# OPERATING AND SERVICE MANUAL

-hp- Part No. 00461-90006

# MODELS 461A/462A
# WIDEBAND AMPLIFIERS

**Serials Prefixed: 946- (461A)**
**947- (462A)**

Appendix C, Manual Backdating Changes,
adapts manual to Serial Numbers:
946-03115 and below (461A)
947-01160 and below (462A)


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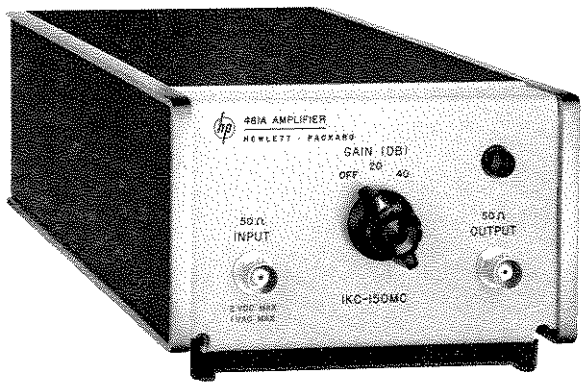



Model 461A
Wide Band Amplifier

Model 462A
Wide Band Amplifier


Figure 1-1. Hewlett-Packard Model 461A/462A
Wideband Amplifier

# SECTION I
# GENERAL INFORMATION

## 1-1. GENERAL INFORMATION.

1-2. The -hp- Model 461A Wide Band Amplifier is used primarily where flatness is important. The -hp- Model 462A Wide Band Amplifier is used primarily where rise time is important. The Model 461A frequency response is ± 1 dB from 1 kHz to 150 MHz. The Model 462A rise and fall times are less than 4 nanoseconds. Either 40 dB or 20 dB gain can be selected with the front panel GAIN (DB switch). The Models 461A and 462A are shown in Figure 1-1. The specifications for both instruments are given in Table 1-1.

1-3. Since the Models 461A and 462A are nearly identical, this manual will discuss the instruments in terms of the Model 461A. The Model 462A will be mentioned only when its operation differs from that of the Model 461A.

## 1-4. ACCESSORIES AVAILABLE.

1-5. The -hp- 11048C 50-ohm feedthrough termination is an available accessory that is connected at the output of the Model 461A. The feedthrough termination should be used to ensure that the Model 461A is operating into its rated impedance in the event the instrument is connected to a device with an impedance greater than 50 ohms.

Table 1-1. Specifications.

| MODEL 461A | MODEL 462A |
|---|---|
| Frequency Range: 1 kHz to 150 MHz. | Pulse Response:<br>Leading Edge and Trailing Edge<br>Rise Time: Less than 4 nanoseconds<br>Overshoot: Less than 5% |
| Frequency Response: +/-1 dB, 1 kHz to 150 MHz when operating into a 50 ohm resistive load (500 kHz reference). | Pulse Overload Recovery: Less than 1 us for 10 times overload. |
| Gain at 500 kHz: 40 dB +/-0.5 dB; or 20 dB +/-1.0 dB, selected by front panel switch (inverting). (20dBm) | Pulse Duration for 10% Droop: 30 us. |
| Input Impedance: Nominal 50 ohms. | Equivalent Input Noise Level: Less than 40 uV in 40 dB position when loaded with 50 ohms. |
| Maximum Input: 1 volt rms or 2 volts p-p pulse.* | Input Impedance: Nominal 50 ohms. |
| Maximum dc Input: +/-2 Volts.* | Maximum Input: 1 volt rms or 2 volts p-p pulse.* |
| Maximum Output: 1/2 volt rms into 50 ohm resistive load. +6.99dBm | Maximum dc Input: +/-2 Volts.* |
| Equivalent Wideband Input Noise Level: Less than 40 $\mu$V in 40 dB position when loaded with 50 $\Omega$. | Gain: 20 or 40 dB selected by front panel switch (inverting). |
| Distortion: Less than 5% at maximum output and rated load. | Maximum Output: 1 volt peak-to-peak into 50 ohm resistive load. +10 dBm |
| Overload Recovery: Less than 1 microsecond for 10 times overload. | Delay: 12-14 nanoseconds. |

*For the protection of the input circuitry.

Table 1-1. Specifications (Cont'd)

| GENERAL | |
|---|---|
| Power Supply: 115 or 230 V +/-10%, 48 to 440 Hz, 5 watts. | Weight: Net: 4 lbs (1,8 kg). Shipping: 5 lbs (2,3 kg.). |
| Dimensions: 5 1/8 in. (13 cm) wide, 3 in. (7,6 cm) high, 11 in. (27,9 cm) deep. | Accessory Furnished: Detachable power cord. |
| Accessory Available: -hp- 11048C, 50 ohm feedthrough termination. | |

## 1-6. INSTRUMENT IDENTIFICATION.

1-7. Hewlett-Packard uses a two-section serial number. The first section (prefix) identifies a series of instruments. The last section (suffix) identifies a particular instrument within the series. If a letter is included with the serial number, it identifies the country in which the instrument was manufactured. If the serial prefix of your instrument differs from the one on the title page of this manual, a change sheet will be supplied to make this manual compatable with newer instruments or the backdating information in Appendix C will adapt this manual to earlier instruments. All corresponcence with Hewlett-Packard should include the complete serial number.

# SECTION II
# INSTALLATION

## 2-1. INTRODUCTION.

2-2. This section contains information and instructions necessary for the installation and shipping of the Model 461A Amplifier. Included are initial inspection procedures, power and grounding requirements, installation information, and instructions for repackaging for shipment.

## 2-3. INITIAL INSPECTION.

2-4. This instrument was carefully inspected both mechanically and electrically before shipment. It should be free of mars and scratches and in perfect electrical order upon receipt. To confirm this, the instrument should be inspected for physical damage in transit. Also check for supplied accessories, and test the electrical performance of the instrument using the procedure outlined in Paragraph 5-5. If there is damage or deficiency, see the warranty on the inside front cover of this manual.

## 2-5. POWER REQUIREMENTS.

2-6. The Model 461A can be operated from any source of 115 or 230 volts (+/-10%), at 48 to 440 Hertz. With the instrument disconnected from the ac power source, move the 115/230 V slide switch on the rear panel until the desired line voltage appears. Power dissipation is 5 watts maximum.

## 2-7. GROUNDING REQUIREMENTS.

2-8. 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 three-prong connector is the ground wire.

2-9. To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter and connect the green pigtail on the adapter to ground.

## 2-10. INSTALLATION.

2-11. The Model 461A is fully transistorized; therefore, no special cooling is required. However, the instrument should not be operated where the ambient temperature exceeds 55° C (131° F) or the relative humidity exceeds 95%.

## 2-12. BENCH MOUNTING.

2-13. The Model 461A is shipped with plastic feet and tilt stand in place, ready for use as a bench instrument.

## 2-14. RACK MOUNTING.

2-15. The Model 461A may be rack mounted by using an adapter frame (-hp- Part No. 5060-0797). The adapter frame is a rack frame that accepts any combination of submodular units. It can be rack mounted only. For additional information, address inquiries to your -hp- Sales and Service Office. (See Appendix B for office locations.)

## 2-16. REPACKAGING FOR SHIPMENT.

2-17. The following paragraphs contain a general guide for repackaging of the isntrument for shipment. Refer to Paragraph 2-18 if the original container is to be used; 2-19 if it is not. If you have any questions, contact your local -hp- Sales and Service Office. (See Appendix B for office locations.)

NOTE

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

2-18. If original container is to be used, proceed as follows:

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

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

2-19. If original container is not to be used, proceed as follows:

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

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

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

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

# SECTION III
# OPERATING INSTRUCTIONS

## 3-1. INTRODUCTION.

3-2. The Model 461A can be used to faithfully amplify signals in the 1KHz to 150 MHz range. Gain settings of 20 dB or 40 dB may be selected with the front panel GAIN (DB) switch. The Model 461A will operate within specifications only when its output is terminated in 50 ohms.

## 3-3. FRONT AND REAR PANEL DESCRIPTION.

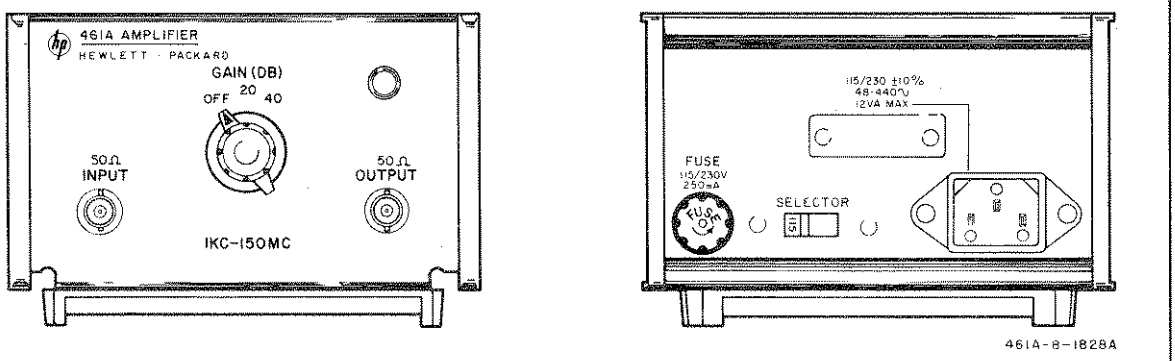
3-4. Figure 3-1 describes the function of all the controls and indicators on both the front and rear panel.

## 3-5. OPERATING INSTRUCTIONS.

3-6. Figure 3-2 contains the operating instructions for the Model 461A. Each instruction is keyed to a drawing of the front panel.

## 3-7. IMPEDANCE MATCHING.

3-8. Both the input impedance and the output impedance of the Model 461A are 50 ohms. The Model 461A output must be connected to a 50 ohm load if it is to operate within specifications. If the input impedance of the load is not 50 ohms, a terminating impedance of 50 ohms must be




(1) GAIN (DB) switch: Applies primary power and selects gain.

(2) 50 OHM INPUT connector: Connects input signal to the instrument. DO NOT APPLY MORE THAN 1 VAC OR 2 VDC TO INPUT.

(3) 50 OHM OUTPUT connector: Connects amplified output to load. Output must be terminated in 50 ohm. VOLTAGE LEVEL AT OUTPUT MUST NOT EXCEED -6 VOLTS DC OR +0.6 VOLTS DC.

(4) AC POWER connector: Connects primary power to the instrument.

(5) LINE VOLTAGE: Selects either 115 volts ac or 230 volts ac primary power.

(6) Fuseholder: Contains a 1/4 ampere fast-blow fuse for both 115 and 230 volt operation.

Figure 3-1. Front and Rear Panel Description

connected across the Model 461A output. The -hp- Model 11048C 50 ohm Feedthrough Termination is recommended for this purpose. The Model 11048C may be easily connected in series with the Model 461A output.

## 3-9. CASCADING AMPLIFIERS.

3-10. The Model 461A will amplify small signals in the 5 to 50 millivolt range to an amplitude of 0.5 volts with minimum distortion. Three 651A's or 652A's can be cascaded with a minimum input of 40 microvolts. For protection of the first instrument, a diode voltage limiter with two diodes in parallel (see Figure 3-3) can be used. To protect the diodes at high voltages a 500 ohm resistor must be placed in series with the input signal. In doing this a ten to one attenuation is obtained for the first amplifier. Therefore the first amplifier must be set to 40 dB gain while the other two should be set to 20 dB gain. The second two amplifier inputs are protected by the clipped output of the preceding amplifier. Should larger output signals be desired, the Model 461A's can be cascaded with other amplifiers. Concerning frequencies from 10 MHz to 150 MHz, the -hp- 230A Power Amplifier can be used in the fourth cascade position.

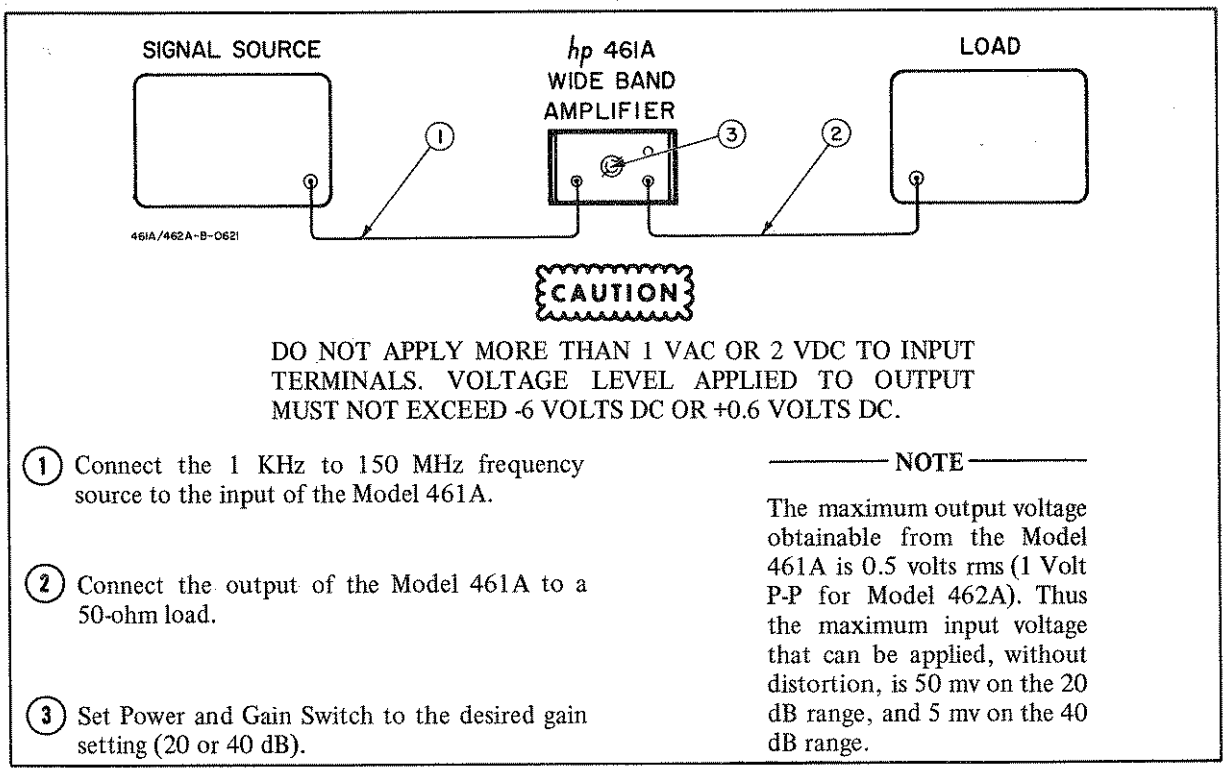



Figure 3-2. Operating Instructions

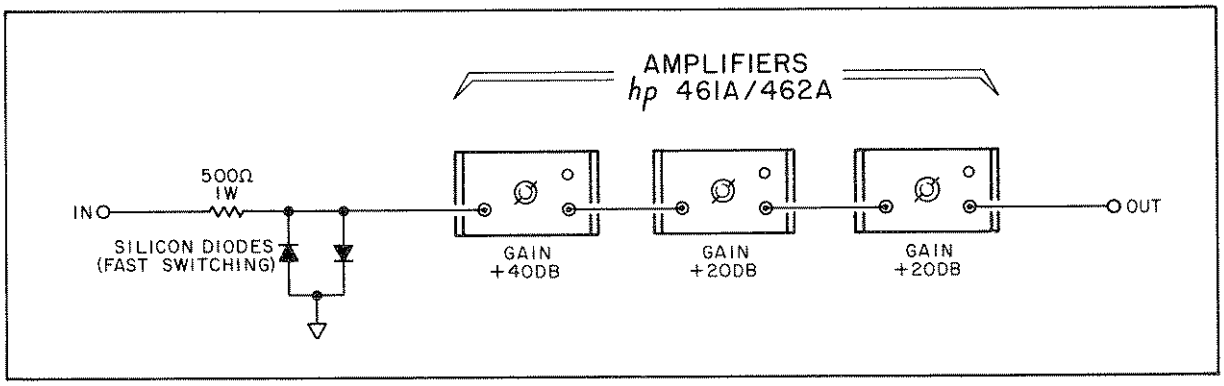



Figure 3-3. Cascading 461A or 462A Amplifiers with Input Protective Circuit

# SECTION IV
# THEORY OF OPERATION

## 4-1. GENERAL DESCRIPTION.

4-2. The Models 461A and 462A Amplifiers are essentially identical. In the Model 462A some of the component values are changed slightly to improve its pulse response. In this section both instruments will be presented in terms of the Model 461A.

4-3. Figure 4-1 shows a simplified block diagram of the Model 461A. The amplifier is a five stage, stagger-tuned, cascaded amplifier with emitter follower input and output stages. The gain is switched from 40 dB to 20 dB by attenuating the input by 20 dB. The power supply is a conventional series regulated supply with +15 volt and -15 volt outputs.

## 4-4. AMPLIFIER CIRCUITS.

4-5. Figure 5-12 shows the schematic diagram of the Model 461A. A3Q3 is the input emitter follower, matching the 50 ohm input impedance to the input impedance of the amplifier. Transistors A3Q4 through A3Q8 constitute a five stage, RC coupled, cascaded amplifier. Each stage has a gain of 8.4 dB. 2 dB is lost in the input and output emitter followers, giving the amplifier a total gain of 40 dB.

4-6. Each stage has an an LR feedback circuit with an adjustable inductor. The feedback circuit in each stage controls the overall gain of the amplifier at a different frequency, so the amplifier must be stagger-tuned. There is some interaction between the stages at certain frequencies. A3Q9 is the output emitter follower, and it matches the amplifier output to a 50 ohm output impedance.

## 4-7. POWER SUPPLY.

4-8. The power supply generates +15 volts and -15 volts bias supply to the amplifiers. Breakdown diode A2CR3 establishes a 15 volt reference. Control transistor A2Q2 detects differences between the reference voltage and the supply output, and its output controls the series regulator Q1.

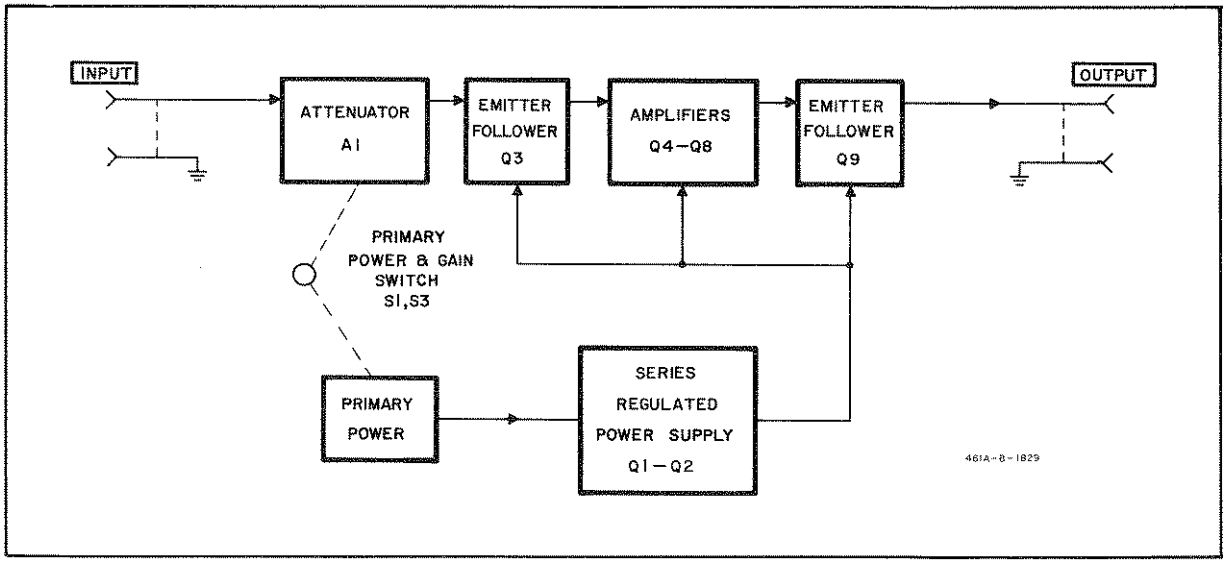



Figure 4-1. Simplified Block Diagram

Table 5-1. Test Equipment Required

| INSTRUMENT TYPE | CRITICAL SPECIFICATIONS | USE | RECOMMENDED MODEL |
|---|---|---|---|
| Wide Range Oscillator | Output: 0.5 volts<br>Impedance: 50 ohms<br>Freq. Range: 1 kHz to 10 MHz<br>Level: 0.5%<br>Distortion: less than 0.5% | Low Freq. Response and Gain Check | -hp- Model 654A Test Oscillator |
| Logarithmic Voltmeter | Accuracy: +/-1% reading to +/-5% reading<br>Freq. Range: 1kHz to 10 MHz<br>DB range: -80 dB to +50 dB | Calibration, Low Freq. Response and Gain Check | -hp- Model 400EL AC Voltmeter |
| Attenuator | Attenuation: 20 dB<br>Accuracy: 0.1 dB (1 kHz to 150 MHz) | Gain Check<br>Freq. Response Check and Calibration | -hp- Model 8491A Option 20 with known accuracy |
| Attenuator | Attenuation: 40 dB<br>Accuracy: 0.1 dB (1 kHz to 150 MHz | Gain Check<br>Freq. Response Check and Calibration | -hp- Model 8491A Opiton 40 with known accuracy |
| Distortion Analyzer | Freq. Range: 1 kHz to 500 kHz<br>Sensitivity: Measure 5% Distortion<br>Accuracy: +/-3% | Distortion Check | -hp- Model 331A, 333A or 334A Distortion Analyzer |
| RF Millivolt-meter | Freq. Range: 500 kHz to 150 MHz<br>Accuracy: from +/-3% to +/-5% f.s.<br>DB Range: -50 to +20 dBm | Frequency Response Check and Calibration | -hp- Model 3406A RF Sampling Voltmeter |
| Multimeter including DC Voltmeter | Accuracy: +/-1% of full scale<br>Input Resistance greater than 10 Megohm | Power Supply Checks and Troubleshooting | -hp- Model 412A Volt-Ohm-Ammeter |
| Signal Generator Sweeper | Freq. Range: 100 kHz to 110 MHz<br>Output: 0.5 V<br>Flatness: 0.20 dB over full range<br>Impedance: 50 ohms | High Freq. Response Check and Adjustment | -hp- Model 8601A Generator/Sweeper |
| Oscilloscope | Bandwidth: dc to 50 MHz with horizontal magnifier<br>Sensitivity: 0.005V/cm to 20V/cm | Pulse Droop Calibration and Overload Check | -hp- Model 180C Oscilloscope with 1801A and 1820A plug-ins |

# SECTION V
# MAINTENANCE

## 5-1. INTRODUCTION.

5-2. This section uses the following sequence: Performance Checks, Cabinet Removal, Calibration Procedure, Troubleshooting, and Repair.

## 5-3. TEST EQUIPMENT REQUIRED.

5-4. The critical specifications and suggested test equipment needed in the performance and calibration procedures are given in Table 5-1.

## 5-5. PERFORMANCE CHECKS.

5-6. The performance checks are in-cabinet procedures that are used to check the instrument against its specification. These procedures can be used as periodic maintenance, after repair or incoming and outgoing quality control checks. The performance checks should be conducted before any attempt is made to calibrate the instrument. A Performance Check Test Card is provided at the end of this section for recording the performance of the instrument during the performance checks. The card can be removed from the manual and used as a permanent record of the incoming inspection or of a routine performance check.

Table 5-1. Test Equipment Required (Cont'd)

| INSTRUMENT TYPE | CRITICAL SPECIFICATIONS | USE | RECOMMENDED MODEL |
|---|---|---|---|
| Pulse Generator | Impedance: 50 ohms<br>Leading and Trailing Edge: less than 1 ns<br>Overshoot and Ringing: less than 5% peak<br>Pulse Width: 30 ns | Pulse response and calibration | -hp- Model 8004A Pulse Generator |
| Square Wave Generator | Frequency: 500 kHz<br>Amplitude: 1 V p-p into 50 ohms | Pulse droop check and overload check | -hp- Model 209A Oscillator (square wave output) |
| Frequency Doubler | Input Impedance: 50 ohms<br>Freq. Range: 1 MHz to 80 MHz input | High frequency response adjustment | -hp- Model 10515A Frequency Doubler |
| 50 ohm Coaxial Termination | Frequency range: 1 kHz to 150 MHz<br>Termination: 50 ohms | Frequency Response Adjustment | -hp- Model 11048C 50 ohm feedthrough load |
| RF Detector | Frequency range: 1 MHz to 160 MHz<br>SWR: 1.3 | High Frequency Response Adjustment | -hp- Model 8471A RF Detector |
| Sampling Oscilloscope | Frequency: to GHz range<br>Rise Time: less than 350 ps<br>Dual Vertical Channels<br>Amplitude: 0.5 volts for 5 50 ohm input | Pulse Response and Delay Checks | -hp- 180C with 1810A/1815A/B Oscilloscope with Sampling Time base and Vertical Plug-ins |

(Table 5-1 cont'd on page 5-2)

5-7. Checks for the Models 461A and 462A are provided. The heading of each paragraph indicates whether the procedure is applicable to one or both instruments.

## 5-8. 500 kHz GAIN CHECK (461A AND 462A); OUTPUT VOLTAGE CHECK (461A).

**NOTE**

An -hp- Model 651B or 652A Oscillator can be used in place of the 654A if the output of the oscillator is monitored by the ac voltmeter at each change of frequency and the oscillator output is adjusted each time to the reference level.

a. Connect the test equipment as in Figure 5-1; connect the oscillator with the 50 ohm load to the ac voltmeter (position A).

b. Set the oscillator frequency to 500 kHz and the oscillator amplitude to read 0 dB on the -10 dB range of the ac voltmeter.

c. Connect the ac voltmeter as in Figure 5-1, position B, using the 40 dB attenuator and the 40 dB GAIN range of the 461A.

d. The ac voltage readings in position A and B should differ by +/-0.5 dB or less.

e. (461A only). With the test setup as in Figure 5-1, position B, slowly increase the

Table 5-1. Test Equipment Required (Cont'd)

| INSTRUMENT TYPE | CRITICAL SPECIFICATIONS | USE | RECOMMENDED MODEL |
|---|---|---|---|
| Variable Line Transformer | Output Voltage: to 127 V ac (or 253 V ac) | Power Supply Check | Superior Electric Powerstat 3PF116 (for 115 V line) 3PF216 (for 230 V line) |
| Decade Attenuator | Attenuation: 60 dBm in 10 dB steps Impedance: 50 ohms Frequency: 1 kHz to 150 MHz | Pulse Response and Delay Check | -hp- 355D VHF Coaxial Attenuator |
| BNC "T" Adapter | UG-274 B/U | Pulse Response and Delay Check | -hp- 1250-0781 |
| Male BNC to Male BNC Adapter | UG-491A/U | Calibration and Frequency Response | UG-491A/U |
| BNC Male to Probe Jack Adapter | Used with 1410A Oscilloscope plug-in | Pulse Response and Delay Check | -hp- 10011B (2 each) |
| BNC to type GR-874 Adapter | Used with 1410A Oscilloscope plug-in | Pulse Response and Delay Check | -hp- 0874-9700 |
| Type N Male to BNC Adapter | UG-1034/U | Calibration, Frequency Response and Gain Check | -hp- 1250-0067 Adapter |
| BNC to Type N Female Adapter | UG-349A/U | Calibration, Frequency Response and Gain Check | -hp- 1250-0077 Adapter |

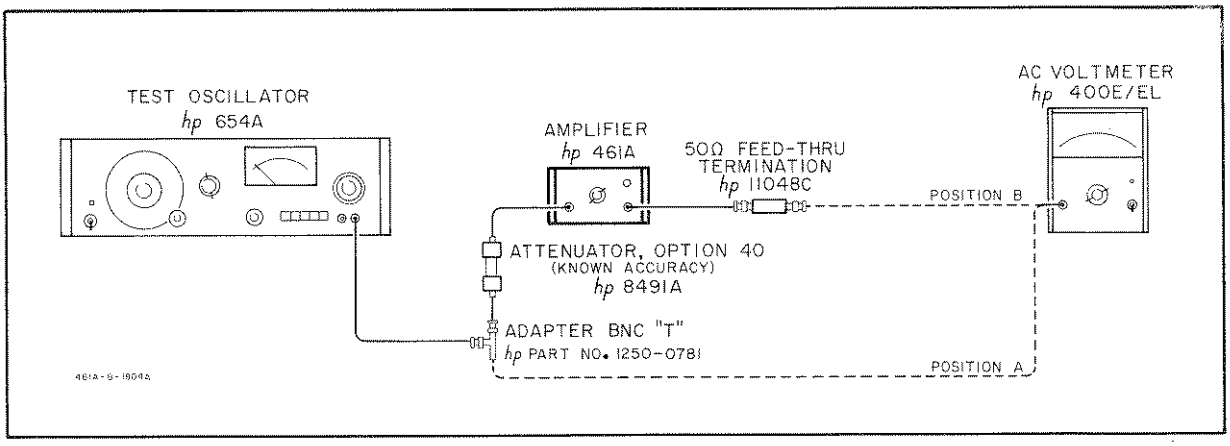



Figure 5-1. Gain Check Setup

amplitude of the oscillator until 0.5 volts is read on the ac voltmeter. This verifies that the 461A will produce an output of 0.5 volts rms.

f. (461A and 462A). Decrease the oscillator's amplitude to minimum and change the 40 dB attenuator to the 20 dB attenuator.

g. Repeat steps a through c using the 20 dB attenuator and the 20 dB GAIN range of the 461A.

h. The ac voltage readings in position A and B should differ by +/-1 dB or less.

## 5-9. LOW FREQUENCY RESPONSE CHECK (461A).

a. Connect the 461A as in Figure 5-1, position B using the 40 dB attenuator and the 461A on the 40 dB GAIN range.

b. Set the oscillator frequency to 500 kHz and adjust its amplitude to read 0 dB on the -10 dB range of the ac voltmeter.

c. Change the oscillator frequency from 1 kHz to 10 MHz and at each frequency measure the voltage at position A and B (this eliminates the frequency response error of the ac voltmeter).

d. The ac voltmeter readings at position A and B should not vary more than +/-1 dB for any one frequency.

e. Record the error at 2 MHz for use in paragraph 5-12. The reference for high frequency response must be at 500 kHz.

## 5-10. DISTORTION CHECK (461A).

a. Connect the 461A as in Figure 5-2, with the Distortion Analyzer connected as in position A.

b. Set the oscillator frequency to 500 kHz and amplitude to minimum.

c. Set the distortion analyzer's FUNCTION switch to VOLTMETER and METER RANGE to 1 volt.

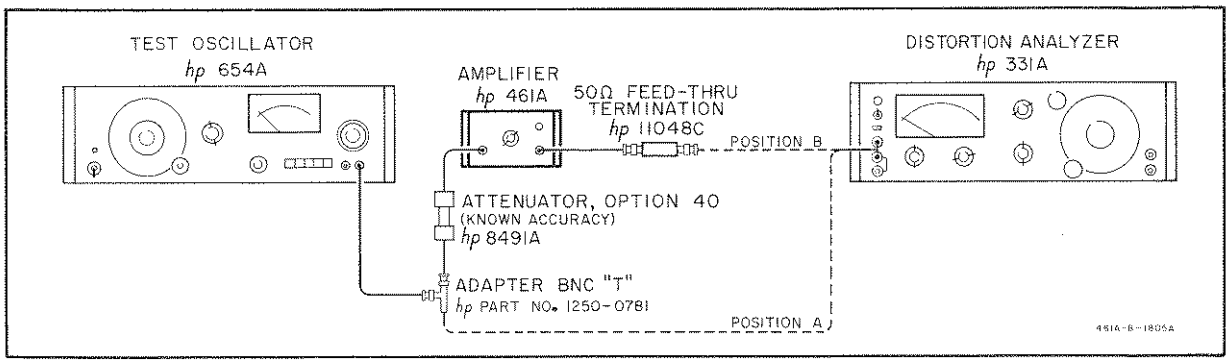



Figure 5-2. Distortion Check Setup

d. Adjust the output amplitude of the oscillator for a 0.5 volt reading on the meter.

e. Measure the distortion of the oscillator (Figure 5-2, position A).

f. Connect the Distortion Analyzer as in Figure 5-2, position B.

g. Measure the distortion. The difference in this distortion measurement and that in step e should be less than 5%.

## 5-11. NOISE CHECK (461A and 462A).

a. Disconnect the input signal from the 461A.

b. Terminate with 50 Ω load (-hp- 11048C).

c. Connect the output of the 461A to an RF Voltmeter.

d. Place the 461A GAIN (DB) control to 40 dB.

e. The RF Voltmeter should indicate 4 millivolts or less.

## 5-12. HIGH FREQUENCY RESPONSE CHECK (461A).

a. Connect the 461A as in Figure 5-3, position B, using the 40 dB attenuator and turning the signal generator output to minimum.

**NOTE**

Use short cables and eliminate cables entirely when possible.

b. Adjust the signal generator frequency to 1 MHz (2 MHz from the frequency doubler) and the 461A GAIN (DB) control to 40 dB.

c. Increase the amplitude of the signal generator to read 0 dB on the 0 dB range of the RF Voltmeter (include the variation from the 500 kHz reference as recorded in paragraph 5-9, step e).

d. Connect the ac voltmeter as in Figure 5-3, position A. Record the voltmeter reading for an input reference level.

e. Change the signal generator to 10 MHz and adjust the signal generator output to the reference level in step d.

f. Connect as in position B. The ac voltmeter must read the reference at 500 kHz (0 dB on the 0 dB range) +/-1 dB or less.

g. Repeat steps e and f for frequencies of 25 MHz, 50 MHz and 75 MHz (50, 100 and 150 MHz output of the frequency doubler).

h. If the frequency response is not within specifications refer to the calibration procedure paragraph 5-23.

j. Connect the circuit in Figure 5-3 using the 20 dB attenuator and placing the 461A in the 20 DB GAIN position. Repeat steps b through g. If the frequency response is not within +/-1 dB refer to Troubleshooting paragraph 5-31 and Table 5-2.

## 5-13.PULSE RESPONSE CHECK (462A).

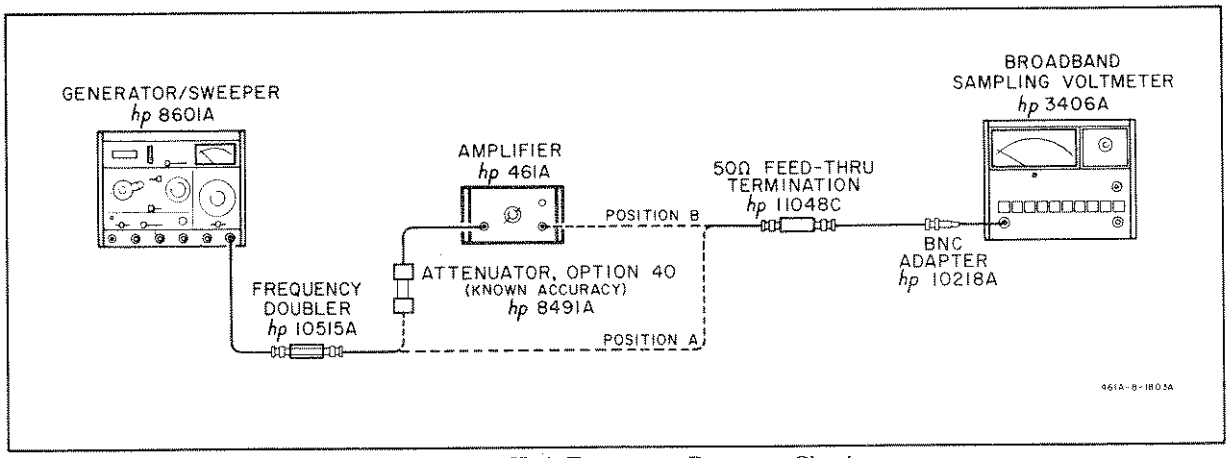



Figure 5-3. High Frequency Response Check

a. Connect the 462A as shown in Figure 5-4, position A.

b. Set the Pulse Generator as follows:

Trigger Source . . .INT. FREQ. .1 to 1 MHz.
Pulse width . . . . . 30 ns
Attenuator . . . . . .10
Pulse polarity . . . . . PLUS (+)

c. Connect the pulse output to the input of the attenuator.

d. Set the attenuator to 20 dB and connect the output of the attenuator to the vertical input channel A. Use a BNC to GR type 874 adapter and internally trigger the sweep.

e. Set the Oscilloscope Sampling Timebase Plug-in as follows:

Main/Delay switch . . . . . .MAIN
Main Sweep Trigger
slope . . . PLUS (+) (located at top right)
Int/Ext switch . . . . . .INT.
Time/cm . . . . . 10 ns
Sweep Multiplier . . . . . .2
Sync pulse . . . . . .ON

f. Adjust the vertical and horizontal position for one pulse and adjust trigger level for optimum trace.

g. Adjust vertical millivolts/cm for a 10 cm pulse. The pulse width should be 6 cm (5ns/cm).

h. Observe the rise time, fall time and flatness of the input pulse.

j. Check the rise time and fall time in ns (time from 10% to 90% of the leading or trailing edge of the pulse (the middle 8 cm). If this is greater than 1 ns call it $TR_1$ for the formula in step m.

k. Connect the 462A as in Figure 5-4, position B. Increase the attenuator to 60 dB and set the 462A GAIN (DB) control to 40 dB. Reverse the polarity of the input pulse to eliminate readjustment of the oscilloscope.

m. Measure the rise time and fall time of the 462A output pulse ($TR_2$) as in step j. If the rise time of the input pulse was less than 1 ns, the output rise time must not exceed 4 ns. Otherwise, apply the following formula:

$$\text{Rise time of the 462A } (TR_0) = \sqrt{(TR_2)^2 - (TR_1)^2}$$

The overshoot and undershoot of the output pulse should exceed that observed on the input pulse by less than 5%.

n. If the output pulse is not within specifications, refer to paragraph 5-26 for calibration procedure.

## 5-14. PULSE DELAY TIME CHECK. (462A).

a. Connect the 462A as shown in Figure 5-5.

b. Connect the pulse generator to the attenuator and set the controls as in paragraph 5-13, step b.

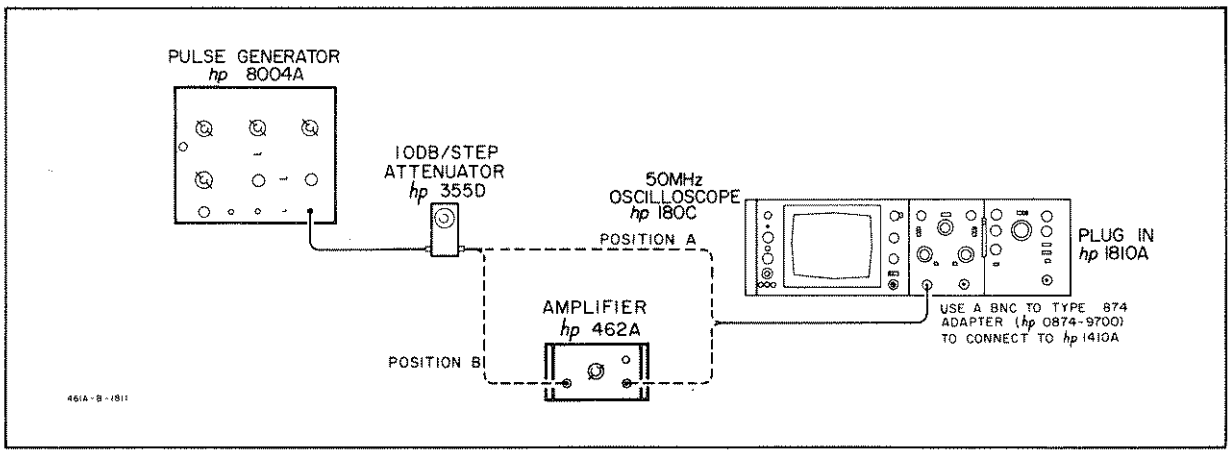



Figure 5-4. Pulse Response Check Setup

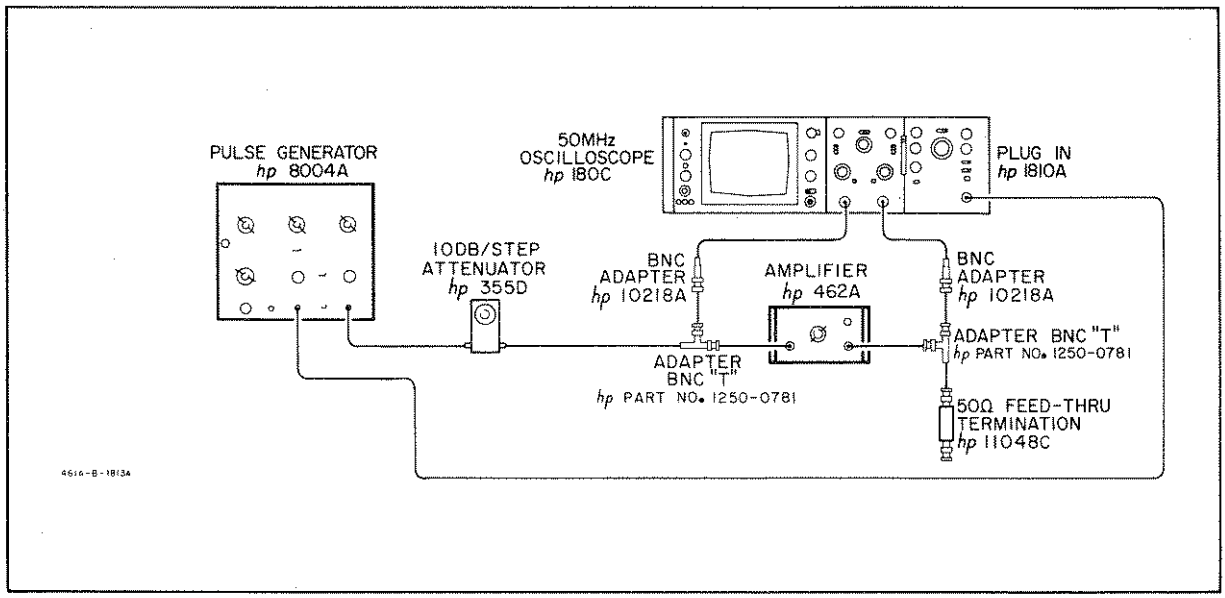



Figure 5-5. Pulse Delay Check Setup

c. Connect the probe of the oscilloscope, channel A, to the output of the attenuator through an adapter and a BNC "T". Set the attenuator to 60 dB.

d. Use an external trigger from the pulse generator and adjust trigger Mode and slope for a pulse on the oscilloscope.

e. Connect the output of the 462A to the probe of the oscilloscope, channel B, through a 50 ohm load. Adjust both pulse widths to 3 cm so that 1 cm on the scope will be 10 ns.

f. The midpoint of the leading edges of the input pulse and the output pulse should differ by 12 to 14 ns.

## 5-15. MAXIMUM OUTPUT CHECK (462A).

a. With the 462A connected as in Figure 5-5, channel "B", increase the amplitude of the pulse generator until a 1 volt peak-to-peak pulse is observed on the oscilloscope. This verifies the maximum output of the 462A Pulse Amplifier.

## 5-16. PULSE DURATION CHECK (462A).

a. Connect the 462A as in Figure 5-6, position A.

b. Adjust the square wave generator for a 30 us pulse (16.6 kHz) displayed on the oscilloscope with less than 0.01 volts peak-to-peak voltage. Observe the flatness of the pulse.

c. Connect the circuit as in Figure 5-6, position B, keeping all leads as short as possible. Set

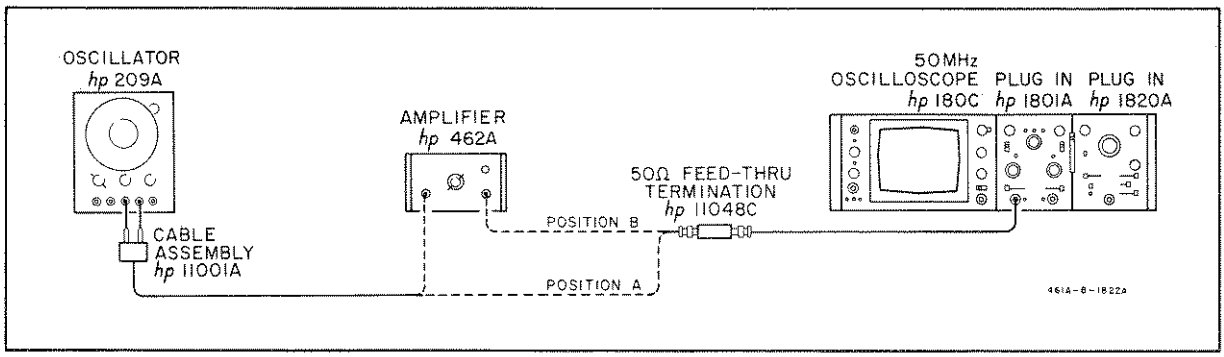



Figure 5-6. Pulse Duration Check

the 462A to 40 dB gain. The pulse must have less than 10% more droop than that observed in step b. Observe the pulse droop at both 20 dB and 40 dB gain of the 462A. (Dual trace can be used on the oscilloscope to show input and output simultaneously.)

## 5-17. OVERLOAD RECOVERY CHECK (461A and 462A).

**NOTE**

The maximum output of the 461A is 0.5V rms or 1.4 volt peak-to-peak. The maximum output of the 462A is 1 volt peak-to-peak. Using these values, the maximum input signal, without clipping, is 0.14 volts peak-to-peak for the 20 dB GAIN range and 0.014 volts peak-to-peak on the 40 dB GAIN range for the 461A. For the 462A the maximum input is 0.1 volt peak-to-peak on the 20 dB GAIN range and 0.01 volt peak-to-peak on the 40 dB GAIN range. For specifications on overload recovery, 10 times these voltages should be the input voltage and recovery time should be less than 1 us.

a. Connect the circuit as in Figure 5-6, position A.

b. Adjust the square wave generator for a 1 us pulse (500 kHz) at 1 volt peak-to-peak as observed on the oscilloscope. Overshoot or ringing on the 461A input signal will show up on the output and it is not contributed by the amplifier.

c. Connect the circuit as in Figure 5-6, position B, with the 461A or 462A in the 20 dB GAIN position. The base line, or level after the pulse, should be restored within 1 us after the trailing edge of the pulse. (Dual channels of the oscilloscope can be used to show input and output pulses simultaneously).

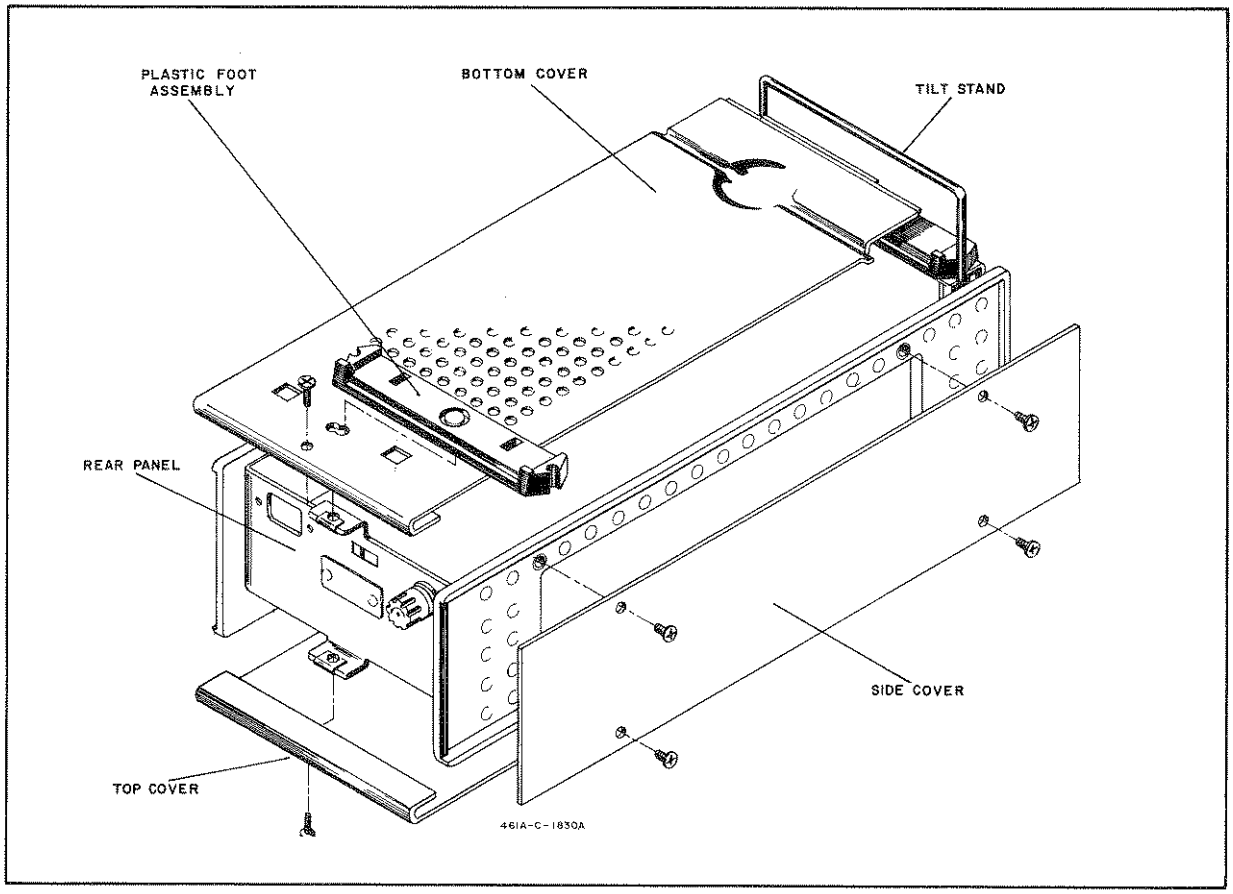



Figure 5-7. Panel Removal and Replacement

## 5-18. PANEL REMOVAL AND REPLACEMENT.

5-19. The Model 461A contains top, bottom and two side panels. For maintenance and calibration, only top or bottom covers need be removed. Side panel removal will be necessary only when replacing front or rear panel etc. Panel removal is illustrated in Figure 5-7.

a. Remove ac power from the Model 461A.

b. Remove the 6/32 screws that hold the panel in place.

c. Remove the panel.

d. When replacing the panel, simply reverse the order.

## 5-20. CALIBRATION PROCEDURE.

5-21. The following is a complete test and adjustment procedure and should be made only if it has been determined that the -hp- Model 461A is out of adjustment as determined by Paragraph 5-5, Performance Check. Indiscriminate adjustment of the internal controls to "refine" settings may actually cause difficulty. Calibration procedures for the Models 461A and 462A are provided. The heading of each paragraph indicates whether the procedure is applicable to one or both instruments.

### 5-22. POWER SUPPLY (461A and 462A).

a. Remove top and bottom covers from Model 461A cabinet (refer to Figure 5-7).

b. Connect Model 461A to a Variable Transformer. Set line voltage to 115 volts.

c. Connect common lead of DC Voltmeter (-hp- Model 412A) to -hp- Model 461A chassis ground and VOLTS probe to terminal No. 6 of Transformer T1 (red wire). Refer to Figure 5-10.

d. The DC Voltmeter should indicate +15 +/-2 volts.

e. Vary input line voltage with variable transformer from 103 to 127 volts. DC Voltmeter reading should not change by more than 0.5 volts from the reading observed in step d.

f. Connect VOLTS probe of DC Voltmeter to emitter of Q1 (yellow wire).

d. The DC Voltmeter should indicate +15 +/-2 volts.

e. Vary input line voltage with variable transformer from 103 to 127 volts. DC Voltmeter reading should not change by more than 0.5 volts from the reading observed in step d.

f. Connect VOLTS probe of DC Voltmeter to emitter of Q1 (yellow wire).

g. DC Voltmeter should indicate -15 volts +/-2 volts.

h. Vary input line voltage with variable transformer from 103 to 127 volts. DC Voltmeter reading should not change by more than 0.5 volts from the reading observed in step g.

j. Measure the ac voltage (-hp- Model 400EL) between emitter of Q1 and ground; ripple voltage must be less than 1 mv for any rated line voltage.

### 5-23. GAIN CALIBRATION (461A and 462A).

a. Connect the 461A as shown in Figure 5-1, using the 40 dB attenuation.

b. Connect the ac voltmeter to position "A" and adjust the output of the oscillator for a reading on the ac voltmeter of -10 dB.

c. Connect the ac voltmeter to position "B" and set the 461A to the 40 GAIN (DB) position.

d. The ac voltmeter should read -10 dB +/-0.5 dB. If not, change the value of A3R18 until the ac voltmeter does read -10 dB +/-0.5 dB. The value of A3R18 is typically 4.7 ohm to 13 ohm. To increase the amplitude, decrease the size of A3R18 and vice versa. If A3R18 will not correct the gain, change the value of A3R29 in like manner. Refer to page 5-13 for possible resistor values.

e. Change the 461A to the 20 GAIN (DB) position. The ac voltmeter should read -30 dB +/-1.0 dB. If the 20 dB position is out of tolerance, refer to Table 5-2.

### 5-24. FREQUENCY RESPONSE CALIBRATION (461A).

NOTE

The test equipment in Figure 5-3 must be used for an accurate check and for a final adjustment for high frequency response. L2 through L6 should not have to be adjusted unless some component is changed in the feedback path. If the coils have to be adjusted, carefully peel away the cement, turn the coil with a plastic tuner and when the alignment is finished, cement the coils again with Duco cement. Refer to Figure 5-11 for location of coils.

a. Connect the test setup as in Figure 5-3 and repeat paragraph 5-12, steps a through g.

b. If the amplitude is slightly out of specifications at 50 MHz (25MHz on the Generator/Sweeper) adjust L2. From 75 MHz to 120 MHz adjust L3 and L4. If the amplitude rolls off approximately 5 dB at 100 MHz (50 MHz on Generator/Sweeper), refer to Troubleshooting Tips, Table 5-2.

c. If the amplitude is slightly out of specifications from 120 MHz to 150 MHz adjust L5 and L6 (Repeat step g paragraph 5-12 several times until flatness is obtained.)

d. When the frequency response is within specification on the 461A GAIN 40 dB position change the attenuator to 20 dB and the 461A GAIN (DB) control to 20 dB position. Repeat step g, paragraph 5-12. If the amplitude falls off at 120 MHz to 150 MHz, refer to Troubleshooting Tips, Table 5-2.

## 5-25. PRELIMINARY FREQUENCY RESPONSE ALIGNMENT.

NOTE

This procedure should only be used when the high frequency response is completely out of alignment and not quickly adjustable by paragraph 5-24.

a. Connect the 461A as shown in Figure 5-8. Set the 8601A Generator/Sweeper as follows:

Frequency . . . . . 80 MHz (Doubled)
Sweep . . . . . Video
Sweep Mode . . . . . fast
Sweep Mode vernier . . completely clockwise
Adjust output level to value used in paragraph 5-12, step c. (Approximately 0.3 volts).

b. 1. Set the 180A/1801A/1820A Oscilloscope as follows:

2. Connect the 8601A Sweep out to Horizontal EXT input.
AC/DC switch . . . . . DC
Magnifier . . . . . X5
Display . . . . . EXT Sens

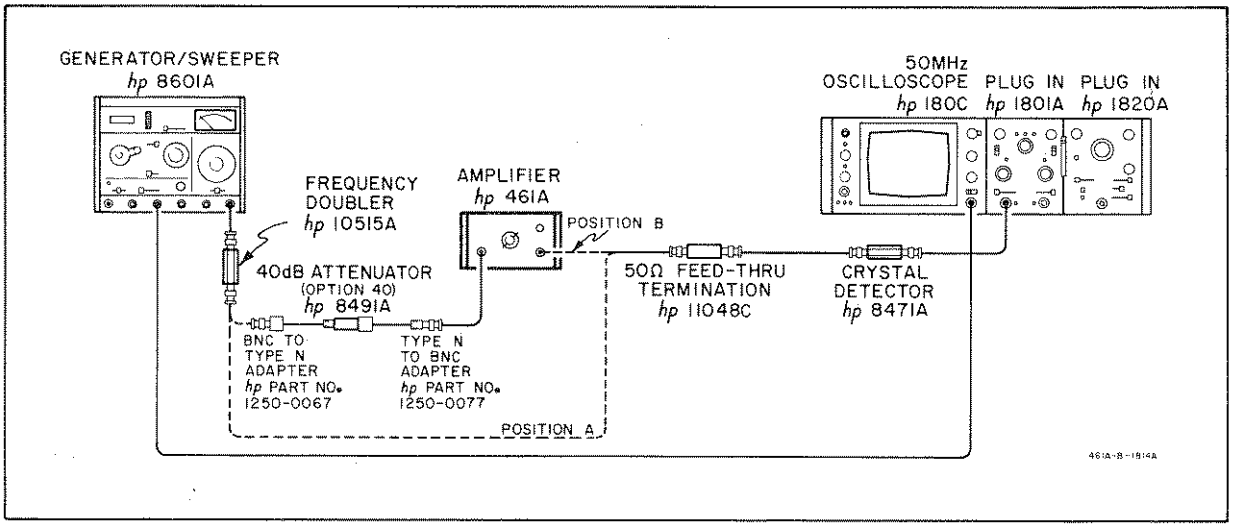



Figure 5-8. Preliminary Frequency Response Calibration Setup

3. Adjust Horizontal position to start sweep at left at side of display.

4. Adjust sweep length for 8 cm (20 MHz per cm).

5. Set vertical display to A.

6. Adjust A position for a display at bottom of the screen.

7. Set the polarity switch to "+ up".

c. Connect the circuit as in Figure 5-8, position A. Draw the sweep trace on the face of the oscilloscope.

d. Connect the circuit as in Figure 5-8, position B. (Slight variations are due to the cut-off frequency of the 461A.) Adjust the coils L2 through L6 as described in paragraph 5-24 making the trace correspond as near as possible to the trace on the oscilloscope. Work back and forth between the coils as there is an intermingled effect between coils.

e. When the scope trace and the mark on the scope correspond as nearly as possible, recheck Gain calibration Paragraph 5-23, steps a thru e and Frequency Response calibration Paragraph 5-24, steps a thru d.

## 5-26. PULSE RESPONSE CALIBRATION (462A).

a. Connect the Model 462A as shown in Figure 5-4, position A.

b. Set the Pulse Generator as follows:

Trigger Source . . . INT. FREQ. .1 to 1 MHz
Pulse width . . . . . 30 ns
Attenuator . . . . . .10
Pulse polarity . . . . . PLUS

c. Connect the pulse output to the input of the attenuator.

d. Set the attenuator to 20 dB and connect the output of the attenuator to the vertical input channel A. Use a BNC to GR type 874 adapter and internally trigger the sweep.

e. Set the Oscilloscope Sampling Timebase Plug-in as follows:

Main/Delay switch . . . . . .MAIN
Main Sweep Trigger-
Slope . . . . . PLUS (located at top right)
Int/Ext switch . . . . . INT
Trigger Level/Mode
control . . . . . AUTO
Time/cm . . . . . 10 ns
Sweep Magnifier . . . . . .2
Sync pulse . . . . . On

f. Adjust the vertical and horizontal position for one pulse (adjust trigger level for optimum trace).

g. Adjust vertical millivolts/cm for a 10 cm pulse. The pulse width should be 6 cm (5 ns/cm).

h. Observe the rise time fall time (middle 8 cm of height) and flatness of the input pulse. If the rise time is greater than 1 ns apply formula paragraph 5-13, step m to the resultant rise time on the scope.

j. Connect the 462A as in position B of Figure 5-4. Change the attenuator to 60 dB and set the 462A to 40 dB gain. Reverse the polarity of the pulse generator as the 462A output is of opposite polarity.

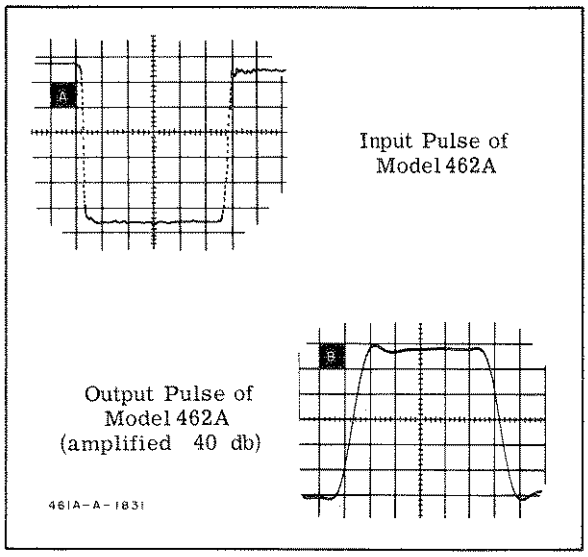



Figure 5-9. Input and Output Pulses of 462A

k. Make slight amplitude adjust if necessary on oscilloscope and repeat step h. If the rise time is too long (4 ns or result of formula paragraph 5-13) adjust L2 to increase the pulse amplitude and decrease rise time.

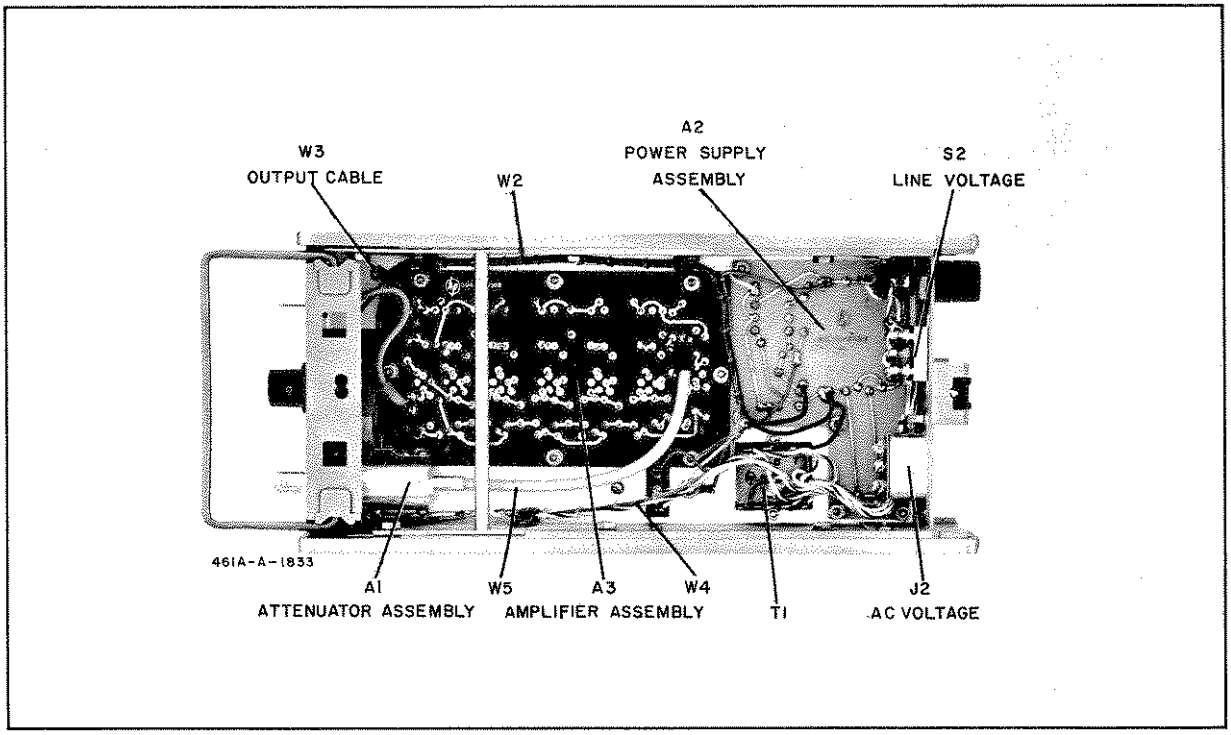



Figure 5-10. Bottom View

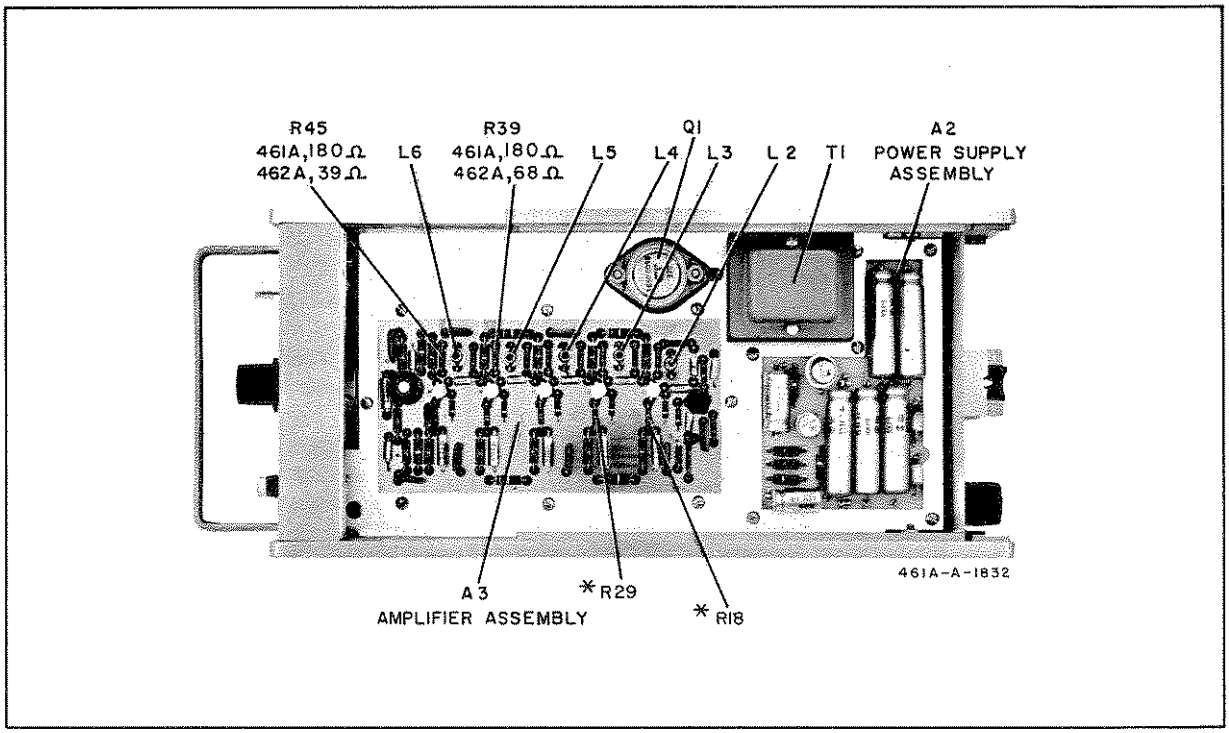



Figure 5-11. Top Veiw

m. Adjust L3, L4, L5 and L6 for maximum flatness and minimum ringing.

n. Change the 462A to 20 dB gain and change to attenuator to 40 dB. Observe the pulse shape for specifications.

## 5-27. ETCHED CIRCUIT BOARDS.

5-28. The Model 461A uses both plated-through and single-sided etched circuit board types. Power supply assembly A2 uses the single-sided etched circuit board. The amplifier assembly A3 uses the plated-through type.

5-29. When replacing a component on the plated-through type of etched circuit board, the component can be soldered from either side of the board. When replacing a component on the single-sided board, the component should be soldered from the conductor side.

5-30. Regardless which type of etched circuit board is used, the following rules should be followed:

a. Avoid applying excessive heat when soldering on the circuit board. Use a 37 to 50 watt pencil tip soldering iron.

b. To remove a damaged component, clip the component lead near the component. Then apply heat and remove the lead with a straight upward motion.

c. Use a toothpick to free eyelet of solder before installing a new component.

d. Solder from the conductor side of the board to insure good connections between the eyelet and the conductor.

## 5-31. TROUBLESHOOTING PROCEDURE.

a. This procedure should only be performed when the 461A or 462A can not be calibrated according to procedure in paragraphs 5-20 through 5-26.

b. Start with a thorough visual inspection. Look for burned out or loose components, loose connections, or any other similar condition which suggests a source of trouble.

c. Inspect the test setup being used when symptoms of malfunction were observed to be certain the source of trouble is not external to Amplifier.

d. Rotate Model 461A GAIN control to 20 dB to determine if malfunction is isolated to Attenuator; Amplitude of signal at base of Q3 should decrease by a factor of 10.

e. Check power supply as outlined in Paragraph 5-22.

f. Check dc levels identified on the schematic diagram, Figure 5-12.

g. Using an AC Voltmeter (-hp- Model 400EL), check the gain of transistors Q4 thru Q8, typically 8.4 dB per stage. 2 dB gain is lost in the input and output emitter followers leaving 40 dB gain for the Amplifier.

NOTE

Gain of Q4 is controlled by the value of R18* and Gain of Q5 is controlled by the value of R29* (4.7 to 13 ohms).

h. The R-L feedback Network and capacitors are responsible for the high frequency performance and should be checked if difficulty is encountered at high frequencies.

j. Refer to Troubleshooting Hints, Table 5-2 for possible causes of the trouble.

k. If Gain, flatness and noise is within specifications the distortion should be satisfactory, unless too large an input signal is applied, resulting in clipping of the output.

m. Perform Calibration and Performance Check Procedures after repair is completed.

Table 5-2. Troubleshooting Tips (461A and 462A)†

| TROUBLE | PROBABLE CAUSE |
|---|---|
| 1. No output | Check power supply (possibly CR3)<br>Check Q3, R9, Q4 and Q5 |
| 2. 20 dB position intermittent | Check GAIN switch for good contact |
| 3. Gain not correct | Check DC voltages listed on Schematic Fig. 5-12<br>Check AC gain of each stage (8.4 dB)<br>Check Q3, Q4 and R18. (Refer to Paragraph 5-23) |
| 4. Flatness | Q3, low frequency; Q7, Q8, high frequency |
| 5. Small roll off at high end | Change size of C26* (range: 10 pF to 22 pF)<br>Increase capacitance to increase amplitude<br>Check for shorted or open coil (adjustment has no effect on flatness) |
| 6. Frequency response at high end on 40 dB not corrected by L6 or C26* | Check C31 |
| 7. Rolls off 5 dB at 100 MHz | Check C31 and Q8 |
| 8. Frequency response at high end is low on 20 dB but 40 dB range is flat | Add C35* in attenuator (A1) |
| 9. Output drops off at high temperatures | Check Q4 |
| 10. Noise on 40 dB range | Check Q3 and Q4 |
| 11. Noise on both ranges | Check ground connection to chassis |
| 12. Intermittent noise | Check Q1 |
| 13. Blow fuse | Check B+ and B- to ground greater than 2 k-ohm<br>Check A2CR3, A2C7 and Q1 |
| 14. Pulse rise time too long (coils have little effect) | Check Q8 and then Q4 |
| 15. Excessive distortion | Check for clipping (use oscilloscope)<br>Decrease input signal. Observe |

†For instruments prefixed 346-, 347-, 414-, 418- or 421- also refer to Backdating Changes, Appendix C.

Possible Resistor Values for A3R18* and A3R29*

| | | | | |
|---|---|---|---|---|
| Resistor fixed | 4.7 ohm | 5% | 1/2W | -hp- Part No. 0698-0001 |
| Resistor fixed | 5.6 ohm | 5% | 1/4W | -hp- Part No. 0683-0565 |
| Resistor fixed | 6.8 ohm | 5% | 1/4W | -hp- Part No. 0683-0685 |
| Resistor fixed | 8.2 ohm | 5% | 1/4W | -hp- Part No. 0683-0825 |
| Resistor fixed | 9.1 ohm | 5% | 1/4W | -hp- Part No. 0698-5839 |
| Resistor fixed | 10.0 ohm | 5% | 1/4W | -hp- Part No. 0683-1005 |
| Resistor fixed | 11.0 ohm | 1% | 1/4W | -hp- Part No. 0757-0490 |
| Resistor fixed | 12.1 ohm | 1% | 1/4W | -hp- Part No. 0757-0491 |

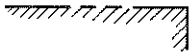
## SCHEMATIC NOTES

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN; PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.
2. COMPONENT VALUES ARE SHOWN AS FOLLOWS UNLESS OTHERWISE NOTED:

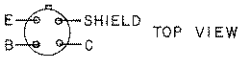
   RESISTANCE IN OHMS
   CAPACITANCE IN MICROFARADS
3. ——— — — ——— DENOTES ASSEMBLY.

   ——————————— DENOTES MAIN SIGNAL PATH.

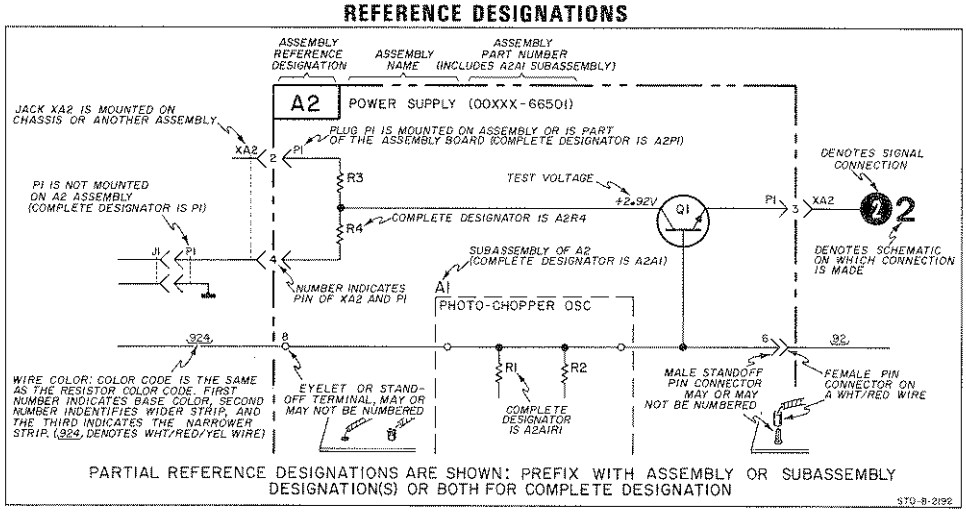
   ——————————— DENOTES FEEDBACK PATH.
4. ▭ DENOTES FRONT PANEL MARKING.

   ▭ DENOTES REAR PANEL MARKING.
5.  DENOTES COMPONENTS NOT MOUNTED ON ASSEMBLY.
6. * AVERAGE VALUE SHOWN, OPTIMUM VALUE SELECTED AT FACTORY.
7. NOT INCLUDED IN MODEL 462A.
8. MAKE THE FOLLOWING VALUE CHANGES FOR MODEL 462A:

   R17 TO 180 OHM — R39 TO 68 OHM
   R24 TO 180 OHM — R45 TO 39 OHM
   R31 TO 120 OHM
9. S1 IS CAM ACTIVATED BY S3 IN THE 20 DB POSITION.
10. Q4 HAS A GROUNDED SHIELD. TERMINAL ARRANGEMENT IS AS SHOWN:

    
    
11. FOR SELECTION OF R18* SEE PARAGRAPH 5-23.
12. FOR INSTRUMENTS PREFIXED 346-, 418-, 347-, 421-, SEE BACKDATING CHANGES, APPENDIX C.
13. Ω DENOTES INDUCTANCE FROM FERRITE BEADS.
14. ⊥ DENOTES OUTER CHASSIS (FRAME) GROUND.
15. ⏚ DENOTES ASSEMBLY GROUND (ON BOARD).

## REFERENCE DESIGNATIONS



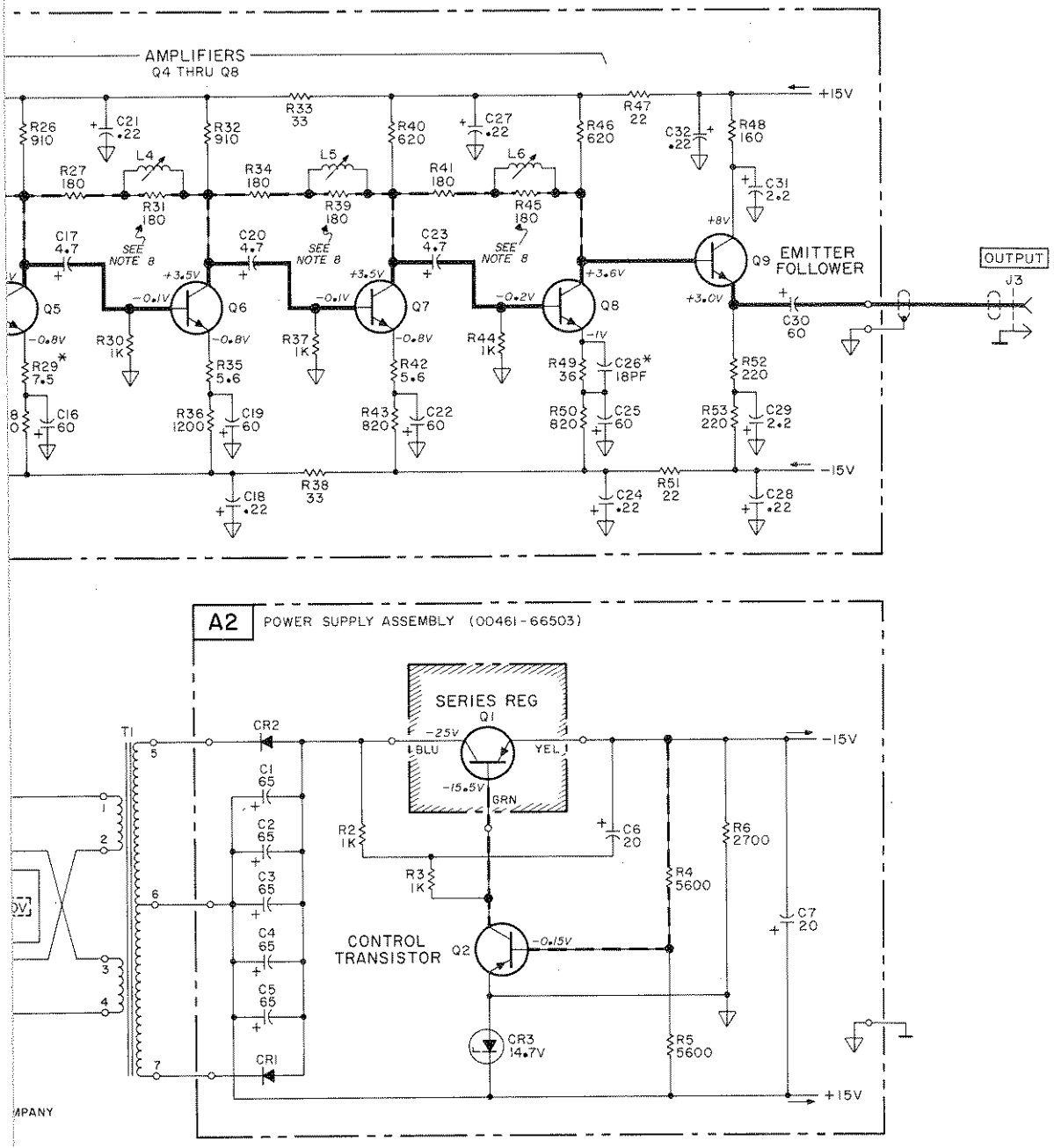



Figure 5-12. Schematic Diagram of Model 461A/462A

PERFORMANCE CHECK TEST CARD

Hewlett-Packard Model 461A or 462A.
Wideband or Pulse Amplifier
Serial No. _____

Test performed by _____
Date _____

| | | |
|---|---|---|
| GAIN: (461A, 462A) | a) 40 dB +/-0.5 dB<br>b) 20 dB +/-1.0 dB | _____<br>_____ |
| OUTPUT VOLTAGE: (461A)<br>(462A) | 0.5 volts rms<br>1 volt p-p | _____ |
| DISTORTION: (461A) | less than 5% maximum output rated load | _____ |
| NOISE: (461A, 462A) | less than 4 mV at 40 dB | _____ |
| FREQUENCY RESPONSE: (461A) | a) Low end, +/-1 dB<br>1 kHz to 10 MHz<br><br>b) High end, +/-1 dB<br>10 MHz to 150 MHz | _____<br><br>_____ |
| OVERLOAD RECOVERY: (461A, 462A) | less than 1 us | _____ |
| PULSE RESPONSE: (462A)<br>Rise Time:<br>Pulse Duration for 10% Droop:<br>Delay: | <br>less than 4 ns<br>30 us<br>12 to 14 ns | <br>_____<br>_____<br>_____ |

# SECTION VI
# REPLACEABLE PARTS

## 6-1. INTRODUCTION.

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

a. Total quantity used in the instrument (TQ) column). The total quantity of a part is given the first time the part number appears.

b. Descriptions of the part. (See list of abbreviations below.)

c. Typical manufacturer of the part in a five-digit code. (See Appendix for list of manufacturers.) Parts that are manufactured by Hewlett-Packard are identified by the abbreviation -hp-.

d. Manufacturer's part number.

e. An exploded view of the attenuator with reference designators identifying the name and -hp- part number.

## 6-3. ORDERING INFORMATION.

6-4. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Field Office. (See Appendix for list of office locations.) Identify parts by their Hewlett-Packard part numbers. Include instrument model and serial numbers.

## 6-5. NON-LISTED PARTS.

6-6. To obtain a part that is not listed, include:

a. Instrument model number.

b. Instrument serial number.

c. Description of the part.

d. Function and location of the part.

**ABBREVIATIONS**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Ag | silver | Hz | hertz (cycle(s) per second) | NPO | negative positive zero (zero temperature coefficient) | sl | slide |
| Al | aluminum | ID | inside diameter | ns | nanosecond(s) = $10^{-9}$ seconds | SPDT | single-pole double-throw |
| A | ampere(s) | impg | impregnated | nsr | not separately replaceable | SPST | single-pole single-throw |
| Au | gold | incd | incandescent | | | | |
| | | ins | insulation(ed) | Ω | ohm(s) | Ta | tantalum |
| C | capacitor | | | obd | order by description | TC | temperature coefficient |
| cer | ceramic | kΩ | kilohm(s) = $10^{+3}$ ohms | OD | outside diameter | $TiO_2$ | titanium dioxide |
| coef | coefficient | kHz | kilohertz = $10^{+3}$ hertz | | | tog | toggle |
| com | common | | | p | peak | tol | tolerance |
| comp | composition | L | inductor | pA | picoampere(s) | trim | trimmer |
| conn | connection | lin | linear taper | pc | printed circuit | TSTR | transistor |
| | | log | logarithmic taper | pF | picofarad(s) $10^{-12}$ farads | | |
| dep | deposited | | | piv | peak inverse voltage | V | volt(s) |
| DPDT | double-pole double-throw | mA | milliampere(s) = $10^{-3}$ amperes | p/o | part of | vacw | alternating current working voltage |
| DPST | double-pole single-throw | MHz | megahertz = $10^{+6}$ hertz | pos | position(s) | var | variable |
| | | MΩ | megohm(s) = $10^{+6}$ ohms | poly | polystyrene | vdcw | direct current working voltage |
| elect | electrolytic | met flm | metal film | pot | potentiometer | | |
| encap | encapsulated | mfr | manufacturer | p-p | peak-to-peak | W | watt(s) |
| | | ms | millisecond | ppm | parts per million | w/ | with |
| F | farad(s) | mtg | mounting | prec | precision (temperature coefficient, long term stability and/or tolerance) | wiv | working inverse voltage |
| FET | field effect transistor | mV | millivolt(s) = $10^{-3}$ volts | | | w/o | without |
| fxd | fixed | μF | microfarad(s) | | | ww | wirewound |
| | | μs | microsecond(s) | R | resistor | | |
| GaAs | gallium arsenide | μV | microvolt(s) = $10^{-6}$ volts | Rh | rhodium | | |
| GHz | gigahertz = $10^{+9}$ hertz | my | Mylar® | rms | root-mean-square | * | optimum value selected at factory, average value shown (part may be omitted) |
| gd | guard(ed) | | | rot | rotary | ** | no standard type number assigned selected or special type |
| Ge | germanium | nA | nanoampere(s) = $10^{-9}$ amperes | | | | |
| gnd | ground(ed) | NC | normally closed | Se | selenium | | |
| | | Ne | neon | sect | section(s) | | |
| H | henry(ies) | NO | normally open | Si | silicon | | |
| Hg | mercury | | | | | | |

® Dupont de Nemours

**DECIMAL MULTIPLIERS**

| Prefix | Symbols | Multiplier | Prefix | Symbols | Multiplier |
|---|---|---|---|---|---|
| tera | T | $10^{12}$ | centi | c | $10^{-2}$ |
| giga | G | $10^{9}$ | milli | m | $10^{-3}$ |
| mega | M or Meg | $10^{6}$ | micro | μ | $10^{-6}$ |
| kilo | K or k | $10^{3}$ | nano | n | $10^{-9}$ |
| hecto | h | $10^{2}$ | pico | p | $10^{-12}$ |
| deka | da | 10 | femto | f | $10^{-15}$ |
| deci | d | $10^{-1}$ | atto | a | $10^{-18}$ |

STD-B-2734

**DESIGNATORS**

| | | | | | |
|---|---|---|---|---|---|
| A | assembly | FL | filter | Q | transistor | TS | terminal strip |
| B | motor | HR | heater | QCR | transistor-diode | U | microcircuit |
| BT | battery | IC | integrated circuit | R | resistor | V | vacuum tube, neon bulb,photocell, etc. |
| C | capacitor | J | jack | RT | thermistor | W | cable |
| CR | diode | K | relay | S | switch | X | socket |
| DL | delay line | L | inductor | T | transformer | XDS | lampholder |
| DS | lamp | M | meter | TB | terminal board | XF | fuseholder |
| E | misc electronic part | MP | mechanical part | TC | thermocouple | Y | crystal |
| F | fuse | P | plug | TP | test point | Z | network |

Table 6-1. Replaceable Parts

| REFERENCE DESIGNATOR | -hp- PART NO. | | TQ | DESCRIPTION | MFR. | MFR. PART NO. |
|---|---|---|---|---|---|---|
| A1 | 00462-63401 | | 1 | **Assembly: Attenuator (461A and 462A)**<br>(These two assemblies are identical except where stated. Reference Designator is from Exploded View.) | -hp- | |

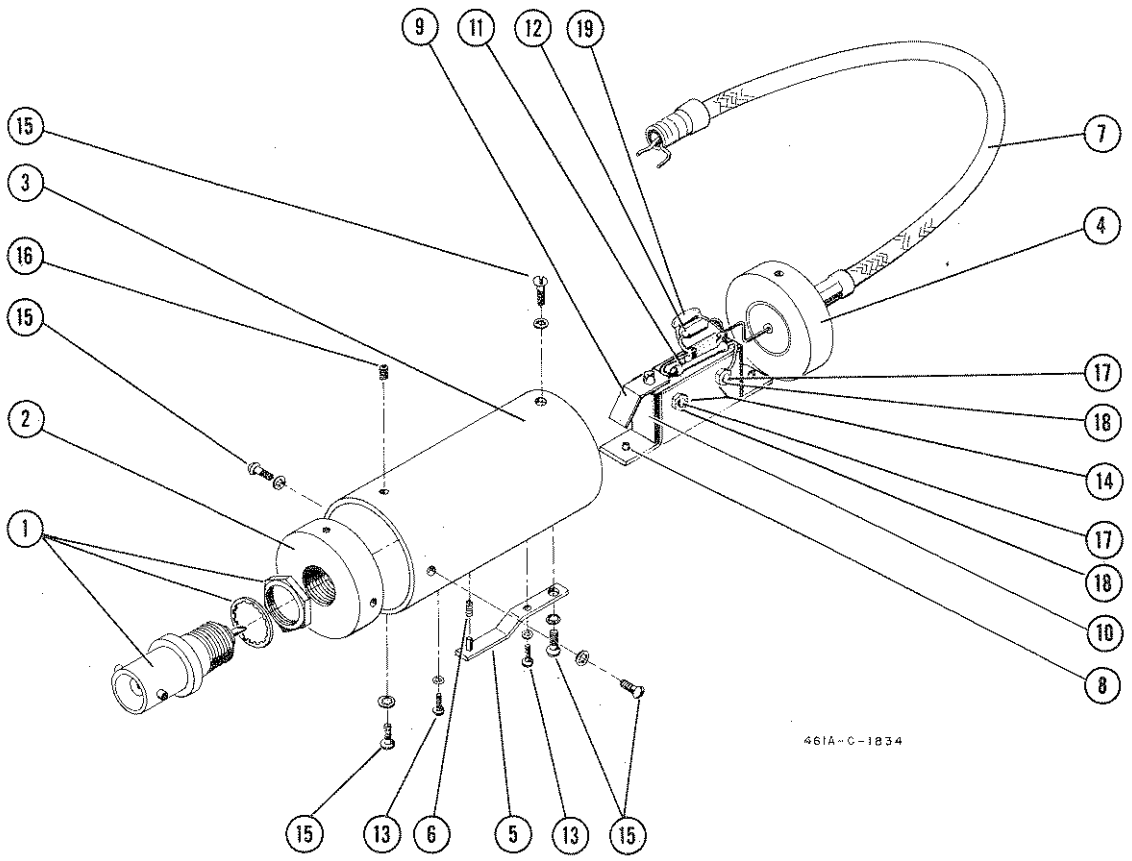



Figure 6-1. Exploded View of A1 Attenuator

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | 1250-0049 | | 1 | Input connector (rubber ring is not used) | -hp- | |
| 2 | 00461-23402 | | 1 | Can front | -hp- | |
| 3 | 00461-23401 | | 1 | Can body | -hp- | |
| 4 | 00461-23403 | | 1 | Can rear | -hp- | |
| 5 | 00461-69101 | | 1 | Spring assembly | -hp- | |
| 6 | 1460-0159 | | 1 | Compression spring | | |
| 7(W5) | 00461-61604 | | 1 | Cable | -hp- | |
| 8 | 00461-01202 | | 1 | Switch bracket | -hp- | |
| 9 | 00461-09102 | | 1 | Contact spring | -hp- | |
| 10(S3) | 3102-0006 | | 1 | Switch: micro SPDT pin plunger | 91929 | 22SM261 |
| 11(R7) | 0757-0356 | | 1 | R: fxd met flm 499 ohms +/-1% 1/8 W (462A only) | 14674 | NA55 |
| 11(R7) | 0698-4123 | | 1 | R: fxd flm 499 ohms +/- 1 % 1/8 W (461A only) | 91637 | CMF-1/10-32 T-1 |
| 12(R8) | 0724-0060 | | 1 | R: fxd C flm 55 ohms +/-1% 1/4 W (462A only) | 91637 | DC1/4 |
| 12(R8) | 0698-4384 | | 1 | R: fxd flm 54.9 ohms +/- 1 % 1/8 W (461A only) | 91637 | CMF-1/10-32 T-1 |
| 13 | 0520-0005 | | 2 | Screw: 56 x 3/16 round head | 73734 | obd |
| 14 | 2190-0014 | | 1 | Washer: internal lock no.2 | 78189 | 1902-00-00-2480 |
| 15 | 2200-0004 | | 4 | Washer and screw: 4-40 round head | 83385 | obd |
| 16 | 3030-0807 | | 4 | Set screw: 40 x 1/8 socket head | 70276 | obd |
| 17 | 0520-0022 | | 2 | Screw: 56 x 3/8 round head | 73734 | obd |
| 18 | 0610-0002 | | 2 | Nut: 56 | -hp- | |
| 19(C35*) | 0150-0029 | | 1 | C: fxd 1 pf +/-10% 500 vdcw (461A only) | 78488 | GA1J0PF |

Table 6-1. Replaceable Parts (Cont'd)

| REFERENCE DESIGNATOR | -hp- PART NO. | | TQ | DESCRIPTION | MFR. | MFR. PART NO. |
|---|---|---|---|---|---|---|
| **A2** | **00461-66503** | | 1 | **Assembly: Power (461A and 462A)** (Contains C1 thru C7, CR1 thru CR3, Q2 and R2 thru R6) | -hp- | |
| C1 thru C5 | 0180-0149 | | 5 | C: fxd elect 65 uF 60 vdcw | 56289 | Type 30D obd |
| C6 | 0180-0045 | | 1 | C: fxd elect 20 uF 0.25 vdcw | 56289 | Type 30D obd |
| C7 | 0180-0049 | | 1 | C: fxd elect 20 uF 50 vdcw | 56289 | 30D198A1 |
| CR1,CR2 | 1901-0158 | | 2 | Diode: Si piv 200 V | 04713 | SR1358-3 |
| CR3 | 1902-0202 | | 1 | Diode: reference 14.7 V +/-5% | -hp- | |
| Q2 | 1853-0012 | | 1 | TSTR: Si PNP 2N2904 | 01295 | 2N2904A |
| R2,R3 | 0687-1021 | | 2 | R: fxd comp 1 kilohm +/-10% 1/2 W | 01121 | EB1021 |
| R4,R5 | 0686-5625 | | 2 | R: fxd comp 5.6 kilohm +/-5% 1/2 W | 01121 | EB5625 |
| R6 | 0687-2721 | | 1 | R: fxd comp 2.7 kilohm +/-10% 1/2 W | 01121 | EB2721 |
| **A3** | **00461-66502** | | 1 | **Assembly: Amplifier (461A only)** | -hp- | |
| **A3** | **00462-66502** | | 1 | **Assembly: Amplifier (462A only)** (Contains: C8 thru C32, L1 thru L14, Q3 thru Q9 and R9 thru R53). These two assemblies are identical except where stated. | -hp- | |
| C8 thru C10 | 0180-0155 | | 5 | C: fxd Ta elect 2.2 uF +/-20% 20 vdcw | 56289 | 150D225X0020A2 |
| C11 | 0180-0309 | | 5 | C: fxd Ta elect 4.7 uF +/- 20% 10 vdcw | 56289 | 150D475X0010A2 |
| C12 thru C13 | 0160-0170 | | 8 | C: fxd cer 0.22 uF +80% -20% 25 vdcw | 56289 | 5C9A |
| C14 | 0180-0106 | | 6 | C: fxd Ta elect 60 uF +/-20% 6 vdcw | 56289 | 150D606X0006B2 |
| C15 | 0180-0309 | | | C: fxd Ta elect 4.7 uF 10 vdcw | 56289 | 150D475X0010A2 |
| C16 | 0180-0106 | | | C: fxd elect 60 uF +/-20% 6 vdcw | 56289 | 150D606X0006B2 |
| C17 | 0180-0309 | | | C: fxd Ta elect 4.7 uF 10 vdcw | 56289 | 150D475X0010A2 |
| C18 | 0160-0170 | | | C: fxd cer 0.22 uF +80% -20% 25 vdcw | 56289 | 5C9A |
| C19 | 0180-0106 | | | C: fxd Ta elect 60 uF +/-20% 6 vdcw | 56289 | 150D606-0006B2 |
| C20 | 0180-0309 | | | C: fxd Ta elect 4.7 uF 10 vdcw | 56289 | 150D475X0010A2 |
| C21 | 0160-0170 | | | C: fxd cer 0.22 uF +80% -20% 25 vdcw | 56289 | 5C9A |
| C22 | 0180-0106 | | | C: fxd Ta elect 60 uF +/-20% 6 vdcw | 56289 | 150D606X0006B2 |
| C23 | 0180-0309 | | | C: fxd Ta elect 4.7 uF +/-20% 10 vdcw | 56289 | 150D475X0010A2 |
| C24 | 0160-0170 | | | C: fxd cer 0.22 uF +80% -20% 25 vdcw | 56289 | 5C9A |
| C25 | 0180-0106 | | | C: fxd Ta elect 60 uF +/-20% 6 vdcw | 56289 | 150D606X0006B2 |
| C26* | 0160-0178 | | 1 | C: fxd mica 27 pF +/-5% 250 V | -hp- | |
| C27,C28 | 0160-0170 | | | C: fxd cer 0.22 uF +80% -20% 25 vdcw | 56289 | 5C9A |
| C29 | 0180-0155 | | | C: fxd Ta elect 2.2 uF +/-20% 20 vdcw | 56289 | 150D225X0020A2 |
| C30 | 0180-0106 | | | C: fxd Ta elect 60 uF +/-20% 6 vdcw | 56289 | 150D606X0006B2 |
| C31 | 0180-0155 | | | C: fxd Ta elect 2.2 uF +/-20% 20 vdcw | 56289 | 150D225X0020A2 |
| C32 | 0160-0170 | | | C: fxd cer 0.22 uF +80% -20% 25 vdcw | 56289 | 5C9A |
| L1 | 00461-86001 | | 1 | Coil: compensating | -hp- | |
| L2 | 00461-86002 | | 1 | Coil: variable 1.2 uH | -hp- | |
| L3 | 00461-86003 | | 1 | Coil: variable 0.4 uH | -hp- | |
| L4 | 00461-86004 | | 1 | Coil: variable 0.2 uH | -hp- | |
| L5 | 00461-86005 | | 1 | Coil: variable 0.2 uH | -hp- | |
| L6 | 00461-86006 | | 1 | Coil: variable 0.1 uH | -hp- | |
| Q3 | 1853-0034 | | 1 | TSTR: Si PNP | 04713 | SM3197 |
| Q4 | 1854-0073 | | 1 | TSTR: NPN 2N3478 | 86684 | 2N3478 |
| Q5 thru Q7 | 1854-0305 | | 3 | TSTR: Si NPN | 04713 | SS98 |
| Q8 | 1854-0009 | | 1 | TSTR: NPN Si 2N709 | -hp- | |
| Q9 | 1854-0554 | | 1 | TSTR: Si NPN | 07263 | 3010 obd |
| | 1205-0018 | | 1 | Heat dissipator for Q9 | 05820 | NF-203 |
| R9 | 0724-0061 | | 1 | R: fxd C flm 59 ohms +/-1% 1/4 W | 19701 | DC1/4A |
| R10 | 0684-1821 | | 1 | R: fxd comp 1.8 kilohms +/-10% 1/4 W | 01121 | CB1821 |
| R11,R12 | | | | Not assigned | | |
| R13 | 0683-8215 | | 1 | R: fxd comp 820 ohms +/-5% 1/4 W | 01121 | CB8215 |
| R14 | 0683-3025 | | 1 | R: fxd comp 3 kilohm +/-5% 1/4 W | 01121 | CB3025 |
| R15 | 0683-1815 | | 8 | R: fxd comp 180 ohms +/-5% 1/4 W | 01121 | CB1815 |
| R16 | 0684-1021 | | 5 | R: fxd comp 1 kilohm +/-10% 1/4 W | 01121 | CB1021 |
| R17 | 0683-2415 | | 2 | R: fxd comp 240 ohms +/-5% 1/4 W (461A only) | 01121 | CB2415 |
| R17 | 0683-1815 | | | R: fxd comp 180 ohms +/-5% 1/4 W (462A only) | 01121 | CB1815 |
| R18* | | | | See Padding List on Page 6-13 | | |
| R19 | 0686-1125 | | 1 | R: fxd comp 1.1 kilohms +/-5% 1/2 W | 01121 | EB1125 |
| R20 | 0686-1525 | | 1 | R: fxd comp 1.5 kilohms +/-5% 1/2 W | 01121 | EB1525 |
| R21 | 0683-1815 | | | R: fxd comp 180 ohms +/-5% 1/4 W | 01121 | CB1815 |
| R22 | 0684-1021 | | | R: fxd comp 1 kilohm +/-10% 1/4 W | 01121 | CB1021 |
| R23 | 0687-3301 | | 4 | R: fxd comp 33 ohms +/-10% 1/2 W | 01121 | EB3301 |
| R24 | 0683-2415 | | | R: fxd comp 240 ohms +/-5% 1/4 W (461A only) | 01121 | CB2415 |
| R24 | 0683-1815 | | | R: fxd comp 180 ohms +/-5% 1/4 W (462A only) | 01121 | CB1815 |
| R25 | 0687-3301 | | | R: fxd comp 33 ohms +/-10% 1/2 W | 01121 | EB3301 |
| R26 | 0686-9115 | | 2 | R: fxd comp 910 ohms +/-5% 1/2 W | 01121 | EB9115 |

Table 6-1. Replaceable Parts (Cont'd)

| REFERENCE DESIGNATOR | -hp- PART NO. | | TQ | DESCRIPTION | MFR. | MFR. PART NO. |
|---|---|---|---|---|---|---|
| R27 | 0683-1815 | | | R: fxd comp 180 ohms +/-5% 1/4 W | 01121 | CB1815 |
| R28 | 0686-1225 | | 2 | R: fxd comp 1.2 kilohms +/-5% 1/2 W | 01121 | EB1225 |
| R29* } R29* } | | | | See Padding List on Page 5-13 | | |
| R30 | 0684-1021 | | | R: fxd comp 1 kilohm +/-10% 1/4 W | 01121 | CB1021 |
| R31 | 0683-1815 | | | R: fxd comp 180 ohms +/-5% 1/4 W (461A only) | 01121 | CB1815 |
| R31 | 0683-1215 | | 1 | R: fxd comp 120 ohms +/-5% 1/4 W (462A only) | 01121 | CB1215 |
| R32 | 0686-9115 | | | R: fxd comp 910 ohms +/-5% 1/2 W | 01121 | EB9115 |
| R33 | 0687-3301 | | | R: fxd comp 33 ohms +/-10% 1/2 W | 01121 | EB3301 |
| R34 | 0683-1815 | | | R: fxd comp 180 ohms +/-5% 1/4 W | 01121 | CB1815 |
| R35 | 0683-0565 | | | R: fxd comp 5.6 ohms +/-5% 1/4 W | 01121 | CB0565 |
| R36 | 0686-1225 | | | R: fxd comp 1.2 kilohms +/-5% 1/2 W | 01121 | EB1225 |
| R37 | 0684-1021 | | | R: fxd comp 1 kilohm +/-10% 1/4 W | 01121 | CB1021 |
| R38 | 0687-3301 | | | R: fxd comp 33 ohms +/-10% 1/2 W | 01121 | EB3301 |
| R39 | 0683-1815 | | | R: fxd comp 180 ohms +/-5% 1/4 W (461A only) | 01121 | CB1815 |
| R39 | 0683-6805 | | 2 | R: fxd comp 68 ohms +/-5% 1/4 W (462A only) | 01121 | CB6805 |
| R40 | 0680-6215 | | 2 | R: fxd comp 620 ohms +/-5% 1/2 W | 01121 | EB6215 |
| R41 | 0683-1815 | | | R: fxd comp 180 ohms +/-5% 1/4 W | 01121 | CB1815 |
| R42 | 0683-0565 | | | R: fxd comp 5.6 ohms +/-5% 1/4 W | 01121 | CB0565 |
| R43 | 0686-8215 | | 2 | R: fxd comp 820 ohms +/-+/-5% 1/2 W | 01121 | CB8215 |
| R44 | 0684-1021 | | 1 | R: fxd comp 1 kilohm +/-10% 1/4 W | 01121 | CB1021 |
| R45 | 0683-1815 | | | R: fxd comp 180 ohms +/-5% 1/4 W (461A only) | 01121 | CB1815 |
| R45 | 0683-3905 | | 1 | R: fxd comp 39 ohms +/-5% 1/4 W (462A only) | 01121 | CB3905 |
| R46 | 0686-6215 | | 2 | R: fxd comp 620 ohms +/-5% 1/2 W | 01121 | EB6215 |
| R47 | 0687-2201 | | 2 | R: fxd comp 22 ohms +/-10% 1/2 W | 01121 | EB2201 |
| R48 | 0686-1615 | | 1 | R: fxd comp 160 ohms +/-10% 1/2 W | 01121 | EB1615 |
| R49 | 0683-3605 | | 1 | R: fxd comp 36 ohms +/-5% 1/4 W | 01121 | CB3605 |
| R50 | 0686-8215 | | | R: fxd comp 820 ohms +/-5% 1/2 W | 01121 | EB8215 |
| R51 | 0687-2201 | | | R: fxd comp 22 ohms +/-10% 1/2 W | 01121 | EB2201 |
| R52,R53 | 0758-0015 | | 2 | R: fxd met flm 220 ohms +/-5% 1/2 W | 07115 | C20 |
| | | | | **CHASSIS MOUNTED COMPONENTS** | | |
| C33,C34 | 0160-3333 | | 1 | C: fxd dual 0.005 uF +/-20% 250 vacw | 56289 | 36C219A |
| DS1 | 1450-0419 | | 1 | Pilot light neon | 08717 | 858-R |
| F1 | 2110-0004 | | | Fuse: 115 V 1/4 A (Fast-Blo) | 75915 | AB-Cat-312-250 |
| L15,L16 | 9170-0016 | | 30 | Beads: ferrite | -hp- | |
| Q1 | 1853-0063 | | 1 | TSTR: Si PNP selected | -hp- | |
| | 1200-0043 | | 1 | Insulator for Q1 | 26365 | obd |
| | 1200-0081 | | 1 | Bushing for Q1 | 26365 | 974 Special |
| R1 | 0687-3331 | | 1 | R: comp 33 kilohms +/-10% 1/2 W | 01121 | EB3331 |
| S1 | 3100-0759 | | 1 | Switch: rotary (GAIN) | 76854 | obd |
| | 0370-0104 | | 1 | Knob for S1 | -hp- | obd |
| S2 | 3101-1234 | | 1 | Switch: slide dpdt (power) | 42190 | 4633 |
| T1 | 9100-0277 | | 1 | Transformer | -hp- | |
| W1 | 8120-1348 | | 1 | Cable: power | 70903 | KH4147 |
| W2 | 00461-61601 | | 1 | Cable assembly: power supply | -hp- | |
| W3 | 00461-61602 | | 1 | Cable assembly: output | -hp- | |
| W4 | 00461-61603 | | 1 | Cable assembly: transformer | -hp- | |
| XF1 | 1400-0084 | | 1 | Fuseholder: extractor post type | 75915 | 342014 |
| J1 | 1250-0118 | | 1 | Connector: input female | 95712 | 30384-1 |
| J2 | 1251-2357 | | 1 | Connector: power 3 pin male | 60427 | H10611G 3L |
| J3 | 1250-0083 | | 1 | Connector: output female | 95712 | 30624-1 |
| | | | | **MISCELLANEOUS** | | |
| | 1400-0116 | | 3 | Clamp: plastic cable W2 W4 | 08717 | obd |
| | 1490-0031 | | 1 | Stand: tilt | -hp- | |
| | 2370-0020 | | 8 | Screw: sideplate mounting 6-32 Phillips head 3/16 | 83385 | obd |
| | 5000-0700 | | 2 | Cover: side † | -hp- | |
| | 5000-0711 | | 1 | Cover: bottom 5 x 11 SM† | -hp- | |
| | 00461-00203 | | 1 | Panel: rear | -hp- | |
| | 5020-0700 | | 2 | Spacer | -hp- | |
| | 5040-0700 | | 2 | Hinge | -hp- | |
| | 5060-0700 | | 2 | Assembly frame | -hp- | |
| | 5060-0709 | | 1 | Top cover † | -hp- | |
| | 5060-0727 | | 2 | Foot assembly: 1/3 module | -hp- | |
| | 00461-90005 | | 1 | Manual | -hp- | |
| | 00462-00202 | | 1 | Panel: Front | -hp- | |
| | 00461-00201 | | 1 | Panel: Front | -hp- | |
| | 5000-8559 | | 2 | Cover: side | -hp- | |
| | 5000-8571 | | 1 | Cover: bottom | -hp- | |
| | 5060-8555 | | 1 | Cover: top | -hp- | |

† These parts are painted with the original 461A/462A colors, i.e. light gray/blue gray. When ordering replacement parts in the old color specify option A85 for the front panel and option Y98 for the covers.

## 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 |
|---|---|---|
| 00000 | U.S.A Common | Any supplier of U.S. |
| 00136 | McCoy Electronics | Mount Holly Springs, Pa. |
| 00213 | Sage Electronics Corp. | Rochester, N.Y. |
| 00287 | Cemco, Inc. | Danielson, Conn. |
| 00334 | Humidial | Colton, Calif. |
| 00348 | Mictron, Co., Inc. | Valley Stream, N.Y. |
| 00373 | Garlock Inc. | Cherry Hill, N.J. |
| 00656 | Aerovox Corp. | New Bedford, Mass. |
| 00779 | Amp. Inc. | Harrisburg, Pa. |
| 00781 | Aircraft Radio Corp. | Boonton, N.J. |
| 00809 | Crowen, Ltd. | Whitby, Ontario, Canada |
| 00815 | Northern Engineering Laboratories, Inc. | Burlington, Wis. |
| 00853 | Sangamo Electric Co., Pickens Div. | Pickens, S.C. |
| 00866 | Goe Engineering Co. | City of Industry, Cal. |
| 00891 | Carl E. Holmes Corp. | Los Angeles, Cal. |
| 00929 | Microlab Inc. | Livingston, N.J. |
| 01002 | General Electric Co., Capacitor Dept. | Hudson Falls, N.Y. |
| 01009 | Alden Products Co. | Brockton, Mass. |
| 01121 | Allen Bradley Co. | Milwaukee, Wis |
| 01255 | Litton Industries, Inc. | Beverly Hills, Cal. |
| 01281 | TRW Semiconductors, Inc. | Lawndale, Cal. |
| 01295 | Texas Instruments, Inc., Transistor Products Div. | Dallas, Texas |
| 01349 | The Alliance Mfg. Co | Alliance, Ohio |
| 01538 | Small Parts Inc. | Los Angeles, Cal. |
| 01589 | Pacific Relays, Inc. | Van Nuys, Cal. |
| 01670 | Gudebrod Bros. Silk Co. | New York, N.Y. |
| 01930 | Amerock Corp. | Rockford, Ill. |
| 01960 | Pulse Engineering Co | Santa Clara, Cal. |
| 02114 | Ferroxcube Corp. of America | Saugerties, N.Y. |
| 02116 | Wheelock Signals, Inc. | Long Branch, N.J. |
| 02286 | Cole Rubber and Plastics Inc. | Sunnyvale, Cal. |
| 02660 | Amphenol-Borg Electronics Corp. | Broadview, Ill. |
| 02735 | Radio Corp. of America, Semiconductor and Materials Division | Somerville, N.J. |
| 02771 | Vocaline Co. of America, Inc. | Old Saybrook, Conn. |
| 02777 | Hopkins EngineeringCo. | San Fernando, Cal. |
| 02875 | Hudson Tool & Die | Newark, N.J. |
| 03296 | Nylon Molding Corp. | Springfield, N.J. |
| 03508 | G.E. Semiconductor Prod. Dept. | Syracuse, N.Y. |
| 03705 | Apex Machine & Tool Co. | Dayton, Ohio |
| 03797 | Eldema Corp. | Compton, Calif. |
| 03818 | Parker Seal Co. | Los Angeles, Cal. |
| 03877 | Transitron Electric Corp. | Wakefield, Mass. |
| 03888 | Pyrofilm Resistor Co., Inc. | Cedar Knolls, N.J. |
| 03954 | Singer Co., Diehl Div., Finderne Plant | Sumerville, N.J. |
| 04009 | Arrow, Hart and Hegeman Elect. Co. | Hartford, Conn. |
| 04013 | Taruus Corp. | Lambertville, N.J. |
| 04062 | Arco Electronic Inc. | Great Neck, N.Y. |
| 04217 | Essex Wire | Los Angeles, Cal. |
| 04222 | Hi-Q Division of Aerovox. | Myrtle Beach, S.C. |
| 04354 | Precision Paper Tube Co. | Wheeling, Ill. |
| 04404 | Palo Alto Division of Hewlett-Packard Co. | Palo Alto, Cal. |
| 04651 | Sylvania Electric Products, Microwave Device Div. | Mountain View, Cal. |
| 04673 | Dakota Engr. Inc. | Culver City, Cal. |
| 04713 | Motorola Inc. Semiconductor Prod. Div. | Phoenix, Arizona |
| 04732 | Filtron Co., Inc. Western Div. | Culver City, Cal. |
| 04773 | Automatic Electric Co. | Northlake, Ill. |
| 04796 | Sequoia Wire Co. | Redwood City, Cal. |
| 04811 | Precision Coil Spring Co. | El Monte, Cal. |
| 04870 | P.M. Motor Company | Westchester, Ill. |
| 04919 | Component Mfg. Service Co. | W. Bridgewater, Mass. |
| 05006 | Twentieth Century Plastics, Inc. | Los Angeles, Cal. |
| 05277 | Westinghouse Electric Corp. Semiconductor Dept. | Youngwood, Pa. |
| 05347 | Ultronix, Inc. | San Mateo, Cal. |
| 05397 | Union Carbine Corp., Elect. Div. | New York, N.Y. |
| 05574 | Viking Ind. Inc. | Canoga Park, Cal. |
| 05593 | Icore Electro-Plastics Inc. | Sunnyvale, Cal. |
| 05616 | Cosmo Plastic (c/o Electrical Spec. Co.) | Cleveland, Ohio |
| 05624 | Barber Colman Co. | Rockford, Ill. |
| 05728 | Tiffen Optical Co. | Roslyn Heights, Long Island, N.Y. |
| 05729 | Metro-Tel Corp. | Westbury, N.Y. |
| 05783 | Stewart Engineering Co. | Santa Cruz, Cal. |
| 05820 | Wakefield Engineering Inc. | Wakefield, Mass. |
| 06004 | Bassick Co., Div. of Stewart Warner Corp. | Bridgeport, Conn. |
| 06090 | Raychem Corp. | Redwood City, Cal. |
| 06175 | Bausch and Lomb Optical Co. | Rochester, N.Y. |
| 06402 | E.T.A. Products Co. of America | Chicago, Ill. |
| 06540 | Amatom Electronic Hardware Co., Inc. | New Rochelle, N.Y. |
| 06555 | Beede Electrical Instrument Co., Inc. | Penacook, N.H. |
| 06666 | General Devices Co., Inc. | Indianapolis, Ind. |
| 06751 | Components Inc., Ariz. Div. | Phoenix, Arizona |
| 06812 | Torrington Mfg. Co., West Div. | Van Nuys, Cal. |
| 06980 | Varian Assoc. Etmac Div. | San Carlos, Cal. |
| 07088 | Kelvin Electric Co. | Van Nuys, Cal. |
| 07126 | Digitran Co. | Pasadena, Cal. |
| 07137 | Transistor Electronics Corp. | Minneapolis, Minn. |
| 07138 | Westinghouse Electric Corp., Electronic Tube Div. | Elmira, N.Y. |
| 07149 | Filmohm Corp. | New York, N.Y. |
| 07233 | Cinch-Graphik Co. | City of Industry, Cal. |
| 07256 | Silicon Transistor Corp. | Carle Place, N.Y. |
| 07261 | Avnet Corp. | Culver City, Cal. |
| 07263 | Fairchild Camera & Inst. Corp., Semiconductor Div. | Mountain View, Cal. |
| 07322 | Minnesota Rubber Co. | Minneapolis, Minn. |
| 07387 | Birtcher Corp, The | Monterey Park, Cal. |
| 07397 | Sylvania Elect. Prod. Inc., Mt. View Operations | Mountain View, Cal. |
| 07700 | Technical Wire Products Inc. | Cranford, N.J. |
| 07829 | Bodine Elect. Co. | Chicago, Ill. |
| 07910 | Continental Device Corp. | Hawthorne, Cal. |
| 07933 | Raytheon Mfg. Co., Semiconductor Div. | Mountain View, Cal. |
| 07980 | Hewlett-Packard Co., New Jersey Division | Rockaway, N.J. |
| 08145 | U.S. Engineering Co. | Los Angeles, Cal. |
| 08289 | Blinn, Delbert Co. | Pomona, Cal. |
| 08358 | Burgess Battery Co. | Niagara Falls, Ontario, Canada |
| 08524 | Deutsch Fastener Corp. | Los Angeles, Cal. |
| 08664 | Bristol Co., The | Waterbury, Conn |
| 08717 | Sloan Company | Sun Valley, Cal. |
| 08718 | ITT Cannon Electric Inc., Phoenix Div. | Phoenix, Arizona |
| 08727 | National Radio Lab. Inc. | Paramus, N.J. |
| 08792 | CBS Electronics Semiconductor Operations, Div. of CBS Inc | Lowell, Mass. |
| 08806 | General Electric Co., Miniature Lamp Dept. | Cleveland, Ohio |
| 08984 | Mel-Rain | Indianapolis, Ind. |
| 09026 | Babcock Relays Div. | Costa Mesa, Cal. |
| 09097 | Electronic Enclosures Inc. | Los Angeles, Calif. |
| 09134 | Texas Capacitor Co. | Houston, Texas |
| 09145 | Tech. Ind. Inc. Atohm Elect. | Burbank, Cal. |
| 09250 | Electro Assemblies, Inc. | Chicago, Ill. |
| 09353 | C & K Components Inc. | Newton, Mass. |
| 09569 | Mallory Battery Co. of Canada, Ltd. | Toronto, Ontario, Canada |
| 09795 | Pennsylvania Fiorocarbon. | Clifton Heights, Penn. |
| 09922 | Burndy Corp. | Norwalk, Conn. |
| 10214 | General Transistor Western Corp. | Los Angeles, Cal. |
| 10411 | Ti-Tal, Inc. | Berkeley, Cal. |
| 10646 | Carborundum Co. | Niagara Falls, N.Y. |
| 11236 | CTS of Berne, Inc. | Berne, Ind. |
| 11237 | Chicago Telephone of California, Inc. | So. Pasadena, Cal. |
| 11242 | Bay State Electronics Corp. | Waltham, Mass. |
| 11312 | Teledyne Inc., Microwave Div. | Palo Alto, Cal. |
| 11314 | National Seal | Downey, Cal. |
| 11453 | Precision Connector Corp. | Jamaica, N.Y. |
| 11534 | Duncan Electronics Inc. | Costa Mesa, Cal. |
| 11711 | General Instrument Corp., Semiconductor Division Products Group | Newark, N.J. |
| 11717 | Imperial Electronic, Inc. | Buena Park, Cal. |
| 11870 | Melabs, Inc. | Palo Alto, Cal. |
| 12136 | Philadelphia Handle Co. | Camden, N.J. |
| 12361 | Grove Mfg. Co., Inc. | Shady Grove, Pa. |
| 12574 | Gulton Ind. Inc., Data System Div. | Albuquerque, N.M. |
| 12697 | Clarostat Mfg. Co. | Dover, N.H. |
| 12728 | Elmar Filter Corp | W. Haven, Conn. |
| 12859 | Nippon Electric Co., Ltd. | Tokyo, Japan |
| 12881 | Metex Electronics Corp. | Clark, N.J. |
| 12930 | Delta Semiconductor Inc. | Newport Beach, Cal. |
| 12954 | Dickson Electronics Corp. | Scottsdale, Arizona |
| 13019 | Airco Supply Co., Inc. | Witchita, Kansas |
| 13061 | Wilco Products | Detroit, Mich. |
| 13103 | Thermolloy | Dallas, Texas |
| 13327 | Solitron Devices Inc. | Tappan, N.Y. |
| 13396 | Telefunken (GmbH) | Hanover, Germany |
| 13835 | Midland-Wright Div. of Pacific Industries, Inc. | Kansas City, Kansas |
| 14099 | Sem-Tech | Newbury Park, Cal. |
| 14193 | Calif. Resistor Corp | Santa Monica, Cal. |
| 14298 | American Components, Inc. | Conshohocken, Pa. |
| 14433 | ITT Semiconductor, a Div. of Int. Telephone and Telegraph Corporation | West Palm Beach, Fla. |
| 14493 | Hewlett-Packard Company. | Loveland, Colo. |
| 14655 | Cornell Dublier Electric Corp | Newark, N.J. |
| 14674 | Corning Glass Works | Corning, N.Y. |
| 14752 | Electro Cube Inc. | San Gabriel, Cal. |
| 14960 | Williams Mfg. Co. | San Jose, Cal. |
| 15106 | The Sphere Co., Inc. | Little Falls, N.J. |
| 15203 | Webster Electronics Co. | New York, N.Y. |
| 15287 | Scionics Corp. | Northridge, Cal. |
| 15291 | Adjustable Bushing Co. | N. Hollywood, Cal. |
| 15558 | Micron Electronics. | Garden City, Long Island, N.Y. |
| 15566 | Amprobe Inst. Corp. | Lynbrook, N.Y. |
| 15631 | Cabletronics | Costa Mesa, Cal. |
| 15772 | Twentieth Century Coil Spring Co. | Santa Clara, Cal. |
| 15801 | Fenwal Elect. Inc. | Framingham, Mass. |
| 15818 | Ametco Inc. | Mountain View, Cal. |
| 16037 | Spruce Pine Mica Co. | Spruce Pine, N.C. |
| 16179 | Omni-Spectra Inc. | Detroit, Ill. |
| 16352 | Computer Diode Corp. | Lodi, N.J. |
| 16554 | Electroid Co. | Union, N.J. |
| 16585 | Boots Aircraft Nut Corp. | Pasadena, Cal. |
| 16688 | Ideal Prec. Meter Co., Inc., De Jur Meter Div. | Brooklyn, N.Y. |
| 16758 | Delco Radio Div. of G.M. Corp. | Kokomo, Ind. |
| 17109 | Thermonetics Inc. | Canoga Park, Cal. |
| 17474 | Tranex Company | Mountain View, Cal. |
| 17675 | Hamlin Metal Products Corp. | Akron, Ohio |
| 17745 | Angstrohm Prec. Inc. | No. Hollywood, Cal. |
| 17856 | Siliconix Inc. | Sunnyvale, Cal. |
| 17870 | McGraw-Edison Co. | Manchester, N.H. |
| 18042 | Power Design Pacific Inc. | Palo Alto, Cal. |
| 18083 | Clevite Corp. Semiconductor Div. | Palo Alto, Cal. |
| 18324 | Signetics Corp. | Sunnyvale, Cal. |
| 18476 | Ty-Car Mfg. Co., Inc. | Holliston, Mass. |
| 18486 | TRW Elect. Comp. Div. | Des Plaines, Ill. |
| 18565 | Chomerics | Plainville, Mass. |
| 18583 | Curtis Instrument, Inc. | Mt. Kisco, N.Y. |
| 18612 | Vishay Instruments Inc. | Malvern, Pa. |
| 18873 | E.I. DuPont and Co., Inc. | Wilmington, Del. |
| 18911 | Durant Mfg. Co. | Milwaukee, Wis. |
| 19315 | The Bendix Corp., Navigation & Control Div. | Teterboro, N.J. |
| 19500 | Thomas A. Edison Industries, Div. of McGraw-Edison | West Orange, N.J. |
| 19589 | Concoa | Baldwin Park, Cal. |

## CODE LIST OF MANUFACTURERS (Continued)

| Code No. | Manufacturer | Address |
|---|---|---|
| 19644 | LRC Electronics | Horseheads, N.Y. |
| 19701 | Electra Mfg. Co. | Independence, Kansas |
| 20183 | General Atronics Corp. | Philadelphia, Pa. |
| 21226 | Executone, Inc. | Long Island City, N.Y. |
| 21355 | Fafnir Bearing Co., The | New Britian, Conn. |
| 21520 | Fansteel Metallurgical Corp. | N. Chicago, Ill. |
| 23020 | General Reed Co. | Metuchen, N.J. |
| 23042 | Texscan Corp. | Indianapolis, Ind. |
| 23783 | British Radio Electronics Ltd. | Washington, D.C. |
| 24455 | G.E. Lamp Division, Nela Park | Cleveland, Ohio |
| 24655 | General Radio Co. | West Concord, Mass. |
| 24681 | Memcor Inc., Comp. Div. | Huntington, Ind. |
| 26365 | Gries Reproducer Corp. | New Rochelle, N.Y. |
| 26462 | Grobert File Co. of America, Inc. | Carlstadt, N.J. |
| 26851 | Compac/Hollister Co. | Hollister, Cal. |
| 26992 | Hamilton Watch Co. | Lancaster, Pa. |
| 28480 | Hewlett-Packard Co. | Palo Alto, Cal. |
| 28520 | Heyman Mfg. Co. | Kenilworth, N.J. |
| 30817 | Instrument Specialties Co., Inc. | Little Falls, N.J. |
| 33173 | G.E. Receiving Tube Dept. | Owensboro, Ky. |
| 35434 | Lectrohm Inc. | Chicago, Ill. |
| 36196 | Stanwyck Coil Products, Ltd. | Hawkesbury, Ontario, Canada |
| 36287 | Cunningham, W.H. & Hill, Ltd. | Toronto, Ontario, Canada |
| 37942 | P.R. Mallory & Co., Inc. | Indianapolis, Ind. |
| 39543 | Mechanical Industries Prod. Co. | Akron, Ohio |
| 40920 | Miniature Precision Bearings, Inc. | Keene, N.H. |
| 40931 | Honeywell Inc. | Minneapolis, Minn. |
| 42190 | Muter Co. | Chicago, Ill. |
| 43990 | C.A. Norgren Co. | Englewood, Colo. |
| 44655 | Ohmite Mfg. Co. | Skokie, Ill. |
| 46384 | Penn Eng. & Mfg. Corp. | Doylestown, Pa. |
| 47904 | Polaroid Corp. | Cambridge, Mass. |
| 48620 | Precision Thermometer & Inst. Co. | Southampton, Pa. |
| 49956 | Microwave & Power Tube Div. | Waltham, Mass. |
| 52090 | Rowan Controller Co. | Westminster, Md. |
| 52983 | HP Co., Med. Elec. Div. | Waltham, Mass. |
| 54294 | Shallcross Mfg. Co. | Selma, N.C. |
| 55026 | Simpson Electric Co. | Chicago, Ill. |
| 55933 | Sonotone Corp. | Elmsford, N.Y. |
| 55938 | Raytheon Co. Commercial Apparatus & System Div. | So. Norwalk, Conn. |
| 56137 | Spaulding Fibre Co., Inc. | Tonawanda, N.Y. |
| 56289 | Sprague Electric Co. | North Adams, Mass. |
| 58474 | Superior Elect. Co. | Bristol, Conn. |
| 59446 | Telex Corp. | Tulsa, Okla. |
| 59730 | Thomas & Betts Co. | Elizabeth, N.J. |
| 60741 | Triplett Electrical Inst. Co. | Bluffton, Ohio |
| 61775 | Union Switch and Signal Div. of Westinghouse Air Brake Co. | Pittsburgh, Pa. |
| 62119 | Universal Electric Co. | Owosso, Mich. |
| 63743 | Ward-Leonard Electric Co. | Mt. Vernon, N.Y. |
| 64959 | Western Electric Co., Inc. | New York, N.Y. |
| 65092 | Weston Inst. Inc. Weston-Newark | Newark, N.J. |
| 66295 | Wittek Mfg. Co. | Chicago, Ill. |
| 66346 | Minnesota Mining & Mfg. Co. Revere Mincom Div. | St. Paul, Minn. |
| 70276 | Allen Mfg. Co. | Hartford, Conn. |
| 70309 | Allied Control | New York, N.Y. |
| 70318 | Allmetal Screw Product Co., Inc. | Garden City, N.Y. |
| 70417 | Amplex, Div. of Chrysler Corp. | Detroit, Mich. |
| 70485 | Atlantic India Rubber Works, Inc. | Chicago, Ill. |
| 70563 | Amperite Co., Inc. | Union City, N.J. |
| 70674 | ADC Products Inc. | Minneapolis, Minn. |
| 70903 | Belden Mfg. Co. | Chicago, Ill. |
| 70998 | Bird Electric Corp. | Cleveland, Ohio |
| 71002 | Birnbach Radio Co. | New York, N.Y. |
| 71034 | Bliley Electric Co., Inc. | Erie, Pa. |
| 71041 | Boston Gear Works Div. of Murray Co. of Texas | Quincey, Mass. |
| 71218 | Bud Radio, Inc. | Willoughby, Ohio |
| 71279 | Cambridge Thermionics Corp. | Cambridge, Mass. |
| 71286 | Camloc Fastener Corp. | Paramus, N.J. |
| 71313 | Cardwell Condenser Corp. | Lindenhurst, L.I., N.Y. |
| 71400 | Bussmann Mfg. Div. of McGraw-Edison Co. | St. Louis, Mo. |
| 71436 | Chicago Condenser Corp. | Chicago, Ill. |
| 71447 | Calif. Spring Co., Inc. | Pico-Rivera, Cal. |
| 71450 | CTS Corp. | Elkhart, Ind. |
| 71468 | ITT Cannon Electric Inc. | Los Angeles, Cal. |
| 71471 | Cinema, Div. Aerovox Corp. | Burbank, Cal. |
| 71482 | C.P. Clare & Co. | Chicago, Ill. |
| 71590 | Centralab Div. of Globe Union Inc. | Milwaukee, Wis. |
| 71616 | Commercial Plastics Co. | Chicago, Ill. |
| 71700 | Cornish Wire Co., The | New York, N.Y. |
| 71707 | Coto Coil Co., Inc. | Providence, R.I. |
| 71744 | Chicago Miniature Lamp Works | Chicago, Ill. |
| 71785 | Cinch Mfg. Co., Howard B. Jones Div. | Chicago, Ill. |
| 71984 | Dow Corning Corp. | Midland, Mich. |
| 72136 | Electro Motive Mfg. Co., Inc. | Willimantic, Conn. |
| 72619 | Dialight Corp. | Brooklyn, N.Y. |
| 72656 | Indiana General Corp., Electronics Div. | Keasby, N.J. |
| 72699 | General Instrument Corp., Cap Division | Newark, N.J. |
| 72765 | Drake Mfg. Co. | Harwood Heights, Ill. |
| 72825 | Hugh H. Eby Inc. | Philadelphia, Pa. |
| 72928 | Gudeman Co. | Chicago, Ill. |
| 72962 | Elastic Stop Nut Corp. | Union, N.J. |
| 72964 | Robert M. Hadley Co. | Los Angeles, Cal. |
| 72982 | Erie Technological Products, Inc. | Erie, Pa. |
| 73061 | Hansen Mfg. Co., Inc. | Princeton, Ind. |
| 73076 | H.M. Harper Co. | Chicago, Ill. |
| 73138 | Helipot Div. of Beckman Inst., Inc. | Fullerton, Cal. |
| 73293 | Hughes Products Division of Hughes Aircraft Co. | Newport Beach, Cal. |
| 73445 | Amperex Elect. Co. | Hicksville, L.I., N.Y. |
| 73506 | Bradley Semiconductor Corp. | New Haven, Conn. |
| 73559 | Carling Electric, Inc. | Hartford, Conn. |
| 73586 | Circle F Mfg. Co. | Trenton, N.J. |
| 73682 | George K. Garrett Co., Div. MSL Industries, Inc. | Philadelphia, Pa. |
| 73734 | Federal Screw Products, Inc. | Chicago, Ill. |
| 73743 | Fischer Special Mfg. Co. | Cincinnati, Ohio |
| 73793 | General Industries Co., The | Elyria, Ohio |
| 73846 | Goshen Stamping & Tool Co. | Goshen, Ind. |
| 73899 | JFD Electronics Corp. | Brooklyn, N.Y. |
| 73905 | Jennings Radio Mfg. Corp. | San Jose, Cal. |
| 73957 | Groove-Pin Corp. | Ridgefield, N.J. |
| 74276 | Signalite Inc. | Neptune, N.J. |
| 74455 | J.H. Winns, and Sons | Winchester, Mass. |
| 74861 | Industrial Condenser Corp. | Chicago, Ill. |
| 74868 | R.F. Products Division of Amphenol-Borg Electronic Corp. | Danbury, Conn. |
| 74970 | E.F. Johnson Co. | Waseca, Minn. |
| 75042 | International Resistance Co. | Philadelphia, Pa. |
| 75263 | Keystone Carbon Co., Inc. | St. Marys, Pa. |
| 75378 | CTS Knights, Inc. | Sandwich, Ill. |
| 75382 | Kulka Electric Corp. | Mt. Vernon, N.Y. |
| 75818 | Lenz Electric Mfg. Co. | Chicago, Ill. |
| 75915 | Littlefuse, Inc. | Des Plaines, Ill. |
| 76005 | Lord Mfg. Co. | Erie, Pa. |
| 76210 | C.W. Marwedel | San Francisco, Cal. |
| 76433 | General Instrument Corp., Micamold Division | Newark, N.J. |
| 76487 | James Millen Mfg. Co., Inc. | Malden, Mass. |
| 76493 | J.W. Miller Co. | Los Angeles, Cal. |
| 76530 | Cinch-Monadnock, Div. of United Carr Fastener Corp. | San Leandro, Cal. |
| 76545 | Mueller Electric Co. | Cleveland, Ohio |
| 76703 | National Union | Newark, N.J. |
| 76854 | Oak Manufacturing Co. | Crystal Lake, Ill. |
| 77068 | The Bendix Corp., Electrodynamics Div. | N. Hollywood, Cal. |
| 77075 | Pacific Metals Co. | San Francisco, Cal. |
| 77221 | Phaostran Instrument and Electronic Co. | So. Pasadena, Cal. |
| 77252 | Philadelphia Steel and Wire Corp. | Philadelphia, Pa. |
| 77342 | American Machine & Foundry Co. Potter & Brumfield Div. | Princeton, Ind. |
| 77630 | TRW Electronic Components Div. | Camden, N.J. |
| 77638 | General Instrument Corp., Rectifier Division | Brooklyn, N.Y. |
| 77764 | Resistance Products Co. | Harrisburg, Pa. |
| 77969 | Rubbercraft Corp. of Calif. | Torrance, Cal. |
| 78189 | Shakeproof Division of Illinois Tool Works | Elgin, Ill. |
| 78277 | Sigma | So. Braintree, Mass. |
| 78283 | Signal Indicator Corp. | New York, N.Y. |
| 78290 | Struthers-Dunn Inc. | Pitman, N.J. |
| 78452 | Thompson-Bremer & Co. | Chicago, Ill. |
| 78471 | Tilley Mfg. Co. | San Francisco, Cal. |
| 78488 | Stackpole Carbon Co. | St. Marys, Pa. |
| 78493 | Standard Thomson Corp. | Waltham, Mass. |
| 78553 | Tinnerman Products, Inc. | Cleveland, Ohio |
| 78790 | Transformer Engineers | San Gabriel, Cal. |
| 78947 | Ucinite Co. | Newtonville, Mass. |
| 79136 | Waldes Kohinoor Inc. | Long Island City, N.Y. |
| 79142 | Veeder Root, Inc. | Hartford, Conn. |
| 79251 | Wenco Mfg. Co. | Chicago, Ill. |
| 79727 | Continental-Wirt Electronics Corp. | Philadelphia, Pa. |
| 79963 | Zierick Mfg. Corp. | New Rochelle, N.Y. |
| 80031 | Mepco Division of Sessions Clock Co. | Morristown, N.J. |
| 80033 | Prestole Corp. | Toledo, Ohio |
| 80120 | Schnitzer Alloy Products Co. | Elizabeth, N.J. |
| 80131 | Electronic Industries Association. Standard tube or semi-conductor device, any manufacturer. | |
| 80207 | Unimax Switch, Div. Maxon Electronics Corp. | Wallingford, Conn. |
| 80223 | United Transformer Corp. | New York, N.Y. |
| 80248 | Oxford Electric Corp. | Chicago, Ill. |
| 80294 | Bourns Inc. | Riverside, Cal. |
| 80411 | Arco Div. of Robertshaw Controls Co. | Columbus, Ohio |
| 80486 | All Star Products Inc. | Defiance, Ohio |
| 80509 | Avery Label Co. | Monrovia, Cal. |
| 80583 | Hammarlund Co., Inc. | Mars Hill, N.C. |
| 80640 | Stevens, Arnold, Co., Inc. | Boston, Mass. |
| 80813 | Dimco Gray Co. | Dayton, Ohio |
| 81030 | International Inst. Inc. | Orange, Conn. |
| 81073 | Grayhill Co. | LaGrange, Ill. |
| 81095 | Triad Transformer Corp. | Venice, Cal. |
| 81312 | Winchester Elec. Div. Litton Ind., Inc. | Oakville, Conn. |
| 81349 | Military Specification | |
| 81483 | International Rectifier Corp. | El Segundo, Cal. |
| 81541 | Airpax Electronics, Inc. | Cambridge, Maryland |
| 81860 | Barry Controls, Div. Barry Wright Corp. | Watertown, Mass. |
| 82042 | Carter Precision Electric Co. | Skokie, Ill. |
| 82047 | Sperti Faraday Inc., Copper Hewitt Electric Div. | Hoboken, N.J. |
| 82116 | Electric Regulator Corp. | Norwalk, Conn. |
| 82142 | Jeffers Electronics Division of Speer Carbon Co. | Du Bois, Pa. |
| 82170 | Fairchild Camera & Inst. Corp., Space & Defense Systems Div. | Paramus, N.J. |
| 82209 | Magurie Industries, Inc. | Greenwich, Conn. |
| 82219 | Sylvania Electric Prod., Inc. Electronic Tube Division | Emporium, Pa. |
| 82376 | Astron Corp. | East Newark, Harrison, N.J. |
| 82389 | Switchcraft, Inc. | Chicago, Ill. |
| 82647 | Metals & Controls Inc., Spencer Products | Attleboro, Mass. |
| 82768 | Phillips-Advance Control Co. | Joliet, Ill. |
| 82866 | Research Products Corp. | Madison, Wis. |
| 82877 | Rolton Mfg. Co., Inc. | Woodstock, N.Y. |
| 82893 | Vector Electronic Co. | Glendale, Cal. |
| 83058 | Carr Fastener Co. | Cambridge, Mass. |
| 83086 | New Hampshire Ball Bearing, Inc. | Peterborough, N.H. |
| 83125 | General Instrument Corp., Capacitor Div. | Darlington, S.C. |
| 83148 | ITT Wire and Cable Div. | Los Angeles, Cal. |
| 83186 | Victory Eng. Corp. | Springfield, N.J. |
| 83298 | Bendix Corp., Red Bank Div. | Red Bank, N.J. |
| 83315 | Hubbell Corp. | Mundelein, Ill. |
| 83324 | Rosan Inc. | Newport Beach, Cal. |
| 83330 | Smith, Herman H., Inc. | Brooklyn, N.Y. |
| 83332 | Tech Labs | Palisades Park, N.J. |
| 83385 | Central Screw Co. | Chicago, Ill. |
| 83501 | Gavitt Wire and Cable Co., Div. of Amerace Corp. | Brookfield, Mass. |
| 83594 | Burroughs Corp., Electronic Tube Div. | Plainfield, N.J. |
| 83740 | Union Carbide Corp., Consumer Prod. Div. | New York, N.Y. |
| 83777 | Model Eng. and Mfg., Inc. | Huntington, Ind. |
| 83821 | Loyd Scruggs Co. | Festus, Mo. |
| 83942 | Aeronautical Inst. & Radio Co. | Lodi, N.J. |
| 84171 | Arco Electronics Inc. | Great Neck, N.Y. |
| 84396 | A.J. Glesener Co., Inc. | San Francisco, Cal. |
| 84411 | TRW Capacitor Div. | Ogallala, Neb. |

## CODE LIST OF MANUFACTURERS (Continued)

| Code No. | Manufacturer | Address |
|---|---|---|
| 94870 | Sarkes Tarzian, Inc. | Bloomington, Ind. |
| 85454 | Boonton Molding Company | Boonton, N.J. |
| 85471 | A. B. Boyd Co. | San Francisco, Cal. |
| 85474 | R. M. Bracamonte & Co. | San Francisco, Cal. |
| 85660 | Koiled Kords, Inc. | Hamden, Conn. |
| 85911 | Seamless Rubber Co. | Chicago, Ill. |
| 86174 | Fafnir Bearing Co. | Los Angeles, Calif. |
| 86197 | Clifton Precision Products Co., Inc. | Clifton Heights, Pa. |
| 86579 | Precision Rubber Products Corp. | Dayton, Ohio |
| 86684 | Radio Corp. of America, Electronic Comp. & Devices Division | Harrison, N.J. |
| 86928 | Seastrom Mfg. Co. | Glendale, Cal. |
| 87034 | Marco Industries | Anaheim, Cal. |
| 87216 | Philco Corporation (Lansdale Division) | Lansdale, Pa. |
| 87473 | Western Fibrous Glass Products Co. | San Francisco, Cal. |
| 87664 | Van Waters & Rogers Inc. | San Francisco, Cal. |
| 87930 | Tower Mfg. Corp. | Providence, R.I. |
| 88140 | Cutler-Hammer, Inc. | Lincoln, Ill. |
| 88220 | Gould-National Batteries, Inc. | St. Paul, Minn. |
| 88698 | General Mills, Inc. | Buffalo, N.Y. |
| 89231 | Graybar Electric Co. | Oakland, Cal. |
| 89473 | G.E. Distributing Corp. | Schenectady, N.Y. |
| 89479 | Security Co. | Detroit, Mich. |
| 89665 | United Transformer Co. | Chicago, Ill. |
| 90030 | United Shoe Machinery Corp. | Beverly, Mass. |
| 90179 | U.S. Rubber Co., Consumer Ind. & Plastics Prod. Div. | Passaic, N.J. |
| 90365 | Belleville Speciality Tool Mfg., Inc. | Belleville, Ill. |
| 90763 | United Carr Fastener Corp. | Chicago, Ill. |
| 90970 | Bearing Engineering Co. | San Francisco, Cal. |
| 91146 | ITT Cannon Elect. Inc., Salem Div. | Salem, Mass. |
| 91260 | Connor Spring Mfg. Co. | San Francisco, Cal. |
| 91345 | Miller Dial & Nameplate Co. | El Monte, Cal. |
| 91418 | Radio Materials Co. | Chicago, Ill. |
| 91506 | Augat Inc. | Attleboro, Mass. |
| 91637 | Dale Electronics, Inc. | Columbus, Nebr. |
| 91662 | Elco Corp. | Willow Grove, Pa. |
| 91673 | Epiphone Inc. | New York, N.Y. |
| 91737 | Gremar Mfg. Co., Inc. | Wakefield, Mass. |
| 91827 | K F Development Co. | Redwood City, Cal. |
| 91886 | Malco Mfg., Inc. | Chicago, Ill. |
| 91929 | Honeywell Inc., Micro Switch Division | Freeport, Ill. |
| 91961 | Nahm-Bros. Spring Co. | Oakland, Cal. |
| 92180 | Tru-Connector Corp. | Peabody, Mass. |
| 92367 | Elgeet Optical Co., Inc. | Rochester, N.Y. |
| 92607 | Tensolite Insulated Wire Co., Inc. | Tarrytown, N.Y. |
| 92702 | IMC Magnetics Corp. | Westbury, L.I., N.Y. |
| 92966 | Hudson Lamp Co. | Kearney, N.J. |
| 93332 | Sylvania Electric Prod. Inc., Semiconductor Div. | Woburn, Mass. |
| 93369 | Robbins & Myers Inc. | Pallisades Park, N.J. |
| 93410 | Stemco Controls, Div. of Essex Wire Corp. | Mansfield, Ohio |
| 93632 | Waters Mfg. Co. | Culver City, Cal. |
| 93929 | G.V. Controls | Livingston, N.J. |
| 94137 | General Cable Corp. | Bayonne, N.J. |
| 94144 | Raytheon Co., Comp. Div., Ind. Comp. Operations | Quincy, Mass. |
| 94148 | Scientific Electronics Products, Inc. | Loveland, Colo. |
| 94154 | Wagner Elect. Corp., Tung-Sol Div. | Newark, N.J. |
| 94197 | Curtiss-Wright Corp., Electronics Div. | East Patterson, N.J. |
| 94222 | South Chester Corp. | Chester, Pa. |
| 94330 | Wire Cloth Products, Inc. | Bellwood, Ill. |
| 94375 | Automatic Metal Products Co. | Brooklyn, N.Y. |
| 94682 | Worcester Pressed Aluminum Corp. | Worcester, Mass. |
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| 95566 | Arnold Engineering Co. | Marengo, Ill. |
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| 96501 | Excel Transformer Co. | Oakland, Cal. |
| 96508 | Xcelite, Inc. | Orchard Park, N.Y. |
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# MANUAL BACKDATING CHANGES

MODELS 461A/462A

WIDE BAND AMPLIFIER

Manual Serial Prefixed: 606- (461A), 551- (462A)
-hp- Part No. 00461-90004

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

| Instrument Serial Number | Make Manual Changes |
|---|---|
| 346- (461A) | 1, 2, 3, 4 |
| 418- (461A) | 2, 3, 4 |
| 606-(461A) | 3, 4 |
| 946-03115 and below | 4 |

| Instrument Serial Number | Make Manual Changes |
|---|---|
| 347- (462A) | 1, 2, 3, 4 |
| 421-, 414- (462A) | 2, 3, 4 |
| 551-(462A) | 3, 4 |
| 947-01160 and below | 4 |

CHANGE NO.1 Change C11, C15, C17, C20, and C23 to -hp- Part No. 0180-0155, 2.2 uF. For better low frequency response use current values.

CHANGE NO.2 Change Q4, Q5, Q6, Q7 and Q8 to -hp- Part No. 1854-0031.Change R24 to 330 ohms, -hp- Part No. 0683-3315. Change R31 to 240 ohms, -hp- Part No. 0683-0565. If any one of these transistors fail, replace all transistors (Q4 through Q8), R24 and R31 with current type and value. Recalibrate the 461A/462A as described in Section V of this manual.

CHANGE NO. 3 Change C33 and C34 to 0.01 uF (0150-0119).
Change S2 part number to 3101-0033.
Change J2 part number to 1251-0148.
Change W1 part number to 8120-0078.

CHANGE NO. 4 Change DS1 part number to 1450-0048.