Errata

Title & Document Type: **1801A Dual Channel Vertical Amplifier Operating and Service Manual**

Manual Part Number: **01801-90903**

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1801A
DUAL CHANNEL
VERTICAL AMPLIFIER

OPERATING AND SERVICE MANUAL

HEWLETT hp PACKARD

1801A

OPERATING AND SERVICE MANUAL

H/P Part No. 01801-90903

MODEL 1801A
DUAL CHANNEL VERTICAL AMPLIFIER

SERIALS PREFIXED: 716-

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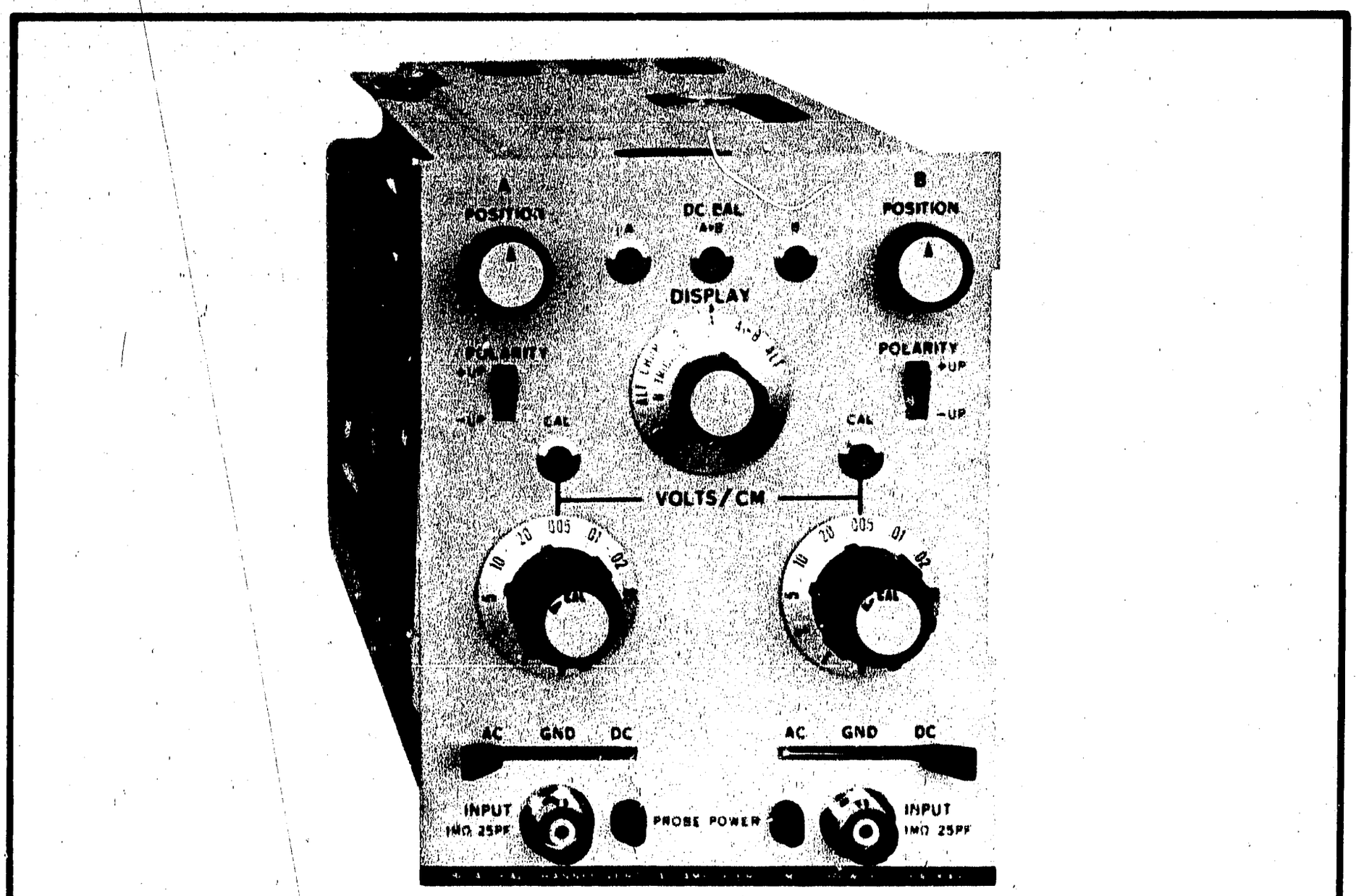


Figure 1-1. Model 1801A Dual Channel Vertical Amplifier

Table 1-1. Specifications

MODE OF OPERATION

Channel A alone.
Channel B alone.
Channels A and B displayed on alternate sweeps.
Channels A and B displayed by switching at approximately a 400 kHz rate, with blanking during switching.
Channel A plus Channel B (algebraic addition).

EACH CHANNEL

Deflection Factor (Sensitivity): 0.005 v/cm to 20 v/cm; vernier extends minimum sensitivity to 50 v/cm; a sensitivity calibration adjustment for each channel is provided on the front panel.
Attenuator Accuracy: ±3%.
Bandwidth (Direct or with probes, 3 db down from 8 cm, 50 kHz reference signal.): DC coupled, dc to 50 MHz; AC coupled, 2 Hz to 50 MHz.
Rise Time (Direct or with probes): Less than 7 nsec with 8 cm input step.
Input RC: 1 megohm shunted by approximately 25 pf.
Maximum Input Signal: AC coupled, 600 volts (DC + peak AC); DC coupled, 150 vdc at 5 mv/cm increasing to 350 vdc at 20 v/cm.
Polarity Presentation: + or - UP selectable.

A + B INPUT

Amplifier: Bandwidth and sensitivity remain unchanged. Either Channel A or B may be inverted to give differential operation.
Differential Input (A-B): Common mode rejection at least 40 db at 5 mv/cm, 20 db on other ranges for frequencies up to 1 MHz. Common mode signal should not exceed an amplitude equivalent to 50 cm.

TRIGGERING

Mode:
Channel A or Channel B alone, or Channel A plus Channel B; on the signal displayed.
Channel A and Channel B displayed by switching at approximately a 400 kc rate; on Channel B alone.
Channel A & B displayed on alternate sweeps; on the signal displayed on each channel or Channel B alone.
Frequency:
Provides sufficient signal to the time base for triggering over the range of dc to 50 MHz in all modes except CHOP (100 kHz in CHOP) with 0.5 cm pk-pk signal or more displayed on the CRT.

WEIGHT

Net, 4 lbs (1,8 kg); Shipping, 6-1/2 lbs (3 kg)

SECTION I
GENERAL INFORMATION

1-1. INSTRUMENT DESCRIPTION.

1-2. The Hewlett-Packard Model 1801A Dual Channel Vertical Amplifier (shown in Figure 1-1) is a versatile wideband plug-in unit for the hp Model 180-series Oscilloscopes. Dual channel capability allows display of one signal alone or two signals simultaneously. Two waveforms can be superimposed, each with the full 8-cm amplitude. Each channel of the plug-in has a bandwidth of 50 MHz, a rise time of less than 7 nsec, and a maximum calibrated deflection factor (sensitivity) of 5 millivolts per centimeter. The minimum calibrated deflection factor is 20 volts per centimeter and a vernier can extend the minimum sensitivity to 50 volts per centimeter.

1-3. In addition to a display of either signal alone, either a chopped or alternating display of two signals is possible. With the chopped display, switching occurs at a 400 kHz rate and the CRT trace is automatically blanked during switching (eliminating undesirable transients from the display). In the chopped mode, the sweep is triggered from the channel B signal. With alternate operation, the time base may be triggered either on the signal displayed by each channel or on the channel B signal alone. Channel A plus channel B (algebraic addition) may also be selected and either channel can be inverted to obtain a differential (A-B or B-A) display. Common mode rejection for the differential input (A-B) operation is at least 40 db at 5 mv/cm and 20 db on other deflection factors for frequencies up to 1 MHz. Complete specifications for the Model 1801A are provided in Table 1-1.

1-4. SCOPE OF MANUAL.

1-5. This manual provides operating and service information for the hp Model 1801A Dual Channel Vertical Amplifier. This manual supplements that information presented in the Operating and Service Manual for the hp Model 180-series Oscilloscopes. For specific information on other plug-ins for the Model 180-series Oscilloscope, refer to the manual for the specific plug-in unit.

1-6. INSTRUMENT IDENTIFICATION.

1-7. Hewlett-Packard uses a two-section eight-digit serial number to identify instruments. The first three digits (preceding the dash) are the serial prefix which identifies a series of instruments; the last five digits identify a particular instrument in the series. The serial number appears on a plate located on the rear panel. All correspondence with a Hewlett-Packard Sales/Service Office in regard to an instrument should reference the model number and the complete serial number.

1-8. MANUAL CHANGES.

1-9. This manual provides complete information for any Model 1801A with a serial number prefixed (see Paragraph 1-6) by the three digits indicated on the title page. If the serial prefix of the instrument is different from that on the title page, a "Manual Changes" sheet supplied, or Section VII of this manual, will describe changes which will adapt this manual to provide correct coverage. Technical corrections (if any) to this manual, due to known errors in print, are called Errata and are shown on the change sheet. For information on manual coverage of any hp instrument, contact the nearest hp Sales/Service Office (addresses are listed at the rear of this manual).

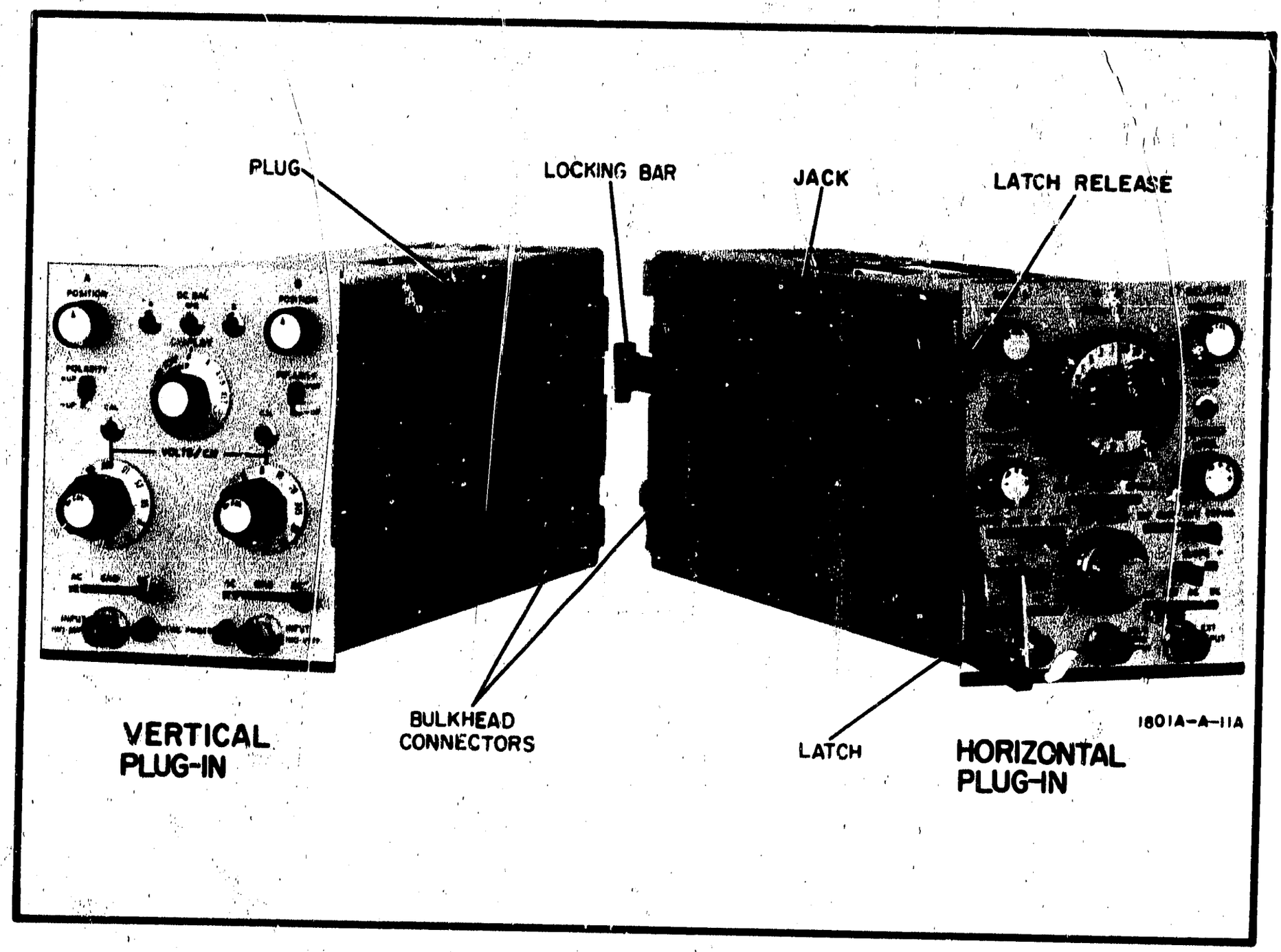


Figure 2-1. Plug-In Mating

SECTION II
INSTALLATION

2-1. INITIAL INSPECTION.

2-2. MECHANICAL CHECK. Check the shipping carton for damage immediately after receipt. If it is damaged, ask the carrier's agent to be present when the instrument is unpacked. Inspect the Model 1801A for physical damage such as bent or broken parts and dents or scratches. If damage is found, refer to Paragraph 2-4 for the recommended claim procedure. If the Model 1801A appears undamaged perform the electrical check (Paragraph 2-3). Retain the packaging material for possible future use.

2-3. ELECTRICAL CHECK. The performance check is given in Paragraphs 5-5 through 5-17. This check will determine whether or not the instrument is still operating within its specifications as listed in Table 1-1. The initial performance and accuracy of this instrument are certified as stated on the inside front cover of this manual. If the Model 1801A does not operate as specified, refer to Paragraph 2-4 for the recommended claim procedure.

2-4. CLAIMS.

2-5. If physical damage is found or if the instrument does not operate within specifications when received notify the carrier and the nearest Hewlett-Packard Sales/Service Office immediately. The Sales/Service Office will arrange for the repair or replacement of the instrument without waiting for a claim to be settled with the carrier.

2-6. The warranty statement for all Hewlett-Packard products is on the inside front cover of this manual. Contact the nearest Sales/Service Office for information about warranty claims.

2-7. REPACKAGING FOR SHIPMENT.

2-8. If the instrument is to be shipped to a Hewlett-Packard Sales/Service Office attach a tag to it showing owner and owner's address, instrument's model number and 8 digit serial number, and a description of the services required.

2-9. The original shipping carton and packaging materials, except for the accordion-pleated pads, should be used for reshipment. If they are not available or reusable, the instrument should be repackaged with the following materials:

a. A double walled carton (refer to Table 2-1 for test strength required).

b. Heavy paper or sheets of cardboard to protect all instrument surfaces (use a nonabrasive material such as polyurethane or a cushioned paper such as Kimpak around all projecting parts.

c. At least 4 inches of tightly packed industry approved shock absorbing material, such as extra firm polyurethane foam.

d. Heavy duty shipping tape to secure outside of carton.

Table 2-1. Shipping Carton Test Strengths

Gross Weight (lbs)	Carton Test Strength (lbs)
up to 10	200
10 to 30	275
30 to 120	350
120 to 140	500
140 to 160	600

2-10. PREPARATION FOR USE.

2-11. The Model 1801A and the Horizontal Plug-In are locked together and inserted as a unit into the plug-in compartment of the Model 180-series Oscilloscope. This procedure is explained below. Power for the Model 1801A is supplied by the Oscilloscope through the Horizontal Plug-In.

2-12. Install Plug-Ins as follows:

a. Move locking bar to rear (see Figure 2-1).

b. Fit vertical plug into horizontal jack (make certain that bulkhead connectors are aligned) and press plug-ins firmly together.

c. After ensuring that front and rear panels are aligned, push locking bar forward.

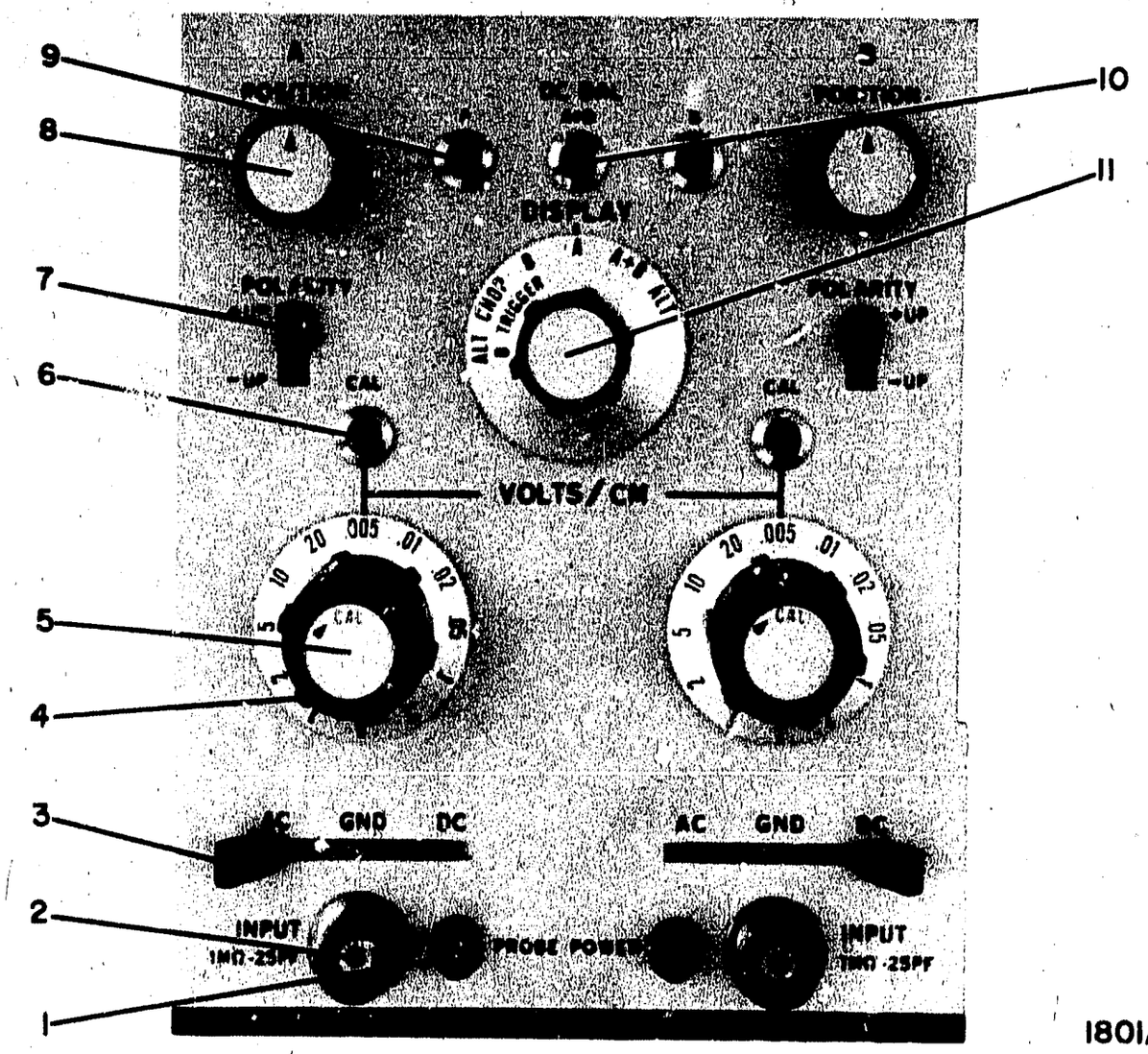
d. Rotate plug-in latch downward and insert plug-ins into the Model 180-series Oscilloscope.

e. Rotate plug-in latch upward and push forward to lock,

OPERATION

AND

THEORY



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1. PROBE POWER. Connector to supply +15 and -12.6 volts to active probe (if used).

2. INPUT. BNC to connect input signal.

3. Coupling. Selects capacitive (AC) or direct (DC) coupling of input signal, or grounds amplifier's input stage while disconnecting the INPUT.

4. VOLTS/CM. Selects the input amplitude necessary to give one cm of deflection.

5. Vernier. Provides continuous adjustments of volts/cm between calibrated positions of VOLTS/CM switch.

6. CAL. Adjustment to align amplifier with setting of VOLTS/CM switch.

7. POLARITY. Selects between a normal (+UP) or inverted (-UP) display.

8. POSITION. Varies vertical position of display.

9. DC BAL A. Adjustment to minimize vertical shift of trace when POLARITY is switched.

10. DC BAL A+B. Adjustment to balance trace when in A+B operation.

11. DISPLAY. Selects type of display; either single channel or dual channel.

Figure 3-1. Controls and Connectors

SECTION III
OPERATION

3-1. INTRODUCTION.

3-2. The Model 1801A Dual Channel Vertical Amplifier provides Model 180-series Oscilloscopes with the capability of displaying two waveforms either singly or simultaneously. The waveforms may be from dc to 50 MHz at a maximum amplitude of 600 v. The calibrated accuracy over this range is ±3%. The input impedance is 1 megohm shunted by 25 pf.

3-3. CONTROLS AND CONNECTORS.

3-4. Locations of controls and connectors are shown in Figure 3-1 along with a brief description of their function. Controls that perform the same function in each channel are explained for channel A only. The following paragraphs explain some control functions in more detail.

3-5. COUPLING. This switch selects either capacitive (AC) or direct (DC) coupling of the input signal to the amplifier, or it grounds (GND) the amplifier's input stage while disconnecting the input signal. It should be positioned to DC when viewing long duration pulses or dc levels of waveforms. AC should be selected when viewing waveforms riding large dc levels. GND is used to set an accurate zero reference before measuring dc potentials.

3-6. DISPLAY. This control selects the type of display. Input signals may be displayed either singly or simultaneously as explained below.

a. A. Presents a display of the input to channel A only.

b. B. Presents a display of the input to channel B only.

c. A+B. Displays algebraic sum of inputs to both channels. The POLARITY setting of each channel determines whether the display is the sum or the difference of the input amplitudes. There are two possible displays of the sum (A+B and -A-B) and of the difference (A-B and B-A).

d. ALT. Presents a separate display of each channel's input signal. Each input is displayed on alternate sweeps. This mode should not be used with slower sweep speeds as the display will flicker. The composite switched signal is sent to the horizontal plug-in and may be used to trigger the sweep.

e. CHOP (B TRIGGER). This position presents separate displays of each input. Both inputs are displayed during the same sweep by switching each channel on and off at a rate of 400 kHz. This mode should not be used with the faster sweep speeds as each display is turned off when the other is visible and the gaps may be objectionable. The B channel input signal is sent to the horizontal plug-in for possible use as an internal trigger.

f. ALT (B TRIGGER). This position allows each input to be displayed separately on alternate sweeps. This mode differs from the other ALT in that B channel input signal is supplied to the horizontal plug-in and may be used to trigger the sweep. ALT (B TRIGGER) should be used with the faster sweep speeds when accurate time comparisons of the two inputs are necessary.

3-7. INPUT PROBES.

3-8. The two Model 10004A 10:1 Divider Probes supplied with each Model 180A/AR Oscilloscope should be used with the Model 1801A whenever possible. The high input impedance of the probes reduces circuit loading. The 10:1 voltage division must be compensated for by multiplying the selected deflection factor by 10. When measuring very small amplitude signals and it is not possible to use the Model 10004A probes, a shielded cable should be used. Unshielded leads should never be used as they may couple unwanted signals to the input.

3-9. INTERNAL TRIGGER.

3-10. A vertical input signal that will provide .5 cm of vertical deflection will produce an internal trigger with a certain amplitude. Figure 3-2 illustrates the internal trigger amplitude as a function of frequency. This graph should be used in conjunction with the trigger amplitude requirements of the horizontal plug-in.

3-11. OPERATING INSTRUCTIONS.

3-12. Figures 3-3 through 3-8 give step-by-step operating instructions for the Model 1801A. These instructions are keyed to the photograph in each figure with index numbers. The preceding paragraphs contain additional information and should be read before using the operating instructions.

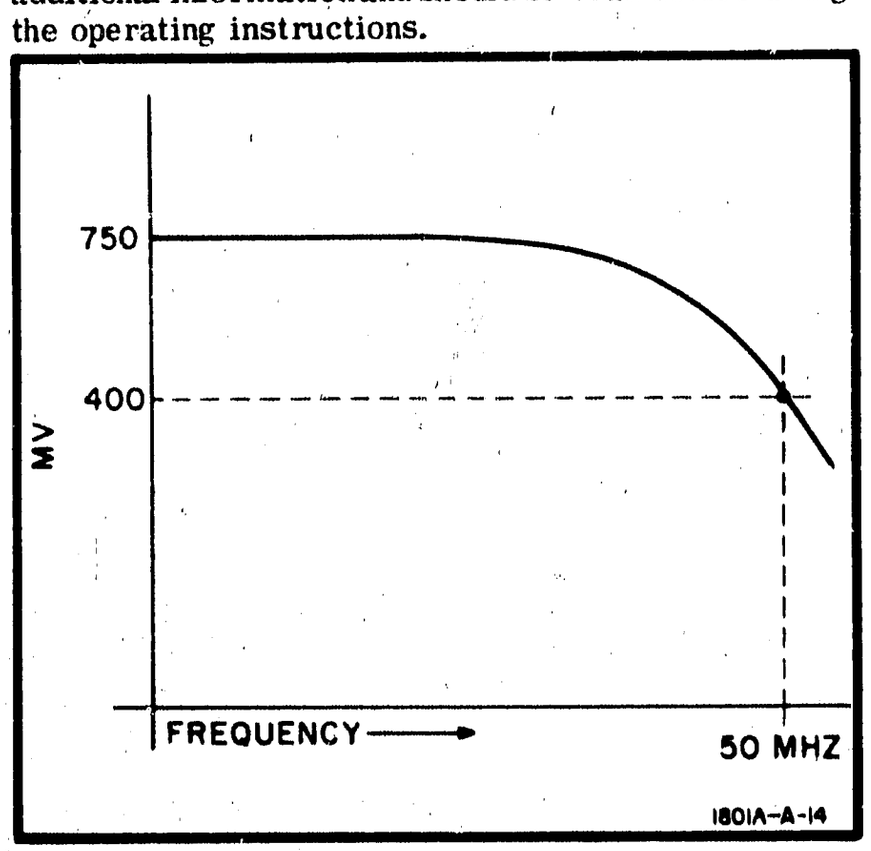
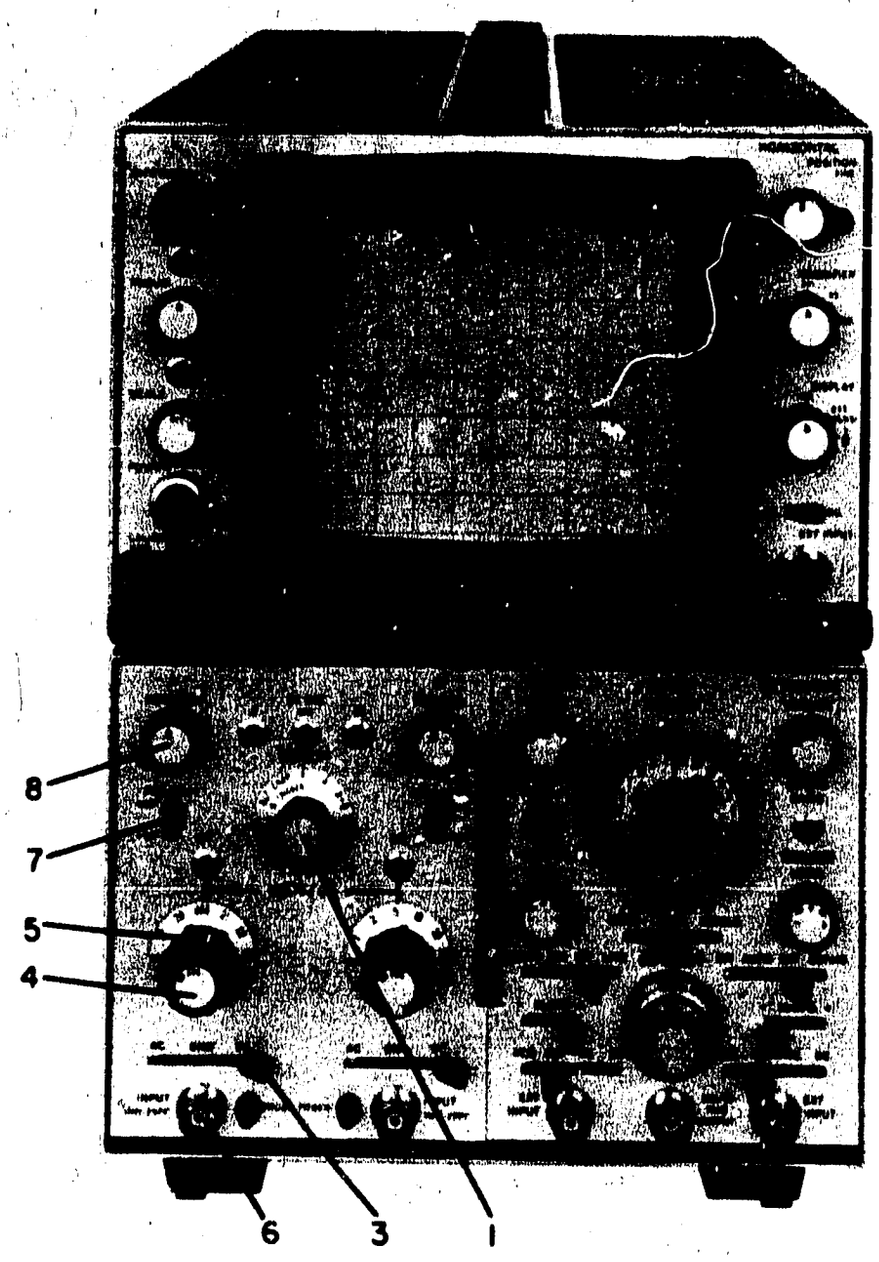


Figure 3-2. Internal Trigger Amplitude



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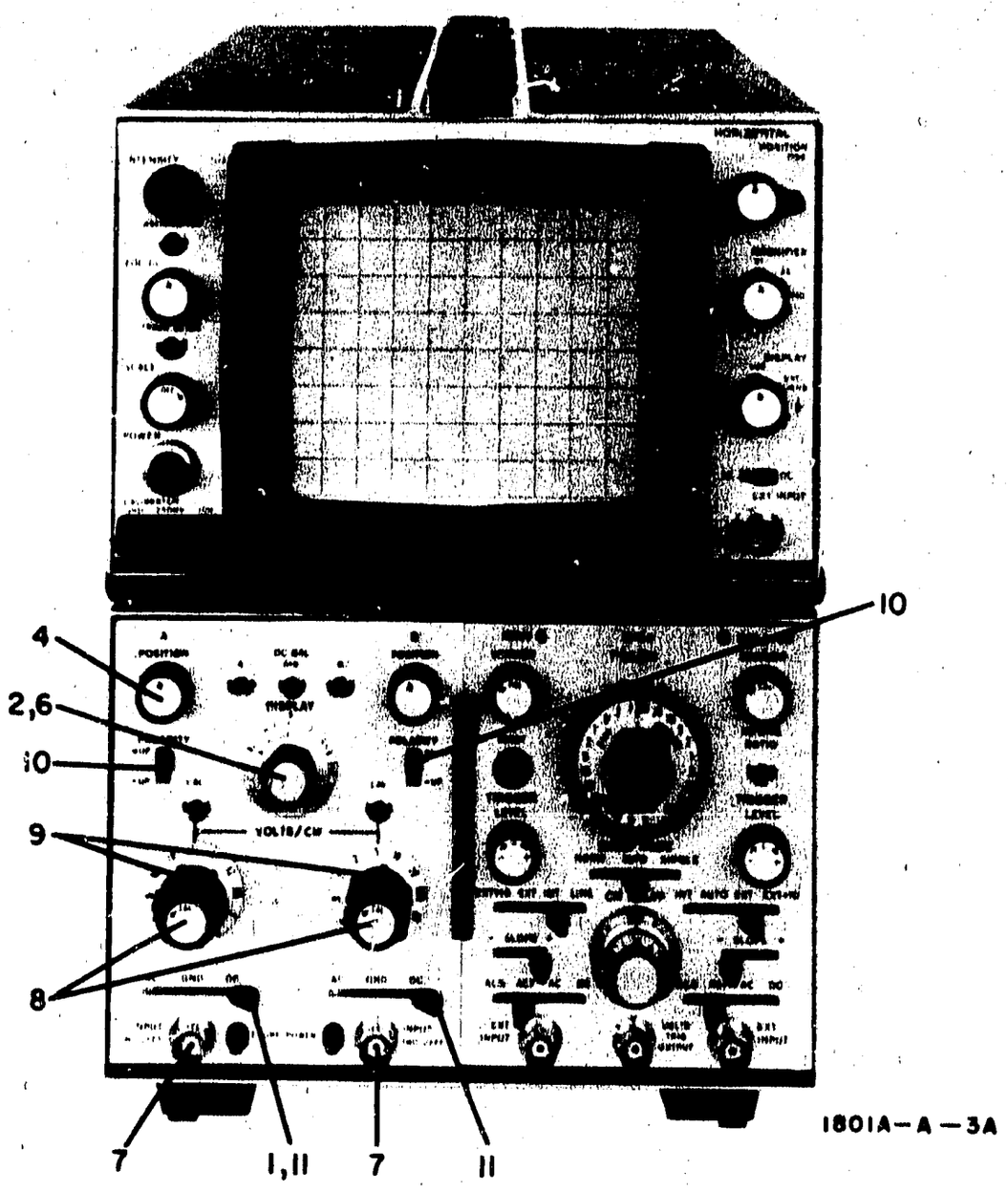
1. Set DISPLAY to A, B, ALT, ALT B TRIGGER, or CHOP B TRIGGER as desired (see Paragraph 3-6).

   Note
   If ALT, ALT B TRIGGER, or CHOP B TRIGGER is selected, perform steps for both channels.

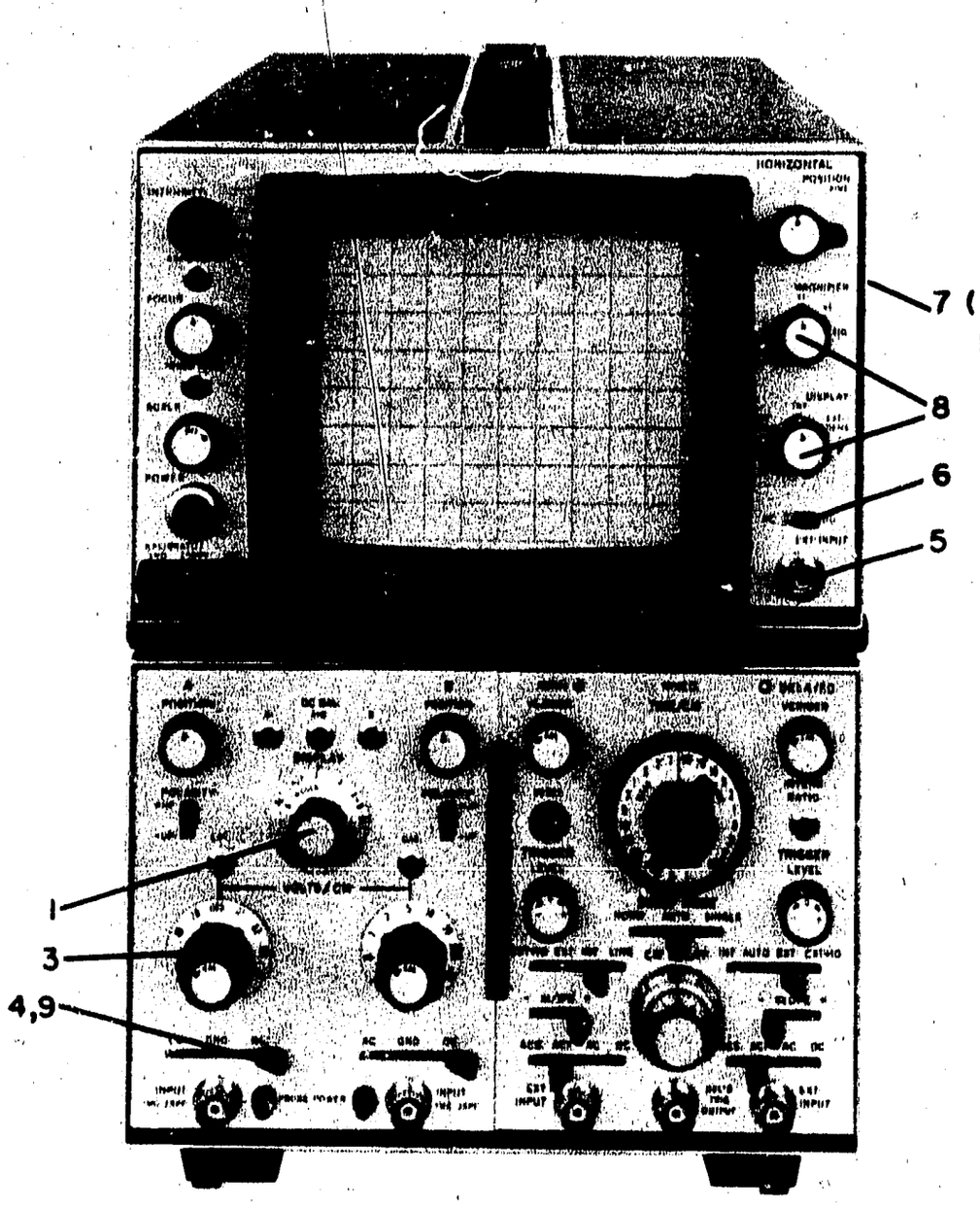
2. Obtain a baseline (refer to horizontal plug-in manual).
3. Set coupling as required.
4. Set Vernier to CAL for calibrated display (if desired).
5. Set VOLTS/CM as desired.
6. Connect signal to INPUT.
7. Set POLARITY as desired.
8. Adjust POSITION as desired.

Figure 3-3. Single or Dual Channel Operation



1. Set Coupling to GND.
2. Set DISPLAY to A.
3. Obtain a baseline (refer to horizontal plug-in manual).
4. Center baseline with POSITION.
5. Repeat steps 1 through 4 for channel B.
6. Set DISPLAY to A+B.
7. Connect signals to INPUT.
8. Set Vernier to CAL (if calibrated display is desired).
9. Set VOLTS/CM as desired.
10. Set POLARITY as desired.
11. Set Coupling as desired.

Figure 3-4. A + B Operation



1. Set vertical DISPLAY to A, B, or A+B.

2. Make control settings using an applicable operating procedure.

3. Adjust VOLTS/CM for desired amount of deflection (both channels if used).

4. Set vertical Coupling to GND (both channels if used).

5. Connect horizontal signal to EXT INPUT.

6. Select horizontal Coupling.

7. If measuring phase relationships, set Phase/Bandwidth switch to Phase.

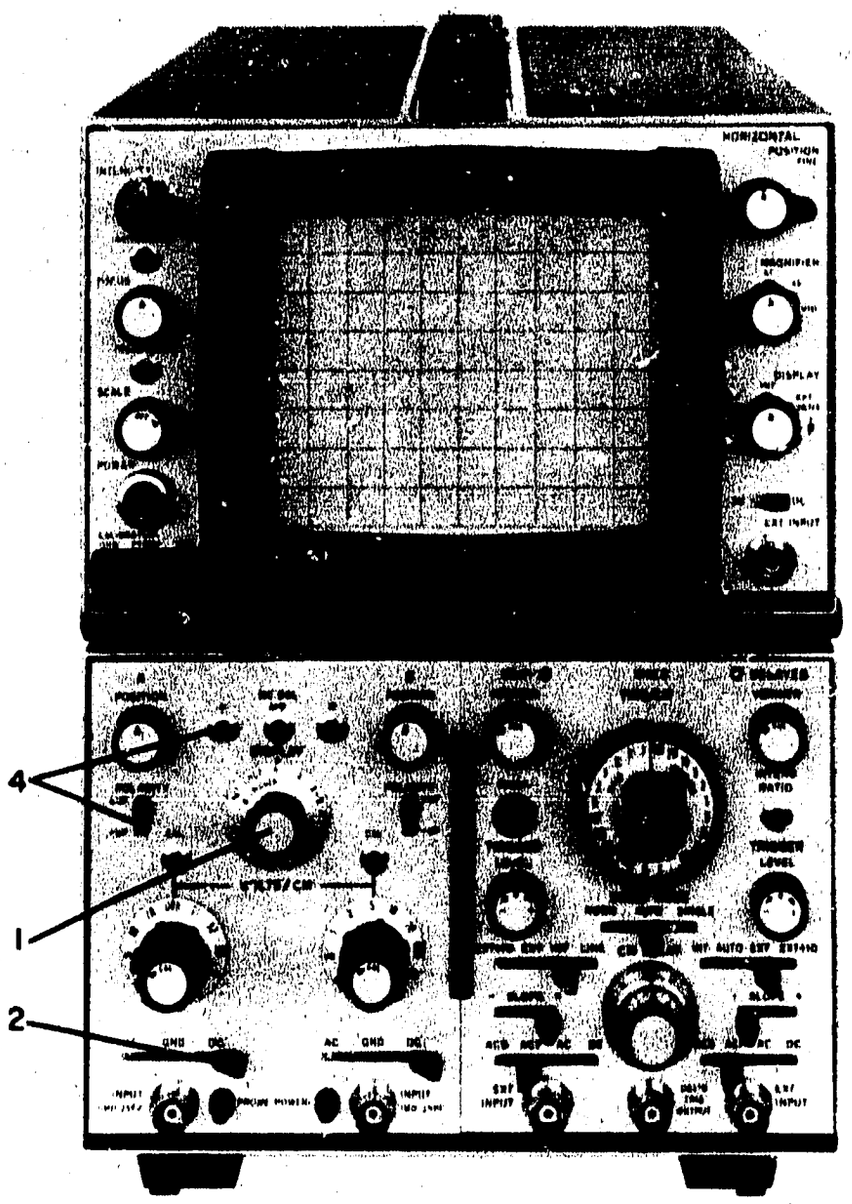
8. Adjust horizontal DISPLAY and MAGNIFIER for desired amount of deflection.

9. Set vertical Coupling as desired (both channels if used).

Note

Make certain that Phase/Bandwidth switch is placed to Bandwidth after making phase measurements. This will allow normal operation.

Figure 3-5. XY Operation



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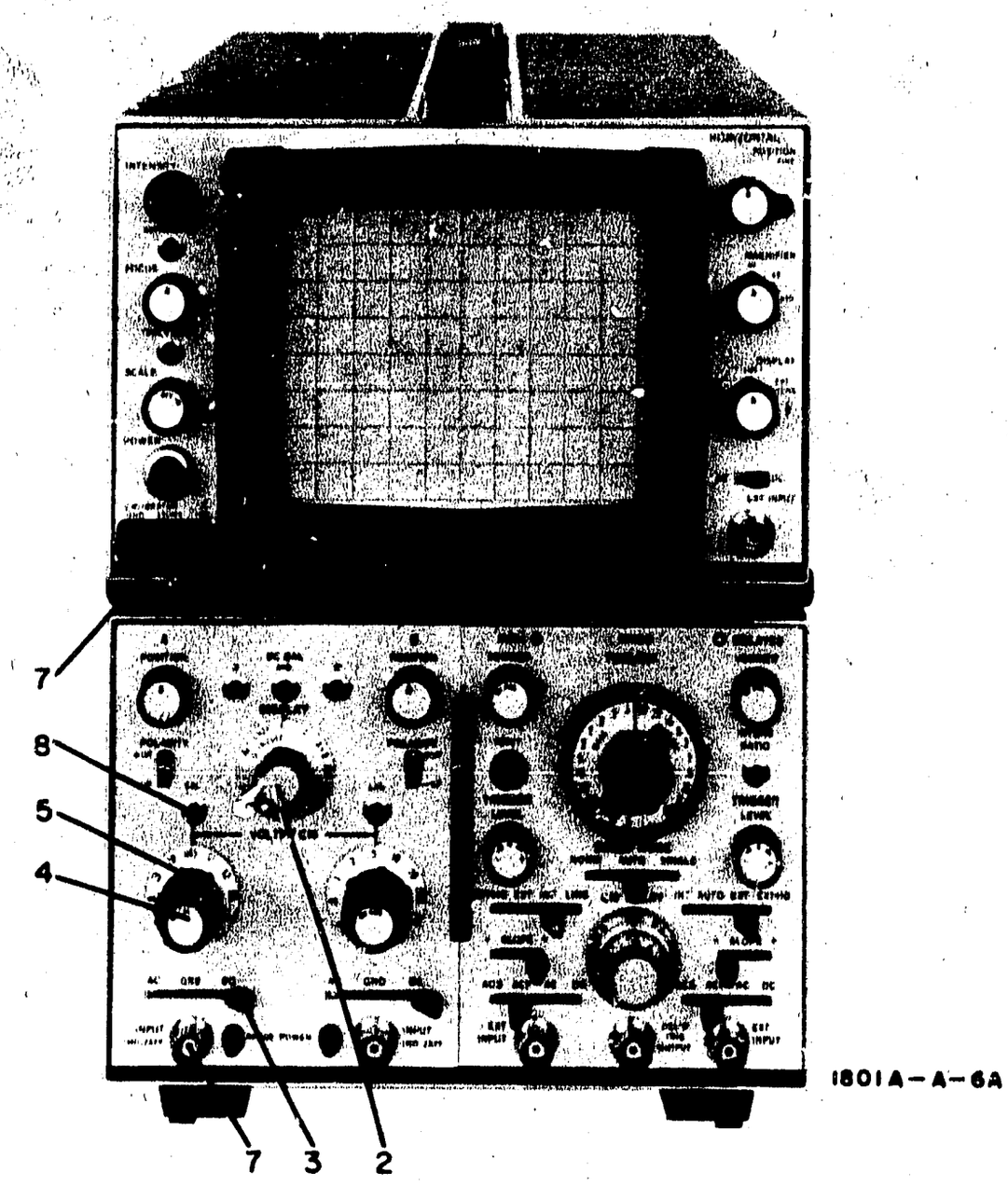
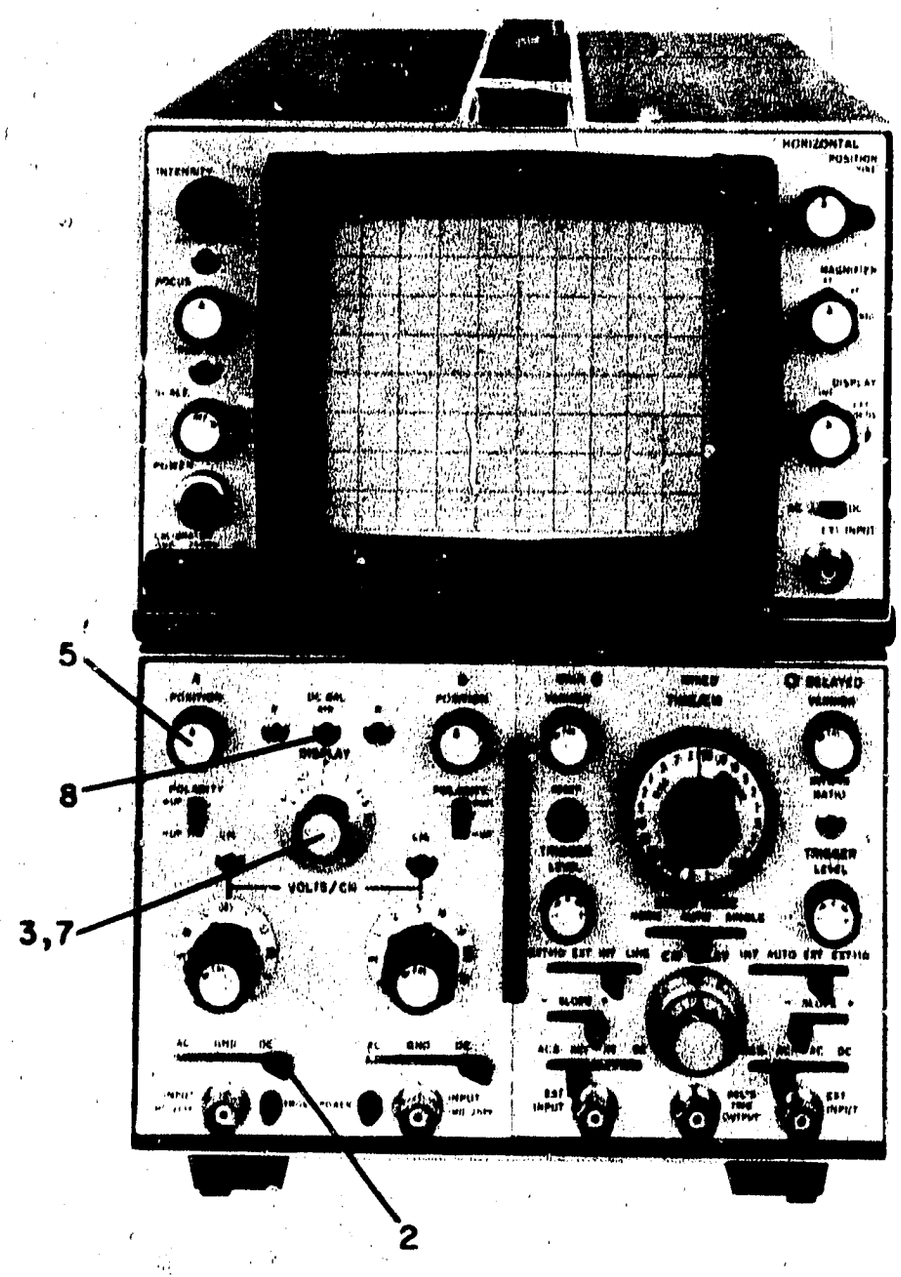
1. Set DISPLAY to A.
2. Set Coupling to GND.
3. Obtain a baseline (refer to horizontal plug-in manual).
4. Adjust DC BAL A for no vertical shift of trace while switching POLARITY between +UP and -UP.
5. Repeat procedure for channel B.

Figure 3-6. Amplifier Balance Adjustment



1. Perform amplifier balance adjustment.
2. Set DISPLAY to A.
3. Set A and B Coupling to AC.
4. Set A and B Vernier to CAL.
5. Set A and B VOLTS/CM to .005.
6. Obtain a baseline (refer to Horizontal Plug-In manual.
7. Connect the 250 MV signal from CALIBRATOR to A INPUT with 10:1 Divider Probe.
8. Adjust A CAL for 5 cm of deflection.
9. Connect the 250 MV signal from CALIBRATOR to both A and B INPUT with 10:1 Divider Probes.
10. Set DISPLAY to A + B.
11. Set A POLARITY to +UP and B POLARITY to -UP.
12. Adjust B CAL for 0 cm of deflection.

Figure 3-7. Vertical Sensitivity Adjustment



1. Perform amplifier balance and vertical sensitivity adjustments.
2. Set Coupling to GND.
3. Set DISPLAY to A.
4. Obtain a baseline (refer to horizontal plug-in manual).
5. Center baseline with POSITION.
6. Repeat steps 1 through 5 for channel B.
7. Set DISPLAY to A+B.
8. Adjust DC BAL A+B to recenter baseline.

Figure 3-8. A + B Balance Adjustment

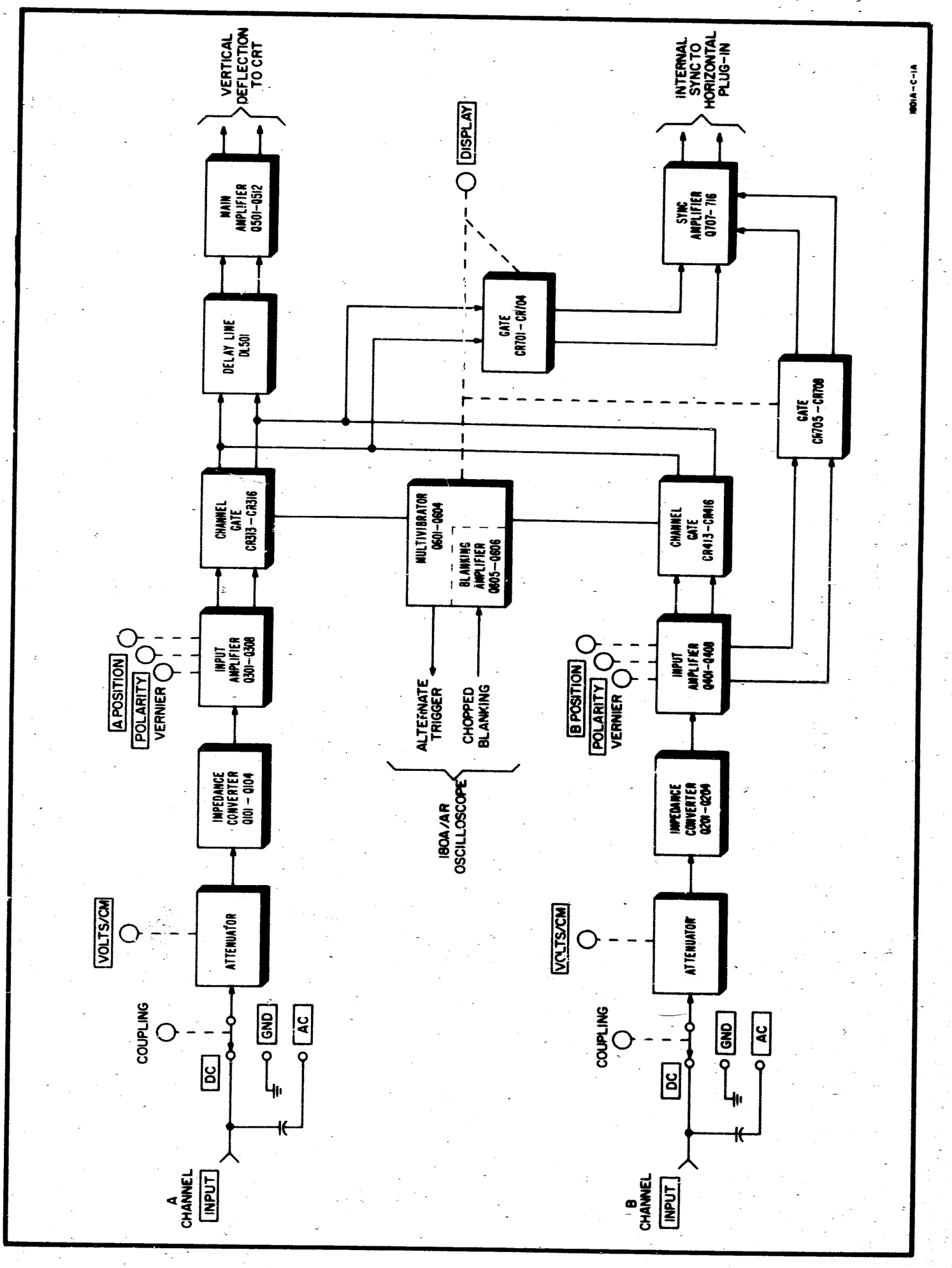


Figure 4-1. Model 1801A Block Diagram

SECTION IV
PRINCIPLES OF OPERATION

4-1. INTRODUCTION.

4-2. The Model 1801A Dual Trace Vertical Amplifier allows two input signals to be displayed separately or simultaneously on Model 180-series Oscilloscopes. A block diagram of the Model 1801A is shown in Figure 4-1 and a brief explanation of its function is given in the following paragraphs.

4-3. FUNCTIONAL DESCRIPTION.

4-4. The input signals to channel A and B are applied through the Coupling switches to the attenuators. The signals are attenuated on all but the lowest setting of each VOLTS/CM switch, and applied to impedance converters. Signals from the converters are applied to the input amplifier where they are converted to differential signals, amplified, and directed to the channel gates. The gates (controlled by a multivibrator, as explained later) determine whether the signals are blocked or passed. From the gates, the composite signal is directed to the delay line and also picked-off for synchronizing the horizontal time-base. The purpose of the delay line is to allow synchronization of vertical and horizontal deflection signals. This makes it possible to observe the leading edge of fast rise-time low duty cycle pulses. The delayed signal is amplified in the Main Amplifier to drive the deflection plates.

4-5. A OR B. When single channel operation is selected (A or B) the multivibrator turns on the gate of the selected channel and turns off the gate of the other channel. The input signal for the selected channel is passed through its gate and applied to two circuits. It is coupled through the delay line and main vertical amplifier to the CRT for vertical deflection. It is also applied through a diode gate to the Sync Amplifier where it is amplified and converted to a single-ended signal. From the Sync Amplifier it is coupled to the horizontal plug-in where it may be used to trigger the sweep.

4-6. A + B. Positioning the DISPLAY switch to A + B sets the multivibrator so that both channel gates are turned on. The input signals to both channels are summed and the resultant signal (composite) is coupled through the delay line and main amplifier for vertical deflection. As in single channel operation, the composite signal (from the gates) is coupled to the Sync Amplifier and used to trigger the sweep.

4-7. CHOP B. TRIGGER. Selecting chopped operation with DISPLAY sets the multivibrator to its astable state at a free-running frequency of 400 kHz. During each horizontal sweep the gates are alternately switched on for 1.25 μsec. The resulting signal (1.25 μsec of one input, then 1.25 μsec of the other) is coupled through the delay line and the main amplifier for vertical deflection. Each time the multivibrator changes state the gate switches, and a positive pulse (called chopped blanking) is generated and applied to the gate amplifier in the Oscilloscope. This amplified pulse turns the CRT off so that the switching transients will not be seen. The signal from Channel B is selected to drive the Sync Amplifier.

4-8. ALT or ALT B TRIGGER. Selecting either ALT or ALT B TRIGGER with the DISPLAY switch sets the multivibrator for bistable operation. At the end of each sweep the alternate trigger pulse from the Model 180-series Oscilloscope sets the multivibrator to its other state. The result is that each input channel is alternately on for one complete sweep. When operating in the ALT mode the "on" channel signal is coupled to the Sync Amplifier. In ALT B TRIGGER the signal from the channel B is coupled to the Sync Amplifier.

4-9. CIRCUIT DETAILS.

4-10. The following paragraphs provide a detailed explanation of the individual circuits in the Model 1801A. Circuits that are identical for both channels are explained for channel A only.

4-11. ATTENUATOR.

4-12. The instrument features a constant input impedance attenuator, which is in two sections consisting of four switchable decade dividers in series with three switchable binary dividers. The first decade section consists of dividers with ratios of 1:1, 10:1, 100:1, and 1000:1; and the binary section contains dividers with ratios of 1:1, 2:1 and 4:1. The most sensitive position of the VOLTS/CM switch (.005) utilizes the 1:1 divider of both sections; the second most sensitive position utilizes the 1:1 divider of the first section and the 2:1 divider of the second section, etc. Each divider in the first section is used in turn with each divider in the second section, providing 12 possible ranges. The attenuator circuit and the component values for each range maintain the desired input impedance (R and C) and also provide the required voltage division.

4-13. The input capacitance of Q101, C128, and the stray wiring capacitance are present on all ranges. These capacitances determine the input capacitance of the instrument on the most sensitive range, and establish the value to which the range switched capacitances must be set.

4-14. In the most sensitive range (.005 position of the VOLTS/CM switch), R118, C128, the stray wiring capacitance, and the input capacitance of Q101 determine the input impedance. In the .01 VOLTS/CM position, R112 in series with the parallel resistance of R113 and R118 determine the input resistance and voltage division. The adjusted value of C120 in parallel with C121 provides high frequency compensation. The value of C118 with C119 maintains the input capacitance as established on the .005 range. In the .05 position, the input resistance and voltage division are determined by series resistor R101 and the paralleled

value of R102 and R118. C105 provides for adjustment of the high frequency compensation. The input capacitance is established by C103 and C104. The input impedance and voltage division functions of the attenuator are accomplished in the same manner for the other ranges. A Field Effect Transistor, Q101, operates as a source follower with a very high gate input resistance, and has little effect on the resistive operation of the attenuator.

4-15. INPUT IMPEDANCE CONVERTER.

4-16. The signal voltage from the attenuator is applied to an impedance converter consisting of Q101 and Q103. Connected as emitter-followers, the main function of Q102 and Q104 is to provide temperature compensation for Q101 and Q103. Additional temperature compensation is achieved by using a common heatsink for Q101 and Q102, and a common envelope configuration for Q103/Q104. Protection against excessive signal input to Q101 is provided by R119, R120 and CR102. The back-resistance current flow through CR102, although small, is compensated for by CR101. High-frequency signals through R119 are provided a low reactance path by C129, which ensures that there will be no loss of high frequency signal components. DC balance adjustment of the input converter is accomplished with R124, which is used to equalize the source voltages of Q101 and Q102.

4-17. INPUT AMPLIFIER.

4-18. The signal from the emitter of Q103 and Q104 is applied to the differential cascode amplifier Q301/Q303 and Q302/Q304. Differential amplifier action is obtained by cross-coupling Q301 and Q302 emitter current flow through R304 and C301. The differential signal current generated flows into the emitter of Q303 and Q304. The over-all gain of the cascode amplifier is controlled by R308 (Calibrate) and R309 (VERNIER), which shunt current from the emitters of Q303 and Q304. Differences in the base-emitter drop of Q303 and Q304 are compensated for by adjustment of R317 to eliminate variation of the DC output level of the instrument when an amplification change is made by varying R309 and/or R308. The over-all DC level is adjusted by R303.

4-19. Compensation for the signal phase-delay occuring in the un-driven section of the differential cascode amplifier is the function of the network consisting of T301, C305, and C306; and is accomplished prior to driving emitter-followers Q305/Q306.

4-20. Polarity diode gates are used for selection of +UP (non-inverting) or -UP (inverting) of the instrument input signal. This action is controlled by the POLARITY selection switch, S301. Selecting +UP turns on CR306-CR309, coupling the signal from Q305 to Q307 and from Q306 to Q308. When -UP is selected CR302-CR305 are turned on, coupling the output of Q305 to Q308 and the output of Q306 to Q307. The front-panel control POSITION (R338) establishes the relative base voltages of Q307 and Q308, thus determining the vertical position of the trace on the CRT. Frequency compensation for this stage is accomplished in the emitter circuits of Q307 and Q308. A portion of the Channel B signal at the bases of Q407 and Q408 is directed to the Sync Amplifier through R718 and R719.

4-21. Channel A or Channel B selection and switching is accomplished by the use of channel diode gates. Voltages for operation of the gates are obtained from a multivibrator, which is controlled by the front panel DISPLAY switch. A negative output voltage from the multivibrator will cause CR313 and CR314 to become non-conducting and CR315 and CR316 to conduct. Channel A signals are thus passed on for further amplification and display. Application of a positive voltage from the multivibrator causes CR313 and CR314 to conduct and short-out the signal voltage, while CR315 and CR316 become non-conducting and disconnect the channel amplifier. In the A+B mode of DISPLAY, both channels are turned on by negative voltages from the multivibrator. R354 is used to balance the gate current flowing through delay line DL501. A portion of the differential signal from the output of the channel diode gates is fed to the Sync Amplifier through R701 and R702.

4-22. MAIN AMPLIFIER.

4-23. The differential signals from the channel selector diode gates pass through the 160 nsec Delay Line, DL501, to the current summing amplifiers Q501 and Q502. Capacitor C501 is used to match the delay line and amplifier impedances for optimum response. Signals from the collectors of Q501 and Q502 are applied to emitter-followers Q503/Q504 which drive signal amplifiers Q505 and Q506. The amplified output signal is coupled through emitter-followers Q507/Q508 to the cascode differential amplifiers Q509/Q512, and the Oscilloscope vertical deflection plates are driven by the output voltage variation of the cascode amplifiers. Diodes CR501 and CR502 are used to provide high frequency compensation for Q509 and Q510 by utilizing their variation in reverse-bias capacitance occuring with changes in signal voltage.

4-24. BEAM FINDER.

4-25. Current for operation of the cascode amplifier flows through the normally closed contacts of the FIND BEAM switch of the Oscilloscope. When this switch is depressed, the contacts are opened and the current source for the amplifier is reduced by R528 to limit the vertical excursion of the CRT beam so that it is on-screen.

4-26. MULTIVIBRATOR.

4-27. Operation of multivibrator Q601/Q602 is controlled by the DISPLAY switch, S302. Its outputs are applied through emitter followers Q603/Q604 to the Channel A and B diode gates.

4-28. When the DISPLAY switch is set in the ALT or ALT B TRIGGER position the multivibrator is bistable. This is accomplished by connecting the +15V supply to R607 and R610. A negative-going alternate trigger signal is generated by the Oscilloscope at the end of each sweep. These pulses are coupled to the bases of Q601 and Q602 through the steering diodes CR603 and CR604. Each trigger pulse turns on the non-conducting transistor, switching the multivibrator to its other state. Thus each channel is alternately switched on for a complete sweep.

4-29. In the CHOP B TRIGGER mode of operation the multivibrator is made astable by applying -12V through R607 and R610, and +15V through R619. Diodes CR603

and CR604 are biased off, blocking the alternate trigger signal, and the multivibrator operates to switch the channels on and off at a 400 kHz rate.

Table 4-1. Multivibrator Status and Output

Display Selected	MV STATE		Output voltage to Channel Diode Gates	
	Q601	Q602	A	B
A	OFF	ON	-	+
B	ON	OFF	+	-
A+B	OFF	OFF	-	-

4-30. Selecting Channel A, Channel B or A+B (both channels) sets the multivibrator to a fixed state. The accompanying Table 4-1 provides details of the multivibrator status and voltage output for each of these selected operating modes. Keep in mind that a + voltage puts the channel diode gate in a condition of shorting the amplifier signal and disconnecting the channel, resulting in no display signal from that channel.

4-31. In the CHOP mode of operation, the junction of R626/R627 is grounded, turning off Q605. The square wave signal from Q603 and Q604 is differentiated by C607/R618 and C608/R620, and the positive - going voltage pulses are detected by CR608 and CR609. Applied to the base of Q605 the positive-going signal turns on Q605, resulting in a negative-going pulse at its collector. Current flow through the divider network R630/R631 holds Q606 biased off. The negative pulse from the collector of Q605 is differentiated and turns Q606 on, resulting in a positive collector voltage. This positive voltage is directed to the Oscilloscope CRT blanking circuitry, and results in CRT trace blanking during channel switching.

4-32. When any other mode of operation is selected, +15V is applied to the base of Q605 through R626/R627, resulting in saturation. CR608 and CR609 are also biased off by the positive voltage. Therefore, no signal will be developed at the input to Q605.

4-33. SYNC AMPLIFIER.

4-34. The deflection signal from the channel gates is applied to the base of Q701 and Q702. After being inverted it is coupled through emitter followers Q703/Q704 to a diode gate, CR701 through CR704. R707 adjusts the operating point of the inverter. The Channel B signal is coupled through emitter followers Q705 and Q706 to a diode gate, CR705 through CR708. The DISPLAY switch determines which diode gate is on. In the ALT, A + B, A, and B modes, CR701 through CR704 are turned on, and the composite signal is applied to the cascode amplifier, Q707 through Q710.

4-35. Selecting either CHOP B TRIGGER or ALT B TRIGGER modes turns on CR705 through CR708, directing the Channel B signal to the cascode amplifier. When the composite signal is selected R715 provides for Balance adjustment of the dc output of the cascode amplifier. The output is balanced by R729 when the Channel B signal is selected. The output of the cascode amplifier is applied to the balun amplifier which converts the balanced push-pull signal from the cascode amplifier into a single ended output signal. R751 adjusts the operating point of the balun amplifier.

4-36. Amplified by Q714, the single-ended signal is coupled through complementary emitter follower Q715/Q716 to the Horizontal Plug-In. CR710 and CR711 prevent Q714 from saturating in an overload condition.

4-37. Selecting CHOP B TRIGGER forward biases CR712 and CR713, thus inserting C719 into collector circuit of Q714. The addition of C719 decreases the bandwidth of the Sync Amplifier, preventing the possibility of triggering on high frequency noise.

PERFORMANCE CHECK

Table 5-1. Required Test Equipment

Recommended Instrument		Required Characteristics	Par. Ref.
Type	Model		
Voltmeter Calibrator	hp Model 738AR, BR	30 mv - 100 v pk-pk 0.2% accuracy	5-12 5-13 5-24 5-25
Constant Amplitude Signal Generator	Tektronix Type 191A	50 kHz - 50 MHz @ 4 v pk-pk	5-14 5-15 5-16
50 Ohm Terminaticn	hp Model 10100A		5-14 5-17 5-32
RF Voltmeter	hp Model 411A	50 kHz - 50 MHz 3% accuracy	5-15
Oscillator	hp Model 200CD	100 kHz @ 1 v pk-pk	5-16
Pulse Generator	hp Model 8000A	Rise time $\leq$ 1 nsec Amplitude $\geq$ 0.5 v	5-17 5-30 5-31 5-32 5-33
DC Voltmeter	hp Model 412A	5 mv - 10 vdc 1% accuracy	5-23 5-25 5-26 5-27 5-28 5-29
Square Wave Generator	hp Model 211A/B	Rise time $\leq$ 20 nsec 60 mv - 30 v	5-31
LC Meter	Tektronix Type 130	20 - 50 pf 3% accuracy	5-32
Plug-In Extender	hp Model 10407A		5-31

SECTION V
PERFORMANCE CHECK AND ADJUSTMENTS

5-1. INTRODUCTION.

5-2. This section provides the performance check (Paragraph 5-5) and the adjustment procedure (Paragraph 5-18) for the Model 1801A. Troubleshooting information, schematic diagrams, and component identification are in Section VIII.

5-3. TEST EQUIPMENT.

5-4. Test equipment required for maintaining and checking the performance of the Model 1801A is listed in Table. 5-1. Test equipment having characteristics similar to those listed in the table may be used for the performance check and adjustment. Use a non-metalic alignment tool for making the required adjustments.

5-5. PERFORMANCE CHECK.

5-6. The performance check verifies whether or not the Model 1801A is operating within the specifications as stated in Table 1-1. This check may be used as part of an incoming quality control inspection, as a periodic operational check, or after repairs and/or adjustments have been made. Recently calibrated test equipment should be used when performing this check.

5-7. A Performance Check Record is included in this manual on Page 5-5/5-6. As the initial performance check is accomplished, the actual reading should be entered on the form. The form should then be removed from the manual and filed in a safe place, so that readings taken at a later date can be compared with the original readings.

5-8. The performance check must be performed in the sequence given below. Do not attempt to start the procedure in mid-sequence, as succeeding steps are dependent on control settings and results of previous steps.

5-9. PRELIMINARY SET-UP.

5-10. Lock plug-ins together and install in Model 180A-series Oscilloscope. Apply power and allow a fifteen minute warm-up. Perform Amplifier Balance Adjustment, Figure 3-6, and Vertical Sensitivity Adjustment, Figure 3-7, before attempting Performance Check.

5-11. INITIAL CONTROL SETTINGS.

a. Model 180-AR Oscilloscope:

MAGNIFIER	X1
Horizontal DISPLAY	INT

b. Model 1801A Dual Channel Vertical Amplifier:

Vertical DISPLAY	A
A & B POLARITY	+UP
A & B Vernier	CAL
A & B VOLTS/CM	20
A & B Coupling	AC

c. Time Base (set controls as applicable):

Sweep Display	MAIN
Sweep Mode	AUTO
Main Vernier	CAL
Main Trigger Source	INT
Main Slope	+
Main Trigger Coupling	AC
Main Time/cm	1 MSEC
Delayed Time/cm	OFF

5-12. DEFLECTION FACTOR.

a. Connect a 400 Hz signal from Voltmeter Calibrator output to A INPUT (B INPUT).

b. Set Voltmeter Calibrator output and A VOLTS/CM (B VOLTS/CM) according to Table 5-2.

c. Adjust Main Trigger Level for stable display.

d. Observe vertical deflection specified in Table 5-2.

e. Switch vertical DISPLAY to B.

f. Repeat steps a through d for channel B using components in parenthesis.

Table 5-2. Deflection Factor Accuracy

Voltmeter Calibrator Volts (pk-pk)	VOLTS/CM	Display Height (cm)
.03	.005	6 ± 1.8 mm
.05	.01	5 ± 1.5 mm
.1	.02	5 ± 1.5 mm
.3	.05	6 ± 1.8 mm
.5	.1	5 ± 1.5 mm
1	.2	5 ± 1.5 mm
3	.5	6 ± 1.8 mm
5	1	5 ± 1.5 mm
10	2	5 ± 1.5 mm
30	5	6 ± 1.8 mm
50	10	5 ± 1.5 mm
100	20	5 ± 1.5 mm

5-13. VERNIER.

a. Rotate B VERNIER fully ccw.

b. Observe vertical display of less than 2 cm.

c. Set vertical DISPLAY to A.

d. Connect Voltmeter Calibrator output to A INPUT.

e. Rotate A VERNIER fully ccw.

f. Observe vertical display of less than 2 cm.

5-14. COMMON MODE REJECTION.

a. Set:

VOLTS/CM (both channels)	0.05
VERNIER (both channels)	CAL
Coupling (both channels)	GND

b. Connect Constant Amplitude Signal Generator output to Channel A and B INPUT. Adjust to obtain a 1 MHz signal.

c. Adjust A POSITION to center baseline exactly.

d. Set Channel A coupling to AC and adjust Signal Generator for a 5 cm display.
e. Set Vertical DISPLAY to B.
f. Adjust B POSITION to center baseline exactly.
g. Set:

Vertical DISPLAY	A+B
B POLARITY	-UP
A & B VOLTS/CM	0.005
B Coupling	AC

h. Observe vertical display of less than 5 mm.

Note

A Vernier or B Vernier may be adjusted to obtain less than 5 mm of deflection.

5-15. BANDWIDTH.

a. Set:

Vertical Display	A
Channel B Polarity	+UP
VOLTS/CM (both channels)	0.5
Vernier (both channels)	CAL

b. Connect Signal Generator output and RF Voltmeter input to A INPUT as shown in Figure 5-1.

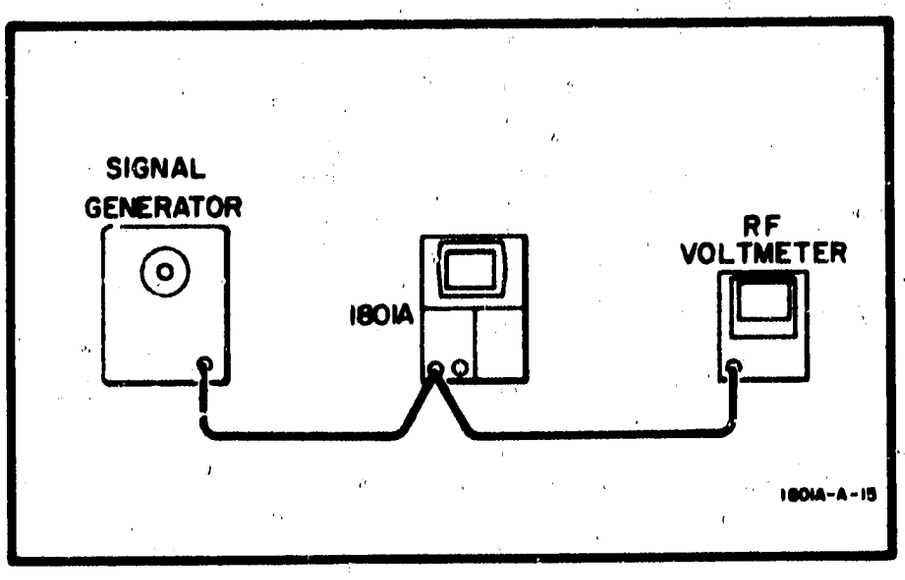


Figure 5-1. Channel A Bandwidth Test Set-Up

c. Adjust Signal Generator for a 50 kHz signal.
d. Adjust Signal Generator for an 8 cm display and note voltage with RF Voltmeter.
e. Adjust Signal Generator for a 50 MHz signal.
f. Adjust Signal Generator amplitude for same voltage indication as noted in step d.
g. Observe more than 5.7 cm of vertical deflection.
h. Connect Signal Generator output and RF Voltmeter input to B INPUT as shown in Figure 5-2.

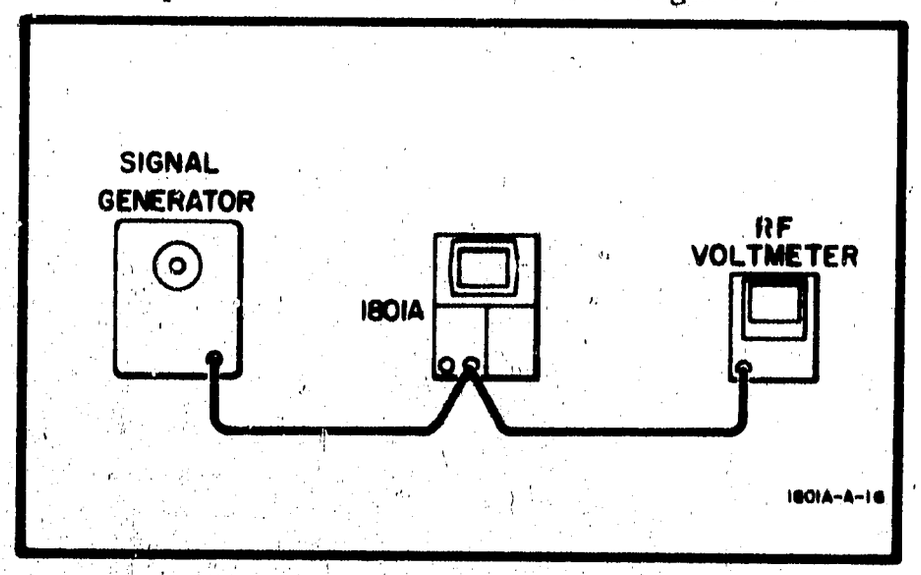


Figure 5-2. Channel B Bandwidth Test Set-Up

i. Set Vertical DISPLAY to B.
j. Repeat steps c through g.

5-16. TRIGGERING.

a. Set Main Time/cm to 0.1 μSEC and Vertical DISPLAY to ALT B TRIGGER.
b. Adjust Constant Amplitude Signal Generator output amplitude for 0.5 cm of vertical deflection on Channel B.
c. Adjust Main Trigger Level and note stable display.
d. Set Vertical DISPLAY to B.
e. Adjust Main Trigger Level, if necessary, and note stable display.
f. Connect 100 kHz signal from hp 200CD Oscillator output to B INPUT.
g. Set Vertical DISPLAY to CHOP B TRIGGER and Main Time/cm to 10 μSEC.
h. Adjust Oscillator output amplitude for 0.5 cm of vertical deflection on Channel B.
i. Adjust Main Trigger Level and note stable display.

5-17. RISE TIME.

a. Set:

Horizontal MAGNIFIER	X10
Main TIME/CM	0.1 μSEC
Vertical DISPLAY	A
A & B VOLTS/CM	0.05

b. Connect Pulse Generator output to A INPUT (B INPUT) using a 50 ohm termination.
c. Set Pulse Generator for a 0.5 v pulse. Adjust Main Trigger Level for a stable display.
d. Adjust horizontal POSITION to observe leading edge of pulse. Readjust Main Trigger Level if necessary.
e. Adjust A Vernier (B Vernier) for an 8 cm display.
f. Observe rise time of less than 7 nsec (dotted horizontal graticule lines are 10% and 90% references).
g. Set Vertical DISPLAY to B.
h. Repeat steps b through f for Channel B using components in parenthesis.

5-18. ADJUSTMENTS.

5-19. Procedures for making adjustments in the Model 1801A are given in Paragraphs 5-20 through 5-33. Required test equipment is listed in Table 5-1. Test equipment with similar characteristics may be substituted if necessary. Figure 8-2 shows the location of adjustments in the Model 1801A.

5-20. PRELIMINARY SET-UP.

5-21. Lock the plug-ins together and install in the Model 180-series Oscilloscope. Apply power and allow a fifteen minute warm-up.

5-22. INITIAL CONTROL SETTINGS.

a. Model 180A/AR Oscilloscope:

Set:

Horizontal MAGNIFIER	X1
Horizontal DISPLAY	INT

b. Model 1801A Dual Channel Vertical Amplifier:
Set: Vertical DISPLAY . . . . . A
A & B POLARITY . . . . . +UP
A & B Vernier . . . . . CAL
A & B VOLTS/CM 0.005
A & B Coupling . . . . . GND

c. Time Base (set controls as applicable):
Set: Sweep Display . . . . . MAIN
Sweep Mode . . . . . AUTO
Main Vernier . . . . . CAL
Main Trigger Source . . . . . INT
Main Slope . . . . . +
Main Trigger Coupling . . . . . AC
Main Time/cm . . . . . 2 msec
Delayed Time/cm . . . . . OFF

5-23. AMPLIFIER BALANCE AND DC LEVEL.

a. Obtain a baseline with A POSITION (B POSITION) and INTENSITY controls.

b. Adjust DC BAL A (DC BAL B) for less than 2 mm vertical shift of baseline while switching A POLARITY (B POLARITY) between +UP and -UP.

c. Center baseline exactly with A POSITION (B POSITION).

d. Monitor voltage on collector of Q303 (Q403) with a DC Voltmeter.

e. Adjust R303 (R403) for -7.3 vdc.

f. Adjust R317 (R417) for less than 2 mm vertical shift of baseline while rotating A Vernier (B Vernier) from one extreme to the other.

g. Repeat steps b and f until no further adjustment is required.

h. Set vertical DISPLAY to B and repeat steps a through g for channel B using components in parenthesis.

5-24. A + B BALANCE.

a. Set VERTICAL DISPLAY to ALT.

b. Adjust Trigger Level if required.

c. Adjust A POSITION and B POSITION to center both traces.

d. Set Vertical Display to A + B.

e. Adjust DC BAL A + B to center trace.

5-25. GAIN.

a. Set Vertical DISPLAY to A and Channel A coupling switch to AC.

b. Connect a 400 Hz 30 mv pk-pk signal from Voltmeter Calibrator output to A INPUT.

c. Adjust A CAL for a 6 cm display.

d. Connect a 400 Hz 30 mv pk-pk signal from Voltmeter Calibrator output to A INPUT and B INPUT.

e. Set:
Vertical DISPLAY . . . . . A & B
A POLARITY . . . . . +UP
B POLARITY . . . . . -UP
B Coupling . . . . . AC

f. Adjust B Cal for minimum vertical deflection.

5-26. B TRIGGER BALANCE.

a. Set vertical DISPLAY to ALT B TRIGGER and both A & B Coupling switches to GND.

b. Center channel B baseline exactly with B POSITION. Recenter if drift occurs during adjustment.

c. Monitor voltage between TP701 and TP702 (see Figure 8-15) with a DC Voltmeter.

d. Adjust R729 for 0 vdc, ± 50 mv.

5-27. TRIGGER OUTPUT LEVEL.

a. Center channel B baseline exactly with B POSITION.

b. Monitor voltage at output of Internal Trigger Amplifier in the Horizontal Plug-In with a DC Voltmeter.

c. Adjust R751 for 0 vdc.

5-28. COMPOSITE TRIGGER BALANCE.

a. Set vertical DISPLAY to B.

b. Center baseline exactly with channel B POSITION.

c. Monitor voltage between TP701 and TP702 with a DC Voltmeter.

d. Adjust R715 for 0 vdc.

5-29. COMPOSITE INVERTER CURRENT.

a. Center channel B baseline exactly with B POSITION.

b. Monitor voltage at TP701 with a DC Voltmeter.

c. Adjust R707 for +5 vdc.

d. Center baseline exactly with channel B POSITION.

e. Monitor voltage at output of Internal Trigger Amplifier in the Horizontal Plug-In with a DC Voltmeter.

f. Readjust R707 for 0 vdc.

5-30. DELAY LINE TERMINATION.

a. Set: MAGNIFIER X5
Main Time/cm . . . . . 0.2 μSEC
Vertical DISPLAY . . . . . A
A VOLTS/CM 0.05
A Coupling . . . . . DC

b. Connect a Pulse Generator output to channel A INPUT.

c. Adjust Main Trigger Level for display.

d. Adjust Pulse Generator output Amplitude and A Vernier for a 6 cm display.

e. Adjust horizontal POSITION to observe leading edge of pulse. Readjust main Trigger Level if necessary.

f. Adjust C501 to reduce reflection to one baseline width (reflection is 8 cm from leading edge of pulse).

5-31. ATTENUATOR COMPENSATION.

a. Set: MAGNIFIER X1
Main Time/cm . . . . . 20 μSEC
A Vernier . . . . . CAL
A & B Coupling . . . . . AC

Note

Plug-In Extender, hp Model 10407A is necessary to make attenuator adjustments.

b. Connect a 10 kHz square wave from Square Wave Generator output to A INPUT (B INPUT).

c. Set A VOLTS/CM (B VOLTS/CM) according to Table 5-3 and adjust Pulse Generator output for a 6 cm display.

d. Adjust main Trigger Level for stable display.

e. Make appropriate adjustment according to Table 5-3 for best square wave response.

f. Set vertical DISPLAY to B and repeat steps b through e for channel B using components in parenthesis.

Table 5-3. Attenuator Compensation

VOLTS/CM	ADJUST	
	Channel A	Channel B
.01	C120	C220
.02	C125	C225
.05	C105	C205
.1	C118	C218
.2	C123	C223
.5	C109	C209
5	C114	C214

5-32. INPUT CAPACITANCE.

a. Set B VOLTS/CM (A VOLTS/CM) to 0.005 and B Coupling (A Coupling) to DC.

b. Connect LC Meter to B INPUT (A INPUT) and measure input capacitance.

c. Set B VOLTS/CM (A VOLTS/CM) according to Table 5-4 and make appropriate adjustment to obtain same input capacitance as measured in step b.

d. Set vertical DISPLAY to A and repeat steps a through c using components in parenthesis.

Table 5-4. Input Capacitance

VOLTS/CM	ADJUST	
	Channel A	Channel B
.05	C103	C203
.5	C107	C207
5	C112	C212

5-33. PULSE RESPONSE.

a. Set A & B VOLTS/CM to 0.005 and MAIN TIME/CM to 0.1 μsec.

b. Connect Pulse Generator output to Channel A INPUT using a 50 ohm termination at INPUT.

c. Adjust Pulse Generator output amplitude and channel A Vernier for a 6 cm vertical display.

d. Adjust main Trigger Level for a stable display.

e. Switch MAGNIFIER to X5.

f. Completely detune Channel A and Main Amplifiel. Follow the sequence listed, adjust to obtain the smoothest and roundest pulse possible.

1. C301
2. C316
3. R348 (fully cw)
4. C507
5. C510

g. Adjust Channel A and Main Amplifier pulse response to obtain the best rise time and flat-topped pulse. Follow the sequence listed:

1. C510
2. C507
3. R348
4. C316
5. C301

h. Readjust each control in sequence to obtain best pulse response.

i. Connect Pulse Generator output to Channel B INPUT, using a 50 ohm termination at input.

j. Adjust Channel B Vernier for 6 cm display.

k. Completely detune Channel B. Follow the sequence listed and adjust to obtain the smoothest and roundest pulse possible.

1. C401
2. C416
3. R448 (fully cw)

l. Adjust Channel B pulse response to obtain the best risetime and flat-topped pulse. Follow the sequence listed.

1. R348
2. C316
3. C301

m. Readjust each control in sequence to obtain best pulse response.

Note

If the desired pulse response is not obtained by readjustment, readjust C507 and/or C510 in the main amplifier. If this is necessary the pulse response of Channel B must be rechecked and adjusted.

n. A small overshoot forming a "hook" at the top of the pulse leading edge may occasionally be present. Adjust C305 and C306 (C405 and C406) to minimize the variation and obtain a flat-topped pulse response with best rise time. A mid-range setting is correct if the leading edge variation does not occur.

CUT ALONG DOTTED LINE

PERFORMANCE CHECK RECORD

Paragraph	Check	Min	Reading	Max
5-12	Deflection Factor			
step d	.005	5.82 cm	_____	6.18 cm
"	.01	4.85 cm	_____	5.15 cm
"	.02	4.85 cm	_____	5.15 cm
"	.05	5.82 cm	_____	6.18 cm
"	.1	4.85 cm	_____	5.15 cm
"	.2	4.85 cm	_____	5.15 cm
"	.5	5.82 cm	_____	6.18 cm
"	1	4.85 cm	_____	5.15 cm
"	2	4.85 cm	_____	5.15 cm
"	5	5.82 cm	_____	6.18 cm
"	10	4.85 cm	_____	5.15 cm
"	20	4.85 cm	_____	5.15 cm
5-13	Vernier			
step b	B		_____	2 cm
step f	A		_____	2 cm
5-14	C.M.R.			
step h	A+B		_____	5 mm
5-15	Bandwidth			
step g	A 50 MHz	5.7 cm	_____	
step j	B 50 MHz	5.7 cm	_____	
5-16	Triggering			
step c	ALT B TRIGGER	Stable display	_____	Yes or No
step e	B	Stable display	_____	Yes or No
step i	CHOP B TRIGGER	Stable display	_____	Yes or No
5-17	Rise Time			
step f	A		_____	7 nsec
step h	B		_____	7 nsec

PARTS

LIST

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replaceable parts for the instrument. Table 6-2 lists the parts in alpha-numerical order of their reference designations and provides the following information for each item:

a. hp Part Number.

b. Total quantity (TQ) used in instrument; given only first time a part number is listed.

c. Description of part; see Table 6-1 for list of reference designators and abbreviations.

6-3. Parts not identified by a reference designation are listed at the end of Table 6-2, under Miscellaneous.

6-4. ORDERING INFORMATION.

6-5. To order replacement parts from the Hewlett-Packard Company, address the order or inquiry to the nearest Hewlett-Packard Sales/Service Office (list at the rear of manual) and supply the following information:

a. hp Part Number of item(s).

b. Model number and eight-digit number or the instrument.

c. Quantity of parts desired.

6-6. To order a part not listed in the table, provide the following information:

a. Model number and eight-digit serial number of instrument.

b. Description of part including function and location.

6-7. Component descriptions given in Table 6-2 are as complete as possible to assist in obtaining replacement parts from manufacturers other than hp. However, many parts are manufactured only by hp, or are produced by other manufacturers to hp proprietary specifications, and are therefore available only from hp. Actual manufacturer and manufacturers part number for non-hp parts will be supplied upon request. Contact the nearest hp Sales/Service Office.

Table 6-1. List of Reference Designators and Abbreviations

REFERENCE DESIGNATORS

A = assembly	F = fuse	MP = mechanical part	TP = test point
B = motor	FL = filter	P = plug	V = vacuum tube, neon bulb, photocell, etc.
C = capacitor	J = jack	Q = transistor	
CP = coupling	K = relay	R = resistor	VR = voltage regulator (diode)
CR = diode	L = inductor	RT = thermistor	
DL = delay line	LS = speaker	S = switch	W = cable
DS = device signaling (lamp)	M = meter	T = transformer	X = socket
E = misc electronic part	MC = microcircuit	TB = terminal board	Y = crystal

ABBREVIATIONS

A = amperes	GL = glass	MTG = mounting	RF = radio frequency
AMPL = amplifier	GRD = ground(ed)	MY = "mylar"	
			S-B = slow-blow
BP = bandpass	H = henries	N = nano (10^{-9})	SCR = screw
	HG = mercury	N/C = normally closed	SE = selenium
CAR = carbon	HR = hour(s)	NE = neon	SECT = section(s)
CCW = counterclockwise	hp = Hewlett-Packard	N/O = normally open	SEMICON = semiconductor
CER = ceramic		NPO = negative positive zero (zero temperature coefficient)	SI = silicon
COEF = coefficient	IF = intermediate freq.		SIL = silver
COM = common	IMPG = impregnated		SL = slide
COMP = composition	INCD = incandescent	NSR = not separately replaceable	SPL = special
CONN = connector	INCL = include(s)		
CRT = cathode-ray tube	INS = insulation(ed)		TA = tantalum
CW = clockwise	INT = internal	OBD = order by description	TD = time delay
		OX = oxide	TGL = toggle
DEPC = deposited carbon	K = kilo = 1000		TI = titanium
		PC = printed circuit	TOL = tolerance
ELECT = electrolytic	LIN = linear taper	PF = picofarads = 10^{-12} farads	TRIM = trimmer
ENCAP = encapsulated	LOG = logarithmic taper		
EXT = external	LPF = low pass filter	PIV = peak inverse voltage	μ = micro = 10^{-6}
		P/O = part of	
F = farads	M = milli = 10^{-3}	POLY = polystyrene	VAR = variable
FET = field effect transistor	MEG = meg = 10^{6}	PORC = porcelain	VDCW = dc working volts
	METFLM = metal film	POS = position(s)	
FXD = fixed	MET OX = metal oxide	POT = potentiometer	W/ = with
	MFR = manufacturer	PK-PK = peak-to-peak	W = watts
GE = germanium	MINAT = miniature		WW = wirewound
	MOM = momentary	RECT = rectifier	W/O = without

Table 6-2. Replaceable Parts

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)
A1	01801-63401		1	A: attenuator
A2	01801-63402		1	A: attenuator
A3	01801-66507		1	A: main board
A4	01801-66502		1	A: output board
A5	01801-66504		1	A: switch board
A6	01801-66503		1	A: sync amp board
C101	0160-2449		2	C: fxd cer .1 μf
C103	0132-0005		6	C: var poly 0.7-3 pf 300vdcw
C104	0160-2259		6	C: fxd cer 12 pf 5% 500vdcw
C105	0121-0168		6	C: var teflon 0.5-1.5 pf 600vdcw
C107	0132-0005			C: var poly 0.7-3 pf 300vdcw
C108	0160-2259			C: fxd cer 12 pf 5% 500vdcw
C109	0121-0168			C: var teflon 0.5-1.5 pf 600vdcw
C110	0160-2484		2	C: fxd mica 100 pf 10% 500vdcw
C112	0132-0002		4	C: var poly 0.7-3 pf
C113	0160-2259			C: fxd cer 12 pf 5% 500vdcw
C114	0121-0168			C: var teflon 0.5-1.5 pf 600vdcw
C115	0160-2485		2	C: fxd mica 1000 pf 10% 500vdcw
C118	0132-0002			C: var poly 0.7-3 pf
C119	0160-2241		4	C: fxd cer 2.2 pf 500vdcw
C120	0132-0004		8	C: var poly 0.7-3 pf 350vdcw
C121	0160-2257		2	C: fxd cer 10 pf 5% 500vdcw
C123	0132-0005			C: var poly 0.7-3 pf 350vdcw
C124	0160-2250		2	C: fxd cer 5.1 pf 500vdcw
C125	0132-0004			C: var poly 0.7-3 pf 350vdcw
C126	0160-2241			C: fxd cer 2.2 pf 500vdcw
C128	0150-0091		1	C: fxd cer 1.5 pf ± .25 pf 500vdcw
C129	0150-0024		2	C: fxd cer .02 μf -20%+80% 600vdcw
C130	0180-0230		17	C: fxd ta elect 1 μf 20% 50vdcw
C201	0160-2449			C: fxd cer 0.1 μf 500vdcw
C203	0132-0005			C: var poly 0.7-3pf 300vdcw
C204	0160-2259			C: fxd cer 12 pf 500vdcw
C205	0121-0168			C: var teflon 12 pf 600vdcw
C207	0132-0005			C: var poly 0.7-3 pf 300vdcw
C208	0160-2259			C: fxd cer 12 pf 5% 500vdcw
C209	0121-0168			C: var teflon 0.5-1.5 pf 600vdcw
C210	0160-2484			C: fxd mica 12 pf 10% 500vdcw
C212	0132-0002			C: var poly 0.7-3 pf
C213	0160-2259			C: fxd cer 12 pf 5% 500vdcw
C214	0121-0168			C: var teflon 0.5-1.5 pf 600vdcw
C215	0160-2485			C: fxd mica 1000 pf 10% 500vdcw
C218	0132-0002			C: var poly 0.7-3 pf
C219	0160-2241			C: fxd cer 2.2 pf 500vdcw
C220	0132-0004			C: var poly 0.7-3 pf 350vdcw
C221	0160-2257			C: fxd cer 10 pf 5% 500vdcw

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Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)		
C223	0132-0005			C: var poly 0.7-3 pf 350vdcw		
C224	0160-2250			C: fxd cer 5.1 pf 500vdcw		
C225	0132-0004			C: var poly 0.7-3 pf 350vdcw		
C226	0160-2241			C: fxd cer 2.2 pf 500vdcw		
C228	0160-2236		1	C: fxd cer 1 pf ± .25 pf 500vdcw		
C229	0150-0024			C. fxd cer .02 μf -20% +80% 600vdcw		
C230	0180-0230			C: fxd ta elect 1 μf 20% 50vdcw		
C301	0121-0046		4	C: var cer 9-35 pf 500vdcw		
C305	0132-0004			C: var poly 0.7-3 pf 350vdcw		
C306	0132-0004			C: var poly 0.7-3 pf 350vdcw		
C307	0180-0230			C: fxd ta elect 1 μf 20% 50vdcw		
C308	0150-0050		4	C: fxd cer 1000 pf 600vdcw		
C309	0150-0050			C: fxd cer 1000 pf 600vdcw		
C311	0140-0176		7	C: fxd mica 100 pf 2% 300vdcw		
C312	0140-0176			C: fxd mica 100 pf 2% 300vdcw		
C313	0160-0153		7	C: fxd my 1000 pf 10% 200vdcw		
C314	0160-0153			C: fxd my 1000 pf 10% 200vdcw		
C315	0140-0220		2	C: fxd mica 200 pf 1% 300vdcw		
C316	0121-0046			C: var cer 9-35 pf 500vdcw		
C317	0160-2150		1	C: fxd mica 33 pf 5% 300vdcw		
C401	0121-0046			C: var cer 9-35 pf 500vdcw		
C405	0132-0004			C: var poly 0.7-3 pf 350vdcw		
C406	0132-0004			C: var poly 0.7-3 pf 350vdcw		
C407	0180-0230			C: fxd ta elect 1 μf 20% 50vdcw		
C408	0150-0050			C: fxd cer 1000 pf 600vdcw		
C409	0150-0050			C: fxd cer 1000 pf 600vdcw		
C411	0140-0176			C: fxd mica 100 pf 2% 300vdcw		
C412	0140-0176			C: fxd mica 100 pf 2% 300vdcw		
C413	0160-0153			C: fxd my 1000 pf 10% 200vdcw		
C414	0160-0153			C: fxd my 1000 pf 10% 200vdcw		
C415	0140-0220			C: fxd mica 200 pf 1% 300vdcw		
C416	0121-0046			C: var cer 9-35 pf 500vdcw		
C417	0140-0204			C: fxd mica 47 pf 5% 300vdcw		
C501	0121-0060		1	C: var cer 2-8 pf 300vdcw		
C502	0160-0132		2	C: fxd cer 12 pf 5% 500vdcw		
C503	0160-0132			C: fxd cer 12 pf 5% 500vdcw		
C505	0180-0230			C: fxd ta elect 1 μf 20% 50vdcw		
C506	0140-0176			C: fxd 100 pf 2%		
C507	0121-0061		2	C: var cer 5.5-18 pf 300vdcw		
C508	0140-0191		2	C: fxd mica 56 pf 5% 300vdcw		
C509	0140-0201		1	C: fxd mica 12 pf 5%		
C510	0121-0061			C: var cer 5.5-18 pf 300vdcw		
C512	0180-0230			C: fxd ta elect 1 μf 20% 50vdcw		
C514	0160-0207		1	C: fxd my .01 μf 5% 200vdcw		

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)		
C516	0180-0230			C: fxd ta elect 1 μf 20% 50vdcw		
C517	0180-0116		2	C: fxd ta elect 6.8 μf 10% 35vdcw		
C518	0180-0230			C: fxd ta elect 1 μf 20% 50vdcw		
C519	0180-0230			C: fxd ta elect 1 μf 20% 50vdcw		
C520	0180-0230			C: fxd ta elect 1 μf 20% 50vdcw		
C521	0180-0230			C: fxd ta elect 1 μf 20% 50vdcw		
C523	0180-0230			C: fxd ta elect 1 μf 20% 50vdcw		
C524	0180-0230			C: fxd ta elect 1 μf 20% 50vdcw		
C528	0180-0116			C: fxd ta elect 6.8 μf 10% 35vdcw		
C529	0180-0230			C: fxd ta elect 1 μf 20% 50vdcw		
C533	0180-0230			C: fxd ta elect 1 μf 20% 50vdcw		
C534	0180-0228		3	C: fxd teflon 22 μf 10% 15vdcw		
C535	0180-0230			C: fxd ta elect 1 μf 20% 50vdcw		
C536	0180-0228			C: fxd teflon 22 μf 10% 15vdcw		
C601	0140-0176			C: fxd mica 100 pf 2% 300vdcw		
C602	0150-0093		3	C: fxd cer .01 μf -20% +80%		
C603	0140-0176			C: fxd mica 100 pf 2% 300vdcw		
C604	0150-0093		3	C: fxd cer .01 μf -20% +80%		
C607	0140-0216		2	C: fxd mica 120 pf 2% 300vdcw		
C608	0140-0216			C: fxd mica 120 pf 2% 300vdcw		
C612	0150-0093			C: fxd cer .01 μf -20% +80%		
C613	0180-0230			C: fxd ta elect 1 μf 20% 50vdcw		
C614	0180-0230			C: fxd ta elect 1 μf 20% 50vdcw		
C705	0150-0111		2	C: fxd cer 220 pf 5% 300vdcw		
C706	0150-0111			C: fxd cer 220 pf 5% 300vdcw		
C707	0140-0151		1	C: fxd mica 820 pf 2% 300vdcw		
C708	0140-0175		1	C: fxd mica 39 pf 2% 300vdcw		
C712	0180-0059		1	C: fxd ta elect 10 μf -10% +100% 25vdcw		
C713	0180-0230			C: fxd ta elect 1 μf 20% 50vdcw		
C714	0180-0228			C: fxd teflon 22 μf 10% 15vdcw		
C718	0160-0155			C: fxd my 3300 pf 10% 200vdcw		
C719	0160-0153			C: fxd my 1000 pf 10% 200vdcw		
C720	0160-0153			C: fxd my 1000 pf 10% 200vdcw		
C721	0140-0191			C: fxd mica 56 pf 5% 300vdcw		
C722	0160-0153			C: fxd mica 1000 pf 10% 200vdcw		

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)		
CR101	1901-0376		4	CR: si		
CR102	1901-0376			CR: si		
CR201	1901-0376			CR: si		
CR202	1901-0376			CR: si		
CR302	5080-0442		2	CR: si, matched set (includes CR302-309)		
CR303				NSR: p/o CR302		
CR304				NSR: p/o CR302		
CR305				NSR: p/o CR302		
CR306				NSR: p/o CR302		
CR307				NSR: p/o CR302		
CR308				NSR: p/o CR302		
CR309				NSR: p/o CR302		
CR313	1901-0040		8	CR: si		
CR314	1901-0040			CR: si		
CR315	1901-0040			CR: si		
CR316	1901-0040			CR: si		
CR402	5080-0442			CR: si, matched set (includes CR402 - CR409)		
CR403				NSR: p/o CR402		
CR404				NSR: p/o CR402		
CR405				NSR: p/o CR402		
CR406				NSR: p/o CR402		
CR407				NSR: p/o CR402		
CR408				NSR: p/o CR402		
CR409				NSR: p/o CR402		
CR413	1901-0040			CR: si		
CR414	1901-0040			CR: si		
CR415	1901-0040			CR: si		
CR416	1901-0040			CR: si		
CR501	1901-0033		2	CR: si		
CR502	1901-0033			CR: si		

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)		
CR601	1901-0040		19	CR: si		
CR602	1901-0040			CR: si		
CR603	1901-0040			CR: si		
CR604	1901-0040			CR: si		
CR608	1901-0040			CR: si		
CR609	1901-0040			CR: si		
CR701	1901-0040			CR: si		
CR702	1901-0040			CR: si		
CR703	1901-0040			CR: si		
CR704	1901-0040			CR: si		
CR705	1901-0040			CR: si		
CR706	1901-0040			CR: si		
CR707	1901-0040			CR: si		
CR708	1901-0040			CR: si		
CR710	1901-0040			CR: si		
CR711	1910-0016		1	CR: ge		
CR712	1901-0040			CR: si		
CR713	1901-0040			CR: si		
DL501	01801-66505		1	DL		
J2	1250-0897		1	J: bulkhead connector, male 1 pin		
J101	1250-0083		2	J: female BNC		
J102	5060-0436		2	J: female 2 pin		
J201	1250-0083			J: female BNC		
J202	5060-0436			J: female 2 pin		
L101	9140-0115		2	L: fxd 22 μh 10%		
L201	9140-0115			L: fxd 22 μh 10%		
L301	9140-0080		2	L: fxd 0.18 μh 10%		
L401	9140-0080			L: fxd 0.18 μh 10%		
L402	9170-0029		4	L: bead		
L403	9170-0029			L: bead		
L503	9170-0029			L: bead		
L504	9170-0029			L: bead		
L506	9140-0047		12	L: fxd 20 μh		
L507	9140-0047			L: fxd 20 μh		
L510	9140-0047			L: fxd 20 μh		
L511	9140-0047			L: fxd 20 μh		
L512	9140-0047			L: fxd 20 μh		
L513	9140-0047			L: fxd 20 μh		
L514	9140-0047			L: fxd 20 μh		

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)		
L518	9140-0047			L: fxd 20 μh		
L519	9140-0047			L: fxd 20 μh		
L520	9140-0047			L: fxd 20 μh		
L601	9140-0137		2	L: fxd 1 mh		
L602	9140-0137			L: fxd 1 mh		
L701	9140-0047			L: fxd 20 μh		
L702	9140-0047			L: fxd 20 μh		
P1	01801-27601		1	P: female 24 pin		
P2	01801-26506		1	P: slide 2 pin		
Q101	5080-0449		2	Q: fet (Matched pair - includes Q102)		
Q102				NSR: p/o Q101		
Q103	1854-0280		2	Q: dual si npn (NSR: includes Q104)		
Q104				NSR: p/o Q103		
Q201	5080-0449			Q: fet (Matched pair - includes Q202)		
Q202				NSR: p/o Q201		
Q203	1854-0280			Q: dual si npn (NSR: includes Q204)		
Q204				NSR: p/o Q203		
Q301	1853-0026		8	Q: si pnp		
Q302	1853-0026			Q: si pnp		
Q303	1853-0026			Q: si pnp		
Q304	1853-0026			Q: si pnp		
Q305	1854-0092		16	Q: si npn		
Q306	1854-0092			Q: si npn		
Q307	1854-0019		10	Q: si npn		
Q308	1854-0019			Q: si npn		
Q401	1853-0026			Q: si pnp		
Q402	1853-0026			Q: si pnp		
Q403	1853-0026			Q: si pnp		
Q404	1853-0026			Q: si pnp		
Q405	1854-0092			Q: si npn		
Q406	1854-0092			Q: si npn		
Q407	1854-0019			Q: si npn		
Q408	1854-0019			Q: si npn		
Q501	1854-0092			Q: si npn		
Q502	1854-0092			Q: si npn		
Q503	1854-0092			Q: si npn		
Q504	1854-0092			Q: si npn		
Q505	1854-0091		5	Q: si npn		

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)		
Q506	1854-0091			Q: si npn		
Q507	1854-0019			Q: si npn		
Q508	1854-0019			Q: si npn		
Q509	1854-0091			Q: si npn		
Q510	1854-0091			Q: si npn		
Q511	1854-0056		2	Q: si npn		
Q512	1854-0056			Q: si npn		
Q601	1853-0015		6	Q: si pnp		
Q602	1853-0015			Q: si pnp		
Q603	1854-0019			Q: si npn		
Q604	1854-0019			Q: si npn		
Q605	1854-0092			Q: si npn		
Q606	1853-0015			Q: si pnp		
Q701	1853-0015			Q: si pnp		
Q702	1853-0015			Q: si pnp		
Q703	1854-0092			Q: si npn		
Q704	1854-0092			Q: si npn		
Q705	1854-0092			Q: si npn		
Q706	1854-0092			Q: si npn		
Q707	1854-0019			Q: si npn		
Q708	1854-0019			Q: si npn		
Q709	1854-0092			Q: si npn		
Q710	1854-0092			Q: si npn		
Q711	1854-0092			Q: si npn		
Q712	1853-0015			Q: si pnp		
Q713	1853-0009		2	Q: si pnp		
Q714	1854-0092			Q: si npn		
Q715	1854-0091			Q: si npn		
Q716	1853-0009			Q: si pnp		
R100	0757-0398		8	R: fxd metflm 75 ohms 1% 1/8w		
R101	0698-5131		2	R: fxd metflm 900k ohms 0.5% 1/4w		
R102	0698-5470		2	R: fxd metflm 111k ohms 1% 1/8w		
R104	0698-5132		2	R: fxd metflm 990k ohms 0.5% 1/4w		
R105	0698-3109		2	R: fxd metflm 10.1k ohms 1% 1/8w		
R107	0698-3146		2	R: fxd metflm 999k ohms 0.25% 1/4w		
R108	0757-0280		8	R: fxd metflm 1k ohm 1% 1/8w		
R111	0757-0388		12	R: fxd metflm 30.1 ohms 1% 1/8w		
R112	0698-3263		2	R: fxd metflm 500k ohms 1% 1/8w		
R113	0757-0344		4	R: fxd metflm 1 megohm 1% 1/4w		
R115	0757-0486		2	R: fxd metflm 750k ohms 1% 1/8w		
R116	0698-5471		2	R: fxd metflm 333k ohms 1% 1/8w		
R118	0757-0344			R: fxd metflm 1 megohm 1% 1/4w		
R119	0757-0475		2	R: fxd metflm 274k ohms 1% 1/8w		
R120	0757-0401		11	R: fxd metflm 100 ohms 1% 1/8w		
R121	0757-0401			R: fxd metflm 100 ohms 1% 1/8w		
R122	0757-0433		4	R: fxd metflm 3.32k ohms 1% 1/8w		

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)		
R123	0757-0433			R: fxd metflm 3.32k ohms 1% 1/8w		
R124	2100-2062		2	R: var comp 500 ohms 10% lin 1/2w		
R125	0757-0274		2	R: fxd metflm 1.21k ohms 1% 1/8w		
R126	0757-0410		5	R: fxd metflm 301 ohms 1% 1/8w		
R127	0757-0410			R: fxd metflm 301 ohms 1% 1/8w		
R200	0757-0398			R: fxd metflm 75 ohms 1% 1/8w		
R201	0698-5131			R: fxd metflm 900k ohms 0.5% 1/4w		
R202	0698-5470			R: fxd metflm 111k ohms 1% 1/8w		
R204	0698-5132			R: fxd metflm 990k ohms 0.5% 1/4w		
R205	0698-3109			R: fxd metflm 10.1k ohms 1% 1/8w		
R207	0698-3146			R: fxd metflm 999k ohms 0.25% 1/4w		
R208	0757-0280			R: fxd metflm 1k ohm 1% 1/8w		
R211	0757-0388			R: fxd metflm 30.1 ohms 1% 1/8w		
R212	0698-3263			R: fxd metflm 500k ohms 1% 1/8w		
R213	0757-0344			R: fxd metflm 1 megohm 1% 1/4w		
R215	0757-0486			R: fxd metflm 750k ohms 1% 1/8w		
R216	0698-5471			R: fxd metflm 333k ohms 1% 1/8w		
R218	0757-0344			R: fxd metflm 1 megohm 1% 1/4w		
R219	0757-0475			R: fxd metflm 274k ohms 1% 1/8w		
R220	0757-0401			R: fxd metflm 100 ohms 1% 1/8w		
R221	0757-0401			R: fxd metflm 100 ohms 1% 1/8w		
R222	0757-0433			R: fxd metflm 3.32k ohms 1% 1/8w		
R223	0757-0433			R: fxd metflm 3.32k ohms 1% 1/8w		
R224	2100-2062			R: var comp 500 ohms 10% lin 1/2w		
R225	0757-0274			R: fxd metflm 1.21k ohms 1% 1/8w		
R226	0757-0410			R: fxd metflm 301 ohms 1% 1/8w		
R227	0757-0410			R: fxd metflm 301 ohms 1% 1/8w		
R301	0757-0421		4	R: fxd metflm 825 ohms 1% 1/8w		
R302	0757-0421			R: fxd metflm 825 ohms 1% 1/8w		
R303	2100-2061		2	R: var metflm 200 ohms 3% 1/4w		
R304	0757-0276		2	R: fxd metflm 61.9 ohms 1% 1/8w		
R305	0757-0408		10	R: fxd metflm 243 ohms 1% 1/8w		
R306	0757-0408			R: fxd metflm 243 ohms 1% 1/8w		
R307	0757-0401			R: fxd metflm 100 ohms 1% 1/8w		
R308	2100-2271		2	R: var comp 20k ohms 10% log taper 1/4w		
R309	2100-2008		2	R: var car comp 10k ohms 10% 1/4w		
R310	0757-0398			R: fxd metflm 75 ohms 1% 1/8w		
R311	0757-0398			R: fxd metflm 75 ohms 1% 1/8w		
R315	0757-0400		5	R: fxd metflm 90.9 ohms 1% 1/8w		
R316	0757-0388			R: fxd metflm 30.1 ohms 1% 1/8w		
R317	2100-2060		2	R: var metflm 50 ohms 30% 1/4w		
R318	0757-0346		5	R: fxd metflm 10 ohms 1% 1/8w		
R319	0757-0346			R: fxd metflm 10 ohms 1% 1/8w		
R320	0757-0428		2	R: fxd metflm 1.62k ohms 1% 1/8w		
R324	0757-0282		9	R: fxd metflm 221 ohms 1% 1/8w		
R325	0757-0282			R: fxd metflm 221 ohms 1% 1/8w		
R326	0757-0400			R: fxd metflm 90.9 ohms 1% 1/8w		
R327	0757-0414		12	R: fxd metflm 432 ohms 1% 1/8w		
R328	0757-0414			R: fxd metflm 432 ohms 1% 1/8w		

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)		
R329	0757-0420		4	R: fxd metflm 750 ohms 1% 1/8w		
R330	0757-0420			R: fxd metflm 750 ohms 1% 1/8w		
R332	0757-0414			R: fxd metflm 432 ohms 1% 1/8w		
R333	0757-0414			R: fxd metflm 432 ohms 1% 1/8w		
R334	0757-0388			R: fxd metflm 30.1 ohms 1% 1/8w		
R335	0757-0388			R: fxd metflm 30.1 ohms 1% 1/8w		
R336	0757-0437		4	R: fxd metflm 4.75k ohms 1% 1/8w		
R337	0757-0437			R: fxd metflm 4.75k ohms 1% 1/8w		
R338	2100-2146		2	R: var comp 10k ohms 10% 3/4w		
R342	0757-0282			R: fxd metflm 221 ohms 1% 1/8w		
R343	0727-0282			R: fxd metflm 221 ohms 1% 1/8w		
R344	0757-0408			R: fxd metflm 243 ohms 1% 1/8w		
R345	0757-0408			R: fxd metflm 243 ohms 1% 1/8w		
R346	0757-0430		3	R: fxd metflm 2210 ohms 1% 1/8w		
R347	0757-0395		2	R: fxd metflm 56.2 ohms 1% 1/8w		
R348	2100-1984		2	R: var metflm 100 ohms 30% 1/2w		
R351	0757-0400			R: fxd metflm 90.9 ohms 1% 1/8w		
R352	0757-0422		7	R: fxd metflm 909 ohms 1% 1/8w		
R353	0757-0422			R: fxd metflm 909 ohms 1% 1/8w		
R354	2100-2063		1	R: var comp 1k ohm 10% 1/2w		
R401	0757-0421			R: fxd metflm 825 ohms 1% 1/8w		
R402	0757-0421			R: fxd metflm 825 ohms 1% 1/8w		
R403	2100-2061			R: var metflm 200 ohms 30% 1/4w		
R404	0757-0276			R: fxd metflm 61.9 ohms 1% 1/8w		
R405	0757-0408			R: fxd metflm 243 ohms 1% 1/8w		
R406	0757-0408			R: fxd metflm 243 ohms 1% 1/8w		
R407	0757-0401			R: fxd metflm 100 ohms 1% 1/8w		
R408	2100-2271			R: var comp 20k ohms 10% log taper 1/4w		
R409	2100-2008			R: var car comp 10k ohms 10% 1/4w		
R410	0757-0398			R: fxd metflm 75 ohms 1% 1/8w		
R411	0757-0398			R: fxd metflm 75 ohms 1% 1/8w		
R415	0757-0400			R: fxd metflm 90.9 ohms 1% 1/8w		
R416	0757-0388			R: fxd metflm 30.1 ohms 1% 1/8w		
R417	2100-2060			R: var metflm 50 ohms 30% 1/4w		
R418	0757-0346			R: fxd metflm 10 ohms 1% 1/8w		
R419	0757-0346			R: fxd metflm 10 ohms 1% 1/8w		
R420	0757-0428			R: fxd metflm 1.62k ohms 1% 1/8w		
R424	0757-0282			R: fxd metflm 221 ohms 1% 1/8w		
R425	0757-0282			R: fxd metflm 221 ohms 1% 1/8w		
R426	0757-0400			R: fxd metflm 90.9 ohms 1% 1/8w		
R427	0757-0414			R: fxd metflm 432 ohms 1% 1/8w		
R428	0757-0414			R: fxd metflm 432 ohms 1% 1/8w		
R429	0757-0420			R: fxd metflm 750 ohms 1% 1/8w		
R430	0757-0420			R: fxd metflm 750 ohms 1% 1/8w		
R432	0757-0414			R: fxd metflm 432 ohms 1% 1/8w		
R433	0757-0414			R: fxd metflm 432 ohms 1% 1/8w		
R434	0757-0388			R: fxd metflm 30.1 ohms 1% 1/8w		
R435	0757-0388			R: fxd metflm 30.1 ohms 1% 1/8w		
R436	0757-0437			R: fxd metflm 4.75k ohms 1% 1/8w		

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)		
R437	0757-0437			R: fxd metflm 4.75k ohms 1% 1/8w		
R438	2100-2146			R: fxd comp 10k ohms 10% 3/4w		
R442	0757-0282			R: fxd metflm 221 ohms 1% 1/8w		
R443	0757-0282			R: fxd metflm 221 ohms 1% 1/8w		
R444	0757-0408			R: fxd metflm 243 ohms 1% 1/8w		
R445	0757-0408			R: fxd metflm 243 ohms 1% 1/8w		
R446	0757-0430			R: fxd metflm 2210 ohms 1% 1/8w		
R447	0757-0395			R: fxd metflm 56.2 ohms 1% 1/8w		
R448	2100-1984			R: var metflm 100 ohms 30% 1/2w		
R501	0757-0393		2	R: fxd metflm 47.5 ohms 1% 1/8w		
R502	0757-0393			R: fxd metflm 47.5 ohms 1% 1/8w		
R503	0757-0436		1	R: fxd metflm 4.32k ohms 1% 1/8w		
R504	0757-0414			R: fxd metflm 432 ohms 1% 1/8w		
R508	0757-0722		1	R: fxd metflm 332 ohms 1% 1/4w		
R509	0757-0408			R: fxd metflm 243 ohms 1% 1/8w		
R510	0757-0408			R: fxd metflm 243 ohms 1% 1/8w		
R511	0757-0273		4	R: fxd metflm 3.01k ohms 1% 1/8w		
R512	0757-0273			R: fxd metflm 3.01k ohms 1% 1/8w		
R516	0757-0809		2	R: fxd metflm 332 ohms 1% 1/2w		
R517	0757-0809			R: fxd metflm 332 ohms 1% 1/2w		
R518	0757-0397		1	R: fxd metflm 68.1 ohms 1% 1/8w		
R519	0757-0447		1	R: fxd metflm 16.2k ohms 1% 1/8w		
R520	0757-0422			R: fxd metflm 909 ohms 1% 1/8w		
R521	0757-0158		2	R: fxd metflm 619 ohms 1% 1/2w		
R522	0757-0158			R: fxd metflm 619 ohms 1% 1/2w		
R526	0757-0824		2	R: fxd metflm 2k ohms 1% 1/2w		
R527	0757-0824			R: fxd metflm 2k ohms 1% 1/2w		
R528	0757-0813		1	R: fxd metflm 475 ohms 1% 1/2w		
R529	0698-5569		2	R: fxd metflm 1.5k ohms 1% 1w		
R530	0698-5569			R: fx. metflm 1.5k ohms 1% 1w		
R531	0811-2071		2	R: fxd ww 453 ohms 1% 3w		
R532	0811-2071			R: fxd ww 453 ohms 1% 3w		
R533	0757-0407		7	R: fxd metflm 200 ohms 1% 1/8w		
R534	0757-0282			R: fxd metflm 221 ohms 1% 1/8w		
R538	0811-2069		2	R: fxd ww 162 ohms 1% 3w		
R539	0811-2069			R: fxd ww 162 ohms 1% 3w		
R540	0757-0401			R: fxd metflm 100 ohms 1% 1/8w		
R541	0757-0401			R: fxd metflm 100 ohms 1% 1/8w		
R542	0757-0341		1	R: fxd metflm 30.1k ohms 1% 1/4w		
R543	0811-2070		2	R: fxd ww 400 ohms 1% 4w		
R544	0811-2070			R: fxd ww 400 ohms 1% 4w		
R545	0811-0041		1	R: fxd ww 169 ohms 1% 4w		
R549	0757-0417		4	R: fxd metflm 562 ohms 1% 1/8w		
R550	0757-0411		4	R: fxd metflm 332 ohms 1% 1/8w		
R551	0757-0411			R: fxd metflm 332 ohms 1% 1/8w		

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)
R554	0757-0411			R: fxd metflm 332 ohms 1% 1/8w
R555	0757-0417			R: fxd metflm 562 ohms 1% 1/8w
R601	0757-0280			R: fxd metflm 1k ohm 1% 1/8w
R602	0757-0442		4	R: fxd metflm 10k ohms 1% 1/8w
R603	0757-0288		2	R: fxd metflm 9.09k ohms 1% 1/8w
R604	0757-0288			R: fxd metflm 9.09k ohms 1% 1/8w
R605	0757-0442			R: fxd metflm 10k ohms 1% 1/8w
R606	0757-0280			R: fxd metflm 1k ohm 1% 1/8w
R607	0757-0461		2	R: fxd metflm 68.1k ohms 1% 1/8w
R608	0757-0430			R: fxd metflm 2.21k ohms 1% 1/8w
R609	0757-0444		1	R: fxd metflm 12.1k ohms 1% 1/8w
R610	0757-0461			R: fxd metflm 68.1k ohms 1% 1/8w
R611	0757-0728		1	R: fxd metflm 619 ohms 1% 1/4w
R615	0757-0718		2	R: fxd metflm 200 ohms 1% 1/4w
R616	0757-0401			R: fxd metflm 100 ohms 1% 1/8w
R617	0757-0280			R: fxd metflm 1k ohms 1% 1/8w
R618	0757-0283		4	R: fxd metflm 2k ohms 1% 1/8w
R619	0757-0280			R: fxd metflm 1k ohm 1% 1/8w
R620	0757-0283			R: fxd metflm 2k ohms 1% 1/8w
R621	0757-07[illegible]			R: fxd metflm 200 ohms 1% 1/4w
R622	0757-04[illegible]			R: fxd metflm 100 ohms 1% 1/8w
R626	0757-0442			R: fxd metflm 10k ohms 1% 1/8w
R627	0757-0442			R: fxd metflm 10k ohms 1% 1/8w
R628	0757-0280			R: fxd metflm 1k ohm 1% 1/8w
R629	0757-0280			R: fxd metflm 1k ohm 1% 1/8w
R630	0757-0457			R: fxd metflm 47.5k ohms 1% 1/8w
R631	0757-0427		1	R: fxd metflm 1.5k ohms 1% 1/8w
R632	0757-0446		2	R: fxd metflm 15k ohms 1% 1/8w
R633	0757-0446			R: fxd metflm 15k ohms 1% 1/8w
R701	0757-0407			R: fxd metflm 200 ohms 1% 1/8w
R702	0757-0407			R: fxd metflm 200 ohms 1% 1/8w
R703	0757-0417			R: fxd metflm 562 ohms 1% 1/8w
R704	0757-0417			R: fxd metflm 562 ohms 1% 1/8w
R705	0757-0418		4	R: fxd metflm 619 ohms 1% 1/8w
R706	0757-0418			R: fxd metflm 619 ohms 1% 1/8w
R707	2100-1788		1	R: var metflm 500 ohms 30% 1/2w
R708	0757-0422			R: fxd metflm 909 ohms 1% 1/8w
R709	0757-0422			R: fxd metflm 909 ohms 1% 1/8w
R710	0757-0735		1	R: fxd metflm 1.3k ohms 1% 1/8w
R711	0757-0388			R: fxd metflm 30.1 ohms 1% 1/8w
R712	0757-0388			R: fxd metflm 30.1 ohms 1% 1/8w
R715	2100-0898		2	R: var ww 500 ohms 5% 1w
R716	0757-0416		4	R: fxd metflm 511 ohms 1% 1/8w
R717	0757-0416			R: fxd metflm 511 ohms 1% 1/8w
R718	0757-0418			R: fxd metflm 619 ohms 1% 1/8w
R719	0757-0418			R: fxd metflm 619 ohms 1% 1/8w

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)
R720	0757-0422			R: fxd metflm 909 ohms 1% 1/8w
R721	0757-0422			R: fxd metflm 909 ohms 1% 1/8w
R722	0757-0388			R: fxd metflm 30.1 ohms 1% 1/8w
R723	0757-0388			R: fxd metflm 30.1 ohms 1% 1/8w
R727	0757-0416			R: fxd metflm 511 ohms 1% 1/8w
R728	0757-0416			R: fxd metflm 511 ohms 1% 1/8w
R729	2100-0898			R: var ww 500 ohms 5% 1w
R730	0757-0445		2	R: fxd metflm 13k ohms 1% 1/8w
R731	0757-0445			R: fxd metflm 13k ohms 1% 1/8w
R732	0757-0407			R: fxd metflm 200 ohms 1% 1/8w
R733	0757-0407			R: fxd metflm 200 ohms 1% 1/8w
R734	0757-0390		1	R: fxd metflm 36.5 ohms 1% 1/8w
R735	0757-0401			R: fxd metflm 100 ohms 1% 1/8w
R736	0757-0407			R: fxd metflm 200 ohms 1% 1/8w
R737	0757-0414			R: fxd metflm 432 ohms 1% 1/8w
R738	0757-0414			R. fxd metflm 432 ohms 1% 1/8w
R740	0757-0389		1	R: fxd metflm 33.2 ohms 1% 1/8w
R741	0757-0988		1	R: fxd metflm 15 ohms 1% 1/2w
R744	0757-0415		2	R: fxd metflm 475 ohms 1% 1/8w
R745	0757-0415			R: fxd metflm 475 ohms 1% 1/8w
R746	0757-0408			R: fxd metflm 243 ohms 1% 1/8w
R747	0757-0410		2	R: fxd metflm 301 ohms 1% 1/8w
R748	0757-0408			R: fxd metflm 243 ohms 1% 1/8w
R749	0757-0411			R: fxd metflm 332 ohms 1% 1/8w
R750	0757-0338		1	R: fxd metflm 1k ohms 1% 1/4w
R751	2100-1738		1	R: var car flm 10k ohms 30% lin 1/2w
R755	0757-0284			R: fxd metflm 150 ohms 1% 1/8w
R756	0757-0817		1	R: fxd metflm 750 ohms 1% 1/2w
R757	0757-0283			R: fxd metflm 2k ohms 1% 1/8w
R758	0757-040		1	R: fxd metflm 182 ohms 1% 1/8w
R759	0757-02 3			R: fxd metflm 3.01k ohms 1% 1/8w
R760	0757-0407			R: fxd metflm 200 ohms 1% 1/8w
R761	0757-0346			R: fxd metflm 10 ohms 1% 1/8w
R762	0757-0414			R: fxd metflm 432 ohms 1% 1/8w
R763	0757-0283			R: fxd metflm 2k ohms 1% 1/8w
S101	3100-1348		2	S: lever
S102				NSR: p/o A1
S201	3100-1348			S: lever
S202				NSR: p/o A2
S301	3101-0070		2	S: slide
S302	3100-1350		1	S: rotary
S401	3101-0070			S: slide

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)
T301	01801-61101		2	T: toroid (for core only order 5080-0401)
T401	01801-61101			T: toroid (for core only order 5080-0401)
VR301	1902-0041		3	VR: avalanche 5.11 v 5%
VR401	1902-0041			VR: avalanche 5.11 v 5%
VR501	1902-0243		1	VR: avalanche 30 v
VR701	1902-0210		1	VR: avalanche 10 v
VR702	1902-0052		1	VR: avalanche 6.81 v
VR703	1902-0041			VR: avalanche 5.11v 5%
				MISCELLANEOUS
	0340-0152		4	Insulator (Q509-Q512)
	1480-0231		1	Pin: vernier
	1750A-64A		4	Holder: trimmer
	5000-0234		4	Spring
	0370-0432		2	Knob: lever
	5040-0218		1	Coupler: vernier
	00180-67402		2	Knob: black (position)
	01410-04103		2	Plate (mounts R309 or R409)
	01801-00101		1	Chassis: left
	01801-00201		1	Panel: front
	01801-00202		1	Panel: sub
	01801-00203		1	Panel: rear
	01801-00603		2	Cover: attenuator
	01801-00604		1	Shield: attenuator a
	01801-00605		1	Shield: attenuator b
	01801-01201		1	Bracket: heat sink (Q509-Q512)
	01801-01202		1	Bracket (R124, R224, R354)
	01801-01203		1	Bracket: front vert amp
	01801-01204		1	Bracket: cent vert amp
	01801-04702		1	Support: plug-in
	01801-09101		2	Spring: locking bar
	01801-22301		2	Heat Equalizer
	01801-23201		2	Coupler: long (vert sens)
	01801-23202		3	Coupler: short (balance)
	01801-23206		1	Shaft: vernier
	01801-61201		1	Bracket: attenuator b (includes S201)
	01801-61202		1	Bracket: attenuator a (includes S101)
	01801-61606		1	Cable main
	01801-61602		1	Coax (P1 pin 24 to C602)
	01801-61604		1	Coax (R711 & R712 to CR701 & CR703)
	01801-61605		1	Coax (R633 to P1 pin 16)
	01801-67401		2	Knob: black (cal)
	01801-67402		1	Knob: black (display)
	01801-67403		2	Knob: black (v/cm)

BACK DATING MANUAL CHANGES

SECTION VII

MANUAL CHANGES AND OPTIONS

7-1. MANUAL CHANGES.

7-2. This manual applies directly to the standard Model 1801A Dual Channel Vertical Amplifier (as manufactured) with a serial prefix 716-. The following paragraphs explain how to adapt this manual to apply to newer instruments (higher serial prefix) or to older instruments (lower serial prefix). Technical corrections to this manual (if any) are called errata and are listed on a separate "Manual Changes" sheet supplied with this manual.

7-3. NEWER INSTRUMENTS. If the serial prefix of your Model 1801A is above 716, refer to the separate "Manual Changes" sheet supplied with this manual. Locate the serial prefix of your instrument and make the indicated changes to the manual.

7-4. OLDER INSTRUMENTS. If the serial prefix of your Model 1801A is below 716, refer to Table 7-1 for the changes necessary to adapt this manual to your particular instrument. Locate the serial prefix of your instrument in the table and make the indicated changes. Note that these changes adapt the manual to cover the instrument as manufactured and therefore may not apply to an instrument that has been modified in the field.

7-5. OPTIONS.

7-6. Options are standard modifications performed on hp instruments at the factory. No options for the Model 1801A are offered at the present time.

7-7. SPECIAL INSTRUMENTS.

7-8. Special instruments are standard hp instruments that are modified at the factory according to customer specifications. These instruments are identified with a special prefix to the instrument model number. A separate insert sheet is included with the manual for each instrument that has been modified in a manner which alters operation, instrument specifications or replaceable parts. The insert describes both the modification and any required changes to this manual.

Table 7-1. Manual Changes

Instrument Serial Prefix	Make Changes
614	1, 2, 3, 5, 6
644	2, 3, 5, 6
649	3, 4, 5, 6
712	4, 5, 6
715	6

CHANGE 1

Table 6-2,
C103, C107, C203, C207: Change hp Part No. to 0132-0002.
C112, C212: Change to hp Part No. 00132-0005; C: var, poly, 0.7-3 pf, 350vdcw.
J2: Delete.
R329, R330, R429, R430: Change to hp Part No. 0757-0419; R: fxd, metflm, 681 ohms, 1%, 1/8w.
R336, R337, R436, R437: Change to hp Part No. 0757-0273; R: fxd, metflm, 3.01k ohms, 1%, 1/8w.
R338, R438: Change to hp Part No. 2100-2064; R: var, comp, 20k ohms, 10%, 1/2w.
Miscellaneous,
hp Part No. 01801-61606: Change to hp Part No. 01801-61601.
Add: hp Part No. 01801-61603; Coax (R761 to P1 pin 14).
Page 8-7, Figure 8-6,
R329, R330, R429, R430: Change value to 681 ohms.
R336, R337, R436, R437: Change value to 3010 ohms.
R338, R438: Change value to 20k ohms.
Page 8-13, Figure 8-12,
J2: Change to P1 pin 14.
Page 8-14, Figure 8-13,
P1 pin 14: connect Internal Trigger signal from junction R761/R762.

CHANGE 2

Table 6-2,
A3: Change to hp Part No. 01801-66501.
Add: L501, L502; hp Part No. 9170-0016; L: bead, ferrite, Mfr hp.
Miscellaneous,
hp Part No. 1480-0231: Delete.
hp Part No. 5040-0218: Delete.
Add: hp Part No. 01801-01101; Sink: heat (R543-R545).
Add: hp Part No. 01801-01102; Sink: heat (R529-R532, R538, R539)
Add: hp Part No. 01801-23205; Coupler: vernier.
hp Part No. 01801-23206: Delete.
Page 8-9, Figure 8-8,
Add: L501, L502; bead. Place in collector lead of Q503 and Q504 respectively.

CHANGE 3

Table 6-2, miscellaneous,
hp Part No. 01801-04702: Change to hp Part No. 01801-04701.

CHANGE 4

Table 6-2,
Add: L501, L502: hp Part No. 9170-0016; L: bead, ferrite.
Page 8-9, Figure 8-8,
Add: L501, L502; bead; place in emitter lead of

CHANGE 4 (CONT'D)

Q503 and Q504, respectively.

CHANGE 5

Table 6-2,
Add: C537, C538; hp Part No. 0180-0230; C: fxd, ta elect, 1 μf, 20%, 50vdcw.
C722: Delete.
Add: CR714, CR715; hp Part No. 1901-0040; CR: si.
R308, R408: Change to hp Part No. 2100-2065; R: var comp, 20k ohms, 10%, lin, 1/4w.
R744, R745: Change to hp Part No. 0757-0420; R: fxd, metflm, 750 ohms, 1%, 1/8w.
R747: Change to hp Part No. 0757-0284; R: fxd, metflm, 150 ohms, 1%, 1/8w.
R760: Change to hp Part No. 0757-0395; R: fxd, metflm, 56.2 ohms, 1%, 1/8w.
R762: Change to hp Part No. 0757-0346; R: fxd, metflm, 10 ohms, 1%, 1/8w.
R763: Change to hp Part No. 0757-0273; R: fxd, metflm, 3.01k ohms, 1%, 1/8w.
VR703: Delete.
Page 8-9, Figure 8-8,
Add: C537, C538; 1 μf, connect in parallel between ground and -12.6 VF (C) side of L520. Observe polarity, + side to ground.
Page 8-13, Figure 8-12,
C722: Delete.
VR703: Delete.
Add: CR714, CR715; connect in series. Anode of CR714 to base of Q715, cathode of CR715 to base of Q716.
R744, R745: Change value to 750 ohms.
R747: Change value to 150 ohms.
R760: Change value to 56.2 ohms.
R762: Change value to 10 ohms.
R763: Change value to 3010 ohms.

CHANGE 6

Table 6-2,
L402, L403: Delete.
L503, L504: Change to hp Part No. 9170-0016; L: bead ferrite (2 required).
R346, R446: Change to hp Part No. 0757-0426; R: fxd, metflm, 1.3k ohms, 1%, 1/8w.
R519: Change to hp Part No. 0757-0440; R: fxd, metflm, 7.5k ohms, 1%, 1/8w.
Page 8-7, Figure 8-6,
L402, L403: Delete.
R346, R446: Change value to 1300 ohms.
Page 8-9, Figure 8-8,
R519: Change value to 7500 ohms.

SCHEMATIC DIAGRAMS

SECTION VIII
SCHEMATICS AND TROUBLESHOOTING

8-1. INTRODUCTION.

8-2. This section combines detailed information including repair and replacement, component identification, schematic diagrams, and troubleshooting, all integrated with the appropriate schematic. Other information and procedures related to performance check and adjustment procedures are in Section V.

8-3. SCHEMATIC DIAGRAMS.

8-4. All schematic diagrams for the Model 1801A are in this section. (Refer to the List of Illustrations to locate a circuit by description.) They are drawn to show the electronic function of the circuitry, and a given schematic may include all or part of several different physical assemblies. Table 8-1 provides information about the symbols and conventions used. The schematics also indicate waveform test points and typical dc voltages; refer to troubleshooting paragraph for details of interpreting waveforms and dc voltages. Note that all schematics are printed so the entire schematic unfolds outside the right-hand edge of the manual.

8-5. COMPONENT IDENTIFICATION.

8-6. Whenever possible, the location of components appearing on a schematic is shown on the page opposite that schematic. When components or an assembly appear on more than one schematic, the location of all components on that assembly are identified opposite the first schematic showing that assembly. Adjustments and chassis mounted components are identified in Figure 8-1.

8-7. TROUBLESHOOTING.

8-8. GENERAL. Troubleshooting information in this manual applies directly only to the Model 1801A. Refer to the appropriate manual for information on other instruments. The most important prerequisite to systematic troubleshooting is an understanding of instrument circuitry operation. Refer to Section IV for a block diagram and principles of operation. To isolate trouble to either the main frame oscilloscope or the horizontal or vertical plug-in, use the basic operating procedure given in Section III to isolate a trouble to a circuit associated with a front panel control. Also check for the proper outputs from the low and high voltage power supplies as these voltages affect the CRT display and operation of the plug-ins.

8-9. VISUAL INSPECTION. It is recommended that prior to using waveforms and dc voltages for troubleshooting, a thorough visual inspection of the instrument(s) be made. Check for burned or loose components, loose wire connections, faulty switch contacts, or any similar condition suggesting a source of the trouble. If the faulty operation is still present, proceed to the electrical checkout.

8-10. ELECTRICAL CHECKOUT. Typical waveforms are located near the schematic where appropriate. Always refer to the specified conditions given with the waveforms for waveform measurement. Check the waveforms in a signal flow sequence; an incorrect waveform (or none) indicates the circuit likely to be at fault. Testpoints given on the schematics are shown at an electrical point which should be readily accessible at the physical/electrical corresponding point on the etched circuit board. Check the typical dc voltages (given on the schematic) in the suspect circuit to further isolate the trouble to a specific component. Conditions for dc voltages are given opposite the individual schematics. Always allow time for a stable dc voltage level to be reached before noting the reading. In locating test points on

CAUTION

When taking waveform or dc measurements, use extreme care to ensure that no supply voltages or components are shorted.

the board assemblies, note that a small dot etched on the board identifies the emitter lead of transistors, the source lead of FET, the cathode lead of diodes, and the positive side of electrolytic capacitors.

8-11. REPAIR AND REPLACEMENT.

8-12. Almost all electrical components are accessible for replacement from the component side of the etched circuit boards. Component identification is summarized in Paragraph 8-5. Section VI provides a detailed parts list to allow ordering replacements from Hewlett-Packard. Mechanical and miscellaneous electrical parts are listed at the end of Table 6-2. If satisfactory operation or repair cannot be accomplished, contact the nearest Hewlett-Packard Sales/Service Office (addresses at rear of this manual). If shipment for repair is recommended, see Section II for recommended repackaging information.

8-13. SERVICING CIRCUIT BOARDS.

8-14. Etched circuit boards in this instrument have components mounted on one side of the board, conductive surfaces on both sides, and plated-through component mounting holes. Hewlett-Packard Service Note M-20D contains useful information on servicing etched circuit boards. Important considerations are as follows:

a. Use a low heat (37 to 47.5 watts, less than 800°F idling temperature), slightly bent chisel tip (1/16 to 1/8 inch diameter) soldering iron, and a small diameter rosin core solder.

b. Components may be removed by placing the soldering iron on the component lead of either side of the board, and pulling up on the lead. If heat is applied to the component side of the board, greater care is required to avoid damage to the component (especially true for semiconductors). If heat damage may occur, grip the lead with a pair of pliers to provide a heat sink between the soldering iron and component.

c. If a component is obviously damaged or faulty, clip the lead close to the component and then unsolder the leads from the board.

d. Large components such as potentiometers may be removed by rotating the soldering iron from lead to lead and applying steady pressure to lift the part free (the alternative is to clip the leads of a damaged part).

e. Since the conductor portion of the etched circuit board is a metal plated surface covered with solder, use care to avoid overheating which causes the conductor to lift away from the board. A lifted conductor may be cemented back in place with a quick-drying acetate base cement (use sparingly) having good insulating properties. Another method of repair is to solder a section of good conducting wire along the damaged area.

f. Clear the solder from the component hole before inserting a new component lead. Heat the solder in the hole, remove the iron, and quickly insert a pointed non-metallic object, such as a toothpick.

g. Shape the new component leads and clip to proper length. Insert the leads into the holes, apply heat, and solder (preferably on the side opposite the component).

Table 8-1. Schematic Diagram Notes

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

= Etched circuit board

= Front panel marking

= Rear panel marking

= Front panel control

= Screwdriver adjustment

P/O = Part of

CW = Clockwise end of variable resistor

N.C. = No connection

= Waveform test point (with number)

= Common electrical point (with letter) not necessarily ground

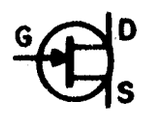
= Single pin connector

= Pin of a plug-in board (with letter or number)

= Primary signal flow

= Secondary signal flow

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



= Field effect transistor (N-channel)

= Breakdown diode

= Tunnel diode

= Step recovery diode

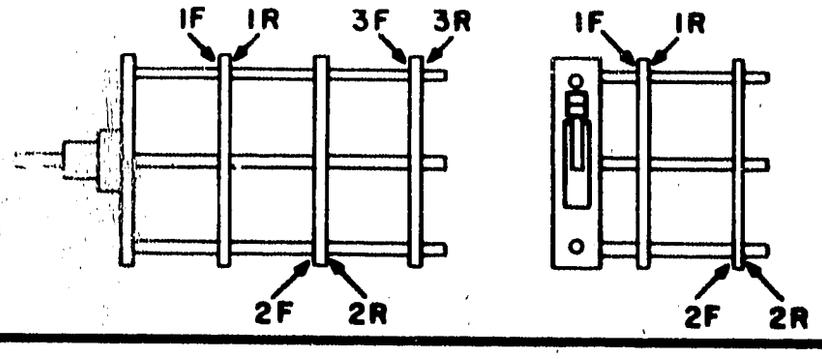
= Circuits or components drawn with dashed lines (phantom) show function only and are not intended to be complete. The circuit or component is shown in detail on another schematic.

Unless otherwise indicated:
resistance in ohms
capacitance in picofarads
inductance in microhenries

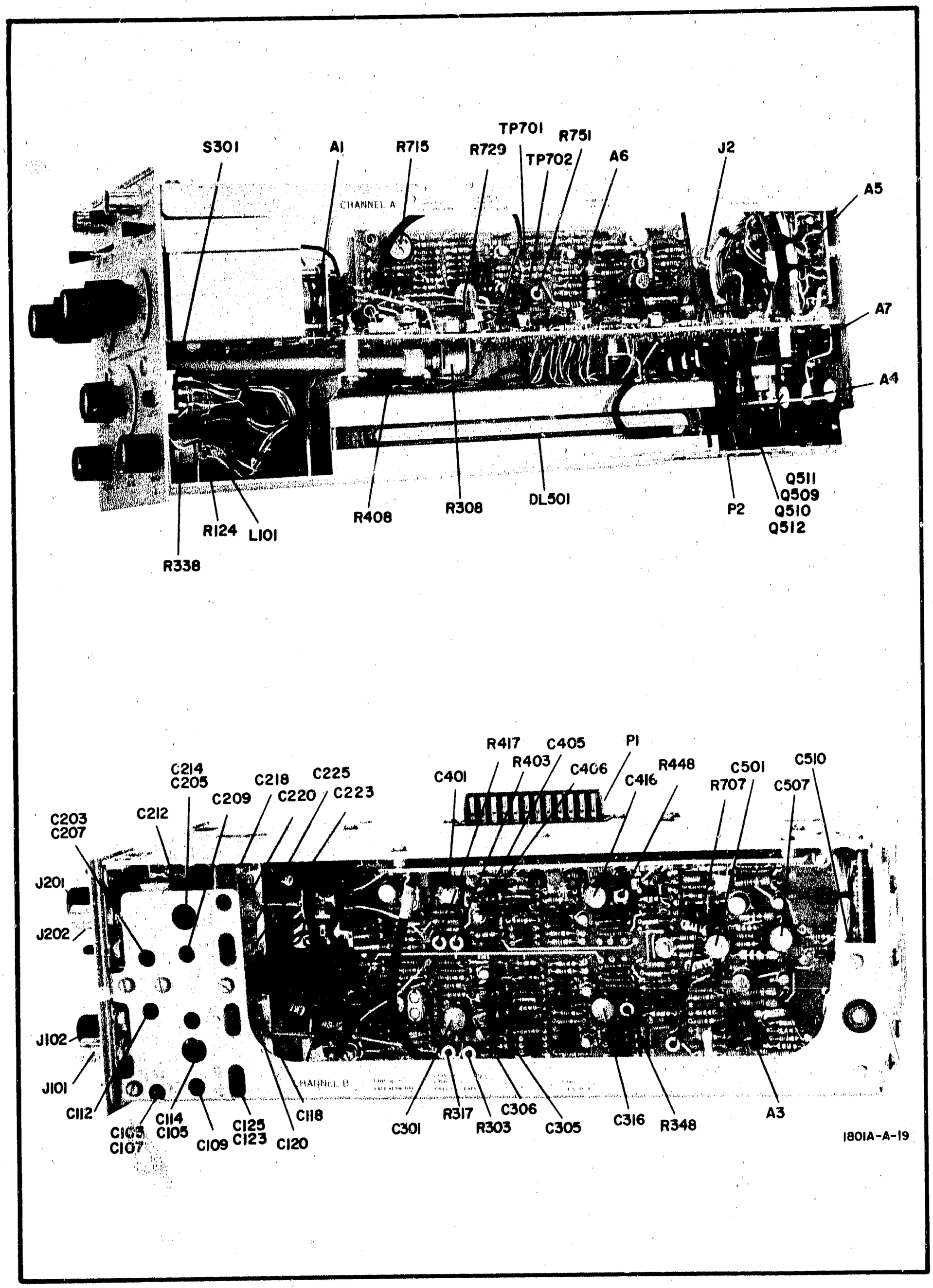
Wire colors are given by numbers in parentheses using the resistor color code [(925) is wht-red-grn].

0 - Black	5 - Green
1 - Brown	6 - Blue
2 - Red	7 - Violet
3 - Orange	8 - Gray
4 - Yellow	9 - White

Switch wafers are identified as follows:

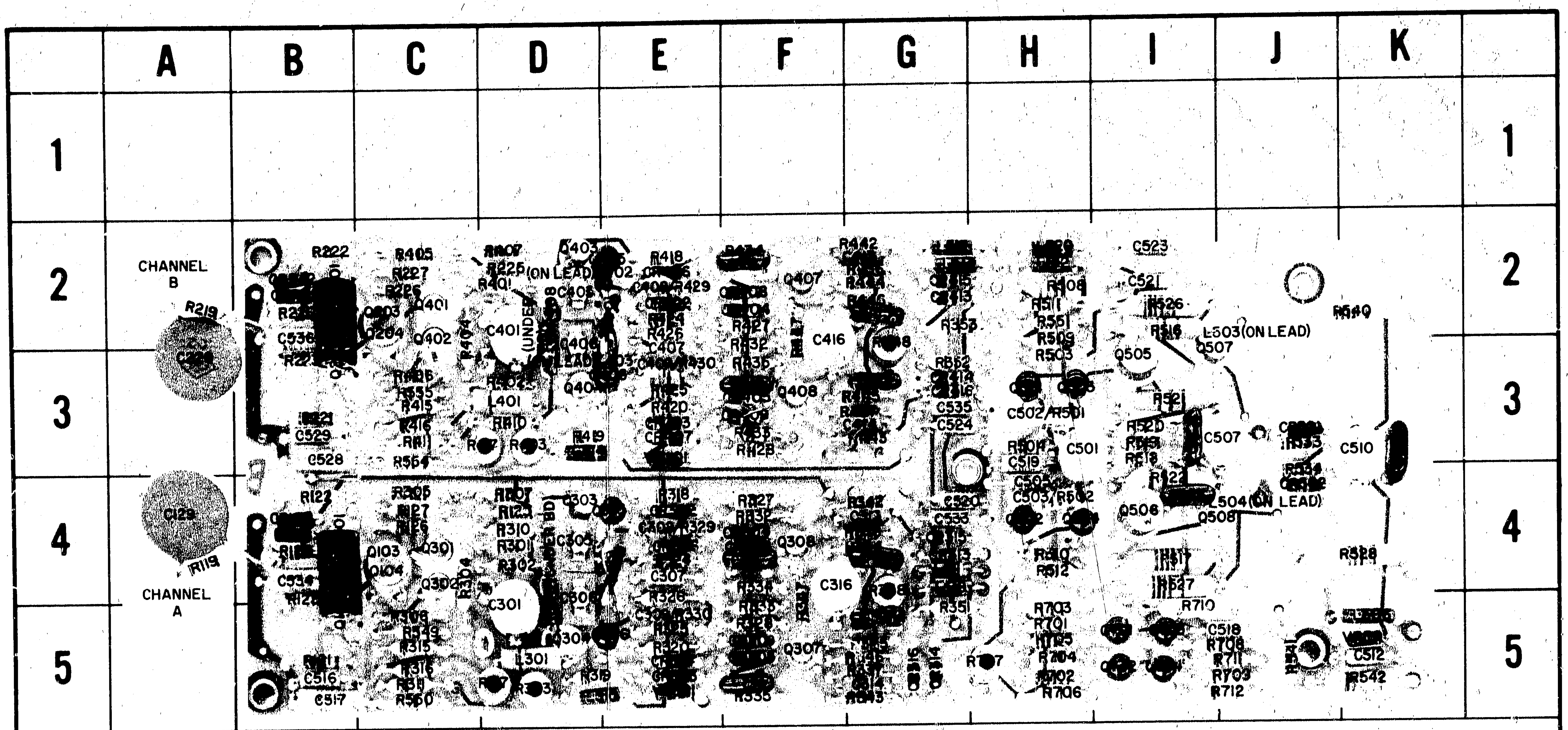


02590-2



02590-3

Figure 8-1. Adjustment Location and Component Identification



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C129	A-4	C417	G-3	CR201	B-2	CR502	J-4	Q304	D-5	R121	B-5	R318	E-4	R402	D-3	R437	G-3	R533	J-3
C229	A-3	C501	H-3	CR202	B-2	L301	D-5	Q305	E-4	R122	B-4	R319	D-5	R403	D-3	R442	G-2	R534	J-4
C301	D-5	C502	H-3	CR302	E-4	L401	D-3	Q306	E-5	R123	B-4	R320	E-5	R404	C-2	R443	G-3	R540	K-2
C305	D-4	C503	H-4	CR303	E-5	L402	E-2	Q307	F-5	R125	D-4	R324	E-4	R405	C-2	R444	G-2	R541	J-5
C306	D-4	C505	H-4	CR304	F-4	L403	E-3	Q308	F-4	R126	C-4	R325	E-5	R406	C-3	R445	G-3	R542	K-5
C307	E-4	C506	I-4	CR305	F-5	L503	J-2	Q401	C-2	R127	C-4	R326	E-4	R407	D-2	R446	G-2	R549	C-5
C308	E-4	C507	J-3	CR306	E-4	L504	J-4	Q402	C-2	R219	A-2	R327	F-5	R408	D-2	R447	F-2	R550	C-5
C309	E-5	C508	I-3	CR307	E-5	L506	K-5	Q403	D-2	R220	B-2	R328	F-4	R410	D-3	R448	G-3	R551	H-2
C311	F-4	C509	K-3	CR308	F-4	L510	E-5	Q404	D-3	R221	B-3	R329	E-4	R411	C-3	R501	H-3	R554	C-3
C312	F-5	C510	K-3	CR309	F-5	L511	G-4	Q405	E-3	R222	B-2	R330	E-5	R415	C-3	R502	H-4	R555	C-3
C313	G-4	C512	K-5	CR313	G-4	L512	H-2	Q406	E-3	R223	B-3	R332	F-4	R416	C-3	R503	H-3	R701	H-5
C314	G-5	C516	B-5	CR314	G-5	L513	G-2	Q407	F-2	R225	D-2	R333	F-4	R417	D-3	R504	H-3	R702	H-5
C315	G-5	C517	B-5	CR315	G-4	L514	D-3	Q408	F-3	R226	C-2	R334	F-4	R418	E-2	R508	H-2	R703	H-5
C316	F-4	C518	J-5	CR316	G-5	L518	G-4	Q501	H-3	R227	C-2	R335	F-4	R419	D-3	R509	H-2	R704	H-5
C317	G-4	C519	H-3	CR402	E-2	L519	G-2	Q502	H-4	R301	D-4	R336	G-4	R420	E-3	R510	H-4	R705	H-5
C401	D-2	C520	G-4	CR403	E-3	L520	H-2	Q503	H-3	R302	D-4	R337	G-5	R424	E-2	R511	H-2	R706	H-5
C405	D-2	C521	I-2	CR404	F-2	Q101	B-4	Q504	H-4	R303	D-5	R342	G-4	R425	E-3	R512	H-4	R707	H-5
C406	D-2	C523	I-2	CR405	F-3	Q102	B-5	Q505	I-3	R304	C-4	R343	G-5	R426	E-2	R516	I-2	R708	J-5
C407	E-3	C524	G-3	CR406	E-2	Q103	C-4	Q506	I-4	R305	C-4	R344	G-4	R427	F-2	R517	I-4	R709	J-5
C408	E-2	C528	B-3	CR407	E-3	Q104	C-4	Q507	I-3	R306	C-5	R345	G-5	R428	F-3	R518	I-3	R710	I-5
C409	E-3	C529	B-3	CR408	F-2	Q201	B-2	Q508	I-4	R307	D-4	R346	G-5	R429	E-2	R519	I-3	R711	J-5
C411	E-2	C533	G-4	CR409	F-3	Q202	B-3	Q701	I-5	R308	D-5	R347	F-5	R430	E-3	R520	I-3	R712	J-5
C412	F-3	C534	B-4	CR413	G-2	Q203	C-2	Q702	I-5	R310	D-4	R348	G-4	R432	F-2	R521	I-3	T301	E-4
C413	G-2	C535	G-3	CR414	G-3	Q204	C-2	Q703	I-5	R311	C-5	R351	G-5	R433	F-3	R522	I-4	T401	E-2
C414	G-3	C536	B-2	CR415	G-2	Q301	C-4	Q704	I-5	R315	C-5	R352	G-3	R434	F-2	R526	I-2	VR301	E-5
C415	G-2	CR101	B-4	CR416	G-3	Q302	C-4	R119	A-4	R316	C-5	R353	G-2	R435	F-3	R527	I-4	VR401	E-3
C416	F-2	CR102	B-4	CR501	J-3	Q303	D-4	R120	B-4	R317	D-5	R401	D-2	R436	G-2	R528	K-4	VR501	K-5

1801A-B-1B

Figure 8-2. Component Identification for A3

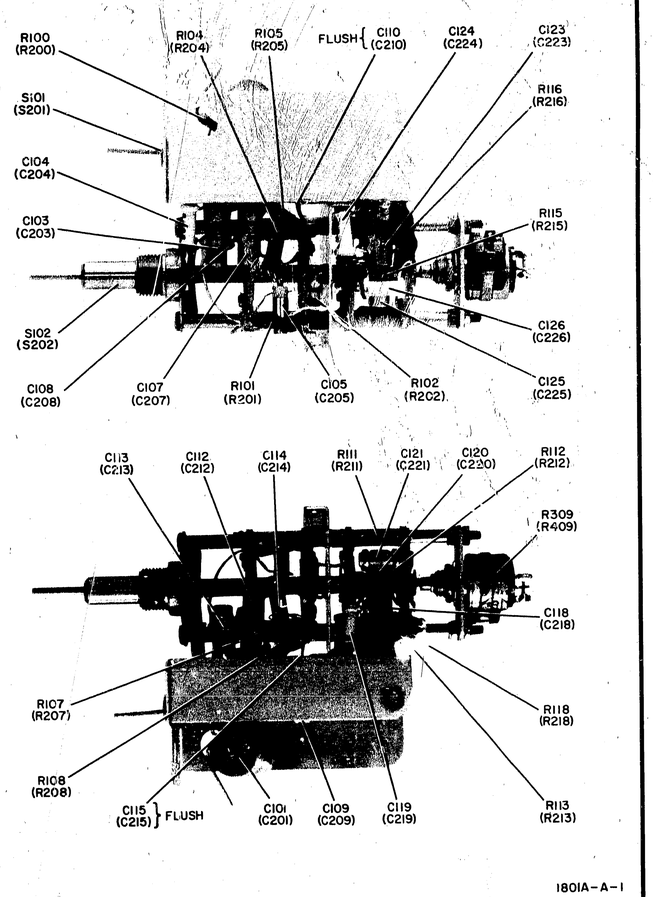


Figure 8-3. Component Identification for A1 and A2

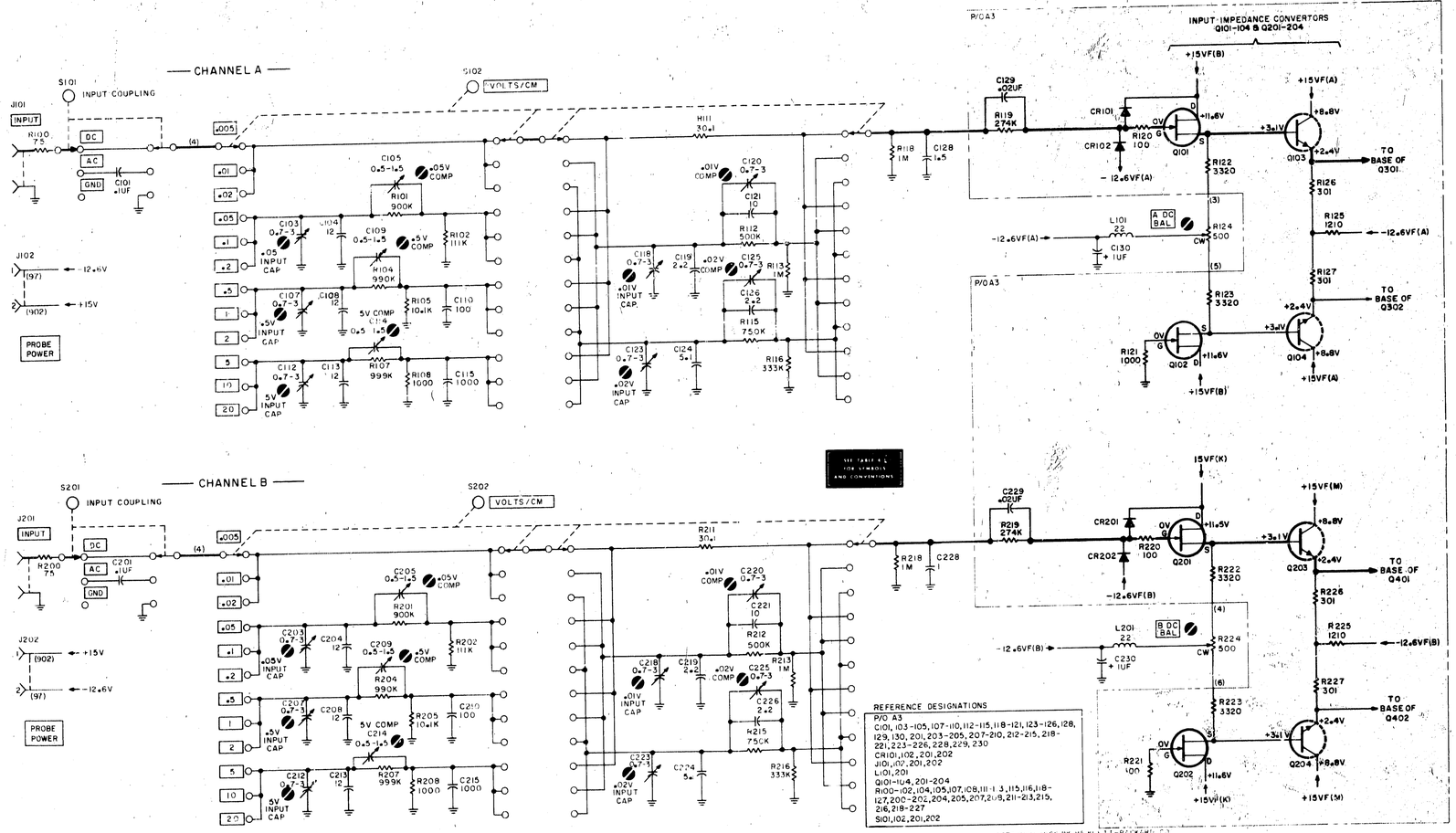


Figure 8-4. Attenuators and Impedance Converters

COMPONENT IDENTIFICATION

for A3 in Figure 8-2

DC VOLTAGE MEASUREMENT CONDITIONS

Control Settings:

Model 180A/AR

MAGNIFIER	X1
DISPLAY	INT

Model 1801A

DISPLAY	A
POLARITY, both channels	+UP
VOLTS/CM, both channels	1
Vernier, both channels	CAL
Input coupling, both channels	GND
POSITION, A	center trace

WAVEFORM MEASUREMENT CONDITIONS

1. Control Settings:

   Model 1801A

VOLTS/CM, both channels	2
Vernier, both channels	CAL
POLARITY, both channels	+UP
DISPLAY	A
POSITION, both channels	center trace
Input coupling, both channels	AC

2. Connect Model 180A/AR CALIBRATOR 10V output (pk-pk, 1 kc) to the Model 1801A channel A INPUT. To check channel B operation, change DISPLAY to B and connect CALIBRATOR output to channel B INPUT; same waveforms apply.

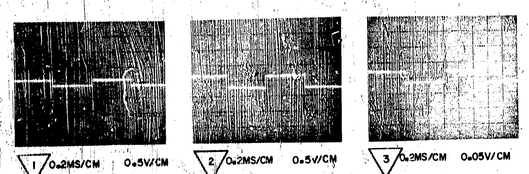


Figure 8-5. Input Amplifier Measurement Conditions and Waveforms

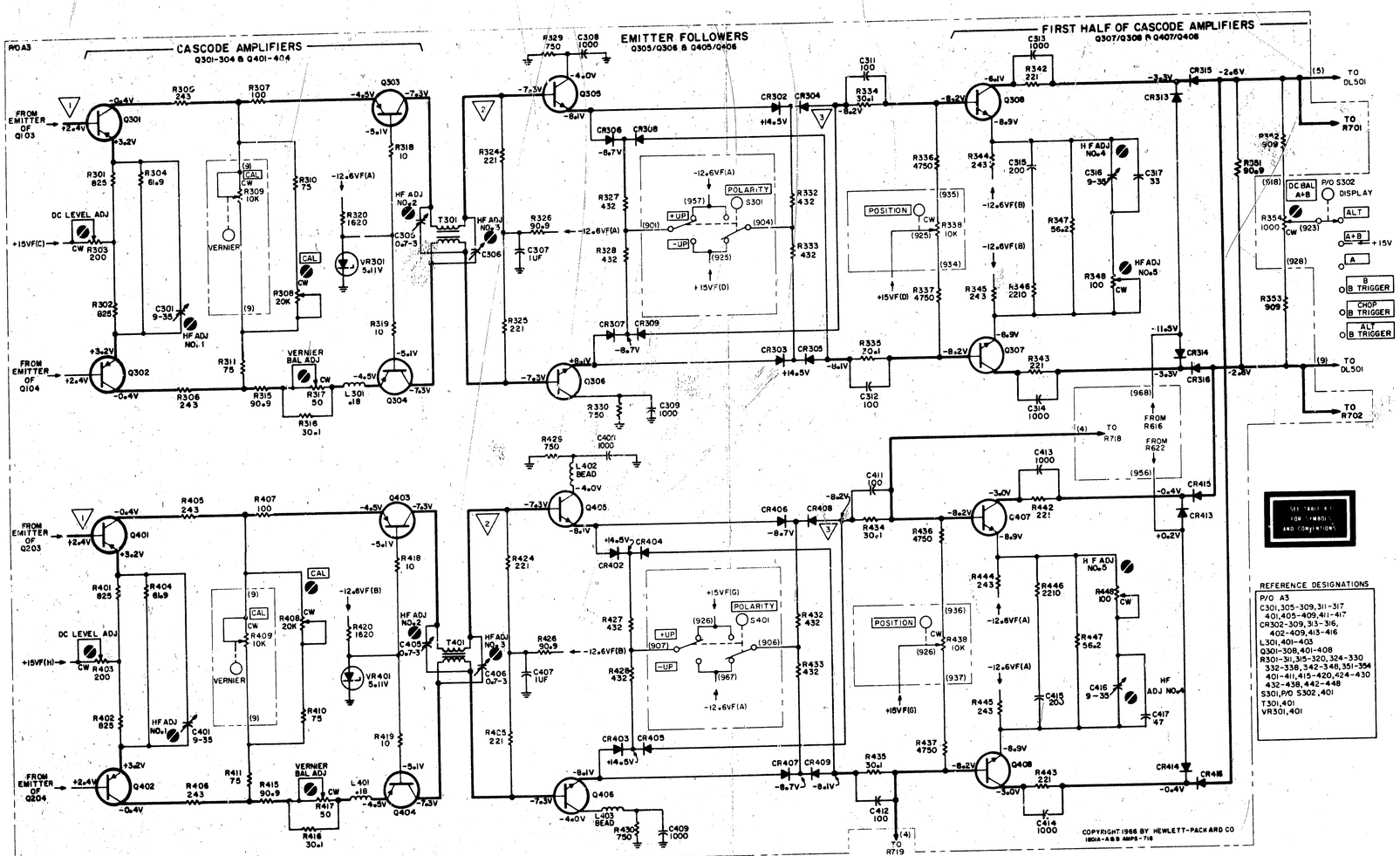
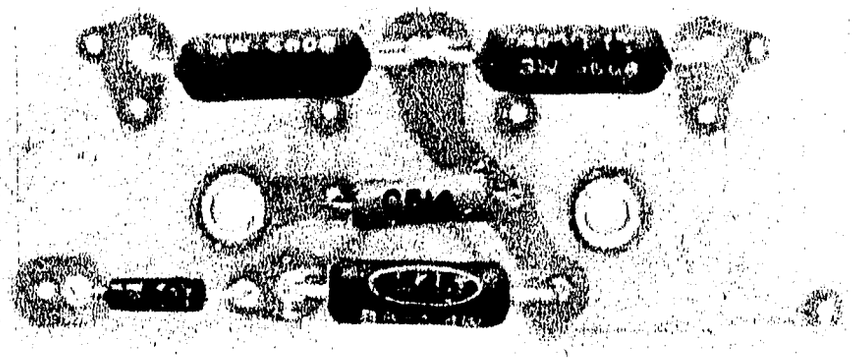


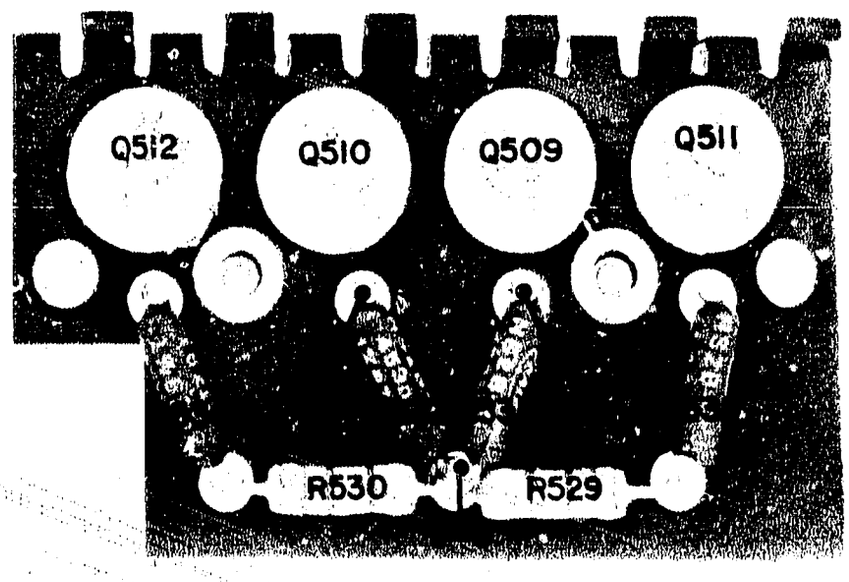
Figure 8-6. Input Amplifier

COMPONENT IDENTIFICATION

for A3 in Figure 8-3



A4 1801A-A-9



A7 1801A-A-18

Figure 8-7. Component Identification for A4 and A7

DC VOLTAGE MEASUREMENT CONDITIONS

Control Settings:

Model 180A/AR

MAGNIFIER	X1
DISPLAY	INT

Model 1801A

DISPLAY	A
POLARITY, both channels	+UP
VOLTS/CM, both channels	1
Vernier, both channels	CAL
Input coupling, both channels	GND
POSITION, A	center trace

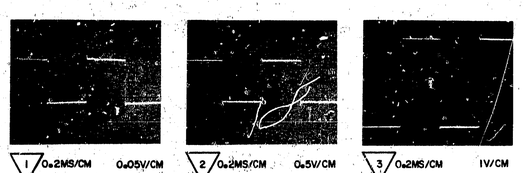
WAVEFORM MEASUREMENT CONDITIONS

1. Control Settings:

   Model 1801A

VOLTS/CM, both channels	2
Vernier, both channels	CAL
POLARITY, both channels	+UP
DISPLAY	A
POSITION, both channels	center trace
Input coupling, both channels	AC

2. Connect Model 180A/AR CALIBRATOR 10V output (pk-pk, 1 kc) to the Model 1801A channel A INPUT.



1801A-8-5A

Figure 8-8. Main Amplifier Measurement Conditions and Waveforms

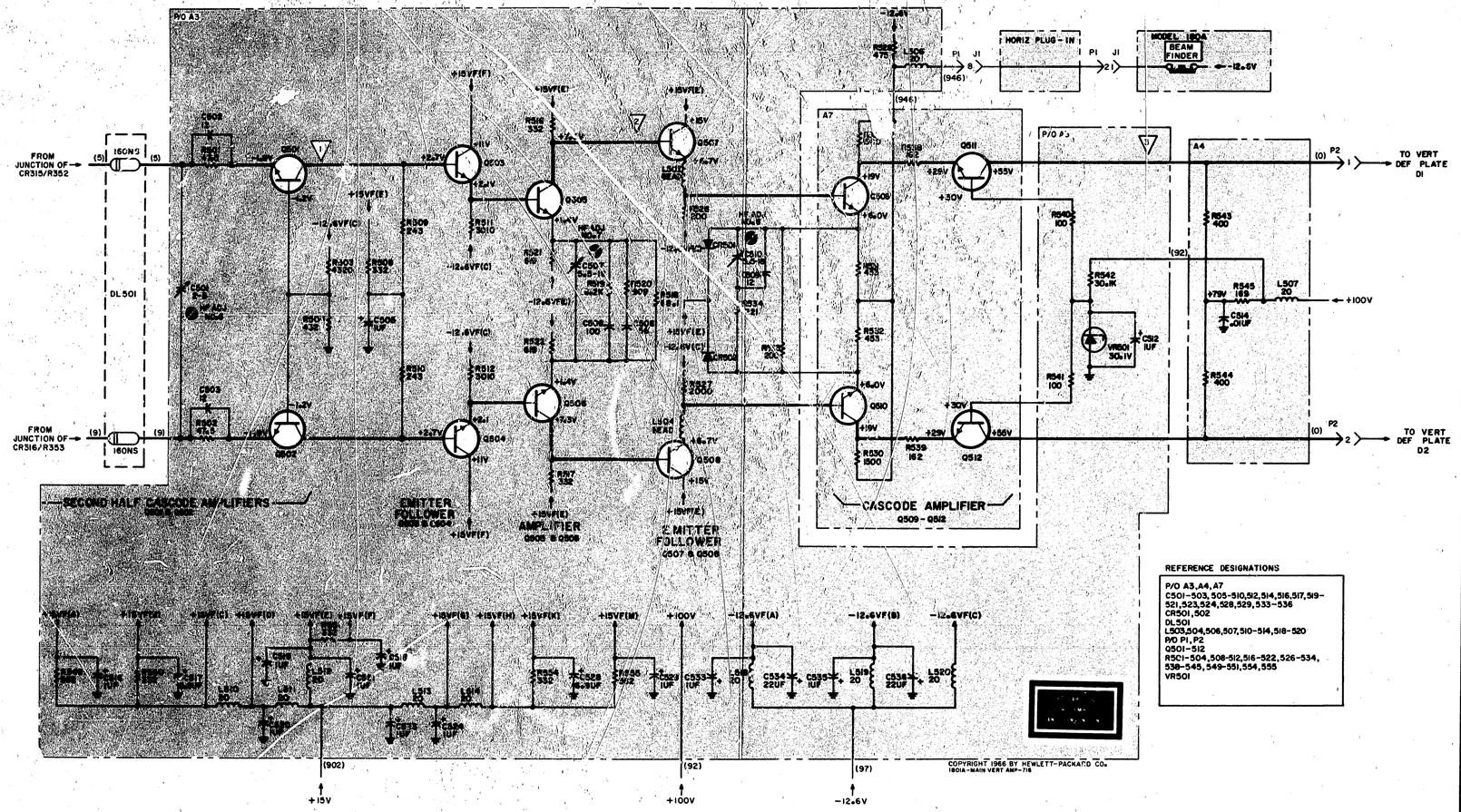
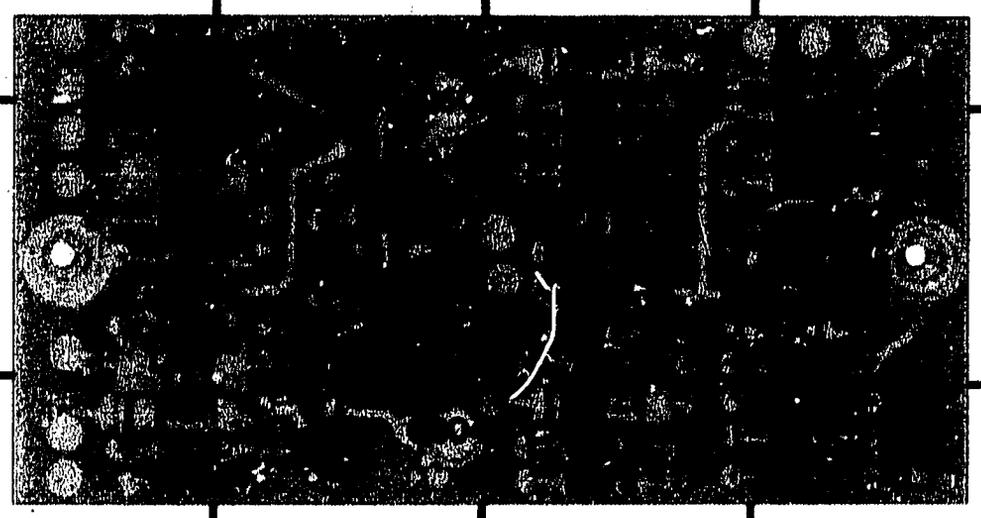


Figure 8-9. Main Amplifier



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C601	C2	C614	B2	L101	B2	Q605	E2	R604	C2	R610	B3	R619	D3	R628	E2
C602	B1	CR601	C2	L102	B3	Q606	E2	R605	D2	R611	B3	R620	E3	R629	E3
C603	C2	CR602	C3	Q601	C1	Q608	D2	R606	D3	R615	D1	R621	D3	R603	E3
C604	B2	CR603	B1	Q602	C3	R601	D1	R607	B1	R616	D2	R622	D2	R631	E3
C607	D2	CR604	B3	Q603	C1	R602	D2	R608	B2	R617	D2	R626	E2	R632	E2
C612	E2	CR608	D2	Q604	C3	R603	C2	R609	B2	R618	E2	R627	E2	R633	E1
C613	B2	CR609	D2												

1801A-A-10

Figure 8-10. Component Identification for A5

DC VOLTAGE MEASUREMENT CONDITIONS

Control Settings:

Model 1801A

DISPLAY	A
POLARITY, both channels	+UP
VOLTS/CM, both channels	1
Vernier, both channels	CAL
Input coupling, both channels	GND
POSITION, A	center trace

WAVEFORM MEASUREMENT CONDITIONS

1. Control Settings:

Model 1801A

DISPLAY	CHOP

Figure 8-11. Multivibrator Measurement Conditions and Waveforms

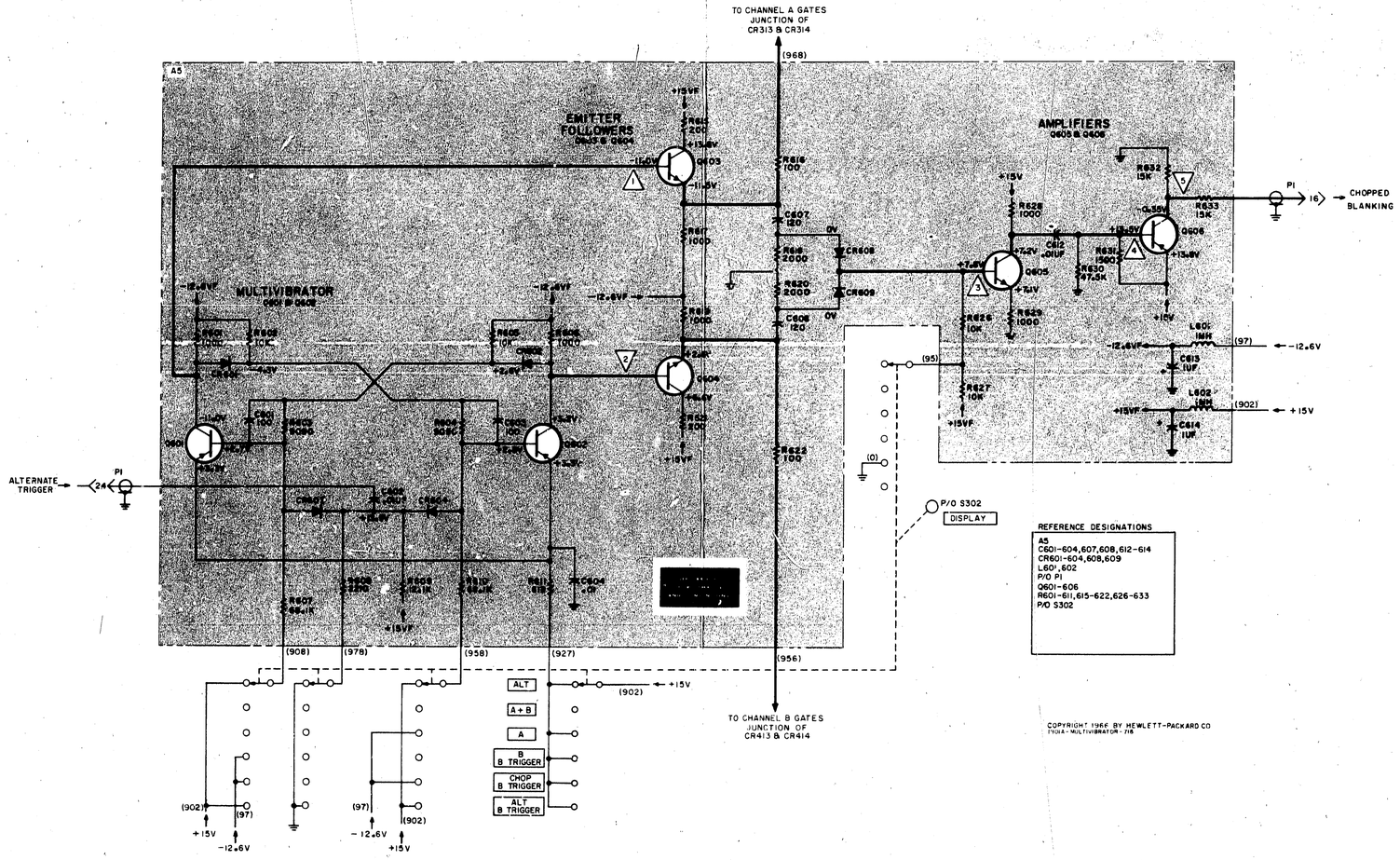


Figure 8-12. Multivibrator

Component Identification for A3 in Figure 8-2

REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C706	D-1	CR707	F-2	Q713	C-2	R730	D-2	R750	C-1
C707	E-2	CR708	E-1	Q714	C-2	R731	D-1	R751	D-1
C708	E-2	CR710	C-1	Q715	B-1	R732	E-2	R755	C-1
C712	A-1	CR711	C-2	Q716	B-2	R733	E-2	R756	C-1
C713	A-2	CR712	A-1	R715	F-2	R734	E-2	R757	C-1
C714	A-2	CR713	A-1	R716	F-2	R735	E-2	R758	B-2
C718	A-1	L701	B-1	R717	F-2	R736	D-2	R759	A-2
C719	A-1	L702	A-2	R718	F-1	R738	D-1	R760	B-1
C720	B-1	Q705	F-1	R719	F-1	R740	B-2	R761	A-2
C721	B-2	Q706	F-1	R720	F-1	R741	B-2	R762	A-2
C722	A-2	Q707	D-2	R721	F-1	R744	D-2	R763	B-1
CR701	F-2	Q708	D-1	R722	F-2	R745	D-1	TP701	D-2
CR702	F-2	Q709	D-2	R723	F-1	R746	D-2	TP702	D-1
CR703	E-2	Q710	D-1	R727	F-1	R747	C-1	VR701	B-2
CR704	E-2	Q711	D-2	R728	F-1	R748	C-2	VR702	B-2
CR705	F-2	Q712	C-2	R729	E-1	R749	C-2	VR703	B-1
CR706	E-2								

1801A-A-13A

Figure 8-13. Component Identification for A6

DC VOLTAGE MEASUREMENT CONDITIONS

Control Settings:

Model 1801A

DISPLAY	A
POLARITY, both channels	+UP
VOLTS/CM, both channels	1
Vernier, both channels	CAL
Input coupling, both channels	GND
POSITION, A	center trace

WAVEFORM MEASUREMENT CONDITIONS

1. Control Settings:

Model 1801A

VOLTS/CM, both channels	2
Vernier, both channels	CAL
POLARITY, both channels	+UP
DISPLAY	A
POSITION, both channels	center trace
Input coupling, both channels	AC

2. Connect Model 180A/AR 10 v output (pk-pk, 1 kc) to both the channel A and B INPUT.

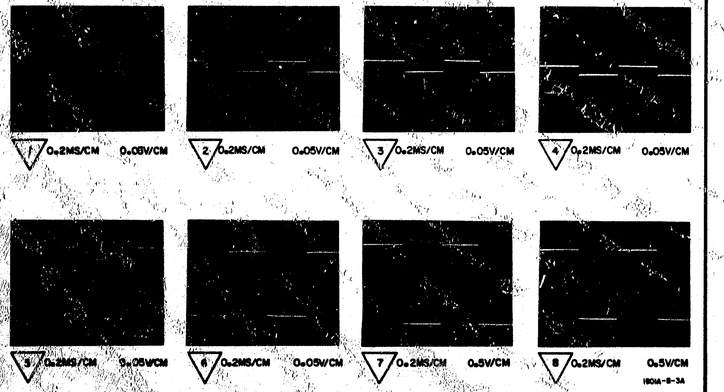


Figure 8-14. Sync Amplifier Measurement Conditions and Waveforms

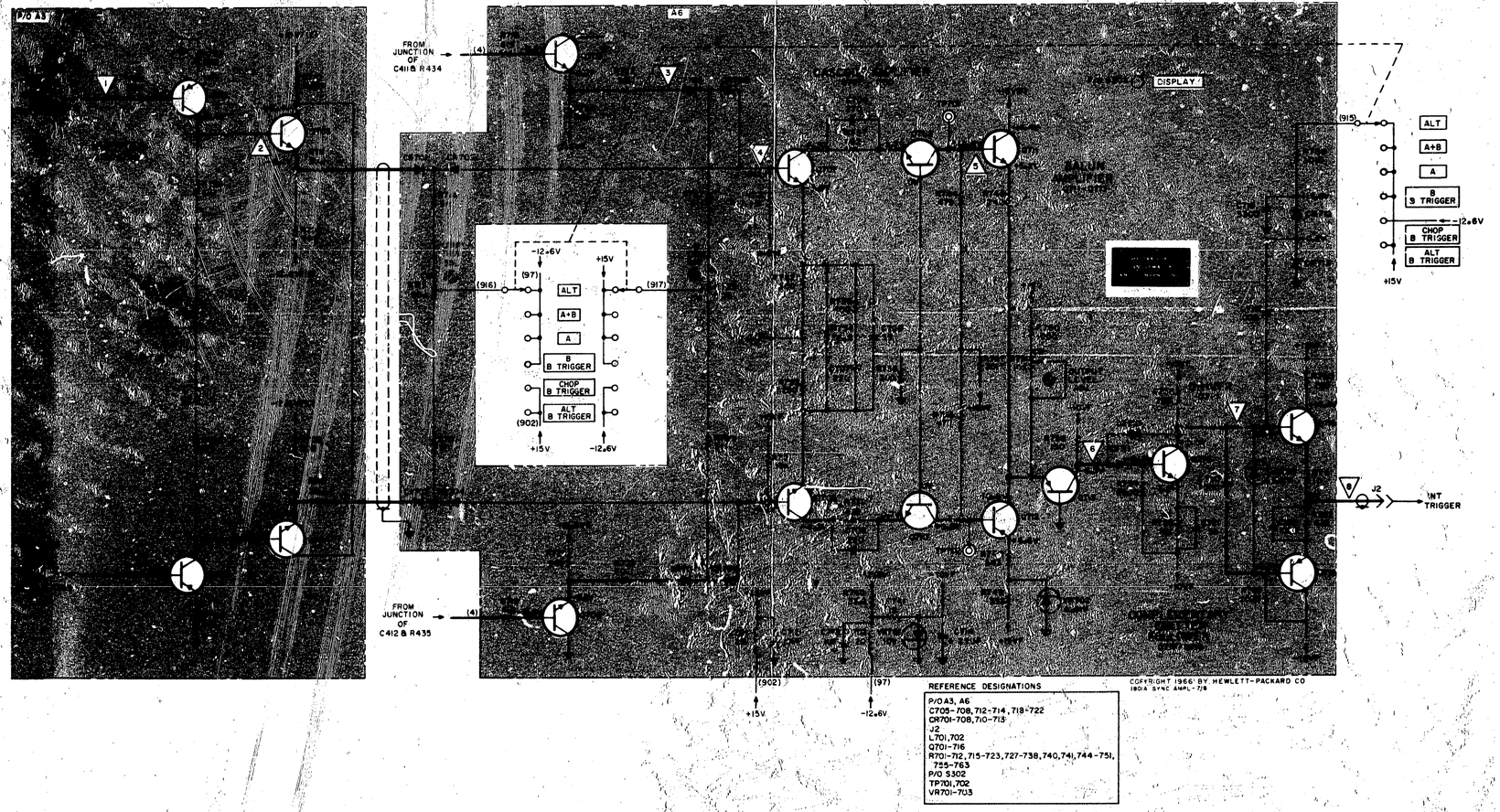


Figure 8-15. Sync Amplifier

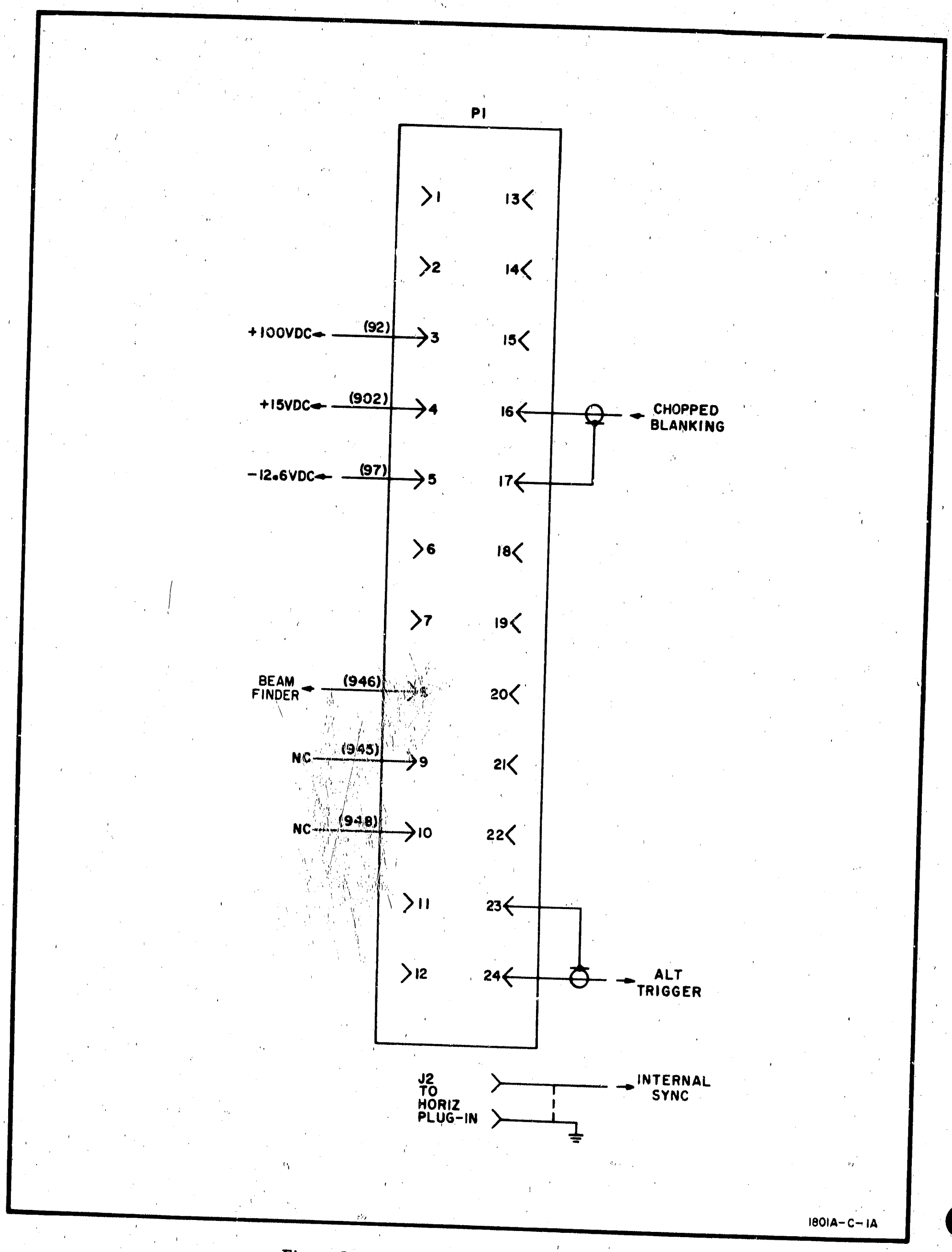


Figure 8-16. Plug and Jack Connections

MANUAL CHANGES

MANUAL CHANGES

MODEL 1801A

DUAL CHANNEL VERTICAL AMPLIFIER

Manual Serials Prefixed: 716-
Manual Printed: FEB 1968

Make all changes in this manual according to the Errata below. Also check the following table for your instrument serial prefix (3 digits) and/or serial number (8 digits) and make any listed change(s) in the manual:

Serial Prefix or Number	Make Manual Changes	Serial Prefix or Number	Make Manual Changes
716-	1		

ERRATA

Page 5-3, Paragraphs 5-27c, 5-28d, 5-29f,
Change to read: - - - - - for 0 (±50mv) vdc.
Page 5-4, Paragraph 5-33l,
Change to read: 1. R448, 2. C416, 3. C401.
Table 6-2,
C105, C109, C114, C205, C209, C214: Change description to 0.2-1.5 pF.
CR101, CR201: Change to hp Part No. 5080-0467; TQ2; CR: si (matched pair). (Preferred replacement).
CR102: Delete hp Part No.; change description to NSR (p/o CR101).
CR202: Delete hp Part No.; change description to NSR (p/o CR201).
Page 8-5, Figure 8-4, Schematic,
R121: Change value to 100 ohms.
Figure 8-13, A6;
CR702, CR703: Transpose component identification.

CHANGE 1

Table 6-2,
A1: Change hp Part No. to 01801-63403.
A2: Change hp Part No. to 01801-63404.
A3: Change hp Part No. to 01801-66516.
A4: Change hp Part No. to 01801-66513.
A5: Change hp Part No. to 01801-66515.
A6: Change hp Part No. to 01801-66514.
Add: A7, hp Part No. 01801-69504. A: output heat sink
C502, C503: Change to hp Part No. 0160-2259.
Add: C605, hp Part No. 0150-0050, C: fxd cer .001µf 600 vwdc.
△ C417: Change to hp Part No. 0160-2150; C: fxd mica 33 pF 5% 300 vdcw.
C712: Change to hp Part No. 0180-0374.
Q301, Q302, Q401, Q402: Change to hp Part No. 1853-0026. Q: si pnp.
Q307, Q308, Q407, Q408: Change to hp Part No. 1854-0019. Q: si npn.
Q601, Q602, Q606: Change to hp Part No. 5080-0466, Q: si pnp 2N3640.
△ R336, R337, R436, R437: Change to hp Part No. 0757-0435; R: fxd metflm 3920 ohms 1% 1/2w.
R346, R446: Change to hp Part No. 0757-0424, R: fxd metflm 1100 ohms 1% 1w.
△ R741: Change to hp Part No. 0757-0003; R: fxd metflm 26.1 ohms 1% 1/2w.
R747: Change to hp Part No. 0757-0413, R: fxd metflm 392 ohms 1% 1/8w.
MISCELLANEOUS:
Add: 01801-22301 TQ2 Heat equalizer.
01801-61606: Change to hp Part No. 01801-61607.
Page 8-7, Figure 8-6,
△ R336, R337, R436, R437: Change value to 3920 ohms.
R346, R446: Change value to 1100 ohms.
Page 8-11, Figure 8-12,
Add: C605, .001µf, connect between ground and junction of wire (978) with wiper terminal of S302.
Page 8-13, Figure 8-15,
△ R741: Change value to 26.1 ohms.
R747: Change value to 392 ohms.