

## Errata

**Title & Document Type:** 489A/491C Microwave Amplifier Operating and Service Manual

**Manual Part Number:** 00489-90006

**Revision Date:** August 1970

### About this Manual

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

### HP References in this Manual

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

### Support for Your Product

Agilent no longer sells or supports this product. You will find any other available product information on the Agilent Test & Measurement website:

[www.agilent.com](http://www.agilent.com)

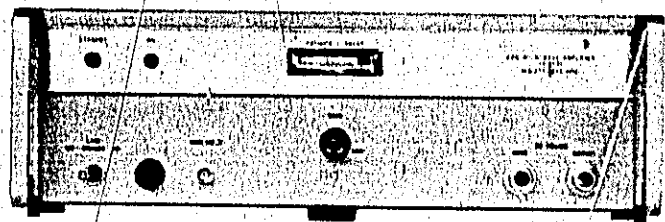
Search for the model number of this product, and the resulting product page will guide you to any available information. Our service centers may be able to perform calibration if no repair parts are needed, but no other support from Agilent is available.



**Agilent Technologies**

OPERATING AND SERVICE MANUAL

# MICROWAVE AMPLIFIER 489A/491C



 **HEWLETT  
PACKARD**

## CERTIFICATION

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

## WARRANTY

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

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

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

## LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

**NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HP SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE**

## EXCLUSIVE REMEDIES

**THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HP SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.**

## ASSISTANCE

*Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.*

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

**MICROWAVE AMPLIFIER  
MODELS 489A/491C**

**SERIAL PREFIX 972-**

This manual applies directly to HP Models  
489A/491C Microwave Amplifiers having  
serial prefix number 972-.

**SERIAL PREFIXES NOT LISTED**

See INSTRUMENTS COVERED BY  
MANUAL paragraph in Section I.

Copyright HEWLETT-PACKARD COMPANY 1970  
1501 PAGE MILL ROAD, PALO ALTO, CALIFORNIA, U.S.A.

00489-90006

Printed: August 1970



## TABLE OF CONTENTS

Section		Page	Section		Page
I	GENERAL INFORMATION	1-1	4-5.	Test Record	4-1
	1-1. Introduction	1-1	4-7.	Power Amplification	4-2
	1-3. Instruments Covered by Manual	1-1	4-8.	Gain Control Power On-Off Ratio	4-3
	1-6. Description	1-1	4-9.	Modulator On-Off Ratio	4-3
	1-12. Options	1-1	4-10.	Modulator Sensitivity Vs. Frequency Response	4-4
	1-14. Warranty	1-1	4-11.	Residual AM	4-6
II	INSTALLATION	2-1	4-12.	SWR	4-7
	2-1. Initial Inspection	2-1	V	ADJUSTMENTS	5-1
	2-2. Mechanical Check	2-1	5-1.	Introduction	5-1
	2-4. Electrical Check	2-1	5-3.	Equipment Required for Adjustments	5-1
	2-6. Claims for Damage	2-1	5-5.	TWT Filament Adjustment	5-2
	2-8. Preparation for Use	2-1	5-6.	TWT Collector/Helix Adjustment	5-3
	2-9. Power Requirements	2-1	5-7.	TWT Anode Adjustment	5-3
	2-10. Selecting 115 or 230 Volt Operation	2-1	5-8.	-350 Volt Adjustment	5-4
	2-13. Three-Conductor Power Cable	2-1	5-9.	TWT Grid Voltage Adjustment	5-4
	2-15. Operating Environment	2-1	5-10.	Square-Wave Response Adjustment	5-5
	2-17. Bench Operation	2-1	5-11.	Cathode Current Meter Adjustment	5-6
	2-19. Rack Mounting	2-2	VI	REPLACEABLE PARTS	6-1
	2-21. Repackaging for Shipment	2-2	6-1.	Introduction	6-1
	2-22. Using Original Packaging	2-2	6-6.	Ordering Information	6-1
	2-24. Other Packing Materials	2-2	VII	MANUAL CHANGES	7-1
III	OPERATION	3-1	7-1.	Introduction	7-1
	3-1. Introduction	3-1	VIII	SERVICE	8-1
	3-3. Front Panel Features	3-1	8-1.	Introduction	8-1
	3-5. Operating Instructions	3-1	8-3.	Principles of Operation	8-1
	3-8. Operator's Maintenance	3-1	8-5.	Troubleshooting	8-1
	3-9. Fuses	3-1	8-7.	Schematic Diagrams	8-1
	3-11. Fan	3-2			
	3-13. Lamp Replacement	3-2			
IV	PERFORMANCE TESTS	4-1			
	4-1. Introduction	4-1			
	4-3. Equipment Required	4-1			

**LIST OF ILLUSTRATIONS**

Figure		Page	Figure		Page
1-1.	Model 489A/491C Microwave Amplifiers . . . . .	1-0	8-5.	Overall Block Diagram . . . . .	8-4
3-1.	Front Panel Features . . . . .	3-3	8-6.	Relay Sequence . . . . .	8-5
4-1.	Power Amplification Test Setup . . . . .	4-2	8-7.	Overall Troubleshooting Tree . . . . .	8-5
4-2.	Modulator On-Off Ratio Test Setup . . . . .	4-3	8-8.	Component Identification A300 Filament Regulator Assembly . . . . .	8-6
4-3.	Modulator Sensitivity vs. Frequency Response Test Setup . . . . .	4-5	8-9.	Component Identification, A1 High Voltage Power Supply Assembly . . . . .	8-7
4-4.	Residual AM Test Setup . . . . .	4-6	8-10.	Primary Power and Regulated Filament Circuit, Schematic Diagram . . . . .	8-7
5-1.	TWT Voltage Adjustments Test Setup . . . . .	5-2	8-11.	Component Identification, A1 High Voltage Power Supply Assembly . . . . .	8-8
5-2.	Square-Wave Response Test Setup . . . . .	5-5	8-12.	Component Identification, A10 Rectifier Assembly . . . . .	8-9
7-1.	A1 High Voltage Power Supply Assembly Serial Prefixes 811-01155 and below . . . . .	7-4	8-13.	Component Identification, A200 TWT Test Board Assembly . . . . .	8-9
7-2.	Primary Power and Regulated Filament Circuit, Schematic Diagram Prefixes 930-01395 and below . . . . .	7-5	8-14.	Regulated Power Supply, Schematic Diagram . . . . .	8-9
8-1.	General Information on Schematic Diagrams . . . . .	8-1	8-15.	Component Identification, A10 Rectifier Assembly . . . . .	8-11
8-2.	Schematic Diagram Notes . . . . .	8-2	8-16.	Component Identification, A101 Modulator Assembly . . . . .	8-11
8-3.	Top Internal View . . . . .	8-3	8-17.	Modulator, Schematic Diagram . . . . .	8-11
8-4.	Bottom Internal View . . . . .	8-3			

**LIST OF TABLES**

Table		Page	Table		Page
1-1.	Specifications . . . . .	1-2	6-1.	Reference Designators and Abbreviations . . . . .	6-2
1-2.	Recommended Test Equipment . . . . .	1-3	6-2.	Replaceable Parts . . . . .	6-3
4-1.	Performance Test Record . . . . .	4-8	6-3.	Code List of Manufacturers . . . . .	6-7

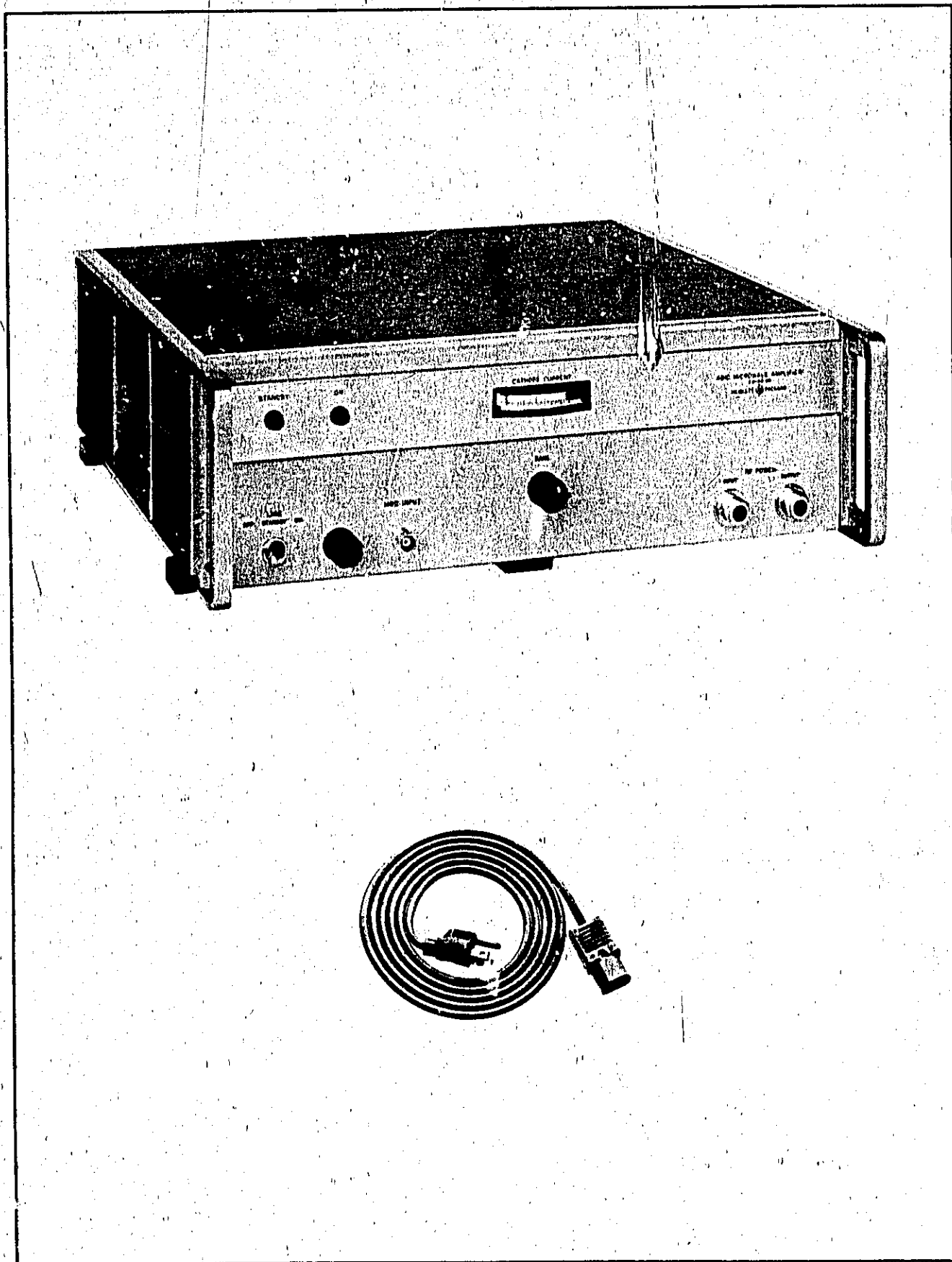


Figure 1-1. Model 489A/491C Microwave Amplifiers

## SECTION I GENERAL INFORMATION

### 1-1. INTRODUCTION

1-2. This manual contains installation, operation, and service information for HP Model 489A/491C Microwave Amplifiers, shown in Figure 1-1. Complete specifications are given in Table 1-1.

### 1-3. INSTRUMENTS COVERED BY MANUAL

1-4. Each Model 489A/491C is identified by a two-section, eight-digit (000-00000) serial number on the rear of the instrument. The three-digit number is a serial prefix number used to document changes, and the five-digit number is an identification number unique to each instrument.

1-5. All instruments with the same serial prefix are the same. The groups of instruments to which this manual applies directly are identified on the title page. For instruments with lower serial prefix numbers than those listed, make manual changes listed in Section VII. For instruments with higher serial prefix numbers, a Manual Changes sheet is included, describing the required changes. If a Manual Changes sheet is missing, the information can be supplied by any Hewlett-Packard Sales and Service office (see list at rear of manual).

### 1-6. DESCRIPTION

1-7. The HP Model 489A/491C is a broadband linear amplifier that provides signal amplification of at least 30 dB. The Model 489A covers the 1 to 2 GHz range; the Model 491C covers the 2 to 4 GHz range. Both instruments produce at least 1 watt at the output with the application of 1 milliwatt or less at the input.

1-8. The Model 489A/491C output can be amplitude modulated. Externally supplied modulation signals are applied to the MOD INPUT jack on the front panel. Since the modulation circuit is dc coupled, an external leveler circuit can be connected to the MOD INPUT jack to obtain relatively flat power output across the band.

1-9. The instrument requires no tuning and is particularly useful for signal amplification over a broad band of frequencies. The GAIN control is the only front panel control. It controls RF amplification and average RF power output.

1-10. The traveling-wave amplifier tubes (TWT's) used in the Model 489A/491C utilize periodic permanent magnet focusing. They are light weight, compact, and consume less power than previous solenoid focused TWT's.

1-11. An instrument of one frequency range may be easily converted to an instrument of another frequency range, since the Model 489A/491C are identical except for the traveling wave amplifier tube.

### 1-12. OPTIONS

1-13. Model 489A/491C Option 01 has its RF input and output connectors on the rear panel. In all other respects, the instrument is the same as the standard Microwave Amplifier.

### 1-14. WARRANTY

1-15. Microwave tubes are warranted to be free from manufacturing defects for a period of one year from date of purchase from Hewlett-Packard. The conditions of warranty are given in the rear of this manual.



Table 1-1. Specifications

<p><b>Frequency Range:</b>            Model 489A: 1 to 2 GHz            Model 491C: 2 to 4 GHz</p> <p><b>Power Output:</b>            1 watt or greater with 1 mW or less input.</p> <p><b>Gain:</b>            30 dB or greater with 1 mW or less input.</p> <p><b>Gain Variation with Frequency:</b>            At 1 watt output: 6 dB or less across the band.            Small Signal: 12 dB or less across the band; 5 dB or less across any 10% of the band.</p> <p><b>Gain Variation with Line Voltage:</b>            1.0 dB or less for 10% variation from rated line voltage.</p> <p><b>Maximum RF Input:</b>            100 mW</p> <p><b>Input/Output Characteristics:</b>            Impedance: 50 ohms.            SWR: 2.5:1 or less (cold).</p> <p><b>Connectors:</b>            Type N female.</p> <p><b>Amplitude Modulation:</b>  <b>Sensitivity vs Frequency Response:</b> A modulation input of -20V peak or greater reduces the RF output by more than 20 dB from dc to 50 kHz. Above 50 kHz, modulation decreases approximately 6 dB per octave.  <b>Input Impedance:</b> 100K shunted by approximately 50 pF.  <b>Pulse Response:</b> Less than 1 <math>\mu</math>sec rise and fall times.  <b>Residual AM:</b> At least 45 dB below modulated output.</p> <p><b>Noise:</b>            Noise Figure: 30 dB or less.            Noise Power Output: -10 dBm or less.</p>	<p><b>Front Panel Control:</b>            Gain, varies grid voltage on TWT.</p> <p><b>Meter:</b> Monitors cathode current.</p> <p><b>Net Weight:</b>            40 lb. (18 kg).</p> <p><b>Power:</b>            115 or 230 Vac <math>\pm</math>10%, 50 to 60 Hz, approximately 225 watts.</p> <p><b>Dimensions:</b></p> <p><b>Accessories Furnished:</b>            Power Cord, 7-1/2 feet long (2290 mm), NEMA plug (IEC approved). Hardware for converting cabinet to EIA-conforming rack mount.</p> <p><b>Accessories Available:</b>            11501A Cable, type N male to type N female, 6 ft. long (1830 mm).            11500A Cable, type N male connectors, 6 ft. long (1830 mm).</p>
--	---

Table 1-2. Recommended Test Equipment

Instrument Type	Critical Specifications	Recommended Model	Use (see Note)
Oscilloscope	Bandpass: dc to 1 MHz Sensitivity: 0.5V/cm	HP 140A with 1402A/ 1420A	P, A, T
Square Wave Generator	Freq. Range: 0.5 kHz to 50 kHz Square Wave Output: 40 Volts peak-to-peak	HP 211B	P, A, T
AC VTVM	Range: 5 to 25 mV Accuracy: 2% Freq. Range: 10 Hz to 1 kHz Impedance: 10 megohms	HP 400E	P, A, T
Signal Generator (for Model 489A only)	Freq. Range: 1 to 2 GHz Power Output: 1 mW Leveled Output: +0.5 dB	HP 8614A	P, T
Signal Generator (for Model 491C only)	Freq. Range: 1 to 2 GHz Power Output: 1 mW Leveled Output: +5 dB	HP 8616A	P, T
Power Meter	Range: 0.1 mW to 3W Freq. Range: 1 to 4 GHz Accuracy: 5%	HP 434A	P, T
Crystal Detector	Freq. Response: 1 to 4 GHz Square Law Characteristic: $\pm 1$ dB Sensitivity: 0.1V/mW	HP 420B	P, T
Fixed Attenuator (2 required)	Attenuation: 20 dB	HP 8491A Option 20	P, T
DC Power Supply	Regulated Output: 0 to -20 Vdc	HP 721A	P, T
DC Digital Voltmeter	Range: 5 to 1000 Vdc Accuracy: 1% Impedance: 10 Megohms Floating Input	HP 3440A with 3443A	A, T
Adjustable Line Voltage Transformer	Range: 103 to 127 Vac	General Radio W10-MT3A or Superior Electric UC1M	A, T
Clip-on Milliammeter	Range: 3 mA to 100 mA Accuracy: 3%	HP 428B	T
Note			
P = Performance Tests; A = Adjustments; T = Troubleshooting			

## SECTION II INSTALLATION

### 2-1. INITIAL INSPECTION

#### 2-2. Mechanical Check

2-3. If external damage to the shipping carton is evident, ask the carrier's agent to be present when the instrument is unpacked. Check the instrument for external damage, such as broken controls or connectors, and dents or scratches on the panel surface. Also, check the cushioning material for signs of severe stress.

#### 2-4. Electrical Check

2-5. The electrical performance of the Model 489A/491C should be verified as soon as possible upon receipt. Performance Tests suitable for incoming inspection are given in Section IV, PERFORMANCE TESTS. Equipment required for performance evaluation is listed in Table 1-2.

#### 2-6. Claims for Damage

2-7. If physical damage is evident, or if the instrument does not meet specifications when received, notify the carrier and the nearest Hewlett-Packard Sales and Service Office (see list at rear of manual). Retain the shipping carton and packing material for the carrier's inspection. The Sales and Service Office will arrange for repair or replacement without waiting for settlement of a claim with the carrier.

### 2-8. PREPARATION FOR USE

#### 2-9. Power Requirements

2-10. The HP Model 489A/491C Microwave Amplifier requires a power source of 115 or 230 Vac  $\pm 10\%$ , 48 to 66 Hz, single phase, at approximately 225 watts.

#### 2-11. Selecting 115 or 230 Volt Operation

2-12. A rear panel two-position slide switch permits operation from either a 115 or 230 Vac line source. The number visible on the switch indicates the line voltage to which the instrument should be connected. To prepare the Model 489A/491C for operation, position the switch for the line voltage available, and install the appropriate fuse as shown on the rear panel.

### CAUTION

To avoid damage to the instrument, set the 115/230 Volt switch to the line voltage available before connecting power to the instrument.

#### 2-13. Three-Conductor Power Cable

2-14. To protect operating personnel, the National Electrical Manufacturers Association (NEMA) recommends that the instrument panel and cabinet be grounded. All Hewlett-Packard instruments are equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cable connector is the ground pin. The Model 489A/491C employs power connector, switches, and safety requirements as recommended by the International Electrotechnical Commission (IEC). To preserve the protection feature when using the instrument with a two-contact outlet, use a three-prong to two-prong adapter (HP Part No. 1251-0048) and connect the green pigtail on the adapter to ground.

#### 2-15. Operating Environment

2-16. Clearances for ventilation should be three to four inches at the rear of the cabinet, and two to three inches at the sides. The clearances provided by the plastic feet in bench stacking are sufficient for the top and bottom cabinet surfaces.

#### Note

The instrument fan is located on the rear panel. Make provisions to insure that the instrument obtains sufficient air.

#### 2-17. Bench Operation

2-18. The model 489A/491C cabinet has plastic feet and a foldaway tilt stand for bench operation. The tilt stand raises the front of the instrument, and the plastic feet are shaped to make similar-width HP modular instruments self-aligning when stacked.

**2-19. Rack Mounting**

2-20. To convert instrument to rack mounting, perform the following:

a. Remove the trim strips on the sides of the instrument. The trim strips have an adhesive backing, so simply pry off with a screwdriver.

b. Remove the tilt stand by pressing the two sides of the tilt stand toward the center of the instrument.

c. Remove the five feet on the bottom of the instrument (press button in center of each foot, slide toward center of instrument, and remove foot).

d. Place the rack mounting flanges where the trim strips had been, and secure with the screws provided. The large notch on flange should be placed toward the bottom of the instrument.

**2-21. REPACKAGING FOR SHIPMENT****2-22. Using Original Packaging**

2-23. Containers and packing materials identical to those used by the factory are available through your nearest Hewlett-Packard Sales and Service Office. If the Model 489A/491C is being returned for servicing and repair, attach a tag indicating

type of service, return address, and full instrument serial number. Also, mark the box FRAGILE to assure careful handling. In any correspondence regarding your instrument, refer to the instrument by its full HP model number, and full serial number.

**2-24. Other Packing Materials**

2-25. The following general instructions should be used for repackaging with commercially available materials:

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

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

c. Use enough shock-absorbing material (three to four inch layer) around all sides of the instrument to provide firm cushion and prevent movement inside the container. Protect the control panel with cardboard.

d. Seal the shipping container securely.

e. Mark the shipping container FRAGILE to assure careful handling.

## SECTION III OPERATION

### 3-1. INTRODUCTION

3-2. The HP Model 489A/491C is a broadband linear amplifier capable of providing signal amplification of at least 30 dB. The output of the Microwave Amplifier may be amplitude modulated using an externally supplied signal.

### 3-3. FRONT PANEL FEATURES

3-4. Front panel features are described in Figure 3-1. Description numbers match the numbers on the illustration.

### 3-5. OPERATING INSTRUCTIONS

3-6. Connect the instrument to ac line source, then proceed with the following:

#### CAUTION

Never apply RF power to the input unless the output is terminated with a 50 ohm load, or TWT may be damaged.

a. Set LINE switch to ON. The STANDBY lamp should glow. Heater voltages are applied to all tubes in the instrument, and -350 volts is supplied to the modulator. Approximately 90 seconds later, the ON lamp should glow, indicating that high voltage is applied to the instrument. If the LINE switch is placed in the STANDBY position, the STANDBY lamp should glow. Heater voltages are applied to all tubes, and -350 volts is supplied to the modulator. After approximately 90 seconds has elapsed, high voltage will be applied to the instrument when the LINE switch is switched from STANDBY to ON. The purpose of the STANDBY position is to turn RF power output "on" or "off" after initial turn-on, without waiting for the 90 second delay. Due to the time constant of C102B and R130, a few seconds delay from ON to OFF to ON is required for the circuitry to recover.

b. Rotate GAIN control fully clockwise. With the CATHODE CURRENT meter pointer set within RATED POWER limits, a maximum of 1 milliwatt at the INPUT jack produces a mini-

mum of 1 watt at the OUTPUT jack across the frequency range. Signal gain is at least 30 dB. A constant 1 milliwatt signal across the band at the INPUT jack produces at the OUTPUT jack a variation of less than 6 dB across the band.

#### Note

If excessive helix current is drawn by the traveling wave amplifier tube, the overload relay (K3) will energize, removing high voltage from the circuit. Also, if the filament voltage is too high, the fail-safe relay (K304) will energize, removing high voltage and filament voltage from the circuit. In such cases, the LINE switch must be switched off, then on again. If condition persists, remove power from the instrument and troubleshoot.

c. Connect Model 489A/491C OUTPUT jack to the instrument into which the amplified signal is to be applied.

d. Apply RF power to the INPUT jack. The maximum power that may be applied to the INPUT jack is 100 mW.

3-7. If it is desired to modulate the output signal, proceed with the following:

a. Rotate GAIN control for required RF output out.

b. Apply an audio signal to the MOD INPUT jack. Bandpass for signal inputs up to 10 volts is dc to 500 kHz; bandpass for signal inputs up to 20 volts is dc to 100 kHz.

#### CAUTION

Peak cathode current must not be allowed to exceed rated power level.

### 3-8. OPERATOR'S MAINTENANCE

#### 3-9. Fuses

3-10. Protection for the instrument is provided by F1, located on rear panel. A 4 ampere fuse is

used for 115 Vac operation; a 2 ampere fuse is used for 230 Vac operation.

**3-11. Fan**

3-12. The Model 489A/491C uses the forced-air cooling method for maintaining the desired temperature within the instrument. Incoming air is filtered through a specially treated filter at the rear of the instrument. The air filter should be checked periodically and if necessary cleaned. It should be washed in hot water and detergent to

thoroughly removal all dirt deposits. After filter is clean, allow it to dry. Compressed air speeds the drying process.

**3-13. Lamp Replacement**

3-24. The two neon lamps used for indicating STANDBY and ON are HP Part No. 1450-0419. Should replacement be necessary, the leads must be unsoldered, and then the lamp may be unclamped from the front panel.

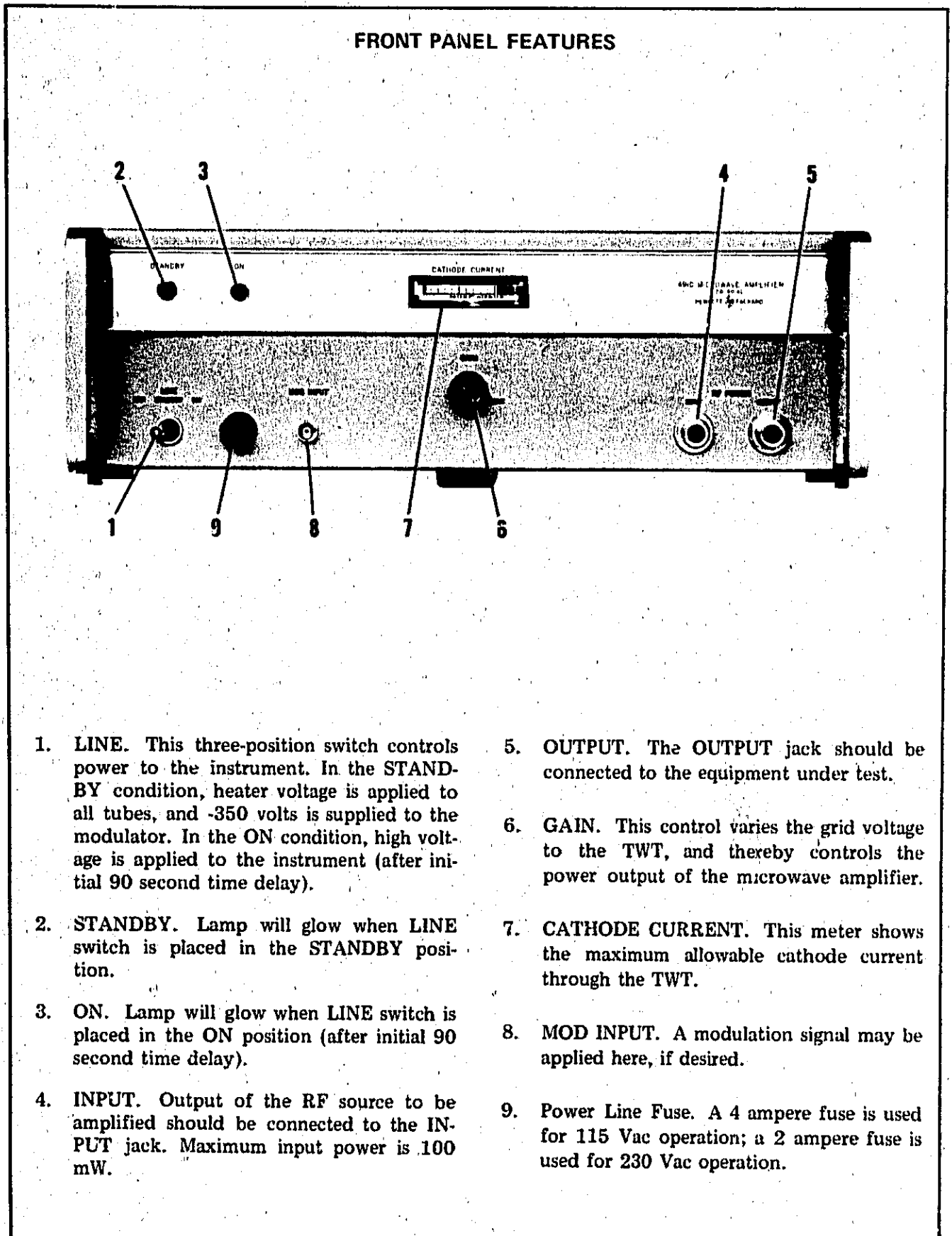


Figure 3-1. Front Panel Features

## SECTION IV PERFORMANCE TESTS

### 4-1. INTRODUCTION

4-2. The procedures outlined in this section check the performance of the Model 489A/491C Microwave Amplifier for incoming inspection, periodic evaluation, or after troubleshooting or repair. The tests may be performed without access to the instrument interior.

### 4-3. EQUIPMENT REQUIRED

4-4. Recommended test equipment is listed in Table 1-2. Test instruments other than the ones

listed may be used if their performance equals or exceeds the Critical Specifications listed in the table.

### 4-5. TEST RECORD

4-6. Table 4-1 is a performance test record. This table may be used during the test to record the test values obtained. It provides a permanent record of the test values for use at a later time during calibration or periodic evaluation.



**PERFORMANCE TESTS**

**4-7. POWER AMPLIFICATION**

**Specification:**

At least 1 watt output within the input of 1 milliwatt or less.

**Description:**

A low level signal from the signal generator is applied to the INPUT jack, and an amplified signal is measured at the OUTPUT jack.

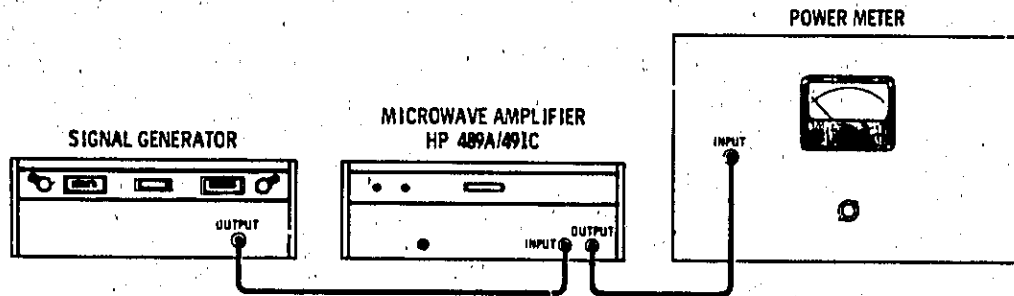


Figure 4-1. Power Amplification Test Setup

**Equipment:**

Signal Generator	HP 8614A/8616A
Power Meter	HP 434A

**Procedure:**

1. Connect equipment as shown in Figure 4-1, and set the controls as follows:

*Microwave Amplifier*

LINE	ON
GAIN	Fully clockwise

*Signal Generator*

LINE	Depressed
RF	Depressed
ALC	Depressed
FREQUENCY	2 GHz for Model 489A 4 GHz for Model 491C
ALC CAL OUTPUT	Adjust for 0 dBm reading on output meter
ATTENUATION	000

*Power Meter*

RANGE	3.0 Watt
-------	----------

2. Measure RF power output. Indication on power meter should be at least 1 watt (less cable loss).

---

**PERFORMANCE TESTS**


---

**4-8. GAIN CONTROL-POWER ON-OFF RATIO****Specification:**

Power output change at least 20 dB with GAIN control.

**Description:**

A low level signal from the signal generator is applied to the INPUT jack, and an amplified signal, controlled by the GAIN control is measured at the OUTPUT jack.

**Equipment:**

Same as paragraph 4-7.

**Procedure:**

1. Make the same settings as in paragraph 4-7. Record RF power output.
  2. Rotate GAIN control fully counterclockwise. Record RF power output. Difference between the two readings should be at least 20 dB.
- 

**4-9. MODULATOR ON-OFF RATIO****Specification:**

At least 20 dB gain control at RF OUTPUT 0 to -20 volts at MOD INPUT.

**Description:**

The application of -20 Vdc to the MOD INPUT jack will decrease the RF power output at least 20 dB.

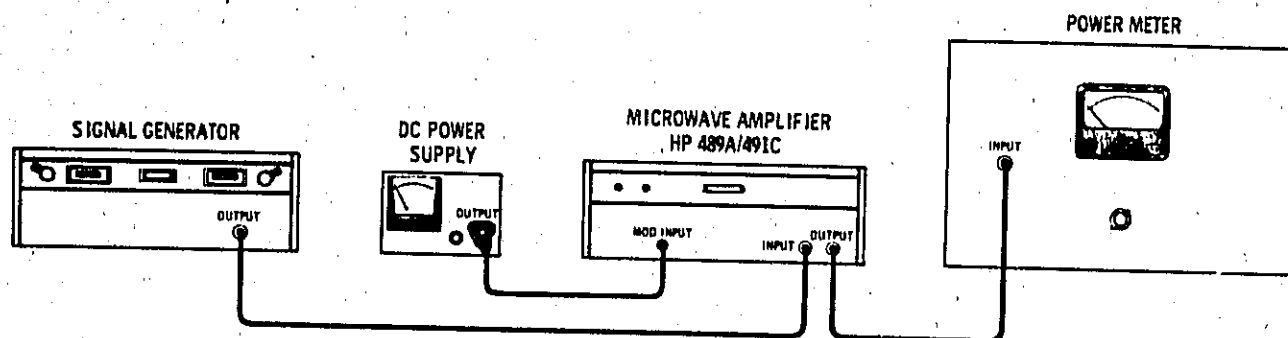


Figure 4-2. Modulator On-Off Ratio Test Setup

**PERFORMANCE TESTS**

**4-9. MODULATOR ON-OFF RATIO (Cont.)**

*Equipment:*

Signal Generator	HP 8614A/8616A
Power Meter	HP 434A
DC Power Supply	HP 721A

*Procedure:*

1. Connect equipment as shown in Figure 4-1, and set the controls as follows:

*Microwave Amplifier:*

LINE	ON
GAIN	Fully clockwise

*Signal Generator*

LINE	Depressed
RF	Depressed
ALC	Depressed
FREQUENCY	2 GHz for Model 489A 4 GHz for Model 491C
ALC CAL OUTPUT	Adjust for 0 dBm reading on output meter
ATTENUATION	000

*Power Meter*

RANGE	3.0 Watt
-------	----------

*DC Power Supply*

METER RANGE	30 Vdc
VOLTAGE ADJUST	fully counterclockwise

2. Measure and record RF power output.
3. Adjust dc power supply for output of -20 Vdc.
4. Measure and record RF power output. The difference between the two readings should be at least 20 dB.

**4-10. MODULATOR SENSITIVITY VS. FREQUENCY RESPONSE**

*Specification:*

A modulation input of -20V peak or greater reduces the RF output by more than 20 dB from dc to 50 kHz. Above 50 kHz, modulation decreases approximately 6 dB per octave.

*Description:*

The application of a -20V peak modulation signal to the MOD INPUT jack will decrease the RF power output at least 20 dB.

PERFORMANCE TESTS

4-10. MODULATOR SENSITIVITY Vs. FREQUENCY RESPONSE (Cont.)

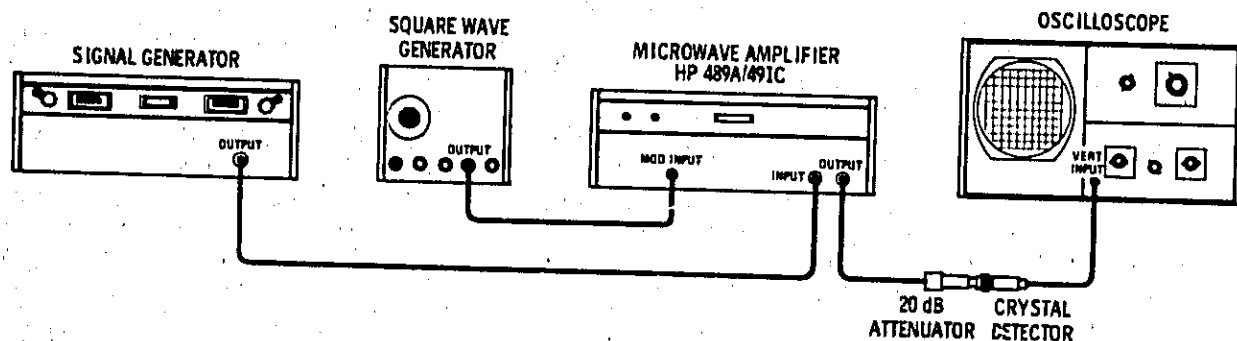


Figure 4-3. Modulator Sensitivity vs. Frequency Response Test Setup

Equipment:

Signal Generator	HP 8614A/8616A
Square Wave Generator	HP 211B
Oscilloscope	HP 140A with 1402A and 1420A Plug-Ins
20 dB Fixed Attenuator (2 required)	HP 8419A, Option 20
Crystal Detector	HP 420B

Procedure:

1. Connect equipment as shown in Figure 4-3 and set the controls as follows:

*Microwave Amplifier*

LINE	ON
GAIN	Maximum rated power

*Signal Generator*

LINE	Depressed
RF	Depressed
ALC	Depressed
FREQUENCY	2 GHz for Model 489A 4 GHz for Model 491C
ALC CAL OUTPUT	Adjust for 0 dBm reading on output meter
ATTENUATION	005

*Square Wave Generator*

FREQUENCY	dc to 50 kHz
AMPLITUDE	-20V

*Oscilloscope*

VERTICAL SENSITIVITY	.1V/div
TRIGGER SOURCE	INT
SWEEP TIME	.1 ms/div
VERTICAL COUPLING	DC

**PERFORMANCE TESTS**

**4-10. MODULATOR SENSITIVITY Vs. FREQUENCY RESPONSE (Cont.)**

2. Observe the oscilloscope for a calibration line and set vertical position to convenient location.
3. Insert another 20 dB Attenuator in series with the output.
4. Observe the position of the calibration line on oscilloscope and adjust vertical sensitivity to a point which establishes a convenient 20 dB reference point.
5. Apply the -20V square wave signal to the front panel MOD INPUT jack. Observe square wave pattern on oscilloscope. Pattern will exceed the 20 dB reference point on the oscilloscope for any frequency from dc to 50 kHz. Above 50 kHz, modulation will fall off approximately 6 dB per octave.

**4-11. RESIDUAL AM**

*Specification:*

At least 45 dB below modulated output.

*Description:*

A square-wave modulated signal is applied to the INPUT jack, and residual AM is measured at the OUTPUT jack.

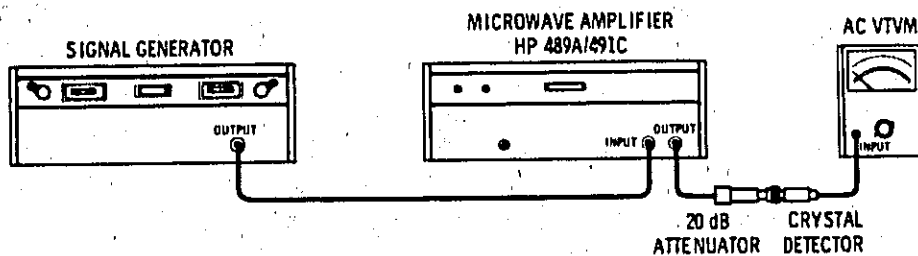


Figure 4-4. Residual AM Test Setup

*Equipment:*

Signal Generator	.....	HP 8614A/8616A
AC VTVM	.....	HP 400E
Crystal Detector	.....	HP 420B
20 dB Fixed Attenuator	.....	HP 8491A, Option 20

*Procedure:*

1. Connect equipment as shown in Figure 4-4, and set the controls as follows:

*Microwave Amplifier*

LINE	.....	ON
GAIN	.....	Fully clockwise

**PERFORMANCE TESTS**

**4-11. RESIDUAL AM (Cont.)**

*Signal Generator*

LINE	.....	Depressed
RF	.....	Depressed
ALC	.....	Depressed
SQ WAVE	.....	Depressed
FREQUENCY	.....	2 GHz for Model 489A 4 GHz for Model 491C
ALC CAL OUTPUT	.....	Adjust for 0 dBm reading on output meter
SQ WAVE FREQ	.....	Approximately 1000 Hz
ATTENUATION	.....	Approximately -15 dB

*AC VTVM*

RANGE	.....	100 mV (-20 dB)
-------	-------	-----------------

2. Adjust the signal generator ATTENUATION knob for 100 mV reference reading on AC VTVM (approximately -18 dB).
3. Release SQ WAVE button and record the AC VTVM reading. Reading should be less than -55 dB on AC VTVM. This takes into account the correction factor of approximately 8 dB for the crystal detector.

**4-12. SWR**

*Specification:*

2.5:1 or less (cold).

*Description:*

SWR of the RF input and output circuit is 2.5:1 or better, and normally need not be checked if the instrument meets gain and output power specifications. If it is desired to check the SWR, normal SWR measuring techniques (i.e., slotted line or swept frequency reflectometer) may be employed. HP Application Note 54 (available from your local Hewlett-Packard Sales and Service Office) describes new, improved swept frequency techniques for measurement of SWR, etc.

**Note**

Depending on the TWT manufacturer, the DC resistance of the input and output circuits, when measured at the panel jacks from center conductor to ground, may measure anywhere between 50 ohms and open circuit.

Table 4-1. Performance Test Record

Hewlett-Packard Model 489A/491C Microwave Amplifier		Test Performed by _____		
Serial Number _____		Date _____		
Para No.	Test Description	Minimum	Actual	Maximum
4-7	Power Amplification	1 watt	_____	
4-8	Gain Control-Power On-Off Ratio	20 dB	_____	
4-9	Modulator On-Off Ratio	20 dB	_____	
4-10	Modulator Sensitivity vs. Frequency Response	20 dB	_____	
4-11	Residual AM		_____	-55 dB

## SECTION V ADJUSTMENTS

### 5-1. INTRODUCTION

5-2. This section outlines the alignment procedures to make adjustments to the Model 489A/491C Microwave Amplifier. This procedure should not be performed as routine maintenance, but should be performed (1) after replacement of a part or component, (2) when the performance tests show that the specifications in Table 1-1 cannot be met, or (3) when instructed to do so in the trouble-

shooting tree. Before attempting any adjustment, allow a 30 minute warm-up period.

### 5-3. EQUIPMENT REQUIRED FOR ADJUSTMENTS

5-4. The test equipment required to perform the adjustment procedure is listed in Table 1-2. Test equipment other than that listed may be used, providing its performance equals or exceeds the Critical Specifications listed in the table.



## ADJUSTMENTS

## 5.5. TWT FILAMENT ADJUSTMENT

*Description:*

While observing the dc digital voltmeter, the TWT filament voltage is adjusted to the value marked on the TWT capsule.

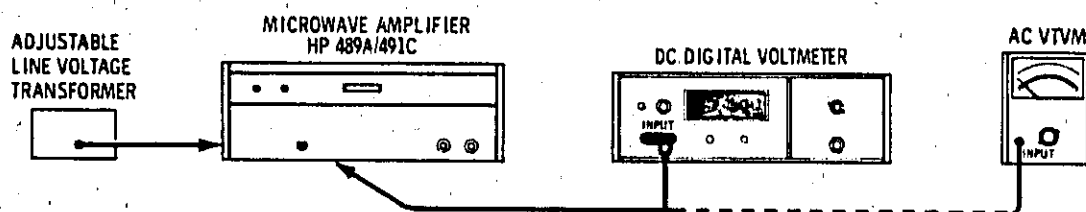


Figure 5-1. TWT Voltage Adjustments Test Setup

*Equipment:*

AC VTVM	HP 400E
DC Digital Voltmeter	HP 3440A with 3443A Plug-in
Adjustable Line Voltage Transformer	General Radio W10MT3A or Superior Electric UC1M

*Procedure:*

1. Rotate FILAMENT ADJUST R306 fully clockwise.
2. Connect dc digital voltmeter positive lead to E1-B (brown lead); connect common lead to E1-E (yellow lead).
3. Set Model 489A/491C LINE switch to STANDBY.
4. Set FILAMENT ADJUST R306 for filament voltage marked on the TWT capsule. Recheck it after ten minute warmup.
5. Adjust line voltage from 103 to 127 Vac. The filament voltage should vary less than  $\pm 0.1$  volt from initial value.

---

**ADJUSTMENTS**

---

**5-6. TWT COLLECTOR/HELIX ADJUSTMENT***Description:*

While observing the dc digital voltmeter, the TWT collector/helix voltage is adjusted to the value marked on the TWT capsule.

*Equipment:*

Same as paragraph 5-5.

*Procedure:*

1. Parallel ac VTVM and dc digital voltmeter between E1-D (orange lead) and ground.
  2. Set Model 489A/491C LINE switch to ON.
  3. Adjust HIGH VOLTAGE ADJUST R37 for collector/helix voltage marked on the TWT capsule.
  4. Adjust ac line voltage from 103 to 127 Vac. The collector/helix voltage should vary less than  $\pm 5$  volts. Ripple voltage should not exceed 10 mV rms.
- 

**5-7. TWT ANODE ADJUSTMENT***Description:*

While observing the dc digital voltmeter, the TWT anode voltage is adjusted to the value marked on the TWT capsule.

*Equipment:*

Same as paragraph 5-5.

*Procedure:*

1. Connect TWT anode lead (blue) to E1-G.
  2. Parallel ac VTVM and dc digital voltmeter and connect between E1-G (blue lead) and ground.
  3. Set CATHODE CURRENT ADJUST R43 for anode voltage marked on the TWT capsule.
  4. Vary ac line voltage from 103 to 127 Vac. The anode voltage should vary less than  $\pm 5$  volts. Ripple voltage should not exceed 25 mV rms.
-

---

**ADJUSTMENTS**

---

**5-8. -350 VOLT ADJUSTMENT***Description:*

While observing the dc digital voltmeter, the -350 volt power supply is adjusted for the proper value.

*Equipment:*

Same as paragraph 5-5.

*Procedure:*

1. Set Model 489A/491C LINE switch to ON.
  2. Parallel ac VTVM and dc digital voltmeter and connect between R118 — R124 junction and ground.
  3. Set -350 VOLT ADJUST R108 to -350 volts.
  4. Vary ac line voltage from 103 to 127 Vac. The -350 volt power supply should vary less than  $\pm 3$  volts. Ripple voltage should not exceed 10 mV rms.
- 

**5-9. TWT GRID VOLTAGE ADJUSTMENT***Description:*

While observing the dc digital voltmeter, the TWT grid voltage is adjusted to the value marked on the TWT capsule.

*Equipment:*

Same as paragraph 5-5.

*Procedure:*

1. Parallel ac VTVM and dc digital voltmeter and connect between E1-F (green lead) and E1-E (yellow lead).
  2. Rotate GAIN control fully clockwise.
  3. Set GAIN LIMIT CONTROL R121 to the grid voltage marked on the TWT capsule.
  4. Vary ac line voltage from 103 to 127 Vac. The grid voltage should vary less than  $\pm 2$  volts. Ripple voltage should not exceed 10 mV rms.
-

## ADJUSTMENTS

## 5-10. SQUARE-WAVE RESPONSE ADJUSTMENT

*Description:*

With the application of a square wave signal to the MOD INPUT jack, the oscilloscope will display the response at the grid of the TWT.

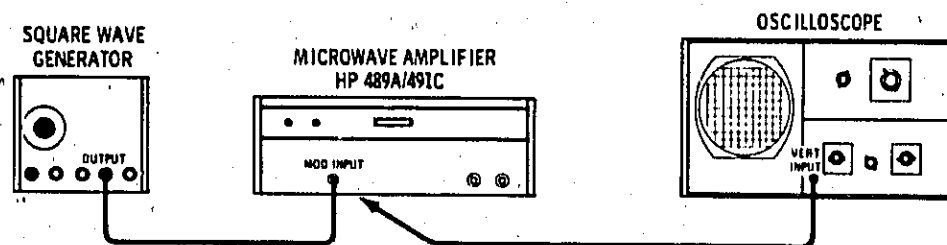


Figure 5-2. Square-Wave Response Test Setup

*Equipment:*

Square-Wave Generator . . . . . HP 211B  
 Oscilloscope . . . . . HP 140A with 1402A and 1420A Plug-ins

*Procedure:*

1. Connect oscilloscope probe to E1-F (green lead).
2. Rotate GAIN control fully clockwise.
3. Set square-wave generator frequency to 10 kHz and adjust square-wave generator amplitude for modulator output of 10 volts peak-to-peak.
4. Adjust FREQUENCY ADJUST C108 and C111 for optimum square wave output. Rise time should be less than 0.8  $\mu$ sec. Overshoot should be less than 5%.
5. Set square-wave generator frequency to 1 kHz, and increase its signal amplitude to produce a 100 volt peak-to-peak signal at the grid of the TWT. Rise time should be less than 10  $\mu$ sec. Overshoot should be less than 5%.

---

**ADJUSTMENTS**

---

**5-11. CATHODE CURRENT METER ADJUSTMENT***Description:*

With the LINE switch in the ON position, and the GAIN control fully clockwise, adjust the CATHODE CURRENT METER ADJUST for a meter reading within RATED POWER limits.

*Equipment:*

None.

*Procedure:*

1. Perform adjustments in paragraphs 5-5 through 5-10 in sequence prior to making this adjustment.
2. Set LINE switch to ON.
3. Rotate GAIN control fully clockwise.
4. Adjust METER SENSITIVITY R205 for a meter reading between the RATED POWER lines.

## SECTION IV REPLACEABLE PARTS

### 6-1. INTRODUCTION

6-2. This section contains information for ordering replaceable parts. Table 6-1 gives the meanings of the abbreviations and reference designations used in the table of replaceable parts.

6-3. Table 6-2 is the table of replaceable parts and is organized as follows:

a. Electrical assemblies and their component parts in alpha-numerical order by reference designation.

b. Chassis parts in alpha-numerical order by reference designation.

c. Miscellaneous parts.

d. Illustrated parts breakdowns, if appropriate.

6-4. The information given for each part consists of:

a. The Hewlett-Packard part number.

b. Total quantity (TQ) in the instrument. Total quantity for each part is given only once — at the first appearance of the part number.

c. Description of the part.

d. Typical manufacturer of the part, in a five-digit code.

e. The manufacturer's number for the part.

6-5. Table 6-3 contains the names and addresses that correspond to the manufacturer's code numbers.

### 6-6. ORDERING INFORMATION

6-7. To order a part listed in the replaceable parts table, quote the Hewlett-Packard part number, indicate the quantity required, and address the order to the nearest Hewlett-Packard office.

6-8. To order a part that is not listed in the replaceable parts table, include the instrument model number, instrument serial number, the description and function of the part, and the number of parts required. Address the order to the nearest Hewlett-Packard office.

Table 6-2. Reference Designators and Abbreviations

REFERENCE DESIGNATORS							
A	= assembly	F	= fuse	P	= plug	V	= vacuum tube, neon bulb, photocell, etc.
B	= motor	FL	= Filter	Q	= transistor	VR	= voltage regulator
BT	= battery	J	= jack	R	= resistor	W	= cable
C	= capacitor	K	= relay	RT	= thermistor	X	= socket
CP	= coupler	L	= inductor	S	= switch	Y	= crystal
CR	= diode	LS	= loud speaker	T	= transformer	Z	= tuned cavity, network
DL	= delay line	M	= meter	TB	= terminal board		
DS	= device signaling (lamp)	MK	= microphone	TP	= test point		
E	= misc electronic part	MP	= mechanical part	U	= integrated circuit		

ABBREVIATIONS							
A	= amperes	H	= henries	N/O	= normally open	RMO	= rack mount only
AFC	= automatic frequency control	HDW	= hardware	NOM	= nominal	RMS	= root-mean square
AMPL	= amplifier	HEX	= hexagonal	NPO	= negative positive zero (zero temperature coefficient)	RWV	= reverse working voltage
BFO	= beat frequency oscillator	HR	= hour(s)			S-B	= slow-blow
BE CU	= beryllium copper	Hz	= Hertz	NPN	= negative-positive-negative	SCR	= screw
BH	= binder head	IF	= intermediate freq			SE	= selenium
BP	= bandpass	IMPG	= impregnated	NRFR	= not recommended for field replacement	SECT	= section(s)
BRS	= brass	INCD	= incandescent			SEMICON	= semiconductor
BWO	= backward wave oscillator	INCL	= include(s)	NSR	= not separately replaceable	SI	= silicon
		INS	= insulation(ed)			SIL	= silver
		INT	= internal	OBD	= order by description	SL	= slide
		K	= kilo = 1000	OH	= oval head	SPG	= spring
CCW	= counterclockwise			OX	= oxide	SPL	= special
CER	= ceramic	LH	= left hand	P	= peak	SST	= Stainless steel
CMO	= cabinet mount only	LIN	= linear taper	PC	= printed circuit	SR	= split ring
COEF	= coefficient	LK WASH	= lock washer	PF	= picofarads = 10 <sup>-12</sup> farads	STL	= steel
COM	= common	LOG	= logarithmic taper	PH BRZ	= phosphor bronze	TA	= tantalum
COMP	= composition	LPF	= low pass filter	FHL	= Phillips	TD	= time delay
COMPL	= complete	M	= milli = 10 <sup>-3</sup>	PIV	= peak inverse voltage	TGL	= toggle
CONN	= connector	MEG	= meg = 10 <sup>6</sup>			THD	= thread
CP	= cadmium plate	MET FLM	= metal film			TI	= titanium
CRT	= cathode-ray tube	MET OX	= metallic oxide	PNP	= positive-negative-positive	TOL	= tolerance
CW	= clockwise	MFR	= manufacturer			TRIM	= trimmer
DEPC	= deposited carbon	MHz	= mega Hertz			TWT	= traveling wave tube
DR	= drive	MINAT	= miniature	P/O	= part of		
ELECT	= electrolytic	MOM	= momentary	POLY	= polystyrene	μ	= micro = 10 <sup>-6</sup>
ENCAP	= encapsulated	MOS	= metallized substrate	FORC	= porcelain	VAR	= variable
EXT	= external	MTG	= mounting	POS	= position(s)	VDCW	= dc working volts
F	= farads	MY	= "mylar"	POT	= potentiometer		
FH	= flat head	N	= nano (10 <sup>-9</sup> )	PP	= peak-to-peak	W/	= with
FIL H	= Fillister head	N/C	= normally closed	PT	= point	W	= watts
FXD	= fixed	NE	= neon	PWV	= peak working voltage	WIV	= working inverse voltage
G	= giga (10 <sup>9</sup> )	NI PL	= nickel plate	RECT	= rectifier	WW	= wirewound
GE	= germanium			RF	= radio frequency	W/O	= without
GL	= glass			RH	= round head or right hand		
GRD	= ground(ed)						

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1	489A-65B	1	ASSY:HIGH VOLTAGE POWER SUPPLY	28480	489A-65B
A2			THRU		
A9			NOT ASSIGNED		
A10	489A-65A	1	ASSY:RECTIFIER	28480	489A-65A
A11			THRU		
A100			NOT ASSIGNED		
A101	489A-65C	1	ASSY:MODULATOR	28480	489A-65C
A102			THRU		
A199			NOT ASSIGNED		
A200	489A-65E	1	TMT TEST BOARD ASSY	28480	489A-65E
A201			THRU		
A299			NOT ASSIGNED		
A300	489A-65D	1	ASSY:FILAMENT REGULATOR	28480	489A-65D
B1	3160-0026	1	FAN:TUBEXIAL 50-60CPS	28480	3160-0026
C1			THRU		
C5			NOT ASSIGNED		
C6	0150-0066	2	C:FXD CER 0.1 UF +80-20% 100VDCW	56289	33C4185-CDH
C7			THRU		
C9			NOT ASSIGNED		
C10	0180-0024	2	C:FXD ELECT 40UF 450VDCW	56289	032441
C11	0160-0102	2	C:FXD PAPER 4UF 10% 1000VDCW	02777	08D
C12	0160-0102	2	C:FXD PAPER 4UF 10% 1000VDCW	02777	08D
C13	0150-0052	3	C:FXD CER 0.05 UF 20% 400VDCW	56289	33C17A
C14	0150-0012	7	C:FXD CER 0.01 UF 20% 1000VDCW	56289	29C214A3
C15	0150-0012	7	C:FXD CER 0.01 UF 20% 1000VDCW	56289	29C214A3
C16	0150-0012		C:FXD CER 0.01 UF 20% 1000VDCW	56289	29C214A3
C17	0150-0012		C:FXD CER 0.01 UF 20% 1000VDCW	56289	29C214A3
C18	0180-0058	1	C:FXD ELECT 50UF -10%+100% 25VDCW	56289	30D5N6G025D34M1
C19	0150-0012		C:FXD CER 0.01 UF 20% 1000VDCW	56289	29C214A3
C20			THRU		
C100			NOT ASSIGNED		
C101	0180-0024		C:FXD ELECT 40UF 450VDCW	56289	032441
C102	0150-0012		C:FXD CER 0.01 UF 20% 1000VDCW	56289	29C214A3
C103	0150-0052		C:FXD CER 0.05 UF 20% 400VDCW	56289	33C17A
C104	0150-0052		C:FXD CER 0.05 UF 20% 400VDCW	56289	33C17A
C105	0150-0012		C:FXD CER 0.01 UF 20% 1000VDCW	56289	29C214A3
C106	0140-0178	2	C:FXD MICA 560 PF 2%	72136	RDW15F561G3C
C107	0140-0194	1	C:FXD MICA 110 PF 5%	72136	RDW15F110J3C
C108	0130-0013	2	C:VAR CER 3-12 PF NPO	28480	0130-0013
C109	0160-0013	1	C:FXD MY 0.1 UF 10% 400VDCW	56289	1A0P10494-P4D
C110	0150-0029	1	C:FXD TI 1 PF 10% 500VDCW	78488	TYPE GA
C111	0130-0017	1	C:VAR CER 8-50 PF	28480	0130-0017
C112	0140-0178		C:FXD MICA 560 PF 2%	72136	RDW15F561G3C
C113			THRU		
C200			NOT ASSIGNED		
C201	0150-0086		C:FXD CER 0.1 UF +80-20% 100VDCW	56289	33C4185-CDH
C202			THRU		
E300			NOT ASSIGNED		
E301	0180-0124	1	C:FXD ELECT 2800 UF +50-10% 30VDCW	56289	D35718 DFP
E302	0180-0061	1	C:FXD ELECT 100UF +100%-10% 15VDCW	56289	30197G0150D4
E303	0180-0063	1	C:FXD ELECT 500UF -10%+100% 3VDCW	56289	30D5N7G0070H4M1
E38			THRU		
CR9	1901-0029	1	NOT ASSIGNED		
CR10	1901-0030	10	DIODE:SILICON 800 PIV	28480	1901-0029
CR11	1901-0030		DIODE:SILICON 800 PIV	28480	1901-0030
CR12	1901-0030		DIODE:SILICON 800 PIV	28480	1901-0030
CR13	1901-0030		DIODE:SILICON 800 PIV	28480	1901-0030
CR14	1901-0030		DIODE:SILICON 800 PIV	28480	1901-0030
CR15	1901-0030		DIODE:SILICON 800 PIV	28480	1901-0030
CR16	1901-0030		DIODE:SILICON 800 PIV	28480	1901-0030
CR17			THRU		
CR180			NOT ASSIGNED		
CR101	1901-0030		DIODE:SILICON 800 PIV	28480	1901-0030
CR102	1901-0030		DIODE:SILICON 800 PIV	28480	1901-0030
CR103	1901-0030		DIODE:SILICON 800 PIV	28480	1901-0030
CR104	1901-0025	5	DIODE:SILICON 100MA/1V	07263	FD 2387
CR105	1901-0025	5	DIODE:SILICON 100MA/1V	07263	FD 2387
CR106	1902-0215	3	DIODE:BRKAOON16.49V 5%	28480	1902-0215
CR107	1901-0012	2	RECTIFIER:MET 1N2071 600V 10UA	01295	1N2071
CR108	1901-0012		RECTIFIER:MET 1N2071 600V 10UA	01295	1N2071
CR109	1901-0033	1	DIODE:SILICON 100MA 180WV	07263	FD3369
CR110			THRU		
CR300			NOT ASSIGNED		
CR301	1901-0025		DIODE:SILICON 100MA/1V	07263	FD 2387

See introduction to this section for ordering information



Table 6-2. Replaceable Parts (Cont.)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
CA302	1901-0032	2	DIODE:SILICON 1N3209	04713	1N3209
CA303	1901-0032		DIODE:SILICON 1N3209	04713	1N3209
CA304	1902-0218	1	DIODE BREAKDOWN:9.53V 5% 1.5W	28480	1902-0218
CA305	1902-0215		DIODE BREAKDOWN:6.49V 5%	28480	1902-0215
CA306	1901-0025		DIODE:SILICON 100MA/1V	07263	FD 2387
CA387	1901-0025		DIODE:SILICON 100MA/1V	07263	FD 2387
CA308	1902-0215		DIODE BREAKDOWN:6.49V 5%	28480	1902-0215
OS1	1450-0419	2	LIGHT INDICATOR SELECTED ME-2H	28480	1450-0419
OS2	1450-0419		LIGHT INDICATOR SELECTED ME-2H	28480	1450-0419
E1	0360-0017	1	BOARD:9 TERMINAL	71785	354-1R-08-001
F1	2110-0055	1	FUSE:CARTRIDGE 4 AMP 250V	75915	312006
F1			(FOR 115V OPERATION)		
F1	2110-0002	1	FUSE:CARTRIDGE 2 AMP 3 AG	75915	312.002
F1			(FOR 230V OPERATION)		
J1	1250-0099	2	CONNECTOR:RF REAR PANEL MOUNT JACK	91737	7738-5
J2	1250-0099		CONNECTOR:RF REAR PANEL MOUNT JACK	91737	7738-5
J3	1251-2357	1	SOCKET:3-PIN MALE POWER RECEPTACLE	82389	FAC-301
J4			THRU		
J100			NOT ASSIGNED		
J101	1250-0083	1	CONNECTOR:8NC	02660	31-221-1020
K1	0490-0933	1	RELAY:TIME DELAY 5PST	28480	0490-0933
K2	0490-0746	1	RELAY:DPT	70309	T255-CC-6V
K2	0490-0750	1	RELAY:RETAINER FOR 2 FORM C RELAY	70309	30040-4
K2	0490-0751	1	RELAY:SOCKET FOR 2 POLE RELAY	24796	A11-1 W/O RETAINER
K3	0490-0010	1	RELAY:SPDT 115VAC 0.25 AMP	77342	SM-4107 SPECIAL
K4			NOT ASSIGNED		
K5	0490-0124	1	RELAY:3PDT	77342	HA14AY
K6			THRU		
K303			NOT ASSIGNED		
K304	0490-0038	1	RELAY:DPT 5 AMP RESISTIVE	78277	50F2-A-AC
M1			THRU		
M200			NOT ASSIGNED		
M201	1120-0131	1	METER:1 MA	28480	1120-0131
Q1			THRU		
Q100			NOT ASSIGNED		
Q101	1854-0003	1	TSTR:SI NPN:SELECTED FROM 2N1711	28480	1854-0003
Q102			THRU		
Q300			NOT ASSIGNED		
Q301	1850-0038	1	TSTR:GE PNP	86684	1850-0038
Q302	1850-0021	2	TSTR:GE PNP	80131	2N441
Q303	1850-0021		TSTR:GE PNP	80131	2N441
R1	0687-3331	2	RIFXD COMP 33K OHM 10% 1/2W	01121	ER 3331
R2	0687-3331		RIFXD COMP 33K OHM 10% 1/2W	01121	ER 3331
R3			THRU		
R4			NOT ASSIGNED		
R10	0693-1021	1	RIFXD COMP 1000 OHM 10% 2W	01121	HR 1021
R11	0690-1041	4	RIFXD COMP 100K OHM 10% 1W	01121	GR 1041
R12	0813-0020	1	RIFXD WM 100 OHM 10% 5W	28480	0813-0020
R13	0692-4745	6	RIFXD COMP 470K OHM 5% 2W	01121	HR 4745
R14	0692-4745		RIFXD COMP 470K OHM 5% 2W	01121	HR 4745
R15	0692-4745		RIFXD COMP 470K OHM 5% 2W	01121	HR 4745
R16	0692-4745		RIFXD COMP 470K OHM 5% 2W	01121	HR 4745
R17	0692-4745		RIFXD COMP 470K OHM 5% 2W	01121	HR 4745
R18	0692-4745		RIFXD COMP 470K OHM 5% 2W	01121	HR 4745
R19	0690-1011	2	RIFXD COMP 100 OHM 10% 1W	01121	GB 1011
R20	0690-1011		RIFXD COMP 100 OHM 10% 1W	01121	GB 1011
R21	0687-1051	2	RIFXD COMP 1 MEGOHM 10% 1/2W	01121	ER 1051
R22	0687-1021	2	RIFXD COMP 1000 OHM 10% 1/2W	01121	FB 1021
R23	0689-5115	2	RIFXD COMP 510 OHM 5% 1W	01121	GB 5115
R24	0689-5115		RIFXD COMP 510 OHM 5% 1W	01121	GB 5115
R25	0687-1021		RIFXD COMP 1000 OHM 10% 1/2W	01121	FB 1021
R26	0687-1011	1	RIFXD COMP 100 OHM 10% 1/2W	01121	ER 1011
R27	0687-1541	1	RIFXD COMP 150K OHM 10% 1/2W	01121	FB 1541
R28	0687-1241	1	RIFXD COMP 120K OHM 10% 1/2W	01121	FB 1241
R29	0698-3545	1	RIFXD MET FLM 988K OHM 1.0% 1/2W	28480	0698-3545
R30	0757-0139	1	RIFXD MET FLM 1.1 MEGOHM 2% 1/2W	28480	0757-0139
R31	0757-0059	2	RIFXD MET FLM 1 MEGOHM 1% 1/2W	28480	0757-0059
R32	0757-0052	1	RIFXD MET FLM 500K OHM 1% 1/2W	28480	0757-0052
R33	0690-4741	1	RIFXD COMP 470K OHM 10% 1W	01121	GB 4741
R34	0687-1051		RIFXD COMP 1 MEGOHM 10% 1/2W	01121	FB 1051
R35	0693-3341	1	RIFXD COMP 330K OHM 10% 2W	01121	HR 3341
R36	0757-0353	2	RIFXD MET FLM 249K OHM 1.0% 1/2W	28480	0757-0353
R37	2100-0100	2	RIFAR COMP 3.5 MEGOHM 30% 1/4W	28480	2100-0100
R38	0698-3457	1	RIFXD MET FLM 316K OHM 1% 1/8W	28480	0698-3457
R39	0757-0155	3	RIFXD MET FLM 604K OHM 1% 1/2W	28480	0757-0155
R40	0757-0155		RIFXD MET FLM 604K OHM 1% 1/2W	28480	0757-0155

See Introduction to this section for ordering information.

Table 6-2. Replaceable Parts (Cont.)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
R41	0687-2721	1	RIFXD COMP 2700 OHM 10% 1/2W	01121	EB 2721
R41			FACTORY SELECTED PART		
R42	0757-0060	1	RIFXD MET FLM 110 R OHM 1% 1/2W	28480	0757-0060
R42			FACTORY SELECTED PART		
R43	2100-0100		RIVAR COMP 3.5 MEGOHM 30% LIN 1/4W	28480	2100-0100
R44	0730-0110	1	RIFXD DEPC 1.65 MEGOHM 1% 1W	28480	0730-0110
R45	0757-0869	1	RIFXD MET FLM 681K OHM 1% 1/2W	28480	0757-0869
R45			FACTORY SELECTED PART		
R46	0757-0865	1	RIFXD MET FLM 365K OHM 1% 1/2W	28480	0757-0865
R47	0687-5631	1	RIFXD COMP 56K OHM 10% 1/2W	01121	FB 5631
R48			THRU		
R100			NOT ASSIGNED		
R101	0690-4701	1	RIFXD COMP 47 OHM 10% 1W	01121	GB 4701
R102	0690-1041		RIFXD COMP 100K OHM 10% 1W	01121	GB 1041
R103	0690-1041		RIFXD COMP 100K OHM 10% 1W	01121	GB 1041
R104	0693-4741	1	RIFXD COMP 470K OHM 10% 2W	01121	HB 4741
R105	0693-1031	2	RIFXD COMP 10K OHM 10% 2W	01121	HB 1031
R106	0693-1031		RIFXD COMP 10K OHM 10% 2W	01121	HB 1031
R107	0757-0155		RIFXD MET FLM 604K OHM 1% 1/2W	28480	0757-0155
R108	2100-0094	1	RIVAR COMP 50K OHM 30% LIN 1/5W	28480	2100-0094
R109	0757-0363		RIFXD MET FLM 249K OHM 1.0% 1/2W	28480	0757-0363
R110	0693-8231	1	RIFXD COMP 82K OHM 10% 2W	01121	HB 8231
R111	0687-4731	1	RIFXD COMP 47K OHM 10% 1/2W	01121	FB 4731
R112	0687-1231	1	RIFXD COMP 12K OHM 10% 1/2W	01121	FB 1231
R113	0693-6831	1	RIFXD COMP 68K OHM 10% 2W	01121	HB 6831
R114	0690-1041		RIFXD COMP 100K OHM 10% 1W	01121	GB 1041
R115	0693-2731	2	RIFXD COMP 27K OHM 10% 2W	01121	HB 2731
R116	0693-2731		RIFXD COMP 27K OHM 10% 2W	01121	HB 2731
R117	0693-1531	1	RIFXD COMP 15K OHM 10% 2W	01121	HB 1531
R118	0727-0295	1	RIFXD DEPC 3.6 MEGOHM 1% 1/2W	28480	0727-0295
R119	0757-0870	1	RIFXD MET FLM 825K OHM 1% 1/2W	28480	0757-0870
R120	2100-0043	1	RIVAR COMP 500K OHM 10% LIN 2W	28480	2100-0043
R121	2100-0144	1	RIVAR COMP 250K OHM 30% LIN 1/5W	28480	2100-0144
R122	0757-0367	1	RIFXD MET FLM 100K OHM 1% 1/2W	28480	0757-0367
R123	0730-0093	1	RIFXD DEPC 516K OHM 1% 1W	28480	0730-0093
R124	0698-3570	1	RIFXD MET FLM 7.98K OHM 1.0% 1/2W	28480	0698-3570
R125	0757-0059		RIFXD MET FLM 1 MEGOHM 1% 1/2W	28480	0757-0059
R126	0773-0010	2	RIFXD MET FLM 85K OHM 5% 5W	28480	0773-0010
R127	0773-0010		RIFXD MET FLM 85K OHM 5% 5W	28480	0773-0010
R128	0687-1521	1	RIFXD COMP 1500 OHM 10% 1/2W	01121	EB 1521
R129	0687-4741	1	RIFXD COMP 470K OHM 10% 1/2W	01121	FB 4741
R130	0686-6845	1	RIFXD COMP 680K OHM 5% 1/2W	01121	FB 6845
R131			THRU		
R200			NOT ASSIGNED		
R201	0727-0043	2	RIFXD DEPC 100 OHM 1% 1/2W	28480	0727-0043
R202	0757-0159	2	RIFXD MET FLM 1000 OHM 1% 1/2W	28480	0757-0159
R203	0757-0159		RIFXD MET FLM 1000 OHM 1% 1/2W	28480	0757-0159
R204	0727-0043		RIFXD DEPC 100 OHM 1% 1/2W	28480	0727-0043
R205	2100-1767	1	RIVAR MM 10 OHM 5% TYPE H 1W	28480	2100-1767
R206			THRU		
R300			NOT ASSIGNED		
R301	0687-5601	1	RIFXD COMP 56 OHM 10% 1/2W	01121	EB 5601
R302	0687-6801	1	RIFXD COMP 68 OHM 10% 1/2W	01121	EB 6801
R303	0687-3911	1	RIFXD COMP 390 OHM 10% 1/2W	01121	EB 3911
R304	0812-0019	2	RIFXD MM 0.33 OHM 5% 3W	28480	0812-0019
R305	0812-0019		RIFXD MM 0.33 OHM 5% 3W	28480	0812-0019
R306	2100-0308	1	RIVAR MM 20HM 10% LIN 5W	28480	2100-0308
R307	0816-0015	1	RIFXD MM 50 OHM 10% 10W	28480	0816-0015
R71	0839-0017	1	THERMISTOR: 250 OHM 10%	24446	10 751
S1	3101-0041	1	SWITCH:TOGGLE DPST	88140	8906A370
S2	3101-1272	1	SWITCH:SLIDE	28480	3101-1272
T1	9100-0153	1	TRANSFORMER:POWER	28480	9100-0153
T2	9100-0299	1	TRANSFORMER:POWER	28480	9100-0299
V1	1923-0048	2	ELECTRON TUBE: 8068 BEAM PENTODE	33173	8068
V2	1923-0048		ELECTRON TUBE: 8068 BEAM PENTODE	33173	8068
V3	1940-0004	1	ELECTRON TUBE: 0A2 VOLTAGE REGULATOR	86684	0A2
V4	1933-0004	2	ELECTRON TUBE: 6AU6 ON 6UBA TRIODE PENT	33173	6AU6
V5	1921-0010	2	ELECTRON TUBE:L284A	33173	1284A
V6	1923-0043	2	ELECTRON TUBE: 6EW6 PENTODE	33173	6EW6
V7	1952-0014 OR	1	ELECTRON TUBE:TWT 1.0 TO 2.0 TW4268CC	28480	1952-0014
V7			(489A ONLY)		
V7	1952-0020 OR	1	ELECTRON TUBE:TWT 1-2GHZ 1W	96341	MA-2342
V7			(489A ONLY)		
V7	1952-0029	1	ELECTRON TUBE:TWT 1-2 GHZ 1W	28480	1952-0029
V7			(489A ONLY)		

See introduction to this section for ordering information

Table 6-2. Replaceable Parts (Cont.)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
V7	1952-0015 OR	1	ELECTRON TUBE:TNT 2.0 4.0 GC (491C ONLY)	28480	1952-0015
V7	1952-0021 OR	1	ELECTRON TUBE:TNT 2-4 GHZ IM (491C ONLY)	96341	WA 2343
V7	1952-0030	1	ELECTRON TUBE:TNT 2-4 GHZ IM (491C ONLY)	28480	1952-0030
V8	1921-0010		ELECTRON TUBE:12B4A THRU	33173	12B4A
V9			NOT ASSIGNED		
V100	1933-0005	1	ELECTRON TUBE:E1A 7734 TRIODE-PENTODE	05277	7734
V101					
V102	1940-0007	1	ELECTRON TUBE:0B2	02735	0B2
V103	1933-0006		ELECTRON TUBE: 6UB OR 6UBA TRIODE PENT	33173	6UB
V104	1923-0043		ELECTRON TUBE: 6EW6 PENTODE	33173	6EW6
W1	8120-0189	1	CABLE:ELECT 168 22 AWG SHIELDED INCLUDES P1 AND P2	28480	8120-0189
W1					
XA1	1251-0160	2	CONNECTOR:15 PIN THRU	28480	1251-0160
XA2			NOT ASSIGNED		
XA100	1251-0160		CONNECTOR:15 PIN	28480	1251-0160
XA101	1400-0084	1	FUSEHOLDER:EXTRACTOR POST TYPE	75915	342014
XF1					
XJ101	1200-0044	1	SOCKET-TRANSISTOR MISCELLANEOUS	97464	M7(IPB)
	489A-12H	1	MOUNT:TNT	28480	489A-12H
	489A-12I	1	MOUNT:TNT	28480	489A-12I
	489A-12L	1	RETAINER:ELECTRON TUBE	28480	489A-12L
	489A-12M	1	RETAINER:ELECTRON TUBE	28480	489A-12M
	489A-16D	1	CABLE ASSY:RF INCL J11	28480	489A-16D
	489A-16E	1	CABLE ASSY:RF INCL J21	28480	489A-16E
	489A-43A	1	PLATE:IDENTIFICATION(489A)	28480	489A-43A
	0370-0026	1	KNOB:BLK W/ARROW 3/4" OD 1/8" SHAFT	28480	0370-0026
	1251-0135	1	CONNECTOR:BODY 15 PIN	28480	1251-0135
	3150-0010	1	AIR FL:3 5/8 X 7 11/16 X 1/2	82864	10337
	8120-1348	1	CABLE ASSY:POWER, DETACHABLE	70903	KHS-7041
			CABINET PARTS		
	1490-0030		STAND:TILT	28480	1490-0030
	5060-0222		HANDLE ASSY:RH SIDE	28480	5060-0222
	5060-0740		TOP COVER ASSY:16L FM	28480	5060-0740
	5060-0752		BOTTOM COVER ASSY:16L FM	28480	5060-0752
	5060-0767		FOOT ASSY:FM	28480	5060-0767
	5060-0775		KIT:5 H RACK MOUNT	28480	5060-0775

See Introduction to this section for ordering information

Table 6-3. Code List of Manufacturers

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

Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address
00000	U. S. A. Common	Any supplier of U.S.	05347	Ultronix, Inc.	San Mateo, Cal.	11236	CFS of Berne, Inc.	Berne, Ind.
00136	McCoy Electronics	Mount Holly Springs, Pa.	05307	Union Carbine Corp., Elect.	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	Day State Electronics Corp.	Waltham, Mass.
00287	Cemco, Inc.	Danielson, Conn.	05593	Jeora Electro-Plastics Inc.	Sunnyvale, Cal.	11312	Teledyne Inc., Microwave Div.	Palo Alto, Cal.
00334	Humidial	Colton, Calif.	05610	Cosmo Plastic (e/o Electrical Spec. Co.)	Cleveland, Ohio	11314	National Seal	Downey, Cal.
00348	Mictron, Co., Inc.	Valley Stream, N. Y.	05624	Barber Colman Co.	Rockford, Ill.	11453	Precision Connector Corp.	Jamaica, N. Y.
00373	Carlock Inc.	Cherry Hill, N. J.	05720	Ti'en Optical Co.	Roslyn Heights, Long Island, N. Y.	11534	Duncan Electronics Inc.	Costa Mesa, Cal.
00656	Aerovox Corp.	New Bedford, Mass.	05720	Ti'en Optical Co.	Westbury, N. Y.	11771	General Instrument Corp., Semiconductor Division Products	Newark, N. J.
00779	Amp, Inc.	Harrisburg, Pa.	05729	Metro-Tel Corp.	Westbury, N. Y.	11717	Imperial Electronic, Inc.	Buena Park, Cal.
00781	Aircraft Radio Corp.	Boonton, N. J.	05783	Stewart Engineering Co.	Santa Cruz, Cal.	11870	McLain, Inc.	Palo Alto, Cal.
00800	Croven, Ltd.	Whitby, Ontario, Canada	05820	Wakefield Engineering Inc.	Wakefield, Mass.	12136	Philadelphia Handle Co.	Camden, N. J.
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.	06004	Bascock Co., Div. of Stewart Warner Corp.	Bridgeport, Conn.	12361	Grove Mfg. Co., Inc.	Shady Grove, Pa.
00853	Sangamo Electric Co., Pickens Div.	Pickens, S. C.	06090	Raychem Corp.	Redwood City, Cal.	12574	Gallion Ind. Inc., Data System Div.	Albuquerque, N. M.
00866	Goe Engineering Co.	City of Industry, Cal.	06175	Bausch and Lomb Optical Co.	Rochester, N. Y.	12607	Clarostat Mfg. Co.	Dover, N. H.
00891	Carl E. Holmes Corp.	Los Angeles, Cal.	06402	E. T. A. Products Co. of America	Chicago, Ill.	12728	Elmar Filter Corp.	W. Haven, Conn.
00920	Microlab Inc.	Livingston, N. J.	06540	Amatom Electronic Hardware Co., Inc.	New Rochelle, N. Y.	12859	Nippon Electric Co., Ltd.	Tokyo, Japan
01002	General Electric Co., Capacitor Dept.	Hudson Falls, N. Y.	06556	Beude Electrical Instrument Co., Inc.	Penacook, N. H.	12881	Motex Electronics Corp.	Clark, N. J.
01009	Alden Products Co.	Brookton, Mass.	06686	General Devices Co., Inc.	Indianapolis, Ind.	12930	Dickson Semiconductor Inc.	Newport Beach, Cal.
01121	Allon Bradley Co.	Milwaukee, Wis.	06751	Components Inc., Ariz. Div.	Phoenix, Arizona	12954	Dickson Electronics Corp.	Scottsdale, Arizona
01255	Litton Industries, Inc.	Beverly Hills, Cal.	06812	Torrington Mfg. Co., West Div.	Van Nuys, Cal.	13019	Airco Supply Co., Inc.	Wichita, Kansas
01281	TRW Semiconductors, Inc.	Lawndale, Cal.	06960	Varian Assoc. Etmac Div.	San Carlos, Cal.	13061	Wilco Products	Detroit, Mich.
01205	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas	07088	Kelvin Electric Co.	Van Nuys, Cal.	13103	Thermolloy	Dallas, Texas
01340	The Alliance Mfg. Co.	Alliance, Ohio	07126	Digitran Co.	Pasadena, Cal.	13327	Soltron Devices Inc.	Cappan, N. Y.
01538	Small Parts Inc.	Los Angeles, Cal.	07137	Transistor Electronics Corp.	Minneapolis, Minn.	13396	Telefunken (GmbH)	Hannover, Germany
01580	Pacific Relays, Inc.	Van Nuys, Cal.	07138	Westinghouse Electric Corp., Electronic Tube Div.	Elmira, N. Y.	13035	Midland-Wright Div. of Pacific Industries, Inc.	Kansas City, Kansas
01670	Gudebrodt Bros. Silk Co.	New York, N. Y.	07149	Filmohm Corp.	New York, N. Y.	14099	Sem-Tech	Newbury Park, Cal.
01930	Amerock Corp.	Rockford, Ill.	07233	Cinch-Graphix Co.	City of Industry, Cal.	14193	Calit Resistor Corp.	Santa Monica, Cal.
01960	Pulse Engineering Co.	Santa Clara, Cal.	07256	Silicon Transistor Corp.	Carle Place, N. Y.	14206	American Components, Inc.	Conshohocken, Pa.
02114	Ferroxcube Corp. of America	Saugerties, N. Y.	07261	Avnet Corp.	Culver City, Cal.	14433	ITT Semiconductor, a Div. of Int. Telephone and Telegraph Corporation	West Palm Beach, Fla.
02116	Whoolect Signals, Inc.	Long Branch, N. J.	07263	Fairchild Camera & Inst. Corp., Semiconductor Div.	Mountain View, Cal.	14403	Hewlett-Packard Company	Loveland, Colo.
02286	Cole Rubber and Plastics Inc.	Sunnyvale, Cal.	07317	Minnesota Rubber Co.	Minneapolis, Minn.	14655	Cornell Dublier Electric Corp.	Newark, N. J.
02660	Amphenol-Borg Electronics Corp.	Broadview, Ill.	07317	Bircher Corp., The	Monterey Park, Cal.	14674	Corning Glass Works	Corning, N. Y.
02735	Radio Corp. of America, Semiconductor and Materials Division	Somerville, N. J.	07397	Sylvania Elect. Prod. Inc., Mt. View Operations	Mountain View, Cal.	14752	Electro Cube Inc.	San Gabriel, Cal.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.	07700	Technical Wire Products Inc.	Cranford, N. J.	14800	Williams Mfg. Co.	San Jose, Cal.
02777	Hopkins Engineering Co.	San Fernando, Cal.	07829	Bodine Elect. Co.	Chicago, Ill.	15106	The Sphere Co., Inc.	Little Falls, N. J.
02875	Hudson Tool & Die	Newark, N. J.	07910	Continental Device Corp.	Hawthorne, Cal.	15203	Webster Electronics Co.	New York, N. Y.
03296	Nylon Molding Corp.	Springfield, N. J.	07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Cal.	15287	Seiconics Corp.	Northridge, Cal.
03508	G. E. Semiconductor Prod. Dept.	Syracuse, N. Y.	07900	Hewlett-Packard Co., New Jersey Division	Rockaway, N. J.	15291	Adjustable Bushing Co.	N. Hollywood, Cal.
03705	Apex Machine & Tool Co.	Dayton, Ohio	08146	U. S. Engineering Co.	Los Angeles, Cal.	15558	Miron Electronics	Garden City, Long Island, N. Y.
03707	Eldema Corp.	Compton, Calif.	08289	Blinn, Delbert Co.	Pomona, Cal.	15566	Amprobe Inst. Corp.	Lynbrook, N. Y.
03818	Parker Seal Co.	Los Angeles, Cal.	08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada	15631	Cabletronics	Costa Mesa, Cal.
03877	Transitron Electric Corp.	Wakefield, Mass.	08524	Deutsch Fastener Corp.	Los Angeles, Cal.	15772	Twentieth Century (Co) Spring Co.	Santa Clara, Cal.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N. J.	08604	Bristol Co., The	Waterbury, Conn.	15801	Fenwal Elect. Co.	Franklinham, Mass.
03954	Singer Co., Diehl Div., FINDERNE Plant	Somerville, N. J.	08711	Sloan Company	Sun Valley, Cal.	15818	Amelco Inc.	Mountain View, Cal.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.	08718	ITT Cannon Electric Inc., Phoenix Div.	Phoenix, Arizona	16037	Spruce Pine Mica Co.	Spruce Pine, N. C.
04013	Tarus Corp.	Lambertville, N. J.	08727	National Radio Lab. Inc.	Paramus, N. J.	16179	Omni-Spectra Inc.	Detroit, Ill.
04062	Arco Electronic Inc.	Great Neck, N. Y.	08792	CBS Electronics Semiconductor Operations, Div. of CBS Inc.	Lowell, Mass.	16362	Computer Diode Corp.	Lodi, N. J.
04217	Essex Wire	Los Angeles, Cal.	08806	General Electric Co., Miniature Lamp Dept.	Cleveland, Ohio	16554	Electroid Co.	Union, N. J.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S. C.	08984	Mel-Rain	Indianapolis, Ind.	16585	Boots Aircraft Nut Corp.	Pasadena, Cal.
04334	Precision Paper Tube Co.	Wheeling, Ill.	09026	Babeck Relay Div.	Costa Mesa, Cal.	16688	Ideal Prec. Meter Co., Inc., De Jur Motor Div.	Brooklyn, N. Y.
04404	Palo Alto Division of Hewlett-Packard Co.	Palo Alto, Cal.	09097	Electronic Enclosures Inc.	Los Angeles, Calif.	16758	Deico Radio Div. of G. M. Corp.	Kokomo, Ind.
04651	Sylvania Electric Products, Microwave Device Div.	Mountain View, Cal.	09145	Texas Capacitor Co.	Houston, Texas	17109	Thermometrics Inc.	Canoga Park, Cal.
04673	Dakota Engr. Inc.	Culver City, Cal.	09250	Elect. Ind. Inc. Atchm	Durbank, Cal.	17474	Tranex Company	Mountain View, Cal.
04713	Motorola Inc. Semiconductor Prod. Div.	Phoenix, Arizona	09250	Electro Assemblies, Inc.	Chicago, Ill.	17876	Hamlin Metal Products Corp.	Akron, Ohio
04732	Filttron Co., Inc. Western Div.	Culver City, Cal.	09353	C & K Components Inc.	Newton, Mass.	17745	Angstrom Prec. Inc.	No. Hollywood, Cal.
04773	Automatic Electric Co.	Northlake, Ill.	09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada	17958	Siliconix Inc.	Sunnyvale, Cal.
04790	Sequoia Wire Co.	Redwood City, Cal.	09700	Pennsylvania Fluorocarbon	Clifton Heights, Penn.	17879	McGraw-Edison Co.	Manchester, N. H.
04811	Precision Coil Spring Co.	El Monte, Cal.	09822	Burdny Corp.	Norwalk, Conn.	18042	Power Design Pacific Inc.	Palo Alto, Cal.
04870	P. M. Motor Company	Westchester, Ill.	10214	General Transistor Western Corp.	Los Angeles, Cal.	18003	Clevite Corp. Semiconductor Div.	Palo Alto, Cal.
04910	Component Mfg. Service Co.	W. Bridgewater, Mass.	10411	Ti-Tal, Inc.	Berkeley, Cal.	18324	Signetics Corp.	Sunnyvale, Cal.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Cal.	10446	Carborundum Co.	Niagara Falls, N. Y.	18476	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
05277	Westinghouse Electric Corp. Semiconductor Dept.	Youngwood, Pa.				18486	TRW Elect. Comp. Div.	Des Plaines, Ill.

00013-49  
Revised: May, 1970

From Handbook Supplements  
H4-1 Dated January 1970

Table 6-3. Code List of Manufacturers (Cont.)

Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address
19644	LRC Electronics	Horseshoeds, N.Y.	71492	C. P. Clark & Co.	Chicago, Ill.	78452	Thompson-Dremer & Co.	Chicago, Ill.
19701	Electra Mfg. Co.	Independence, Kansas	71500	Centralab Div. of		78471	Tilley Mfg. Co.	San Francisco, Cal.
20143	General Atrolines Corp.	Philadelphia, Pa.		Globe Union Inc.	Milwaukee, Wis.	78488	Stackpole Carbon Co.	St. Marys, Pa.
21226	Esoratorne, Inc.	Long Island City, N.Y.	71616	Commercial Plastics Co.	Chicago, Ill.	78493	Standard Thomson Corp.	Waltham, Mass.
21355	Fahor Bearing Co., The	New Britain, Conn.	71700	Corning Wire Co., The	New York, N.Y.	78553	Timberman Products, Inc.	Cleveland, Ohio
21520	Fanshcl Metallurgical Corp.	N. Chicago, Ill.	71707	Coit Coil Co., Inc.	Providence, R.I.	78700	Transformer Engineers	San Gabriel, Cal.
23020	General Reed Co.	Motuchen, N.J.	71744	Chicago Miniature Lamp Works	Chicago, Ill.	78947	Uehlin Co.	Newtonville, Mass.
23042	Texscan Corp.	Indianapolis, Ind.	71783	Cinch Mfg. Co.		79136	Waldes Kohnsner Inc.	Long Island City, N.Y.
23783	British Radio Electronics Ltd.	Washington, D.C.		Howard B. Jones Div.	Chicago, Ill.	79142	Vender Root, Inc.	Hartford, Conn.
24455	G. E. Lamp Division	Nela Park, Cleveland, Ohio	71904	Dow Corning Corp.	Midland, Mich.	79251	Wenco Mfg. Co.	Chicago, Ill.
24655	General Radio Co.	West Concord, Mass.	72136	Electro Motive Mfg. Co., Inc.		79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
24781	Memcor Inc., Comp. Div.	Huntington, Ind.	72619	Dualight Corp.	Willmante, Conn.			
26365	Gries Reproducer Corp.	New Rochelle, N.Y.	72656	Indian General Corp.	Brooklyn, N.Y.	79063	Zierick Mfg. Corp.	New Rochelle, N.Y.
26462	Geobert File Co. of America, Inc.	Carlstadt, N.J.		Electronics Div.	Keasby, N.J.	80031	Mopco Division of Sessions Clock Co.	
26851	Compac Hollister Co.	Hollister, Cal.	72699	General Instrument Corp.		80633	Presdole Corp.	Morrisstown, N.J.
26992	Hamilton Watch Co.	Lancaster, Pa.		Cap Division	Newark, N.J.	80120	Schmitzer Alloy Products Co.	Elizabeth, N.J.
28480	Hewlett-Packard Co.	Palo Alto, Cal.	72765	Drake Mfg. Co.	Harwood Heights, Ill.	80131	Electronic Industries Association	
28520	Heyman Mfg. Co.	Kendallworth, N.J.	72925	Hugh H. Eby Inc.	Philadelphia, Pa.		Standard tube or semi-conductor device, any manufacturer.	
30817	Instrument Specialties Co.		72928	Gudeman Co.	Union, N.J.	80207	Unimax Switch, Div. Maxon Electronics Corp.	Wallingford, Conn.
	Inc.	Little Falls, N.J.	72962	Elastic Stop Nut Corp.	Union, N.J.	80248	Oxford Electric Corp.	Chicago, Ill.
33173	G. E. Receiving Tube Dept.	Owensboro, Ky.	72964	Robert M. Hadley Co.	Los Angeles, Cal.	80294	Bourns Inc.	Riverside, Cal.
35434	Lectromat Inc.	Chicago, Ill.	72982	Eric Technological Products, Inc.	Erie, Pa.	80411	Arco Div. of Robertshaw Controls Co.	
36196	Stansyck Coal Products, Ltd.	Hawkesbury, Ontario, Canada	73001	Hansen Mfg. Co., Inc.	Princeton, Ind.	80480	All Star Products Inc.	Columbus, Ohio
	Ltd.		73076	H. M. Harper Co.	Chicago, Ill.	80509	Avery Label Co.	Delliance, Ohio
36287	Cunningham, W. H. & Hill, Ltd.	Toronto, Ontario, Canada	73138	Helipot Div. of Berkman Inst., Inc.		80563	Hammarland Co., Inc.	Mars Hill, N.C.
	Ltd.				Fallerton, Cal.	80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
37242	P. B. Mathoy & Co., Inc.	Indianapolis, Ind.	73293	Hughes Products Division of		80813	Dimro Gray Co.	Dayton, Ohio
39543	Mechanical Industries Prod. Co.	Akron, Ohio		Hughes Aircraft Co.	Newport Beach, Cal.	81030	International Inst. Inc.	Orange, Conn.
40920	Miniature Precision Bearings, Inc.	Kerne, N.H.	73445	Amperex Elect. Co.	Hicksville, L.I., N.Y.	81073	Grayhill Co.	LaGrange, Ill.
40931	Honeywell Inc.	Minneapolis, Minn.	73506	Bradley Semiconductor Corp.		81095	Triad Transformer Corp.	Ventee, Cal.
42100	Mifer Co.	Chicago, Ill.	73559	Carling Electric, Inc.	Hartford, Conn.	81312	Whelanster Elec. Div. Litton Ind., Inc.	
43000	C. A. Norgren Co.	Englewood, Colo.	73586	Cleco F Mfg. Co.	Trenton, N.J.			
44655	Ohmitic Mfg. Co.	Skokie, Ill.	73662	George K. Garrett Co.		81349	Military Specification	
46364	Penn Eng. & Mfg. Corp.	Doylesstown, Pa.	73734	Federal Screw Products, Inc.	Chicago, Ill.	81463	International Rectifier Corp.	El Segundo, Cal.
47004	Polaroid Corp.	Cambridge, Mass.	73743	Fischer Special Mfg. Co.	Cincinnati, Ohio	81541	Airpax Electronics, Inc.	Cambridge, Maryland
48620	Precision Thermometer & Inst. Co.	Southampton, Pa.	73793	General Industries Co., The	Elyria, Ohio	81860	Barry Controls, Div. Barry Wright Corp.	
49056	Microwave & Power Tube Div.	Waltham, Mass.	73846	Goshen Stamping & Tool Co.	Goshen, Ind.	82042	Cartel Precision Electric Co.	Skokie, Ill.
52000	Rowan Controller Co.	Westminster, Md.	73889	JFD Electronics Corp.	Brooklyn, N.Y.	82047	Spartan Parady Inc., Copper Hewitt Electric Div.	Hoboken, N.J.
52983	HP Co., Med. Elec. Div.	Waltham, Mass.	73905	Jeanings Radio Mfg. Corp.	San Jose, Cal.	82116	Electric Regulator Corp.	Norwalk, Conn.
54294	Shallcross Mfg. Co.	Selma, N.C.	73957	Gronow-Pin Corp.	Ridgely, N.J.	82142	Jeffers Electronics Division of	
55020	Simpson Electric Co.	Chicago, Ill.	74276	Signalite Inc.	Neptune, N.J.		Speer Carbon Co.	Du Bois, Pa.
55933	Sonotone Corp.	Elmsford, N.Y.	74455	J. H. Wynn and Sons	Winchester, Mass.	82170	Fairchild Camera & Inst. Corp.	
55938	Raytheon Co. Commercial Apparatus & System Div.	So. Norwalk, Conn.	74801	Industrial Condenser Corp.	Chicago, Ill.		Spare & Defense Systems Div., Paramus, N.J.	
56137	Spaullding Fibre Co., Inc.	Tanawanta, N.Y.	74868	H. F. Products Division of		82209	Maguire Industries, Inc.	Greenwich, Conn.
56289	Sprague Electric Co.	North Adams, Mass.		Anphenol-Dorp Electronic Corp.	Danbury, Conn.	82219	Sylvania Electric Prod., Inc.	
58474	Superior Elect. Co.	Bristol, Conn.	74970	E. E. Johnson Co.	Waseca, Minn.		Electronic Tube Division	Emporium, Pa.
59446	Tolex Corp.	Tulsa, Okla.	75042	International Resistance Co.	Philadelphia, Pa.	82376	Astron Corp.	East Newark, Harrison, N.J.
59730	Thomas & Belts Co.	Elizabeth, N.J.	75263	Kryston Carbon Co., Inc.	St. Marys, Pa.	82389	Suwalkraft, Inc.	Chicago, Ill.
60741	Triplet Electrical Inst. Co.	Hullton, Ohio	75376	CFS Knights, Inc.	Sandwich, Ill.	82647	Metals & Controls Inc.	
61775	Union Switch and Signal Div. of		75382	Kulka Electric Corp.	MI. Vernon, N.Y.		Spencer Products	Attleboro, Mass.
	Westinghouse Air Brake Co.	Pittsburgh, Pa.	75818	Lenz Electric Mfg. Co.	Chicago, Ill.	82708	Phillips-Advance Control Co.	Joliet, Ill.
62119	Universal Electric Co.	Owensio, Mich.	75915	Littlehouse, Inc.	Des Plaines, Ill.	82866	Research Products Corp.	Madison, Wis.
63743	Ward-Leonard Electric Co.	MI. Vernon, N.Y.	76005	Lord Mfg. Co.	Erie, Pa.	82877	Rollen Mfg. Co., Inc.	Woodsstock, N.Y.
64950	Western Electric Co., Inc.	New York, N.Y.	76210	C. W. Marwedel	San Francisco, Cal.	82893	Vector Electronic Co.	Glendale, Cal.
65092	Weston Inst. Inc. Weston-Newark	Newark, N.J.	76433	General Instrument Corp.		83058	Carr Fastener Co.	Cambridge, Mass.
66285	White Mfg. Co.	Chicago, Ill.		Alcamold Division	Newark, N.J.	83080	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
68346	Minnesota Mining & Mfg. Co.		76487	James Miller Mfg. Co., Inc.	Malden, Mass.	83125	General Instrument Corp.	
	Reverse Alncom Div.	St. Paul, Minn.	76493	J. W. Miller Co.	Los Angeles, Cal.		Capacitor Div.	Darlington, S.C.
70276	Allen Mfg. Co.	Hartford, Conn.	76530	Cinch-Monadnock, Div. of United Carr Fastener Corp.	San Leandro, Cal.	83148	ITT Wire and Cable Div.	Los Angeles, Cal.
70309	Allied Control	New York, N.Y.	76545	Mueller Electric Co.	Cleveland, Ohio	83186	Victory Eng. Corp.	Springfield, N.J.
70318	Allmetal Screw Product Co., Inc.		76703	National Union	Newark, N.J.	83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
		Garden City, N.Y.	76854	Oak Manufacturing Co.	Crystal Lake, Ill.	83315	Hubbell Corp.	Mundelein, Ill.
70417	Amplex, Div. of Chrysler Corp.	Detroit, Mich.	77008	The Bendix Corp.		83324	Rosan Inc.	Newport Beach, Cal.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.		Electrodynamics Div.	N. Hollywood, Cal.	83330	Smith, Herman II., Inc.	Brooklyn, N.Y.
70563	Amperite Co., Inc.	Union City, N.J.	77075	Pacific Metals Co.	San Francisco, Cal.	83332	Tech Labs	Palisades Park, N.J.
70674	ADC Products Inc.	Minneapolis, Minn.	77221	Phaotran Instrument and Electronic Co.	So. Pasadena, Cal.	83385	Central Screw Co.	Chicago, Ill.
70683	Beldin Mfg. Co.	Chicago, Ill.	77342	American Machine & Foundry Co.		83501	Gayit Wire and Cable Co., Div. of Ameracorp	Brookfield, Mass.
70908	Bird Electric Corp.	Cleveland, Ohio		Potter & Brownfield Div.	Princeton, Ind.	83594	Burrroughs Corp., Electronic Tube Div.	Plainfield, N.J.
71002	Birdsach Radio Co.	New York, N.Y.	77530	TRW Electronic Components Div.	Camden, N.J.	83740	Union Carbide Corp., Consumer Prod. Div.	New York, N.Y.
71034	Daley Electric Co., Inc.	Erie, Pa.	77638	General Instrument Corp.			Model Eng. and Mfg., Inc.	Huntington, Ind.
71041	Boston Gear Works Div. of			Refitler Division	Brooklyn, N.Y.	83821	Loyd Scruggs Co.	Festus, Mo.
	Murray Co. of Texas	Quincy, Mass.	77764	Hostitance Products Co.	Harrisburg, Pa.	83942	Aeronautical Inst. & Radio Co.	Lodi, N.J.
71218	Bud Radio, Inc.	Willoughby, Ohio	77860	Hubberdt Corp. of Calif.	Torrance, Cal.	84171	Arco Electronics Inc.	Great Neck, N.Y.
71279	Cambridge Thermionics Corp.	Cambridge, Mass.	78189	Shakeproof Division of		84396	A. J. Glesener Co., Inc.	San Francisco, Cal.
71286	Camloc Fastener Corp.	Paramus, N.J.		Hilmis Tool Works	Elgin, Ill.	84411	TRW Capacitor Div.	Ogallala, Neb.
71313	Cardwell Condenser Corp.		78277	Sigma	So. Braintree, Mass.			
		Lindenhurst, L.I., N.Y.	78283	Signal Indicator Corp.	New York, N.Y.			
71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.	78290	Struthers-Dunn Inc.	Ritman, N.J.			
71436	Chicago Condenser Corp.	Chicago, Ill.						
71447	Calh. 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.						

00015-49  
Revised: May, 1970

From: Handbook Supplements  
H4-1 Dated January 1970

Table 6-3. Code List of Manufacturers (Cont.)

Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address
94870	Sarkes Tarzian, Inc.	Bloomington, Ind.	91020	Honeywell Inc., Micro Switch Division	Freeport, Ill.	90995	Hi-Q Div. of Aerovox Corp.	Olean, N. Y.
85454	Doonton Molding Company	Boonton, N.J.	91961	Nahn-Bros. Spring Co.	Oakland, Cal.	90256	Thordarson-Melssner Inc.	Mt. Carmel, Ill.
85471	A. B. Boyd Co.	San Francisco, Cal.	92180	Tru-Connector Corp.	Peabody, Mass.	90290	Solar Mfg. Co.	Los Angeles, Cal.
85474	R. M. Bracamonte & Co.	San Francisco, Cal.	92367	Elgeot Optical Co., Inc.	Rochester, N. Y.	90396	Microswitch, Div. of Minn.-Honeywell	Freeport, Ill.
85860	Kollid Kords, Inc.	Hamden, Conn.	92607	Tensolite Insulated Wire Co., Inc.	Tarrytown, N. Y.	90330	Carlton Screw Co.	Chicago, Ill.
85911	Seamless Rubber Co.	Chicago, Ill.	92702	IMC Magnetica Corp.	Westbury, L.I., N. Y.	90341	Microwave Associates, Inc.	Burlington, Mass.
86174	Fairair Bearing Co.	Los Angeles, Calif.	92966	Hudson Lamp Co.	Kearney, N. J.	90501	Excel Transformer Co.	Oakland, Cal.
86197	Clifton Precision Products Co., Inc.	Clifton Heights, Pa.	93332	Sylvania Electric Prod. Inc., Semiconductor Div.	Woburn, Mass.	90508	Xcelite, Inc.	Orchard Park, N. Y.
86570	Precision Rubber Products Corp.	Dayton, Ohio	93360	Robbins & Myers Inc.	Pallsades Park, N. J.	90733	San Fernando Elec. Mfg. Co.	San Fernando, Cal.
86684	Radio Corp. of America, Electronic Comp. & Devices Division	Harrison, N. J.	93410	Semco Controls, Div. of Essex Wire Corp.	Manfield, Ohio	90881	Thomson Ind. Inc.	Long Island, N. Y.
86928	Seastrom Mfg. Co.	Glendale, Cal.	93632	Waters Mfg. Co.	Culver City, Cal.	97464	Industrial Retaining Ring Co.	Irrington, N. J.
87034	Marco Industries	Anaheim, Cal.	93929	G. V. Controls	Livingston, N. J.	97530	Automatic & Precision Mfg.	Englewood, N. J.
87216	Phileo Corporation (Lansdale Division)	Lansdale, Pa.	94137	General Cable Corp.	Dayton, N. J.	97970	Con Resistor Corp.	Yonkers, N. Y.
87473	Western Fibrous Glass Products Co.	San Francisco, Cal.	94144	Raytheon Co., Comp. Div., Ind. Comp. Operations	Quincy, Mass.	97983	Liton System Inc., Adler-Westrex Commun. Div.	New Rochelle, N. Y.
87664	Van Waters & Rogers Inc.	San Francisco, Cal.	94148	Scientific Electronics Products, Inc.	Loveland, Colo.	98141	R-Tronics, Inc.	Jamaica, N. Y.
87630	Tower Mfg. Corp.	Providence, R. I.	94154	Wagner Elect. Corp., Tung-Sol Div.	Newark, N. J.	98159	Rubber Teck, Inc.	Garland, Cal.
88140	Cutter-Hammer, Inc.	Lincoln, Ill.	94197	Curtiss-Wright Corp., Electronics Div.	East Patterson, N. J.	98220	Hewlett-Packard Co., Medical Elec. Div.	Pasadena, Cal.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.	94222	South Chester Corp.	Chester, Pa.	98278	Microdot, Inc.	So. Pasadena, Cal.
88698	General Mills, Inc.	Buffalo, N. Y.	94330	Wire Cloth Products, Inc.	Bellwood, Ill.	98291	Sealectro Corp.	Mamaroneck, N. Y.
89231	Graybar Electric Co.	Oakland, Cal.	94375	Automatic Metal Products Co.	Brooklyn, N. Y.	98376	Zero Mfg. Co.	Burbank, Cal.
89473	G. E. Distributing Corp.	Schenectady, N. Y.	94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.	98410	Ete Inc.	Cleveland, Ohio
89479	Security Co.	Detroit, Mich.	94686	Magnecraft Electric Co.	Chicago, Ill.	98431	General Mills Inc., Electronics Div.	Minneapolis, Minn.
89665	United Transformer Co.	Chicago, Ill.	95023	George A. Philbrick Researchers, Inc.	Boston, Mass.	98734	Paeco Division of Hewlett-Packard Co.	Palo Alto, Cal.
90030	United Shoe Machinery Corp.	Beverly, Mass.	95146	Alco Elect. Mfg. Co.	Lawrence, Mass.	98821	North Hills Electronics, Inc.	Glen Cove, N. Y.
90179	U. S. Rubber Co., Consumer Ind. & Plastics Prod. Div.	Passaic, N. J.	95236	Allison Products Corp.	Dania, Fla.	98974	International Electronic Research Corp.	Burbank, Cal.
90365	Bellville Speciality Tool Mfg., Inc.	Bellville, Ill.	95238	Continental Connector Corp.	Woodside, N. Y.	99109	Columbia Technical Corp.	New York, N. Y.
90763	United Carr Fastener Corp.	Chicago, Ill.	95263	Lencraft Mfg. Co., Inc.	Long Island, N. Y.	99313	Varian Associates	Palo Alto, Cal.
90970	Bearing Engineering Co.	San Francisco, Cal.	95265	National Coil Co.	Sheridan, Wyo.	99378	Atlas Corp.	Winchester, Mass.
91146	ITT Cannon Elect. Inc.	Salem, Mass.	95275	Vitramon, Inc.	Bridgport, Conn.	99515	Marshall Ind., Capacitor Div.	Monrovia, Cal.
91260	Connor Spring Mfg. Co.	San Francisco, Cal.	95348	Gordus Corp.	Bloomfield, N. J.	99707	Control Switch Division, Controls Co. of America	El Segundo, Cal.
91345	Miller Dial & Nameplate Co.	El Monte, Cal.	95354	Methode Mfg. Co.	Rolling Meadows, Ill.	99800	Dolevan Electronics Corp.	East Aurora, N. Y.
91418	Radio Materials Co.	Chicago, Ill.	95568	Arnold Engineering Co.	Marengo, Ill.	99848	Wilco Corporation	Indianapolis, Ind.
91508	Augat Inc.	Attleboro, Mass.	95712	Dage Electric Co., Inc.	Franklin, Ind.	99926	Brunson Corp.	Whippany, N. J.
91637	Dale Electronics, Inc.	Columbus, Nebr.	95984	Siemon Mfg. Co.	Wayne, Ill.	99934	Rumbrandt, Inc.	Boston, Mass.
91662	Elco Corp.	Willow Grove, Pa.	95987	Weckesser Co.	Chicago, Ill.	99942	Hoffman Electronics Corp., Semiconducto. Division	El Monte, Cal.
91673	Epiphone Inc.	New York, N. Y.	96087	Microwave Assoc. West, Inc.	Sunnyvale, Cal.	99957	Technology-Instrument Corp. of California	Newbury Park, Cal.
91737	Greinar Mfg. Co., Inc.	Wakellfield, Mass.						
91827	K F Development Co.	Redwood City, Cal.						
91886	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	Coultron	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.						

## SECTION VII MANUAL CHANGES

### 7-1. INTRODUCTION

7-2. This manual applies directly to instruments bearing serial prefix 972-. For serial prefixes higher than 972-, a Manual Changes Sheet is provided with the manual. For serial prefixes lower than 972-, refer to the chart below to find required serial prefix and make the changes listed for that prefix to the manual.

Serial Prefix or Number	Make Manual Changes
151-	A thru L
207-	B thru L
226-	C thru L
351-	D thru L
424-	E thru L
449-00446 thru 449-00565	F thru L
449-00566 thru 449-01015	G thru L
811-01016 thru 811-01135	H thru L
811-01136 thru 811-01155	I thru L
811-01156 thru 811-01215	J, K, L
843-01216 thru 843-01315	K, L
930-01316 thru 930-01395	L

**CHANGE A** Figure 8-10:

Change T2 pins 10 and 11 to 16 and 17 respectively.  
Change T2 pins 16 and 17 to 10 and 11 respectively.

Figure 8-17:

Reverse terminal numbers. 1 becomes 15, 15 becomes 1.

**CHANGE B** Figure 8-17 and Parts List:

Change R118 to R:FXD, dep c, 3.0 Megohm, 1%, 1/2W, HP Part No. 0727-0292.

**CHANGE C** Parts List:

Change K1 to Relay: 3 minute time delay, HP Part No. 0490-0037.

Entire Manual:

Change K1 reference from "90 second time delay" to "3 minute time delay".

**CHANGE D** Figure 8-10:

Change T2, pins 14 and 15 to read "6.5 Vac".

## Parts List:

Change T2 to HP Part No. 9100-0152.

**CHANGE E** Parts List:

V7: TWT supplied with the instrument:

489A: HP Part No. 1952-0014

491C: HP Part No. 1952-0015

Replacement TWT, either as above, or:

489A: HP Part No. 1952-0020

491C: HP Part No. 1952-0021

If 1952-0021 is supplied for the 491C, R205 should be the 10 ohm wirewound potentiometer listed in the Parts List (HP Part No. 2100-1767). The 10 ohm potentiometer is satisfactory for all replacement tubes.

**CHANGE F** Figure 8-17 and parts List:

Change R105 and R106 to 15K ohm, HP Part No. 0693-1531.

**CHANGE G** Figure 8-14 and Parts List:

Change A200 Assembly from HP Part No. 489A-65E to HP Part No. 495A-65E for Model 491C only.

Change R205 to 4 ohm, HP Part No. 2100-0334.

**CHANGE H** Figure 8-17 and Parts List:

Delete CR109.

**CHANGE I** Parts List:

Change K2 to HP Part No. 0490-0039.

Delete reference to Relay Retainer, HP Part No. 0490-0750, and to Relay Socket, HP Part No. 0490-0751. Refer to Figure 7-1 and use in place of Figures 8-9 and 8-11 for component placement.

**CHANGE J** Figure 8-14 and Parts List:

Change R29 to R:FXD, dep c, 975K ohm, 1%, 1/2W, HP Part No. 0727-0266.

Change R30 to R:FXD, dep c, 1.13 Megohm, 1%, 1/2W, HP Part No. 0727-0278.

Change R31 to R:FXD, dep c, 1 Megohm, 1%, 1/2W, HP Part No. 0727-0276.

Change R32 to R:FXD, dep c, 500K ohm, 1%, 1/2W, HP Part No. 0727-0245.

Change R36 to R:FXD, dep c, 250K ohm, 1%, 1/2W, HP Part No. 0727-0226.

Change R38 to R:FXD, dep c, 312K ohm, 1%, 1/2W, HP Part No. 0727-0232.

Change R39 and R40 to R:FXD, dep c, 600 K ohm, 1%, 1/2W, HP Part No. 0727-0246.

Change R42 to R:FXD, dep c, 115K ohm, 1%, 1/2W, HP Part No. 0727-0213.

Change R45 to R:FXD, dep c, 667K ohm, 1%, 1/2W, HP Part No. 0727-0249.

Change R46 to R:FXD, dep c, 376K ohm, 1%, 1/2W, HP Part No. 0727-0237.

Change R202 and R203 to R:FXD, dep c, 1000 ohm, 1%, 1/2W, HP Part No. 0727-0100.

## Figure 8-17 and Parts List:

Change R107 to R:FXD, dep c, 600K ohm, 1%, 1/2W, HP Part No. 0727-0246.

Change R109 to R:FXD, dep c, 150K ohm, 1%, 1/2W, HP Part No. 0727-0226.

Change R119 to R:FXD, dep c, 800K ohm, 1%, 1/2W, HP Part No. 0727-0255.



Change R122 to R:FXD, dep c, 100K ohm, 1%, 1/2W, HP Part No. 0727-0208.  
Change R124 to R:FXD, dep c, 7960 ohm, 1%, 1/2W, HP Part No. 0727-0149.  
Change R125 to R:FXD, dep c, 1 Megohm, 1%, 1/2W, HP Part No. 0727-0276.

**CHANGE K** Table 1-1, Specifications, under Gain Variation with Frequency:

Change to read, "At 1 watt output: 6 dB or less across the band."

Change to read, "Small signal: 10 dB or less across the band, 5 dB or less across any 10% of the band."

**Parts List:**

V7: TWT supplied with the instrument:

489A: HP Part No. 1952-0014 or

HP Part No. 1952-0020

491C: HP Part No. 1952-0015 or

HP Part No. 1952-0021

Replacement TWT, either as above, or:

489A: HP Part No. 1952-0029

491C: HP Part No. 1952-0030

The 10 ohm wirewound potentiometer listed for R205 in the Parts List is satisfactory for all replacement TWT's.

**Figure 8-10 and Parts List:**

Delete R47.

**CHANGE L** Figure 8-10:

Refer to Figure 7-2 and use in place of Figure 8-10.

**Parts List:**

Change F1 (115V) to 3 amp, HP Part No. 2110-0003.

Change F1 (230V) to 1.5 amp, HP Part No. 2110-0043.

Change J3 to HP Part No. 1251-0148.

Delete K3.

Change S2 to HP Part No. 3101-0034.

Change Detachable Power Cord to HP Part No. 8120-0078.

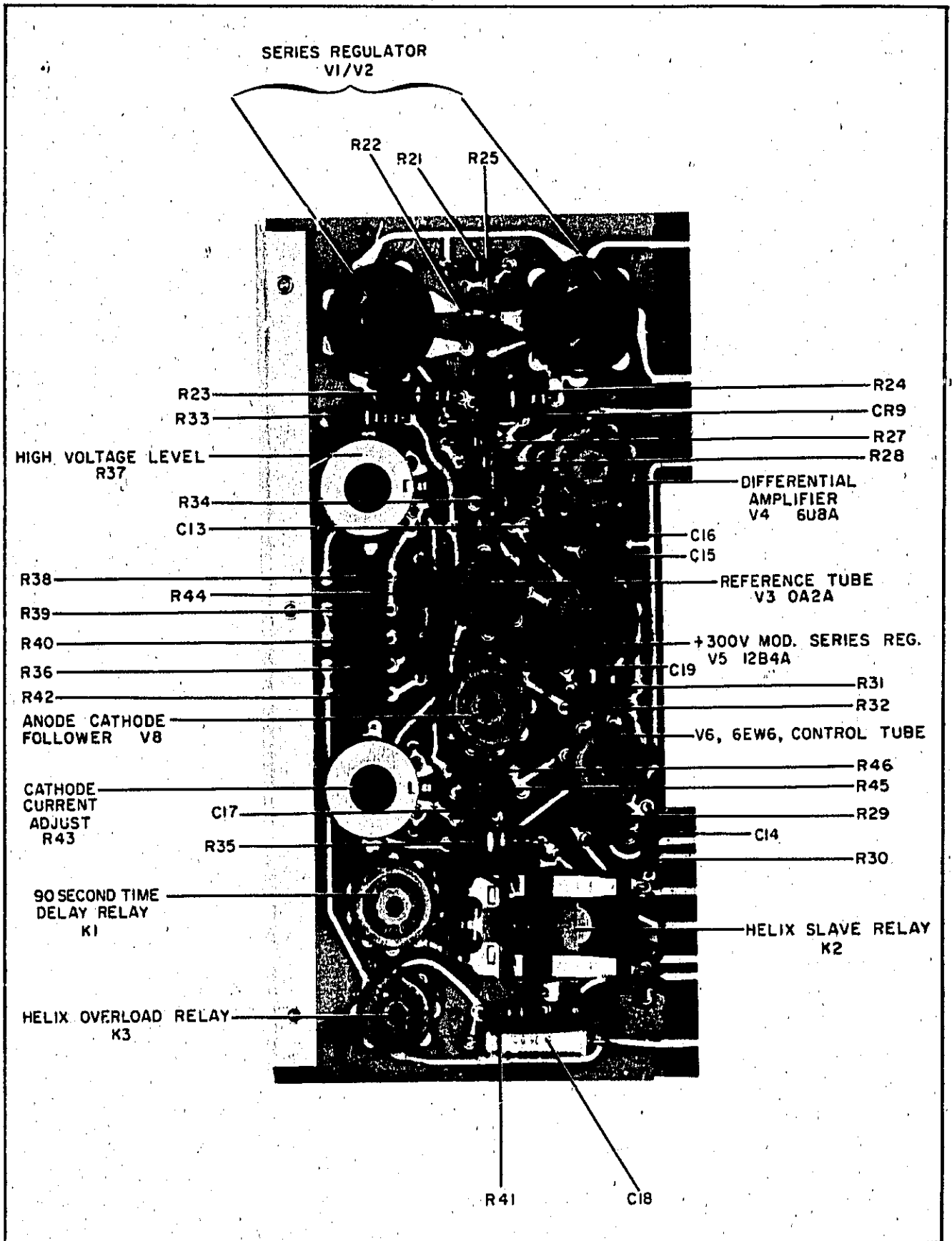


Figure 7-1. A1 High Voltage Power Supply Assembly Serial Prefixes 811-01155 and below

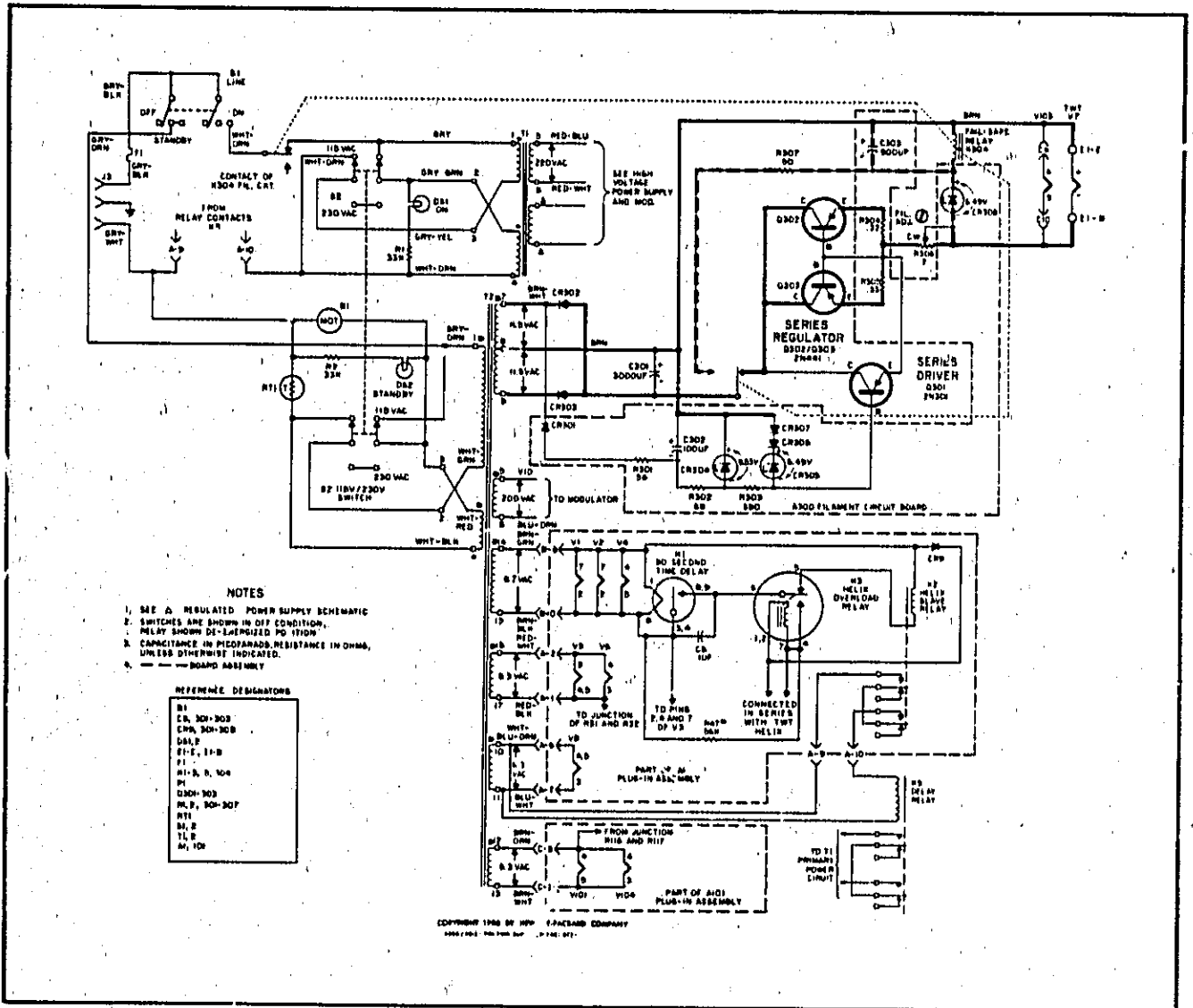


Figure 7-2. Primary Power and Regulated Filament Circuit, Schematic Diagram Prefixes 930-01395 and below

## SECTION VIII SERVICE

### 8-1. INTRODUCTION

8-2. This section contains principles of operation, circuit descriptions, troubleshooting procedures, and schematic diagrams.

### 8-3. PRINCIPLES OF OPERATION

8-4. A description of the overall block diagram and general principles of operation are presented opposite Figures 8-5 through 8-7. A detailed description is shown opposite each appropriate fold-out schematic diagram.

### 8-5. TROUBLESHOOTING

8-6. A logical troubleshooting tree is shown in Figure 8-7. Recommended test equipment for use in troubleshooting is shown in Table 1-2.

### 8-7. SCHEMATIC DIAGRAMS

8-8. The schematic diagrams in this section represent the circuits electrically. They are not wiring diagrams, though wire colors are given where practical.

8-9. Some of the general information obtainable from the schematics is shown in Figure 8-1. Notes and explanations pertaining to all diagrams are contained in Figure 8-2. Notes about specific components, circuits or conditions are given on the diagram to which they apply.

8-10. As an aid to finding components and assemblies in the diagrams, each diagram has a box labelled "Reference Designations" that contains all the reference designations appearing on the diagram.

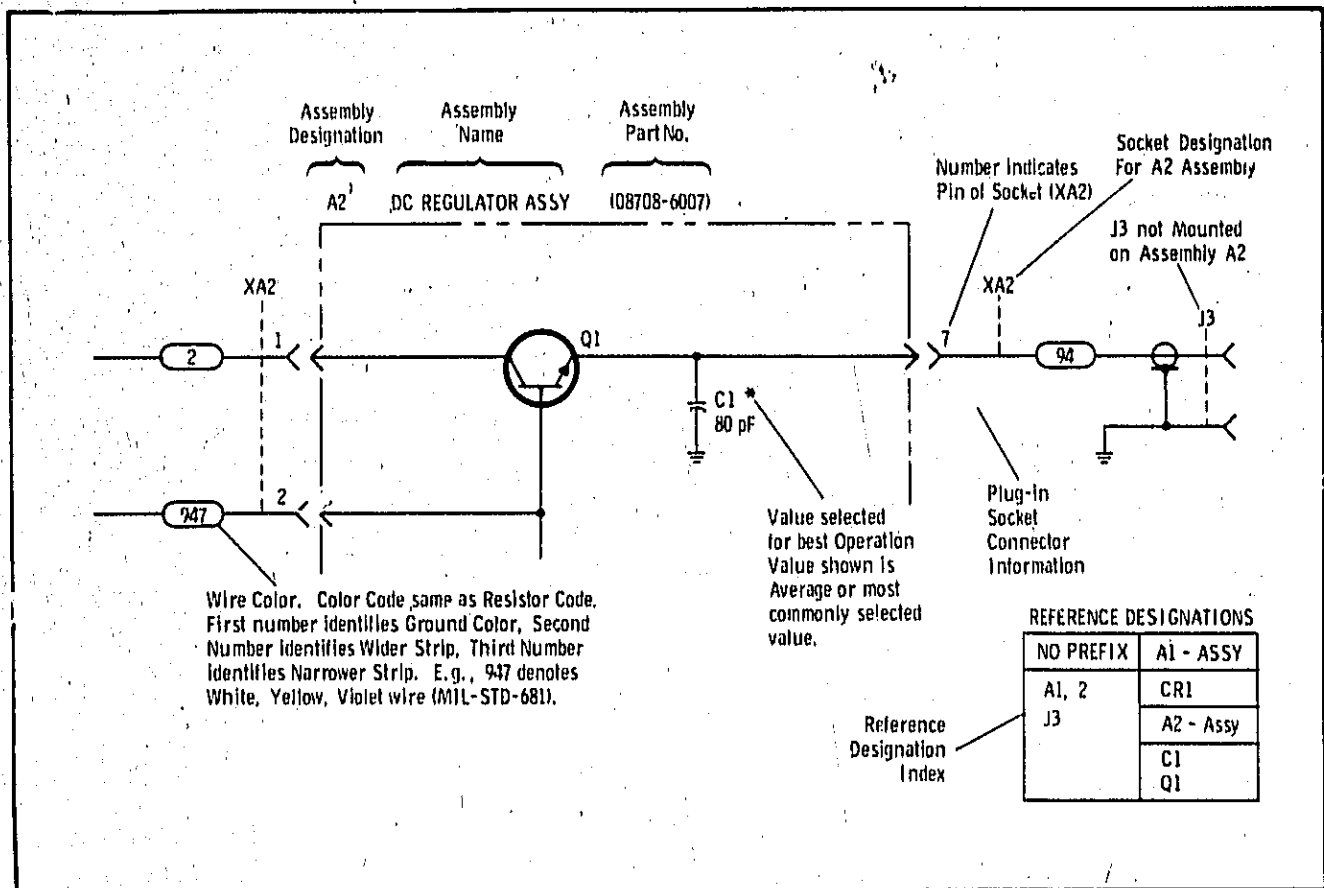


Figure 8-1. General Information on Schematic Diagrams

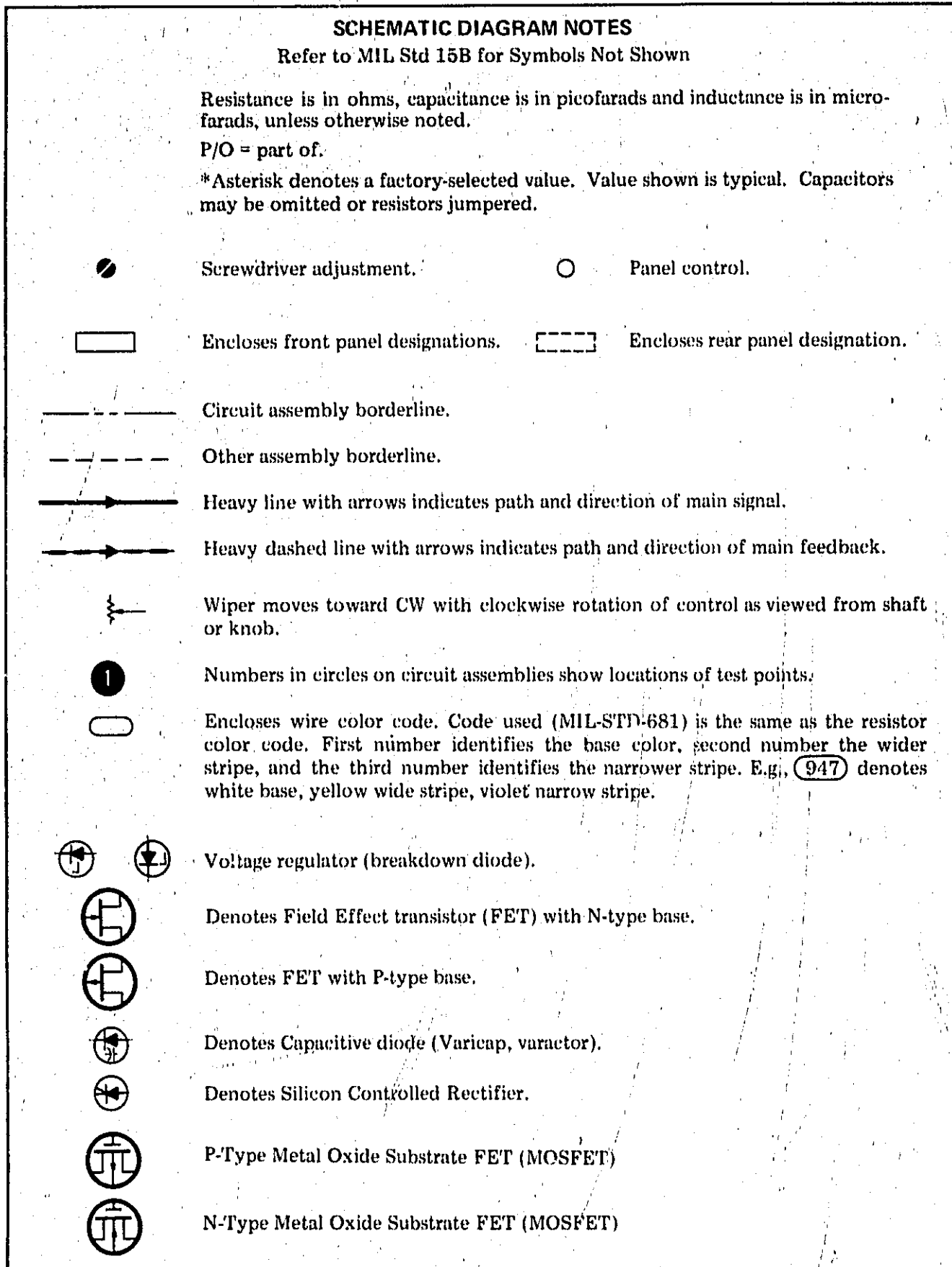


Figure 8-2. Schematic Diagram Notes

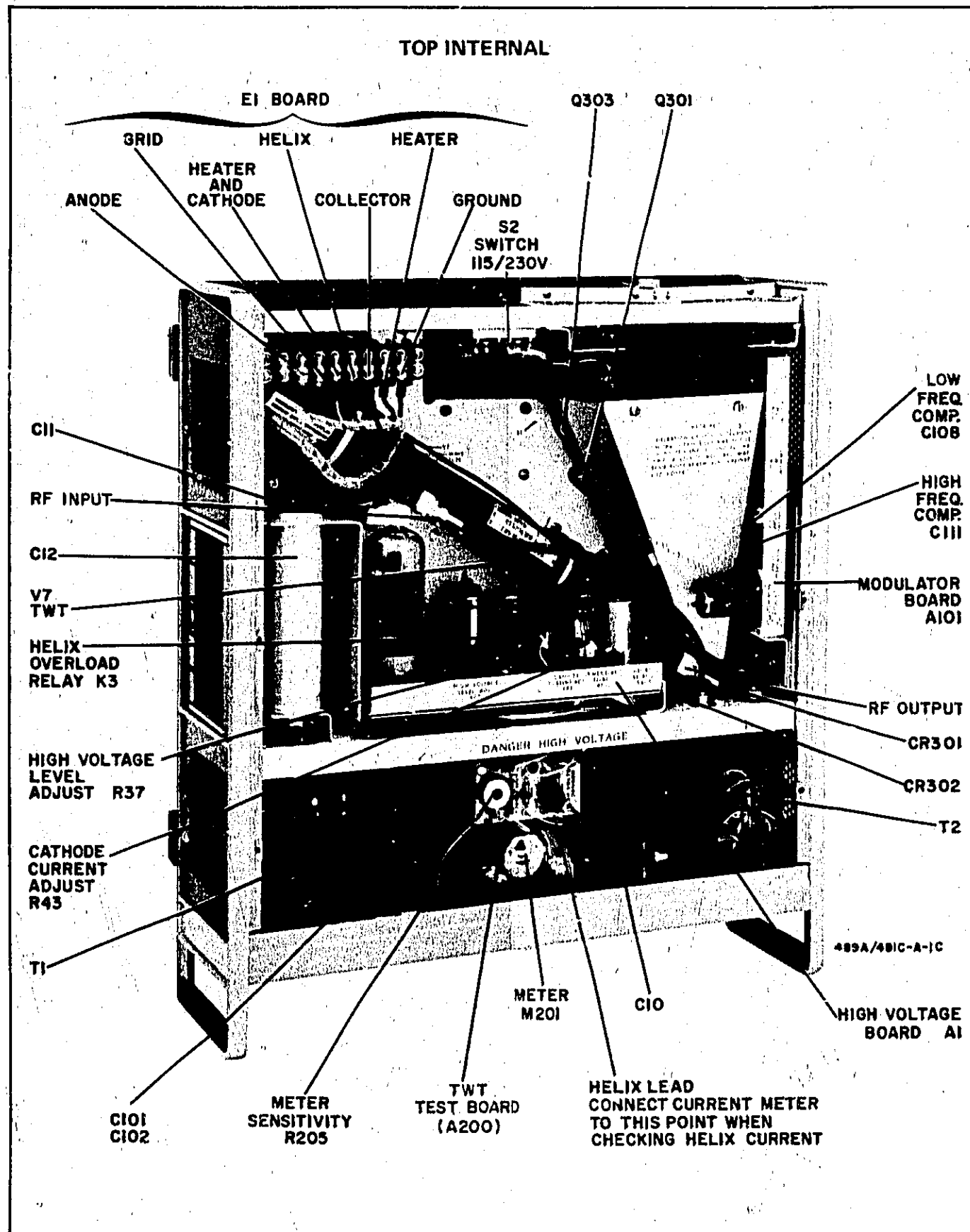


Figure 8-3. Top Internal View

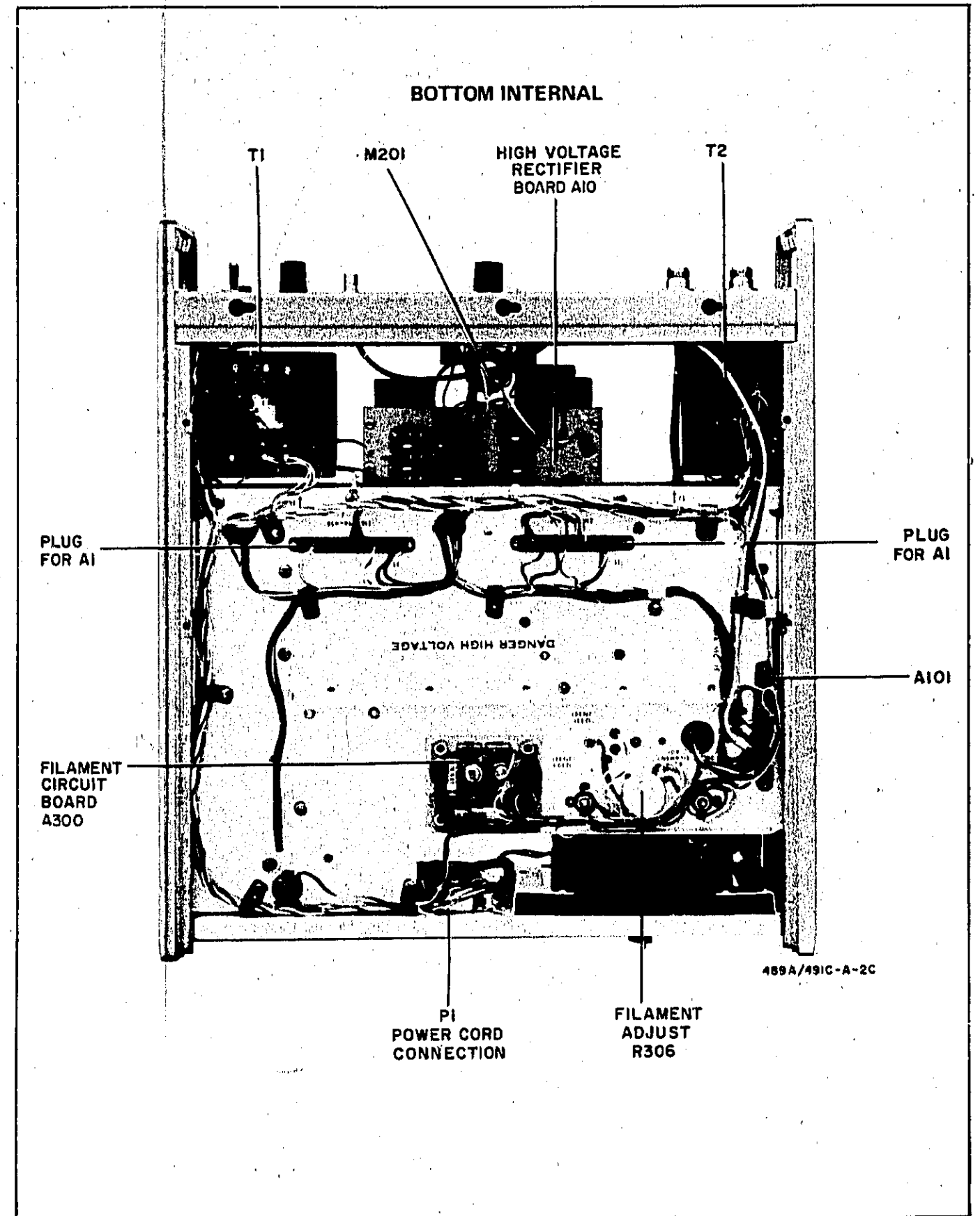


Figure 8-4. Bottom Internal View

**SERVICE SHEET 1**

**Block Diagram**

The RF input signal is applied to the Microwave Amplifier INPUT, amplified by the traveling-wave amplifier tube (TWT), and taken at the Microwave Amplifier OUTPUT. Within the instrument all the voltages required by the traveling-wave amplifier tube are supplied by the regulated high voltage power supply and modulator. The regulated high voltage power supply provides helix/collector, anode and modulator voltages. The circuit supplies high voltage to the collector and helix directly. Anode voltage is supplied to the anode through cathode follower V8; modulator voltages are supplied through +300 volt series regulator V5, and +400 to +750 volts from the

high voltage power supply is supplied to the modulator directly. -350 volts is supplied to the modulator by the -350 volt regulated power supply. The modulator controls voltage to the grid of the TWT. This voltage is made variable by the front panel GAIN control from approximately -40 to -300 volts. Thus the GAIN control sets the gain of the amplifier.

The Microwave Amplifier can be amplitude modulated. Externally applied modulation signals are applied to the front panel MOD INPUT and dc coupled through the modulator to the grid of the TWT.

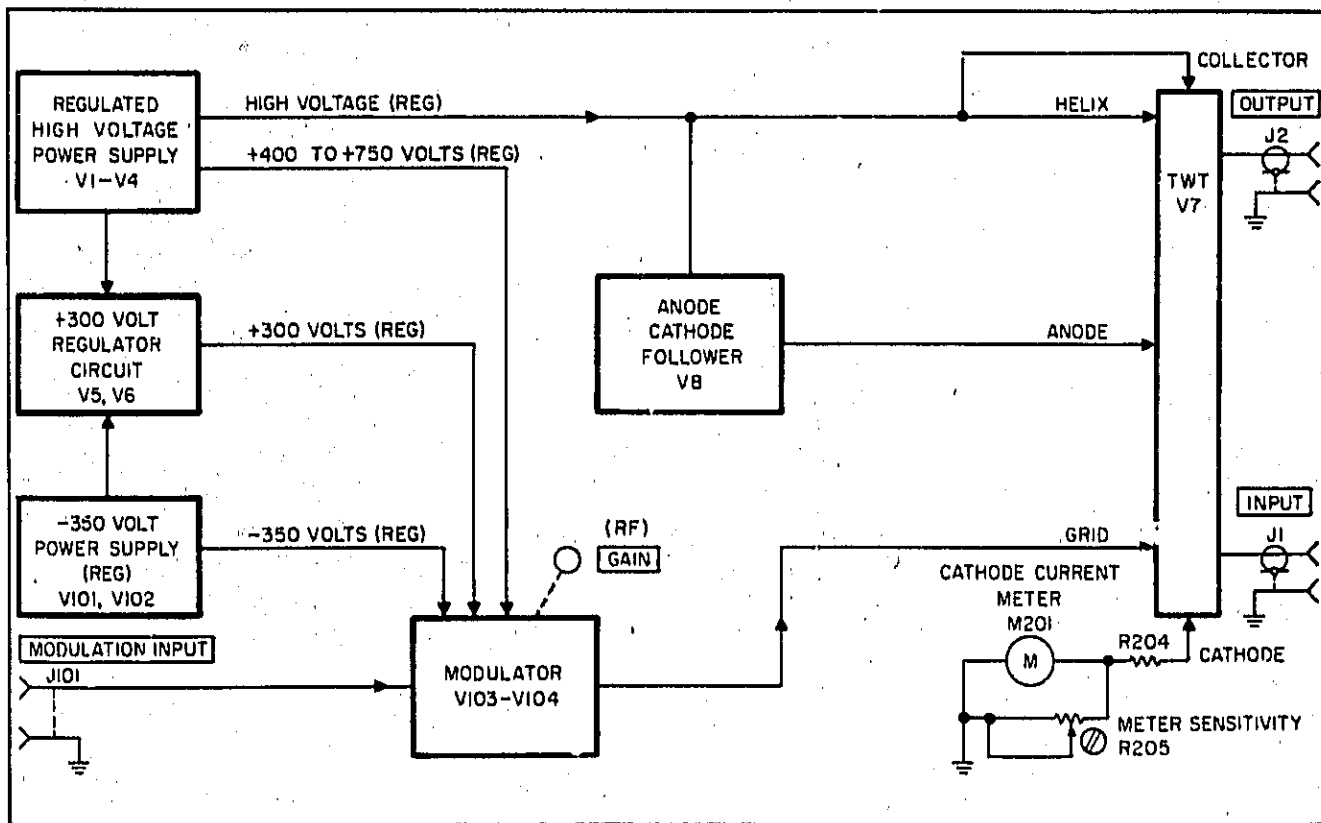


Figure 8-5. Overall Block Diagram

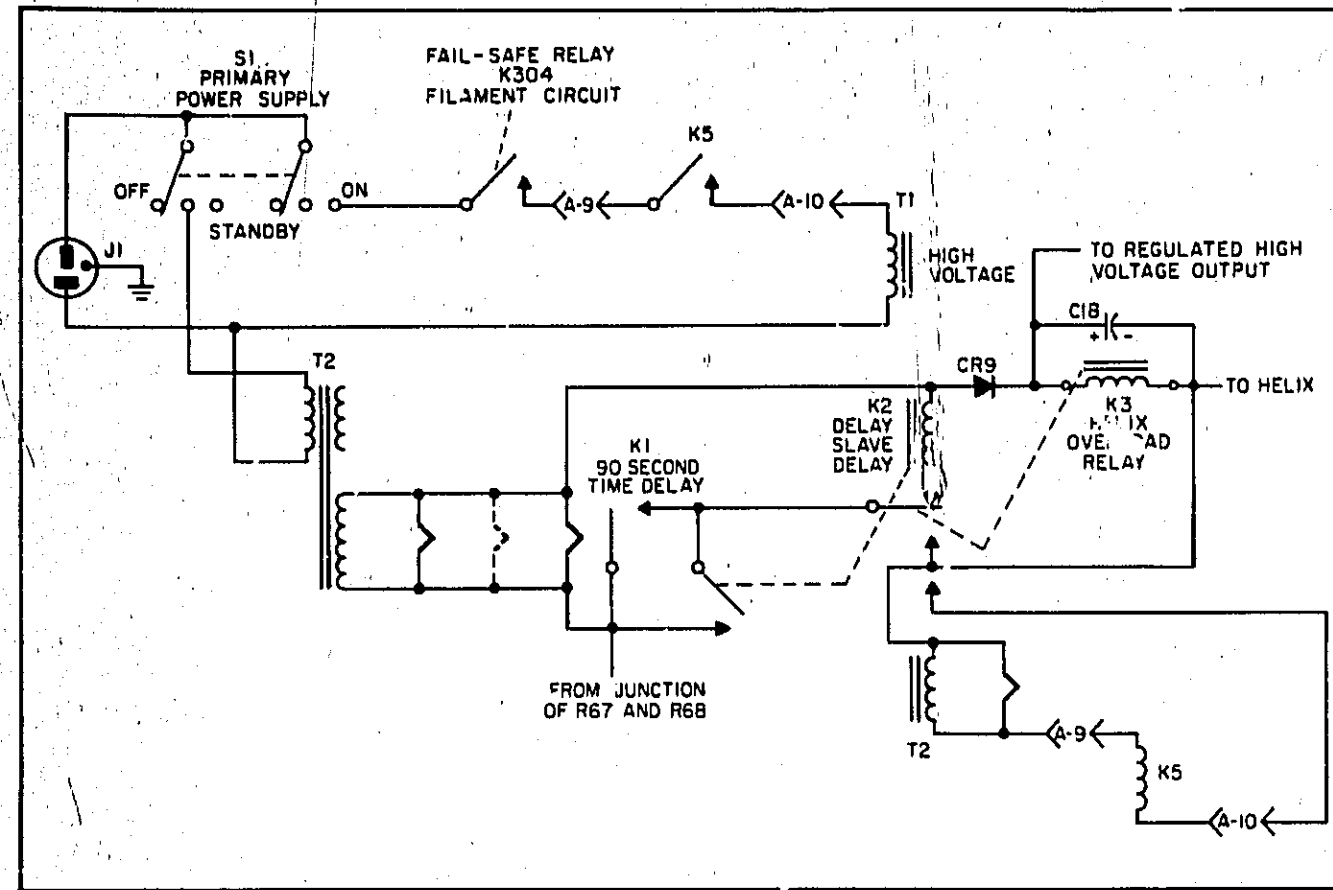
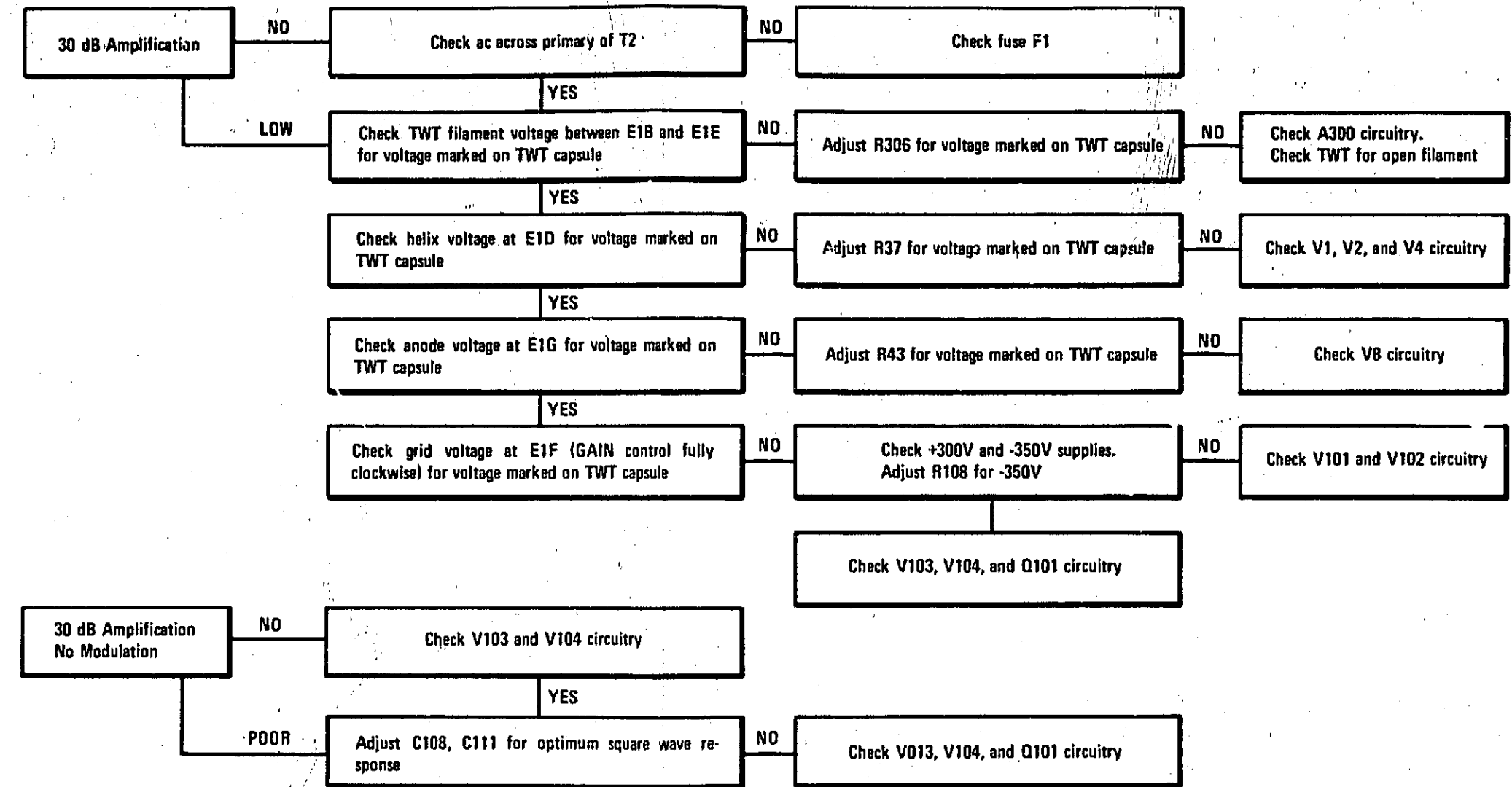


Figure 8-6. Relay Sequence



**CAUTION**

If the line fuse (F1) constantly blows, or the helix overload relay (K3) or the fail-safe relay (K304) constantly triggers, DO NOT ATTEMPT to troubleshoot with the TWT connected to the Amplifier Circuitry. Perform the following before proceeding with the troubleshooting tree:

- a. Remove all TWT connections from E1.
- b. Connect the following dummy loads:
  1. Connect a 24K ohm, 80 watt resistor between the collector (E1C) and ground. This can be made with four 6000 ohm, 20 watt resistors.
  2. Connect a 5 ohm, 5 watt resistor between the heater terminals (E1B and E1E).
- c. Proceed with the troubleshooting tree as shown.

Figure 8-7. Overall Troubleshooting Tree



## SERVICE SHEET 2

## Regulated Filament Supply

The filament supply is a conventional series regulated power supply that supplies dc voltage to the filaments of differential amplifier V103, and TWT V7. Successive regulation is provided by CR304 and CR305 to hold the base of Q301 constant. FILAMENT ADJUST R306 sets the regulated output voltage.

Protection is provided by relay K304 and CR308, in the event that the filament voltage exceeds the limits set by FILAMENT ADJUST R306. K304 and CR308 are placed in parallel with the filaments. If the voltage limits set by FILAMENT ADJUST R306 are exceeded, CR308 will break down and K304 will energize, opening the filament circuit and removing ac power to high voltage supply.

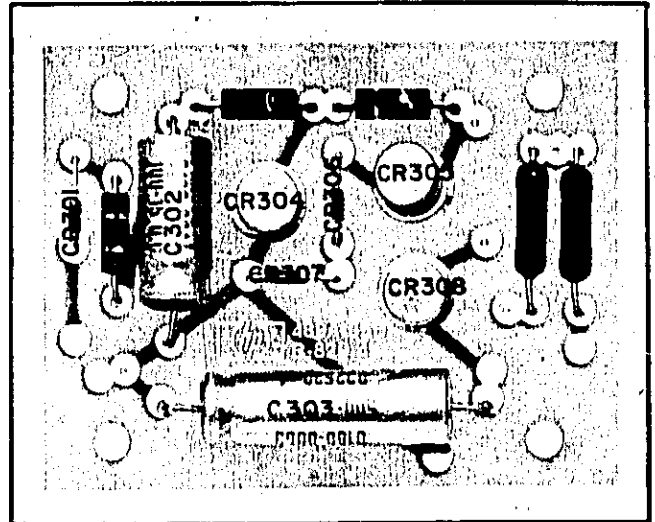


Figure 8-8. Component Identification A300  
Filament Regulator Assembly

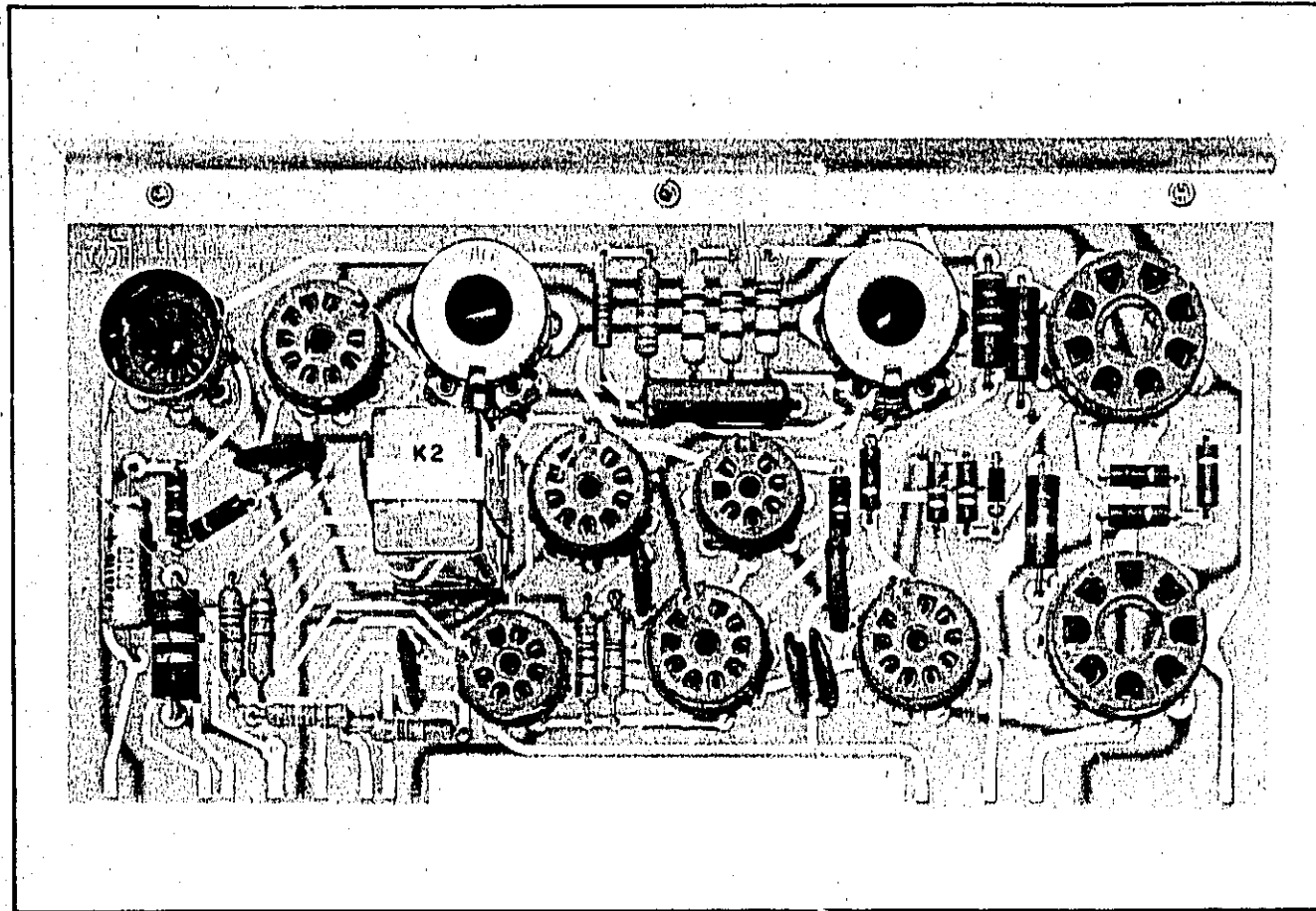
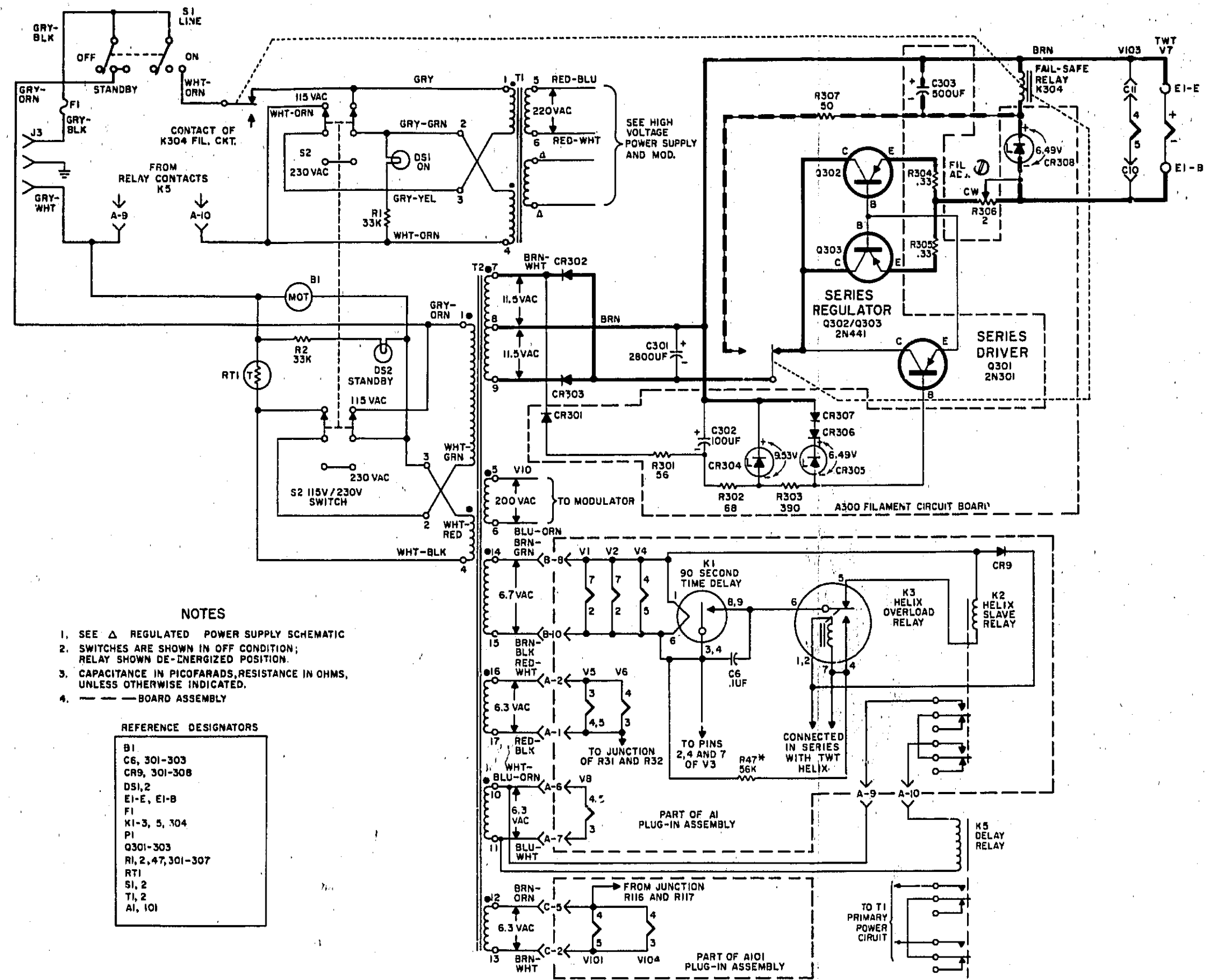


Figure 8-9. Component Identification, A1 High Voltage Power Supply Assembly



NOTES

1. SEE Δ REGULATED POWER SUPPLY SCHEMATIC
2. SWITCHES ARE SHOWN IN OFF CONDITION; RELAY SHOWN DE-ENERGIZED POSITION.
3. CAPACITANCE IN PICOFARADS, RESISTANCE IN OHMS, UNLESS OTHERWISE INDICATED.
4. --- BOARD ASSEMBLY

REFERENCE DESIGNATORS

B1
C6, 301-303
CR9, 301-308
DS1, 2
E1-E, E1-B
F1
K1-3, 5, 304
P1
Q301-303
R1, 2, 47, 301-307
RT1
S1, 2
T1, 2
A1, 101

COPYRIGHT 1962 BY HEWLETT-PACKARD COMPANY  
489A/491C-PRI PWR SUP- SER PREL 972-

Figure 8-10. Primary Power and Regulated Filament Circuit, Schematic Diagram

## SERVICE SHEET 3

## Regulated High Voltage Power Supply

The series regulated high voltage power supply includes series regulator tubes V1 and V2, reference tube V3, and differential amplifier tube V4.

V1 and V2 are connected in series with the main load. A regulated output voltage is obtained by varying the internal resistance of the series regulator to compensate for variations in load current and source voltage. Initially, HIGH VOLTAGE ADJUST R37 sets the desired regulated output voltage. If the output voltage varies from this pre-set value, the variation is sensed by differential amplifier V4A/B. The amplified output is applied to the grid of the series regulator tubes, thereby keeping output voltage constant. Reference tube V3 maintains a constant 150 volt difference potential between regulated output voltage terminal and the grid of V4A.

Capacitor C13 shunts ac frequency changes in the output voltage directly to the grid of V4A. Capacitors C15 and C16 hold the grid of V4B constant once HIGH VOLTAGE ADJUST R37 has been set.

Unregulated dc voltage for the high voltage power supply is supplied by the voltage doubler which consists of CR11 through CR16, and C11 and C12.

Anode cathode follower V8 supplies an adjustable voltage for the anode of traveling-wave amplifier tube V7. CATHODE CURRENT ADJUST R43 sets the TWT anode voltage and thus the beam current to a value that will produce at least 1 watt at the RF OUTPUT, with the application of 1 milliwatt to the RF INPUT.

## +300 Volt Power Supply

This regulated power supply includes +300 volt series regulator V5, and control tube V6. The circuit is a series regulated supply similar in operation to that of the high voltage supply. It derives its voltage from the regulated high voltage power supply, and thus produces a

nearly ripple-free, highly regulated voltage to the modulator. There are no controls for adjustment of the +300 volt modulator power supply. All components are fixed to provide a +300 volt output to the modulator regardless of the high voltage power supply output voltage.

## Meter M201

The meter monitors cathode current. It is adjusted for proper sensitivity with METER SENSITIVITY ADJUST R205.

## Traveling-Wave Amplifier Tube

The traveling-wave amplifier tube used in the Model 489A/491C includes an electron gun which projects a focused beam through a helically-wound coil to a collector electrode. The focused electrons are held in a pin-like beam through the helix by the periodic permanent magnet focusing structure which produces a powerful magnetic field along the full length of the tube.

The RF signal coupled into the gun-end of the helix travels around the turns of the helix and thus has its linear velocity reduced by an amount equal to the ratio of the length of wire in the helix to the length of the helix itself. The electron beam velocity, determined by the potential difference between the cathode and the helix, is adjusted so that the electron beam travels a little faster than the RF signal. The electric field of the RF signal on the helix interacts with the electric field created by the electron beam and increases the amplitude of the signal on the helix, thus producing the desired amplification.

## Note

The ceramic magnets used in the TWT will defocus the electron beam if ambient temperature within the instrument exceeds 35°C. If TWT is operating above this temperature, poor power amplification can be expected.

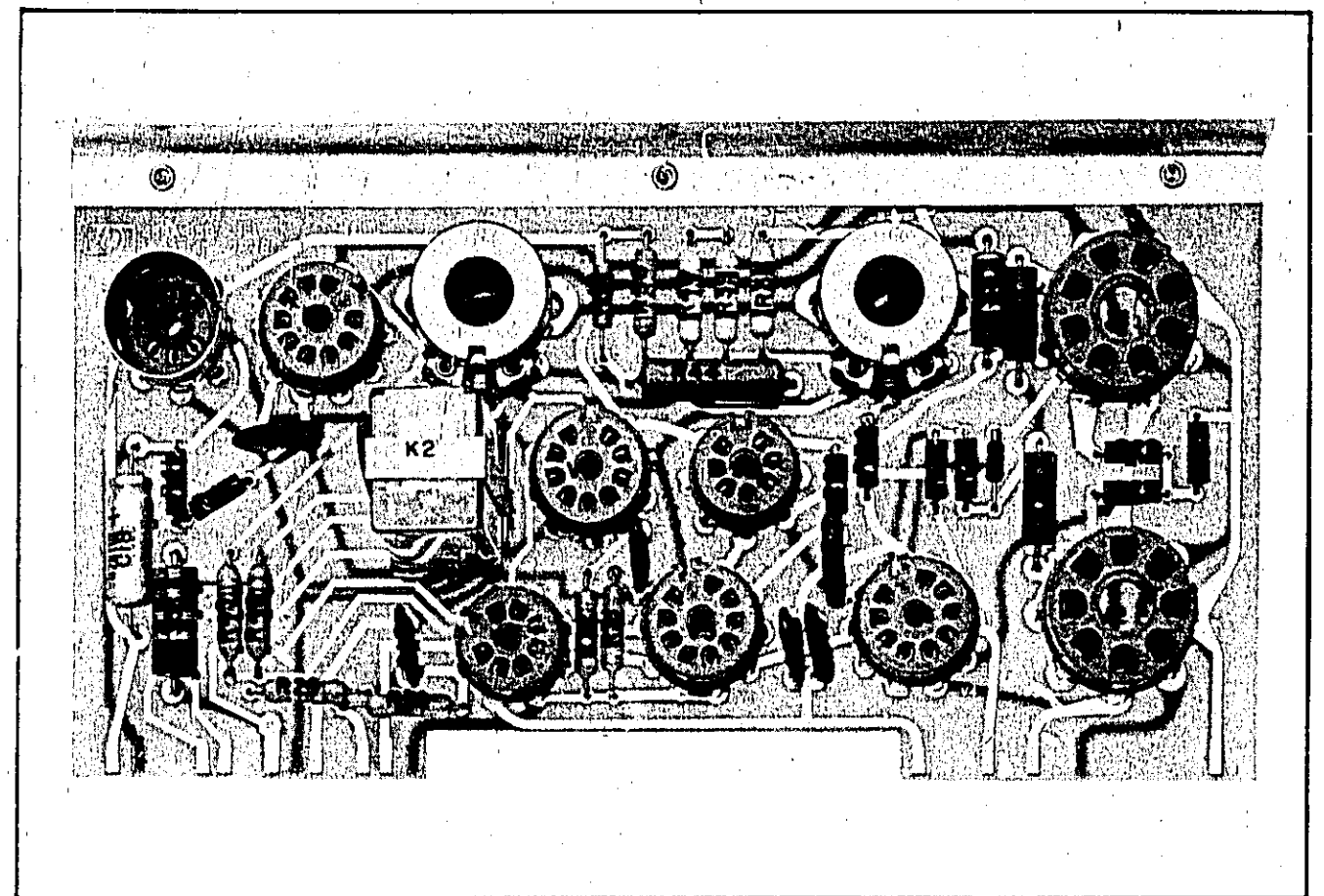


Figure 8-11. Component Identification, A1 High Voltage Power Supply Assembly

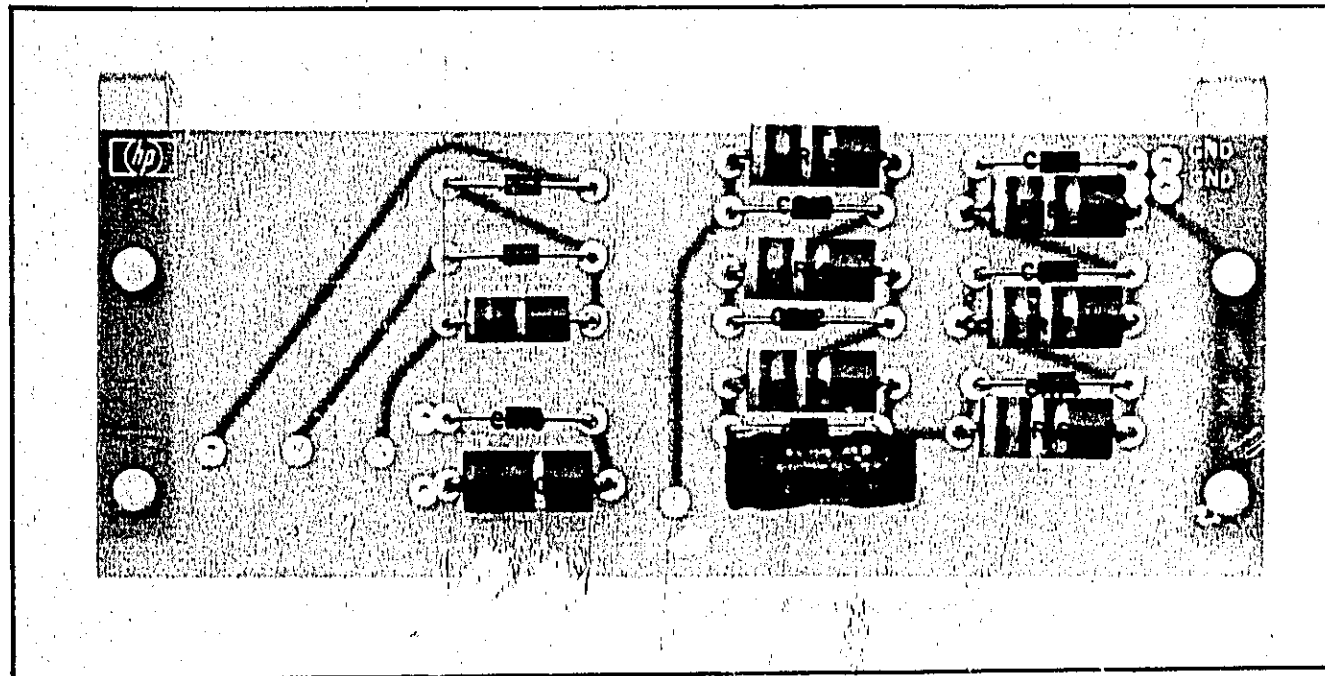


Figure 8-12. Component Identification, A10 Rectifier Assembly

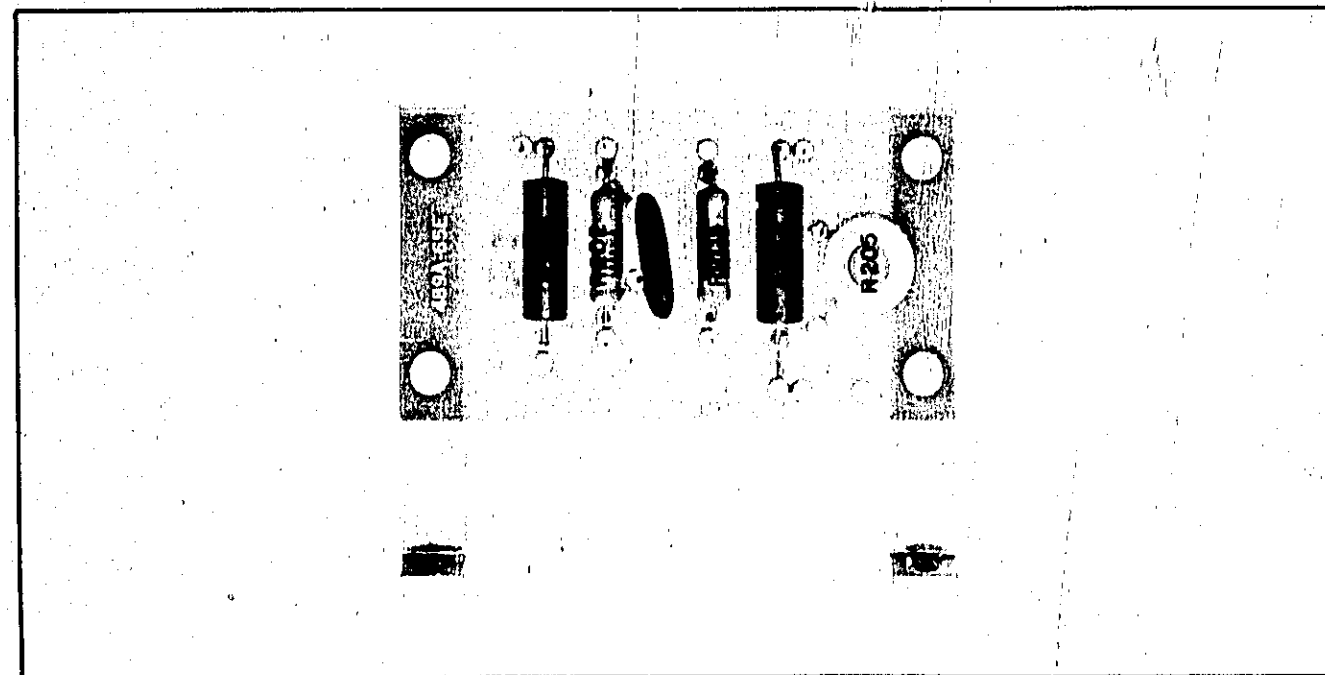


Figure 8-13. Component Identification, A200 TWT Test Board Assembly

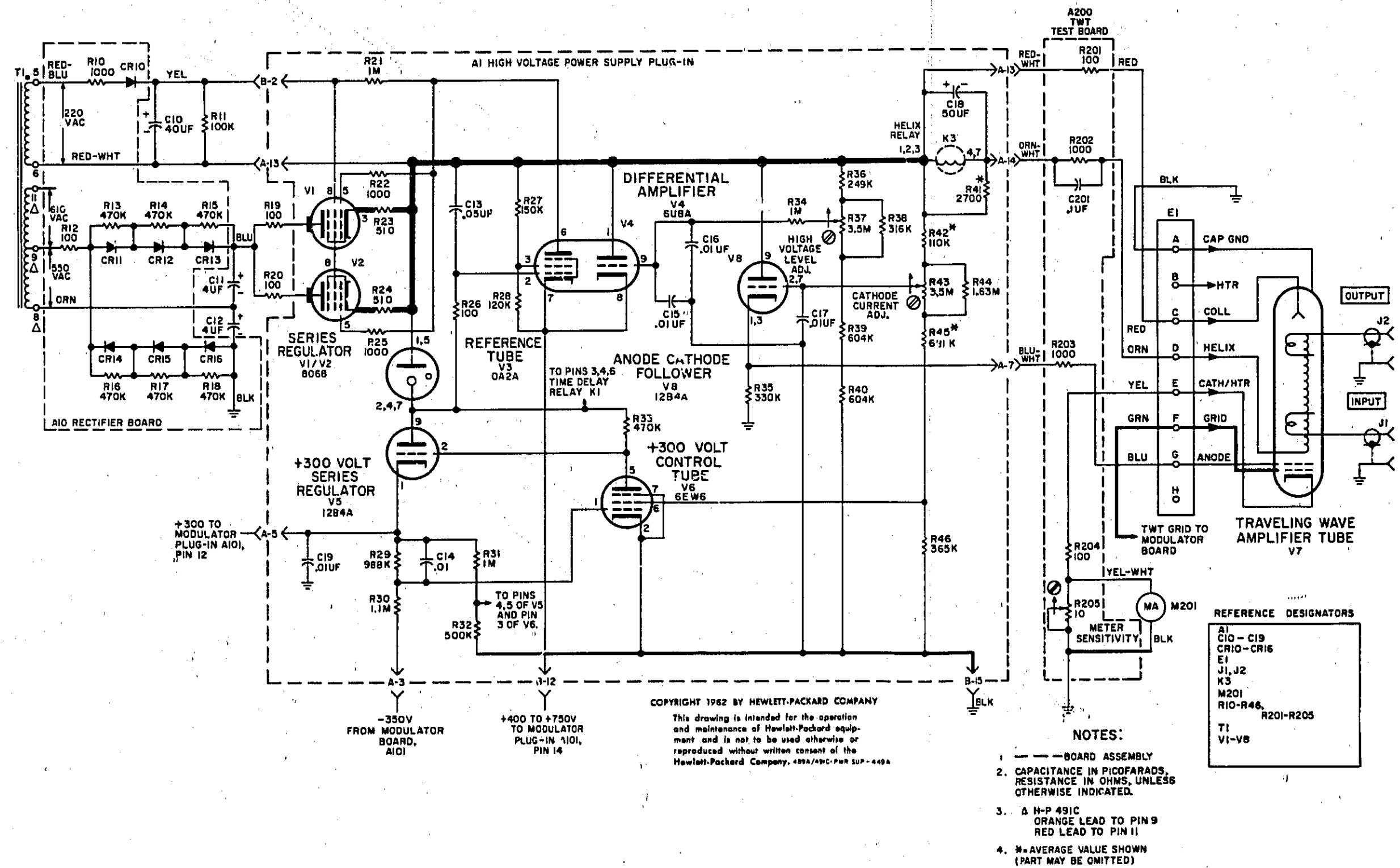


Figure 8-14. Regulated Power Supply, Schematic Diagram

**SERVICE SHEET 4****Modulator**

The modulator includes the amplifier circuit and regulated power supply. The amplifier circuit is a dc coupled circuit that sets the gain of the traveling-wave amplifier tube, and accepts externally applied amplitude modulated signals from dc to 500 kHz (dc to 100 kHz for large input signals). The regulated power supply provides -350 volts for this amplifier circuit and the +300 volt supply.

**Amplifier Circuit**

The amplifier circuit includes differential amplifier V103, output amplifier V104, and current sink Q101. Externally applied modulation signals are applied through the A section of differential amplifier V103 to the output amplifier V104. The output of V104 is applied to the grid of the TWT. Degenerative feedback is applied from the output of V104 to V103 to increase stability and frequency response.

The B section of differential amplifier V103, by means of the front panel GAIN control, sets both the gain of the TWT and the average output level for the externally applied amplitude modulation signals. GAIN LIMIT ADJUST R121 sets the

least negative voltage on the grid of the TWT (approximately -40 volts). Current sink Q101 minimizes attenuation of the signal coming from V103 at low dc levels. The voltage at the base of Q101 is held constant by diodes CR104, CR105 and CR106. Variable capacitors C108 and C111 are adjusted for high frequency compensation. CR103 provides current through R104 when the instrument is in the STANDBY position. This permits operation of the -350 volt power supply and thus keeps the TWT grid voltage at a negative potential when the instrument is in the STANDBY condition. Voltage divider (R129, R130), diode CR108, and capacitor C102B at the modulator output cause the TWT grid voltage to rise slowly (when instrument is first turned on) from a negative voltage to its normal operating voltage, yet does not affect externally applied modulation voltages. When the instrument is in operation, CR108 is back biased, effectively removing C102B from the TWT grid.

**-350 Volt Regulated Power Supply**

This is a conventional series regulated power supply that provides -350 volts for the amplifier circuit. The circuit includes series regulator V101A, control tube V101B, and reference tube V102. -350 VOLT ADJUST R108 sets the regulated voltage output of the circuit.

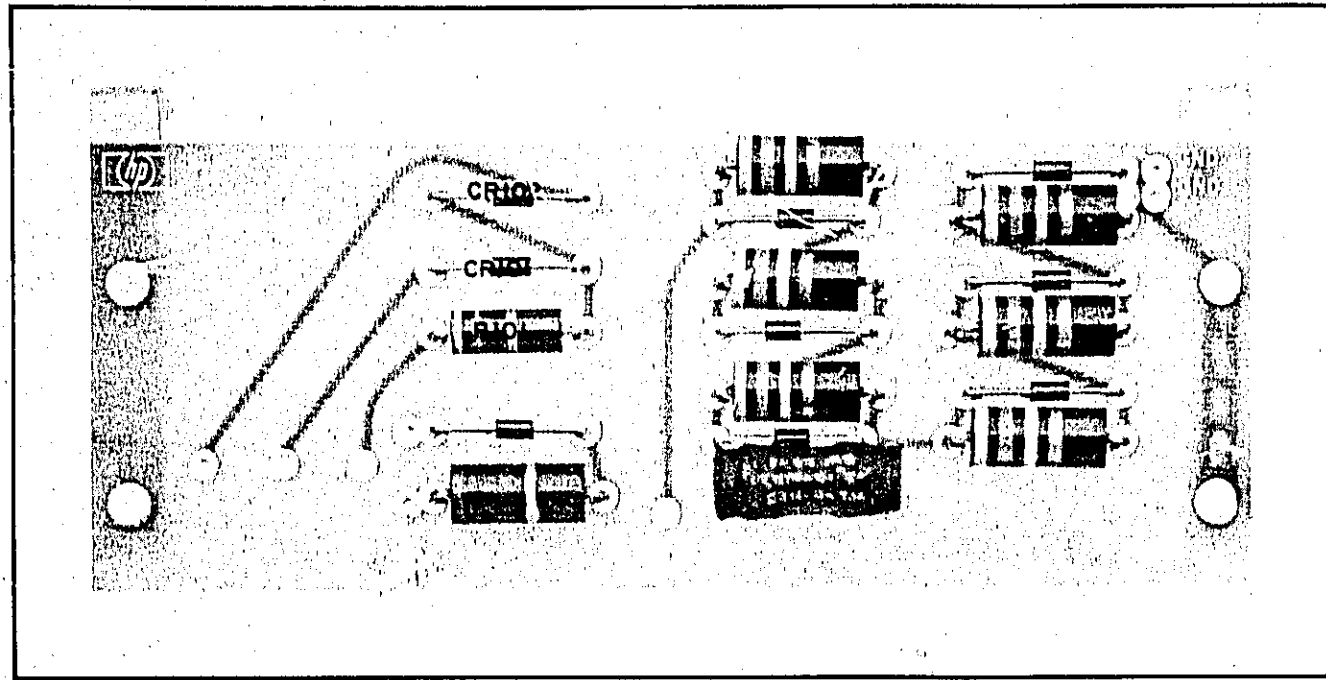


Figure 8-15. Component Identification, A10 Rectifier Assembly

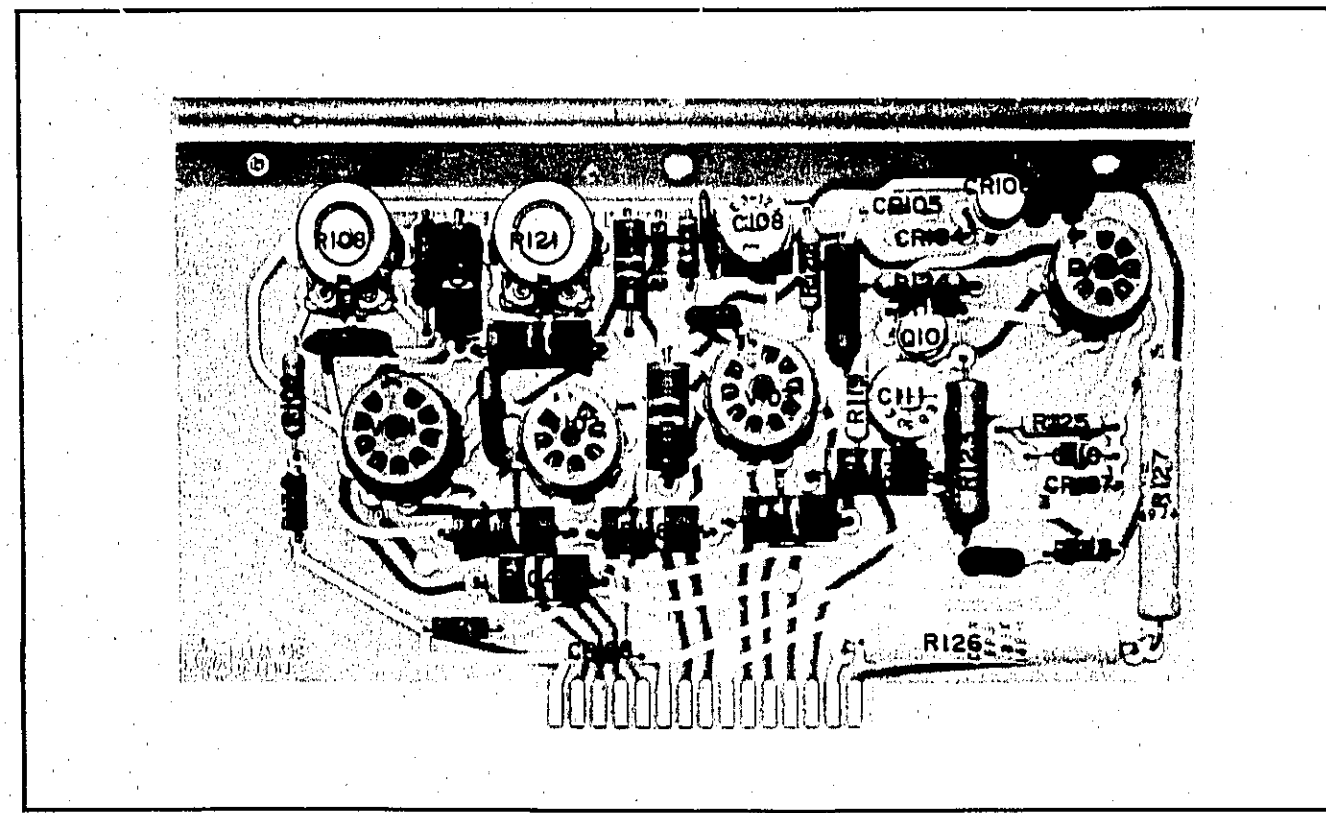
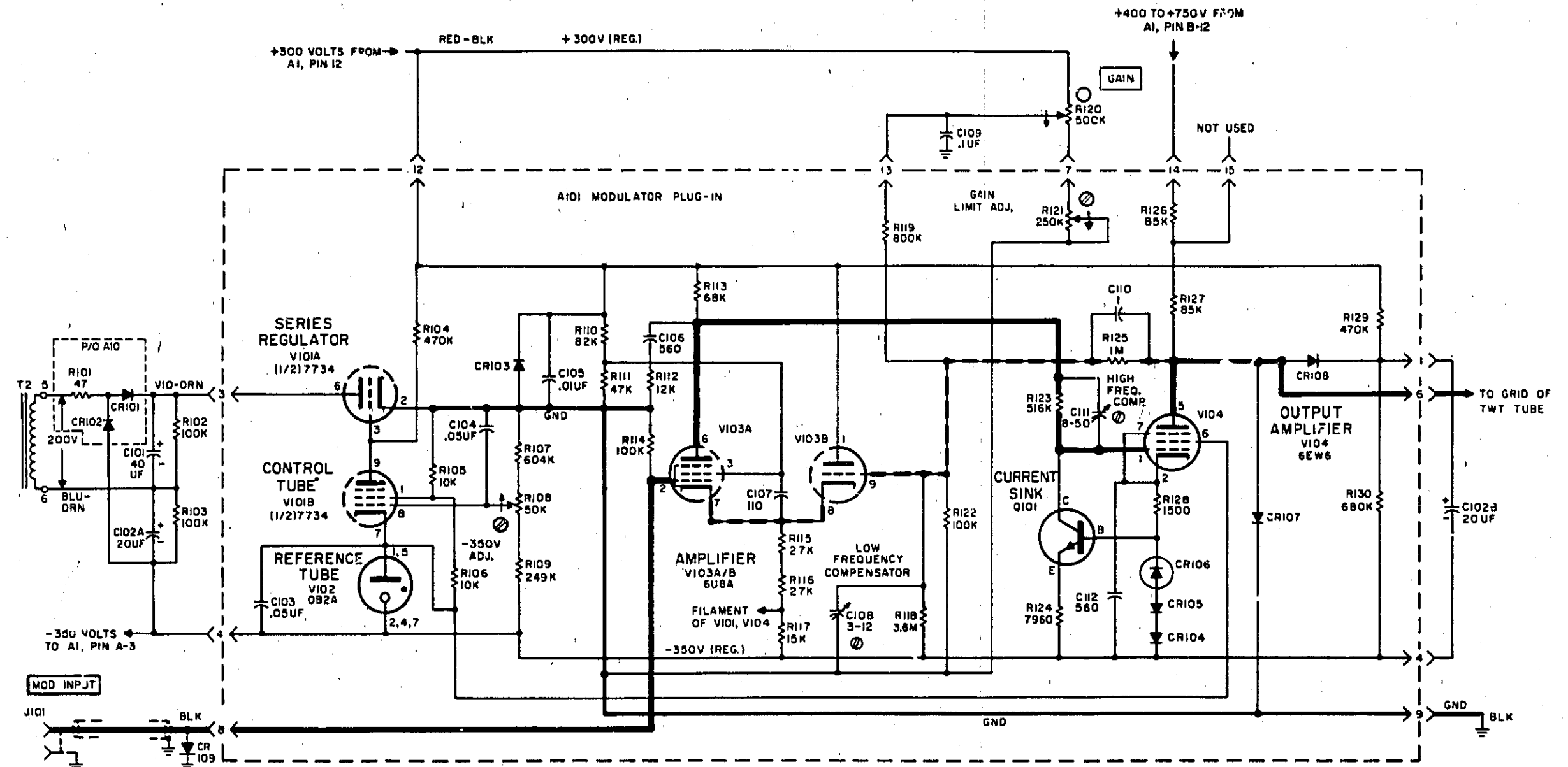


Figure 8-16. Component Identification, A101 Modulator Assembly



COPYRIGHT 1982 BY HEWLETT-PACKARD COMPANY  
 This drawing is intended for the operation and maintenance of Hewlett-Packard equipment and is not to be used otherwise or reproduced without written consent of the Hewlett-Packard Company, 40957/49C MOD. CAT 449A

- NOTES:
1. --- BOARD ASSEMBLY
  2. CAPACITANCE IN PICO FARADS, RESISTANCE IN OHMS, UNLESS OTHERWISE INDICATED.
  3. P/O = PART OF

REFERENCE DESIGNATORS	
A101	
C101 - 112	
CR101 - 109	
J101	
Q101	
R101 - 130	
T2	
V101 - 104	

Figure 8-17. Modulator, Schematic Diagram



# MANUAL CHANGES

## MANUAL IDENTIFICATION

Model Number: 489A/491C  
 Date Printed: August 1970  
 Part Number: 00489-90006

This supplement contains important information for correcting manual errors and for adapting the manual to instruments containing improvements made after the printing of the manual.

To use this supplement:

Make all ERRATA corrections

Make all appropriate serial number related changes indicated in the tables below.

Serial Prefix or Number <del>489A</del>	Make Manual Changes
1144A01566 thru 1144A01695	1
1144A01696 thru 1144A01715	1, 2
1144A01716 thru 1144A prefix	1, 2, 3
1545A, 1640A	1, 2, 3
1653A	1, 2, 3, 4
1707A	1, 2, 3, 4, 5
1715A	1, 2, 3, 4, 5, 6

Serial Prefix or Number <del>491C</del>	Make Manual Changes
1144A01566 thru 1144A01715	1
1144A01716 thru 1144A01775	1, 2
1144A01776 thru 1144A prefix	1, 2, 3
1545A	1, 2, 3
1649A	1, 2, 3, 4
1713A	1, 2, 3, 4, 5
1715A	1, 2, 3, 4, 5, 6

### ► NEW ITEM

### ERRATA

Inside Front Cover:

Add: "CONDITIONS OF WARRANTY FOR BACKWARD WAVE OSCILLATOR TUBES AND TRAVELING WAVE TUBES" contained within this Manual Changes.

Page 1-2, Table 1-1:

After Dimensions, add Figure 1 of this Manual Changes.

Change Amplitude Modulation specification to read:

"Sensitivity vs Frequency Response: A modulation signal of DC to 50 kHz with amplitude of -20V peak reduces the RF output by more than 20 dB. Above 50 kHz, sensitivity decreases approximately 6 dB per octave increase in modulation frequency."

Accessories Furnished:

Delete all references to Rack Mounting Kit.

Accessories Available:

Add: "A Rack Mounting Kit is available to install the instrument in a 19-inch rack. Rack Mounting Kits may be obtained through your nearest Hewlett-Packard office by ordering HP Part Number 5060-8740."

### NOTE

Manual change supplements are revised as often as necessary to keep manuals as current and accurate as possible. Hewlett-Packard recommends that you periodically request the latest edition of this supplement. Free copies are available from all HP offices. When requesting copies quote the manual identification information from your supplement, or the model number and print date from the title page of the manual.

12 APRIL 1982

8 pages



**HEWLETT  
PACKARD**

**ERRATA (Cont'd)**

## ▶ Page 1-1, Section I:

Add a **SAFETY CONSIDERATION** information sheet (attached) to Section I.

## Page 1-3, Table 1-2:

Change critical specification of the HP Model 8616A Signal Generator to read:  
 "Freq. Range: 2 to 4 GHz, Power Output: 1 mW, Leveled Output: +0.5 dB."

## Page 3-1, Paragraph 3-6:

Change **CAUTION** to read as follows:

**CAUTION**

**RF POWER OUTPUT** port must be terminated with a 50-ohm load when **LINE** switch is set to **ON** position. Failure to terminate the output port, regardless of whether or not a signal is present at the **RF POWER INPUT** port, may result in permanent damage to the TWT.

Change all references to time delay in step a to 120 seconds (three places).

Change second sentence in step b to read:

"A maximum of 1 milliwatt at the **INPUT** jack produces a minimum of 1 watt at the **OUTPUT** jack across the frequency range."

## Page 3-1, Paragraph 3-7:

Change **CAUTION** to read:

**CAUTION**

Peak cathode current must not be allowed to enter red region of meter.

Add after **CAUTION**:

**NOTE**

Incorrect meter reading may result due to static charge on meter face.

## Page 3-3, Figure 3-1:

Change all references to time delay to 120 seconds (items 1 and 3).

## Page 4-1, Paragraph 4-2:

Add the following **CAUTION**:

**CAUTION**

**RF POWER OUTPUT** port must be terminated with a 50-ohm load when **LINE** switch is set to **ON** position. Failure to terminate the output port, regardless of whether or not a signal is present at the **RF POWER INPUT** port, may result in permanent damage to the TWT.

## Page 4-2, Paragraph 4-7:

Change *Specification* to read: "Power Output: 1 watt or greater with 1 mW or less input."

Change **ATTENUATION** setting in step 1 to -20.

Change step 2 to read: "Increase signal generator output power with the attenuator until the external power meter reads 1 watt. The attenuator must read less than 0.00 dBm."

## Page 4-5, Paragraph 4-10:

Change setting of **GAIN** control in step 1 of *Procedure* to **FULLY CLOCKWISE**.



## ERRATA (Cont'd)

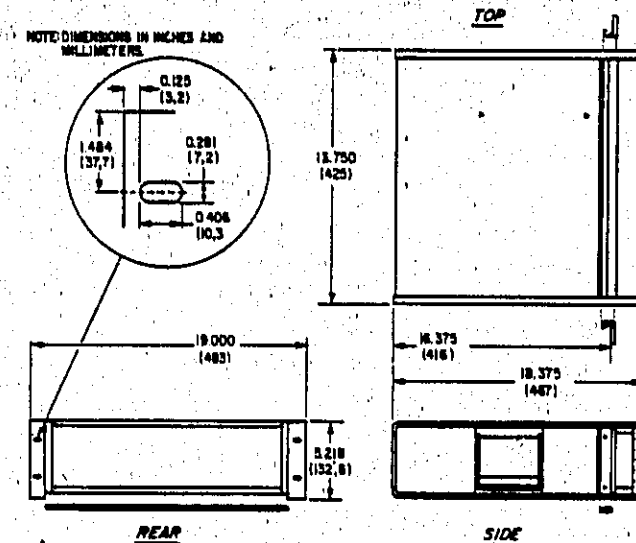


Figure 1. 489A/491C Dimensions (ERRATA)

Page 5-1, Paragraph 5-2:

Add the following CAUTION:

**CAUTION**

**RF POWER OUTPUT** port must be terminated with a 50-ohm load when **LINE** switch is set to **ON** position. Failure to terminate the output port, regardless of whether or not a signal is present at the **RF POWER INPUT** port, may result in permanent damage to the TWT.

Page 5-2, Paragraph 5-5, TWT FILAMENT ADJUSTMENT:

Change step 1 to read: "Rotate FILAMENT ADJUST R306 fully counterclockwise."

Page 5-6, Paragraph 5-11:

Change last part of *Description* to read: "...adjust the CATHODE CURRENT METER ADJUST for a meter reading below the red area of the meter display."Change step 3 of *Procedure* to read: "Rotate GAIN control fully clockwise and tune source to low power point of band."Change step 4 of *Procedure* to read: "Adjust METER SENSITIVITY R205 for a meter reading just below the red area of the meter display."

Page 6-2, Table 6-1:

Change table heading to read "Table 6-1. Reference Designators and Abbreviations."

Page 6-3, Table 6-2:

Change C11 and C12 HP Part Number to 0160-0675.

Change CR104, CR105, and CR301 HP Part Number to 1901-0033.

Change CR107 and CR108 to HP Part Number 1901-0030, DIODE: SILICON 800 PIV.

Page 6-4, Table 6-2:

Change CR306 and CR307 HP Part Number to 1901-0033.

Change Q301 HP Part Number to 1850-0098.

**ERRATA (Cont'd)**

## Page 6-4, Table 6-2 (Cont'd)

- Change R38 HP Part Number to 0698-3425.
- Change first K2 entry to HP Part Number 0490-0695, RELAY: DPDT, 28480, 0490-0695.
- Change second K2 entry to HP Part Number 0490-0752, RELAY RETAINER .950W.

## Page 6-5, Table 6-2:

- Change R41 to HP Part Number 0687-5621, R: FXD COMP 5.6K OHM 10% 1 W.
- Change R118 to HP Part Number 0698-5989, R: FXD DEPC 2.2 MEGOHM 1% 1/2W.
- Change first V7 entry to HP Part Number 1952-0037, ELECTRON TUBE: TWT 1.0 to 2.0 GHz (489A).
- Delete second V7 entry.
- Change third V7 entry to HP Part Number, 1952-0033, ELECTRON TUBE: TWT 1.0 to 2.0 GHz (489A ALTERNATE REPLACEMENT).
- Delete fourth, fifth, and sixth V7 entries.

## Page 6-6, Table 6-2:

- Change first V7 entry to HP Part Number 1952-0038, ELECTRON TUBE: TWT 2.0 to 4.0 GHz (491C).
- Delete second V7 entry.
- Change third V7 entry to HP Part Number 1952-0034, ELECTRON TUBE: TWT 2.0 to 4.0 GHz (491C ALTERNATE REPLACEMENT).
- Delete fourth, fifth, and sixth V7 entries.

## Page 7-5, Figure 7-2:

- Replace Figure 7-2 with Figure 7-2 of this Manual Changes.

## Page 8-5, Figure 8-6:

- Change K1 to read "120 SECOND TIME DELAY."

## Page 8-7, Figure 8-10:

- Change K1 to read: "120 SECOND TIME DELAY."

## Page 8-9, Figure 8-14:

- Add color code at pin A-5 to indicate 902 wire.
- Add color code at pin A-3 to indicate 97 wire.
- Add color code at pin B-12 to indicate 92 wire.
- Change color code at pin B-2 to 94.
- Change color code at pin A-13 to 926 (two places).

## Page 8-11, Figure 8-17:

- Change color code at pin 3 to 937.
- Change color code at pin 4 to 97.
- Change color code at pin 8 to 8.
- Change color code at pin 12 to 902.
- Add color code at pin 13 to indicate 0 wire.
- Add color code at pin 7 to indicate 5 wire.
- Add color code at pin 14 to indicate 92 wire.
- Add color code at pin 1 to indicate 92 wire.
- Add color code at pin 6 to indicate 958 wire.
- Add color code at pin 4 to indicate 97 wire.
- Change R118 to 2.2M.

**CHANGE 1**

## Page 6-6, Table 6-2:

- Change TOP COVER ASSEMBLY HP Part Number to 5060-8589.
- Change BOTTOM COVER ASSEMBLY HP Part Number to 5060-8713.
- Change RACK MOUNT KIT HP Part Number to 5060-8740.

**CHANGE 1 (Cont'd)**

Page 6-6, Table 6-2: (Cont'd)

Add FRONT PANEL, HP Part Number 00489-00002.

Add REAR SIDE COVER, HP Part Number 5000-8709.

Add HANDLE RETAINER ASSEMBLY, HP Part Number 5060-8737.

**CHANGE 2**

Page 6-6, Table 6-2:

Delete 489A-12H entry.

Delete 489A-12I entry.

**CHANGE 3**

Page 6-3, Table 6-2:

Change C18 to HP Part Number 0180-0094, C:FXD 100UF 25 VDC.

Page 8-9, Figure 8-14:

Change C18 value to 100 UF.

**CHANGE 4**

Page 6-6, Table 6-2:

Change XF1 to HP Part Number 2110-0470, FUSEHOLDER BODY.

Add HP Part Number 2110-0465, FUSEHOLDER CAP.

Add HP Part Number 2110-0467, FUSEHOLDER NUT, HEX 1/2 - 28.

Add HP Part Number 2190-0037, WASHER: LOCK.

Add HP Part Number 1400-0090, WASHER: FLAT NEOPRENE.

**CHANGE 5**

Page 6-6, Table 6-2:

Change HP Part Number 0370-0026 to 0370-1311, KNOB: GAIN ADJUST.

Delete 489A-43A (entire line).

Delete 00489-00002, FRONT PANEL.

Add HP Part Number 00489-00004, SUB PANEL.

Add HP Part Number 00489-00006, DECK: VERTICAL.

Add HP Part Number 00489-00005, FRONT PANEL (489A ONLY)

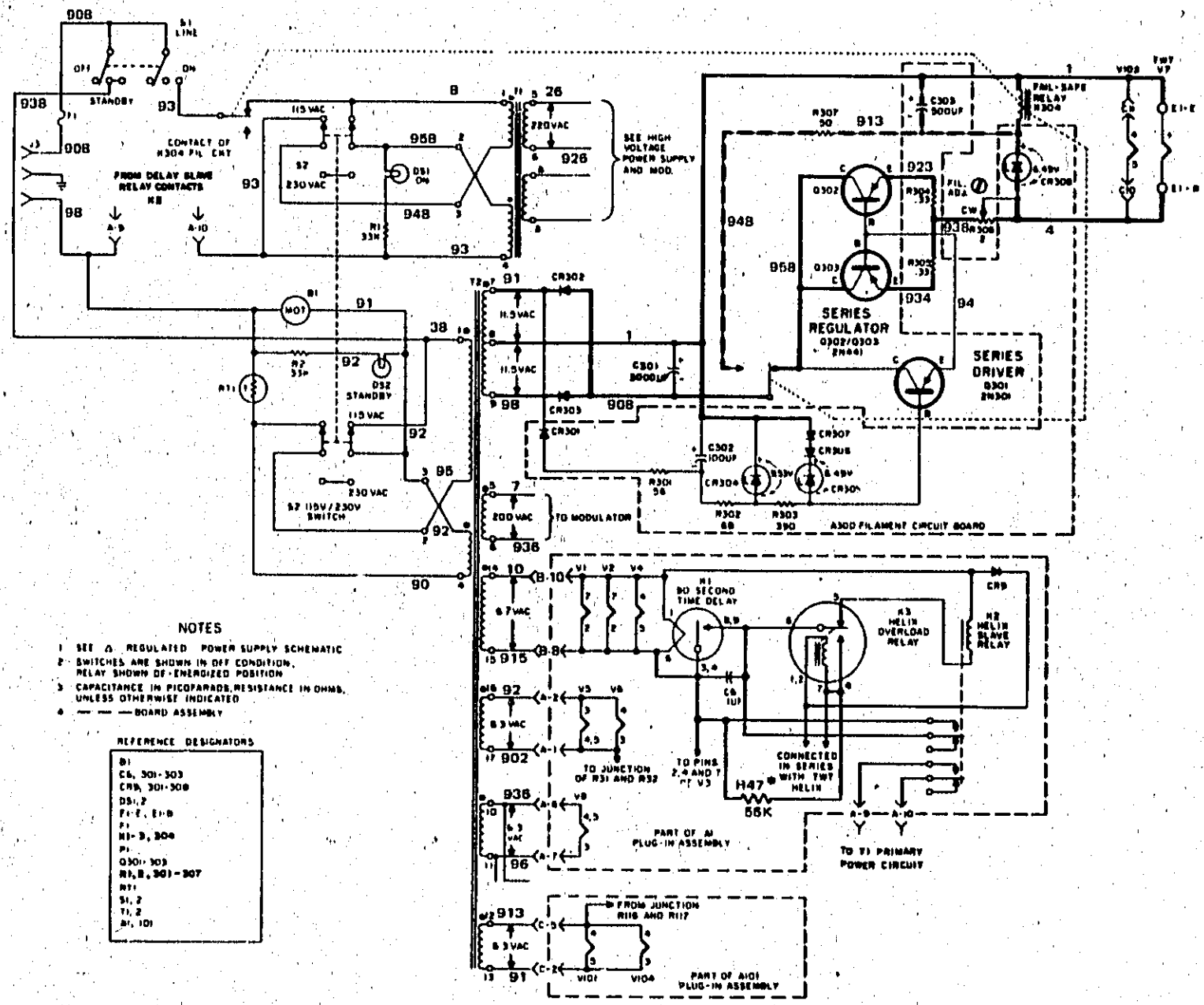
Add HP Part Number 00491-00002, FRONT PANEL (491C ONLY).

Add HP Part Number 7120-1254, LOGO.

**CHANGE 6**

Page 6-5, Table 6-2:

Change R120 to HP Part Number 2100-2736, R:VAR COMP 500K OHM 20% LIN 2W.



- NOTES**
- SEE Δ REGULATED POWER SUPPLY SCHEMATIC
  - SWITCHES ARE SHOWN IN OFF CONDITION, RELAY SHOWN DE-ENERGIZED POSITION
  - CAPACITANCE IN PICOPARADS, RESISTANCE IN OHMS, UNLESS OTHERWISE INDICATED
  - BOARD ASSEMBLY

**REFERENCE DESIGNATORS**

B1
C6, 301-303
CR9, 301-306
DS1, 2
F1, 2, E1-B
F1
N1-3, 304
P1
Q301, 303
R1, R, 301-307
R11
S1, 2
T1, 2
T1, 101

Figure 7-2. Primary Power and Regulated Filament Circuit Schematic (ERRATA)

**CONDITIONS OF WARRANTY  
FOR  
BACKWARD WAVE OSCILLATOR TUBES  
AND  
TRAVELING WAVE TUBES**

*Microwave (BWO, TWT) tubes are warranted to be free from manufacturing defects. The operating tube warranty will be 12 months unconditional from date of shipment from Hewlett-Packard. If a tube carrying this warranty fails and must be replaced, only the applicable remaining warranty of the first tube is transferred to the replacement tube, or 90 days, which ever is greater. The Hewlett-Packard Company will process warranty claims for customers on tubes which were supplied by Hewlett-Packard for use in Hewlett-Packard instruments. The serial number of the tube failing and the serial number of the replacement tube must be noted on the warranty claim form.*

*"In Warranty" tubes purchased from Hewlett-Packard must be returned immediately (not to exceed 30 days from date of failure) with a complete Warranty Claim Form, to your local Hewlett-Packard Sales and Service Office. Addresses are listed in the instrument Manual. Be sure to pack the tube in accordance with the Packing Instructions listed on the Warranty Claim Form; warranty allowance cannot be made on tubes received broken due to improper packaging or showing evidence of tampering.*

*Instructions for filing a warranty claim are listed on the "Microwave Tube Warranty Claim" form which is included with the Operating and Service Manual for your instrument. This form is also included with replacement Microwave tubes supplied by Hewlett-Packard. Additional copies may be obtained from your local Hewlett-Packard Sales and Service Office. (Please ref: HP Stock No. 9320-1865.)*

*Hewlett-Packard specified replacement tubes can be obtained from your local Hewlett-Packard Sales and Service Office.*

## SAFETY CONSIDERATIONS

### GENERAL

This product and related documentation must be reviewed for familiarization with safety markings and instructions before operation. This product has been designed and tested in accordance with international standards.

### SAFETY SYMBOLS



Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual (refer to Table of Contents).



Indicates hazardous voltages.



Indicates earth (ground) terminal.

#### WARNING

The WARNING sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

#### CAUTION

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.

### SAFETY EARTH GROUND

This is a Safety Class I product (provided with a protective earthing terminal). An uninterruptible safety earth ground must be provided from the main power source to the product input wiring terminals, power cord, or supplied power cord set. Whenever it is likely that the protection has been impaired, the product must be made inoperative and be secured against any unintended operation.

### BEFORE APPLYING POWER

Verify that the product is configured to match the available main power source per the input power configuration instructions provided in this manual.

If this product is to be energized via an autotransformer, make sure the common terminal is connected to the neutral (grounded side of mains supply).

### SERVICING

#### WARNING

*Any servicing, adjustment, maintenance, or repair of this product must be performed only by qualified personnel.*

*Adjustments described in this manual may be performed with power supplied to the product while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.*

*Capacitors inside this product may still be charged even when disconnected from its power source.*

*To avoid a fire hazard, only fuses with the required current rating and of the specified type (normal blow, time delay, etc.) are to be used for replacement.*