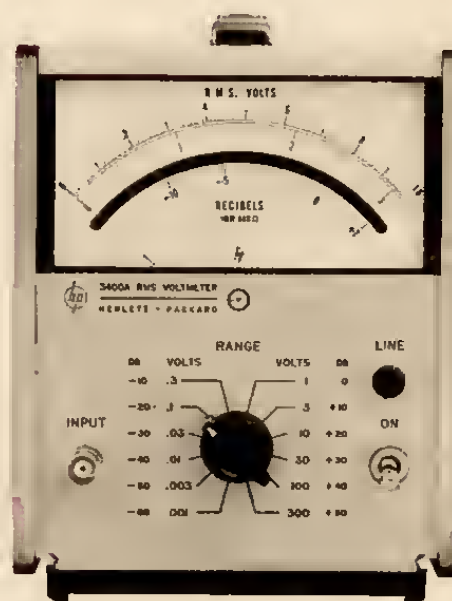


OPERATING AND SERVICE MANUAL

RMS VOLTMETER

3400A

**HEWLETT**  **PACKARD**

CERTIFICATION

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

WARRANTY AND ASSISTANCE

This Hewlett-Packard product is warranted against defects in materials and workmanship for a period of one year from the date of shipment, except that in the case of certain components, if any, listed in Section I of this operating manual, the warranty shall be for the specified period. Hewlett-Packard will, at its option, repair or replace products which prove to be defective during the warranty period provided they are returned to Hewlett-Packard, and provided the proper preventive maintenance procedures as listed in this manual are followed. Repairs necessitated by misuse of the product are not covered by this warranty. **NO OTHER WARRANTIES ARE EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. HEWLETT-PACKARD IS NOT LIABLE FOR CONSEQUENTIAL DAMAGES.**

If this product is sold as part of a Hewlett-Packard integrated instrument system, the above warranty shall not be applicable, and this product shall be covered only by the system warranty.

Service contracts or customer assistance agreements are available for Hewlett-Packard products.

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



MANUAL CHANGES

Model 3400A

RMS VOLTMETER

Manual Part No. 03400-90008

I New or Revised Item

ERRATA:

Page 5-3, Paragraph 5-12 d and f. Change reference from 0.707 volts to 0.707 millivolts.

Page 6-5/6-6, Figure 6-2. Change value of C403 to 0.1 μ F.

Page 6-9/6-10, Figure 6-4. Change Part No. on A7 schematic to 03400-66510.

Page 7-3, Table 7-1. Change C403 to Part No. 0160-0269, C:fxd 0.1 μ F 500 V.

Page 7-4. Change C427 to a selected component, C427*.

Page 7-5. Change R403 and R404 to R403* and R404*. Change R419* to Part No. 0683-3315, R:fxd $330 \Omega \pm 5\%$ 1/4W.

Page 7-6. Change R426 and R429 to R426* and R429*.

CHANGE NO. 1: For All Serial Numbers.

Page 7-8. Add Part No. 1200-0077, Insulator:transistor mica, TQ = 3 to Miscellaneous Parts.

CHANGE NO. 2: For Serial No. 1218A14726 and Greater.

Page 7-6. Change R207 to Part No. 0757-0848.

CHANGE NO. 3: For Serial No. 1218A16126 and Greater.

Page 6-9/6-10, Figure 6-4. Change value of A7R708 to 24.

Page 7-4. Change CR704 to Part No. 1901-0701.

Page 7-5. Change Q1 to Part No. 1853-0063 Tstr:Si PNP.

Page 7-7. Change R708 to Part No. 0683-2405 R:fxd $24 \Omega \pm 5\%$ 1/4W.

CHANGE NO. 4: For Serial Numbers 1218A16126 thru 1218A16425.

C711 is 0170-0019 C:fxd 0.1 μ F 200 V R701, R702 are 0757-0852 R:fxd 47.5 K 1%.

If C711, R701 or R702 require replacement, replace with part number listed above. If unable to obtain above part numbers, replace all three components with part numbers specified in Table 7-1. This is necessary to maintain the same oscillator frequency provided by the above component values.

CHANGE NO. 5: For Serial Numbers 1218A18576 and Greater.

Page 6-9/6-10, Fig. 6-4. Change T1 lead designation color codes as follows:

	<u>OLD</u>	<u>NEW</u>
Primary Side —	YEL(L)	8LK
	8LU	8LK/GRN
	GRN(L)	8LK/YEL
	VIO	8LK/RED

Secondary Side—	RED(S) pin 16	8LU
	ORN(L) pin 8	VIO

ALL OTHER SECONDARY COLOR CODES REMAIN THE SAME.

Page 7-2, Fig. 7-1. Change Index No. 6, Rear Panel, to Part No. 03400-00205.

CHANGE NO. 6 applies to serial numbers 1218A18776 and greater.

Page 7-8, Miscellaneous. Delete Insulator, 1200-0043 and 1200-0077.
Add Insulator:Transistor, 0340-0580.

CHANGE NO. 7 applies to serial numbers 1218A19076 and greater.

Page 6-3/6-4, A2 Schematic. Change A2C208 from .01 μ F to .02 μ F.

Page 7-3, Table 7-1. Change the -hp- Part Number and description of C208 to 0150-0024, 0.02 μ F.

CHANGE NO. 8 applies to all serial numbers.

Page 1-0, Table 1-1. Change the POWER specification to: 115 or 230 V ac $\pm 10\%$, 48 to 66 Hz, 15 VA max.

Page 6-5/6-6, Figure 6-2. Change R433 from 24 K to 24.9 K.

Page 6-7/6-8, Figure 6-3. Change R617 from 1800 to 1.82 K and R3* from 1200 to 1210.

10 October 1977

Supplement A for 03400-90008

Page 6-9/6-10, Figure 6-4. Change R704 from 36 K to 36.5 K.

Page 7-5 and 7-7, Table 7-1. Change the -hp- Part Numbers and descriptions as shown in Table MC-1.

Table MC-1.

R3*	0757-0734	1.21 k Ω \pm 1%
R433	069B-3217	24.9 k Ω \pm 1% 1/4W
R434, R435	0757-0739	2000 Ω \pm 1% 1/4W
R617	0757-0738	1.82 k Ω \pm 1%
R703	0757-0765	36.5 k Ω \pm 1%

CHANGE ND. 9 applies to all serial numbers.

Page 1-1. Add the following new paragraphs.

1-16. OPTIONS AVAILABLE.

1-17. Option 910. An additional Operating and Service Manual may be ordered, part number 03400-90008.

CHANGE ND. 10 applies to Serial Number 1218A20341 and greater.

Page 7-5, Table 7-1. Change the part number of Q401, 402, 403 and 405 to 1853-02B8.

Change the part number of Q404 and 406 to 1854-0354.

Page 7-6 and 7-7. Show the following reference designators as starred value components.

R403*
R404*
R426*
R429*

CHANGE ND. 11 applies to all serial numbers.

Delete all "RMS" designations throughout the entire manual.

CHANGE ND. 12 (09-14504) applies to all serial numbers.

Page 1-1, Table 1-2. Change item number 1 under IDENTIFICATION NUMBER from 10110A to 10110B.

CHANGE ND. 13 (09-14494) applies to serial numbers 1218A21041 and greater.

Page 7-3, Table 7-1. Change part number of C201 from 0170-0019 to 0160-2671.

CHANGE ND. 14 (09-14530) applies to all serial numbers.

Page 7-6, Table 7-1. Change part number of R104 from 2100-0128 to 5061-1101.

CHANGE ND. 15 (09-14840) applies to serial numbers 1218A21121 and greater.

Page 7-3, Table 7-1.

Delete: P.C. Assy - ATTEN 03400-68501 1 ea.

Add: P.C. Assy - ATTEN 03400-66511 1 ea;

The P.C. assemblies are completely interchangeable.

CHANGE NO. 16 (09-14845) applies to serial numbers 1218A21281 and greater.

Page 7-5.

Delete: Q2, O3 XSTR-GE SP1822 1850-003B 2 ea.

Add: O2, O3 XSTR PNP 2N5875 1853-0305 2 ea.

Page 7-8, Table 7-1.

Delete: R731 R-F 5360 DHM .01 0698-3258 1 ea.

R730 R-F 11.3 K OHM .01 0698-4121 1 ea.

Add: R730 R-F 10.5 K OHM .01 0698-4477 1 ea.

R731 R-F 5620 OHM .01 0757-0200 1 ea.

Page 7-4, Table 7-1.

Delete: CR706 DID-S1 1910-0025 1 ea.

Add: CR706 DIODE-SILICDN 1910-0701 1 ea.



OPERATING AND SERVICE MANUAL

(HP PART NO. 03400-90008)

MODEL 3400A RMS VOLTMETER

SERIALS PREFIXED: 1140A*

* Appendix C, Manual Backdating Changes, adapts this manual to instruments with serial numbers 0979A13725 and below, and serials prefixed: 322-, 401-, 528-, and 714-.

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P. O. Box 301, Loveland, Colorado, 80537 U. S. A.

Printed: JUNE 1972

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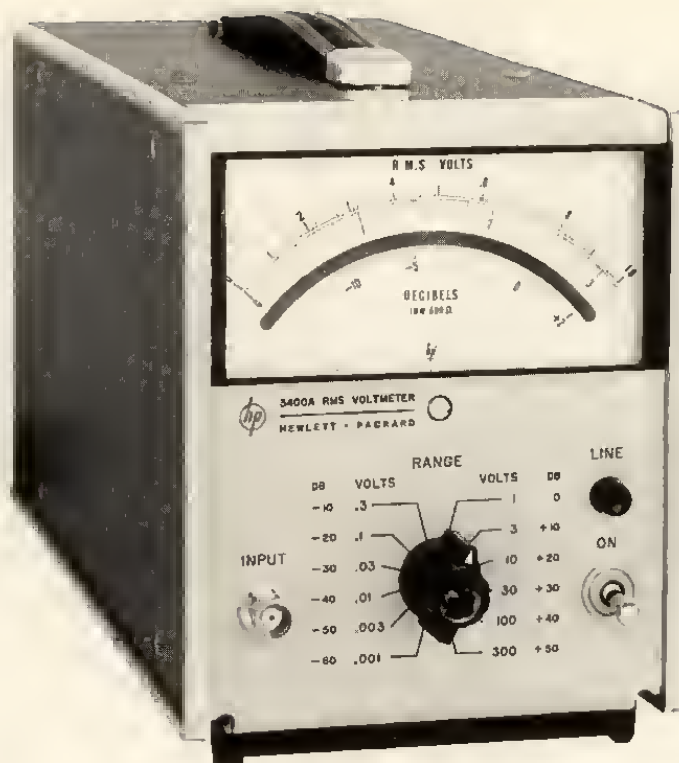


Table 1-1. Model 3400A Specifications

VOLTAGE RANGE: 1 mV to 300 V full scale, 12 ranges.

DB RANGE: -72 to +52 dBm (0 dBm = 1 mW in 600Ω).

FREQUENCY RANGE: 10 Hz to 10 MHz.

RESPONSE: Responds to rms value (heating value) of input signal.

METER ACCURACY: % of Full Scale (20°C to 30°C)*

10 Hz	50 Hz	1 MHz	2 MHz	3 MHz	10 MHz
±5%	±1%	±2%	±3%	±5%	

AC-to-DC CONVERTER ACCURACY: % of Full Scale (20°C to 30°C)*

10 Hz	50 Hz	1 MHz	2 MHz	3 MHz	10 MHz
±5%	±0.75%	±2%	±3%	±5%	

OUTPUT: Negative 1 V dc into open circuit for full-scale deflection, proportional to meter deflection; 1 mA maximum; nominal source impedance 1000Ω.

OUTPUT NOISE: < 1 mV RMS.

CREST FACTOR: (ratio of peak-to-rms amplitude of input signal): 10:1 at full scale (except where limited by maximum input), inversely proportional to meter deflection (e.g., 20:1 at half-scale, 100:1 at tenth-scale).

INPUT IMPEDANCE: 0.001 V to 0.3 V range; 10 MΩ shunted by <50 pF; 1.0 V to 300 V range; 10 MΩ shunted by <20 pF. AC-coupled input.

AC OVERLOAD: 30 dB above full scale or 800 V peak, whichever is less, on each range.

MAXIMUM DC INPUT: 600 V on any range.

RESPONSE TIME: For a step function, < 5 seconds to respond to final value.

POWER: 115 or 230 V ±10%, 48 to 440 Hz. approximately 7 watts.

WEIGHT: Net 7 1/4 lbs. (3, 3kg); shipping 10 lbs. (5 kg).

OVERALL DIMENSIONS: 6 1/2" high; 5 1/8" wide; 11 11/16" deep.

*Temperature Coefficient: ±0.1% over range of 0°C to 20°C and 30°C to 55°C.

SCOPE OF MANUAL

This manual contains the information necessary for operating and servicing the standard Model 3400A RMS Voltmeter and the Model 3400A/Option 01 RMS Voltmeter (DB scale uppermost).

SECTION I GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This section contains general information about the Model 3400A RMS Voltmeter (Figure 1-1). Included are: description of instrument, purpose, instrument identification, equipment supplied and accessory equipment available. Also included is a table of instrument specifications.

1-3. DESCRIPTION AND PURPOSE.

1-4. The Model 3400A RMS Voltmeter measures the actual root-means-square (RMS) value of ac voltages between 100 microvolts and 300 volts. Frequency range is from 10 Hz to 10 MHz. Full scale measurements of nonsinusoidal waveforms with crest factors (ratio of peak voltage to rms voltage) of 10 can be made.

1-5. Ac voltages are measured with a specified full-scale accuracy of $\pm 1\%$ from 50 Hz to 1 MHz, $\pm 2\%$ from 1 MHz to 2 MHz, $\pm 3\%$ from 2 MHz to 3 MHz, and $\pm 5\%$ from 10 Hz to 50 Hz and 3 MHz to 10 MHz. A single front panel control selects one of 12 voltage or decibel ranges.

1-6. The Model 3400A crest factor rating is 10:1 which enables full scale readings for pulses which have a 1% duty cycle. At 1/10th of full scale, pulse trains with 0.01% duty cycle (100:1 crest factor) can be accurately measured.

1-7. The Model 3400A provides a dc output which is proportional to the front panel meter reading. By using this voltage to drive auxiliary equipment, the Model 3400A functions as an rms ac-to-dc converter.

1-8. SPECIFICATIONS.

1-9. Table 1-1 contains the specifications for the Model 3400A.

1-10 INSTRUMENT AND MANUAL IDENTIFICATION.

1-11. Hewlett-Packard uses a two-section serial number. If the first section (serial prefix) of the serial

01768-4

number on your instrument does not agree with those on the title page of this manual, change sheets supplied with the manual will define the differences between your instrument and the Model 3400A described in this manual. Some serial numbers may have a letter separating the two sections of the number. This letter indicates the country in which the instrument was manufactured.

1-12. EQUIPMENT SUPPLIED.

1-13. The equipment supplied with each Model 3400A is listed and described in Table 1-2.

Table 1-2. Equipment Supplied

IDENTIFICATION NUMBER	QUANTITY	DESCRIPTION
10110A	1	Adapter (BNC to dual banana jack)
8120-1348	1	Power Cord
03400-90008	1	Operating and Service Manual

1-14. ACCESSORY EQUIPMENT AVAILABLE.

1-15. The accessory equipment available is listed in Table 1-3. For further information contact your local -hp- Sales and Service Office. (See Appendix B for office locations.)

Table 1-3. Accessory Equipment Available

IDENTIFICATION NUMBER	DESCRIPTION
10503A	Cable (Male BNC to male BNC, 48 inches)
11001A	Cable (Male BNC to dual banana plug, 45 inches)
11002A	Test Lead (dual banana plug to alligator clips, 60 inches)
11003A	Test Lead (dual banana plug to probe and alligator clip, 60 in.)
456A	Current Probe

SECTION II

INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains information and instructions necessary for installation and shipping of the -hp- Model 3400A RMS Voltmeter. Included are initial inspection procedures, power requirements, installation information, and instructions for repackaging for shipment.

2-3. INITIAL INSPECTION.

2-4. The -hp- Model 3400A RMS Voltmeter received a careful mechanical and electrical inspection before shipment. As soon as the Model 3400A is received, verify that the contents are intact and as ordered. Although the instrument should be free of marks and scratches and in perfect electrical condition, it should be inspected for any physical damage which may have been incurred in transit. Also test the electrical performance of the instrument using the procedures given in paragraph 5-5. If any physical damage or electrical deficiency is found, refer to the warranty on the inside front cover of this manual. Should shipping of the instrument become necessary, refer to paragraph 2-14 for repackaging and shipping instructions.

2-5. POWER REQUIREMENTS.

2-6. The Model 3400A can be operated from any ac source of 115- or 230- volts ($\pm 10\%$), at 48 to 440 cycles. With the instrument disconnected from the ac power source, move the slide switch (located on the rear panel) until the desired line voltage value appears. The ac line fuse is a 0.25 amp, fast blow type for 115- or 230-volt operation. Power dissipation is approximately 7 watts.

2-7. The Model 3400A is equipped with a three-prong power cord. To protect operating personnel, it is necessary to preserve the grounding feature of this plug when using a two contact ac outlet. Use a three-prong to two-prong adapter and connect the green pigtail lead on the adapter to ground.

2-8. INSTALLATION.

2-9. The Model 3400A is a submodular unit suitable for bench top use. 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 for this purpose.

2-10. COMBINING CASE (-hp- Models 1051A or 1052A).

2-11. The combining case is a full-module unit which accepts various combinations of submodular units. Being a full-module unit, it can be bench or rack mounted and is analogous to any full-module instrument.

2-12. ADAPTER FRAME (-hp- Part No. 5060-0797).

2-13. The adapter frame is a rack frame that accepts any combination of submodular units. It can be rack mounted only. For additional information, address inquiries to your -hp- Sales and Service Office. (See Appendix B for office location.)

2-14. REPACKAGING FOR SHIPMENT.

2-15. The following paragraphs contain a general guide for repackaging for shipment. Refer to paragraph 2-16 if the original container is to be used; 2-17 if it is not. If you have any questions, contact your local -hp- Sales and Service Office.

NOTE

If the instrument is to be shipped to Hewlett-Packard for service or repair, attach a tag to the instrument identifying the owner and indicate the service or repair to be accomplished; include the model number and full serial number of the instrument. In any correspondence, identify the instrument by model number, serial number, and serial number prefix.

2-16. If original container is to be used, proceed as follows:

a. Place instrument in original container if available. If original container is not available, one can be purchased from your nearest -hp- Sales and Service Office.

b. Ensure that the container is well sealed with strong tape or metal bands.

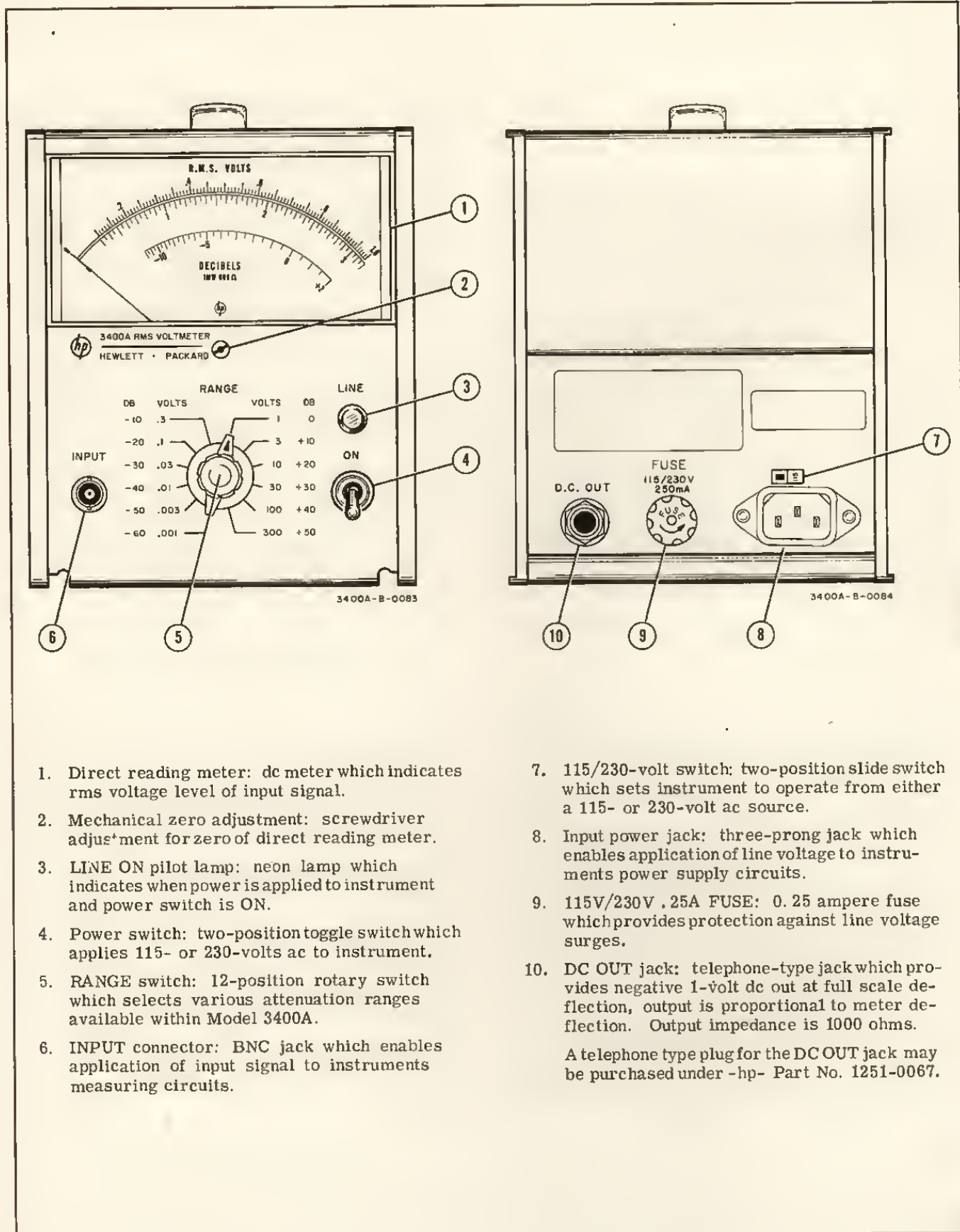
2-17. If original container is not to be used, proceed as follows:

a. Wrap instrument in heavy paper or plastic before placing in an inner container.

b. Use packing material around all sides of instrument and protect panel face with cardboard strips.

c. Place instrument and inner container in a heavy carton or wooden box and seal with strong tape or metal bands.

d. Mark shipping container with "DELICATE INSTRUMENT," "FRAGILE," etc.



1. Direct reading meter: dc meter which indicates rms voltage level of input signal.
2. Mechanical zero adjustment: screwdriver adjustment for zero of direct reading meter.
3. LINE ON pilot lamp: neon lamp which indicates when power is applied to instrument and power switch is ON.
4. Power switch: two-position toggle switch which applies 115- or 230-volts ac to instrument.
5. RANGE switch: 12-position rotary switch which selects various attenuation ranges available within Model 3400A.
6. INPUT connector: BNC jack which enables application of input signal to instruments measuring circuits.

7. 115/230-volt switch: two-position slide switch which sets instrument to operate from either a 115- or 230-volt ac source.
8. Input power jack: three-prong jack which enables application of line voltage to instruments power supply circuits.
9. 115V/230V .25A FUSE: 0.25 ampere fuse which provides protection against line voltage surges.
10. DC OUT jack: telephone-type jack which provides negative 1-volt dc out at full scale deflection, output is proportional to meter deflection. Output impedance is 1000 ohms.

A telephone type plug for the DC OUT jack may be purchased under -hp- Part No. 1251-0067.

Figure 3-1. Model 3400A Controls and Indicators

SECTION III

OPERATING INSTRUCTIONS

3-1. INTRODUCTION.

3-2. This section consists of instructions and information necessary for the operation of the -hp- Model 3400A RMS Voltmeter. This section contains identification of controls and indicators, turn-on procedures, and operating instructions. Also included is a discussion of the applications for the Model 3400A.

3-3. CONTROLS AND INDICATORS.

3-4. Each operating control, connector, and indicator located on the Model 3400A is identified and described in Figure 3-1. The description of each component is keyed to an illustration of that component which is included within the figure.

3-5. TURN ON PROCEDURE.

3-6. To turn on the Model 3400A, proceed as follows:

- a. Set 115/230 switch (7, Figure 3-1) to correct position for input line voltage.
- b. Apply ac voltage to Model 3400A by plugging power cord into input power jack (8) ac receptacle.
- c. Operate power switch (4) to ON; ensure that LINE indicator (3) lights.

NOTE

Allow five minutes for the Model 3400A to warm up and stabilize before making a reading.

3-7. OPERATING INSTRUCTIONS.

CAUTION

DO NOT MEASURE SIGNAL ABOVE 80 VOLTS WITH 10 TO 1 CREST FACTOR. OTHERWISE, THE MAXIMUM INPUT RATING (800 VOLTS PEAK) WILL BE EXCEEDED. WHEN MEASURING SIGNALS UP TO 80 VOLTS RMS WITH A 10 TO 1 CREST FACTOR, USE THE BNC TO DUAL BANANA JACK, ACCESSORY 10110A, SUPPLIED WITH THE INSTRUMENT, OR OTHER INPUT TEST LEADS AND CONNECTIONS THAT WILL WITHSTAND THE MAXIMUM INPUT OF 800 VOLTS PEAK.

3-8. To operate the Model 3400A as an rms voltmeter proceed as follows:

- a. Attach test lead to INPUT connector (6, Figure 3-1). (See Table 1-3 for a list of test leads available.)
- b. Set RANGE switch (5) to 300 VOLTS position.

CAUTION

WHEN MEASURING AN AC SIGNAL SUPERIMPOSED ON A DC LEVEL, ALWAYS SET THE RANGE SWITCH TO THE 300 VOLT POSITION. A HIGH VOLTAGE TRANSIENT DUE TO THE APPLICATION OF A DC VOLTAGE WILL DAMAGE THE INPUT CIRCUITRY.

- c. Connect test lead to point to be measured.
- d. Rotate RANGE switch counterclockwise until meter (1) indicates on upper two thirds of scale.

3-9. APPLICATIONS.

3-10. The Model 3400A can be used in conjunction with other test instruments to measure the rms value of ac signal with a dc component, measure rms current and act as an rms ac-to-dc converter. For additional information on special applications, contact your -hp- Sales and Service Office.

3-11. RMS VALUE OF AC SIGNALS WITH DC COMPONENT.

3-12. Since the 3400A is an ac device it will measure only the rms value of the ac component. If it is necessary to include the rms value of the dc component when measuring a signal use a -hp- Model 412A DC Voltmeter to measure the dc component. Substitute the reading from the Model 412A and Model 3400A in the following formula: The ac signal (up to 800 V peak) may be superimposed on a dc level of up to 600 V.

$$e_{rms} = \sqrt{e_{ac}^2 + e_{dc}^2}$$

3-13. RMS CURRENT.

3-14. To measure rms current, use an -hp- Model 456A AC Current Probe. This probe clips around the current conductor and provides an output voltage that is proportional to the current being measured. Using this method, rms currents of one milliampere to one ampere can be measured.

3-15. RMS AC-TO-DC CONVERTER.

3-16. Since the Model 3400A is provided with a dc output (10, Figure 3-1) which is proportional to the meter deflection, it can be used as a linear rms ac to dc converter. The dc output can be used to drive a -hp- Model 3440A Digital Voltmeter for high resolution measurements and/or a Mosely Model 680 Strip Chart Recorder. External loading does not affect the meter accuracy so that both the meter and dc output can be used simultaneously. A plug for DC OUT jack may be purchased under -hp- Part No. 1251-0067.

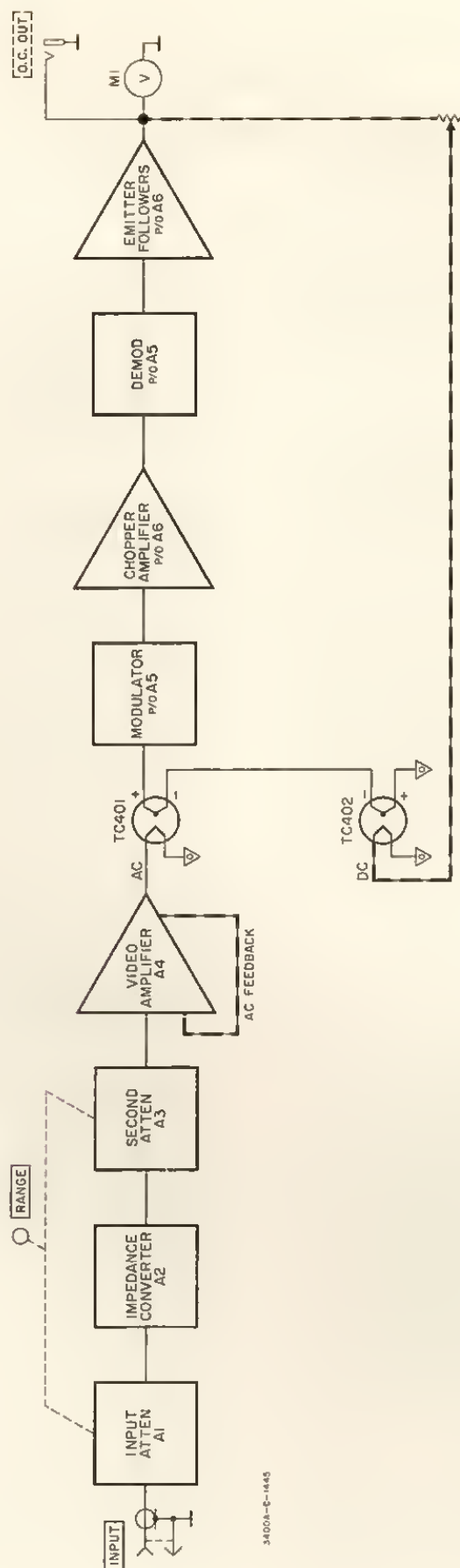


Figure 4-1. Block Diagram

SECTION IV

THEORY OF OPERATION

4-1. INTRODUCTION.

4-2. This section contains the theory of operation of the Model 3400A RMS Voltmeter. Included is a general and detailed description of the theory of operation.

4-3. GENERAL DESCRIPTION.

4-4. The Model 3400A comprises two attenuators, an impedance converter, a video amplifier, a photo-conductor chopper (modulator/demodulator), a chopper amplifier, an emitter follower, a thermocouple pair, and a direct reading meter. (See Figure 4-1.)

4-5. A signal being measured with the Model 3400A is applied to input attenuator A1 through the INPUT jack, located on the Model 3400A front panel. The input attenuator has an input impedance of over 10 megohms and provides two ranges of attenuation. The output of the input attenuator is applied to impedance converter A2. The impedance converter is a non-inverting unity voltage gain amplifier. It presents a high impedance to the input signal and provides a low impedance output to drive the second attenuator A3. The second attenuator provides 6 ranges in a 1, 3, 10 sequence. The two attenuators are switched to provide 12 ranges of attenuation.

4-6. The output of the second attenuator is amplified by video amplifier A4. The video amplifier is a wide-band, five stage amplifier. The overall gain of the video amplifier is controlled by an ac feedback loop. The ac output of the amplifier is applied to TC401; one of the thermocouples of the thermocouple pair.

4-7. The dc output of TC401 is modulated by modulator A5. The modulator comprises two photocells which are alternately illuminated by two neon lamps which in turn are controlled by the oscillator located on power supply assembly A7. The output of the modulator is a square wave whose amplitude is proportional to the dc input level.

4-8. The square wave output of the modulator is amplified by chopper amplifier A6. The chopper amplifier is a high gain ac amplifier. Its output is applied to demodulator A5. The demodulator output is a dc level whose magnitude is proportional to the amplitude of the ac input. The demodulator output is applied to two direct coupled emitter followers. The emitter follower is used to make the impedance transformation from the high impedance output of the demodulator to the low impedance of the direct reading meter M1 and TC402; the second thermocouple of the thermocouple pair.

4-9. The thermocouple pair TC401 and TC402 acts as a summing point for the ac output of the video amplifier A4 and the dc output of the emitter followers.

The difference in the heating effect of these voltages is felt as a dc input to modulator A5. This difference input is amplified and is fed to TC402 and to meter M1. This amplified dc voltage represents the rms value of the ac signal applied at the INPUT jack. By using two "matched" thermocouples and measuring the difference, the output to the modulator will be linear. Using two thermocouples also provides temperature stability.

4-10. The dc voltage driving meter M1 is also available at the DC OUT jack, located at the rear of the Model 3400A.

4-11. DETAILED DESCRIPTION.

4-12. INPUT ATTENUATOR ASSEMBLY A1.

4-13. The input attenuator assembly is a capacitive-compensated attenuator which provides two ranges of attenuation for the 12 positions of the RANGE switch. See input attenuator schematic diagram illustrated on Figure 6-1.

4-14. When the RANGE switch is positioned to one of the six most sensitive ranges (.001 to .3 VOLTS), the attenuator output voltage is equal to the input voltage. When the RANGE switch is positioned to one of six highest ranges (1 to 300 VOLTS), the input signal is attenuated 60 dB (1000: 1 voltage division) by the resistive voltage divider consisting of R101, R103, and R104. Trimmer C102 is adjusted at 100 kHz, and R104 is adjusted at 400 Hz to provide constant attenuation over the input frequency range.

4-15. IMPEDANCE CONVERTER ASSEMBLY A2.

4-16. The impedance converter assembly utilizes a nuvistor tube cathode follower circuit to match the high output impedance of the input attenuator to the low input impedance of the second attenuator. The cathode follower circuit preserves the phase relationship of the input and output signals while maintaining a gain of unity. See impedance converter assembly schematic diagram illustrated on Figure 6-1.

4-17. The ac signal input to the impedance converter is RC coupled to the grid of cathode follower V201 through C201 and R203. The output signal is developed by Q201 which acts as a variable resistance in the cathode circuit of V201. The bootstrap feedback from the cathode of V201 to R203 increases the effective resistance of R203 to the input signal. This prevents R203 from loading the input signal and preserves the high input impedance of the Model 3400A. The gain compensating feedback from the plate of V201 to the base of Q201 compensates for any varying gain in V201 due to age or replacement.

4-18. Breakdown diode CR201 controls the grid bias

voltage on V201 thereby establishing the operating point of this stage. CR202 and R211 across the base-emitter junction of Q201 protects Q201 in the event of a failure in the +75 volt power supply. Regulated dc is supplied to V201 filaments to avoid inducing ac hum in the signal path. This also prevents the gain of V201 changing with line voltage variations.

4-19. SECOND ATTENUATOR ASSEMBLY A3.

4-20. The second attenuator is a resistive divider which attenuates the ac input signal while maintaining a low impedance output for the following amplification stages. See second attenuator assembly schematic diagram illustrated in Figure 6-1.

4-21. The ac input signal is applied to a precision resistance voltage divider consisting of R302 through R312. These resistors are arranged to give six ranges of attenuation at 10 dB per range. The six ranges of the second attenuator combined with the two ranges of the input attenuator make up the 12 ranges of attenuation (0.001 to 300V). Trimmer capacitor C303 (10 MHz 0.3V ADJ) provides an adjustment for frequency response at the higher frequencies.

4-22. VIDEO AMPLIFIER ASSEMBLY A4.

4-23. The video amplifier functions to provide constant gain to the ac signal being measured over the entire frequency range of Model 3400A. See video amplifier assembly schematic diagram illustrated on Figure 6-2.

4-24. The ac input signal from the second attenuator is coupled through C402 to the base of input amplifier Q401. Q401, a class A amplifier, amplifies and inverts the signal which is then direct coupled to the base of bootstrap amplifier Q402. The output, taken from Q402 emitter is applied to the base of Q403 and fed back to the top of R406 as a bootstrap feedback. This positive ac feedback increases the effective ac resistance of R406 allowing a greater portion of the signal to be felt at the base of Q402. In this manner, the effective ac gain of Q401 is increased for the mid-band frequencies without disturbing the static operating voltages of Q401.

4-25. Driver amplifier Q403 further amplifies the ac signal and the output at Q403 collector is fed to the base circuit emitter follower Q404. The feedback path from the collector of Q403 to the base of Q402 through C405 (10 MHz ADJ) prevents spurious oscillations at high input frequencies. A dc feedback loop exists from the emitter circuit of Q403, to the base of Q401 through R425. This feedback stabilizes the Q401 bias voltage. Emitter follower Q404 acts as a driver for the output amplifier consisting of Q405 and Q406; a complimentary pair operating as a push-pull amplifier. The video amplifier output is taken from the collectors of the output amplifiers and applied to thermocouples TC401. A gain stabilizing feedback is developed in the emitter circuits of the output amplifiers. This negative feedback is applied to the emitter of input amplifier Q401 and establishes the overall gain of the video amplifier.

4-26. Trimmer capacitor C405 is adjusted at 10 MHz for frequency response of the video amplifier. Diodes CR402 and CR406 are protection diodes which prevent voltage surges from damaging transistors in the video amplifier. CR401, CR407, and CR408 are temperature compensating diodes to maintain the zero signal balance condition in the output amplifier over the operating temperature range. CR403, a breakdown diode, establishes the operating potentials for the output amplifier.

4-27. PHOTOCHOPPER ASSEMBLY A5, CHOPPER AMPLIFIER ASSEMBLY A6, AND THERMOCOUPLE PAIR (PART OF A4).

4-28. The modulator/demodulator, chopper amplifier, and thermocouple pair form a servo loop which functions to position the direct reading meter M1 to the rms value of the ac input signal. See modulator/demodulator, chopper amplifier, and thermocouple pair schematic diagram illustrated in Figure 6-3.

4-29. The video amplifier output signal is applied to the heater of thermocouple TC401. This ac voltage causes a dc voltage to be generated in the resistive portion of TC401 which is proportional to the heating effect (rms value) of the ac input. The dc voltage is applied to photocell V501.

4-30. Photocells V501 and V502 in conjunction with neon lamps DS501 and DS502 form a modulator circuit. The neon lamps are lighted alternately between 90 and 100 Hz. Each lamp illuminates one of the photocells. DS501 illuminates V501; DS502 illuminates V502. When a photocell is illuminated it has a low resistance compared to its resistance when dark. Therefore, when V501 is illuminated, the output of thermocouple TC401 is applied to the input of the chopper amplifier through V501. When V502 is illuminated, a ground signal is applied to the chopper amplifier. The alternate illumination of V501 and V502 modulates the dc input at a frequency between 90 and 100 Hz. The modulator output is a square wave whose amplitude is proportional to the dc input level.

4-31. The chopper amplifier, consisting of Q601 through Q603, is a high gain amplifier which amplifies the square wave developed by the modulator. Power supply voltage variations are reduced by diodes CR601 thru CR603. The amplified output is taken from the collector of Q603 and applied to the demodulator through emitter follower Q604.

4-32. The demodulator comprises two photocells, V503 and V504, which operate in conjunction with DS501 and DS502; the same neon lamps used to illuminate the photocells in the modulator. Photocells V503 and V504 are illuminated by DS501 and DS502, respectively.

4-33. The demodulation process is the reverse of the modulation process discussed in Paragraph 4-30. The output of the demodulator is a dc level which is proportional to the demodulator input. The magnitude and phase of the input square wave determines the magnitude and polarity of the dc output level. This dc output level is applied to two emitter follower output stages.

4-34. The emitter follower is needed to match the high output impedance of the demodulator to the low input impedance of the meter and thermocouple circuits. The voltage drop across CR604 in the collector circuit of Q605 is the operating bias for Q604. This fixed bias prevents Q605 failure when the base voltage is zero with respect to ground.

4-35. The dc level output, taken from the emitter of Q606, is applied to meter M1 and to the heating element of thermocouple TC402. The dc voltage developed in the resistive portion of TC402 is effectively subtracted from the voltage developed by TC401. The input signal to the modulator then becomes the difference in the dc outputs of the two thermocouples. When the difference between the two thermocouples becomes zero the dc from the emitter followers (driving the meter) will be equal to the ac from the video amplifier.

4-36. Noise on the modulated square wave is suppressed by feedback from emitter of Q606 through C607 and C608 to the resistive element of TC402.

4-37. POWER SUPPLY ASSEMBLY A7.

4-38. The power supply assembly provides dc operating voltages for the tube and transistors used in the Model 3400A. See power supply assembly schematic diagram illustrated on Figure 6-4.

4-39. Either 115 or 230 volts ac is connected to the primary of power transformer T1 through fuse F1 and the POWER switch S1. Switch S2 (slide switch on rear panel) connects T1 primary windings in series for 230-volt operation or in parallel for 115-volt operation. Neon lamp DS1 lights to indicate LINE power ON when ac power is applied and S1 is closed.

4-40. REGULATOR OPERATION.

4-41. The series regulator acts as a dynamic variable resistor in series with the power supply output. A control amplifier senses changes in the output voltage by comparing the output with a fixed reference voltage. The control amplifier then supplies any output voltage changes to the driver transistor, which in turn changes the resistance of the series regulator to oppose the change in output voltage. Diodes CR704, CR713 and CR706 across the base emitter junction of the series regulator provide overload current protection.

4-42. +75 VOLT SUPPLY.

4-43. The +75 volt supply consists of a full-wave rectifier (CR701 and CR702) whose output is filtered by C1A and C1B and regulated by series regulator Q1. The +75 volt supply provides regulated +75 volts which is used as the plate supply voltage for V201. Voltage variation from the output is felt at Q702 base circuit through C704, R715, and R716. The C703 and R709 network provides phase correction for power supply stability. The regulation circuitry is in the negative leg of the +75 volt supply, and uses the -17.5 volt supply as a reference.

4-44. -17.5 VOLT SUPPLY.

4-45. The regulated -17.5 volt supply consists of a full-wave rectifier (CR711, and CR712) whose output is filtered by C706 and C707 and regulated by Q2. Breakdown diode CR715 provides reference voltage at the base of Q2. Regulation operation is the same described in Paragraph 4-41.

4-46. -6.3 VOLT SUPPLY.

4-47. The regulated -6.3 volt supply consists of a full-wave rectifier (CR716 and CR717) whose output is filtered by C2 and regulated by Q3. Emitter follower Q705 is connected to the -17.5 volt supply which provides a reference for the -6.3 volt supply. Series regulator Q3 acts as a dynamic variable resistor in series with the output to oppose changes in output voltage.

4-48. NEON LAMP DRIVE OSCILLATOR.

4-49. The neon lamp drive oscillator consists of transistor Q706, diode CR718, resistors R701, R702, R712, R713, and capacitor C711. Transistor Q706 is held on (conducting) by the base bias developed at the junction of R712 and CR718. The collector current of Q706 charges up capacitor C711 through R701 or R702 depending upon the illuminated neon lamp on the Chopper Amplifier Assembly A6. When the capacitor reaches a sufficient charge to fire the dark neon lamp, the illumination of the neon lamps alternate and the capacitor discharges through the previously dark neon lamp. With the previously dark neon lamp illuminated, the capacitor charges up in the opposite direction until firing the previously illuminated neon lamp. The cycle described above repeats at a frequency of 90 to 100 Hz as determined by the RC time constants of R701 and C711, and R702 and C711.

Table 5-1. Required Test Equipment

INSTRUMENT TYPE	REQUIRED CHARACTERISTICS	USE	RECOMMENDED MODEL
DC Voltmeter	Accuracy: $\pm 0.1\%$ full scale Voltage Range: 10 mV to 100 V	Performance Checks Adjustment and Calibration	-hp- Model 3440A/3443A Digital Voltmeter
Voltmeter Calibrator	Voltage Range: 1 mV to 300 V rms Frequency: 400 Hz	Performance Checks Adjustment and Calibration Troubleshooting	-hp- Model 738B Volt- meter Calibrator
Oscillator	Frequency Range: 10 Hz to 10 MHz Output: 1 mV to 3 V Frequency Response: 0.25% (expand scale)	Performance Checks Adjustment and Calibration Troubleshooting	-hp- Model 652A Test Oscillator
Oscilloscope	Sensitivity: 0.005 v/cm Bandwidth: dc to 20 MHz	Adjustment and Calibration Troubleshooting	-hp- Model 140A/ 1402A/1420A
Pulse Generator	Pulse Width: variable to 10 μ sec Pulse Amp: ± 10 volts peak, variable Pulse Rate: 250 to 1000 pps	Performance Checks	-hp- Model 214A Pulse Generator
Frequency Counter	Range: 250 to 1000 Hz Accuracy: ± 1 count Time Interval: 1 μ sec	Performance Checks	-hp- Model 5233L Electronic Counter
Peak Responding Voltmeter	Voltage Range: 0.5 V to 300 V Accuracy: $\pm 3\%$ full scale	Performance Checks	-hp- Model 410C Voltmeter
Average Responding Voltmeter	Voltage Range: 0.001 to 300 V Accuracy: 1% full scale	Adjustment and Calibration Troubleshooting	-hp- Model 400E/EL Voltmeter
Current Supply/ Ohmmeter	Output: 5 mA of current into 100 Ω Ohm Range: 1 Ω to 10 M Ω Accuracy: $\pm 5\%$	Troubleshooting	-hp- Model 412A DC Vacuum Tube Voltmeter
RMS Respond- ing Volt- meter	Range: 1 mV full scale	Performance Checks	-hp- Model 3400A RMS Voltmeter
Resistor	200 k Ω , metal film, 1/4 W 1%	Performance Checks	-hp- Part No. 0757-0782
Resistor	499 k Ω , metal film, 1/4 W 1%	Troubleshooting	-hp- Part No. 0757-0327
Capacitor	1 μ F	Troubleshooting	-hp- Part No. 0180-0269
50 Ω Feedthru Termination	Resistor: fixed comp 50 Ω $\pm 5\%$ 1/4 W	Performance Checks	-hp- Model 11048B 50 Ω Feedthru
BNC-T- Adapter	- -	Performance Checks Adjustment and Calibration	-hp- Part No. 1250-0072
Adapter	410C to Dual Banana	Performance Checks	-hp- Model 11018A
Extender Board	15 pin programmable	Troubleshooting	-hp- Part No. 5060-6038

SECTION V MAINTENANCE

5-1. INTRODUCTION.

5-2. This section contains the information necessary for maintenance of the Model 3400A RMS Voltmeter. Included are performance checks, adjustment and calibration procedures, and troubleshooting procedures.

5-3. TEST EQUIPMENT.

5-4. The test equipment required for the maintenance of the Model 3400A is listed in Table 5-1. If the recommended model is not available, use any substitute that meets the required characteristics.

5-5. PERFORMANCE CHECKS.

5-6. The Performance Checks are in-cabinet tests that compare the Model 3400A with its given specifications. These checks may be used for incoming inspection, periodic maintenance, and for specification checks after a repair. A Performance Check Test Card is provided at the end of this section for recording the performance of the instrument during the Performance Checks. The card may be removed from the manual and used as a permanent record of the incoming inspection or of a routine performance check. If the instrument fails to meet any of its specifications, perform the Adjustment and Calibration Procedures outlined in Paragraph 5-15.

NOTE

Allow a 30-minute warmup period before making performance checks. During the performance checks, periodically vary the Model 3400A line voltage $\pm 10\%$ with a power line transformer to assure that the instrument operates correctly at various ac line voltages.

5-7. ACCURACY, LINEARITY, AND DC OUTPUT CHECK.

5-8. The accuracy, linearity, and dc output test setup is illustrated in Figure 5-1. A Voltmeter Calibrator -hp- Model 738B and a DC Voltmeter -hp- Model 3440A/3443A) are required for this test.

- a. Connect test setup illustrated in Figure 5-1.
- b. Set Model 3400A RANGE switch to 0.001 position.
- c. Adjust Voltmeter Calibrator for 0.001 volt, rms 400 Hz output; set the DC Voltmeter to measure 1 volt.
- d. If Model 3400A does not indicate within values listed under "meter reading" in Table 5-2, perform low frequency calibration procedure, Paragraph 5-21. Record 3400A readings.
- e. Dc output as indicated on dc voltmeter should be within values listed under "3400A DC output" in Table 5-2.
- f. Continue to check accuracy, linearity, and dc output using Table 5-2.

Table 5-2. Accuracy, Linearity, and DC Output Check Data

VOLTMETER CALIBRATOR OUTPUT (V)	3400A VOLTAGE RANGE (V)	3400A METER READING (V)	3400A DC OUTPUT (V)
0.001	0.001	0.000990 to 0.00101	0.992 to 1.008
0.003	0.003	0.00297 to 0.00303	0.942 to 0.957
0.01	0.01	0.00990 to 0.0101	0.992 to 1.008
0.03	0.03	0.0297 to 0.0303	0.942 to 0.957
0.1	0.1	0.0990 to 0.101	0.992 to 1.008
0.3	0.3	0.297 to 0.303	0.942 to 0.957
1.0	1.0	0.990 to 1.01	0.992 to 1.008
0.9	1.0	0.89 to 0.91	0.892 to 0.908
0.8	1.0	0.79 to 0.81	0.792 to 0.808
0.7	1.0	0.69 to 0.71	0.692 to 0.708
0.6	1.0	0.59 to 0.61	0.592 to 0.608
0.5	1.0	0.49 to 0.51	0.492 to 0.508
0.4	1.0	0.39 to 0.41	0.392 to 0.408
0.3	1.0	0.29 to 0.31	0.292 to 0.308
0.2	1.0	0.19 to 0.21	0.192 to 0.208
0.1	1.0	0.090 to 0.11	0.092 to 0.108
3.0	3.0	2.97 to 3.03	0.942 to 0.957
10.0	10.0	9.90 to 10.10	0.992 to 1.008
30.0	30.0	29.7 to 30.3	0.942 to 0.957
100.0	100.0	99.0 to 101.0	0.992 to 1.008
300.0	300.0	297.0 to 303.0	0.942 to 0.957

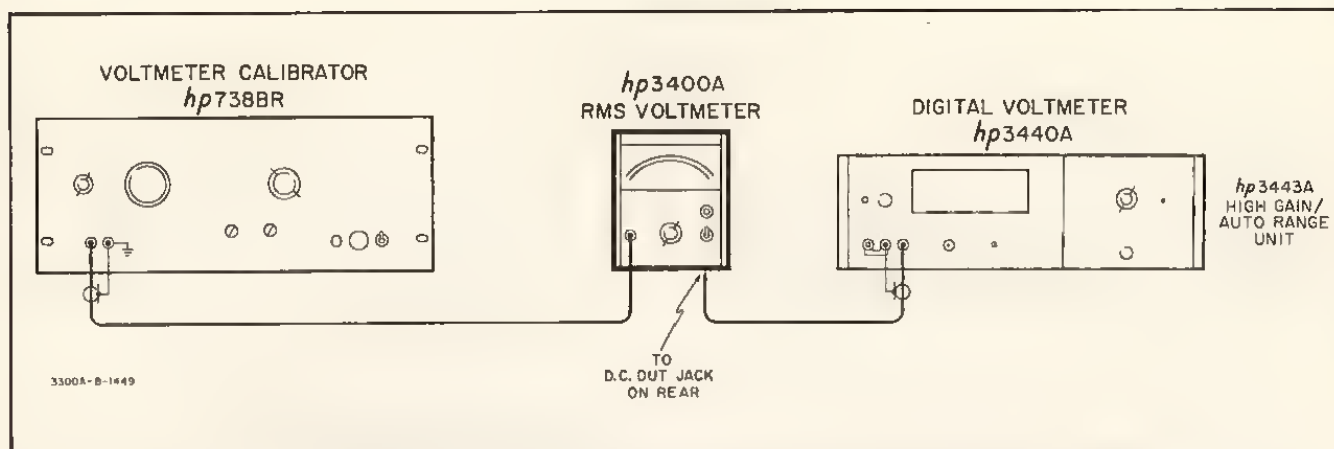


Figure 5-1. Accuracy, Linearity, and DC Output Test Setup

5-9. FREQUENCY RESPONSE CHECK.NOTE

Connect 50Ω feedthru termination directly to 3400A INPUT to eliminate loss in output cable at high frequency.

- Connect test setup illustrated in Figure 5-2.
- Set Model 3400A RANGE switch and Test Oscillator output attenuator to 1 volt position.
- Set Test Oscillator for 400 Hz output and adjust output amplitude for the reading obtained in Paragraph 5-8 step d on the Model 3400A.
- Switch the Test Oscillator monitor switch to expand mode and set a convenient reference level.
- Adjust test oscillator output frequency to values listed under "frequency" in Table 5-3; adjust oscillator output voltage to maintain reference level set in step d. If Model 3400A does not indicate within values under "meter reading" in Table 5-3, perform high frequency calibration procedures, Paragraph 5-25.

Table 5-3. Frequency Response Check

FREQUENCY	METER READING
15 Hz	0.95 to 1.05
45 Hz	0.95 to 1.05
100 Hz	0.99 to 1.01
900 kHz	0.99 to 1.01
1.2 MHz	0.98 to 1.02
1.8 MHz	0.98 to 1.02
2.2 MHz	0.97 to 1.03
2.8 MHz	0.97 to 1.03
3.2 MHz	0.95 to 1.05
9.8 MHz	0.95 to 1.05

5-10. INPUT IMPEDANCE CHECK.5-11. RESISTANCE CHECK.

- Connect the Test Oscillator, 50 ohm feedthru and -hp- Model 3400A to position A in Figure 5-3.
- Set 3400A to 1 volt range and Test Oscillator to 400 Hz.
- Adjust Test Oscillator output for 1 volt indication on Model 3400A.

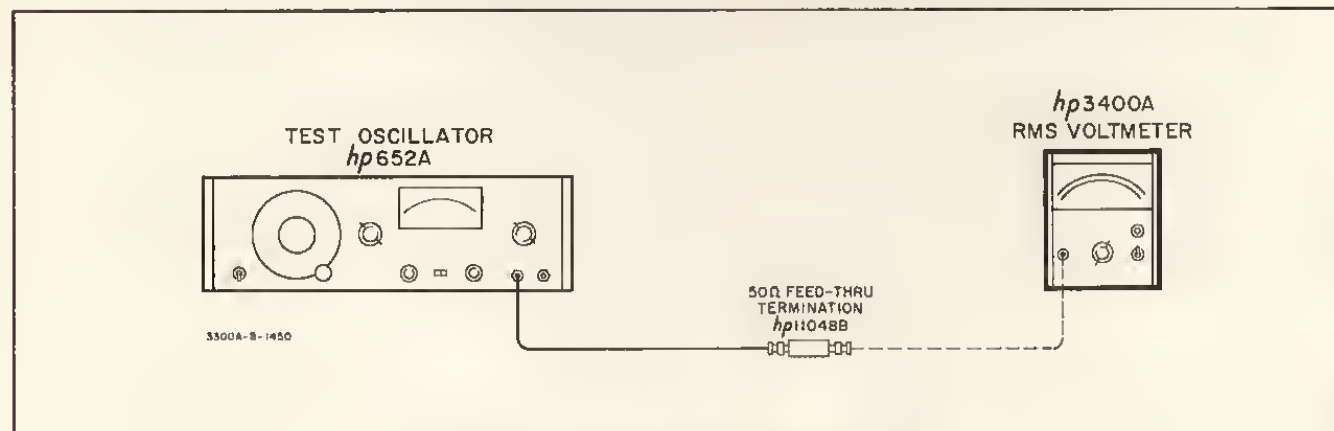


Figure 5-2. Frequency Response Test Setup

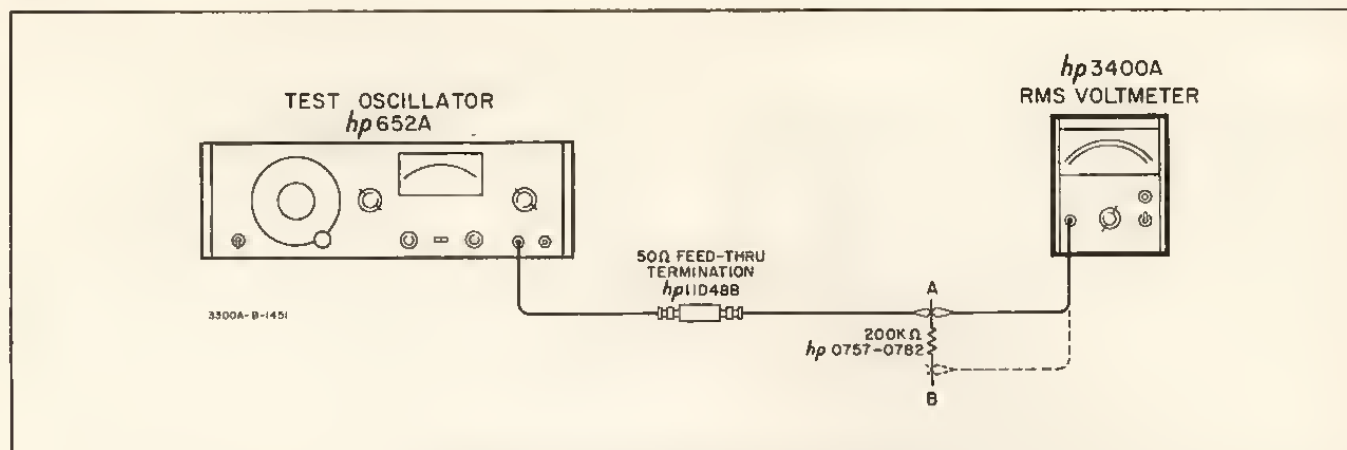


Figure 5-3. Input Impedance Test Setup

- d. Connect Model 3400A to position B in Figure 5-3. The 3400A meter reading should change less than 0.02 volts (2 minor divisions). This corresponds to an input impedance of 10 megohms.

5-12. CAPACITANCE CHECK.

- a. Connect Test Oscillator, 50 ohm feedthru and Model 3400A to position B in Figure 5-3. Insert the resistor lead directly into the BNC connector on the 3400A as an adapter adds capacitances to the measurement.
- b. Set 3400A to 0.001 volt range and Test Oscillator to 400 Hz.
- c. Adjust Test Oscillator output for full scale indication on Model 3400A. Switch the Test Oscillator Switch to Expand mode and set a convenient reference level.
- d. Change Test Oscillator frequency to 16 kHz, maintaining the reference level set in step c. The Model 3400A reading should be greater than 0.707 volts. This corresponds to an input shunt capacity of less than 50 pF.
- e. Set Model 3400A Range switch to 1 V position and repeat step c.
- f. Change Test Oscillator frequency to 40 kHz, maintaining the reference level set in step c. The Model 3400A reading should be greater than 0.707 volts. This corresponds to an input shunt capacity of less than 20 pF.

5-13. CREST FACTOR CHECK.

- a. Connect test setup as illustrated in Figure 5-4.
- b. Set Model 3400A Range switch to 1 volt position.

- c. Adjust Pulse Generator for pulse output with the following characteristics:

Pulse Rate - 990 pps as indicated on electronic counter.

Pulse Width - 10 μ sec as indicated on electronic counter in time internal mode.

Pulse Amplitude - 7.07 volts as indicated on Model 410C.

NOTE

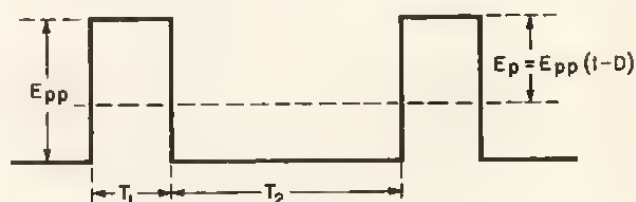
The 410C responds to the positive peak above the average of the input waveform. Since the Model 410C is calibrated to read the rms value of a sine wave a correction factor is required to measure pulse amplitude. The correction factor under these conditions is:

$$E_{410C} = \frac{E_{pp}}{\sqrt{2} \left(1 + \frac{T_1}{T_2} \right)}$$

see waveform below

$$E_{410C} = \frac{E_p \frac{T_2}{T_1 + T_2}}{\sqrt{2} \left(1 + \frac{T_1}{T_2} \right)}$$

$$E_{410C} = 7.07 \text{ V}$$



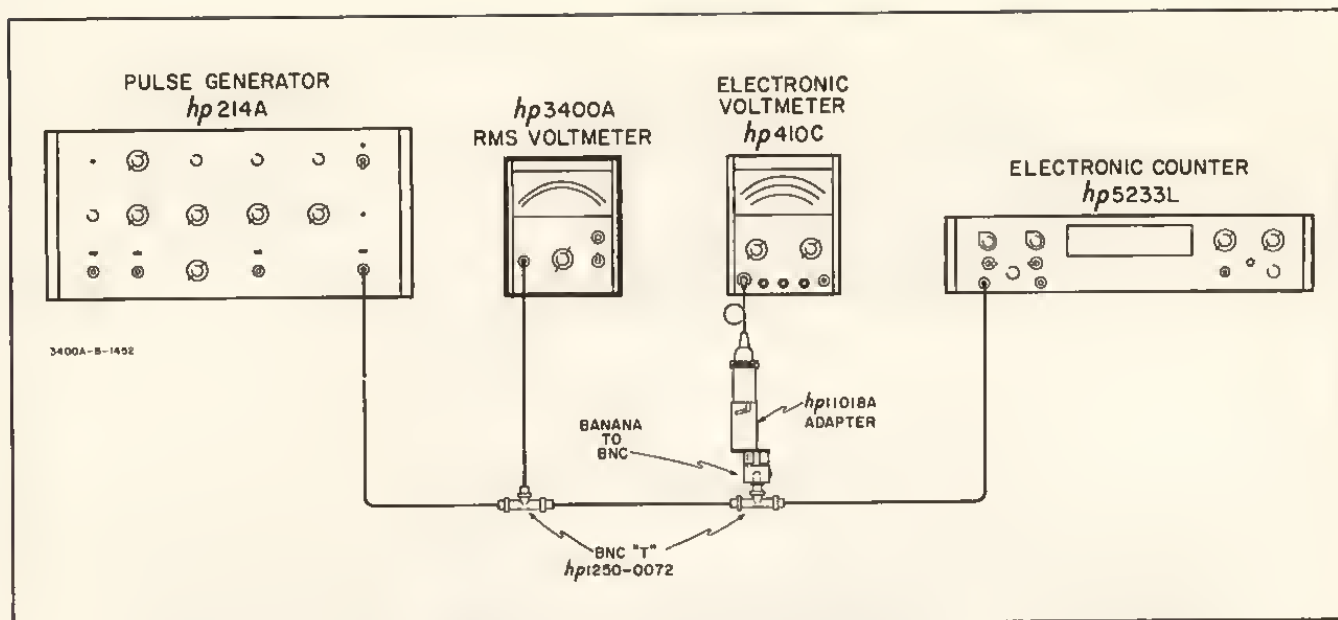


Figure 5-4. Crest Factor Test Setup

This corresponds to a crest factor of 10 where:

$$E_{rms} = E_{pp} \sqrt{D(1-D)} \text{ where } D = \frac{T_1}{T_1 + T_2}$$



$$C. F. = \frac{E_p}{E_{rms}}$$

$$C. F. = \frac{E_{pp}(1-D)}{E_{pp} \sqrt{D(1-D)}}$$

$$C. F. = \sqrt{\frac{1-D}{D}}$$

- d. The Model 3400A should indicate 1 volt, $\pm 4\%$ (includes the $\pm 3\%$ accuracy of 410C).
- e. Adjust pulse generator pulse rate to 250 pps as indicated on electronic counter. This corresponds to a crest factor of 20.
- f. Model 3400A should indicate 0.5 volt, $\pm 4\%$ (includes the $\pm 3\%$ accuracy of 410C).

5-14. OUTPUT NOISE CHECK.

- a. Connect 50 ohm feedthru to 3400A INPUT.

- b. Connect another RMS Voltmeter to DC output.
- c. Set -hp- Model 3400A to 0.001 volt range.
- d. The reading on the RMS Voltmeter should not exceed 1 mV.

5-15. ADJUSTMENT AND CALIBRATION PROCEDURES.

5-16. The following is a complete adjustment and calibration procedure for the Model 3400A. These procedures should be conducted only if it has previously been established by Performance Checks, Paragraph 5-5 to 5-14, that the Model 3400A is out of adjustment. Indiscriminate adjustment of the internal controls to refine settings may actually cause more difficulty. If the procedures outlined do not rectify any maladjustments that may exist, and you have carefully rechecked your connections and settings, refer to Paragraph 5-29, Troubleshooting Procedures for possible cause and recommended corrective action.

5-17. MECHANICAL METER ZERO.

5-18. The mechanical meter zero screw is located on the instrument front panel. If the meter pointer does not indicate zero when the instrument power has been off for at least one minute, mechanically zero the meter following the procedure outlined below.

- a. Turn instrument power off; disconnect input signal and any cable connected to J2 (DC OUT) at rear of instrument and allow one minute for meter pointer to stabilize.
- b. Rotate zero adjust CW until pointer is to left of zero, moving up scale. Continue until pointer is at zero. If pointer overshoots zero, repeat operation.

- c. When the pointer is exactly at zero, rotate the adjusting screw slightly counterclockwise to remove tension on pointer suspension. If the meter pointer moves to the left during this adjustment, repeat steps b and c.

5-19. POWER SUPPLY CHECKS.

5-20. Power supply voltage and ac ripple tolerances are listed in Table 5-4. Test points are also indicated in this table. When making ripple voltage measurements, it may be desirable to use a battery powered A. C. Voltmeter (H-P 403B) to avoid any undesirable ground loop currents.

5-21. LOW FREQUENCY CALIBRATION.

5-22. AMPLIFIER GAIN ADJUSTMENT.

- Connect test setup illustrated in Figure 5-1.
- Set Model 3400A RANGE switch to 0.01 volt position.
- Adjust Voltmeter Calibrator for 0.01 volt rms, 400 Hz output; set DC Voltmeter to read 1.0.
- Remove Model 3400A top cover; adjust R4 (CAL) for 1.0 volt as indicated on DC Voltmeter. If R4 (CAL) does not have enough range to calibrate the dc output, the value of R3 should be changed. The range of R3 is from 820 ohms to 2.16 k ohms.
- Adjust R6 (FULL-SCALE ADJUST) for Model 3400A full-scale meter indication.

5-23. 1/10 SCALE ADJUSTMENT.

- Connect test setup illustrated in Figure 5-1; omit the DC Voltmeter.
- Set Model 3400A RANGE switch to 0.1 volt position and adjust Voltmeter Calibrator for 0.01 volt rms, 400 Hz output.

NOTE

The 1/10 SCALE ADJUST should be set slightly low (needle's width) to reduce meter (needle) offset with shorted input.

- Adjust R7 (1/10 SCALE ADJUST) for Model 3400A 1/10 scale meter indication. Change value of R8 if it is necessary to increase the adjustment range of R7. The range of R8 is from approximately 270 ohms to 430 ohms. See Table 5-7.

5-24. 1 VOLT ADJUSTMENT.

- Connect test setup illustrated in Figure 5-1; omit the DC Voltmeter.
- Set Model 3400A RANGE switch to 1 volt position.
- Adjust voltmeter calibrator for 1.0 volt rms, 400 Hz output.
- Remove right side cover (INPUT side) and adjust R104 (1 V ADJUST) for Model 3400A full-scale meter indication.

Table 5-4. Power Supply Checks

POWER SUPPLY	TEST EQUIPMENT AND CHECK POINT	DC VOLTAGE SPECIFICATIONS	REGULATION (Vary Line Voltage Between 103.5 and 126.5 vac)	RIPPLE SPECIFICATIONS
-17.5 Vdc	Connect DC Voltmeter, AC Voltmeter, or Oscilloscope between violet lead on video amplifier (A4) board and chassis ground.	-16.8 to 18.2 Vdc	± 0.5 volt from nominal reading at 115 Vac line.	400 μ V rms or 1.1 mV p-p
+75 Vdc	Connect DC Voltmeter, AC Voltmeter, or Oscilloscope between red/wht/blue on video amplifier A4 and chassis ground.	70.0 to 78.0 Vdc	± 1 volt from nominal reading at 115 Vac line.	400 μ V rms or 1.1 mV p-p
-6.3 Vdc	Connect DC Voltmeter, AC Voltmeter, or Oscilloscope between Q3 emitter (grey lead) and chassis ground.	-5.9 to -6.5 Vdc	± 0.1 volt from nominal reading at 115 Vac line.	750 μ V rms or 2.0 mV p-p

5-25. HIGH FREQUENCY CALIBRATION.**5-26. AMPLIFIER GAIN ADJUSTMENT.****NOTE**

The Test Oscillator used in this procedure should be calibrated at the end of its output cable.

- a. Connect test setup illustrated in Figure 5-2.
- b. Set Model 3400A RANGE switch and Test Oscillator output attenuator to 0.001V position.
- c. Adjust Test Oscillator output frequency for 400 Hz; output voltage for 90% of full scale as indicated on Model 3400A meter.
- d. Switch the Test Oscillator monitor switch to expand mode and set a convenient reference level.
- e. Change Test Oscillator frequency to 10 MHz. Adjust Test Oscillator output voltage to maintain reference level set in step d.
- f. Adjust C405 (10 MHz ADJUST) on A4 board for 90% full scale as indicated on the Model 3400A meter. Replace right side cover; readjust C405 if meter reading varies after replacing the cover.
- g. Vary oscillator between 3 and 10 MHz; maintaining reference level set in step d. If the Model 3400A meter reading varies below 85% or above 95% of full scale, repeat step f until optimum response is obtained between 3 and 10 MHz.

5-27. INPUT ATTENUATOR ADJUSTMENT.**NOTE**

The Test Oscillator used in this procedure should be calibrated at the end of its output cable.

- a. Connect test setup illustrated in Figure 5-2.
- b. Set Model 3400A RANGE switch and Test Oscillator output attenuator to 1 volt position.
- c. Adjust Test Oscillator output frequency for 400 Hz, output voltage for 90% full scale as indicated on Model 3400A meter.
- d. Switch the Test Oscillator monitor switch to expand mode and set a convenient reference level.
- e. Change Test Oscillator frequency to 100 kHz; adjust Test Oscillator output voltage to maintain reference level set in step d.
- f. Remove Model 3400A bottom cover. Adjust C102 (1 V, 100 KC ADJ) for 90% full scale as indicated on Model 3400A meter.

- g. Vary oscillator between 100 kHz and 10 MHz; maintain test oscillator output voltage to reference level set in step d. If Model 3400A meter reading varies more than $\pm 1\%$ to 1 MHz, $\pm 2\%$ from 1 MHz to 2 MHz, $\pm 3\%$ from 2 MHz to 3 MHz, or $\pm 5\%$ from 3 MHz to 10 MHz, re-adjust C102 until optimum response is obtained.

5-28. SECOND ATTENUATOR ADJUSTMENT.**NOTE**

The Test Oscillator used in this procedure should be calibrated at the end of its output cable.

- a. Connect test setup illustrated in Figure 5-2.
- b. Set Model 3400A RANGE switch and Test Oscillator output attenuator to a 0.3 volt position.
- c. Adjust Test Oscillator output frequency for 400 Hz; output voltage for 90% full scale as indicated on Model 3400A meter.
- d. Switch the Test Oscillator monitor switch to expand mode and set a convenient reference level.
- e. Change Test Oscillator output frequency to 3 MHz; adjust output voltage to maintain reference level set in step d.
- f. Adjust C303 (10 MC .3V ADJ) for 90% full scale as indicated on Model 3400A meter.
- g. Vary Test Oscillator between 3 MHz and 10 MHz; maintain test oscillator output voltage to reference level set in step d. If Model 3400A meter reading varies below 85% or above 95% of full scale, repeat steps e and f until optimum response is obtained between 3 and 10 MHz.

5-29. TROUBLESHOOTING PROCEDURES.

5-30. This section contains procedures designed to assist in the isolation of malfunctions. These operations should be undertaken only after it has been established that the difficulty cannot be eliminated by the Adjustment and Calibration Procedures, Paragraph 5-15. An investigation should also be made to ensure that the trouble is not a result of conditions external to the Model 3400A.

5-31. Conduct a visual check of the Model 3400A for possible burned or loose components, loose connections, or any other condition which might suggest a source of trouble.

5-32. Table 5-5 contains a summary of known problems by front panel symptoms.

5-33. Table 5-6 contains procedures which may be used as a guide in isolating malfunctions. The checks outlined in Table 5-6 are not designed to measure all

circuit parameters, rather only to localize the malfunction. Therefore, it is quite possible that additional measurements will be required to completely isolate the problem. Amplifier gain and biasing may vary slightly from instrument to instrument; therefore, it should not be necessary to precisely duplicate waveforms or values described.

————— NOTE —————

Do not use an extender board on the Chopper Amplifier Board (A6).

5-34. CHECKING THERMOCOUPLES TC401 AND TC402.

5-35. The following procedure will allow you to check the thermocouples for proper operation in the -hp- Model 3400A RMS Voltmeter.

————— NOTE —————

This check will not yield any information concerning thermocouple operation for either sluggish or overshoot-under-shoot response on 3400A meter. If a 3400A has the above symptoms replace thermocouples.

5-36. To perform these checks, supply 5 mA of current to the heaters of the thermocouples. The -hp- Model 412A DC Vacuum Tube Voltmeter in ohms function on X100 range is ideal for this application. Instruments required for these checks are as follows:

One -hp- Model 412A DC Vacuum Tube Voltmeter.

One DC Voltmeter with 10 mV F. S. capability such as another -hp- 412A or 3440A/3443A Digital Voltmeter.

If the thermocouples fail any of the following checks replace the thermocouples according to procedures outlined in Paragraph 5-37.

- a. Turn the instrument off and remove the A6 board.

————— NOTE —————

See Figure 6-3 for component locations.

- b. Connect test leads of 412A, in ohms function on X100 range, between ground and junction of C413 and C415 on A4 board (this step checks the resistance of heater in TC401). 412A should indicate between 76.5 to 103.5 ohms. If not within limits, replace the matched set of thermocouples (-hp- Part No. 0853-0003).
- c. Leave the 412A connected as in Step b (412A is used to supply 5 mA of current to heater of TC401 in this step). Connect a DC Voltmeter as follows:

Negative lead to pin 11 on A6 socket.
Positive lead to pin 13 on A6 socket.

Voltmeter should indicate between +6.5 mV and +9 mV. Note the indication for future reference. If within the test limits, leave DC Voltmeter connected and proceed to step d page 5-14.

Table 5-5. Front Panel Symptoms

SYMPTOMS	POSSIBLE CAUSE
1/2 scale readings on all RANGE switch settings and input voltages.	Chopper Amplifier (A6), Check C612.
3 to 5% meter offset on all ranges with shorted input.	R7 (1/10 SCALE ADJ) misadjusted. C405 (10 MHz ADJ) misadjusted.
400 Hz calibration low and frequency response falls off above 50 kHz.	Q401 or Q402 shorted.
Switching transients exceed 5% of full scale with shorted input.	Check collector voltage of Q201 (should not exceed 9.0 V).
Instrument has been overloaded.	Check Q201, Q401, Q402 and TC401. See Paragraph 5-34 for details on TC401.
Meter jitter exceeds 0.5% of full scale.	Check Q601, Photochopper Assembly (neons) see Figure 5-9. Verify the value of R606 to be 3.3 k Ω (-hp- Part No. 0683-3325).
Full-scale difference from range to range.	Check resistors in second attenuator.
Meter pegs full scale.	Check thermocouples. See Paragraph 5-34 for details.
Overshoot, undershoot or sluggish response on meter.	Replace Thermocouples. See Paragraph 5-37.

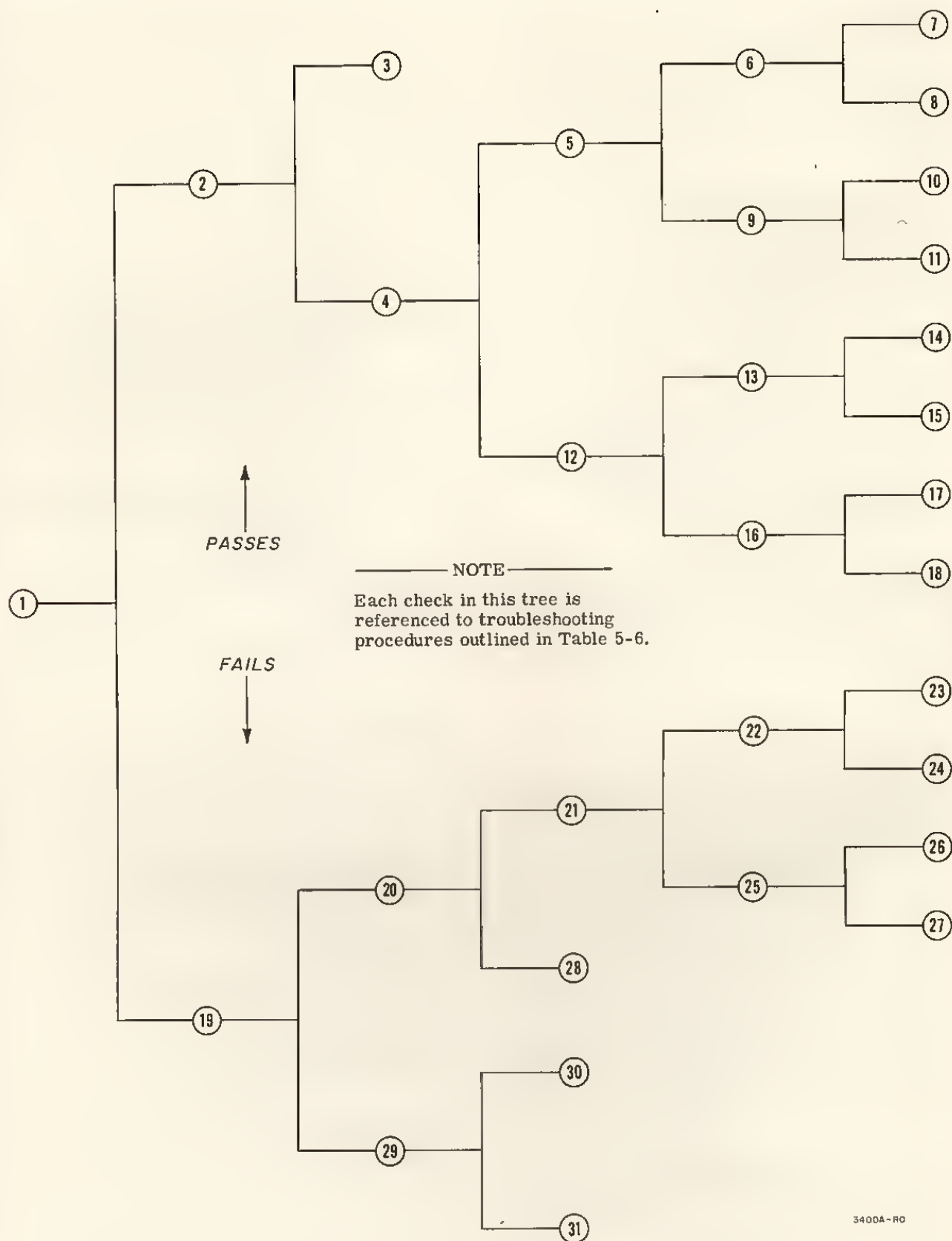
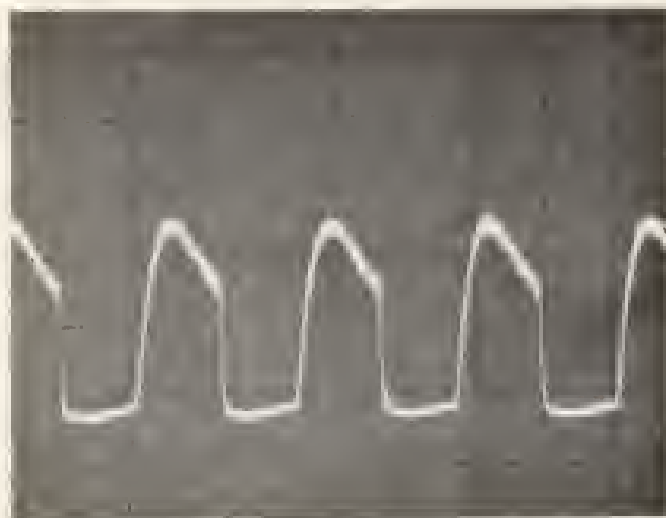


Figure 5-5. Troubleshooting Tree

Table 5-6. Troubleshooting Procedure

CHECK	PROCEDURE	ACTION
①	Apply a 1 volt 400 Hz signal and set the 3400A to the 1 volt range. Measure ac signal at junction of C413 and C415. The reading should be between 240 mV and 280 mV RMS. —————NOTE————— Do not use an extender board for measurements on Chopper Amplifier board A6.	PASSES: Proceed to ② FAILS: Proceed to ⑱ (Trouble proceeding the Chopper Amplifier)
②	Measure ac signal at junction of C605 and Demodulator V503 and V504. Refer to Figure 5-6 for waveform.	PASSES: Proceed to ③ FAILS: Proceed to ④ (Trouble in the Chopper Amplifier).



POSITIVE SIDE OF C605

Full Scale deflection

Sweep = 5 ms/cm

Vertical = 0.5 V/cm

DC coupled

use 10:1 probe

Figure 5-6. Input to Demodulator

Table 5-6. Troubleshooting Procedure (Cont'd)

CHECK	PROCEDURE	ACTION
③	Investigate meter (M1), R5, and R6 for opens.	PASSES: Proceed to ⑤ FAILS: Proceed to ⑫
④	Remove the input to 3400A. Unsolder red lead from pin 13 (A6) and insert a +10 mV dc signal from 738BR through a 499 k Ω resistor (-hp- Part No. 0757-0327) to pin 13. Measure ac signal at positive side of C605. Refer to Figure 5-7 for waveform.	

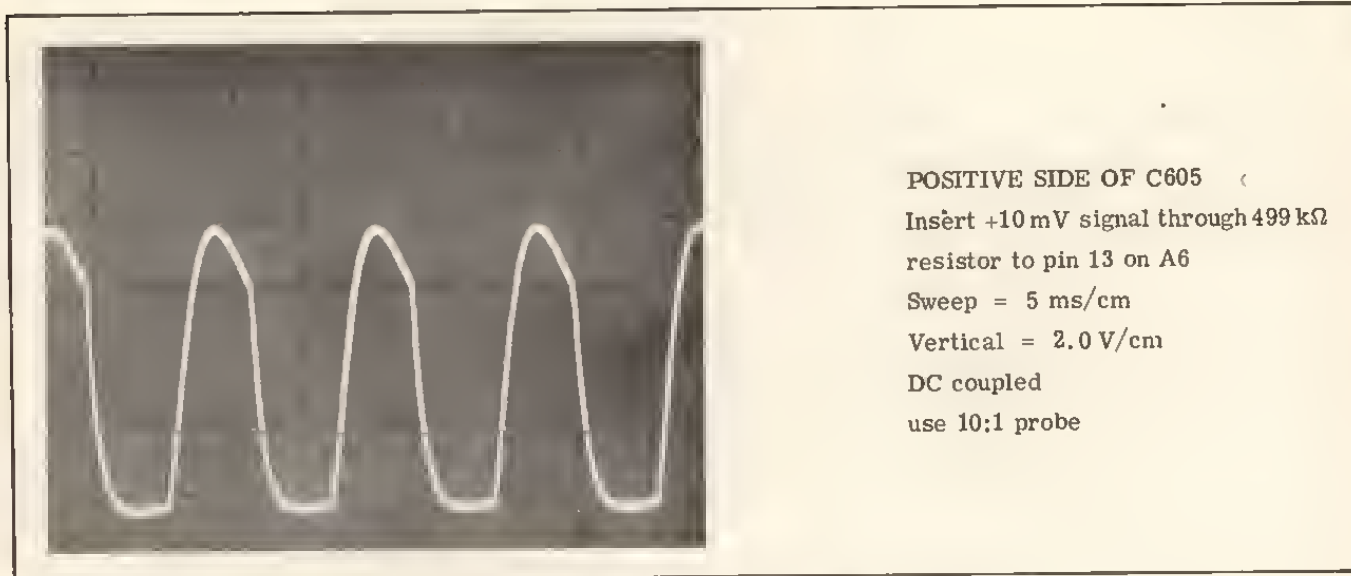


Figure 5-7. Input to Demodulator (feedback loop open)

Table 5-6. Troubleshooting Procedure (Cont'd)

CHECK	PROCEDURE	ACTION
⑤	Measure the dc signal at emitter of Q605. Reading should be approximately -2.35 Vdc.	PASSES: Proceed to ⑥ FAILS: Proceed to ⑨
⑥	Measure the dc signal at pin 9 (A6). Reading should be approximately -1.65 Vdc.	PASSES: Proceed to ⑦ FAILS: Proceed to ⑧
⑦	Investigate R619, R4, and thermocouples. See Paragraph 5-34 for thermocouple check.	
⑧	Investigate Q606 and associated circuit.	
⑨	Measure the ac signal at base of Q605. Refer to Figure 5-8 for waveform.	PASSES: Proceed to ⑩ FAILS: Proceed to ⑪

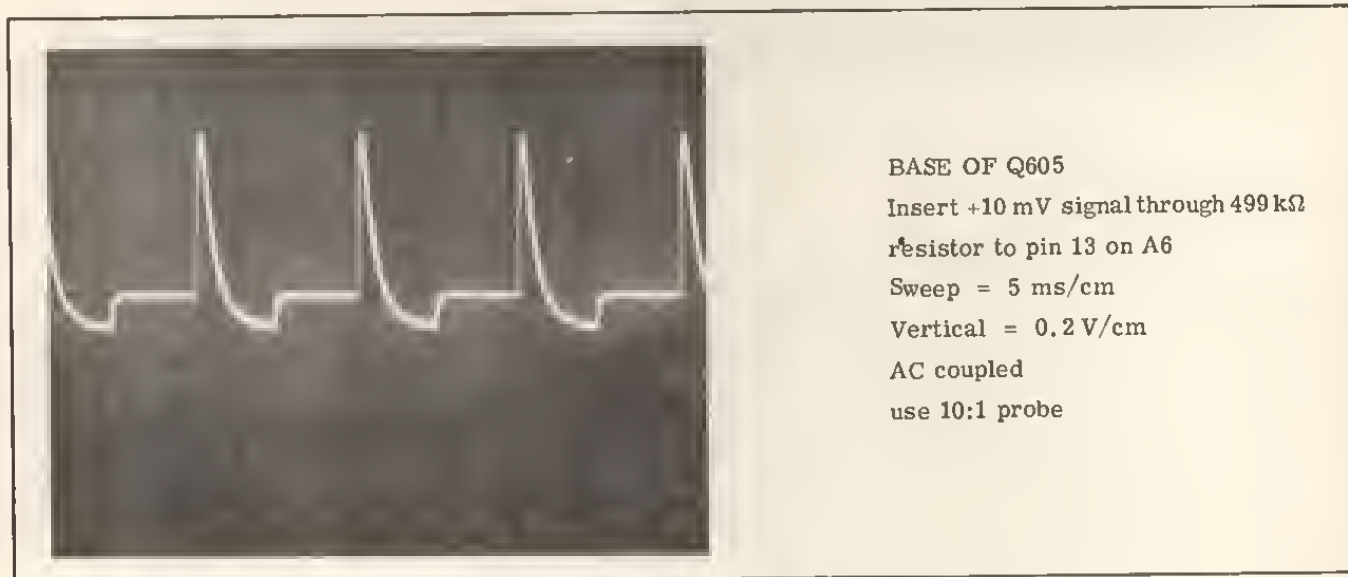


Figure 5-8. Output of Demodulator (feedback loop open)

Table 5-6. Troubleshooting Procedure (Cont'd)

CHECK	PROCEDURE	ACTION
⑩	Investigate Q605, CR604, and R615.	
⑪	Investigate demodulator V503 and V504. See Paragraph 5-39 for photochopper check. Check chopper neon voltage. Refer to Figure 5-9 for waveform. Current variation through neons may cause meter jitter. For proper chopper action, neon firing potential (most negative point on waveform) is normally between 50V and 60V. If the waveform displays noise (nonlinearity) at both extremities, jitter will occur on the meter. If the waveform displays a noise replace the neon subassembly as outlined in Paragraph 5-41.	

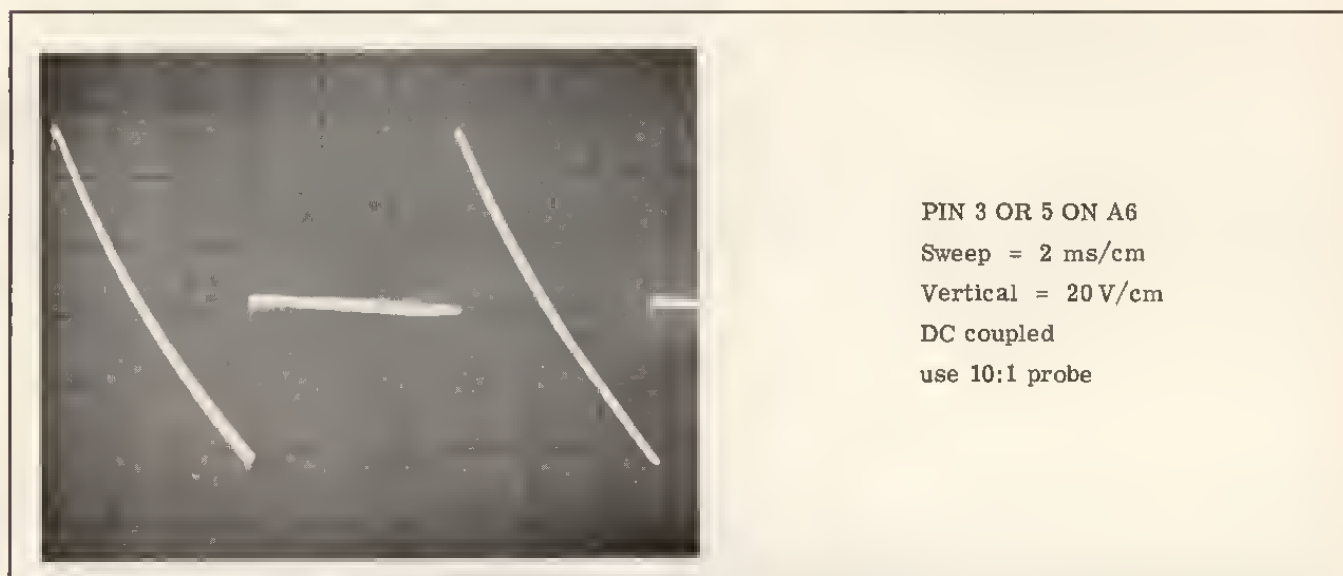
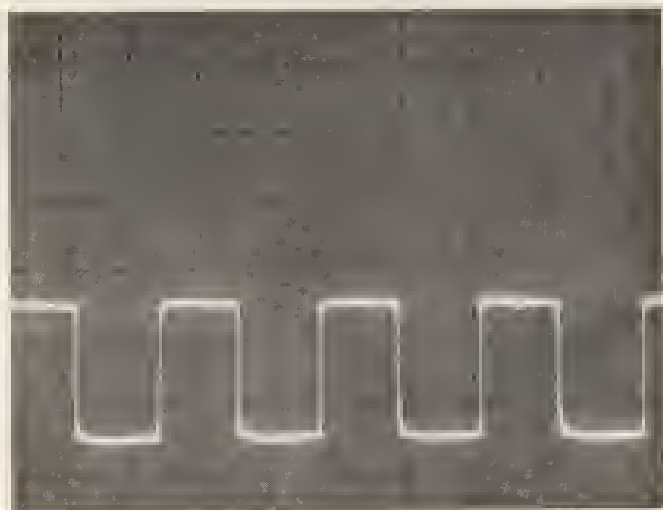


Figure 5-9. Neon Drive Voltage

Table 5-6. Troubleshooting Procedure (Cont'd)

CHECK	PROCEDURE	ACTION
⑫	Measure the ac signal at collector of Q602. Refer to Figure 5-10 for waveform.	PASSES: Proceed to ⑬ FAILS: Proceed to ⑯

**COLLECTOR OF Q602**

Insert +10 mV signal through
499 k Ω resistor to pin 13 on A6

Sweep = 5 ms/cm

Vertical = 0.5 V/cm

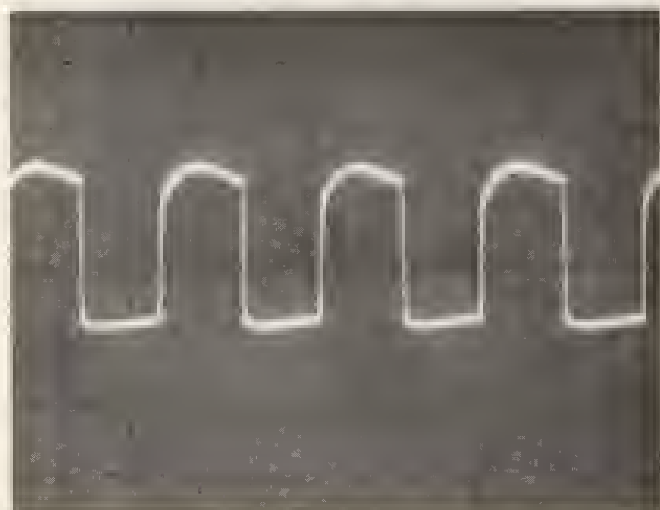
DC coupled

use 10:1 probe

Figure 5-10. Collector of Q602 (feedback loop open)

Table 5-6. Troubleshooting Procedure (Cont'd)

CHECK	PROCEDURE	ACTION
13	Measure the ac signal at base of Q604. Refer to Figure 5-11 for waveform.	PASSES: Proceed to (14) FAILS: Proceed to (15)

**BASE OF Q604**

Insert +10 mV signal through
499 k Ω resistor to pin 13 on A6

Sweep = 5 ms/cm

Vertical = 5 V/cm

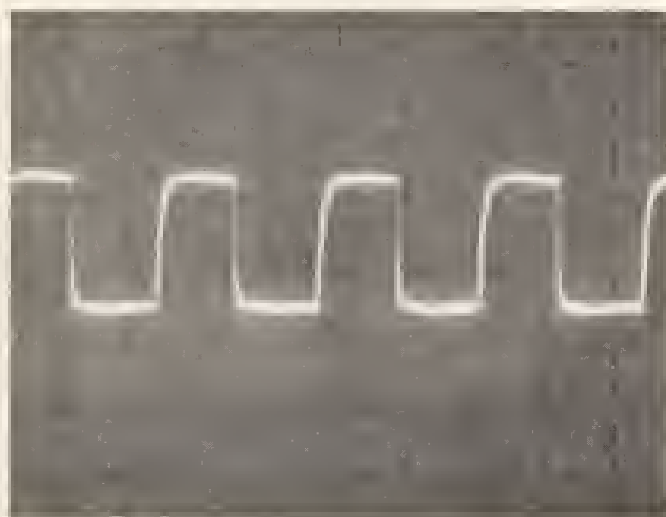
AC coupled

no probe required

Figure 5-11. Base of Q604 (feedback loop open)

Table 5-6. Troubleshooting Procedure (Cont'd)

CHECK	PROCEDURE	ACTION
(14)	Investigate Q604, C605, (and demodulator), V503 and V504. See Paragraph 5-39 for photochopper check. Check chopper neon voltage. Refer to Figure 5-9 for waveform. See check number (11) for details.	
(15)	Investigate Q603 and associated circuit.	
(16)	Increase the level of the inserted signal to +0.2 Vdc. Measure the ac signal at the base of Q601. Refer to Figure 5-12 for waveform.	PASSES: Proceed to (17) FAILS: Proceed to (18)



BASE OF Q601

+.2V signal through 499 k Ω
resistor to pin 13 on A8

Sweep = 5 ms/cm

Vertical = 5 mV/cm

AC coupled

no probe required

Figure 5-12. Base of Q601 (feedback loop open)

Table 5-6. Troubleshooting Procedure (Cont'd)

CHECK	PROCEDURE	ACTION
(17)	Investigate Q601 and associated circuit.	
(18)	Investigate V501, V502, C601, C602 and R601. See Paragraph 5-39 for photochopper check. Check chopper neon voltage. Refer to Figure 5-9 for waveform. See check number (11) for details.	
(19)	Measure the ac signal at the output of impedance converter A2 (negative side of C205). The reading should be approximately 0.96 mV rms.	PASSES: Proceed to (20) FAILS: Proceed to (23)
(20)	Measure the ac signal at the input to video amplifier A4 positive side of C402. The reading should be approximately 0.96 mV rms.	PASSES: Proceed to (21) FAILS: Proceed to (28)
(21)	Measure the ac signal at the base of Q404. The reading should be approximately 155 mV rms.	PASSES: Proceed to (22) FAILS: Proceed to (25)

Table 5-6. Troubleshooting Procedure (Cont'd)

CHECK	PROCEDURE	ACTION
(22)	Measure the ac signal at the negative side of C427. The reading should be approximately 32 mV rms.	PASSES: Proceed to (23) FAILS: Proceed to (24)
(23)	Investigate C413 and C415.	
(24)	Investigate Q404, Q405, and Q406 circuit. Also check thermocouples. See Paragraph 5-34 for thermocouple check.	
(25)	Measure the ac signal at emitter of Q402. Reading should be 1.85 mV rms.	PASSES: Proceed to (26) FAILS: Proceed to (27)
(26)	Investigate Q401 and Q402 circuit.	
(27)	Investigate Q403 circuit.	
(28)	Investigate second attenuator circuit A3.	
(29)	Measure the ac signal at the input to the impedance converter pin 7 on A2 board. The reading should be approximately 1 mV rms.	PASSES: Proceed to (30) FAILS: Proceed to (31)
(30)	Investigate the impedance converter or power supply. See Table 5-4 for specifications on power supply.	
(31)	Investigate the input attenuator A1.	

- d. Remove leads of 412A, connected in step b, and connect 412A between silver-colored lead on R4 (CAL pot on chassis) and pin 14 on A6 socket (this step checks the resistance of heater in TC402. 412A should indicate between 76.5 to 103.5 ohms.
- e. Leave 412A connected as in step d (412A is used to supply 5 mA of current to heater of TC402 in this step). Note indication on DC Voltmeter connected between pins 11 and 13 on A6 socket. Indication should be negative with respect to reading in step c and within 1 mV of that reading.
- f. Remove the DC Voltmeter and 412A from 3400A. Connect the 412A between pins 11 and 14 on A6 socket (this step checks for thermocouples shorted to ground through cover. Indication of 412A should be greater than 200 k Ω . If less than 200 k Ω , look for short to ground.

5-37. THERMOCOUPLE REPLACEMENT.



EXERCISE EXTREME CARE WHEN REMOVING OR REPLACING THE AMPLIFIER PRINTED CIRCUIT BOARD ASSEMBLY AND WHEN SHAPING THE THERMOCOUPLE LEADS.

5-38. Should a thermocouple be defective, it is necessary to replace both as a matched pair (see Section VII, Table of Replaceable Parts) for part number. To replace thermocouples, perform the following steps:

- a. Turn instrument power off and remove right-side (INPUT side) and top covers.
- b. Remove the four lead connection to the A4 amplifier board.
 1. Black coaxial cable (two leads)
 2. Violet lead
 3. White lead/blue lead.
- c. Remove the three mounting screws on the amplifier board.
- d. Gently pull bottom of board out at the same time relieving stress on thermocouple cable until the board will drop down and the top will clear main frame. Carefully fold board down to expose the four nuts holding the thermocouple shield.
- e. Remove four shield nuts; lift shield off. Remove thermocouples, noting orientation.
- f. Leads on new thermocouples must be shaped before inserting into PC board. During the shaping process, hold leads between bending point and glass with long-nose pliers.

- g. Place the red dots on the thermocouples face down on the A4 Video Amplifier Board. If one of the thermocouples has an additional colored dot place it in the TC402 position.
- h. Carefully insert new thermocouple leads and solder.
- i. Reverse steps e, d, c, b. Note: the violet lead goes to the lower of the two top connectors on the A4 board.
- j. After thermocouple replacements perform a complete adjustment and calibration procedure as outlined in Paragraph 5-15.

5-39. CHECKING PHOTOCHOPPER ASSEMBLY A5.

NOTE

The following procedure should also be performed after replacing a neon subassembly to verify proper position of neons.

5-40. The following procedure verifies proper operation of the Photochopper Assembly. If the Photochopper fails any of the tests below replace the entire Photochopper Assembly (-hp- Part No. 1990-0223) or the neon subassembly (-hp- Part No. 1990-0224) according to procedures outlined in Paragraph 5-41. See Figure 5-9 to check operation of the neons. To check the photochopper assembly proceed as follows:

- a. Remove the Chopper Amplifier board A6.
- b. Lift the following component leads from the A6 board.
 - Negative side of C601
 - Positive side of C605
 - Negative side of C606
 - Base of Q605
- c. Place the A6 board on a programmable extender board (-hp- Part No. 5060-6038). Remove pin 13 lead on extender board closest to the A6 board.
- d. Place a 1 μ F capacitor (-hp- Part No. 0180-0269) across the input leads of an ohmmeter (note the polarity of capacitor and ohmmeter leads).
- e. Connect the ohmmeter between pin 13 and ground.
- f. Turn on the 3400A. The ohmmeter should indicate $> 10 \text{ k}\Omega$ (this checks the dynamic series resistance of the modulator).
- g. Turn off the 3400A, and disconnect ohmmeter.
- h. Ground pin 13 on A6 board. Connect ohmmeter between ground and junction of V501 and V502.

- i. Turn on the 3400A. The ohmmeter should indicate $< 7 \text{ k}\Omega$ (this checks the dynamic parallel resistance of modulator).
- j. Turn off the 3400A. Disconnect all connections made in step h.
- k. Connect ohmmeter between ground and V503 lead going to base of Q605.
- l. Turn on the 3400A. The ohmmeter should indicate $> 10 \text{ k}\Omega$ (this checks the dynamic series resistance of demodulator).
- m. Turn off the 3400A. Disconnect ohmmeter.
- n. Ground V503 lead going to base of Q605 and connect ohmmeter between ground and the junction of V503 and V504.
- o. Turn on the 3400A. The ohmmeter should indicate $< 10 \text{ k}\Omega$ (this checks the dynamic parallel resistance of demodulator).
- p. Turn off the 3400A. Disconnect ohmmeter and reconnect all component leads disconnected in step b.
- q. Replace chopper amplifier board.

5-41. REPLACEMENT OF NEON SUBASSEMBLY -hp- PART NO. 1990-0224.

5-42. To replace neon subassembly, proceed as follows:

- a. Remove chopper amplifier assembly (A6).
- b. Disconnect the photochopper cable at pins 2, 3, 4, and 5 on PC board.
- c. Remove two phillipshead screws on top cover of the photochopper block.

NOTE

Note the orientation of neon subassembly. The neon subassembly does not lie flat but at an angle within the photochopper block.

- d. Remove the neon subassembly.

NOTE

Clean the neon lamps with a tissue to remove finger prints before inserting new neon subassembly in photochopper block.

- e. With a new neon subassembly, feed the cable through the hole in the PC board. Place the new neon subassembly into photochopper block in the same orientation as the old neon subassembly.

- f. Replace the top cover and two phillips head screws in photochopper block.
- g. Reconnect the cable to pins 2, 3, 4 and 5. The larger black lead in the cable connects to pin 2. Other leads identifications are as follows:
 - White lead to pin 3
 - Green and red lead to pin 4
 - Thin black lead to pin 5.

h. Replace chopper amplifier board.

5-43. SERVICING ETCHED CIRCUIT BOARDS.

5-44. The -hp- Model 3400A has five etched circuit boards. Use caution when removing them to avoid damaging mounted components. The assembly and -hp- Part No. are silk screened on the interior of the circuit board to identify it. Refer to Section VII for parts replacement and -hp- part number information.

5-45. The etched circuit boards are a plated-through type. The electrical connection between sides of the board is made by a layer of metal plated through the component holes. When working on these boards, observe the following general rules:

- a. Use a low-heat (25 to 50 watts) small-tip soldering iron and a small diameter rosin core solder.

- b. Circuit components can be removed by placing the soldering iron on the component lead on either side of the board and pulling upon lead. If a component is obviously damaged, clip leads as close to component as possible and then remove. Excess heat can cause the circuit and board to separate or cause damage to the component.
- c. Component lead hole should be cleaned before inserting new lead.
- d. To replace components, shape new leads and insert them in holes. Reheat with iron and add solder as required to insure a good electrical connection.
- e. Clean excess flux from the connection and adjoining area.



WATER, COMMERCIAL CLEANERS, OR DETERGENTS WILL CAUSE PERMANENT DAMAGE TO PHOTOCHOPPER ASSEMBLY A5.

- f. To avoid surface contamination of the printed circuit, clean with weak solution of warm water and mild detergent after repair. Rinse thoroughly with clean water. When completely dry, spray lightly with Krylon (#1302 or equivalent).

Table 5-7. Factory Selected Components

DESIGNATOR	FUNCTION	VALUE		
		LOW	NORMAL	HIGH
C205	Adjust low frequency (10 Hz) response.	---	100 μ F (selected)	---
C302	Adjust high frequency (10 MHz) of Second Attenuator on 0.001 V and 1 V ranges.	5 pF	12 pF	15 pF
C304	Adjust high frequency (3 MHz to 10 MHz) of Second Attenuator on 0.3 V and 300 V ranges.	---	24 pF	39 pF
C305	Adjust high frequency (10 MHz) of Second Attenuator on 0.01 V and 10 V ranges.	---	5 pF	12 pF
C427	See NOTE on schematic.	---	200 μ F (selected)	---
R3	Adjust the range of R4 (CAL).	820 Ω	1200 Ω	2.16 k Ω
R8	Adjust the range of R7 (1/10 SCALE ADJ).	---	390 Ω (selected)	---
R419	Adjust voltage at collector of Q406 (no signal input, 1.5 to 2.5 Vdc).	270	300	---

PERFORMANCE CHECK TEST CARD

Hewlett-Packard Model 3400A RMS Voltmeter Serial No. _____		Tests performed by _____ Date _____																																																																																									
DESCRIPTION		CHECK																																																																																									
ACCURACY, LINEARITY AND DC OUTPUT: <table border="1"> <thead> <tr> <th>Calibrator Output</th> <th>3400A Range</th> <th>Meter Reading</th> <th>DC Output</th> </tr> </thead> <tbody> <tr><td>0.001</td><td>0.001</td><td>0.000990</td><td>0.00101</td></tr> <tr><td>0.003</td><td>0.003</td><td>0.00297</td><td>0.00303</td></tr> <tr><td>0.01</td><td>0.01</td><td>0.00990</td><td>0.0101</td></tr> <tr><td>0.03</td><td>0.03</td><td>0.0297</td><td>0.0303</td></tr> <tr><td>0.1</td><td>0.1</td><td>0.0990</td><td>0.101</td></tr> <tr><td>0.3</td><td>0.3</td><td>0.297</td><td>0.303</td></tr> <tr><td>1.0</td><td>1.0</td><td>0.990</td><td>1.01</td></tr> <tr><td>0.9</td><td>1.0</td><td>0.89</td><td>0.91</td></tr> <tr><td>0.8</td><td>1.0</td><td>0.79</td><td>0.81</td></tr> <tr><td>0.7</td><td>1.0</td><td>0.69</td><td>0.71</td></tr> <tr><td>0.6</td><td>1.0</td><td>0.59</td><td>0.61</td></tr> <tr><td>0.5</td><td>1.0</td><td>0.49</td><td>0.51</td></tr> <tr><td>0.4</td><td>1.0</td><td>0.39</td><td>0.41</td></tr> <tr><td>0.3</td><td>1.0</td><td>0.29</td><td>0.31</td></tr> <tr><td>0.2</td><td>1.0</td><td>0.19</td><td>0.21</td></tr> <tr><td>0.1</td><td>1.0</td><td>0.090</td><td>0.11</td></tr> <tr><td>3.0</td><td>3.0</td><td>2.97</td><td>3.03</td></tr> <tr><td>10.0</td><td>10.0</td><td>9.90</td><td>10.10</td></tr> <tr><td>30.0</td><td>30.0</td><td>29.7</td><td>30.3</td></tr> <tr><td>100.0</td><td>100.0</td><td>99.0</td><td>101.0</td></tr> <tr><td>300.0</td><td>300.0</td><td>297.0</td><td>303.0</td></tr> </tbody> </table>		Calibrator Output	3400A Range	Meter Reading	DC Output	0.001	0.001	0.000990	0.00101	0.003	0.003	0.00297	0.00303	0.01	0.01	0.00990	0.0101	0.03	0.03	0.0297	0.0303	0.1	0.1	0.0990	0.101	0.3	0.3	0.297	0.303	1.0	1.0	0.990	1.01	0.9	1.0	0.89	0.91	0.8	1.0	0.79	0.81	0.7	1.0	0.69	0.71	0.6	1.0	0.59	0.61	0.5	1.0	0.49	0.51	0.4	1.0	0.39	0.41	0.3	1.0	0.29	0.31	0.2	1.0	0.19	0.21	0.1	1.0	0.090	0.11	3.0	3.0	2.97	3.03	10.0	10.0	9.90	10.10	30.0	30.0	29.7	30.3	100.0	100.0	99.0	101.0	300.0	300.0	297.0	303.0		
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INPUT IMPEDANCE CHECK: Resistance _____ Capacitance _____		_____ 10 MΩ or greater _____ 50 pF or less 0.001 V to 0.3 V _____ 20 pF or less 1 V to 300 V																																																																																									
CREST FACTOR CHECK:		_____ 10:1 full scale _____ 20:1 half scale																																																																																									
OUTPUT NOISE CHECK:		_____ 1 mV RMS or less																																																																																									

SECTION VI

CIRCUIT DIAGRAMS

6-1. INTRODUCTION.

6-2. This section contains the circuit diagrams necessary for the operation and maintenance of the Model 3400A RMS Voltmeter. Included are schematic and parts location diagrams.

6-3. SCHEMATIC DIAGRAMS.

6-4. The schematic diagrams depict the circuits contained within each assembly of the 3400A as well as assembly interconnection. Main signal paths and significant feedback paths are identified.







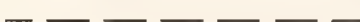

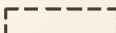



6-5. The schematic diagrams are arranged in ascending order of assembly reference designation.

6-6. PARTS LOCATION DIAGRAMS.

6-7. The parts location diagrams show the physical location of parts within an assembly. Parts are identified by reference designation. A parts location diagram is included for each assembly which does not have adequate silk screening of reference designations.

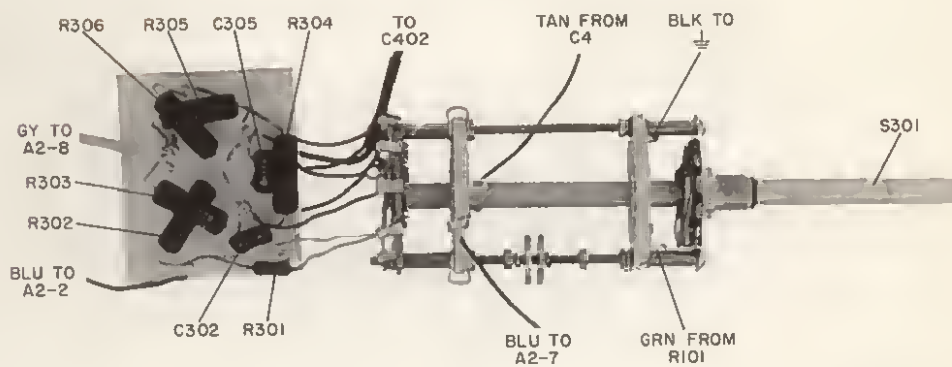
6-8. The parts location diagrams are located on the same figure as the schematic of the assembly.

GENERAL SCHEMATIC NOTES

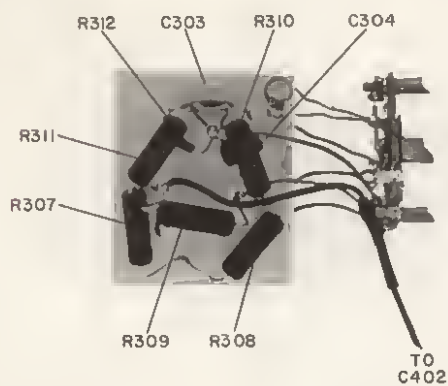
1. COMPLETE REFERENCE DESIGNATIONS ARE SHOWN.
2. COMPONENT VALUES ARE SHOWN AS FOLLOWS UNLESS OTHERWISE NOTED.
 RESISTANCE IN OHMS
 CAPACITANCE IN MICROFARADS
3.  DENOTES POWER LINE GROUND (VOLTMETER CHASSIS \perp).
 DENOTES CIRCUIT GROUND; ON PRINTED CIRCUIT ASSEMBLY.
4.  DENOTES ASSEMBLY.
 DENOTES MAIN SIGNAL PATH.
 DENOTES DC FEEDBACK PATH.
 DENOTES AC FEEDBACK PATH.
 DENOTES SHIELD.
5.  DENOTES FRONT PANEL MARKING.
 DENOTES REAR PANEL MARKING.
 DENOTES SCREWDRIVER ADJUST.
6.  DENOTES COMPONENTS NOT MOUNTED ON ASSEMBLY.
7. * AVERAGE VALUE SHOWN, OPTIMUM VALUE SELECTED AT FACTORY. SEE TABLE 5-7.
8.  DENOTES SECOND APPEARANCE OF A CONNECTOR PIN.

NOTES

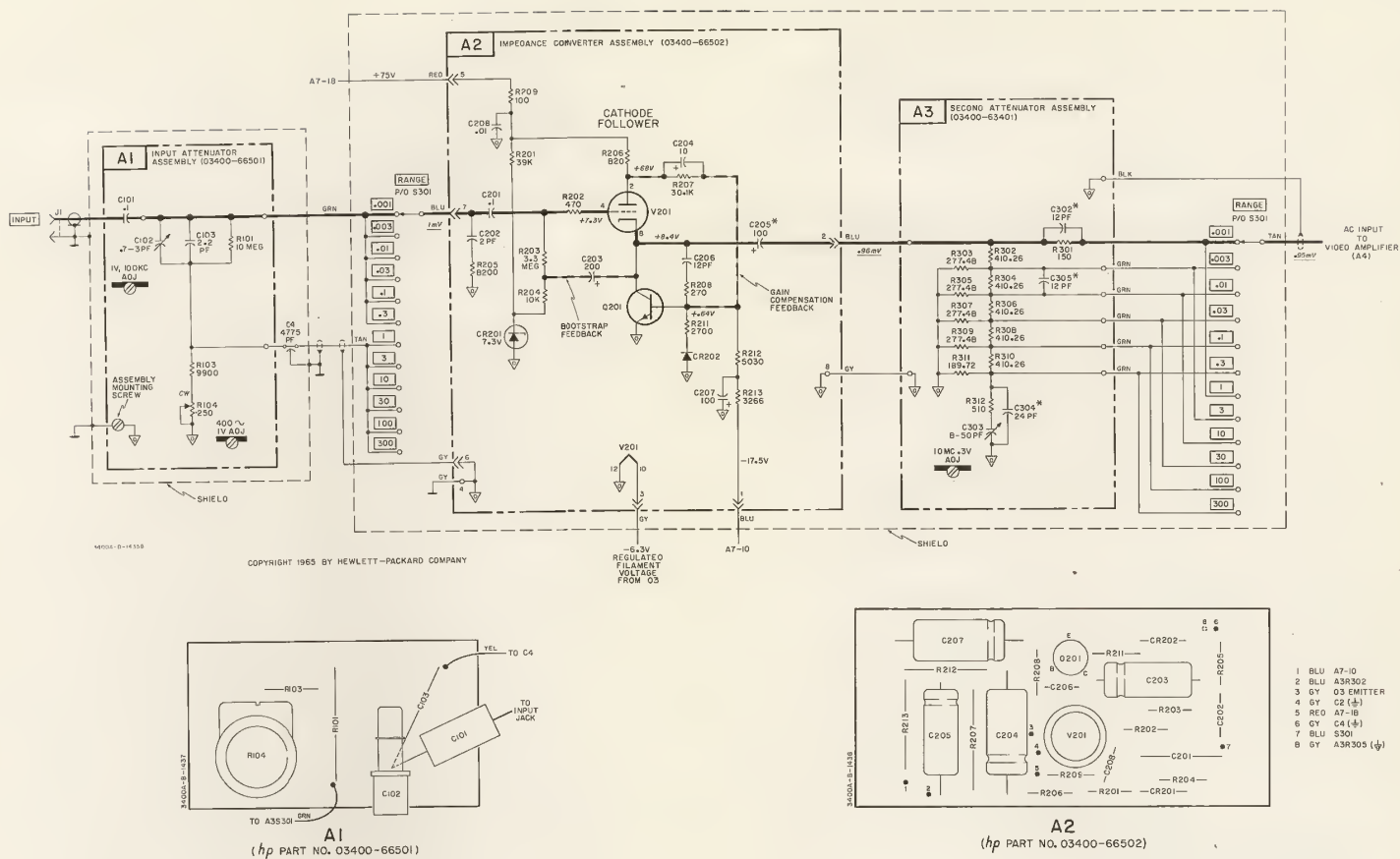
1. ALL DC AND AC VOLTAGE LEVELS SHOWN IN RED ARE WITH 1 MV INPUT (FULL SCALE DEFLECTION). A TOLERANCE OF $\pm 10\%$ SHOULD BE ALLOWED FOR VARIATIONS FROM INSTRUMENT TO INSTRUMENT.
2. ALL AC VOLTAGES ARE UNDERLINED. ALL DC VOLTAGES HAVE A POLARITY INDICATION.



3400A-A-0107

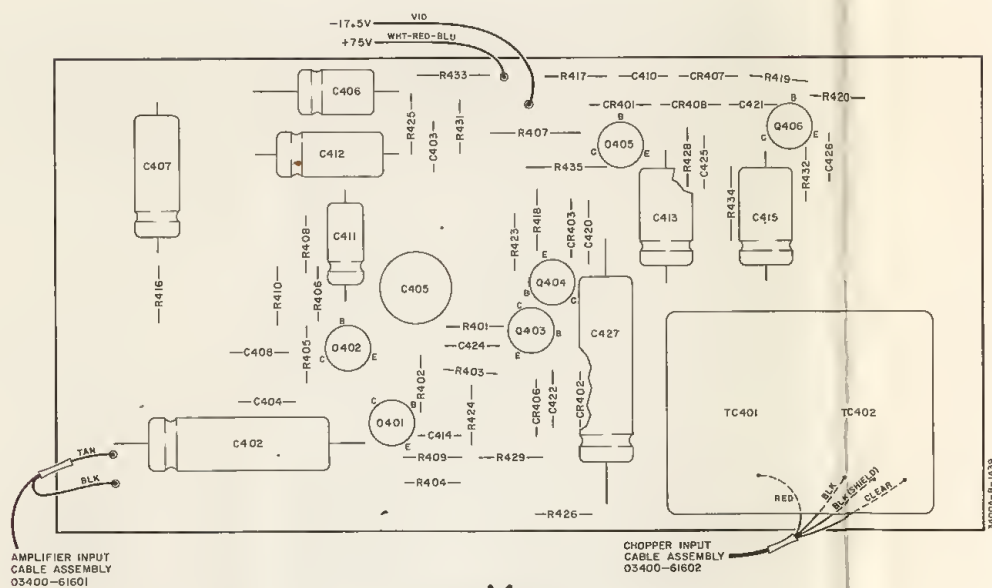


A3
(hp PART NO. 03400-63401)
(BOARD ONLY)



NOTES

1. ALL DC AND AC VOLTAGE LEVELS SHOWN IN RED ARE WITH 1 MV INPUT (FULL SCALE DEFLECTION). A TOLERANCE OF $\pm 10\%$ SHOULD BE ALLOWED FOR VARIATIONS FROM INSTRUMENT TO INSTRUMENT.
2. ALL AC VOLTAGES ARE UNDERLINED. ALL DC VOLTAGES HAVE A POLARITY INDICATION.
3. AC VOLTAGE LEVELS AT Q405 AND Q406 MUST BE OBSERVED WITH 10:1 DIVIDER PROBE.
4. IF C427 IS REPLACED, IT MAY BE NECESSARY TO SELECT THE VALUE OF C427 FOR PROPER FREQUENCY RESPONSE. THIS IS DUE TO CAPACITOR TOLERANCE.



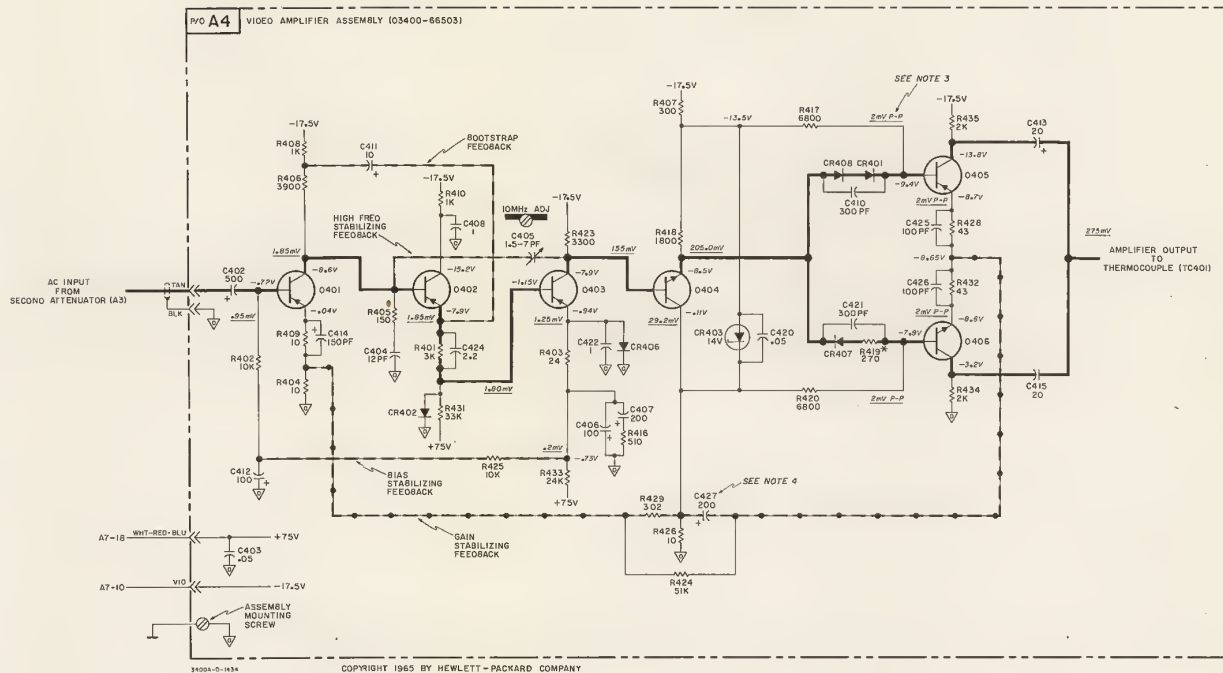
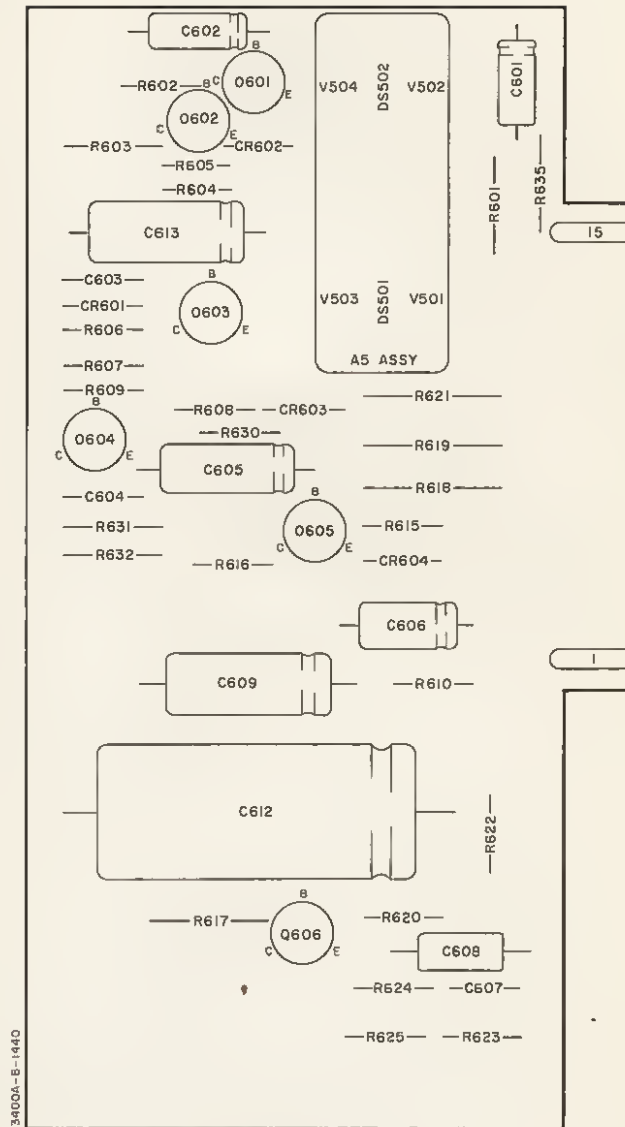


Figure 6-2. Video Amplifier A4 Schematic and Parts Location Diagram



A6
(hp PART NO. 03400-66508)

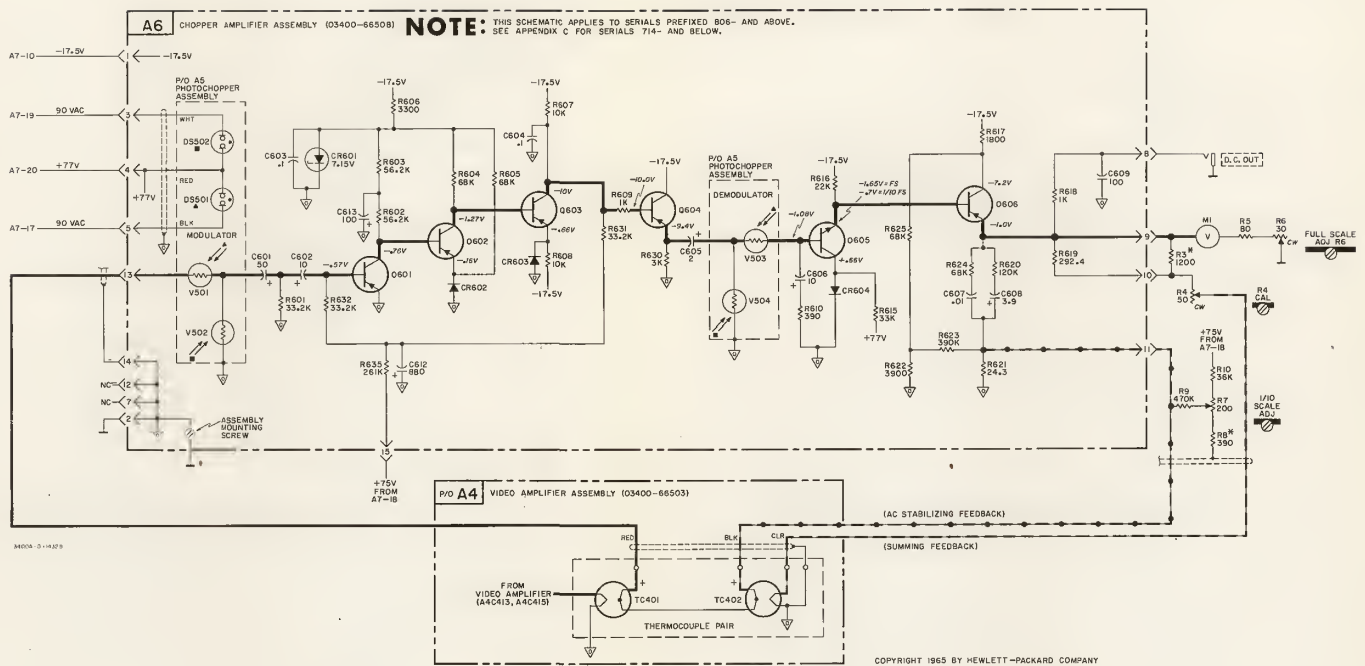
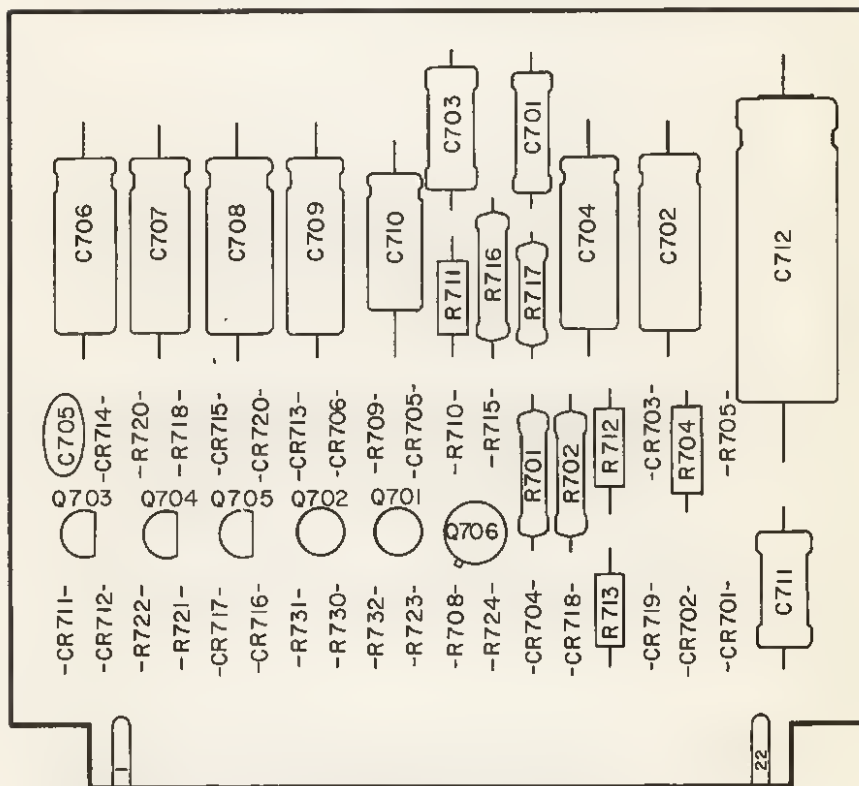


Figure 6-3. Photochopper A5, Chopper Amplifier A6, and Thermocouple Pair (Part of A4) Schematic and Parts Location Diagram

A7

(hp Part No. 03400-66510)

Rev A



3400A - B - 2672

MODEL 3400A
RMS VOLTMETER

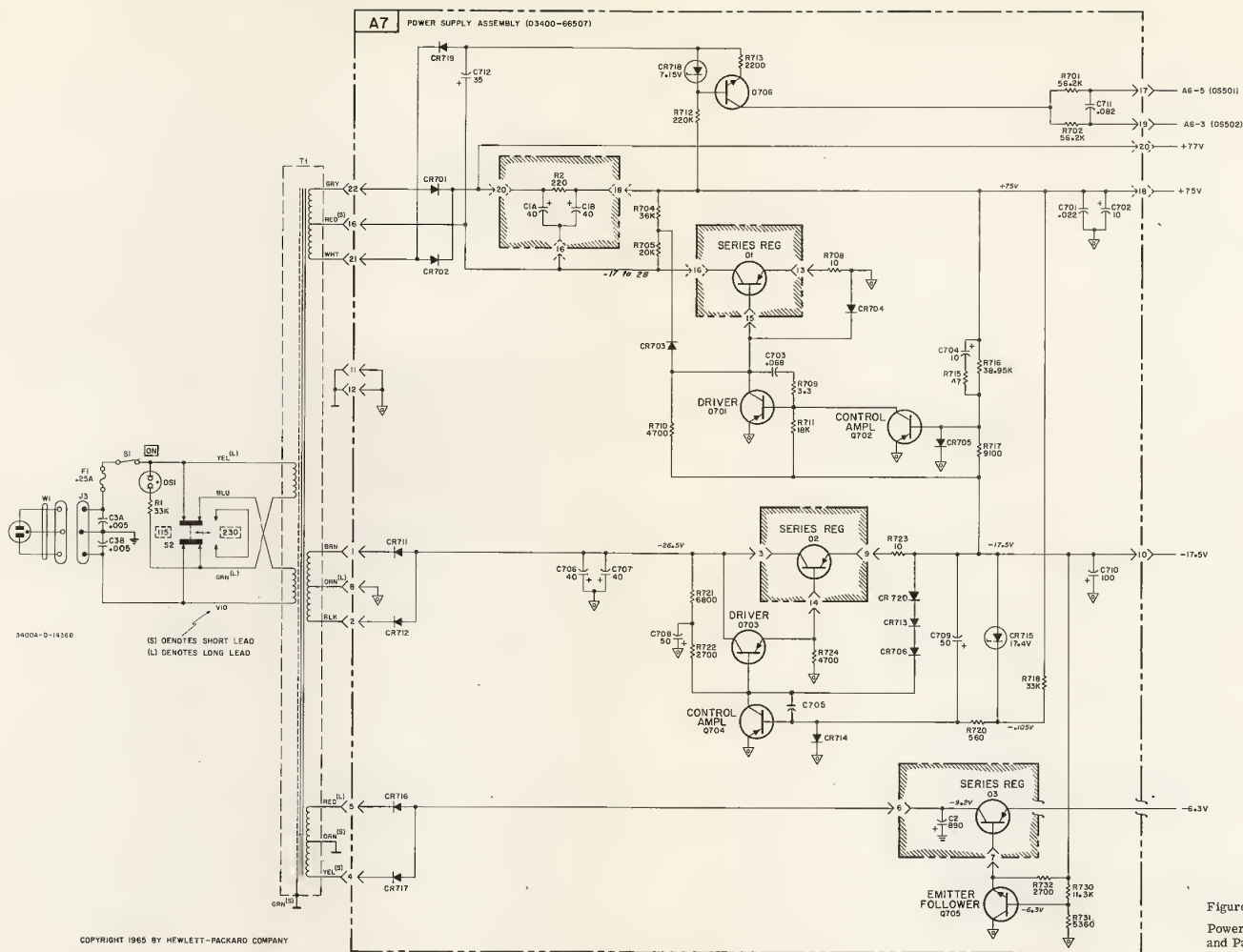


Figure 6-4.
Power Supply A7 Schematic
and Parts Location Diagram

SECTION VII

REPLACEABLE PARTS

7-1. INTRODUCTION.

7-2. This section contains information for ordering replacement parts. Table 7-1 lists parts in alphanumeric order of their reference designators and indicates the description, -hp- part number of each part, together with any applicable notes, and provides the following:

- a. Total quantity used in the instrument (TQ column). The total quantity of a part is given the first time the part number appears.
- b. Description of the part. (See list of abbreviations below.)
- c. Typical manufacturer of the part in a five-digit code. (See Appendix A for list of manufacturers.)
- d. Manufacturer's part number.

7-3. Miscellaneous parts are listed at the end of Table 7-1.

7-4. ORDERING INFORMATION.

7-5. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Field Office. (See Appendix B for list of office locations.) Identify parts by their Hewlett-Packard part numbers. Include instrument model and serial numbers.

7-6. NON-LISTED PARTS.

7-7. To obtain a part that is not listed, include:

- a. Instrument model number.
- b. Instrument serial number.
- c. Description of the part.
- d. Function and location of the part.

DESIGNATORS

A = assembly
B = motor
BT = battery
C = capacitor
CR = diode
DL = delay line
DS = lamp
E = mtsc electronic part

F = fuse
FL = filter
HR = heater
IC = integrated circuit
J = jack
K = relay
L = inductor
M = meter

MP = mechanical part
P = plug
Q = transistor
QCR = transistor-diode
R = resistor
RT = thermistor
S = switch
T = transformer

TC = thermocouple
V = vacuum tube, neon bulb, photocell, etc.
W = cable
X = socket
XDS = lampholder
XF = fuscholder
Z = network

ABBREVIATIONS

Ag = silver
Al = aluminum
A = ampere (s)
Au = gold
C = capacitor
cer = ceramic
coef = coefficient
com = common
comp = composition
conn = connection
dep = deposited
DPDT = double-pole double-throw
DPST = double-pole single-throw
elect = electrolytic
encap = encapsulated
F = farad (s)
FET = field effect transistor
fxd = fixed
GaAs = gallium arsenide
GHz = gigahertz = 10^9 hertz
gd = guard (cd)
Ge = germanium
grd = ground (ed)
H = henry (tes)
Hg = mercury
Hz = hertz (cycle (s) per second)

ID = inside diameter
imp = impregnated
incd = incandescent
ins = insulation (ed)
k Ω = kilohm (s) = 10^3 ohms
kHz = kilohertz = 10^3 hertz
L = inductor
lin = linear taper
log = logarithmic taper
m = milli = 10^{-3}
mA = milliamperes (s) = 10^{-3} amperes
MHz = megahertz = 10^6 hertz
M Ω = megohm (s) = 10^6 ohms
met film = metal film
mfr = manufacturer
mtg = mounting
mV = millivolt (s) = 10^{-3} volts
 μ = micro = 10^{-6}
 μ V = microvolt (s) = 10^{-6} volts
my = Mylar (R)
nA = nanoampere (s) = 10^{-9} amperes
NC = normally closed
Ne = neon
NO = normally open
NPO = negative positive zero (zero temperature coefficient)

ns = nanosecond (s) = 10^{-9} seconds
nsr = not separately replaceable
 Ω = ohm (s)
obd = order by description
OD = outside diameter
p = peak
pc = printed circuit
pF = picofarad (s) = 10^{-12} farads
piv = peak inverse voltage
p/o = part of
pos = position (s)
poly = polystyrene
pot = potentiometer
p-p = peak-to-peak
ppm = parts per million
prec = precision (temperature coefficient, long term stability, and/or tolerance)
R = resistor
Rh = rhodium
rms = root-mean-square
rot = rotary
Se = selenium
sect = section (s)
Si = silicon

sl = slide
SPDT = single-pole double-throw
SPST = single-pole single-throw
Ta = tantalum
TC = temperature coefficient
TiO₂ = titanium dioxide
tog = toggle
tol = tolerance
trim = trimmer
TSTR = transistor
V = volt (s)
vacw = alternating current working voltage
var = variable
vdew = direct current working voltage
W = watt (s)
w/ = with
wiv = working inverse voltage
w/o = without
ww = wirewound
* = optimum value selected at factory, average value shown (part may be omitted)
** = no standard type number assigned (selected or special type)

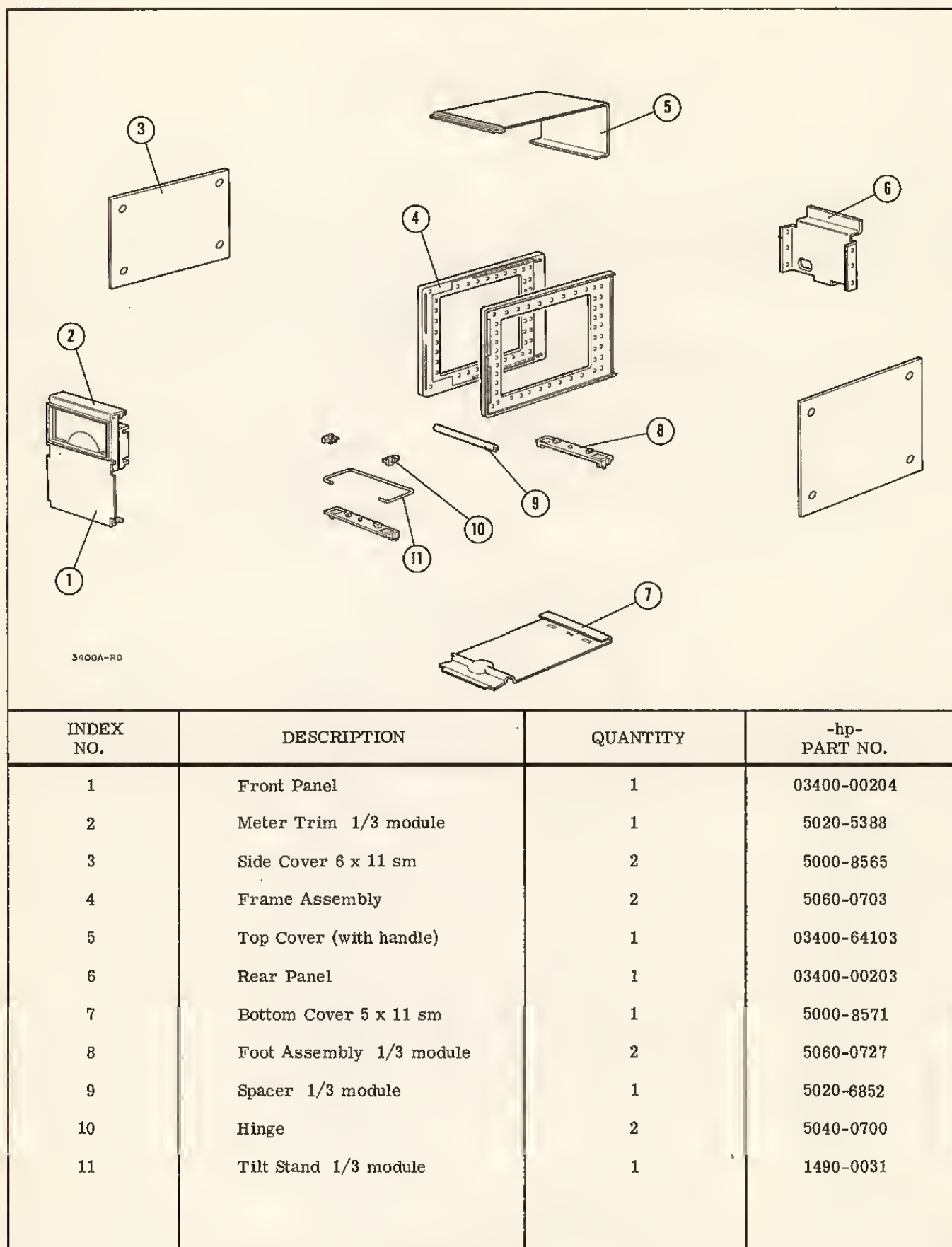


Figure 7-1. Modular Cabinet

Table 7-1. Replaceable Parts

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A1	03400-66501		Assembly: Input Attenuator Board		
A2	03400-66502		Assembly: Impedance Converter Board		
A3	03400-63401		Assembly: Second Attenuator		
A4	03400-66503		Assembly: Amplifier Board		
A5	1990-0223		Assembly: Photoconductor Chopper Part of A6. Note: matched neon subassembly (DS501 and DS502) available, -hp- Part No. 1990-0224		
A6	03400-66508		Assembly: Chopper Amplifier Board		
A7	03400-66510		Assembly: Power Supply Board		
C1	0180-0152		C: fxd Al elect 2X40 μ F +30% -10% 200 vdcw	56289	D36975
C2	0180-0148	1	C: fxd Al elect 890 μ F -10% +100% 15 vdcw	00853	Type PL1
C3A, B	0160-3333	2	C: fxd cer 5000 pF \pm 20%	08988	THD-8-502M-1.4KV
C4	0160-0379	1	C: fxd mica 4775 pF \pm 10% 500 vdcw	72982	633-010
C5 thru C100			Not assigned		
C101	0170-0022	1	C: fxd my 0.1 μ F \pm 20% 600 vdcw	09134	Type 27
C102	0132-0003	1	C: var poly 0.7 - 3.0 pF	72982	535-016-4R
C103	0150-0058	1	C: fxd cer 2.2 pF 600 vdcw	72982	301000 C0J0 229C
C104 thru C200			Not assigned		
C201	0170-0019		C: fxd my 0.1 μ F \pm 5% 200 vdcw	56289	192P10452-PTS
C202	0150-0031	1	C: fxd T1 2 pF \pm 5% 500 vdcw	78488	Type GA 2 pF 5%
C203	0180-0060	2	C: fxd elect 200 μ F -10% +100% 3 vdcw	56289	30D116A1
C204	0180-0089	3	C: fxd elect 10 μ F 150 vdcw	56289	30D218A1
C205*	0180-0039	4	C: fxd Al elect 100 μ F +75% -10% 12 vdcw	56289	107G012CC2-DSM
C206	0140-0201	1	C: fxd mica 12 pF \pm 5% 500 vdcw	04062	DM15C120J
C207	0180-0061	1	C: fxd elect 100 μ F -10% +100% 15 vdcw	56289	30D172A1
C208	0150-0093	3	C: fxd cer 0.01 μ F -20% +80% 100 vdcw	91418	TA obd
C209 thru C301			Not assigned		
C302*	0160-0987		C: fxd mica 12 pF \pm 5% 500 vdcw	72136	obd
C303	0121-0039	1	C: var 8-50 pF	72982	557-062-U2PO-34R
C304*	0160-0196	1	C: fxd mica 24 pF \pm 5%	72136	obd
C305*	0160-0987	2	C: fxd mica 12 pF \pm 5% 500 vdcw	72136	obd
C306 thru C401			Not assigned		
C402	0180-0063		C: fxd elect 500 μ F -10% +100% 3 vdcw	56289	30D120A1
C403	0150-0052	1	C: fxd cer 0.05 μ F \pm 20% 400 vdcw	72982	847-000-Z5UO-503M
C404	0140-0201		C: fxd mica 12 pF \pm 5% 500 vdcw	04062	DM15C120J
C405	0130-0018	1	C: var cer 1.5-7 pF 500 vdcw	72982	557-019-COPO-10R
C406	0180-0137	1	C: fxd Ta elect 100 μ F \pm 20% 10 vdcw	56289	150D107X0010R2
C407	0180-0060		C: fxd elect 200 μ F -10% +100% 3 vdcw	56289	30D116A1
C408	0160-0127	2	C: fxd cer 1 μ F \pm 20% 25 vdcw	56289	5C13
C409			Not assigned		
C410	0140-0225	2	C: fxd mica 300 pF \pm 1% 300 vdcw	04062	DM15F301J 300 V
C411	0180-0224	2	C: fxd elect 10 μ F 10 vdcw	56289	30D106G015BA4
C412	0180-0039		C: fxd elect 100 μ F 12 vdcw	56289	30D154A1
C413	0180-0142	2	C: fxd elect 20 μ F -10% +100% 25 vdcw	56289	Type 40D
C414	0140-0196	1	C: fxd mica 150 pF \pm 5% 300 vdcw	04062	DM15F151J 300 V
C415	0180-0142		C: fxd elect 20 μ F -10% +100% 25 vdcw	56289	Type 40D obd
C416 thru C419			Not assigned		
C420	0150-0096	1	C: fxd cer 0.05 μ F 100 vdcw	91418	TA obd
C421	0140-0225		C: fxd mica 300 pF \pm 1% 300 vdcw	04062	DM15F301J300V
C422	0160-0127		C: fxd cer 1 μ F \pm 20% 25 vdcw	56289	5C13 obd

Table 7-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
C423			Not assigned		
C424	0180-0128	1	C: fxd cer 2.2 μ F $\pm 20\%$ 25 vdcw	56289	5C13 obd
C425, C426	0140-0176	2	C: fxd mica 100 pF $\pm 2\%$ 300 vdcw	04062	DM15F101G 300V
C427	0180-0104	1	C: fxd elect 200 μ F 15 vdcw	56289	30D174A1
C428 thru C600			Not assigned		
C601	0180-0081	1	C: fxd Ta elect 50 μ F $+20\%$ -15% 10 vdcw	10411	MTA-50-10
C602	0180-0032	1	C: fxd elect 10 μ F $+75\%$ -10% 12 vdcw	56289	30D106G012 BA2-DSM
C603, C604	0150-0084	2	C: fxd cer 0.1 μ F $+80\%$ -20% 50 vdcw	56289	33C41
C605	0180-0111	1	C: fxd elect 2 μ F 25 vdcw	56289	40D173A2
C606	0180-0224		C: fxd elect 10 μ F 10 vdcw	56289	30D106G01513A4
C607	0150-0093		C: fxd cer 0.01 μ F $+80\%$ -20% 100 vdcw	91418	TA obd
C608	0180-0022	1	C: fxd Ta elect 3.9 μ F 35 vdcw	05397	K3R9J35KS
C609	0180-0039		C: fxd elect 100 μ F 12 vdcw	56289	30D154A1
C610, C611			Not assigned		
C612	0180-0156	1	C: fxd Al elect 880 μ F $+100\%$ -10% 1 vdcw	56289	Type 34D obd
C613	0180-0039		C: fxd elect 100 μ F 12 vdcw	56289	30D154A1
C614 thru C700			Not assigned		
C701	0170-0024	2	C: fxd my 0.022 μ F $\pm 20\%$ 200 vdcw	56289	192P22302
C702	0180-0089		C: fxd elect 10 μ F $+100\%$ -10% 150 vdcw	56289	30D218A1
C703	0160-0166	1	C: fxd my 0.068 μ F $\pm 10\%$ 200 vdcw	56289	192P68392-PTS
C704	0180-0089		C: fxd elect 10 μ F 100% -10% 150 vdcw	56289	30D218A1
C705	0150-0012	1	C: fxd cer 0.01 μ F $\pm 20\%$ 1000 vdcw	56289	H1038 obd
C706, C707	0180-0050	2	C: fxd elect 40 μ F $+100\%$ -15% 50 vdcw	56289	D32538
C708 thru C709	0180-0105	1	C: fxd elect 50 μ F 25 vdcw	56289	S97441
C710	0180-0098	1	C: fxd elect 100 μ F $\pm 20\%$ 20 vdcw	56289	150D107X0020S2-DYS
C711	0160-2192	1	C: fxd my 0.082 μ F $\pm 5\%$ 200 vdcw	56289	192P82352-PTS
C712	0180-0282	1	C: fxd Al elect 35 μ F $+75\%$ -10% 250 vdcw	56289	D38270
CR201	1902-0045	1	Diode: avalanche 732 V $\pm 2\%$ 400 mW	04713	SZ10939-144
CR202	1901-0025	11	Diode: Si 100 piv	93332	D3072
CR203 thru CR400			Not assigned		
CR401	1901-0025		Diode: Si 100 piv	93332	D3072
CR402	1901-0040	1	Diode: Si	03877	SG 5050
CR403	1902-0040	1	Diode: avalanche 14 V $\pm 5\%$ 400 mW	04713	SZ10939-224
CR404, CR405			Not assigned		
CR406	1901-0025		Diode: Si 100 piv	93332	D3072
CR407, CR408	1910-0016	2	Diode: Ge 60 piv	11711	GD 150
CR409 thru CR600			Not assigned		
CR801	1902-0046	2	Diode: breakdown 7.15 V $\pm 10\%$	04713	SZ10939-139
CR602	1910-0018		Diode: Ge 60 piv	11711	GD 150
CR803, CR604	1901-0025		Diode: Si 100 piv	93332	D3072
CR605 thru CR700			Not assigned		
CR701, CR702	1901-0028	2	Diode: Si 0.5 amp 400 piv	01841	obd
CR703 thru CR706	1901-0025		Diode: Si 100 piv	93332	D3072

Table 7-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		T Q	DESCRIPTION	MFR.	MFR. PART NO.
CR707 thru CR710				Not assigned		
CR711, CR712	1901-0158		2	Diode: Si 200 piv	04713	SRI358-3
CR713, CR714, CR720	1901-0025			Diode: Si 100 piv	93332	D3072
CR715	1902-3223		1	Diode: Si breakdown 17.4 V $\pm 2\%$ 400 mW	04713	SZ10939-225
CR716, CR717	1901-0045		2	Diode: Si 100 piv	86684	34935
CR718	1902-0046			Diode: breakdown 7.15 V $\pm 10\%$ 400 mW	04713	SZ10939-139
CR719	1901-0028			Diode: Si 400 piv	01841	obd
DS1	1450-0419		1	Light: Indicator - Lamp No. A165	72765	599-237-WHITE
F1	2110-0004		1	Fuse: cartridge 1/4 amp 250 V	75915	3AG/CAT. 312.250
J1	1250-0118		1	Connector: BNC	91737	8427
J2	1251-0205		1	Jack: telephone open circuit	82389	2J-1432
J3	1251-2357		1	Connector: AC power cord receptacle	82389	EAC-301
J4	1251-0208		1	Connector: PC 22 contact	95354	91-6922-1500-00
J5	1251-0194		1	Connector: PC 15 contact	95354	91-6915-1113-00
M1	1120-0320		1	Meter: full scale 3 mA	-hp-	
M1	1120-0308		1	Meter: dB scale uppermost (Option 01) only	-hp-	
Q1	1850-0098		1	TSTR: Ge PNP selected	04713	SP-776
Q2, Q3	1850-0038		2	TSTR: Ge PNP	86684	34879
Q4 thru Q200				Not assigned		
Q201	1854-0215		1	TSTR: Si NPN	04713	SPS 3611
Q202 thru Q400				Not assigned		
Q401 thru Q403	1853-0010			TSTR: Si PNP	04713	SM4713
Q404	1854-0005		2	TSTR: Si PNP 2N708	04713	obd
Q405	1853-0010			TSTR: Si PNP	04713	SM4713
Q406	1854-0005			TSTR: Si $\Omega N \Omega$ 2N708	04713	obd
Q407 thru Q600				Not assigned		
Q601 thru Q604	1853-0036		4	TSTR: Si PNP 2N3906	04713	2N3906-5
Q605	1854-0033		1	TSTR: Si NPN 2N3391	24446	2N3391
Q606	1853-0016		1	TSTR: Si PNP 2N3638	07263	2N3638
Q607 thru Q700				Not assigned		
Q701, Q702	1853-0068		2	TSTR: Si PNP	12040	ST62122
Q703, Q704	1853-0086		2	TSTR: Si PNP	04713	SPS3322
Q705	1854-0215		1	TSTR: Si NPN	04713	SPS3611
Q706	1854-0022		1	TSTR: Si NPN 2N2102	03877	ST 1657
R1	0687-3331		1	R: fxd comp 33 k Ω $\pm 10\%$ 1/2 W	01121	EB 3331
R2	0687-2211		1	R: fxd comp 220 Ω $\pm 10\%$ 1/2 W	01121	EB 2211
R3*	0758-0070		1	R: fxd met flm 1200 Ω $\pm 5\%$ 1/2 W	75042	CE 57 obd
R4	2100-0805		1	R: var ww lin 50 Ω $\pm 20\%$ 2 W	71450	Series 117-SPC
R5	0812-0048		1	R: fxd ww 80 Ω $\pm 3\%$ 1/2 W	14193	SA10 obd
R6	2100-0721		1	R: var ww 30 Ω $\pm 20\%$	71450	Series 112-SPL
R7	2100-0412		1	R: var ww lin 200 Ω $\pm 20\%$ 2 W	71450	Type 117 obd
R8*	0686-3915		1	R: fxd comp 390 Ω $\pm 5\%$ 1/2 W	01121	EB 3915
R9	0684-4741		1	R: fxd comp 470 k Ω $\pm 10\%$ 1/4 W	01121	EB 4741
R10	0683-3635		1	R: fxd comp 36 k Ω $\pm 5\%$ 1/4 W	01121	CB 3635
R11 thru R100				Not assigned		

Table 7-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
R101	0698-4128	1	R: fxd met flm $10M \pm 1/4\%$ $1/2$ W	56289	42DET-2
R102			Not assigned		
R103	0698-6204	1	R: fxd met flm $9.9 k\Omega \pm 1\%$ $1/8$ W	75042	CEA T-O obd
R104	2100-0128	1	R: var comp lin $250\Omega \pm 20\%$ $1/3$ W	71450	UPM 70RE (-hp-)
R105 thru R200			Not assigned		
R201	0683-3935	1	R: fxd comp $39 k\Omega \pm 5\%$ $1/4$ W	01121	CB 3935
R202	0683-4715	1	R: fxd comp $470\Omega \pm 5\%$ $1/4$ W	01121	CB 4715
R203	0683-3355	1	R: fxd comp $3.3M \pm 5\%$ $1/4$ W	01121	CB 3335
R204	0683-1035	4	R: fxd comp $10 k\Omega \pm 5\%$ $1/4$ W	01121	CB 1035
R205	0683-8225	2	R: fxd comp $8200\Omega \pm 5\%$ $1/4$ W	01121	CB 8225
R206	0683-8215	1	R: fxd comp $820\Omega \pm 5\%$ $1/4$ W	01121	CB 8215
R207	0727-0439	1	R: fxd depc $30.1 k\Omega \pm 1\%$	91637	DCS 1/2
R208	0683-2715	1	R: fxd comp $270\Omega \pm 5\%$ $1/4$ W	01121	CB 2715
R209	0683-1015	1	R: fxd comp $100\Omega \pm 5\%$ $1/4$ W	01121	CB 1015
R210			Not assigned		
R211	0683-2725	3	R: fxd comp $2700\Omega \pm 5\%$ $1/4$ W	01121	CB 2725
R212	0727-0136	1	R: fxd depc $5.03 k\Omega \pm 1\%$ $1/2$ W	56289	428E
R213	0727-0126	1	R: fxd depc $3.266 k\Omega \pm 1\%$ $1/2$ W	91637	DCS 1/2
R214 thru R300			Not assigned		
R301	0757-0715	1	R: fxd met flm $150\Omega \pm 1\%$ $1/4$ W	91637	MFF-1/4-T1
R302	0698-4119	5	R: fxd met flm $410.28\Omega \pm 0.1\%$ $1/4$ W	91637	MFF 1/4 T-3
R303	0698-4118	4	R: fxd met flm $277.48\Omega \pm 0.1\%$ $1/4$ W	91637	MFF 1/4 T-3
R304	0698-4119		R: fxd met flm $410.26\Omega \pm 0.1\%$ $1/4$ W	91637	MFF 1/4 T-3
R305	0698-4118		R: fxd met flm $277.48\Omega \pm 0.1\%$ $1/4$ W	91637	MFF 1/4 T-3
R306	0698-4119		R: fxd met flm $410.26\Omega \pm 0.1\%$ $1/4$ W	91637	MFF 1/4 T-3
R307	0698-4118		R: fxd met flm $277.48\Omega \pm 0.1\%$ $1/4$ W	91637	MFF 1/4 T-3
R308	0698-4119		R: fxd met flm $410.26\Omega \pm 0.1\%$ $1/4$ W	91637	MFF 1/4 T-3
R309	0698-4118		R: fxd met flm $277.48\Omega \pm 0.1\%$ $1/4$ W	91637	MFF 1/4 T-3
R310	0698-4119		R: fxd met flm $410.26\Omega \pm 0.1\%$ $1/4$ W	91837	MFF 1/4 T-3
R311	0698-4117	1	R: fxd met flm $189.72\Omega \pm 0.1\%$ $1/4$ W	91637	MFF 1/4 T-3
R312	0683-5115	2	R: fxd comp $510\Omega \pm 5\%$ $1/4$ W	91637	MFF 1/4 T-3
R313 thru R400			Not assigned		
R401	0683-3025	2	R: fxd comp $3000\Omega \pm 5\%$ $1/4$ W	01121	CB 3025
R402	0683-1035		R: fxd comp $10 k\Omega \pm 5\%$ $1/4$ W	01121	CB 1035
R403	0683-2405	1	R: fxd comp $24\Omega \pm 5\%$ $1/4$ W	01121	CB 2405
R404	0757-0346	2	R: fxd met oxide $10\Omega \pm 1\%$ $1/8$ W	75042	CEA T-O obd
R405	0683-1515	1	R: fxd comp $150\Omega \pm 5\%$ $1/4$ W	01121	CB 1515
R406	0683-3925	2	R: fxd comp $3900\Omega \pm 5\%$ $1/4$ W	01121	CB 3925
R407	0727-0065	1	R: fxd depc $300\Omega \pm 1\%$ $1/2$ W	56289	428E
R408	0683-1025	2	R: fxd comp $1000\Omega \pm 5\%$ $1/4$ W	01121	CB 1025
R409	0683-1005	2	R: fxd comp $10\Omega \pm 5\%$ $1/4$ W	01121	CB 1005
R410	0683-1025	2	R: fxd comp $1000\Omega \pm 5\%$ $1/4$ W	01121	CB 1025
R411 thru R415			Not assigned		
R416	0683-5115		R: fxd comp $510\Omega \pm 5\%$ $1/4$ W	01121	CB 5115
R417	0683-6825	7	R: fxd comp $8800\Omega \pm 5\%$ $1/4$ W	01121	CB 8825
R418	0883-1825	1	R: fxd comp $1800\Omega \pm 5\%$ $1/4$ W	01121	CB 1825
R419*	0683-2715	1	R: fxd comp $270\Omega \pm 5\%$ $1/4$ W	01121	CB 2715
			Factory selected comp: typical value given		
R420	0683-6825		R: fxd comp $6800\Omega \pm 5\%$ $1/4$ W	01121	CB 6825
R421, R422			Not assigned		
R423	0683-3325	2	R: fxd comp $3300\Omega \pm 5\%$ $1/4$ W	01121	CB 3325

Table 7-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
R424	0683-5135	1	R: fxd comp 51 k Ω $\pm 5\%$ 1/4 W	01121	CB 5135
R425	0683-1035		R: fxd comp 10 k Ω $\pm 5\%$ 1/4 W	01121	CB 1035
R426	0757-0346		R: fxd met oxide 10 Ω $\pm 1\%$ 1/8 W	75042	CEA T-O obd
R427			Not assigned		
R428	0683-4305	2	R: fxd comp 43 Ω $\pm 5\%$ 1/4 W	01121	CB 4305
R429	0757-0345	1	R: fxd met oxide 302 Ω $\pm 1\%$ 1/8 W	19701	N60 obd
R430			Not assigned		
R431	0683-3335	2	R: fxd comp 33 k Ω $\pm 5\%$ 1/4 W	01121	CB 3335
R432	0683-4305		R: fxd comp 43 Ω $\pm 5\%$ 1/4 W	01121	CB 4305
R433	0758-0073	1	R: fxd met flm 24 k Ω $\pm 5\%$ 1/2 W	01121	CB 0033
R434, R435	0758-0033	2	R: fxd met flm 2000 Ω $\pm 5\%$ 1/2 W	01121	CB 0033
R436 thru R600			Not assigned		
R601	0757-0454	3	R: fxd met flm 33.2 k Ω $\pm 1\%$ 1/8 W	75042	CEA T-O obd
R602, R603	0757-0459	2	R: fxd met flm 56.2 k Ω $\pm 1\%$ 1/8 W	75042	CEA T-O obd
R604, R605	0683-6835	3	R: fxd comp 68 k Ω $\pm 5\%$ 1/4 W	01121	CB 6835
R606	0683-3325		R: fxd comp 3300 Ω $\pm 5\%$ 1/4 W	01121	CB 3325
R607, R608	0683-1035		R: fxd comp 10 k Ω $\pm 5\%$ 1/4 W	01121	CB 1035
R609	0683-1025	2	R: fxd comp 1000 Ω $\pm 5\%$ 1/4 W	01121	CB 1025
R610	0683-3915	1	R: fxd comp 390 Ω $\pm 5\%$ 1/4 W	01121	CB 3915
R611 thru R614			Not assigned		
R615	0683-3335		R: fxd comp 33 k Ω $\pm 5\%$ 1/4 W	01121	CB 3335
R616	0683-2235	1	R: fxd comp 22 k Ω $\pm 5\%$ 1/4 W	01121	CB 2235
R617	0758-0043	1	R: fxd met flm 1800 Ω $\pm 5\%$ 1/2 W	75042	CE 57
R618	0727-0100	1	R: fxd depc 1000 Ω $\pm 1\%$ 1/2 W	56289	428E
R619	0727-0063	1	R: fxd depc 292.4 Ω $\pm 1\%$ 1/2 W	56289	428E
R620	0683-1245	1	R: fxd comp 120 k Ω $\pm 5\%$ 1/4 W	01121	CB 1245
R621	0727-0013	1	R: fxd depc 24.3 Ω $\pm 1\%$ 1/2 W	56289	428E
R622	0683-3925		R: fxd comp 3900 Ω $\pm 5\%$ 1/4 W	01121	CB 3925
R623	0683-3945	1	R: fxd comp 390 k Ω $\pm 5\%$ 1/4 W	01121	CB 3945
R624	0683-6835		R: fxd comp 68 k Ω $\pm 5\%$ 1/4 W	01121	CB 6835
R625	0683-6835		R: fxd comp 68 k Ω $\pm 5\%$ 1/4 W	01121	CB 6835
R626 thru R629			Not assigned		
R630	0683-3025		R: fxd comp 3000 Ω $\pm 5\%$ 1/4 W	01121	CB 3025
R631, R632	0757-0454		R: fxd met flm 33.2 k Ω $\pm 1\%$ 1/8 W	75042	CEA T-O obd
R633			Not assigned		
R634			Not assigned		
R635	0698-3455		R: fxd met flm 261 k Ω $\pm 1\%$ 1/8 W	75042	CEA T-O obd
R636 thru R700			Not assigned		
R701, R702	0757-0854	2	R: fxd met flm 56.2 k Ω $\pm 1\%$ 1/2 W	91637	MFF 1/2 T-1 obd
R703			Not assigned		
R704	0758-0064	1	R: fxd met flm 36 k Ω $\pm 5\%$ 1/2 W	75042	obd
R705	0683-2035	1	R: fxd comp 20 k Ω $\pm 5\%$ 1/4 W	01121	CB 2035
R706			Not assigned		
R707			Not assigned		
R708	0683-1005		R: fxd 10 Ω $\pm 5\%$ 1/4 W	01121	CB 1005
R709	0683-0335	1	R: fxd comp 3.3 Ω $\pm 5\%$ 1/4 W	01121	CB 33G5
R710	0683-4725	2	R: fxd comp 4700 Ω $\pm 5\%$ 1/4 W	01121	CB 4725
R711	0687-1831	1	R: fxd comp 18 k Ω $\pm 10\%$ 1/2 W	01121	CB 1831
R712	0687-2241	1	R: fxd comp 220 k Ω $\pm 10\%$ 1/2 W	01121	EB 2241
R713	0686-2225	1	R: fxd comp 2.2 k Ω $\pm 5\%$ 1/2 W	01121	EB 2225
R714			Not assigned		
R715	0683-4705		R: fxd comp 47 Ω $\pm 5\%$ 1/4 W	01121	CB 4705

Table 7-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
R716	0727-0188		1	R: fxd depc 38.95 k Ω \pm 1/2% 1/2 W	91637	DCS 1/2 obd
R717	0727-0153		1	R: fxd depc 9.1 k Ω \pm 1% 1/2 W	56289	428E
R718	0683-3335			R: fxd comp 33 k Ω \pm 5% 1/4 W	01121	CB 3335
R719				Not assigned		
R720	0683-5615		1	R: fxd comp 560 Ω \pm 5% 1/4 W	01121	CB 5615
R721	0683-6825			R: fxd comp 6800 Ω \pm 5% 1/4 W	01121	CB 6825
R722	0683-2725			R: fxd comp 2700 Ω \pm 5% 1/4 W	01121	CB 2725
R723	0884-1001		1	R: fxd comp 10 Ω \pm 10% 1/4 W	01121	CB 1001
R724	0683-4725			R: fxd comp 4700 Ω \pm 5% 1/4 W	01121	CB 4725
R725 thru R729				Not assigned		
R730	0698-4121			R: fxd met flm 11.3 k Ω \pm 1% 1/8 W	14674	C4 obd
R731	0698-3258			R: fxd met flm 5.36k Ω \pm 1% 1/8 W	14674	C4 T-0
R732	0683-2725			R: fxd comp 2700 Ω \pm 5% 1/4 W	01121	CB 2725
S1	3101-0036		1	Switch: toggle SPST 3 amp 250 V	88140	8928K61
S2	3101-1234		1	Switch: slide, marked 115/230 V	82389	11A-1242A
S3 thru S300				Not assigned		
S301	3100-0358		1	Switch: rotary 3 sect 12 pos	76854	obd
T1	9100-1440		1	Transformer	-hp-	
TC401, TC402	0853-0003		2	Thermocouples -- matched pair	11403	obd
V201	1921-0017		1	Electron Tube: 7586 nuvistor triode	86684	7588 obd
W1	8120-1348		1	Power Cord 7-1/2 ft	70903	KHS-7041
XF1	1400-0084		1	Fuseholder: extractor post-type 2-5/64" long	75915	342014
XV201	1200-0086		1	Socket: nuvistor 5-pin	71785	133-65-11-026
	1200-0044			Socket: transistor	97313	1ST1502-3
<u>MISCELLANEOUS</u>						
	0370-0077		1	Knob: bar (with one arrow)	-hp-	
	1200-0043		1	Insulator: transistor anodized aluminum	000LB	obd
	1200-0081		1	Insulator: transistor nylon .235" od.	26365	974 Special
	1520-0002		1	Plate: capacitor mounting	56137	obd
	1520-0003		1	Plate: capacitor mounting	37942	Type BP2 obd
	03400-01202		1	Clamp: capacitor mounting	-hp-	
	03400-01204		1	Bracket: ground	-hp-	
	03400-61601		1	Cable assembly: amplifier input	-hp-	
	03400-61602		1	Cable assembly: chopper input	-hp-	
	03400-61803		1	Cable assembly: input attenuator	-hp-	
	03400-69501		1	Shock mount impedance converter	-hp-	
	1200-0044		1	Socket: TSTR	97913	Type M7 (PB)obd
	03400-90008		1	Manual: Operating and Service	-hp-	

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.	05347	Ultronix, Inc.	San Mateo, Cal.	11236	CTS of Berne, Inc.	Berne, Ind.
00136	McCoy Electronics	Mount Holly Springs, Pa.	05387	Union Carbide Corp., Elect.	Div. New York, N.Y.	11237	Chicago Telephone of	California, Inc. So. Pasadena, Cal.
00213	Sage Electronics Corp.	Rochester, N.Y.	05574	Viking Ind. Inc.	Canoga Park, Cal.	11242	Bay State Electronics Corp.	Walham, Mass.
00287	Cemco, Inc.	Danielson, Conn.	05583	Icore Electro-Plastics Inc.	Sunnyvale, Cal.	11312	Teledyne Inc., Microwave	Div. Palo Alto, Cal.
00334	Humidial	Colton, Calif.	05618	Cosmo Plastic (c/o Electrical	Spec. Co.) Cleveland, Ohio	11314	National Seal	Downey, Cal.
00348	Mietron, Co., Inc.	Valley Stream, N.Y.	05624	Barber Colman Co.	Rockford, Ill.	11453	Precision Connector Corp.	Jamaica, N.Y.
00373	Garlock Inc.	Cherry Hill, N.J.	05728	Tiffen Optical Co.	Roslyn Heights, Long Island, N.Y.	11534	Duncan Electronics Inc.	Costa Mesa, Cal.
00856	Aerovox Corp.	New Bedford, Mass.	05728	Metro-Tel Corp.	Westbury, N.Y.	11711	General Instrument Corp.,	Semiconductor Division Products
00779	Amp. Inc.	Harrisburg, Pa.	05783	Stewart Engineering Co.	Santa Cruz, Cal.	Group Newark, N.J.		
00781	Aircraft Radio Corp.	Boonton, N.J.	05820	Wakefield Engineering Inc.	Wakefield, Mass.	11717	Imperial Electronic, Inc.	Buena Park, Cal.
00809	Crovan, Ltd.	Whitby, Ontario, Canada	06004	Bassick Co., Div. of Stewart	Warner Corp. Bridgeport, Conn.	11870	Melabs, Inc.	Palo Alto, Cal.
00815	Northern Engineering	Laboratories, Inc. Burlington, Wis.	06090	Raychem Corp.	Redwood City, Cal.	12138	Philadelphia Handle Co.	Camden, N.J.
00853	Sangamo Electric Co.,	Pickens Div. Pickens, S.C.	06175	Bausch and Lomb Optical	Co. Rochester, N.Y.	12361	Groves Mfg. Co., Inc.	Shady Grove, Pa.
00866	Gos Engineering Co.	City of Industry, Cal.	06402	E. T. A. Products Co. of	America Chicago, Ill.	12574	Gulton Ind. Inc., Data System	Div. Albuquerque, N.M.
00891	Carl E. Holms Corp.	Los Angeles, Cal.	08540	Amatonic Electronic Hardware	Co., Inc. New Rochelle, N.Y.	12697	Clarostat Mfg. Co.	Dover, N.H.
00929	Microlab Inc.	Livingston, N.J.	06555	Beebe Electrical Instrument	Co., Inc. Penacook, N.H.	12728	Elmar Filter Corp.	W. Haven, Conn.
01002	General Electric Co.,	Capacitor Dept. Hudson Falls, N.Y.	06666	General Devices Co., Inc.	Indianapolis, Ind.	12859	Nippon Electric Co., Ltd.	Tokyo, Japan
01009	Alden Products Co.	Brockton, Mass.	06751	Components Inc., Ariz. Div.	Phoenix, Arizona	12881	Metex Electronics Corp.	Clark, N.J.
01121	Allen Bradley Co.	Milwaukee, Wis.	06812	Torrington Mfg. Co., West Div.	Van Nuys, Cal.	12930	Delta Semiconductor Inc.	Newport Beach, Cal.
01255	Lifton Industries, Inc.	Beverly Hills, Cal.	06880	Varian Assoc. Elmac Div.	San Carlos, Cal.	12854	Dickson Electronics Corp.	Scottsdale, Arizona
01281	TRW Semiconductors, Inc.	Lawndale, Cal.	07088	Kelvin Electric Co.	Van Nuys, Cal.	13019	Aircor Supply Co., Inc.	Wichita, Kansas
01295	Texas Instruments, Inc.,	Transistor Products Div. Dallas, Texas	07126	Digitran Co.	Pasadena, Cal.	13061	Wilco Products	Detroit, Mich.
01349	The Alliance Mfg. Co.	Alliance, Ohio	07137	Transistor Electronics	Corp. Minneapolis, Minn.	13103	Thermolloy	Dallas, Texas
01538	Small Parts Inc.	Los Angeles, Cal.	07138	Westinghouse Electric	Corp., Electronic Tube Div. Elmira, N.Y.	13327	Soliftron Devices Inc.	Tappan, N.Y.
01588	Pacific Relays, Inc.	Van Nuys, Cal.	07148	Filmohm Corp.	New York, N.Y.	13388	Telefunken (GmbH)	Hanover, Germany
01870	Gudebrod Bros. Silk Co.	New York, N.Y.	07233	Cinch-Graphik Co.	City of Industry, Cal.	13635	Midland-Wright Div. of	Pacific Industries, Inc. Kansas City, Kansas
01930	Amcrock Corp.	Rockford, Ill.	07256	Silicon Transistor Corp.	Carle Place, N.Y.	14099	Sem-Tech	Newbury Park, Cal.
01960	Pulse Engineering Co.	Santa Clara, Cal.	07261	Avnet Corp.	Culver City, Cal.	14193	Calif. Resistor Corp.	Santa Monica, Cal.
02114	Ferroxcube Corp. of	America Saugerties, N.Y.	07263	Fairchild Camera & Inst. Corp.,	Semiconductor Div. Mountain View, Cal.	14288	American Components, Inc.	Conshohocken, Pa.
02116	Wheelock Signals, Inc.	Long Branch, N.J.	07322	Minnesota Rubber Co.	Minneapolis, Minn.	14433	ITT Semiconductor, a Div. of	Int. Telephone and Telegraph
02286	Cole Rubber and Plastics Inc.	Sunnyvale, Cal.	07387	Bircher Corp. Ths	Monterey Park, Cal.	Corporation West Palm Beach, Fla.		
02660	Amphenol-Borg Electronics	Corp. Broadview, Ill.	07387	Sylvania Elect. Prod. Inc.,	Mt. View Operations Mountain View, Cal.	14483	Hewlett-Packard Company.	Loveland, Colo.
02735	Radio Corp. of America, Semi-	conductor and Materials	07387	Technical Wire Products	Inc. Cranford, N.J.	14555	Cornell Dublier Electric Corp.	Newark, N.J.
02771	Vocaline Co. of America,	Inc. Old Saybrook, Conn.	07628	Bodins Elect. Co.	Chicago, Ill.	14674	Corning Glass Works	Corning, N.Y.
02777	Hopkins Engineering Co.	San Fernando, Cal.	07910	Continental Device Corp.	Hawthorne, Cal.	14752	Electro Cubo Inc.	San Gabriel, Cal.
02875	Hudson Tool & Die	Newark, N.J.	07833	Raytheon Mfg. Co., Semi-	conductor Div. Mountain View, Cal.	14960	Williams Mfg. Co.	San Jose, Cal.
03296	Nylon Molding Corp.	Springfield, N.J.	07880	Hawlett-Packard Co.,	New Jersey Division Rockaway, N.J.	15106	The Sphere Co., Inc.	Little Falls, N.J.
03508	G.E. Semiconductor Prod.	Dept. Syracuse, N.Y.	08145	U.S. Engineering Co.	Los Angeles, Cal.	15203	Webster Electronics Co.	New York, N.Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio	08289	Blinn, Delbert Co.	Pomona, Cal.	15287	Scionics Corp.	Northridge, Cal.
03797	Eidema Corp.	Compton, Calif.	08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada	15291	Adjustable Bushing Co.	N. Hollywood, Cal.
03818	Parker Seal Co.	Los Angeles, Cal.	08524	Deutsche Fastener Corp.	Los Angeles, Cal.	15558	Micron Electronics, Garden City, Long Island, N.Y.	
03877	Transitron Electric Corp.	Wakefield, Mass.	08664	Bristol Co., The	Waterbury, Conn.	15588	Amprobe Inst. Corp.	Lynbrook, N.Y.
03888	Pyrofilm Resistor Co.,	Inc. Cedar Knolls, N.J.	08717	Sloan Company	Sun Valley, Cal.	15631	Cabletronics	Costa Mesa, Cal.
03954	Singer Co., Diehl Div.,	Flinders Plant Sumerville, N.J.	08718	ITT Cannon Electric Inc.,	Phoenix Div. Phoenix, Arizona	15772	Twentieth Century Coil	Spring Co. Santa Clara, Cal.
04009	Arrow, Hari and Hegeman	Elect. Co. Hartford, Conn.	08727	National Radio Lab. Inc.	Paramus, N.J.	15801	Fenwal Elect. Inc.	Framingham, Mass.
04013	Tarus Corp.	Lambertville, N.J.	08792	CBS Electronics Semiconductor	Operations, Div. of CBS Inc. Lowell, Mass.	15818	Amelco Inc.	Mountain View, Cal.
04062	Arco Electronic Inc.	Great Neck, N.Y.	08808	General Electric Co.,	Miniature Lamp Dept. Cleveland, Ohio	16037	Spruce Pine Mica Co.	Spruce Pine, N.C.
04217	Essax Wirs	Los Angeles, Cal.	08864	Mel-Rain	Indianapolis, Ind.	16179	Omni-Spectra Inc.	Detroit, Ill.
04222	H1-Q Division of Aerovox.	Myrtle Beach, S.C.	09026	Babcock Relays Div.	Costa Mesa, Cal.	18352	Computer Diodes Corp.	Lodi, N.J.
04354	Precision Paper Tube Co.	Whseling, Ill.	09087	Electronic Enclosures Inc.	Los Angeles, Calif.	16554	Electroid Co.	Union, N.J.
04404	Palo Alto Division of Hewlett-	Packard Co. Palo Alto, Cal.	09134	Texas Capacitor Co.	Houston, Texas	16585	Boots Aircraft Nut Corp.	Pasadena, Cal.
04651	Sylvania Electric Products,	Microwave Device Div. Mountain View, Cal.	08145	Tech. Ind. Inc. Atcham	Elect. Burbank, Cal.	18688	Ideal Prec. Mcler Co., Inc.,	De Jur Meter Div. Brooklyn, N.Y.
04673	Dakota Engr. Inc.	Culver City, Cal.	08250	Electro Assemblies, Inc.	Chicago, Ill.	16758	Delco Radio Div. of G.M. Corp.	Kokomo, Ind.
04713	Motorola Inc. Semiconductor	Prod. Div. Phoenix, Arizona	08353	C & K Components Inc.	Newton, Mass.	17109	Thermometrics Inc.	Canoga Park, Cal.
04732	Filttron Co., Inc. Western	Div. Culver City, Cal.	08568	Mallory Battery Co. of	Canada, Ltd. Toronto, Ontario, Canada	17474	Tranex Company	Mountain View, Cal.
04773	Automatic Electric Co.	Northlake, Ill.	08795	Pennsylvania Fluorocarbon. Clifton Heights, Penn.		17675	Hamlin Metal Products Corp.	Akron, Ohio
04796	Squibb Wire Co.	Redwood City, Cal.	08822	Burdny Corp.	Norwalk, Conn.	17745	Angstrom Prec. Inc.	No. Hollywood, Cal.
04811	Precision Coil Spring Co.	El Monte, Cal.	10214	General Transistor Western	Corp. Los Angeles, Cal.	17856	Siliconix Inc.	Sunnyvale, Cal.
04870	P.M. Motor Company	Westchester, Ill.	10411	Ti-Tal, Inc.	Berkeley, Cal.	17870	McGraw-Edison Co.	Manchester, N.H.
04919	Component Mfg. Service	Co. W. Bridgewater, Mass.	10646	Carborundum Co.	Niagara Falls, N.Y.	18042	Power Design Pacific Inc.	Palo Alto, Cal.
05006	Twentieth Century Plastics,	Inc. Los Angeles, Cal.				18083	Clevite Corp. Semiconductor Div.	Palo Alto, Cal.
05277	Westinghouse Electric Corp.	Semiconductor Dept. Youngwood, Pa.				18324	Signetics Corp.	Sunnyvale, Cal.

CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address
19844	LRC Electronics	Horseheads, N.Y.	71482	C. P. Clare & Co.	Chicago, Ill.	78452	Thompson-Bremer & Co.	Chicago, Ill.
19701	Electra Mfg. Co.	Independence, Kansas	71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.	78471	Tilley Mfg. Co.	San Francisco, Calif.
20183	General Atomics Corp.	Philadelphia, Pa.	71616	Commercial Plastics Co.	Chicago, Ill.	78488	Stackpole Carbon Co.	St. Marys, Pa.
21228	Execulone, Inc.	Long Island City, N.Y.	71700	Cornish Wire Co., The	New York, N.Y.	78493	Standard Thomson Corp.	Waltham, Mass.
21355	Fafnir Bearing Co., The	New Britain, Conn.	71707	Coto Coil Co., Inc.	Providence, R.I.	78553	Tinnerman Products, Inc.	Cleveland, Ohio
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.	71744	Chicago Miniature Lamp Works	Chicago, Ill.	78790	Transformer Engineers	San Gabriel, Cal.
23020	General Reed Co.	Metuchen, N.J.	71785	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.	78947	Uconite Co.	Newtonville, Mass.
23042	Texscan Corp.	Indianapolis, Ind.	71984	Dow Corning Corp.	Midland, Mich.	79138	Waldes Kohinor Inc.	Long Island City, N.Y.
23783	British Radio Electronics Ltd.	Washington, D.C.	72138	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.	78142	Veeder Root, Inc.	Hartford, Conn.
24455	G. E. Lamp Division	Nela Park, Cleveland, Ohio	72619	Dialight Corp.	Brooklyn, N.Y.	79251	Wenco Mfg. Co.	Chicago, Ill.
24655	General Radio Co.	West Concord, Mass.	72656	Indiana General Corp., Electronics Div.	Keasby, N.J.	78727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
24681	Memcor Inc., Comp. Div.	Huntington, Ind.	72689	General Instrument Corp., Csp Division	Newark, N.J.	79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.	72785	Drake Mfg. Co.	Harwood Heights, Ill.	80031	Mepco Division of Sessions Clock Co.	Morrisstown, N.J.
26462	Grobert File Co. of America, Inc.	Carlstadt, N.J.	72825	Hugh S. Eby Inc.	Philadelphia, Pa.	80033	Prestole Corp.	Toledo, Ohio
26851	Compac/Hollister Co.	Hollister, Cal.	72928	Gudeman Co.	Chicago, Ill.	80120	Schlitz Alloy Products Co.	Elizabeth, N.J.
26992	Hamilton Watch Co.	Lancaster, Pa.	72982	Elastic Stop Nut Corp.	Union, N.J.	80131	Electronic Industries Association	Standard tube or semi-conductor device, any manufacturer.
28480	Hewlett-Packard Co.	Palo Alto, Cal.	72984	Robert M. Hadley Co.	Los Angeles, Cal.	80207	Unimax Switch, Div. Maxon Electronics Corp.	Wallingford, Conn.
28520	Hewman Mfg. Co.	Kenilworth, N.J.	72982	Erle Technological Products, Inc.	Erie, Pa.	80223	United Transformer Corp.	New York, N.Y.
30817	Instrument Specialties Co., Inc.	Little Falls, N.J.	73061	Hansen Mfg. Co., Inc.	Princeton, Ind.	80248	Oxford Electric Corp.	Chicago, Ill.
33173	G. E. Receiving Tube Dept.	Owensboro, Ky.	73078	H. M. Harper Co.	Chicago, Ill.	80294	Bourns Inc.	Riverside, Cal.
35434	Lectrohm Inc.	Chicago, Ill.	73138	Helipot Div. of Beckman Inst., Inc.	Fullerton, Cal.	80411	Arco Div. of Robertshaw Controls Co.	Columbus, Ohio
36188	Stanwyck Coil Products, Ltd.	Hawkesbury, Ontario, Canada	73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Cal.	80486	All Star Products Inc.	Defiance, Ohio
36287	Cunningham, W. H. & Hill, Ltd.	Toronto, Ontario, Canada	73445	Amperex Elect. Co.	Hicksville, L.I., N.Y.	80509	Avery Lsbl Co.	Monrovia, Cal.
37942	P. R. Mallory & Co., Inc.	Indianapolis, Ind.	73506	Bradley Semiconductor Corp.	New Haven, Conn.	80583	Hammarlund Co., Inc.	Mars Hill, N.C.
39543	Mechanical Industries Prod. Co.	Akron, Ohio	73559	Carling Electric, Inc.	Hartford, Conn.	80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
40920	Miniature Precision Bearings, Inc.	Keene, N.H.	73588	Circle F Mfg. Co.	Trenton, N.J.	80813	Dimco Gray Co.	Dayton, Ohio
40931	Honeywell Inc.	Minneapolis, Minn.	73682	George K. Garrett Co., Div. MSL Industries, Inc.	Philadelphia, Pa.	81030	International Inst. Inc.	Orange, Conn.
42190	Muter Co.	Chicago, Ill.	73734	Federal Screw Products, Inc.	Chicago, Ill.	81073	Grayhill Co.	LaGrange, Ill.
43980	C. A. Norgren Co.	Englewood, Colo.	73743	Fischer Special Mfg. Co.	Cincinnati, Ohio	81095	Triad Transformer Corp.	Venice, Cal.
44655	Ohmite Mfg. Co.	Skokie, Ill.	73793	General Industries Co., The	Elyria, Ohio	81312	Winchester Elec. Div. Litton Ind., Inc.	Oakville, Conn.
46384	Penn Eng. & Mfg. Corp.	Doylestown, Pa.	73846	Goshen Stamping & Tool Co.	Goshen, Ind.	81349	Military Specification	
47904	Polaroid Corp.	Cambridge, Mass.	73889	JFD Electronics Corp.	Brooklyn, N.Y.	81483	International Rectifier Corp.	El Segundo, Cal.
48620	Precision Thermometer & Inst. Co.	Southampton, Pa.	73905	Jennings Radio Mfg. Corp.	San Jose, Cal.	81541	Airpax Electronics, Inc.	Cambridge, Maryland
49956	Microwave & Power Tube Div.	Waltham, Mass.	73957	Groove-Pin Corp.	Ridgefield, N.J.	81880	Barry Controls, Div. Barry Wright Corp.	Watertown, Mass.
52090	Rowan Controller Co.	Westminster, Md.	74278	Signalite Inc.	Neptune, N.J.	82042	Carter Precision Electric Co.	Skokie, Ill.
52883	HP Co., Med. Elec. Div.	Waltham, Mass.	74455	J. H. Wines, and Sons	Winchester, Mass.	82047	Sperli Faraday Inc., Copper Hewitt Electric Div.	Hoboken, N.J.
54294	Shallcross Mfg. Co.	Selma, N.C.	74481	Industrial Condenser Corp.	Chicago, Ill.	82118	Electric Regulator Corp.	Norwalk, Conn.
55026	Simpson Electric Co.	Chicago, Ill.	74868	IL F. Products Division of Amphenol-Borg Electronic Corp.	Danbury, Conn.	82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
55933	Sonolone Corp.	Elmsford, N.Y.	74970	E. F. Johnson Co.	Waseca, Minn.	82170	Fairchild Camera & Inst. Corp., Space & Defense Systems Div.	Paramus, N.J.
55938	Raytheon Co. Commercial Apparatus & System Div.	So. Norwalk, Conn.	75042	International Resistance Co.	Philadelphia, Pa.	82208	Magurle Industries, Inc.	Greenwich, Conn.
56137	Spaidding Fibre Co., Inc.	Tonawanda, N.Y.	75263	Keystone Carbon Co., Inc.	St. Marys, Pa.	82218	Sylvania Electric Prod., Inc. Electronic Tube Division	Emporium, Pa.
56288	Sprague Electric Co.	North Adams, Mass.	75378	KTS Knights, Inc.	Sandwich, Ill.	82378	Astron Corp.	East Newark, Harrison, N.J.
58474	Superior Elect. Co.	Bristol, Conn.	75382	Culka Electric Corp.	Mt. Vernon, N.Y.	82389	Switchcraft, Inc.	Chicago, Ill.
59448	Telex Corp.	Tulsa, Okla.	75818	Lenz Electric Mfg. Co.	Chicago, Ill.	82647	Metals & Controls Inc.	Attleboro, Mass.
59730	Thomas & Betts Co.	Elizabeth, N.J.	75815	Littlefuse, Inc.	Des Plaines, Ill.	82768	Phillips-Advance Control Co.	Joliet, Ill.
60741	Triplet Electrical Inst. Co.	Bluffton, Ohio	76005	Lord Mfg. Co.	Erie, Pa.	82866	Research Products Corp.	Madison, Wis.
61775	Union Switch and Signal Div. of Westinghouse Air Brake Co.	Pittsburgh, Pa.	76210	C. W. Marwedel	San Francisco, Cal.	82877	Rollon Mfg. Co., Inc.	Woodstock, N.Y.
82119	Universal Electric Co.	Owosso, Mich.	76433	General Instrument Corp., Micamold Division	Newark, N.J.	82893	Vector Electronic Co.	Glendale, Cal.
83743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.	76530	Cinch-Monadnock, Div. of United Carr Fastener Corp.	San Leandro, Cal.	83058	Carr Fastener Co.	Cambridge, Mass.
84558	Western Electric Co., Inc.	New York, N.Y.	78487	James Millen Mfg. Co., Inc.	Malden, Mass.	83088	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
85092	Weston Inst. Inc.	Newark, N.J.	78493	J. W. Miller Co.	Los Angeles, Cal.	83125	General Instrument Corp., Capacitor Div.	Darlington, S.C.
88295	Witteck Mfg. Co.	Chicago, Ill.	77068	The Bendix Corp., Electrodynamics Div.	N. Hollywood, Cal.	83148	ITT Wire and Cable Div.	Los Angeles, Cal.
88340	Minnesota Mining & Mfg. Co.	St. Paul, Minn.	77075	Pacific Metals Co.	San Francisco, Cal.	83186	Victory Eng. Corp.	Springfield, N.J.
70276	Allen Mfg. Co.	Hartford, Conn.	77221	Phasotron Instrument and Electronic Co.	So. Pasadena, Cal.	83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
70308	Alliod Control	New York, N.Y.	77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.	83315	Hubbitt Corp.	Mundelein, Ill.
70318	Allmetal Screw Product Co., Inc.	Garden City, N.Y.	77342	American Machine & Foundry Co. Potter & Brumfield Div.	Princeton, Ind.	83324	Rosan Inc.	Newport Beach, Cal.
70417	Amplex, Div. of Chrysler Corp.	Detroit, Mich.	77630	TRW Electronic Components Div.	Csmiden, N.J.	83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.	77838	General Instrument Corp., Rectifier Division	Brooklyn, N.Y.	83332	Tech Labs	Palisades Park, N.J.
70563	Amperite Co., Inc.	Union City, N.J.	77764	Resistance Products Co.	Harrisburg, Pa.	83385	Central Screw Co.	Chicago, Ill.
70674	ADC Products Inc.	Minneapolis, Minn.	77898	Rubbercraft Corp. of Calif.	Torrance, Cal.	83501	Gavitt Wire and Cable Co., Div. of Amercage Corp.	Brookfield, Mass.
70803	Belden Mfg. Co.	Chicago, Ill.	78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.	83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.
70998	Bird Electric Corp.	Cleveland, Ohio	78277	Sigma	So. Braintree, Mass.	83740	Union Carbide Corp., Consumer Prod. Div.	New York, N.Y.
71002	Birnbach Radio Co.	New York, N.Y.	78283	Signal Indicator Corp.	New York, N.Y.	83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
71034	Billy Electric Co., Inc.	Erie, Pa.	78290	Struthers-Dunn Inc.	Pitman, N.J.	83821	Loyd Scruggs Co.	Festus, Mo.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.				83942	Aeronautical Inst. & Radio Co.	Lodi, N.J.
71218	Bud Radio, Inc.	Willoughby, Ohio				84171	Aero Electronics Inc.	Greene Neck, N.Y.
71279	Cambridge Thermionics Corp.	Cambridge, Mass.				84398	A. J. Glesner Co., Inc.	San Francisco, Cal.
71286	Camloc Fastener Corp.	Paramus, N.J.				84411	TRW Capacitor Div.	Ogatafala, Neb.
71313	Cardwell Condenser Corp.	Lindenhurst, L.I., N.Y.						
71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.						
71436	Chicago Condenser Corp.	Chicago, Ill.						
71447	Calif. Spring Co., Inc.	Pico Rivera, Cal.						
71450	CTS Corp.	Elkhart, Ind.						
71468	ITT Cannon Electric Inc.	Los Angeles, Cal.						
71471	Cinema, Div. Aerovox Corp.	Burbank, Cal.						

CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address
94870	Sarkes Tarzian, Inc.	Bloomington, Ind.	91829	Honeywell Inc., Micro Switch Division	Freeport, Ill.	96065	Hi-Q Div. of Aerovox Corp.	Olean, N.Y.
95454	Boonton Molding Company	Boonton, N.J.	91961	Nahm-Bros. Spring Co.	Oakland, Cal.	96256	Thordarson-Melssner Inc.	MI. Carmel, Ill.
95471	A. B. Boyd Co.	San Francisco, Cal.	92180	Tru-Connector Corp.	Peabody, Mass.	96296	Solar Mfg. Co.	Los Angeles, Cal.
95474	R. M. Bracamonte & Co.	San Francisco, Cal.	92367	Elgeet Optical Co., Inc.	Rochester, N.Y.	96396	Microswitch, Div. of	Freeport, Ill.
95680	Kolled Kords, Inc.	Hamden, Conn.	92607	Tensolite Insulated Wire Co., Inc.	Tarrytown, N.Y.	96330	Carlton Screw Co.	Chicago, Ill.
95611	Seamless Rubber Co.	Chicago, Ill.	92702	IMC Magnetics Corp.	Westbury, L.I., N.Y.	96341	Microwave Associates, Inc.	Burlington, Mass.
96174	Fafnir Bearing Co.	Los Angeles, Calif.	92958	Hudson Lamp Co.	Kearney, N.J.	96501	Excel Transformer Co.	Oakland, Cal.
96197	Clifton Precision Products Co., Inc.	Clifton Heights, Pa.	93332	Sylvania Electric Prod. Inc., Semiconductor Div.	Woburn, Mass.	96508	Xcelite, Inc.	Orchard Park, N.Y.
96578	Precision Rubber Products Corp.	Dayton, Ohio	93389	Robbins & Myers Inc.	Pallisades Park, N.J.	96733	San Fernando Elec. Mfg. Co.	San Fernando, Cal.
96684	Radio Corp. of America, Electronic Comp. & Devices Division	Harrison, N.J.	93410	Semco Controls, Div. of Essex Wire Corp.	Mansfield, Ohio	96881	Thomson Ind. Inc.	Long Island, N.Y.
96928	Seastrom Mfg. Co.	Glendale, Cal.	93929	Waters Mfg. Co.	Culver City, Cal.	97464	Industrial Retaining Ring Co.	Irvine, N.J.
97034	Marco Industries	Anaheim, Cal.	94137	General Cable Corp.	Bayonne, N.J.	97538	Automatic & Precision Mfg.	Englewood, N.J.
97216	Philco Corporation (Lansdale Division)	Lansdale, Pa.	94144	Raytheon Co., Comp. Div., Ind. Comp. Operations	Quincy, Mass.	97979	Reon Resistor Corp.	Yonkers, N.Y.
97473	Western Fibrous Glass Products Co.	San Francisco, Cal.	94148	Scientific Electronics Products, Inc.	Loveland, Colo.	97883	Litton System Inc., Adler-Westrex Commun. Div.	New Rochelle, N.Y.
97664	Van Wazers & Rogers Inc.	San Francisco, Cal.	94154	Wagner Elect. Corp., Tung-Sol Div.	Newark, N.J.	98141	R-Tronics, Inc.	Jamaica, N.Y.
97830	Tower Mfg. Corp.	Providence, R.I.	94197	Curtiss-Wright Corp., Electronics Div.	East Patterson, N.J.	98159	Rubber Teck, Inc.	Cardena, Cal.
98140	Cutler-Hammer, Inc.	Lincoln, Ill.	94232	South Chester Corp.	Chester, Pa.	98220	Hewlett-Packard Co., Medical Elec. Div.	Pasadena, Cal.
98220	Gould-National Batteries, Inc.	St. Paul, Minn.	94330	Wire Cloth Products, Inc.	Bellwood, Ill.	98278	Microdot, Inc.	So. Pasadena, Cal.
98698	General Mills, Inc.	Buffalo, N.Y.	94375	Automatic Metal Products Co.	Brooklyn, N.Y.	98291	Sealectro Corp.	Mamaroneck, N.Y.
99231	Graybar Electric Co.	Oakland, Cal.	94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.	98376	Zero Mfg. Co.	Burbank, Cal.
98473	G.E. Distributing Corp.	Schenectady, N.Y.	94686	Magnecraft Electric Co.	Chicago, Ill.	98410	Etc Inc.	Cleveland, Ohio
98479	Security Co.	Detroit, Mich.	95023	George A. Philbrick Researchers, Inc.	Boston, Mass.	98731	General Mills Inc., Electronics Div.	Minneapolis, Minn.
98665	United Transformer Co.	Chicago, Ill.	95146	Alco Elect. Mfg. Co.	Lawrence, Mass.	98734	Paeco Division of Hewlett-Packard Co.	Palo Alto, Cal.
99030	United Shoe Machinery Corp.	Beverly, Mass.	95236	Allies Products Corp.	Dania, Fla.	98821	North Hills Electronics, Inc.	Glen Cove, N.Y.
99179	U.S. Rubber Co., Consumer Ind. & Plastics Prod. Div.	Passaic, N.J.	95238	Continental Connector Corp.	Woodsides, N.Y.	98978	International Electronic Research Corp.	Burbank, Cal.
99365	Belleville Speciality Tool Mfg., Inc.	Belleville, Ill.	95263	Leecraft Mfg. Co., Inc.	Long Island, N.Y.	99109	Columbia Technical Corp.	New York, N.Y.
99783	United Carr Fastener Corp.	Chicago, Ill.	95265	National Coil Co.	Sheridan, Wyo.	99313	Varian Associates	Palo Alto, Cal.
99970	Bearing Engineering Co.	San Francisco, Cal.	95275	Vitramon, Inc.	Bridgeport, Conn.	99378	Atlas Corp.	Winchester, Mass.
91146	ITT Cannon Elect. Inc., Salem Div.	Salem, Mass.	95348	Gordos Corp.	Bloomfield, N.J.	99516	Marshall Ind., Capacitor Div.	Monrovia, Cal.
91280	Connor Spring Mfg. Co.	San Francisco, Cal.	95354	Method Mfg. Co.	Rolling Meadows, Ill.	98707	Control Switch Division, Controls Co. of America	El Segundo, Cal.
91345	Miller Dial & Nameplate Co.	El Monte, Cal.	95568	Arnold Engineering Co.	Marengo, Ill.	98800	Delevan Electronics Corp.	East Aurora, N.Y.
91418	Radio Materials Co.	Chicago, Ill.	95712	Dage Electric Co., Inc.	Franklin, Ind.	99848	Wilco Corporation	Indianapolis, Ind.
91506	Augat Inc.	Attleboro, Mass.	95984	Siemon Mfg. Co.	Wayne, Ill.	99928	Branson Corp.	Whippany, N.J.
91637	Dale Electronics, Inc.	Columbus, Nebr.	95987	Weckesser Co.	Chicago, Ill.	99934	Rembrandt, Inc.	Boston, Mass.
91662	Elco Corp.	Willow Grove, Pa.	96067	Microwave Assoc., West, Inc.	Sunnyvale, Cal.	99942	Hoffman Electronics Corp., Semiconductor Division	El Monte, Cal.
91673	Epiphone Inc.	New York, N.Y.				99857	Technology-Instrument Corp. of California	Newbury Park, Cal.
91737	Grcmar Mfg. Co., Inc.	Wakefield, Mass.						
91827	K F Development Co.	Redwood City, Cal.						
91888	Malco Mfg., Inc.	Chicago, Ill.						

The following HP Vendors have no number assigned in the latest supplement to the Federal Supply Code for Manufacturers Handbook.

0000F	Malco Tool and Die	Los Angeles, Calif.	000CS	Hewlett-Packard Co., Colorado Springs Div.	Colorado Springs, Colorado	000QQ	Cooltron	Oakland, Cal.
0000Z	Willow Leather Products Corp.	Newark, N.J.	000MM	Rubber Eng. & Development	Hayward, Cal.	000WW	California Eastern Lab.	Burlington, Cal.
000AB	ETA	England	000NN	A "N" D Mfg. Co.	San Jose, Cal.	000YY	S.K. Smith Co.	Los Angeles, Cal.
000BB	Precision Instrument Comp. Co.	Van Nuys, Cal.						

SUPPLEMENTAL CODE LIST OF MANUFACTURERS

Code No.	Manufacturer	Address
97913	Industrial Electronic Hardware Corp.	New York, N.Y.

SALES & SERVICE OFFICES AFRICA, ASIA, AUSTRALIA

AMERICAN SAMOA
Calculators Only
Oceanic Systems Inc
P.O. Box 777
Pago Pago Bayfront Road
Pago Pago 96790
Tel: 633 5513
Cable: OCEANIC-Pago Pago

ANGOLA
Empresa Técnica de
Equipamentos
Electrónicos, S.A. R.L.
R. Barbosa Rodrigues 42-POT
Caxa Postal 6487
Luanda
Tel: 35515/6
Cable: TELETRIA Luanda

AUSTRALIA
Hewlett-Packard Australia
Pty Ltd
31 41 Josiah Street
Blackburn Victoria 3130
P.O. Box 36
Dandenong East Victoria 3109
Tel: 89-4351
Tel: 31 024
Cable: HIWPAARD Melbourne
Hewlett-Packard Australia
Pty Ltd
31 Bridge Street
Pymble
New South Wales, 2073
Tel: 449 8566
Tel: 21561
Cable: HEWPAARD Sydney
Hewlett-Packard Australia
Pty Ltd
153 Greenhill Road
Parramatta, 5063, S.A.
Tel: 27 2901
Cable: 82536 ADEL
Cable: HEWPAARD ADELAIDE
Hewlett-Packard Australia
Pty Ltd
141 Spring Highway
Nedlands W.A. 6009
Tel: 86-5455
Tel: 50859 PERTH
Cable: HEWPAARD PERTH
Hewlett-Packard Australia
Pty Ltd
121 Watlington Street
Fyshwick A.C.T. 2609
Tel: 95-3733
Tel: 69550 Canberra
Cable: HIWPAARD CANBERRA
Hewlett-Packard Australia
Pty Ltd
5th Floor
Teachers Union Building
495-498 Bannister Street
Spring Hill 4000 Queensland
Tel: 29-1544
Tel: 4031 207 1672
TWX 60-821 641

DUAM
Medical-Packel Calculators Only
Giem Medical Supply, Inc
Jay Esce Building Room 210
P.O. Box 6383
Tamuning 96911
Tel: 645 4512
Cable: EARMED Guam

HONG KONG
Schmidt & Co (Hong Kong) Ltd
P.O. Box 297
Connaught Centre
39th floor
Connaught Road Central
Hong Kong
Tel: H-255291-5
Tel: 74765 SCHMC HX
Cable: SCHMIDTICO Hong Kong

INDIA
Blue Star Ltd
Kasturba Buildings
Jambhaji Tele Rd
Bombay 400 020
Tel: 29 50 21
Tel: 2156
Cable: BLUESTAR
Blue Star Ltd
Sahas
414/2 V V Sankar Marg
Praharajay 400 025
Tel: 45 76 07
Tel: 4093
Cable: PROSTRIE
Blue Star Ltd
Bano Bano House
Preharajay
Bombay 400 025
Tel: 45 76 01
Tel: 6 88 82
Cable: BLUESTAR
Blue Star Ltd
14/40 Civil Lines
Kanpur 200 001
Tel: 292
Cable: BLUE STAR
Blue Star Ltd
7 Hero Street
Calcutta 700 001
Tel: 23 0151
Tel: 7655
Cable: BLUESTAR
Blue Star Ltd
34 Menaria Gandhi Rd
Lapinagar
New Delhi 110 024
Tel: 62 32 76
Tel: 63
Cable: BLUESTAR
Blue Star Ltd
11/11A Megastar Road
Bangalore 560 025
Tel: 5568
Tel: 430
Cable: BLUESTAR

INDONESIA
Blue Star Ltd
Bano Bano House
Preharajay
Bombay 400 025
Tel: 45 76 01
Tel: 6 88 82
Cable: BLUESTAR
Blue Star Ltd
14/40 Civil Lines
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Tel: 292
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Blue Star Ltd
7 Hero Street
Calcutta 700 001
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Tel: 7655
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Blue Star Ltd
34 Menaria Gandhi Rd
Lapinagar
New Delhi 110 024
Tel: 62 32 76
Tel: 63
Cable: BLUESTAR
Blue Star Ltd
11/11A Megastar Road
Bangalore 560 025
Tel: 5568
Tel: 430
Cable: BLUESTAR

ISRAEL
Electronics & Engineering Div
of Motorola Israel Ltd
P.O. Box 25016
Tel Aviv
Tel: 03-389 73
Tel: 33589
Cable: BASTEL Tel Aviv

JAPAN
Yokogawa-Hewlett-Packard Ltd
Onishi Building
1-59-1 Yoyogi
Shibuya-ku, Tokyo
Tel: 03 370-2261/92
Tel: 232-2024/610
Cable: YHP/PAKET TOK 23-724
Yokogawa-Hewlett-Packard Ltd
Nissei Ibaraki Building
2-8 Kasuga 2-chome Ibaraki-shi
Osaka 567
Tel: 10761 23-1647
Tel: 5332-385 YHP DSAKA
Yokogawa-Hewlett-Packard Ltd
Nekkato Building
24 Kenta Sazagami-cho
Hakamite-ku, Nagoya
Tel: 10521 571-5171

KOREA
American Trading Company
P.O. Box 10311
Tel: 55726-5567/62
Cable: PROTON
Medical Only
International Aeradio (E.A.) Ltd
P.O. Box 19012
Nairobi Airport
Nairobi
Tel: 336055-56
Tel: 22201/22301
Cable: HITATRID Nairobi

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MACAU
Hewlett-Packard (Macau) Ltd
1785 Woodwell Dr.
P.O. Box 426
Tel: 613 225-6530
TWX 610-562-8968
Hewlett-Packard (Macau) Ltd
6877 Goreway Drive
Mission Hills, L.A. 91343
Tel: 410 676-9430
TWX 610-492-4246

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MANUAL BACKDATING CHANGES

MODEL 3400A

RMS VOLTMETER

This manual backdating sheet makes this manual applicable to earlier instruments. Instrument-component values that differ from those in the manual, yet are not listed in the backdating sheet, should be replaced using the part number given in the manual.

Instrument Serial Prefix Make Manual Changes

322-, 401-, 528- and 714-	1, 14 and 8 thru 12
322- or 401-00351 thru 00700	1 thru 5, 7 thru 12, and 14
401-00701 thru 02125	1, 3, 4, 5, 14, and 7 thru 12
401-02126 thru 03025	1, 4, 5, 14, and 7 thru 12
528-	1, 5, 14, and 7 thru 12
714-	1, 14, and 6 thru 12
714-06526 thru 06925	Note #1
714-06926 thru 07925	1, 14 and 8 thru 12

Instrument Serial Prefix Make Manual Changes

806-07926 thru 08125	8 thru 12 and 14
806-08126 thru 08614	9, 10, 11, 12, 14
806-08615 thru 09325	10, 11, 12, 14
806-09325 thru 11525	11, 12, 14
952-11526 thru 12125	12, 14
979-12126 thru 0979A13725	13
All	15

CHANGE #1

Figure 6-3, and Replaceable Parts: Substitute Figure C-1 for Figure 6-3 and replace any component according to Table C-1.

Section IV, Theory of Operation:

Serials prefixed 322-, 401, 528- and 714- with chopper amplifier board 03400-66504) does not have an emitter follower stage prior to the demodulator. In Section IV delete any reference to emitter follower Q604, and change reference designator Q605 and Q606 to Q604 and Q605 respectively.

CHANGE #2

Delete C305, -hp- Part No. 0160-0763, on Figure 6-1 and in Table 7-1.
Add a dashed capacitor in parallel with R301 thru R304 and R306.

REASON: This capacitance obtained by connecting a wire from R301 and C302 junction to a blank switch lug near R306 and R308 junction.

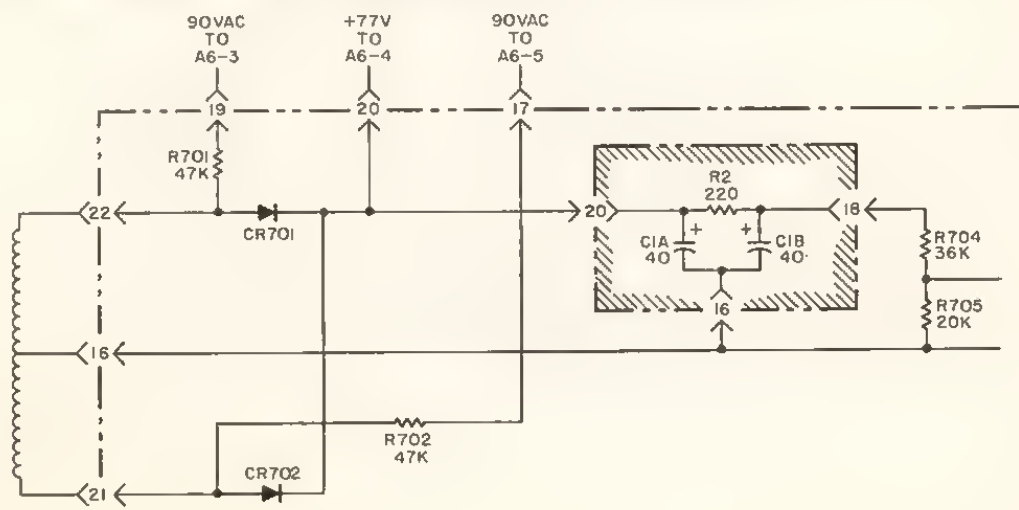
CHANGE #3

Change Q405 to -hp- Part No. 1850-0099, and CR401 to -hp- Part No. 1910-0016.

NOTE: Both Q405 and CR401 should be replaced with components listed in Table 7-1 if either component fails as bias on Q405 is a function of both.

CHANGE #4

Change Figure 6-4, Power Supply Schematic, A7, to the following:



Manual Backdating Changes Model 3400A Page 2

CHANGE #4 (Cont'd)

Table 7-1 Replaceable Parts:

Change R701 and R702 to -hp- Part No. 0693-4731, 47 k Ω . Delete C711 (0160-0167), C712 (0180-0282), R712 (0687-2241), R713 (0686-2225), Q706 (1854-0022), and CR718 (1902-0046).

Change A7 Board Assembly - Power Supply to -hp- Part No. 03400-66505.

NOTE: -hp- Part No. 03400-66507 is directly interchangeable with 03400-66505.

CHANGE #5

Figure C-1 and Table C-1:

Change capacitor C602 to 35 μ F (-hp- Part No. 0180-0064).

Change resistor R630 to 100 k Ω (-hp- Part No. 0683-1045). Also, change transistors Q601 to -hp- Part No. 1850-0060, Q602 and Q603 to -hp- Part No. 1850-0062.

NOTE

To reduce meter jitter replace all of the above components with components listed in Table 7-1. It is also recommended to change resistor R606 to a 3300 Ω resistor described in Table 7-1.

CHANGE #6

Some instruments (Serial Prefixed 714-) may have a 1 μ F capacitor for C602 (Figure C-1). If C602 fails or if low frequency oscillations ($\pm 5\%$) occur on meter change C602 to 10 μ F described in Table 7-1.

Instruments with serial number between 714-06226 and 714-07525 have a 4700 Ω resistor for R606. If R606 fails or if meter jitter occurs replace R606 with 3300 Ω resistor described in Table 7-1.

NOTE #1

NOTE

Some instruments with serial number between 714-06526 and 714-06925 inclusive have a different second attenuator assembly than the one described in this manual. Check the value of resistor R301 on the second attenuator assembly. If resistor R301 is 150 Ω disregard manual changes described below. If the value of R301 is other than 150 Ω , and the Serial No. is within the range shown above, make the following manual changes: (Change #7)

CHANGE #7

Figure 6-1, Second Attenuator Schematic and Table 7-1, Replaceable Parts:

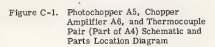
Change value of R301 thru R311 as follows:

R301	to 180 Ω
R302, R304, R306, R308 and R310	to 410.27 Ω
R303, R305	to 277.0 Ω
R307, R309	to 277.7 Ω
R311	to 189.3 Ω

Add the following note to Schematic and Replaceable Parts List:

NOTE

Resistors R302 thru R311 are a matched set. A replacement set may be ordered under -hp- Part No. 03400-69502. See Service Note P-03400-69502 for additional information.



Manual Backdating Changes Model 3400A Page 5

Table C-1. Replaceable Parts

REFERENCE DESIGNATION	-hp- PART NO.	DESCRIPTION
<p style="text-align: center;">NOTE</p> <p>This table applies to instruments with serials prefixed 322-, 401-, 528-, and 714-, with chopper amplifier board 03400-66504. If a 03400-66508 chopper amplifier board is installed use Table 7-1 and Figure 6-3.</p>		
A6	03400-66504	Assembly: chopper amplifier board
A5	1990-0017	Assembly: photoconductor chopper part of A6
		Note
		Matched neon subassembly (DS501 and DS502) available under -hp- Part No. 1990-0206
C601	0180-0081	50 μ F +20% -15% 10 vdcw
C602	0180-0032	10 μ F +75% -10% 12 vdcw
C603 and C604	0150-0084	0.1 μ F -20% +80% 50 vdcw
C605	0180-0111	2 μ F 25 vdcw
C606	0180-0224	10 μ F 10 vdcw
C607	0150-0093	0.01 μ F -20% +80% 100 vdcw
C608	0180-0022	3.9 μ F 35 vdcw
C609	0180-0039	100 μ F 12 vdcw
C610	0180-0119	1 μ F -10% +100% 25 vdcw
C611	0150-0093	0.01 μ F -20% +80% 100 vdcw
C612	0180-0156	880 μ F -10% +100% 1 vdcw
C613	0180-0039	100 μ F 12 vdcw
CR601	1902-0046	Diode breakdown 7.15 V \pm 10%
CR602	1910-0016	Diode germanium 60 piv
CR603 and CR604	1901-0025	Diode silicon 100 piv
Q601 thru Q603	1853-0036	Transistor silicon PNP 2N3906
Q604	1854-0033	Transistor silicon NPN 2N3391
Q605	1853-0016	Transistor silicon PNP 2N3638
R601	0683-3335	33 k Ω \pm 5% 1/4 W
R602 thru R605	0683-6825	6800 Ω \pm 5% 1/4 W
R606	0683-3325	3300 Ω \pm 5% 1/4 W
R607	0683-8225	8200 Ω \pm 5% 1/4 W
R608	0683-1035	10 k Ω \pm 5% 1/4 W
R609	0683-5605	56 Ω \pm 5% 1/4 W
R610	0683-3915	390 Ω \pm 5% 1/4 W
R611 thru R614	Not assigned	
R615	0683-3335	33 k Ω \pm 5% 1/4 W
R616	0683-2235	22 k Ω \pm 5% 1/4 W
R617	0758-0043	1800 Ω \pm 5% 1/4 W
R618	0727-0100	1000 Ω \pm 1% 1/2 W
R619	0727-0063	292.4 Ω \pm 1% 1/2 W

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Table C-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATION	-hp- PART NO.	DESCRIPTION
R620	0683-1245	120 k Ω $\pm 5\%$ 1/4 W
R621	0727-0013	24.3 Ω $\pm 1\%$ 1/2 W
R622	0683-3925	3900 Ω $\pm 5\%$ 1/4 W
R623	0683-3945	390 k Ω $\pm 5\%$ 1/4 W
R624	0683-6835	68 k Ω $\pm 5\%$ 1/4 W
R625	0758-0076	68 k Ω $\pm 5\%$ 1/4 W (met flm)
R626 thru R629	Not assigned	
R630*	0683-1065	10 M Ω $\pm 5\%$ 1/4 W
R631 and R632	0683-3335	33 k Ω $\pm 5\%$ 1/4 W
R633	0683-1835	18 k Ω $\pm 5\%$ 1/4 W
R634	0683-5605	56 Ω $\pm 5\%$ 1/4 W
R635	0683-2745	270 k Ω $\pm 5\%$ 1/4 W

CHANGE #8

Table 7-1, Replaceable Parts:

Change Part No. for transformer T1 to 9100-0344. Note: Color of leads given on schematic does not apply to 9100-0344 transformer.

CHANGE #9

Figure 6-4, Power Supply Schematic, and Table 7-1, Replaceable Parts:

Change value and Part No. of following components:

R701 to 56 k Ω , -hp- Part No. 0687-5631

R702 to 56 k Ω , -hp- Part No. 0687-5631

R709 to 330 Ω , -hp- Part No. 0683-3315

C703 to 0.022 μ F, -hp- Part No. 0170-0024

CHANGE #10

Page 6-9/6-10 and Table 7-1:

Change following components:

R718 to 75 k Ω , -hp- Part No. 0683-7535

R730 to 11 k Ω , -hp- Part No. 0683-1135

R731 to 6.2 k Ω , -hp- Part No. 0683-6225

CHANGE #11

Page 6-9.

C3A and C3B were .01 μ F

Page 7-2.

Change rear panel Part No. to 03400-00202

Page 7-3.

Preferred replacement for C3 is shown.

Page 7-5.

Change J3 to Part No. 1251-0148

Page 7-8.

Change W1 to Part No. 8120-0078

CHANGE #12

Page 6-7.

Some instruments have a separate green wire from + 77 V to DS502 (on A5).

Page 6-9.

Substitute the below parts locator for A7.

Page 7-3.

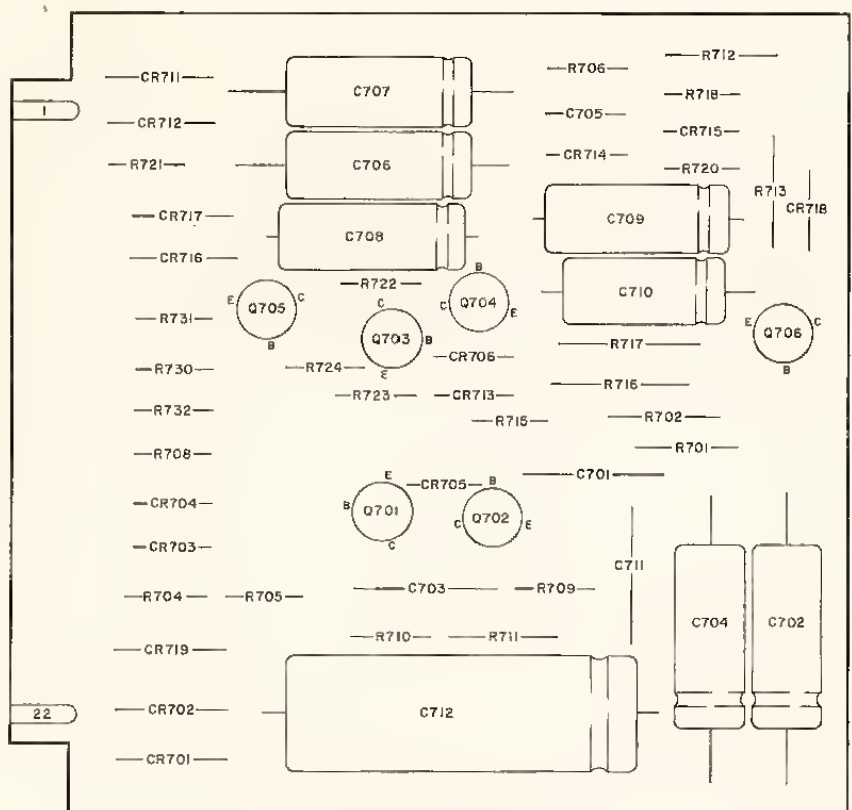
Change A7 to -hp- Part No. 03400-66507.

CHANGE #13

Page 6-9.

Substitute the below parts locator for A7.

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A7

(hp PART NO. 03400-66507)

CHANGE #14

Page 6-9.

Delete CR720. Delete C705. Add C705 (.01 μ F) in series with R706 (47 k) from the base of Q704 to A7 Pin 3.

Page 7-5.

Delete CR720. Change Q701, 702 to 1850-0062.
Change Q703, 704 to 1850-0040.
Change Q705 to 1851-0017 (2N1304).

Page 7-7.

Add R706, 0683-4735, R: fxd comp 47 k 5% 1/4 W.

Page 7-8.

Change R731 to 0757-0290 R: fxd met flm 6.19 k 1% 1/8 W.

CHANGE #15

Page 7-2.

The -hp- Part No.'s listed on page 7-2 of this manual are for brown instruments. The part numbers for blue instruments are listed below:

INDEX NO.	DESCRIPTION	-hp- PART NO.
1	Front Panel	03400-00201
3	Side Cover 6 x 11 sm	5000-0703
5	Top Cover (with Handle)	03400-64102
7	Bottom Cover 5 x 11 sm	5000-0711
9	Spacer 1/3 module	5020-5388

