacuum tube, neon bulb, photocell, etc.
B = motor	FL = filter	Q = transistor	W = cable
C = capacitor	J = jack	R = resistor	X = socket
CR = diode	K = relay	RT = thermistor	Y = crystal
DL = delay line	L = inductor	S = switch	Z = network
DS = device signaling (lamp)	M = meter	T = transformer	
E = misc electronic part	MP = mechanical part		

ABBREVIATIONS

A = amperes	F = farads	NC = normally closed	S-B = slow-blow
BP = bandpass	FXD = fixed	NE = neon	SE = selenium
BWO = backward wave oscillator	GE = germanium	NO = normally open	SECT = section(s)
	GL = glass	NPO = negative positive zero (zero temperature coefficient)	SI = silicon
CER = ceramic	GRD = ground(ed)		SIL = silver
CMO = cabinet mount only	H = henries	NSR = not separately replaceable	SL = slide
COEF = coefficient	HG = mercury		SPL = special
COM = common	HR = hour(s)		TA = tantalum
COMP = composition			TD = time delay
CONN = connection	IMPG = impregnated	OBD = order by description	TI = titanium dioxide
CRT = cathode-ray tube	INCD = incandescent	OX = oxide	TOG = toggle
DEPC = deposited carbon	INS = insulation(ed)		TOL = tolerance
			TRIM = trimmer
EIA = Tubes or transistors meeting Electronic Industries' Association standards will normally result in instrument operating within specifications; tubes and transistors selected for best performance will be supplied if ordered by Φ stock numbers.	K = kilo = 1000	P = peak	TWT = traveling wave tube
	LIN = linear taper	PC = printed circuit board	U = micro = 10 ⁻⁶
	LOG = logarithmic taper	PF = picofarads = 10 ⁻¹² farads	VAC = vacuum
		PP = peak-to-peak	VAR = variable
		PIV = peak inverse voltage	W/ = with
	MEG = meg = 10 ⁶	POR = porcelain	W = watts
	M = milli = 10 ⁻³	POS = position(s)	WW = wirewound
	MINAT = miniature	POLY = polystyrene	W/O = without
	METFLM = metal film	POT = potentiometer	
	MFR = manufacturer		* = optimum value selected at factory, average value shown (part may be omitted)
	MOM = mounting	RECT = rectifier	
ELECT = electrolytic	MTG = momentary	ROT = rotary	
ENCAP = encapsulated	MY = mylar	RMS = root-mean-square	
		RMO = rack mount only	

Table 6-1. Reference Designation Index (cont'd)

Reference Designation	-hp-Stock No.	Description #
A1	00217-63401	ATTENUATOR ASSEMBLY INCLUDES R1 thru R9 and S4
A1 R1	0757-0172	R: FXD MET FLM 37.4Ω 1% 1/2 W
A1 R2 and A1 R3	0757-0801	R: FXD MET FLM 150Ω 1% 1/2 W
A1 R4	0757-0069	R: FXD MET FLM 121Ω 1% 1/4 W
A1 R5 and A1 R6	0757-0795	R: FXD MET FLM 75Ω 1% 1/2 W
A1 R7	0757-0071	R: FXD MET FLM 247.5Ω 1% 1/4 W
A1 R8 and A1 R9	0757-1005	R: FXD MET FLM 61.11Ω 1/4% 1/2 W
A1 S4		SWITCH ATTENUATOR NSR PART OF A1 ASSY
A2	00217-66501	PRINTED CIRCUIT BOARD
A2 C1	0180-0291	C: FXD TA 1μF 10% 35VDCW
A2 C2	0140-0197	C: FXD MICA 180pF 5% 500VDCW
A2 C3	0121-0046	C: VAR CER 9 - 35pF
A2 C4	0140-0194	C: FXD MICA 110pF 5% 300VDCW
A2 C5	0140-0180	C: FXD MICA 2000pF 2% 300VDCW
A2 C6	0160-0504	C: FXD POLYCARB 22nF 1% 400VDCW
A2 C7	0160-0503	C: FXD MET PAPER 0.22μF 2% 160VDCW
A2 C8	0180-0291	C: FXD TA ELECT 1μF 10% 35VDCW
A2 C9	0180-0374	C: FXD TA ELECT 10μF 10% 20VDCW
A2 C10	0180-0137	C: FXD TA ELECT 100μF 20% 10VDCW
A2 C11	0150-0093	C: FXD CER 0.01μF +80% -20% 100VDCW
A2 C12	0180-0094	C: FXD AL ELECT 100μF +75% -10% 25VDCW
A2 C13	0180-0097	C: FXD TA ELECT 47μF 10% 35VDCW
A2 C14	0140-0192	C: FXD MICA 68pF 5% 300VDCW
A2 C15 thru A2 C17	0180-0291	C: FXD TA ELECT 1μF 10% 35VDCW
A2 C18	0150-0093	C: FXD CER 0.01μF +80% -20% 100VDCW
A2 C19	0140-0145	C: FXD MICA 22pF 5% 500VDCW
A2 C20	0150-0121	C: FXD TA 0.1μF +80% -20% 50VDCW
A2 C21	0160-2204	C: FXD MICA 100pF 5% 300VDCW
A2 C22	0150-0071	C: FXD CER 400pF 5% 500VDCW
A2 C23	0150-0093	C: FXD CER 0.01μF +80% -20% 100VDCW
A2 C24	0180-0049	C: FXD AL ELECT 20μF 50VDCW
A2 C25	0150-0121	C: FXD CER 0.1μF +80% -20% 50VDCW
A2 C26	0180-0049	C: FXD AL ELECT 20μF 50VDCW
A2 C27	0150-0093	C: FXD CER 0.01μF +80% -20% 100VDCW
A2 C28	0150-0121	C: FXD CER 0.1μF +80% -20% 50VDCW
A2 CR1 and A2 CR2	1901-0025	DIODE: SILICON
A2 CR3	1902-0074	DIODE: BREAKDOWN 7.15 V
A2 CR4 and A2 CR5	1901-0040	DIODE: SILICON
A2 CR6	1902-0048	DIODE: BREAKDOWN 6.81 V
A2 CR7	1902-0188	DIODE: BREAKDOWN 4.12 V
A2 CR8 and A2 CR9	1901-0045	DIODE: SILICON
A2 CR10	1902-0048	DIODE: BREAKDOWN 6.81 V

Table 6-1. Reference Designation Index (cont'd)

Reference Designation	-hp-Stock No.	Description #
A2 L1 and A2 L2	9140-0096	COIL: FXD RF 1 μ H
A2 L3 and A2 L4	9170-0016	BEAD
A2 Q1	1854-0307	TRANSISTOR: SILICON NPN
A2 Q2	1853-0009	TRANSISTOR: SILICON PNP
A2 Q3	1854-0019	TRANSISTOR: SILICON NPN
A2 Q4	1853-0009	TRANSISTOR: SILICON PNP
A2 Q5	1854-0019	TRANSISTOR: SILICON NPN
A2 Q6	1853-0029	TRANSISTOR: SILICON PNP
A2 Q7	1854-0307	TRANSISTOR: SILICON NPN
A2 Q8	1854-0019	TRANSISTOR: SILICON NPN
A2 Q9	1854-0019	TRANSISTOR: SILICON NPN
A2 Q10 and A2 Q11	1854-0009	TRANSISTOR: SILICON NPN
A2 Q12	1854-0005	TRANSISTOR: SILICON NPN
A2 Q13	1853-0009	TRANSISTOR: SILICON PNP
A2 Q14	1854-0019	TRANSISTOR: SILICON NPN
A2 Q15 and A2 Q16	1854-0267	TRANSISTOR: SILICON NPN
A2 Q17 and A2 Q18	1854-0053	TRANSISTOR: SILICON NPN
A2 Q19	1853-0001	TRANSISTOR: SILICON PNP
A2 Q20	1854-0307	TRANSISTOR: SILICON NPN
A2 Q21	1854-0005	TRANSISTOR: SILICON NPN
A2 Q22 and A2 Q23	1853-0029	TRANSISTOR: SILICON PNP
A2 Q24	1853-0009	TRANSISTOR: SILICON PNP
A2 R1	2100-0521	R: VAR COMP 5000 Ω 30% 1/8 W
A2 R2	0758-0018	R: FXD MET OX 15K Ω 5% 1/2 W
A2 R3	0758-0003	R: FXD MET OX 1000 Ω 5% 1/2 W
A2 R4	0758-0067	R: FXD MET OX 750 Ω 5% 1/2 W
A2 R5	2100-0520	R: VAR COMP LIN 250 Ω 20% 1/8 W
A2 R6 and A2 R7	0757-0159	R: FXD MET FLM 1000 Ω 1% 1/2 W
A2 R8 thru A2 R11	0758-0028	R: FXD MET OX 270 Ω 5% 1/2 W
A2 R12	0758-0035	R: FXD MET OX 3000 Ω 5% 1/2 W
A2 R13	0758-0126	R: FXD MET OX 51 Ω 5% 1/2 W
A2 R14	0683-0685	R: FXD COMP 6.8 Ω 5% 1/4 W
A2 R15 thru A2 R17	2100-0521	R: VAR COMP 5000 Ω 30% 1/8 W
A2 R18	0761-0057	R: FXD MET OX 560 Ω 5% 1 W
A2 R19	0758-0007	R: FXD MET OX 150 Ω 5% 1/2 W
A2 R20	0758-0044	R: FXD MET OX 2200 Ω 5% 1/2 W
A2 R21	0758-0128	R: FXD MET OX 160K Ω 5% 1/2 W
A2 R22	0758-0071	R: FXD MET OX 4300 Ω 5% 1/2 W
A2 R23	0758-0057	R: FXD MET OX 5600 Ω 5% 1/2 W
A2 R24	0758-0127	R: FXD MET OX 430 Ω 5% 1/2 W
A2 R25	0758-0008	R: FXD MET OX 390 Ω 5% 1/2 W
A2 R26	2100-0520	R: VAR COMP LIN 250 Ω 20% 1/8 W
A2 R27	0758-0010	R: FXD MET OX 3300 Ω 5% 1/2 W

See introduction to this section

Table 6-1. Reference Designation Index (cont'd)

Reference Designation	-hp-Stock No.	Description #
A2 R28	0758-0041	R: FXD MET OX 91Ω 5% 1/2 W
A2 R29	0758-0007	R: FXD MET OX 150Ω 5% 1/2 W
A2 R30	0758-0002	R: FXD MET OX 560Ω 5% 1/2 W
A2 R31	0758-0005	R: FXD MET OX 4700Ω 5% 1/2 W
A2 R32	0758-0067	R: FXD MET OX 750Ω 5% 1/2 W
A2 R33	0758-0024	R: FXD MET OX 100Ω 5% 1/2 W
A2 R34	0758-0082	R: FXD MET OX 130Ω 5% 1/2 W
A2 R35	0758-0028	R: FXD MET OX 270Ω 5% 1/2 W
A2 R36	0758-0062	R: FXD MET OX 200Ω 5% 1/2 W
A2 R37	0758-0013	R: FXD MET OX 120Ω 5% 1/2 W
A2 R38 and A2 R39	0698-5290	R: FXD MET OX 100Ω 2% 1 W
A2 R40	0758-0035	R: FXD MET OX 3000Ω 5% 1/2 W
A2 R41 and A2 R42	0761-0041	R: FXD MET OX 56Ω 5% 1 W
A2 R43	0698-5205	R: FXD MET OX 47Ω 5% 1/2 W
A2 R44	0758-0096	R: FXD MET OX 110Ω 5% 1/2 W
A2 R45 and A2 R46	0758-0003	R: FXD MET OX 1000Ω 5% 1/2 W
A2 R47	0758-0044	R: FXD MET OX 2200Ω 5% 1/2 W
A2 R48	0758-0067	R: FXD MET OX 750Ω 5% 1/2 W
A2 R49	0758-0082	R: FXD MET OX 130Ω 5% 1/2 W
A2 R50	0698-5201	R: FXD MET OX 27Ω 5% 1/2 W
A2 R51	0758-0126	R: FXD MET OX 51Ω 5% 1/2 W
A2 R52	0758-0003	R: FXD MET OX 1000Ω 5% 1/2 W
A2 R53	0758-0005	R: FXD MET OX 4700Ω 5% 1/2 W
A2 R54	0758-0003	R: FXD MET OX 1000Ω 5% 1/2 W
A2 R55	0760-0024	R: FXD MET OX 100Ω 5% 1 W
A2 R56	0758-0004	R: FXD MET OX 2700Ω 5% 1/2 W
A2 R57	0760-0024	R: FXD MET OX 100Ω 5% 1 W
A2 R58	0758-0034	R: FXD MET OX 2400Ω 5% 1/2 W
A2 R59	2100-0520	R: VAR COMP LIN 250Ω 20% 1/8 W
A2 R60	0758-0042	R: FXD MET OX 1300Ω 5% 1/2 W
A2 R61	0758-0126	R: FXD MET OX 51Ω 5% 1/2 W
A2 R62	0698-5201	R: FXD MET OX 27Ω 5% 1/2 W
A2 RT1	0837-0502	THERMISTOR: 130Ω 20%
C1	0180-0047	C: FXD ELECT 500μ F
DS1		NSR PART OF S1
F1	2100-0008	FUSE CARTRIDGE SLOW BLOW 1/2 AMP
J1	1251-0148	CONNECTOR AC POWER CORD RECEPTACLE
J2	1250-0083	CONNECTOR BNC
J3	1250-0140	CONNECTOR BNC
Q1	1850-0098	TRANSISTOR PNP
R1	0758-0049	R: FXD MET OX 33KΩ 5% 1/2 W
R2	2100-0535	R: VAR WW LIN 10KΩ 20% 2 W
R3	2100-0519	R: VAR 2 x 1KΩ WW 3%
R4	2100-0036	R: VAR COMP 1000Ω 20% 1/2 W

Table 6-1. Reference Designation Index (cont'd)

Reference Designation	-hp-Stock No.	Description #
S1	3100-0100	SWITCH: PUSH BUTTON LIGHTED SPDT
S2	3100-0033	SWITCH: SLIDE DPDT NON SHORTING
S3	3100-0507	SWITCH: ROTARY (MULTIPLIER)
T1	9100-0522	TRANSFORMER: POWER
W1	8120-0078	CABLE: AC POWER 7.5 FEET LONG (NEMA PLUG)
W1	8120-0100	CABLE: AC POWER 7.5 FEET LONG (SHUKO PLUG)
		MISCELLANEOUS
	0370-0077	KNOB: BLK W/ARROW (AMPLITUDE 500)
	0370-0099	KNOB: BLK CONCENTRIC (MULTIPLIER)
	0370-0133	KNOB: BLK SKIRTED (VERNIER, FREQUENCY)
	0370-0134	KNOB: RED W/ARROW (SYMMETRY)
	1205-0011	HEAT DISSIPATOR FOR TO-5 AND TO-9
	1205-0013	HEAT DISSIPATOR FOR TO-18
	1490-0031	STAND TILT THIRD MODULE
	5000-0711	COVER BOTTOM 5x11SM
	5000-1157	COVER-SIDE 6x11SM
	5060-0706	COVER-TOP
	5060-0727	FOOT ASSEMBLY THIRD MODULE

Table 6-2. Replaceable Parts

Part No.	Description #	Mfr.	Mfr. Part No.	TQ	RS
0121-0046	C: VAR CER 9-35pF	28480	0121-0046	1	
0140-0145	C: FXD MICA 22pF 5% 500VDCW	04062	RDM15C220J5C	1	
0140-0180	C: FXD MICA 2000pF 2% 300VDCW	04062	RDM19F202G3C	1	
0140-0192	C: FXD MICA 68pF 2% 300VDCW	28480	0140-0192	1	
0140-0194	C: FXD MICA 110pF 5% 300VDCW	04062	RDM15F111J3C	1	
0140-0197	C: FXD MICA 180pF 5% 500VDCW	28480	0140-0197	1	
0150-0071	C: FXD CER 400pF 5% 500VDCW	56289	19C294A	1	
0150-0093	C: FXD CER 0.01μF +80% -20% 100VDCW	28480	0150-0093	4	
0150-0121	C: FXD CER 0.1μF +80% -20% 50VDCW	28480	0150-0121	4	
0160-0503	C: FXD MET PAPER 0.22μF 2% 160VDCW	28480	0160-0503	1	
0160-0504	C: FXD POLYCARB 22nF 1% 400VDCW	28480	0160-0504	1	
0160-2204	C: FXD MICA 100pF 5% 300VDCW	28480	0160-2204	1	
0180-0047	C: FXD ELECT 500μF 75VDCW	28480	0180-0047	1	
0180-0049	C: FXD AL ELECT 20μF +75% -10% 50VDCW	56289	30D206G050DC6M1	2	
0180-0094	C: FXD AL ELECT 100μF +75% -10% 25VDCW	56289	30D107G025DH4	1	
0180-0097	C: FXD TA ELECT 47μF 10% 35VDCW	28480	0180-0097	1	
0180-0137	C: FXD TA ELECT 100μF 20% 10VDCW	56289	150D107X0010R2	1	
0180-0291	C: FXD TA ELECT 1μF 10% 35VDCW	56289	150D105X9035A2	4	
0180-0374	C: FXD TA ELECT 10μF 10% 20VDCW	28480	0180-0374	1	
0370-0077	KNOB: BLK W/ARROW (AMPLITUDE 50Ω)	28480	0370-0077	1	
0370-0099	KNOB: BLK CONCENTRIC (MULTIPLIER)	28480	0370-0099	1	
0370-0133	KNOB: BLK SKIRTED (VERNIER,FREQUENCY)	28480	0370-0133	2	
0370-0134	KNOB: RED W/ARROW (SYMMETRY)	28480	0370-0134	1	
0683-0685	R: FXD COMP 6.8Ω 5% 1/4 W	01121	CB68G5	1	
0698-5201	R: FXD MET OX 27Ω 5% 1/2 W	28480	0698-5201	2	
0698-5205	R: FXD MET OX 47Ω 5% 1/2 W	28480	0698-5205	1	
0698-5290	R: FXD MET OX 100Ω 2% 1 W	28480	0698-5290	2	
0757-0159	R: FXD MET OX 1000Ω 1% 1/2 W	28480	0757-0159	2	
0758-0002	R: FXD MET OX 560Ω 5% 1/2 W	28480	0758-0002	1	
0758-0003	R: FXD MET OX 1000Ω 5% 1/2 W	28480	0758-0003	5	
0758-0004	R: FXD MET OX 2700Ω 5% 1/2 W	28480	0758-0004	2	
0758-0005	R: FXD MET OX 4700Ω 5% 1/2 W	28480	0758-0005	2	
0758-0007	R: FXD MET OX 150Ω 5% 1/2 W	28480	0758-0007	2	
0758-0008	R: FXD MET OX 390Ω 5% 1/2 W	28480	0758-0008	1	
0758-0010	R: FXD MET OX 3300Ω 5% 1/2 W	28480	0758-0010	1	
0758-0013	R: FXD MET OX 120Ω 5% 1/2 W	28480	0758-0013	1	
0758-0018	R: FXD MET OX 15KΩ 5% 1/2 W	28480	0758-0018	1	
0758-0024	R: FXD MET OX 100Ω 5% 1/2 W	28480	0758-0024	1	
0758-0028	R: FXD MET OX 270Ω 5% 1/2 W	28480	0758-0028	5	
0758-0034	R: FXD MET OX 2400Ω 5% 1/2 W	28480	0758-0034	1	
0758-0035	R: FXD MET OX 3000Ω 5% 1/2 W	28480	0758-0035	2	
0758-0041	R: FXD MET OX 91Ω 5% 1/2 W	28480	0758-0041	1	
0758-0042	R: FXD MET OX 1300Ω 5% 1/2 W	28480	0758-0042	1	
0758-0044	R: FXD MET OX 2200Ω 5% 1/2 W	28480	0758-0044	2	
0758-0049	R: FXD MET OX 33KΩ 5% 1/2 W	28480	0758-0049	1	
0758-0057	R: FXD MET OX 5600Ω 5% 1/2 W	28480	0758-0057	1	
0758-0062	R: FXD MET OX 200Ω 5% 1/2 W	28480	0758-0062	1	
0758-0067	R: FXD MET OX 750Ω 5% 1/2 W	28480	0758-0067	2	
0758-0071	R: FXD MET OX 4300Ω 5% 1/2 W	28480	0758-0071	1	

Table 6-2. Replaceable Parts

Part No.	Description #	Mfr.	Mfr. Part No.	TQ	RS
0758-0082	R: FXD MET OX 130Ω 5% 1/2W	28480	0758-0082	2	
0758-0096	R: FXD MET OX 110Ω 5% 1/2W	28480	0758-0096	1	
0758-0126	R: FXD MET OX 51Ω 5% 1/2W	28480	0758-0126	3	
0758-0127	R: FXD MET OX 430Ω 5% 1/2W	28480	0758-0127	1	
0758-0128	R: FXD MET OX 160KΩ 5% 1/2W	28480	0758-0128	1	
0760-0024	R: FXD MET OX 100Ω 5% 1W	28480	0760-0024	2	
0761-0041	R: FXD MET OX 56Ω 5% 1W	28480	0761-0041	2	
0761-0057	R: FXD MET OX 560Ω 5% 1W	28480	0761-0057	1	
0837-0502	THERMISTOR 130Ω 20%	28480	0837-0502	1	
1205-0011	HEAT DISSIPATOR FOR TO-5 AND TO-9	28480	1205-0011	3	
1205-0037	HEAT DISSIPATOR FOR TO-18	28480	1205-0037	1	
1250-0083	CONNECTOR BNC	28480	1250-0083	1	
1250-0140	CONNECTOR BNC	28480	1250-0140	1	
1251-0148	CONNECTOR POWER 3 PIN MALE	28480	1251-0148	1	
1490-0031	STAND-TILT THIRD MODULE	28480	1490-0031	1	
1850-0098	TRANSISTOR: GERMANIUM PNP	28480	1850-0098	1	
1853-0001	TRANSISTOR: SILICON PNP	28480	1853-0001	1	
1853-0009	TRANSISTOR: SILICON PNP	28480	1853-0009	4	
1853-0029	TRANSISTOR: SILICON PNP	28480	1853-0029	3	
1854-0005	TRANSISTOR: SILICON NPN	28480	1854-0005	2	
1854-0009	TRANSISTOR: SILICON NPN	28480	1854-0009	2	
1854-0019	TRANSISTOR: SILICON NPN	28480	1854-0019	5	
1854-0053	TRANSISTOR: SILICON NPN	28480	1854-0053	2	
1854-0267	TRANSISTOR: SILICON NPN	28480	1854-0267	2	
1854-0307	TRANSISTOR: SILICON NPN	28480	1854-0307	3	
1901-0025	DIODE: SILICON 100mA 100PIV	28480	1901-0025	2	
1901-0040	DIODE: SILICON 30mA 30PIV	28480	1901-0040	2	
1901-0045	DIODE: SILICON 750mA 100PIV	28480	1901-0045	2	
1902-0048	DIODE: BREAKDOWN 6.81V 400mW 5%	28480	1902-0048	2	
1902-0074	DIODE: BREAKDOWN 7.15V 400mW 5%	28480	1902-0074	1	
1902-0188	DIODE: BREAKDOWN 4.12V 400mW 5%	28480	1902-0188	1	
2100-0036	R: VAR COMP LIN 1000Ω 20% 1/2W	28480	2100-0036	1	
2100-0519	R: VAR WW 2 x 1KΩ 3%	28480	2100-0519	1	
2100-0520	R: VAR COMP LIN 250Ω 20% 1/8W	28480	2100-0520	3	
2100-0521	R: VAR COMP LIN 5KΩ 30% 1/8W	28480	2100-0521	4	
2100-0535	R: VAR WW LIN 10KΩ 20% 2W	28480	2100-0535	3	
3100-0033	SWITCH: SLIDE DPDT NON-SHORTING	28480	3100-0033	1	
3100-0100	SWITCH: PUSH BUTTON LIGHTED SPDT	28480	3100-0100	1	
3100-0507	SWITCH: ROTARY (MULTIPLIER)	28480	3100-0507	1	
5000-0706	COVER: TOP	28480	5000-0706	1	
5000-0711	COVER: BOTTOM 5x11SM	28480	5000-0711	1	
5000-1157	COVER: SLIDE 5x11SM	28480	5000-1157	1	
5060-0728	FOOT: ASSEMBLY THIRD MODULE	28480	5060-0728	2	
8120-0078	CABLE: AC POWER 7.5FT (NEMA PLUG)	28480	8120-0078	1	
8120-0100	CABLE: AC POWER 7.5FT (SCHUKO PLUG)	28480	8120-0100	1	
9100-0522	TRANSFORMER: POWER	28480	9100-0522	1	
9140-0096	COIL: FXD RF 1μH	28480	9140-0096	2	
9170-0016	BEAD	28480	9170-0016	2	
00217-63401	ATTENUATOR ASSEMBLY A1	28480	00217-63401	1	
00217-66501	PRINTED CIRCUIT BOARD A2	28480	00217-66501	1	

TABLE 6-3.
CODE LIST OF MANUFACTURERS

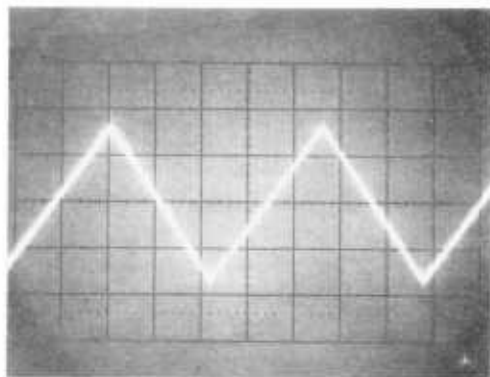
The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 Handbooks.

Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address
00000	U. S. A. Common	Any supplier of U. S.	05397	Union Carbide Corp., Linde Div.	Kemet Dept. Cleveland, Ohio	11242	Bay State Electronics Corp.	Waltham, Mass.
00136	McCoy Electronics	Mount Holly Springs, Pa.	05593	Illumitronic Engineering Co.	Sunnyvale, Calif.	11312	Teledyne Inc., Microwave Div.	Palo Alto, Calif.
00213	Sage Electronics Corp.	Rochester, N. Y.	05616	Cosmo Plastic	Cleveland, Ohio	11534	Duncan Electronics Inc.	Costa Mesa, Calif.
00287	Cemco Inc.	Danielson, Conn.	05624	Barber Colman Co.	Rockford, Ill.	11711	General Instrument Corp., Semiconductor Div.	Newark, N. J.
00334	Humidial	Colton, Calif.	05728	Tiffen Optical Co.	Roslyn Heights, Long Island, N. Y.	11717	Imperial Electronic, Inc.	Buena Park, Calif.
00348	Microtron Co., Inc.	Valley Stream, N. Y.	05729	Metro-Tel Corp.	Westbury, N. Y.	11870	Melabs, Inc.	Palo Alto, Calif.
00373	Garlock Inc.	Camden, N. J.	05783	Stewart Engineering Co.	Santa Cruz, Calif.	12136	Philadelphia Handle Co.	Camden, N. J.
00656	Aerovox Corp.	New Bedford, Mass.	05820	Wakelield Engineering Inc.	Wakefield, Mass.	12361	Grove Mfg. Co., Inc.	Shady Grove, Pa.
00779	Amp. Inc.	Harrisburg, Pa.	06004	Bassick Co., The	Bridgeport, Conn.	12574	Gulton Ind. Inc., CG Elect. Div.	Albuquerque, N. M.
00781	Aircraft Radio Corp.	Boonton, N. J.	06090	Raychem Corp.	Redwood City, Calif.	12697	Clarostat Mfg. Co.	Dover, N. H.
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.	06175	Bausch and Lomb Optical Co.	Rochester, N. Y.	12728	Elmar Filter Corp.	W. Haven, Conn.
00853	Sangamo Electric Co., Capacitor Dept.	Pickens, S. C.	06402	E. T. A. Products Co. of America	Chicago, Ill.	12859	Nippon Electric Co., Ltd.	Tokyo, Japan
00866	Goe Engineering Co.	Los Angeles, Calif.	06540	Amatom Electronic Hardware Co., Inc.	New Rochelle, N. Y.	12881	Meltec Electronics Corp.	Clark, N. J.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.	06555	Beede Electrical Instrument Co., Inc.	Penacook, N. H.	12930	Delta Semiconductor, Inc.	Newport Beach, Calif.
00929	Microtab Inc.	Livingston, N. J.	06666	General Devices Co., Inc.	Indianapolis, Ind.	12954	Dickson Electronics Corp.	Scottsdale, Arizona
01002	General Electric Co., Capacitor Dept.	Hudson Falls, N. Y.	06751	Semcor Div. Components Inc.	Phoenix, Ariz.	13103	Thermolloy	Dallas, Texas
01009	Alden Products Co.	Brockton, Mass.	06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.	13396	Telefunken (GmbH)	Hanover, Germany
01121	Allen Bradley Co.	Milwaukee, Wis.	06980	Varian Assoc. Eimac Div.	San Carlos, Calif.	13835	Midland-Wright Div. of Pacific Industries, Inc.	Kansas City, Kansas
01255	Liton Industries, Inc.	Beverly Hills, Calif.	07088	Kelvin Electric Co.	Van Nuys, Calif.	14099	Sem-Tech	Newbury Park, Calif.
01281	TRW Semiconductors, Inc.	Lawndale, Calif.	07126	Digitran Co.	Pasadena, Calif.	14193	Calif. Resistor Corp.	Santa Monica, Calif.
01295	Texas Instruments, Inc.	Dallas, Texas	07137	Transistor Electronics Corp.	Minneapolis, Minn.	14298	American Components, Inc.	Conshohocken, Pa.
01349	The Alliance Mfg. Co.	Alliance, Ohio	07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N. Y.	14433	ITT Semiconductor, A Div. of Int. Telephone & Telegraph Corp.	West Palm Beach, Fla.
01589	Pacific Relays, Inc.	Van Nuys, Calif.	07149	Filmohm Corp.	New York, N. Y.	14493	Hewlett-Packard Company	Loveland, Colo.
01930	Amerock Corp.	Rockford, Ill.	07233	Cinch-Graphik Co.	City of Industry, Calif.	14655	Cornell Dublier Electric Corp.	Newark, N. J.
01961	Pulse Engineering Co.	Santa Clara, Calif.	07261	Avnet Corp.	Culver City, Calif.	14674	Corning Glass Works	Corning, N. Y.
02114	Ferroxcube Corp. of America	Saugerties, N. Y.	07263	Fairchild Camera & Inst. Corp. Semiconductor Div.	Mountain View, Calif.	14752	Electro Cube Inc.	So. Pasadena, Calif.
02116	Wheelock Signals, Inc.	Long Branch, N. J.	07322	Minnesota Rubber Co.	Minneapolis, Minn.	14960	Williams Mfg. Co.	San Jose, Calif.
02286	Cole Rubber and Plastics Inc.	Sunnyvale, Calif.	07387	Birther Corp., The	Monterey Park, Calif.	15203	Webster Electronics Co.	New York, N. Y.
02660	Amphenol-Borg Electronics Corp.	Chicago, Ill.	07397	Sylvania Electr. Prod. Inc.	Mt. View Operations Mountain View, Calif.	15287	Scionics Corp.	Northridge, Calif.
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N. J.	07700	Technical Wire Products Inc.	Cranford, N. J.	15291	Adjustable Bushing Co.	N. Hollywood, Calif.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.	07910	Continental Device Corp.	Hawthorne, Calif.	15558	Micron Electronics	Garden City, Long Island, N. Y.
02777	Hopkins Engineering Co.	San Fernando, Calif.	07933	Semiconductor Div.	Mountain View, Calif.	15566	Amprobe Inst. Corp.	Lynbrook, N. Y.
03508	G. E. Semiconductor Prod. Dept.	Syracuse, N. Y.	07980	Hewlett-Packard Co.	Boonton Radio Div. Rockaway, N. J.	15631	Cabletronics	Costa Mesa, Calif.
03705	Apex Machine & Tool Co.	Dayton, Ohio	08145	U. S. Engineering Co.	Los Angeles, Calif.	15772	Twentieth Century Coil Spring Co.	Santa Clara, Calif.
03797	Eldema Corp.	Compton, Calif.	08289	Blinn, Delbert Co.	Pomona, Calif.	15818	Amelco Inc.	Mt. View, Calif.
03877	Transitron Electric Corp.	Wakefield, Mass.	08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada	15909	Daven Div. Thomas A. Edison Ind.	Long Island City, N. Y.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N. J.	08524	Deutsch Fastener Corp.	Los Angeles, Calif.	16037	McGraw-Edison Co.	Long Island City, N. Y.
03954	Singer Co., Diehl Div.	Sumerville, N. J.	08664	Bristol Co., The	Waterbury, Conn.	16037	Spruce Pine Mica Co.	Spruce Pine, N. C.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.	08717	Sloan Company	Sun Valley, Calif.	16179	Omni-Spectra Inc.	Detroit, Ill.
04013	Taurus Corp.	Lambertville, N. J.	08718	ITT Cannon Electric Inc.	Phoenix, Arizona	16352	Computer Diode Corp.	Lodi, N. J.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S. C.	08792	CBS Electronics Semiconductor Operations, Div. of C. B. S. Inc.	Lowell, Mass.	16688	Ideal Prec. Meter Co., Inc.	Brooklyn, N. Y.
04354	Precision Paper Tube Co.	Chicago, Ill.	08984	Mel-Rain	Indianapolis, Ind.	16758	De Jur Meter Div.	Brooklyn, N. Y.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.	09026	Babcock Relays Div.	Costa Mesa, Calif.	17109	Thermometrics Inc.	Canoga Park, Calif.
04651	Sylvania Electric Products, Microwave Device Div.	Mountain View, Calif.	09134	Texas Capacitor Co.	Houston, Texas	17474	Tranex Company	Mountain View, Calif.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona	09145	Alotom Electronics	Sun Valley, Calif.	17675	Hamlin Metal Products Corp.	Akron, Ohio
04732	Filtron Co., Inc. Western Div.	Culver City, Calif.	09250	Electro Assemblies, Inc.	Chicago, Ill.	17745	Angstrom Prec. Inc.	No. Hollywood, Calif.
04773	Automatic Electric Co.	Northlake, Ill.	09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada	18042	Power Design Pacific Inc.	Palo Alto, Calif.
04796	Sequora Wire Co.	Redwood City, Calif.	10214	General Transistor Western Corp.	Los Angeles, Calif.	18083	Clevite Corp., Semiconductor Div.	Palo Alto, Calif.
04811	Precision Coil Spring Co.	El Monte, Calif.	10411	Ti-Tal, Inc.	Berkeley, Calif.	18476	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
04870	P. M. Motor Company	Westchester, Ill.	10646	Carborundum Co.	Niagara Falls, N. Y.	18486	TRW Elect. Comp. Div.	Des Plaines, Ill.
04919	Component Mfg. Service Co.	W. Bridgewater, Mass.	11236	CTS of Berne, Inc.	Berne, Ind.	18583	Curtis Instrument, Inc.	Mt. Kisco, N. Y.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.	11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.	18873	E. I. DuPont and Co., Inc.	Wilmington, Del.
05277	Westinghouse Electric Corp. Semi-Conductor Dept.	Youngwood, Pa.				18911	Durant Mfg. Co.	Milwaukee, Wis.
05347	Ultronix, Inc.	San Mateo, Calif.				19315	Bendix Corp., The	Teterboro, N. J.
							Eclipse-Pioneer Div.	Teterboro, N. J.
						19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N. J.
						19589	Concoa	Baldwin Park, Calif.
						19644	LRC Electronics	Horseheads, N. Y.
						19701	Electra Mfg. Co.	Independence, Kansas
						20183	General Altronics Corp.	Philadelphia, Pa.
						21226	Executone, Inc.	Long Island City, N. Y.

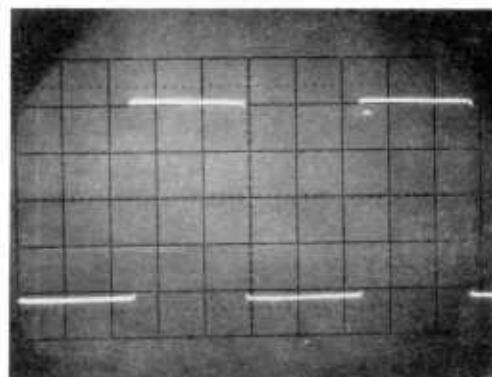
TABLE 6-3.
CODE LIST OF MANUFACTURERS (Cont'd)

Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address
21335	Fafnir Bearing Co., The	New Britain, Conn.	71450	CTS Corp.	Elkhart, Ind.	77075	Pacific Metals Co.	San Francisco, Calif.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.	71468	ITT Cannon Electric Inc.	Los Angeles, Calif.	77221	Phanosran Instrument and Electronic Co.	South Pasadena, Calif.
23783	British Radio Electronics Ltd.	Washington, D.C.	71471	Cinema, Div. Aerovox Corp.	Burbank, Calif.			
24455	G. E. Lamp Division	Nela Park, Cleveland, Ohio	71482	C. P. Clare & Co.	Chicago, Ill.	77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
24655	General Radio Co.	West Concord, Mass.	71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.	77342	American Machine & Foundry Co. Potter & Brumfield Div.	Princeton, Ind.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.	71616	Commercial Plastics Co.	Chicago, Ill.	77630	TRW Electronic Components Div.	Camden, N.J.
26462	Grobet File Co. of America, Inc.	Carlstadt, N.J.	71700	Cornish Wire Co., The	New York, N.Y.	77638	General Instrument Corp., Rectifier Div.	Brooklyn, N.Y.
26992	Hamilton Watch Co.	Lancaster, Pa.	71707	Cow Coil Co., Inc.	Providence, R.I.	77764	Resistance Products Co.	Harrisburg, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Calif.	71744	Chicago Miniature Lamp Works	Chicago, Ill.	77969	Rubbercraft Corp. of Calif.	Torrance, Calif.
28520	Heyman Mfg. Co.	Kenilworth, N.J.	71753	A. O. Smith Corp., Crowley Div.	West Orange, N.J.	78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
33173	G. E. Receiving Tube Dept.	Owensboro, Ky.	71785	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.	78283	Signal Indicator Corp.	New York, N.Y.
35434	Lectrohm Inc.	Chicago, Ill.	71984	Dow Corning Corp.	Midland, Mich.	78290	Struthers-Dunn Inc.	Pitman, N.J.
36196	Stanwyck Coil Products Ltd.	Hawkesbury, Ontario, Canada	72136	Electro Motive Mfg. Co., Inc.	Williamantic, Conn.	78452	Thompson-Bremer & Co.	Chicago, Ill.
36287	Cunningham, W. H. & Hill, Ltd.	Toronto Ontario, Canada	72354	John E. Fast Co., Div. Victrolene Instr. Co.	Chicago, Ill.	78471	Tilley Mfg. Co.	San Francisco, Calif.
37942	P. R. Mallory & Co. Inc.	Indianapolis, Ind.	72619	Dialight Corp.	Brooklyn, N.Y.	78488	Stackpole Carbon Co.	St. Marys, Pa.
39543	Mechanical Industries Prod. Co.	Akron, Ohio	72656	Indiana General Corp., Electronics Div.	Keasby, N.J.	78493	Standard Thomson Corp.	Waltham, Mass.
40920	Miniature Precision Bearings, Inc.	Keene, N.H.	72699	General Instrument Corp., Cap. Div.	Newark, N.J.	78553	Tinnerman Products, Inc.	Cleveland, Ohio
42190	Muter Co.	Chicago, Ill.	72765	Drake Mfg. Co.	Chicago, Ill.	78790	Transformer Engineers	San Gabriel, Calif.
43990	C. A. Norgren Co.	Englewood, Colo.	72785	Hugh H. Eby Inc.	Philadelphia, Pa.	78947	Ucinite Co.	Newtownville, Mass.
44655	Ohmite Mfg. Co.	Skokie, Ill.	72928	Gudeman Co.	Chicago, Ill.	79136	Waltes Kohinor Inc.	Long Island City, N.Y.
46384	Penn Eng. & Mfg. Corp.	Doylestown, Pa.	72964	Robert M. Hadley Co.	Los Angeles, Calif.	79142	Veeder Root, Inc.	Hartford, Conn.
47904	Polaroid Corp.	Cambridge, Mass.	72982	Erie Technological Products, Inc.	Erie, Pa.	79251	Wenco Mfg. Co.	Chicago, Ill.
48620	Precision Thermometer & Inst. Co.	Southampton, Pa.	73061	Hansen Mfg. Co., Inc.	Princeton, Ind.	79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
49956	Microwave & Power Tube Div.	Waltham, Mass.	73076	H. M. Harper Co.	Chicago, Ill.	79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
52090	Rowan Controller Co.	Westminster, Md.	73138	Helipot Div. of Beckman Inst., Inc.	Fulterton, Calif.	80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
52983	Sanborn Company	Waltham, Mass.	73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.	80120	Schnitzer Alloy Products Co.	Elizabeth, N.J.
54294	Shallcross Mfg. Co.	Selma, N.C.	73445	Amperex Electronic Co., Div. of North American Phillips Co., Inc.	Hicksville, N.Y.	80131	Electronic Industries Association, Tube meeting EIA Standards-Washington, DC.	Any brand
55026	Simpson Electric Co.	Chicago, Ill.	73506	Bradley Semiconductor Corp.	New Haven, Conn.	80207	Unimax Switch, Div. Maxon Electronics Corp.	Wallingford, Conn.
55933	Sonotone Corp.	Elmsford, N.Y.	73559	Carling Electric, Inc.	Hartford, Conn.	80223	United Transformer Corp.	New York, N.Y.
55938	Raytheon Co. Commercial Apparatus & Systems Div.	So. Norwalk, Conn.	73586	Circle F Mfg. Co.	Trenton, N.J.	80248	Oxford Electric Corp.	Chicago, Ill.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.	73682	George K. Garrett Co., Div. MSL Industries Inc.	Philadelphia, Pa.	80294	Bourins Inc.	Riverside, Calif.
56289	Sprague Electric Co.	North Adams, Mass.	73734	Federal Screw Products Inc.	Chicago, Ill.	80411	Acro Div. of Robertshaw Controls Co.	Columbus, Ohio
59446	Telex, Inc.	St. Paul, Minn.	73743	Fischer Special Mfg. Co.	Cincinnati, Ohio	80486	All Star Products Inc.	Defiance, Ohio
59730	Thomas & Betts Co.	Elizabeth, N.J.	73793	General Industries Co., The	Elyria, Ohio	80509	Avery Adhesive Label Corp.	Monrovia, Calif.
60741	Triplet Electrical Inst. Co.	Bluffton, Ohio	73846	Goshen Stamping & Tool Co.	Goshen, Ind.	80583	Hammarlund Co., Inc.	New York, N.Y.
61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Pittsburgh, Pa.	73899	JFD Electronics Corp.	Brooklyn, N.Y.	80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
62119	Universal Electric Co.	Owosso, Mich.	73905	Jennings Radio Mfg. Corp.	San Jose, Calif.	81030	International Instruments Inc.	Orange, Conn.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.	74276	Signalite Inc.	Neptune, N.J.	81073	Grayhill Co.	LaGrange, Ill.
64959	Western Electric Co., Inc.	New York, N.Y.	74455	J. H. Winns, and Sons	Winchester, Mass.	81095	Triad Transformer Corp.	Venice, Calif.
65092	Weston Inst. Inc. Weston-Newark	Newark, N.J.	74861	Industrial Condenser Corp.	Chicago, Ill.	81312	Winchester Elec. Div. Litton Ind., Inc.	Oakville, Conn.
66295	Witteck Mfg. Co.	Chicago, Ill.	74868	R. F. Products Division of Amphenol-Borg Electronics Corp.	Danbury, Conn.	81349	Military Specification	
66346	Revere Wollansak Div. Minn. Mining & Mfg. Co.	St. Paul, Minn.	74970	E. F. Johnson Co.	Waseca, Minn.	81483	International Rectifier Corp.	El Segundo, Calif.
70276	Allen Mfg. Co.	Hartford, Conn.	75042	International Resistance Co.	Philadelphia, Pa.	81541	Airpax Electronics, Inc.	Cambridge, Mass.
70309	Allied Control	New York, N.Y.	75378	CTS Knights Inc.	Sandwich, Ill.	81860	Barry Controls, Div. Barry Wright Corp.	Watertown, Mass.
70318	Allmetal Screw Product Co., Inc.	Garden City, N.Y.	75382	Kulka Electric Corporation	Mt. Vernon, N.Y.	82042	Carter Precision Electric Co.	Skokie, Ill.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.	75818	Lenz Electric Mfg. Co.	Chicago, Ill.	82047	Sperli Faraday Inc., Copper Hewitt Electric Div.	Hoboken, N.J.
70563	Amperite Co., Inc.	Union City, N.J.	75915	Littlefuse, Inc.	Des Plaines, Ill.	82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
70674	AOC Products Inc.	Minneapolis, Minn.	76005	Lord Mfg. Co.	Erie, Pa.	82170	Fairchild Camera & Inst. Corp., Defense Prod. Division	Clifton, N.J.
70903	Belden Mfg. Co.	Chicago, Ill.	76210	C. W. Marwedel	San Francisco, Calif.	82209	Maguire Industries, Inc.	Greenwich, Conn.
70998	Bird Electronic Corp.	Cleveland, Ohio	76433	General Instrument Corp., Micamold Division	Newark, N.J.	82219	Sylvania Electric Prod. Inc., Electronic Tube Division	Emporium, Pa.
71002	Birnback Radio Co.	New York, N.Y.	76487	James Millen Mfg. Co., Inc.	Malden, Mass.	82376	Astron Corp.	East Newark, Harrison, N.J.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.	76493	J. W. Miller Co.	Los Angeles, Calif.	82389	Switchcraft, Inc.	Chicago, Ill.
71218	Bud Radio, Inc.	Willoughby, Ohio	76530	Cinch-Monadnock, Div. of United Carr Fastener Corp.	San Leandro, Calif.	82647	Metals & Controls Inc. Spencer Products	Attleboro, Mass.
71286	Camloc Fastener Corp.	Paramus, N.J.	76545	Mueller Electric Co.	Cleveland, Ohio	82768	Phillips-Advance Control Co.	Joliet, Ill.
71313	Cardwell Condenser Corp.	Lindenhurst L.I., N.Y.	76703	National Union	Newark, N.J.			
71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.	76854	Oak Manufacturing Co.	Crystal Lake, Ill.			
71436	Chicago Condenser Corp.	Chicago, Ill.	77068	Bendix Corp., The	N. Hollywood, Calif.			
71447	Calif. Spring Co., Inc.	Pico-Rivera, Calif.						

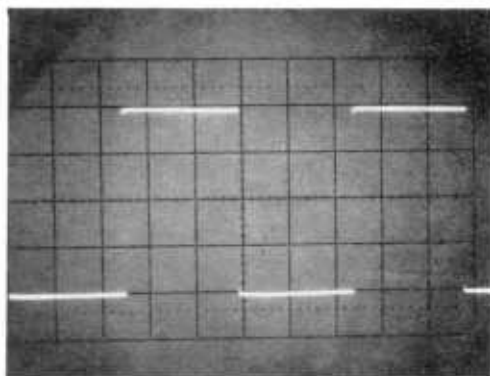
From: FSC Handbook Supplements
H4-1 Dated AUGUST 1966
H4-2 Dated NOV. 1962



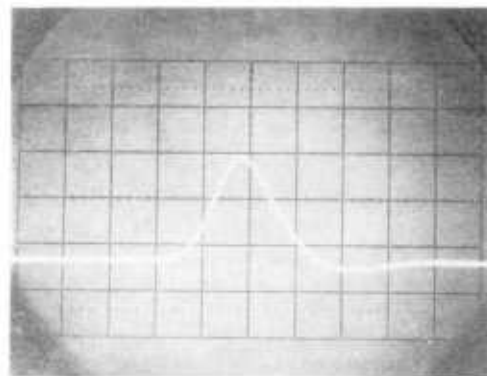
1 TP 1
Vertical 0.05V/cm
Sweep 20 μ s/cm



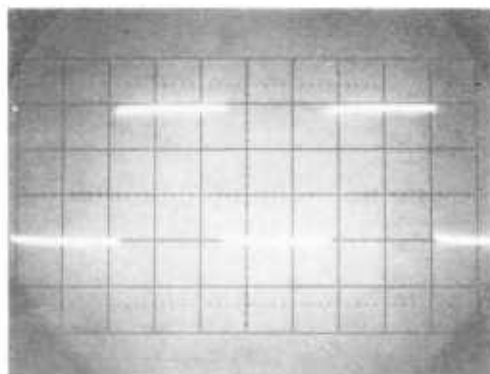
2 TP 2
Vertical 0.1V/cm
Sweep 20 μ s/cm



3 Collector of Q14
Vertical 0.2V/cm
Sweep 20 μ s/cm



4 TRIGGER OUTPUT
Vertical 2V/cm
Sweep 0.1 μ s/cm
Magnifier x 10



5 OUTPUT PULSE
Vertical 2V/cm
Sweep 20 μ s/cm

TYPICAL WAVEFORMS

Waveforms 1, 2 and 3 measured with 10 : 1 attenuator probe.

Waveform 5. Output terminated in 50 Ω .

Measurement Conditions:

MULTIPLIER 1K
FREQUENCY 10
SYMMETRY 50%
AMPLITUDE (V across 50 Ω) .. 5
VERNIER Fully CW

All measurements taken with -hp- 175A

SECTION VII

CIRCUIT DIAGRAM

7-1. INTRODUCTION.

7-2. This section includes the following:

- a. General Notes for Schematic Diagrams (Table 7-1).

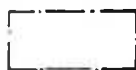
- b. Schematic Diagrams and Component Location illustrations of Model 217A circuits and assemblies. These figures also include voltages (Figure 7-1 thru 7-5).

Refer to MIL-STD-15-1 for schematic symbols not listed in this table.

Unless otherwise indicated:

capacitance in μF inductance in μH

resistance in Ohms



= Etched circuit board



= Front panel marking



= Rear panel marking



= Front panel control



= Screwdriver Adjustment

CW

= Clockwise end of variable resistor; blue disk potentiometers viewed from center (wiper) arm connection side.



= Primary signal path



= Feedback path



= Waveform test point (with number)



= Common point (with letter)



= Avalanche (zener) diode



= Tunnel diode



= Step recovery diode



= Silicon controlled rectifier

Numbers in parentheses indicate wire color using resistor color code, e.g. WHT-RED-GRN is (9-2-5).

0 - Black

1 - Brown

2 - Red

3 - Orange

4 - Yellow

5 - Green

6 - Blue

7 - Violet

8 - Gray

9 - White

P/O

= Part of

*

= Optimum value selected at factory, average value shown; part may have been omitted

N.C.

= No connection

Table 7-1. Schematic Diagram Notes

DC Voltage Measurement Conditions:

MULTIPLIER. 1K
 FREQUENCY. 10
 SYMMETRY. 50%

All measurements taken with -hp- 412A.

AMPLITUDE (V across 50 Ω). 5
 VERNIER. Fully CW

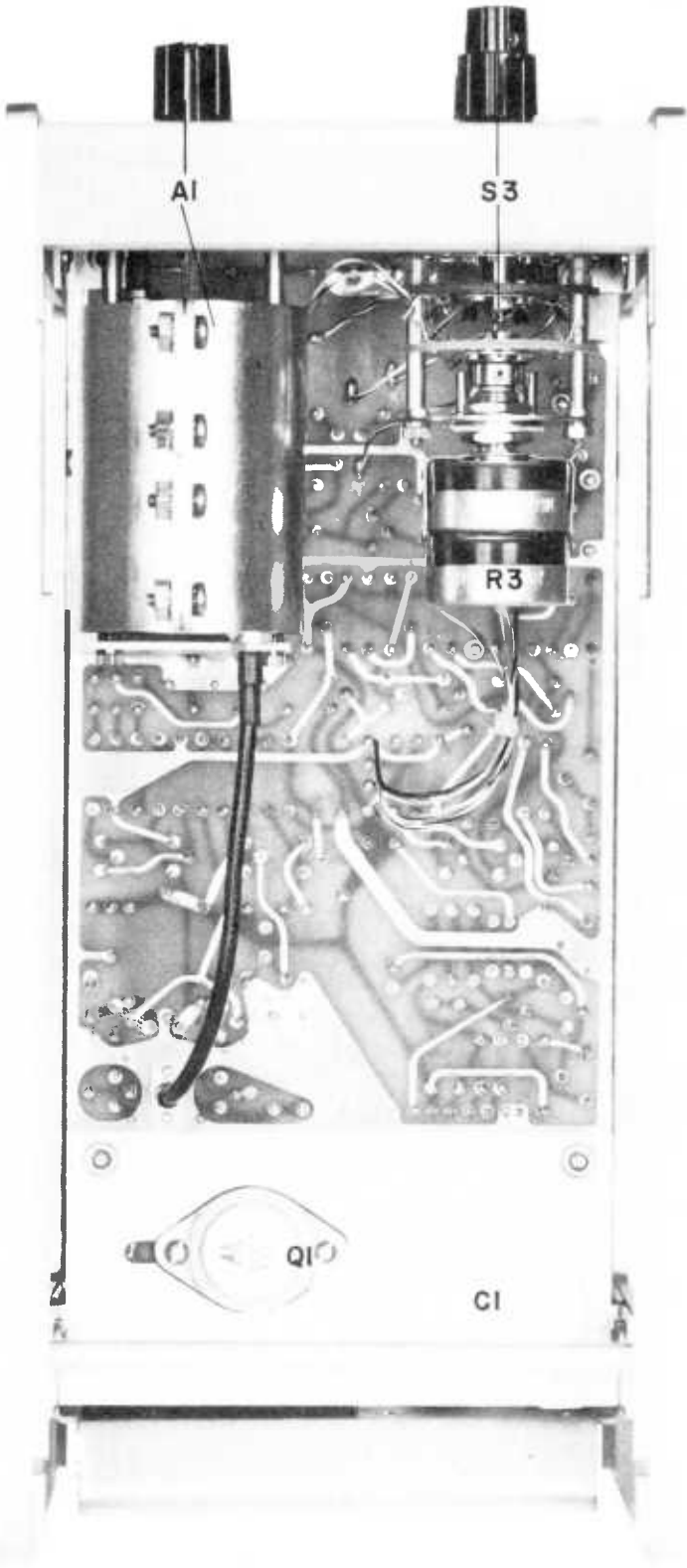


Figure 7-2. Component Location, top view

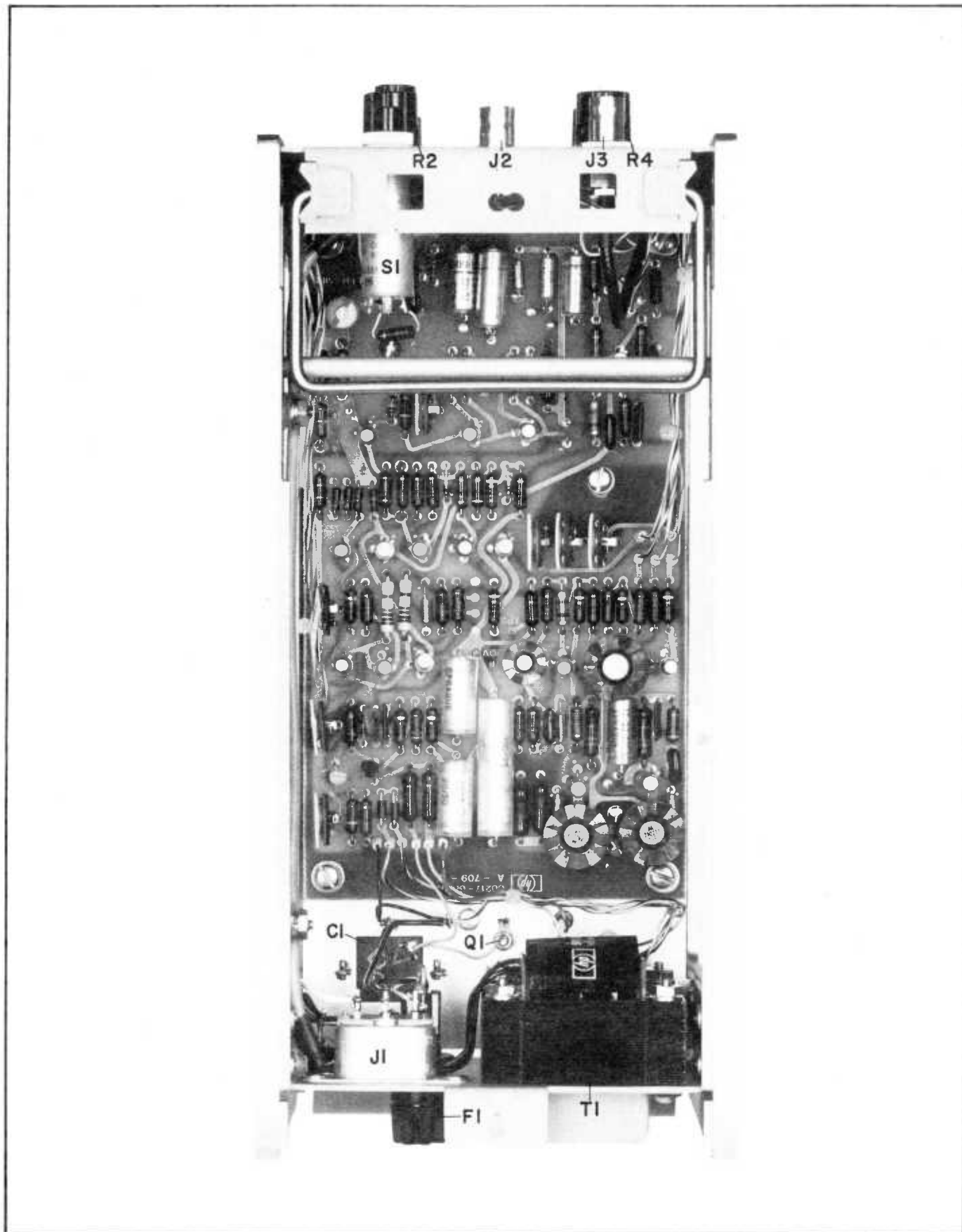


Figure 7-3. Component Location, bottom view

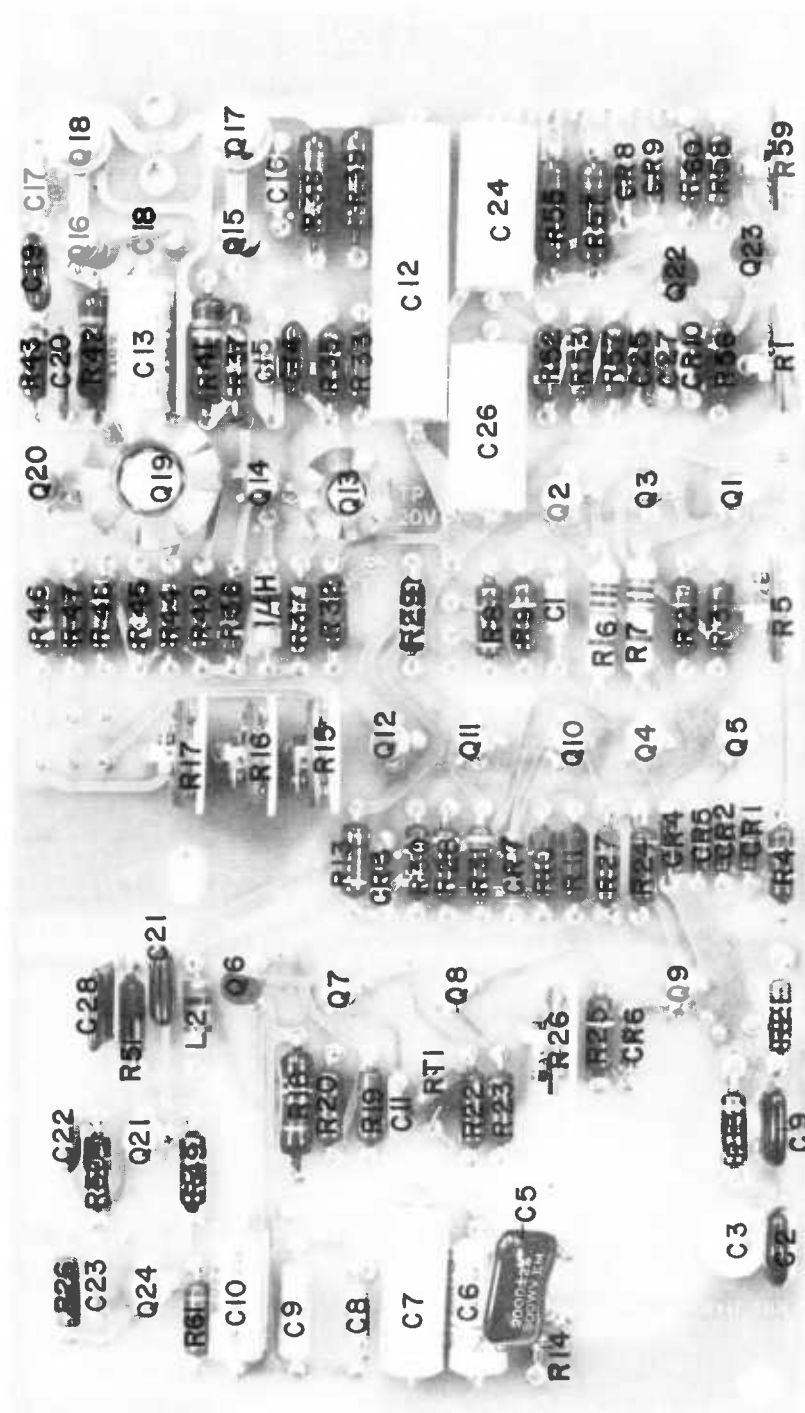
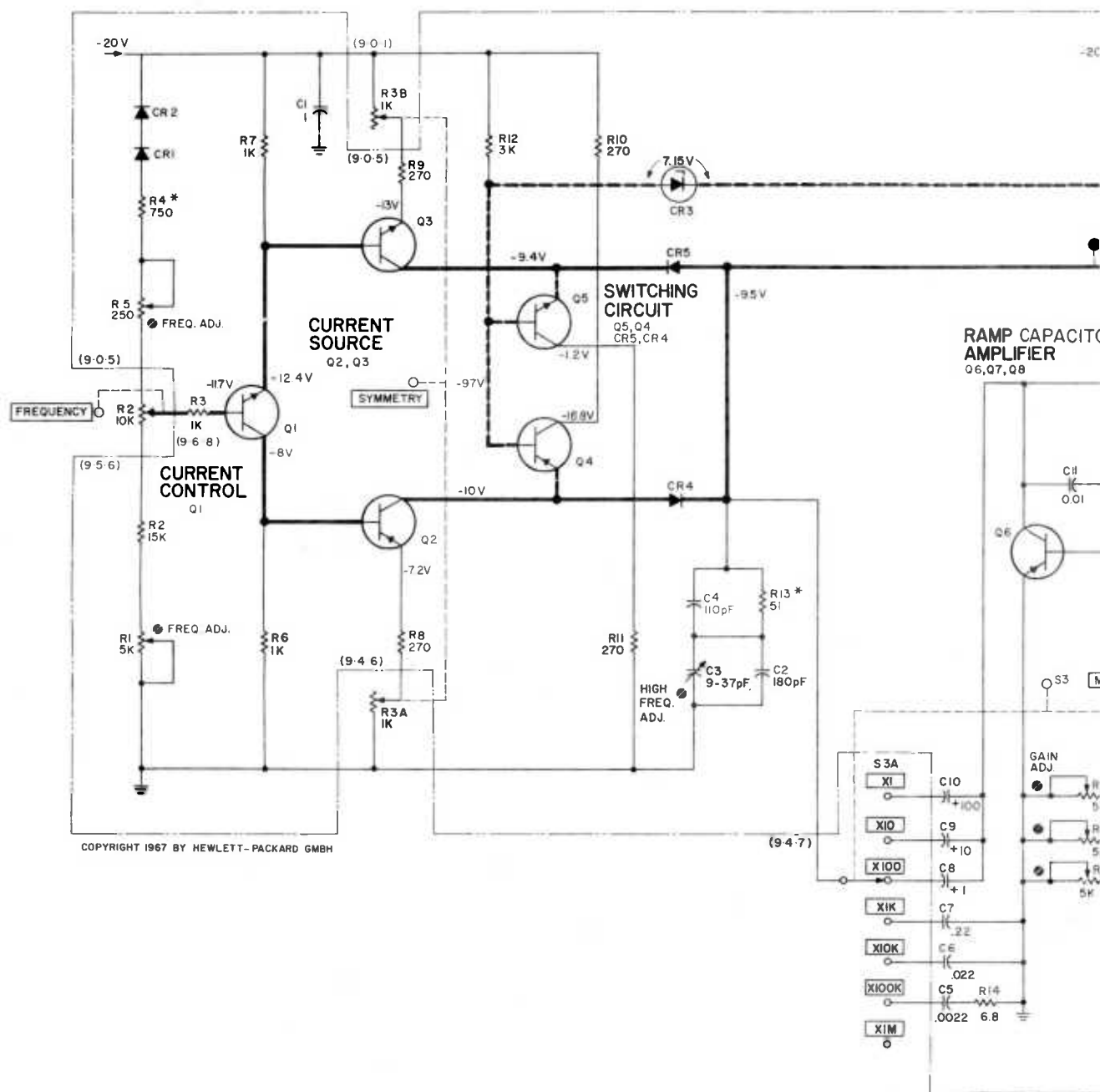


Figure 7-4. Component Location on A2 Board



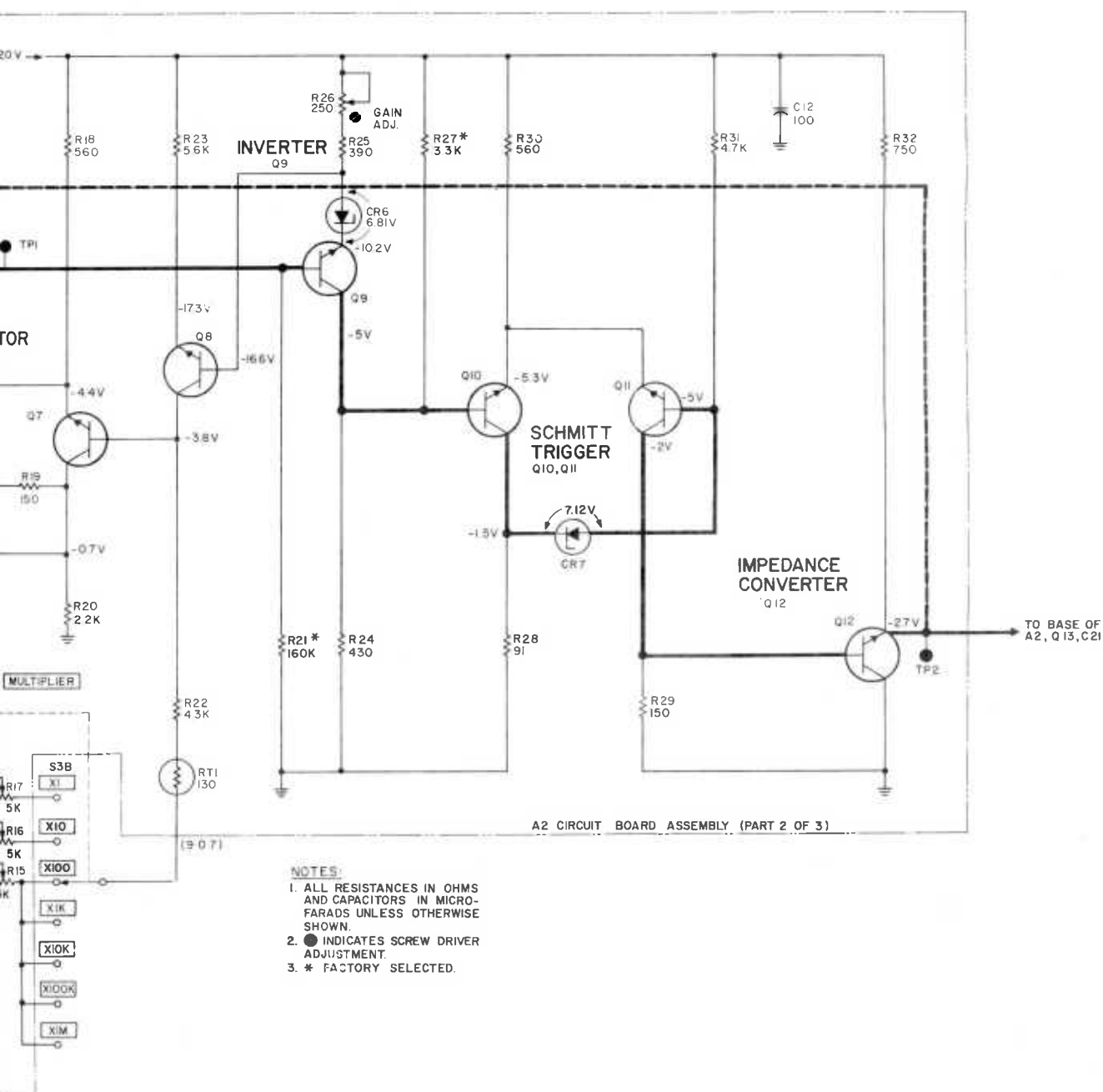
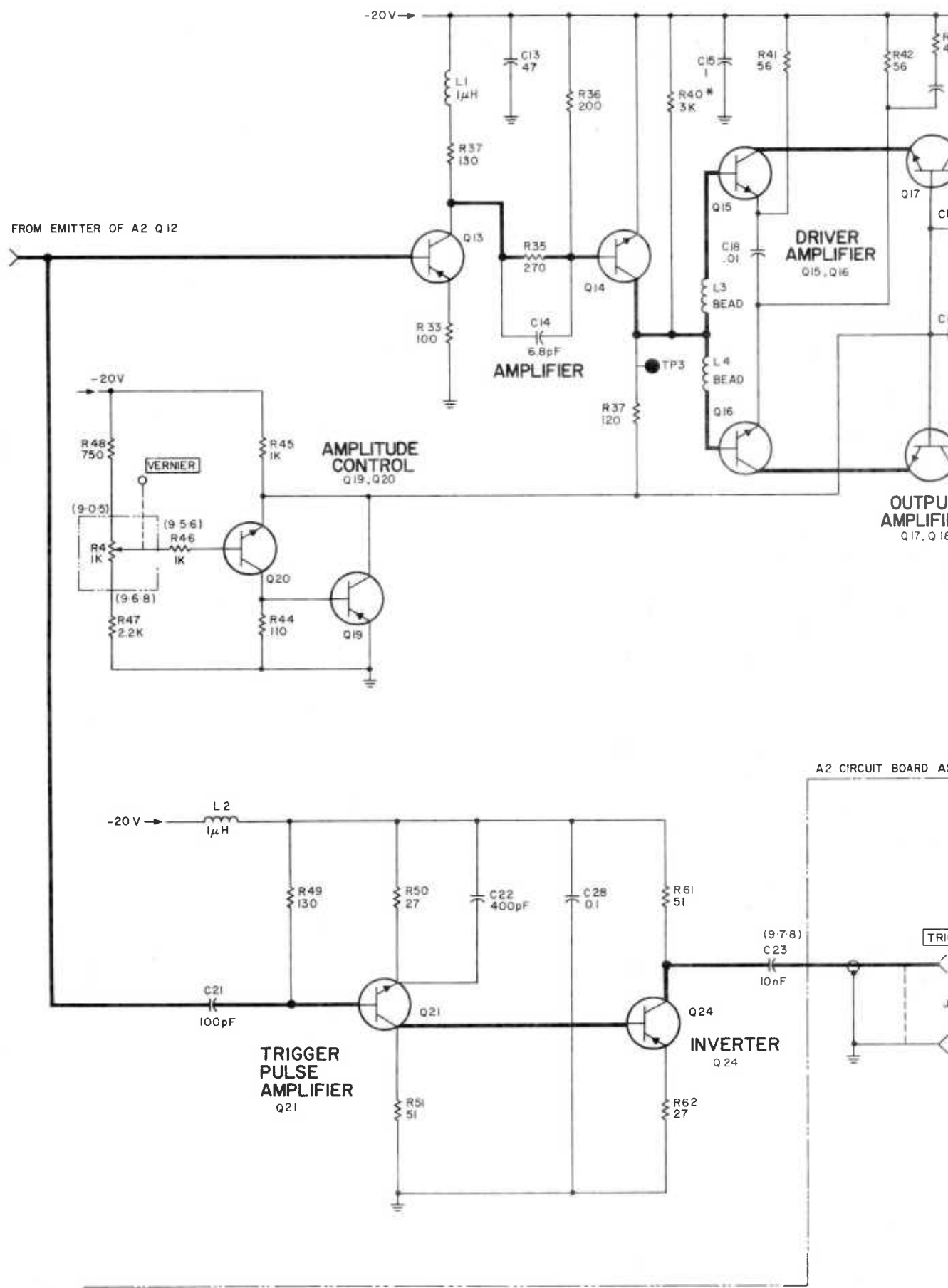


Figure 7-5. Repetition Rate Schematic Diagram



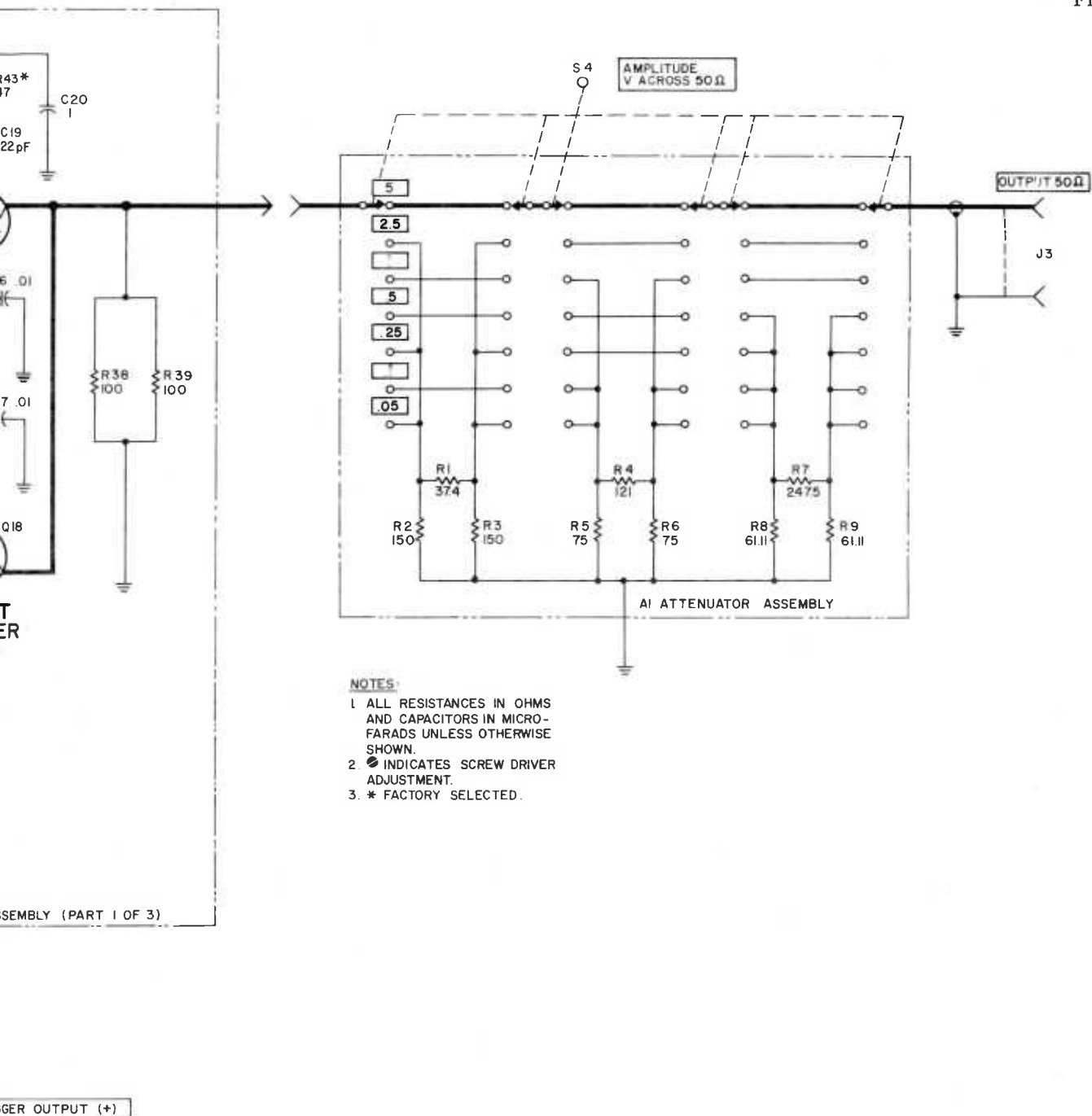
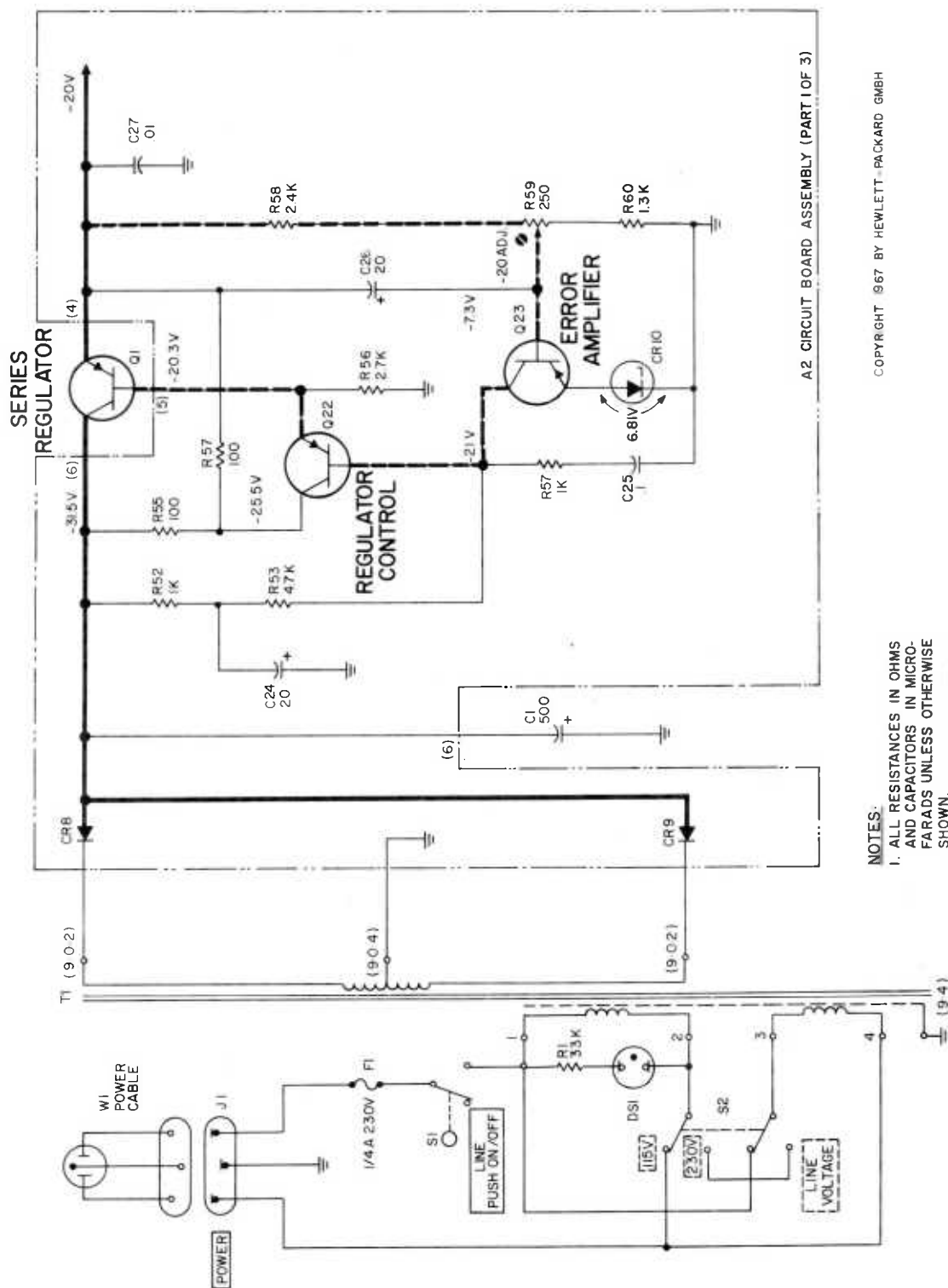


Figure 7-6. Output and Trigger Circuits Schematic Diagram



NOTES:

1. ALL RESISTANCES IN OHMS AND CAPACITORS IN MICRO-FARADS UNLESS OTHERWISE SHOWN.
2. ⌚ INDICATES SCREW DRIVER ADJUSTMENT

Figure 7-7. Power Supply Schematic Diagram

ELECTRONIC INSTRUMENTATION SALES AND SERVICE

UNITED STATES

ALABAMA
P.O. Box 4207
2003 Byrd Spring Road S.W.
Huntsville 35802
Tel: (205) 881-4591
TWX: 810-726-2204

ARIZONA
3009 North Scottsdale Road
Scottsdale 85251
Tel: (602) 945-7601
TWX: 910-950-1282

232 South Tucson Boulevard
Tucson 85716
Tel: (602) 623-2564
TWX: 910-952-1162

CALIFORNIA
3939 Lankershim Boulevard
North Hollywood 91604
Tel: (213) 877-1282
TWX: 910-499-2170

1101 Embarcadero Road
Palo Alto 94303
Tel: (415) 327-6500
TWX: 910-373-1280

2591 Carlsbad Avenue
Sacramento 95821
Tel: (916) 482-1463
TWX: 910-367-2092

1055 Shafter Street
San Diego 92106
Tel: (714) 223-8103
TWX: 910-335-2000

COLORADO
7965 East Prentice
Englewood 80110
Tel: (303) 771-3455
TWX: 910-935-0705

CONNECTICUT
508 Tolland Street
East Hartford 06108
Tel: (203) 289-9394
TWX: 710-425-3416

111 East Avenue
Norwalk 06851
Tel: (203) 853-1251
TWX: 710-468-3750

DELAWARE
3941 Kennett Pike
Wilmington 19807
Tel: (302) 655-6161
TWX: 510-666-2214

FLORIDA
Suite 106
9999 N.E. 2nd Avenue
Miami Shores 33138
Tel: (305) 758-3626
TWX: 810-848-7262

P.O. Box 20007
Herndon Station 32814
621 Commonwealth Avenue
Orlando
Tel: (305) 841-3970
TWX: 810-850-0113

P.O. Box 8128
Madeira Beach 33708
410 150th Avenue
St. Petersburg
Tel: (813) 391-0211
TWX: 810-863-0366

GEORGIA
P.O. Box 28234
2340 Interstate Parkway
Atlanta 30328
Tel: (404) 436-6181
TWX: 810-766-4890

ILLINOIS
5500 Howard Street
Skokie 60076
Tel: (312) 677-0400
TWX: 910-223-3613

INDIANA
4002 Meadows Drive
Indianapolis 46205
Tel: (317) 546-4891
TWX: 810-341-3263

LOUISIANA
P.O. Box 856
1942 Williams Boulevard
Kenner 70062
Tel: (504) 721-6201
TWX: 810-955-5524

MARYLAND
6707 Whitestone Road
Baltimore 21207
Tel: (301) 944-5400
TWX: 710-862-0850

P.O. Box 727
Twinbrook Station 20851
12303 Twinbrook Parkway
Rockville
Tel: (301) 427-7560
TWX: 710-828-9684

MASSACHUSETTS
Middlesex Turnpike
Burlington 01803
Tel: (617) 272-9000
TWX: 710-332-0382

MICHIGAN
24315 Northwestern Highway
Southfield 48075
Tel: (313) 353-9100
TWX: 810-232-1532

MINNESOTA
2459 University Avenue
St. Paul 55114
Tel: (612) 645-9461
TWX: 910-563-3734

MISSOURI
9208 Wyoming Place
Kansas City 64114
Tel: (816) 333-2445
TWX: 910-771-2087

2812 South Brentwood Blvd.
St. Louis 63144
Tel: (314) 644-0220
TWX: 910-760-1670

NEW JERSEY
391 Grand Avenue
Englewood 07631
Tel: (201) 567-3933
TWX: 710-991-9707

NEW MEXICO
P.O. Box 8366
Station C 87108
6501 Lomas Boulevard N.E.
Albuquerque
Tel: (505) 255-5586
TWX: 910-989-1665

156 Wyatt Drive
Las Cruces 88001
Tel: (505) 526-2485
TWX: 910-983-0550

NEW YORK
1702 Central Avenue
Albany 12205
Tel: (518) 869-8462

1219 Campville Road
Endicott 13760
Tel: (607) 754-0050
TWX: 510-252-0890

236 East 75th Street
New York 10021
Tel: (212) 879-2023
TWX: 710-581-4376

82 Washington Street
Poughkeepsie 12601
Tel: (914) 454-7330
TWX: 510-248-0012

39 Saginaw Drive
Rochester 14623
Tel: (716) 473-9500
TWX: 510-253-5981

1025 Northern Boulevard
Roslyn, Long Island 11576
Tel: (516) 869-8400
TWX: 510-223-0811

5858 East Molloy Road
Syracuse 13211
Tel: (315) 454-2486
TWX: 710-541-0482

NORTH CAROLINA
P.O. Box 5187
1923 North Main Street
High Point 27262
Tel: (919) 882-6873
TWX: 510-926-1516

OHIO
5579 Pearl Road
Cleveland 44129
Tel: (216) 864-9209
TWX: 810-421-8500

2460 South Dixie Drive
Dayton 45439
Tel: (513) 298-0351
TWX: 810-459-1925

OREGON
Westhills Mall, Suite 158
4475 S.W. Scholls Ferry Road
Portland 97225
Tel: (503) 292-9171
TWX: 910-464-6103

PENNSYLVANIA
2500 Moss Side Boulevard
Monroeville 15146
Tel: (412) 271-0724
TWX: 710-797-3650

144 Elizabeth Street
West Conshohocken 19428
Tel: (215) 248-1600, 828-6200
TWX: 510-660-8715

TEXAS
P.O. Box 7166
3505 Inwood Road
Dallas 75209
Tel: (214) 357-1881
TWX: 910-861-4081

P.O. Box 22813
4242 Richmond Avenue
Houston 77027
Tel: (713) 667-2407
TWX: 910-881-2645

GOVERNMENT CONTRACT OFFICE
225 Billy Mitchell Road
San Antonio 78226
Tel: (512) 434-4171
TWX: 510-871-1170

UTAH
2890 South Main Street
Salt Lake City 84115
Tel: (801) 486-8166
TWX: 910-925-5681

VIRGINIA
P.O. Box 6514
2111 Spencer Road
Richmond 23230
Tel: (703) 282-5451
TWX: 710-956-0157

WASHINGTON
11556 N.E. Eighth Street
Bellevue 98004
Tel: (206) 454-3971
TWX: 910-443-2303

FOR AREAS NOT LISTED, CONTACT: Hewlett-Packard; 1501 Page Mill Road; Palo Alto, California 94304; Tel: (415) 326-7000; TWX: 910-373-1267; Telex: 34-8461

CANADA

ALBERTA
10010 - 105th Street
Edmonton
Tel: (403) 424-0718
TWX: 610-831-2431

BRITISH COLUMBIA
Hewlett-Packard (Canada) Ltd.
2184 West Broadway
Vancouver
Tel: (604) 738-7520
TWX: 610-922-5050

NOVA SCOTIA
7001 Mumford Road
Suite 356
Halifax
Tel: (902) 455-0511
TWX: 610-271-4482

ONTARIO
Hewlett-Packard (Canada) Ltd.
880 Lady Ellen Place
Ottawa 3
Tel: (613) 722-4223
TWX: 610-562-1952

Hewlett-Packard (Canada) Ltd.
1415 Lawrence Avenue West
Toronto
Tel: (416) 249-9196
TWX: 610-492-2382

QUEBEC
Hewlett-Packard (Canada) Ltd.
275 Hymus Boulevard
Pointe Claire
Tel: (514) 697-4232
TWX: 610-422-3022
Telex: 01-2819

FOR AREAS NOT LISTED, CONTACT: Hewlett-Packard Inter-Americas; 1501 Page Mill Road; Palo Alto, Calif. 94304; Tel: (415) 326-7000; TWX: 910-373-1267; Telex: 034-8461; Cable: HEWPACK Palo Alto

CENTRAL AND SOUTH AMERICA

ARGENTINA
Mauricio A. Suárez
Telecomunicaciones
Carlos Calvo 224
Buenos Aires
Tel: 30-6312, 34-9087
Cable: TELEPILOT Buenos Aires

BRAZIL
Ciental, Importacao e
Comércio Ltda.
Avenida 13 de Maio, 13-22 andar
Rio de Janeiro G.B.
Tel: 42-9483

Ciental, Importacao e
Comércio Ltda.
Rua Des. Eliseu Guilherme, 62
Sao Paulo 8
Tel: 70-2318
Cable: CIENTALCO, Sao Paulo

CHILE
Héctor Calcagni
Casilla 13942
Santiago
Tel: 490-505, 393-119

COLOMBIA
Instrumentacion
Henrik A. Langebaek & Cia. Ltda.
Cra. 7A N° 48-51 59
Apartado Aereo 6287
Bogotá, 1 D.E.
Tel: 45-78-06, 45-55-46
Cable: AARIS Bogotá

COSTA RICA
Lic. Alfredo Gallegos Gudián
Apartado 3243
San José
Tel: 21-86-13
Cable: GALGUR San José

ECUADOR
Laboratorios de Radio-Ingeniería
Calle Guayaquil 1246
Post Office Box 3199
Quito
Tel: 12496
Cable: HORVATH Quito

EL SALVADOR
Electrónica
27 Avenida Norte 1133
Apartado Postal 1589
San Salvador
Tel: 25-74-50
Cable: ELECTRONICA
San Salvador

GUATEMALA
Olander Associates Latin America
Apartado 1226
7a. Calle, 0-22. Zona 1
Guatemala City
Tel: 22812
Cable: OLALA Guatemala City

MEXICO
Hewlett-Packard Mexicana,
S.A. de C.V.
Eugenia 408, Dept. 1
Mexico 12, D.F.
Tel: 43-03-79

NICARAGUA
Roberto Terán G.
Edificio Terán
Apartado Postal 689
Managua
Tel: 3451, 3452
Cable: ROTERAN Managua

PANAMA
Electrónica Balboa, S.A.
P.O. Box 4929
Ave. Manuel Espinosa No. 13-50
Bldg. Alina
Panama City
Tel: 30833
Cable: ELECTRON Panama City

PERU
Fernando Ezeta B.
Av. Petit Thouars 4719
Miraflores
Casilla 3061
Lima
Tel: 50346
Cable: FEPERU Lima

PUERTO RICO
San Juan Electronics, Inc.
P.O. Box 5167
Ponce de León 150, Stop 3
Puerta de Tierra Santa
San Juan 00906
Tel: (809) 725-3342
Cable: SATRONICS San Juan

URUGUAY
Pablo Ferrando
S.A. Comercial e Industrial
Avenida Italia 2877
Casilla de Correo 370
Montevideo
Tel: 40-3102
Cable: RADIUM Montevideo

VENEZUELA
Citec, C.A.
Edif. Arisan-Of. 34
Avda. Francisco de Miranda
Apartado del Este 10934 Chacaito
Caracas
Tel: 71.88.05
Cable: CITECAL Caracas

FOR AREAS NOT LISTED, CONTACT: Hewlett-Packard Inter-Americas; 1501 Page Mill Road; Palo Alto, Calif. 94304; Tel: (415) 326-7000; TWX: 910-373-1267; Telex: 034-8461; Cable: HEWPACK Palo Alto

HEWLETT  PACKARD

ELECTRONIC INSTRUMENTATION SALES AND SERVICE

EUROPE

AUSTRIA

Unilabor H.m.b.H.
Wissenschaftliche Instrumente
Rummelhardtgasse 6/3
P.O. Box 33
Vienna IX 71
Tel: 426 181
Cable: LABORINSTRUMENT
Vienna

BELGIUM

Hewlett-Packard Benelux S.A.
20-24 rue de l'Hôpital
Brussels
Tel: 11 22 20
Cable: PALOBEN Brussels

DENMARK

Tage Olsen A/S
Ronnegade 1
Copenhagen O
Tel: 29 48 00
Cable: TOCOPEN Copenhagen

FINLAND

INTO O.Y.
Meritullinkatu 11
P.O. Box 10153
Helsinki 10
Tel: 61 133
Cable: INTO Helsinki

FRANCE

Hewlett-Packard France
2 rue Tête d'Or
Lyon, 6 - Rhône
Tel: 52 35 66
Hewlett-Packard France
150 Boulevard Massena
Paris 13e
Tel: 707 97 19
Cable: HEWPACK Paris

GERMANY

Hewlett-Packard Vertriebs-GmbH
Lietzenburger Strasse 30
1 Berlin W 30
Tel: 24 86 36

Hewlett-Packard Vertriebs-GmbH
Herrenberger Strasse 110
703 Böblingen, Württemberg
Tel: 07031-6971
Cable: HEPAG Böblingen

Hewlett-Packard Vertriebs-GmbH
Achenbachstrasse 15
4 Düsseldorf 1
Tel: 68 52 58 59

Hewlett-Packard Vertriebs-GmbH
Kurfürstenstrasse 95
6 Frankfurt 50
Tel: 52 00 36
Cable: HEWPACKSA Frankfurt

Hewlett-Packard Vertriebs-GmbH
Beim Strohhause 26
2 Hamburg 1
Tel: 24 05 51 52
Cable: HEWPACKSA Hamburg

Hewlett-Packard Vertriebs-GmbH
Reginfriedstrasse 13
8 Munich 9
Tel: 69 51 21 22
Cable: HEWPACKSA Munich

GREECE

Kostos Karayannis
18, Ermou Street
Athens 126
Tel: 230 301
Cable: RAKAR Athens

IRELAND

Hewlett-Packard Ltd.
224 Bath Road
Slough, Bucks, England
Tel: Slough 28406-9, 29486-9
Cable: HEWPIE Slough

ITALY

Hewlett-Packard Italiana S.p.A.
Viale Lunigiana 46
Milan
Tel: 69 15 84
Cable: HEWPAIT Milan

Hewlett-Packard Italiana S.p.A.
Piazza Marconi 25
Rome - Eur
Tel: 591 2544
Cable: HEWPAIT Rome

NETHERLANDS

Hewlett-Packard Benelux, N.V.
de Boefelaan 1043
Amsterdam, Z 2
Tel: 42 77 77
Cable: PALOBEN Amsterdam

NORWAY

Morgenstjerne & Co. A/S
Ingeniofirma
6 Wessels Gate
Oslo
Tel: 20 16 35
Cable: MOROF Oslo

PORTUGAL

Telectra
Rua Rodrigo da Fonseca 103
P.O. Box 2531
Lisbon 1
Tel: 68 60 72
Cable: TELECTRA Lisbon

SPAIN

Ataio Ingenieros
Urgel, 259
Barcelona, 11
Tel: 230-69-88
Ataio Ingenieros
Enrique Larreta 12
Madrid, 16
Tel: 235 43 44
Cable: TELEATAIO Madrid

SWEDEN

HP Instrument AB
Hagakergatan 7
Malmö
Tel: 031 - 27 68 00
HP Instrument AB
Centralvägen 28
Solna
Tel: 08 - 83 08 30
Cable: MEASUREMENTS
Stockholm

SWITZERLAND

HEWPAK AG
Zürcherstrasse
8952 Schlieren
Zurich
Tel: (051) 98 18 21
Cable: HEWPACKAG Zurich

TURKEY

Telekom Engineering Bureau
P.O. Box 376 - Galata
Istanbul
Tel: 49 40 40
Cable: TELEMATION Istanbul

UNITED KINGDOM

Hewlett-Packard Ltd.
224 Bath Road
Slough, Bucks
Tel: Slough 28406-9, 29486-9
Cable: HEWPIE Slough

YUGOSLAVIA

Beiram S.A.
83 avenue des Mimosas
Brussels 15, Belgium
Tel: 35 29 58
Cable: BELAMEL Brussels

FOR AREAS NOT LISTED, CONTACT: Hewlett-Packard S.A.; 54 Route des Acacias, Geneva, Switzerland; Tel: (022) 42 81 50; Telex: 2.24.86; Cable: HEWPACKSA Geneva

AFRICA, ASIA, AUSTRALIA

AUSTRALIA

Hewlett-Packard Australia
Pty. Ltd.
22-26 Weir Street
Glen Iris, S. E. 6
Victoria
Tel: 20-1371 (4 lines)
Cable: HEWPAUD Melbourne
Hewlett-Packard Australia
Pty. Ltd.
4 Grose Street
Glebe, New South Wales
Tel: 211-2235, 211-2888
Cable: HEWPAUD Sydney

CEYLON

United Electricals Ltd.
P.O. Box 681
Yahala Building
Staples Street
Colombo 2
Tel: 5496
Cable: HOTPOINT Colombo

ETHIOPIA

African Salespower & Agency
Private Ltd., Co.
P.O. Box 718
Addis Ababa
Tel: 44090
Cable: ASACO Addisababa

HONG KONG

Schmidt & Co. (Hong Kong) Ltd.
P.O. Box 297
1511, Prince's Building
10, Chater Road
Hong Kong
Tel: 240168, 232735
Cable: SCHMIDTCO Hong Kong

INDIA

The Scientific Instrument
Co., Ltd.
6, Tej Bahadur Sapru Road
Allahabad 1
Tel: 2451
Cable: SICO Allahbad
The Scientific Instrument
Co., Ltd.
240, Dr. Dadabhai Naoroji Road
Bombay 1
Tel: 26-2642
Cable: SICO Bombay
The Scientific Instrument
Co., Ltd.
11, Esplanade East
Calcutta 1
Tel: 23-4129
Cable: SICO Calcutta
The Scientific Instrument Co., Ltd.
30, Mount Road
Madras 2
Tel: 86339
Cable: SICO Madras

The Scientific Instrument Co., Ltd.
B-7, Ajmeri Gate Extn.
New Delhi 1
Tel: 27-1053
Cable: SICO New Delhi

IRAN

Telecom, Ltd.
P. O. Box 1812
Teheran
Tel: 43850, 48111
Cable: BASCOM Teheran

ISRAEL

Electronics & Engineering
Div. of Motorola Israel Ltd.
16, Kremenetski Street
Tel-Aviv
Tel: 35021/2/3
Cable: BASTEL Tel-Aviv

JAPAN

Yokogawa-Hewlett-Packard Ltd.
Shinhankyu Building
No. 8, Umeda
Kita-ku, Osaka City
Tel: 0726-23-1641
Yokogawa-Hewlett-Packard Ltd.
Ito Building
No. 59, Kotori-cho
Nakamura-ku, Nagoya City
Tel: 551-0215

Yokogawa-Hewlett-Packard Ltd.
Ohashi Building
No. 59, I-chome, Yoyogi
Shibuya-ku, **Tokyo**
Tel: 370-2281
Cable: YOKOHEWPAK Tokyo
Telex: 232-2034

KENYA

R. J. Tilbury Ltd.
P. O. Box 2754
Suite 517/518
Hotel Ambassadeur
Nairobi
Tel: 25670, 26803, 68206
Cable: ARJAYTEE Nairobi

KOREA

American Trading Co., Korea, Ltd.
Seoul P.O. Box 1103
112-35 Sokong-Dong
Jung-ku, **Seoul**
Tel: 3.7049, 3.7613
Cable: AMTRACO Seoul

LEBANON

Constantin E. Macridis
Clemenceau Street
Clemenceau Center
Beirut
Tel: 220846
Cable: ELECTRONUCLEAR Beirut

MALAYSIA

MECOMB Malaysia Ltd.
2 Lorong 13 6A
Section 13
Petaling Jaya, **Selangor**
Cable: MECOMB Kuala Lumpur

NEW ZEALAND

Sample Electronics (N.Z.) Ltd.
8 Matipo Street
Onehunga S.E. 5
Auckland
Tel: 667-356
Cable: ELPMS Auckland

PAKISTAN (EAST)

Mushko & Company, Ltd.
31, Jinnah Avenue
Dacca
Tel: 80058
Cable: COOPERATOR Dacca

PAKISTAN (WEST)

Mushko & Company, Ltd.
Osman Chambers
Victoria Road
Karachi 3
Tel: 51027, 52927
Cable: COOPERATOR Karachi

SINGAPORE

Mechanical and Combustion
Engineering Company Ltd.
9, Jalan Kilang
Singapore, 3
Tel: 642361-3
Cable: MECOMB Singapore

SOUTH AFRICA

F. H. Planter & Co. (Pty.), Ltd.
Rosella House
Buitencingle Street
Cape Town
Tel: 3-3817
Cable: AUTOPHONE Cape Town

F. H. Planter & Co. (Pty.), Ltd.
104 Pharmacy House
80 Jorissen Street
Braamfontein, **Johannesburg**
Tel: 724-4172

TAIWAN

Hwa Sheng Electronic Co., Ltd.
P. O. Box 1558
21 Nanking West Road
Taipei
Tel: 46076, 45936
Cable: VICTRONIX Taipei

THAILAND

The International
Engineering Co., Ltd.
P. O. Box 39
614 Sukhumvit Road
Bangkok
Tel: 913460-1-2
Cable: GYSOM Bangkok

VIETNAM

Landis Brothers and Company,
Inc.
P. O. Box H-3
216 Hien-Vuong
Saigon
Tel: 20.805
Cable: LANBROCOMP Saigon

FOR AREAS NOT LISTED, CONTACT: Hewlett-Packard Export Marketing, 1501 Page Mill Road, Palo Alto, California 94304. Tel: (415) 326-7000; Telex: 034-8461; Cable: HEWPACK Palo Alto

