Errata

Title & Document Type: **1702A Oscilloscope Operating and Service Manual**

Manual Part Number: **01702-90904**

Revision Date: **February 1974**

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HP References in this Manual

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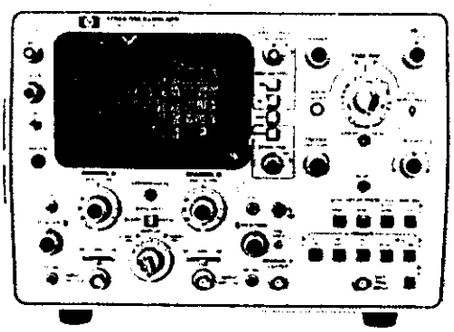
Agilent Technologies

OPERATING AND SERVICE MANUAL

1702A

OSCILLOSCOPE



HEWLETT hp PACKARD

OPERATING AND SERVICE MANUAL

MODEL 1702A
OSCILLOSCOPE

SERIALS PREFIXED: 1406A

Refer to Section VII for instruments with the following serial prefix numbers: **1150A, 1226A, 1230A, 1232A, 1325A, 1331A,** and **1342A.**

Refer to Section VII for instruments with the following standard options: **001** and **002.**

HEWLETT-PACKARD COMPANY/COLORADO SPRINGS DIVISION
1900 G.\RDEN OF THE GODS ROAD, COLORADO SPRINGS, COLORADO, U.S.A.

Manual Part Number 01702-90904.
Microfiche Part Number 01702-90804.

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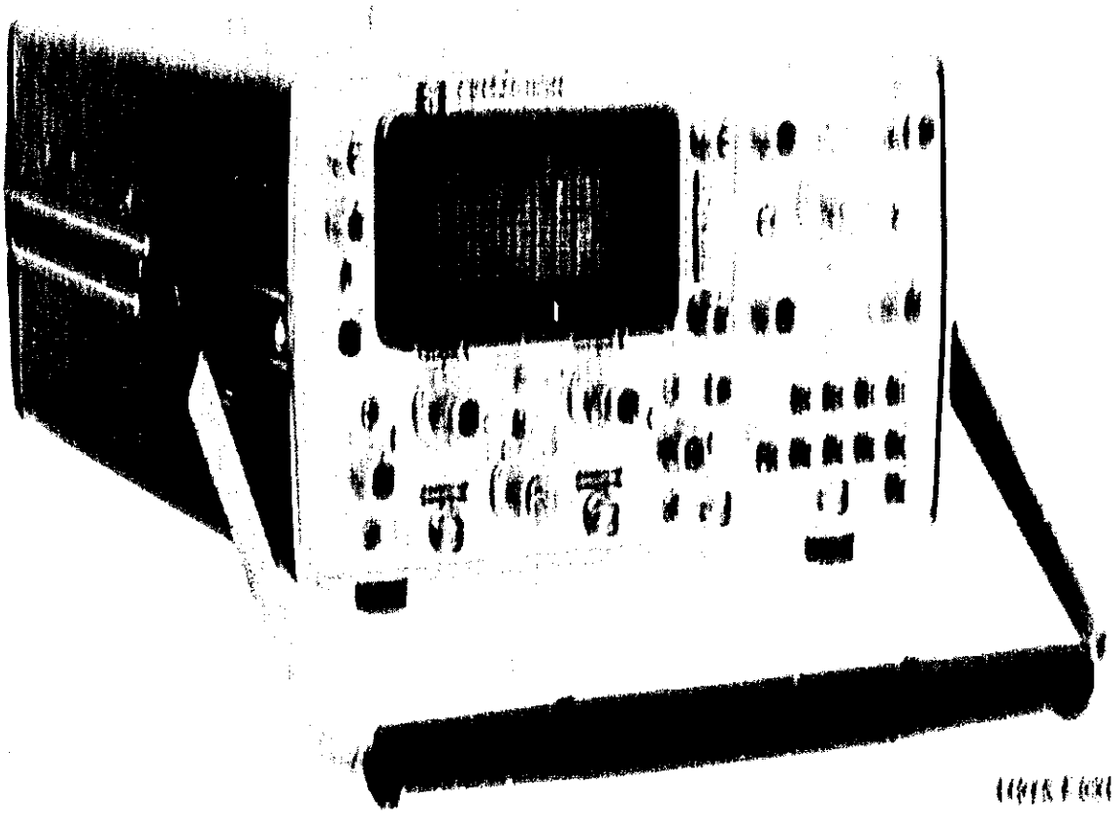

Figure 1-1. Model 1702A Oscilloscope

SECTION 1
GENERAL INFORMATION

1.1 INTRODUCTION

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1.2 ORGANIZATION

1.2.1 INTRODUCTION

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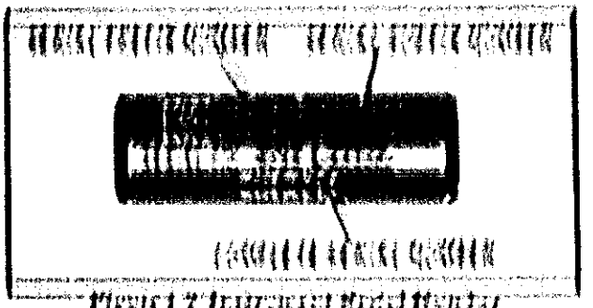

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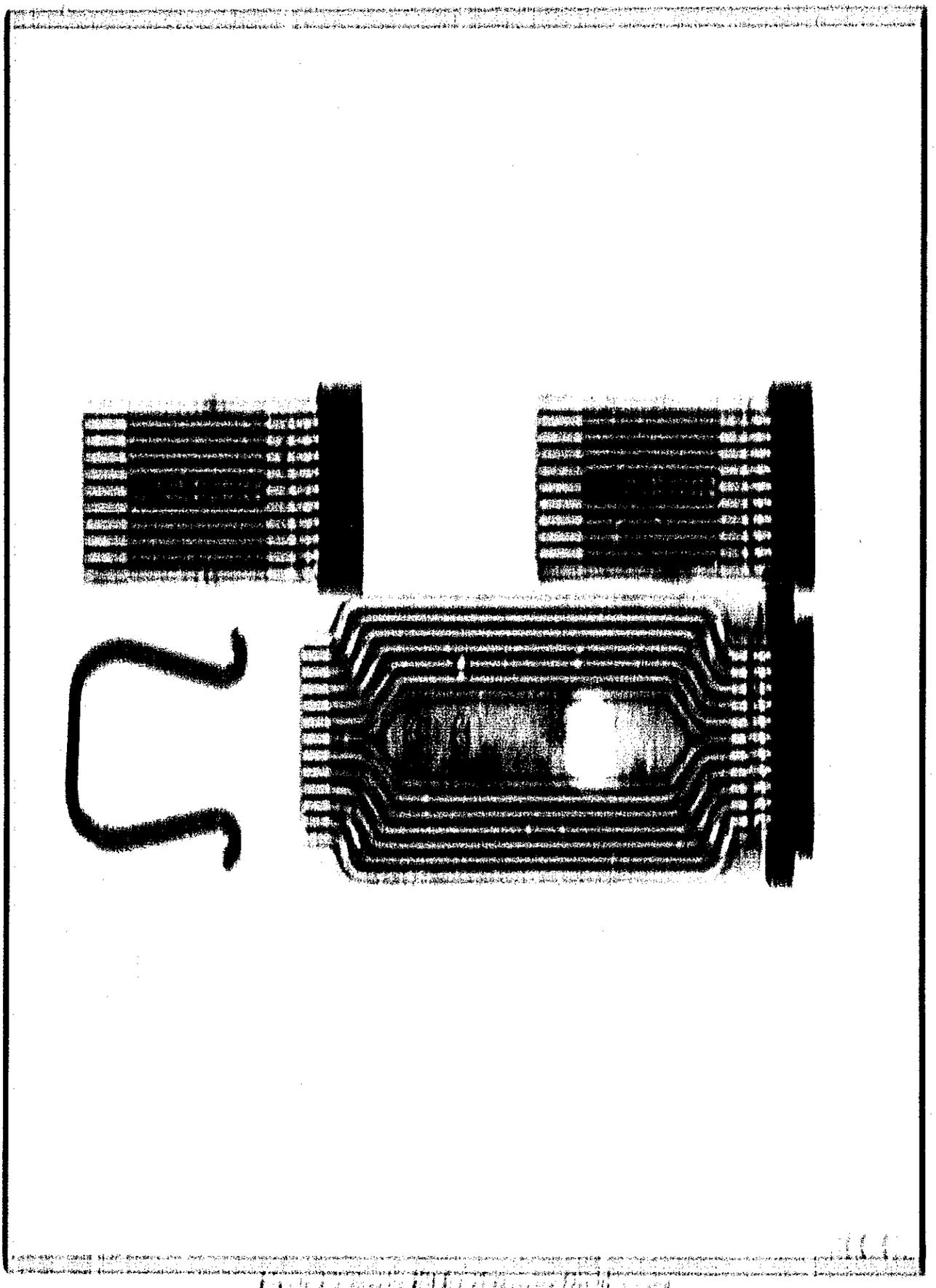


Table 1-2. Specifications (Cont'd)

Battery (optional)

OPERATING TIME: up to 4 hours in Model 1703A.

RECHARGE TIME: 14 hr minimum, with power switch off, if not operated after power indicator flashes.

LOW BATTERY INDICATOR: power light flashes to indicate that batteries are discharged and further operation may damage battery.

RECHARGING: batteries are recharging whenever POWER MODE switch is set to AC with power applied. With POWER switch off, full charge is applied. With POWER switch ON, trickle charge is applied.

WEIGHT

Without Panel Cover: net, 24 lb (11 kg); shipping, 35 lb (15.9 kg).

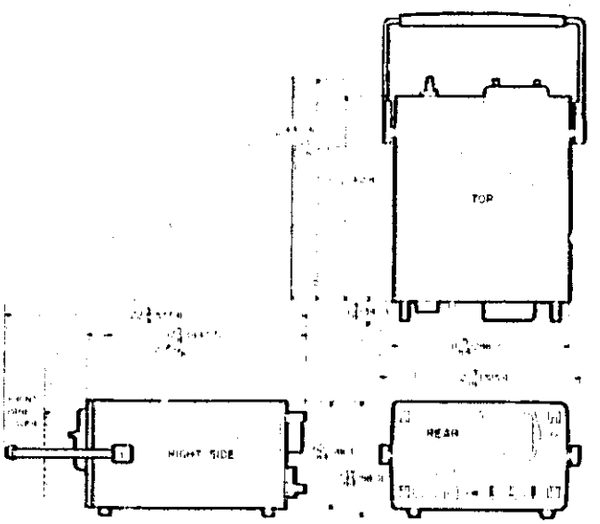
With Panel Cover and Accessories: net, 27 lb (12.3 kg); shipping, 38 lb (17.2 kg).

With Panel Cover, Accessories, and Battery Pack: net, 35 lb (16 kg); shipping, 46 lb (20.9 kg).

ENVIRONMENT (Oscilloscope operates within specifications over following ranges):

temperature 0°C to +55°C; humidity, to 95% relative humidity to 40°C; altitude, to 15,000 ft; vibration, vibrated in three planes for 15 min each with 0.010-inch excursion, 10 to 55 Hz.

DIMENSIONS: refer to outline drawing.



ACCESSORIES FURNISHED: blue contrast filter, Model 10115A; front panel storage cover, Model 10101B; two Model 10006B probes, one dc power plug HP Part No. 1251-2614 for assembling dc power cord; one ac power cord with right angle plug.

SECTION II

INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains instructions for performing an initial inspection of the Model 1702A. Installation procedures and precautions are presented in step-by-step order. The procedures for making a claim for warranty repairs and for repacking the instrument for shipment are also described in this section.

2-3. INITIAL INSPECTION.

2-4. The instrument was inspected mechanically and electrically before shipment. Upon receipt, inspect it for damage that may have occurred in transit. Check for broken knobs, bent or broken connectors, and dents or scratches. If damage is found, refer to the claims paragraph in this section. Retain the packing material for possible future use.

2-5. Check electrical performance of the instrument immediately after receipt. Refer to Section V for the performance check procedure. The performance check will determine whether or not the instrument is operating within the specifications listed in table 1-1. Initial performance and accuracy of the instrument are certified as stated in the front of this manual. If the instrument does not operate as specified, refer to the claims paragraph in this section.

WARNING

Voltages are present inside the instrument when the POWER switch is off and ac power cord connected.

2-6. PREPARATION FOR USE.

2-7. POWER REQUIREMENTS.

2-8. The Model 1702A can operate either from an ac or dc power source. For ac operation, the Model 1702A requires 115- or 230-volt ±20%, single phase, 48- to 440-Hz source that can deliver 50 volt-amperes.

2-9. A slide switch inside the rear panel module (figure 2-1), on the rear panel, determines 115- or 230-volt operation. To check or change the position of this slide switch, proceed as follows:

a. Turn instrument off and remove power cord from rear panel.

b. Move plastic cover to left (figure 2-1).

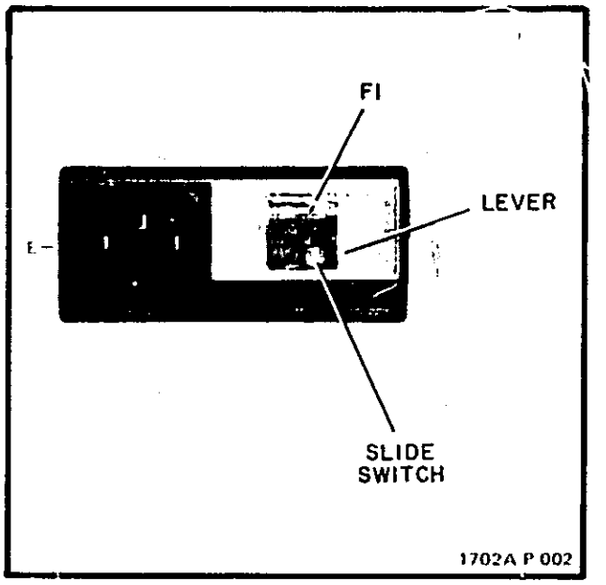


Figure 2-1. Rear Panel Power Module

c. Pull out lever under fuse. This removes fuse (0.5AT for 115V operation) from instrument.

d. Check to see that slide switch (figure 2-1) is to right for 115V operation.

e. For 230V operation, move slide switch to left and install 0.25 AT fuse.

2-10. For dc operation, the Model 1702A requires from 11.5- to 36-volts, 25 watts maximum. The instrument can also be operated from a battery pack. Depending on the power mode of operation, the POWER MODE switch (on rear panel) should be set to one of three positions: DC LINE, INTERNAL BATTERY, or AC LINE to change POWER MODE switch proceed as follows:

CAUTION

Do not change POWER MODE switch setting with instrument on or AC or DC voltage applied to te instrument.

a. Turn instrument off.

b. Disconnect AC or DC power cord from rear panel.

c. Set POWER switch (on rear panel) to desired position.

d. Connect AC or DC power cord.

2-11. THREE-CONDUCTOR AC POWER CABLE.

2-12. For the protection of operating personnel, Hewlett-Packard Company recommends that the instrument panel and cabinet be grounded. This instrument is equipped with a three-conductor, ac power cable that, when connected to an appropriate receptacle, grounds the instrument through the off-set pin. The power jack and mating plug of the power cord meet International Electro-technical Commission (IEC) safety standards. To preserve this protection feature when operating from a two-contact outlet, use a three-conductor to two-conductor adapter, and connect the adapter wire to ground at the power outlet.

2-13. DC PLUG.

2-14. A dc plug is provided for operating from a dc line. The cable used for the dc power cord must be able to carry 2.5A of current with a voltage loss of less than 1V.

2-15. BATTERY INSTALLATION.

2-16. To install the battery pack in Model 1702A, proceed as follows:

CAUTION

Read operating note on battery pack before installation.

a. Turn instrument off and remove power cord from rear of instrument.

b. Set POWER MODE switch to INTERNAL BATTERY position.

c. Turn instrument on its top and loosen fasteners holding bottom cover.

d. Remove bottom cover.

e. Place battery pack in instrument as shown in figure 2-2.

f. Tighten battery screws in place (figure 2-2).

g. Connect P1 to battery J1 as shown in figure 2-2.

h. Replace bottom cover and tighten fasteners.

i. Turn instrument right side up.

j. Turn instrument on and observe power light. If power light is on, resume normal operation.

CAUTION

If power light is flashing, battery is discharged. Damage to the battery may result if operated in this condition. Refer to Section III for battery recharging operation.

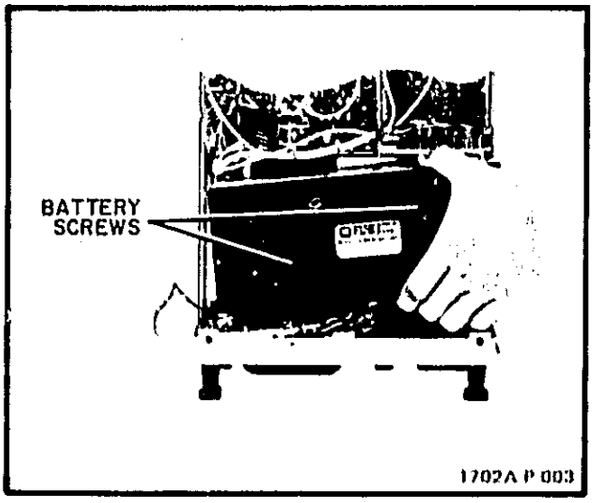


Figure 2-2. Battery Installation

2-17. CLAIMS.

2-18. The warranty statement applicable to this instrument is printed in the front of this manual. Refer to the rear of this manual for the CRT warranty statement. If physical damage is found or if operation is not as specified when the instrument is received, notify the carrier and the nearest Hewlett-Packard Sales/Service Office immediately (refer to the list in back of this manual for addresses). The HP Sales/Service Office will arrange for repair or replacement without waiting for settlement of the claim with the carrier.

2-19. REPACKING FOR SHIPMENT.

2-20. If the Model 1702A is to be shipped to a Hewlett-Packard Sales/Service Office for service or repair, attach a tag showing owner (with address), complete instrument serial number, and a description of the service required.

2-21. Use the original shipping carton and packing material. If the original packing material is not available, the HP Sales/Service Office will provide information and recommendations on materials to be used. Materials used for shipping an instrument normally include the following:

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 non-abrasive material such as polyurethane or cushioned paper such as Kimpak around 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 for securing outside of carton.

Table 2-1. Shipping Carton Test Strength

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

2-22. CRT REPACKING FOR SHIPMENT.

2-23. When the CRT is shipped to a Hewlett-Packard Sales/Service Office, be sure to follow the procedure listed below.

CAUTION

When packing the CRT, never place a storage tube face down. This will place charged material on the storage mesh.

a. Place cardboard on sides and bottom of shipping carton as shown in figure 2-3.

b. Place label on top of carton saying: THIS SIDE UP.

c. If packing materials for shipping storage tubes are not available, contact Hewlett-Packard Company, Colorado Springs Division, 1900 Garden of the Gods Road, Colorado Springs, Colorado U.S.A.

d. Follow CRT shipping instructions as outlined on Cathode-ray Tube Warranty in front of this manual.

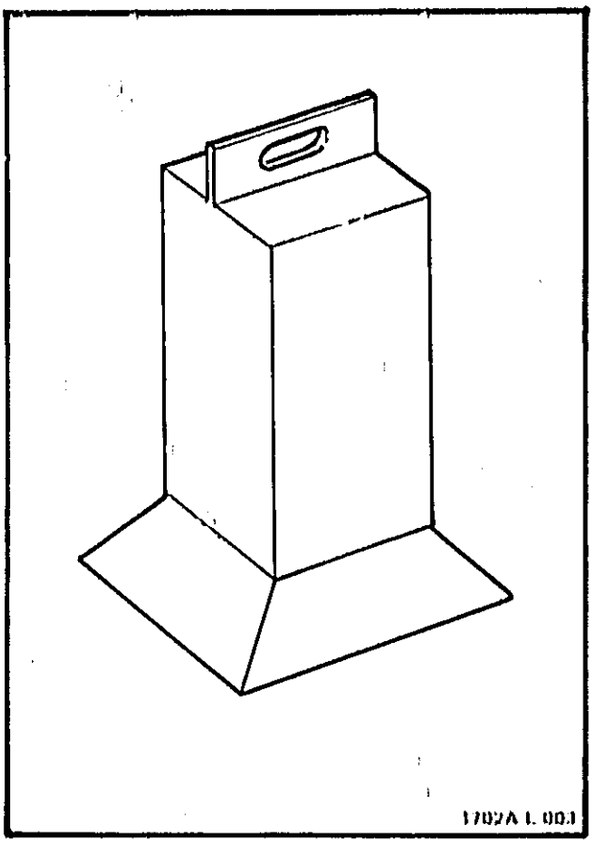
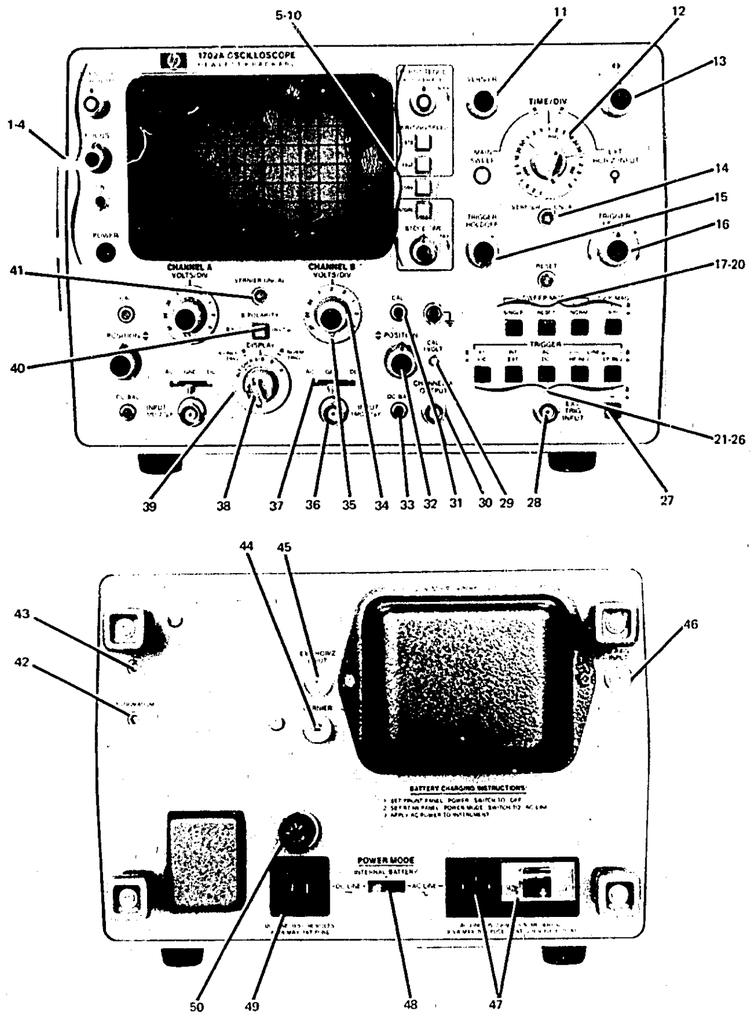


Figure 2-3. Storage Tube, Shipping Container



1. INTENSITY. Controls brightness of display.
2. PUSHBEAM. Returns display to viewing area.
3. FOCUS. Controls sharpness of display.
4. POWER-ON. Toggle switch with indicator light for turning oscilloscope off and on. Light flashes when optional battery is discharged.
5. PERSISTENCE. Controls endurance time of displayed signal.
6. PUSHERASE. Removes stored or written displays.
7. WRITING SPEED.
   a. STD. Operates CRT at normal writing rate with variable persistence.
   b. FAST. Operates CRT at maximum writing rate with variable persistence.
8. CONV. Selects operation as standard oscilloscope. Note intensity level (paragraph 3-25).
9. STORE. Retains displayed signal at reduced intensity.
10. STORE TIME. Determines length of time that signal can be stored.
11. VERNIER. Provides continuous control of sweep time between calibrated positions of TIME/DIV control.
12. TIME/DIV. Controls sweep time.
13. HORIZONTAL POSITION. Controls course and fine horizontal position of display.
14. VERNIER UNCAL. Lights when VERNIER is not in CAL position.
15. TRIGGER HOLDOFF (NORM). Provides continuous control of time between sweeps. NORM holdoff time is minimum.
16. TRIGGER LEVEL. Selects amplitude point on trigger signal that starts sweep.
17. SINGLE. Selects single sweep operation.
18. RESET. Resets sweep in SINGLE sweep
19. AUTO/NORM.
   a. AUTO. Automatic sweep in absence of trigger signal or triggered sweep by applying trigger signal above 40 Hz.
   b. NORM. Sweep is triggered only by applying trigger signal.
20. SWP MAG. In X10 position, sweep is magnified 10 times.
21. +1/+10. Attenuates external trigger signals by factor of 10; increasing external trigger range to ±12V.
22. INT/EXT. Selects trigger internal or external sweep triggering.
23. AC/DC. Selects trigger signal coupling.
24. HF REJ. Attenuates trigger signals above 30 kHz.
25. LF REJ. Attenuates trigger signals below 15 kHz.
26. LINE. Instrument triggers internally on line frequency.
27. slope. Selects slope of trigger that starts sweep.
28. EXT TRIG INPUT. External trigger input.
29. CAL 1 VOLT. Calibrator 1-kHz, 1-volt ± 1% signal.
30. CHANNEL A OUTPUT. Channel A output jack.
31. channel B CAL. Adjust to calibrate amplifier with CHANNEL B VOLTS/DIV settings.
32. channel B POSITION. Controls vertical position of display.
33. channel B DC BAL. Adjust to minimize vertical shift of trace when channel B vernier is rotated.
34. CHANNEL B VOLTS/DIV. Selects vertical deflection factor necessary for calibrated measurements.
35. channel B vernier (CAL). Provides continuous adjustment of VOLTS/DIV between calibrated positions of CHANNEL B VOLTS/DIV control.
36. channel B INPUT. BNC input connector.
37. channel B coupling (AC-GND-DC). Selects capacitive (AC) or direct (DC) coupling of input signal, or grounds input amplifier stage while disconnecting input.
38. trig. Selects internal triggering mode.
   a. A ONLY TRIG. Instrument triggers on signal applied to channel A.
   b. NORM TRIG. Instrument triggers on displayed signal except in DISPLAY ALT mode. In DISPLAY ALT mode, instrument should trigger on composite sync and LF REJ trigger coupling should be used to ensure proper triggering.
39. DISPLAY. Selects type of display; either single channel, dual channel, alternate or chop mode.
40. B POLARITY. Selects polarity of channel B display (NORM/INVT).
41. VERNIER UNCAL. Lights when either channel A or channel B vernier is not in CAL position.
42. ASTIGMATISM. Adjusts roundness of writing spot.
43. TRACE ALIGN. Adjust to align trace with horizontal graticule line.
44. VERNIER. Permits 10:1 horizontal gain ratio.
45. EXT HORIZ INPUT. Input to external horizontal amplifier.
46. Z-AXIS INPUT. Z-axis input connector.
47. AC LINE. Power input from ac line. Power module contains ac line fuse (0.50 AT for 115V operation; 0.25 AT for 230V operation) and line selector switch.
48. POWER MODE. Selects DC LINE, INTERNAL BATTERY or AC LINE operation.
49. DC LINE. Power input for dc line operation.
50. fuse. 2-amp, slow-blow fuse in circuit for ac and external battery modes of operation. Use 3-amp, slow-blow fuse for dc line operation.

Figure 3-1. Controls and Connectors

SECTION III
OPERATION

3-1. INTRODUCTION.

3-2. This section provides general operating instructions and applications information for the Model 1702A. Front and rear panel controls and connectors are identified and briefly described in figure 3-1. General operating instructions are provided in figures 3-3 through 3-7 and operational adjustments are detailed in figure 3-8.

3-3. SPECIAL OPERATING CONSIDERATIONS.

3-4. Prior to operating the Model 1702A, the operator must have a thorough understanding of instrument operation and control functions. This section should be read in its entirety before attempting to operate the instrument.

CAUTION

This instrument contains a new burn-resistant CRT. Although CRT burns are greatly reduced, high intensity settings while in the conventional mode will burn the CRT. Observe all operating cautions.

3-5. To apply power to Model 1702A perform initial turn-on procedure paragraph 3-85.

3-6. CONTROLS AND CONNECTORS.

3-7. The locations of operating controls and connectors are shown in figure 3-1 together with a brief explanation of their functions. Additional information regarding some of these controls and connectors is provided below.

3-8. FOCUS.

3-9. This control provides uniform focus of the trace over the entire CRT screen. To adjust:

a. Set WRITING SPEED to STD.

b. Center low-intensity spot on CRT screen.

c. Adjust FOCUS control for small round, sharply focused spot.

3-10. PUSHBEAM.

3-11. Pressing this pushbutton reduces amplifier gain enough to return the beam to the viewing area. This enables the operator to locate the beam and determine the action necessary to center a display (examples: reduce input signal amplitude, change coupling, adjust deflection factor, trigger level, dc balance or position controls). When centered properly, the beam remains on the CRT when the pushbutton is released.

Note

The beam find function is dependent on the setting of the intensity. If no beam is visible when the PUSHBEAM control is engaged increase the INTENSITY setting until a beam is observed.

3-12. TRACE ALIGN.

3-13. The TRACE ALIGN adjustment compensates for external magnetic fields that may affect alignment of the horizontal trace with the graticule. The alignment should be checked when the instrument is moved to a new location and adjustment made whenever necessary.

3-14. CAL 1 VOLT.

3-15. The 1-volt, 1-kHz calibrator square wave output can be used for vertical sensitivity calibration and for divider probe compensation. The amplitude accuracy is ±1% and frequency accuracy is ±10%.

3-16. COUPLING.

3-17. This lever switch selects either capacitive (AC) or direct (DC) coupling of the input signal to the vertical amplifiers, or it grounds (GND) the vertical amplifier input stage while disconnecting the input signal. The switch should be set to DC when viewing long duration pulses or dc levels of waveforms. AC should be selected when viewing ac waveforms having large dc levels. GND position is used to disconnect the signal source from the amplifier input and at the same time ground the amplifier input. The GND position can be used to establish a reference.

3-18. DISPLAY.

3-19. This control selects the type of vertical display. Input signals may be displayed either singly or simultaneously as explained below.

3-20. Position A displays channel A input signal.

3-21. Position B displays channel B input signal.

3-22. Position A + B (A + B with B POLARITY INVT engaged) displays algebraic sum of channel A and channel B input signals.

3-23. Position CHOP presents separate display of each input. Both inputs are displayed during same sweep by switching between each channel at 200 kHz rate. This mode should be used to display low frequency signals.

3-24. Position ALT displays each channel on alternate sweeps. This mode should be used to display high frequency signals.

3-25. PERSISTENCE AND INTENSITY.

3-26. These controls determine the viewing time of a signal being displayed. The INTENSITY control sets the trace brightness as it is written. The PERSISTENCE control is used to establish the desired duration of signal viewing without rewriting. It accomplishes this by varying the rate that the displayed signal is erased.

3-27. FAST.

3-28. Operation in this mode provides a more rapid buildup display of fast, single sweep signals. Since the background illumination also increases more rapidly, the CRT contrast level and storage time are reduced.

3-29. CONV.

3-30. Selection of this operating mode disables the variable persistence and storage features of the instrument. It will now function as a conventional, general purpose oscilloscope. The PERSISTENCE control does not function in this mode. Always adjust the INTENSITY in std mode, with minimum persistence, for no blooming, then switch to conv. Do not increase intensity beyond this level while in the conv mode.

3-31. STORE.

3-32. In order to retain whatever is visible on the CRT, engage the STORE pushbutton. The signal will be stored at reduced intensity resulting in a storage time greater than 1 hr. The INTENSITY, PERSISTENCE, FOCUS, PUSHERASE, and HORIZONTAL POSITION controls do not affect the presentation in the store mode.

3-33. In some applications, it may be desired to show overlapping traces. This is possible through proper manipulation of the PERSISTENCE and INTENSITY controls. Simply obtain the desired multiple trace display in the std mode, then engage the STORE pushbutton.

3-34. STORE TIME.

3-35. To observe a permanent stored display, turn the STORE TIME control clockwise until the display is observed. The STORE TIME control will increase the brightness level selected during the std mode. Again, the INTENSITY, PERSISTENCE, FOCUS, PUSHERASE, and HORIZONTAL POSITION controls do not affect the display.

3-36. PUSHERASE.

3-37. This control removes stored or written displays.

3-38. TRIG.

3-39. This control selects the signal to be used as the internal sync signal. In A ONLY TRIG position, the channel A signal is used as the internal sync signal. In B ONLY TRIG position, the signal displayed on the CRT is used as the internal sync signal, except in alt operation. In the alt mode of operation, the instrument triggers on the composite sync signals to ensure proper triggering. LF REJ trigger coupling must be used.

3-40. B POLARITY.

3-41. This controls inverts the channel B display (all changes) and can be used to present an A - B display. To operate in the A - B mode, proceed as follows:

a. Set DISPLAY to A + B mode.

b. Set B POLARITY to INVT.

c. Display observed is A - B.

3-42. TIME/DIV.

3-43. The TIME/DIV switch determines the amount of time to sweep horizontally one graticule division. The sweep speeds are selectable in 24 ranges from 0.1 usec/div to 2 sec/div. Also, by switching SWP MAG to X10, a display can be expanded up to 10 times, increasing the fastest sweep to 10 ns/div. Connection to the TIME/DIV switch is the EXT HORIZ INPUT control that applies the external signal to the horizontal amplifier.

3-44. VERNIER.

3-45. Sweep speed is calibrated to the TIME/DIV control when the VERNIER control is set fully cw to

(INT) determines whether the VERTICAL control is turned on. The VERTICAL (INT) switch also holds and resets sweep circuits. The VERTICAL control extends the internal sweep beyond the

3-46. TRIGGER LEVEL:

3-47. The control selects the point on the sync signal that starts the sweep. Trigger is possible only when the sync signal is between +5 V and -5 V. In the INT position, the triggering point is adjustable from +5 V to -5 V along the sync signal.

3-48. TRIGGER HOLDOFF:

3-49. This adjustment is a dual purpose control. It is a two-turn potentiometer. When the control is rotated out of detent position, due to CW position of the control, it acts as a high frequency stability control. This prevents double triggering on high frequency waveforms. As the control is rotated further out of detent position, it functions as a trigger holdoff and allows the instrument to synchronize on complex waveforms.

3-50. SWEEP MODE:

3-51. This group of controls selects the type of sweep triggering. The sweep free runs in auto, giving a bright baseline in the absence of a sync signal. However, if a sync signal of 50 Hz or greater is applied, the sync signal overrides free run operation and triggers the sweep. Due to the presence of a baseline, the auto sweep mode can be used for most applications.

3-52. The NORM mode of the sync signal is greater or is less than 50 Hz. The sync signal is always coupled in auto mode to provide a sweep. When the NORM/AUTO pushbutton is engaged, the sweep is normal or auto sync. To sweep again, press the NORM/AUTO pushbutton and release it. This sets the sweep control. This feature is quite useful for viewing or photographing single transient waveforms.

3-53. TRIGGER:

3-54. The trigger angle is selected by this group of controls. In the INT position, sweep is synchronized to the vertical deflection signal. When EXT is selected, the sweep is triggered by sync signals applied to the EXT TRIG INPUT connector.

3-55. The trigger coupling controls determine the type of sync coupling. The coupling is normally used for sync signals from dc to less than 50 Hz. Capacitive coupling (AC) blocks the dc component of a sync signal and passes only the ac component. AC coupling does, however, attenuate signals below 50 Hz. The HF REJ control attenuates signals below approximately 50 kHz and is used for instances to prevent noise or other high frequency signals from triggering the sweep. The HF REJ control attenuates signals above approximately 50 kHz and can be used to prevent high frequency noise from triggering the sweep.

3-56. SLOPE:

3-57. This control determines whether the sweep triggers on the positive going or negative going portion of the sync signal.

3-58. MAGNETIC INTERFERENCE:

3-59. The CRT is provided with a mu-metal shield for protection against magnetic fields. Due to the sensitivity of the CRT, it is possible that strong magnetic fields from nearby motors or line transformers may still result in undesirable beam deflection. In this event, proceed to relocate the instrument with respect to the interfering device.

3-60. OPERATING CONSIDERATIONS:

3-61. DEFINITIONS

3-62. Several words and phrases, the definitions of which may vary slightly from common usage, are used to describe the operation of the Model 1703A. The definitions of these words and phrases which apply to the Model 1703A are as follows:

3-63. *Persistence.* The length of time a written dot or line remains visible on the CRT screen.

3-64. *Write.* To translate an input signal into a visible display on the CRT screen.

3-65. *Store.* To retain, or produce intermittently, a display that has been on the CRT screen.

3-66. *Clear.* Operation of the oscilloscope in the conventional nonstorage mode.

3-67. *Erase.* To remove all displays and blooms that have been stored or written with persistence on the CRT screen.

3-68. *Intensity.* The brightness of a display as it is written on the CRT screen.

3-69. *Bloom.* A visibly unpleasant defocusing of a display written on the CRT screen.

3-70. *Full Display.* Display obtained by slow blooming. See figure 3-5A.

3-71. *Unexposed Illumination.* A green cloud of illumination visible on the CRT screen. See figure 3-5B.

3-17 OPERATING TIPS

3-18. The following procedures are provided to aid the operator in becoming familiar with the Model 1705A controls and their functions and to acquire a quick but adequate display.

3-19. Normal Presentation. The following procedure is the normal presentation mode. Proceed as follows:

a. Set WAVEFORM SELECTOR to CH I.

b. Turn CH I VOLTS/DIV control fully CW.

c. Adjust CH I POSITION control for proper display.

d. Engage CH I AC-GND-DC pushbutton to the out (normal) position while in CH I AC mode.

e. If sweep speed is changed, always check for proper intensity before making any measurements.

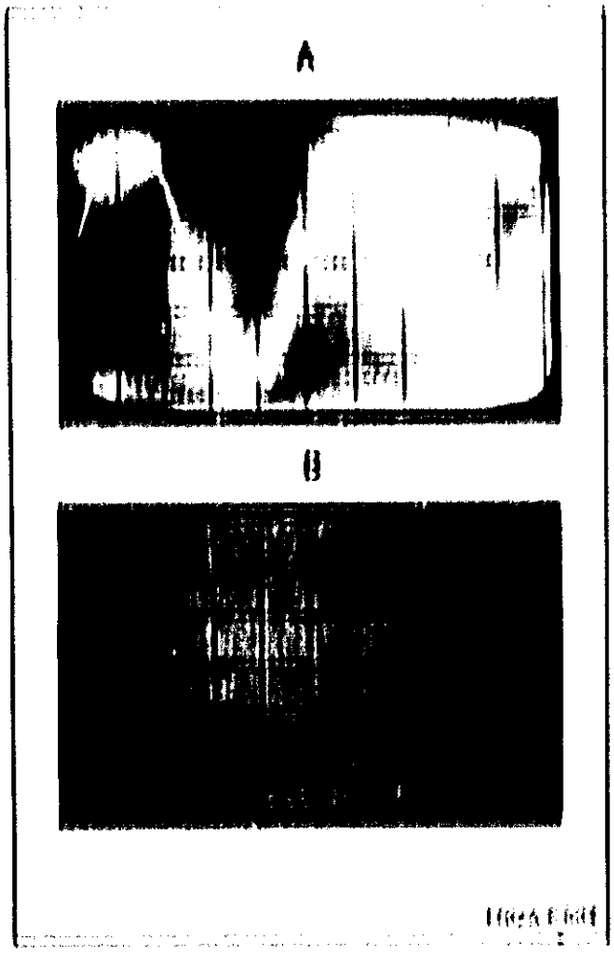


Figure 3-9. Fast Sweeps and Background Illumination

3-20. Triggering. The following procedure will provide operating familiarity with the Model 1705A controls and their functions and techniques for obtaining a triggered display.

3-21. Normal Presentation. The following procedure is the normal presentation mode. Proceed as follows:

a. Set WAVEFORM SELECTOR to CH I.

b. Turn CH I VOLTS/DIV control fully CW.

c. Adjust CH I POSITION control for proper display.

d. Engage CH I AC-GND-DC pushbutton to the out (normal) position while in CH I AC mode.

e. If sweep speed is changed, always check for proper intensity before making any measurements.

CAUTION

When the Model 1705A is put in sweep mode with the beam held stationary for a long period of time, the phosphor in the CRT at the display can be burned permanently. To prevent this, the beam automatically blanks when the sweep is stopped. If the beam is to be stationary for prolonged periods of time, be sure to set the display intensity low enough to prevent damage to the CRT.

3-22. Variable Persistence Operation. To operate in the variable persistence mode, proceed as follows:

a. Set WAVEFORM SELECTOR to CH I.

b. Set minimum PERSISTENCE and maximum PERSISTENCE for comfortable viewing.

c. Engage AC-GND-DC pushbutton.

d. Adjust PERSISTENCE and PERSISTENCE SELECTOR controls for desired display.

3-23. Split Screen Operation. To operate in the split screen mode, proceed as follows:

a. Set WAVEFORM SELECTOR to CH I.

b. Adjust POSITION and PERSISTENCE SELECTOR controls for desired display.

c. Engage AC-GND-DC pushbutton.

d. Adjust SPLIT SCREEN CNTRL control to set time the plot will be stored.

3-24. If more than one display is to be stored, proceed as follows:

a. Set WAVEFORM SELECTOR to CH I.

b. Set POSITION control fully CW.

c. Set PERSISTENCE control as required.

d. Allow first display to be written on CRT.

e. Set PERSISTENCE control fully CW.

f. Connect second signal to be stored.

g. Reverse the position of second display to that to be superimposed on first.

h. Adjust PERSISTENCE control until second signal appears on CRT.

i. Engage AC-GND-DC pushbutton.

[illegible]

a. [illegible]

b. [illegible]

[illegible]

a. [illegible]

b. [illegible]

c. [illegible]

d. [illegible]

e. [illegible]

f. [illegible]

g. [illegible]

h. [illegible]

i. [illegible]

j. [illegible]

k. [illegible]

Note

[illegible]

l. [illegible]

Note

[illegible]

[illegible]

a. [illegible]

b. [illegible]

c. [illegible]

d. [illegible]

e. [illegible]

f. [illegible]

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3-82. BATTERY RECHARGE OPERATION.

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a. [illegible]

[illegible]

[illegible]

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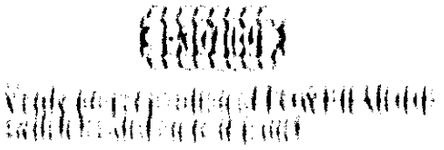

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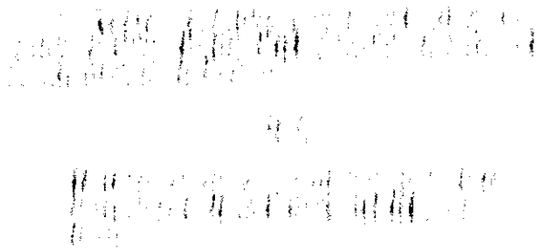

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[illegible] OPERATING PROCEDURES

[illegible]

[illegible] FUNCTIONAL CHECK

[illegible]

[illegible] OPERATING INFORMATION

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[illegible]

[illegible]

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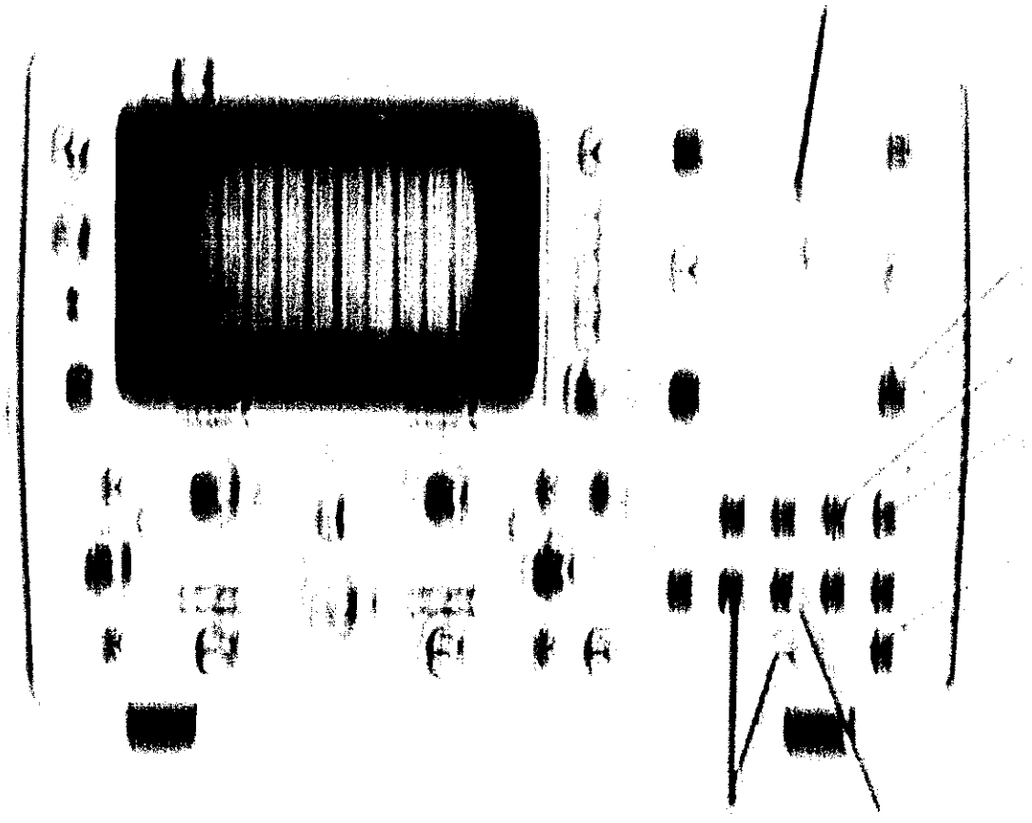
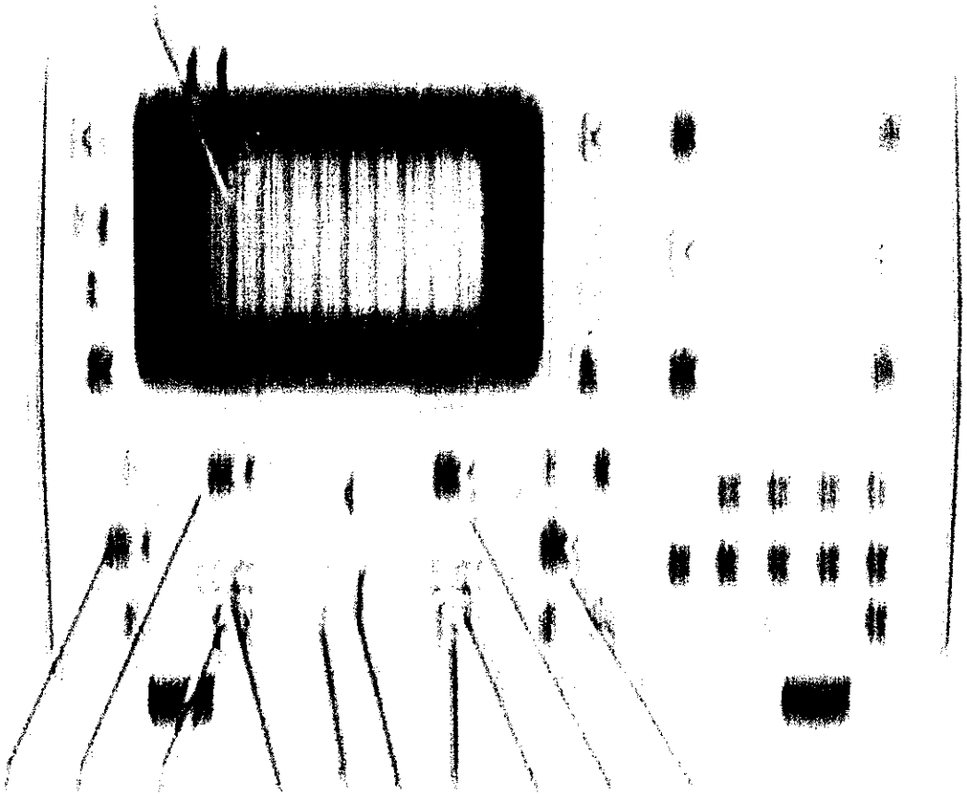
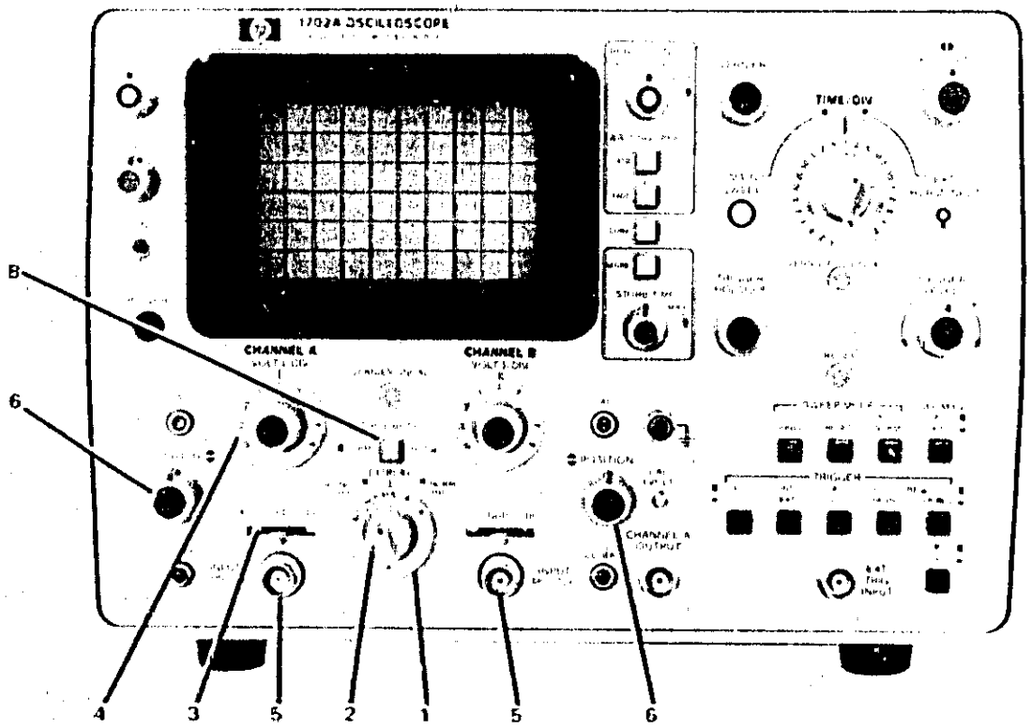
[illegible]







CAUTION

Do not allow trace to bloom. Do not allow unattended instrument to operate in CONV for extended periods of time.

A + B OPERATION

1. Set DISPLAY to A + B.
2. Set trig to NORM TRIG or A ONLY TRIG as desired.
3. Set channel A coupling to AC or DC.
4. Set CHANNEL A VOLTS/DIV to desired range.
5. Connect desired vertical signals to channel A and channel B INPUT connectors.
6. Adjust channel A POSITION and channel B POSITION controls for desired display on screen.

Note

In the A + B mode, only one trace is observed. This trace is the sum of A + B and either channel POSITION control will vary the vertical position display.

A — B OPERATION

A. Repeat steps 1 and 2 of A + B operation.

B. Set B POLARITY pushbutton to INVT.

C. Repeat steps 3 through 6 of A + B operation.

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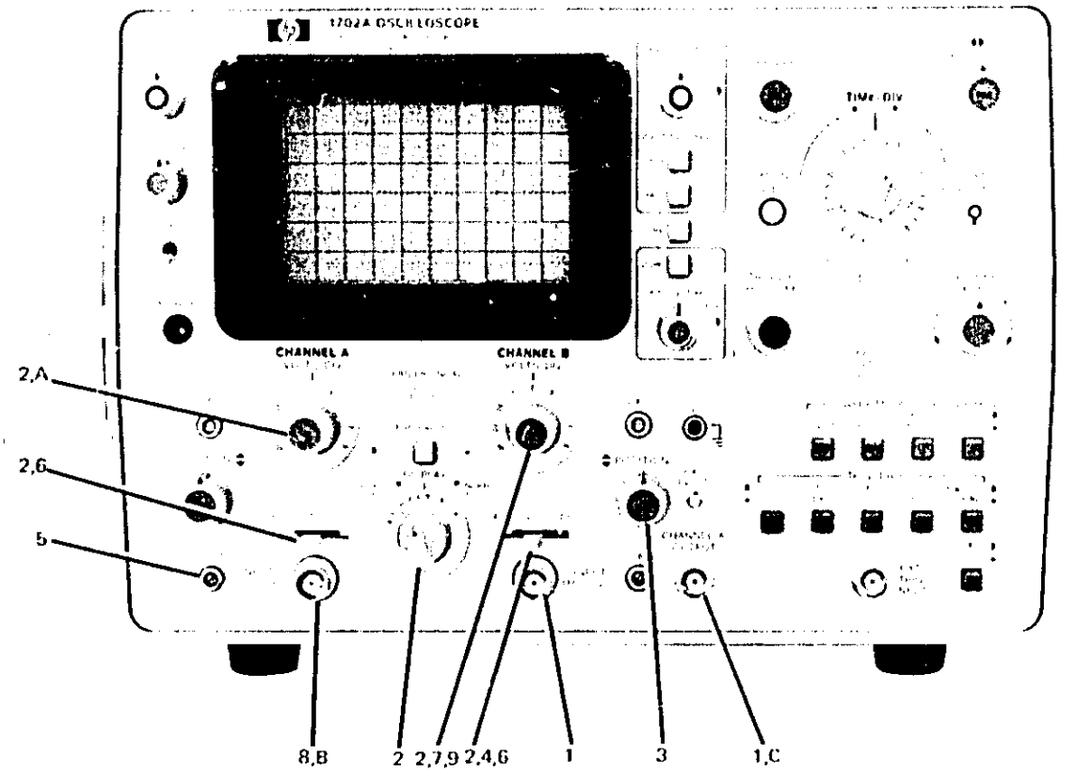
Figure 3-6. A + B and A — B Operation



CASCADED OPERATION, CHANNEL A OUTPUT

1. Connect CHANNEL A OUTPUT to channel B INPUT with BNC cable.
2. Set vertical controls as follows:

DISPLAY	B
channel A VOLTS/DIV	0.1
channel B VOLTS/DIV	.01
channel A coupling	GND
channel B coupling	GND

3. Center trace with channel B POSITION control.
4. Set channel B coupling DC.
5. Center trace with channel A DC BAL control.
6. Set channel A and channel B coupling to desired position.
7. Set channel B VOLTS/DIV to desired range.
8. Connect signal to channel A INPUT.
9. Sensitivity of vertical amplifier (as read on channel B VOLTS/DIV switch) will be increased by a factor of 10.

INDEPENDENT OPERATION, CHANNEL A OUTPUT

A. Set channel A VOLTS/DIV to desired range.

B. Connect desired signal to channel A INPUT.

C. Take amplified signal from CHANNEL A OUTPUT.

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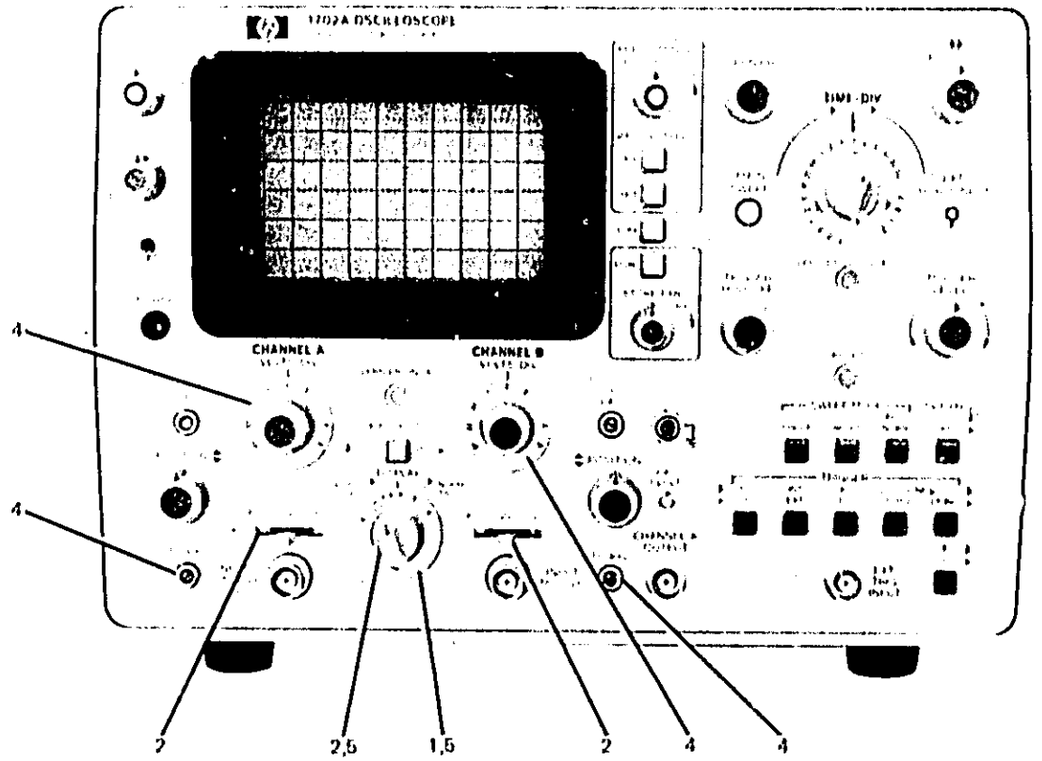
Figure 3-7. Channel A Cascaded and Independent Operation



CAUTION

Do not allow trace to bloom. Do not allow unattended instrument to operate in CONV for expanded periods of time.

DC BALANCE ADJUST

1. Set DISPLAY to A.
2. Set channel A coupling to GND.
3. Obtain baseline per figure 3-3, AUTO operation.
4. Adjust channel A DC BAL until vertical trace does not shift when turning channel A vernier from CAL to maximum attenuation.

Note

If trace is not on CRT screen, press PUSH BEAM pushbutton and adjust channel A DC BAL until trace remains on screen.

5. Repeat steps 1 through 4 for channel B.

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Figure 3-8. Amplifier Balance Adjust

SECTION IV

PRINCIPLES OF OPERATION

4-1. INTRODUCTION.

4-2. This section contains an overall explanation of circuit theory. Refer to the overall block diagram in Section VIII while reading the theory.

4-3. VARIABLE PERSISTENCE AND STORAGE.

4-4. This section deals with basic theory of operation to aid in the understanding of storage concepts.

4-5. The storage CRT consists mainly of a conventional write gun with associated deflection plates and an aluminized phosphor viewing screen. In addition, it contains flood guns, flood beam shaping and accelerating grids, a collector mesh, and storage mesh. A schematic drawing of this CRT is shown in figure 4-1. The write gun functions as a conventional, electrostatic deflection gun. Elements which provide storage and variable persistance are located between the write gun and phosphor.

4-6. The flood guns are located physically just outside the horizontal deflection plates and emit a cloud of electrons from their cathodes. This cloud of electrons is shaped and accelerated toward the viewing area by the collimator (the coating on the inside of the funnel section of the glass) and the collector mesh. The potential on the storage mesh and storage surface exerts further control on the flood of electrons as they arrive at the storage surface, where storage of information takes place.

4-7. The secondary emission ratio curve shown in figure 4-2 is the basis for storage of information on the storage surface. The point where the number of electrons leaving the storage surface is the same as the number of electrons arriving is called "first crossover" point. When more electrons are leaving than arriving, the storage surface potential rises; when more electrons are arriving then leaving, the storage surface potential decreases.

4-8. Figure 4-3 graphically presents the action of the storage mesh and storage surface potentials during the erase cycle. When the PUSH:ERASE control is pressed, the storage mesh and storage surface are brought to the same potential as the collector mesh, +160 volts. After approximatley 100 ms, both storage mesh and storage surface are decreased to a potential of approximately +10 volts and held there for about 400 ms.

4-9. Flood gun electrons that have a potential close to 0 volt will be attracted to the +10 volts. These flood gun electrons then discharge the storage surface, because the potential is below first crossover (figure 4-2), and bring the entire storage surface to 0 volt. At the end of 400 ms, the storage mesh potential

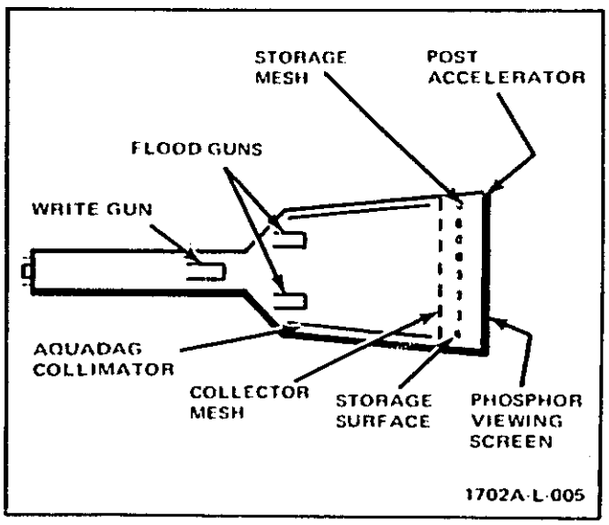

Figure 4-1. Simplified CRT Construction

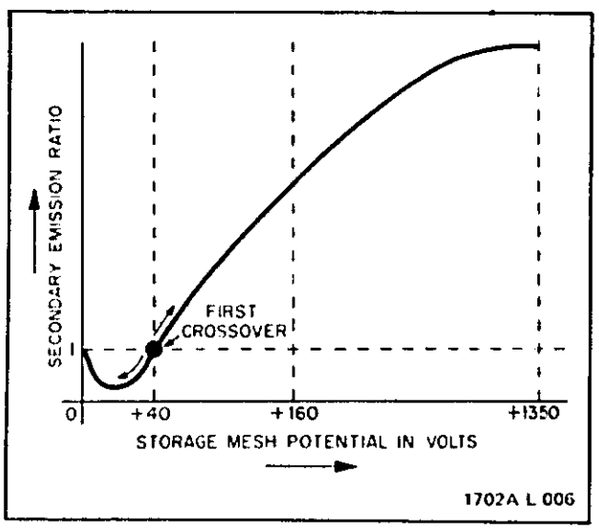

Figure 4-2. Secondary Emission Ratio

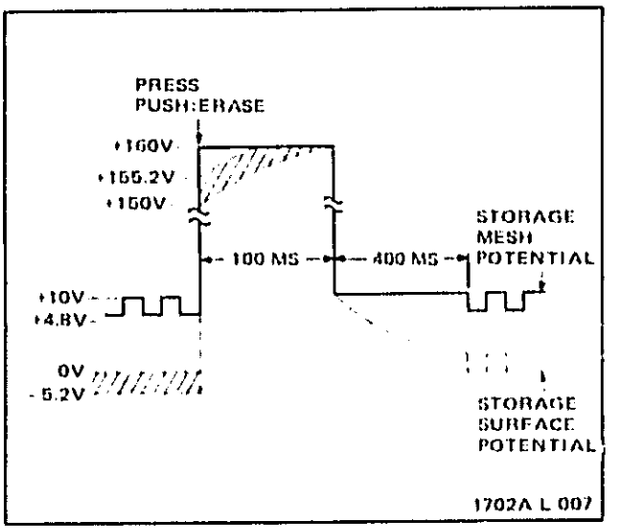

Figure 4-3. Erase Cycle

is decreased to +4.8 volts. The storage surface will follow, due to capacitive coupling, and becomes —5.2 volts.

4-10. Write gun electrons (with much higher than first crossover energy) charge the storage surface in a positive direction only in areas where they strike the storage surface. Flood gun electrons pass through these areas and are pulled to the viewing areas by the high post-accelerator potential.

4-11. The method of obtaining variable persistence is represented in figure 4-4. After the erase cycle, the unwritten storage surface is approximately —5.2 volts. Those areas of the storage surface struck by the write gun electrons become charged to near 0 volt. The written areas are clamped near 0 volt by flood gun electrons. When erase pulses are applied to the storage mesh, the storage surface is capacitively increased to 5.2 volts for the duration of the pulse. While at this potential, the storage surface written areas (about 5.2 volts) attract and capture flood gun electrons. This tends to lower the potential of written areas because it discharges the capacitor (created by the dielectric material) toward 0 volt. When the storage mesh returns to its normal level, the storage surface drops to 5.2 volts. The unwritten areas of the storage surface return to the —5.2 volt potential and written areas return to a slightly negative potential, somewhat lower (more negative) than their initial value. This decrease in potential reduces the ability of the post-accelerator potential to reach through and capture flood gun electrons, and trace brightness is slightly reduced.

4-12. A train of erase pulses gradually erases the written trace as shown in figure 4-4. The repetition rate of the erase pulses varies the persistence of the written trace. While the storage mesh is pulsed positive, flood gun electrons are allowed through to the phosphor viewing screen at all areas on the storage surface, causing a light background glow under some conditions.

4-13. When the storage mesh potential is reduced to about —40 volts, in the conv mode, it acts as a control grid to flood gun electrons, repelling them from the phosphor. It has little effect on the write gun electrons, allowing them to pass through to the viewing area.

4-14. However, some of the write gun electrons strike the storage surface and drive it in a positive direction. At high intensity settings, this change in potential is very rapid. The energy from this sudden change is converted into heat in the storage surface and may burn the dielectric material. In storage modes of operation, this burning action is visible as trace blooming.

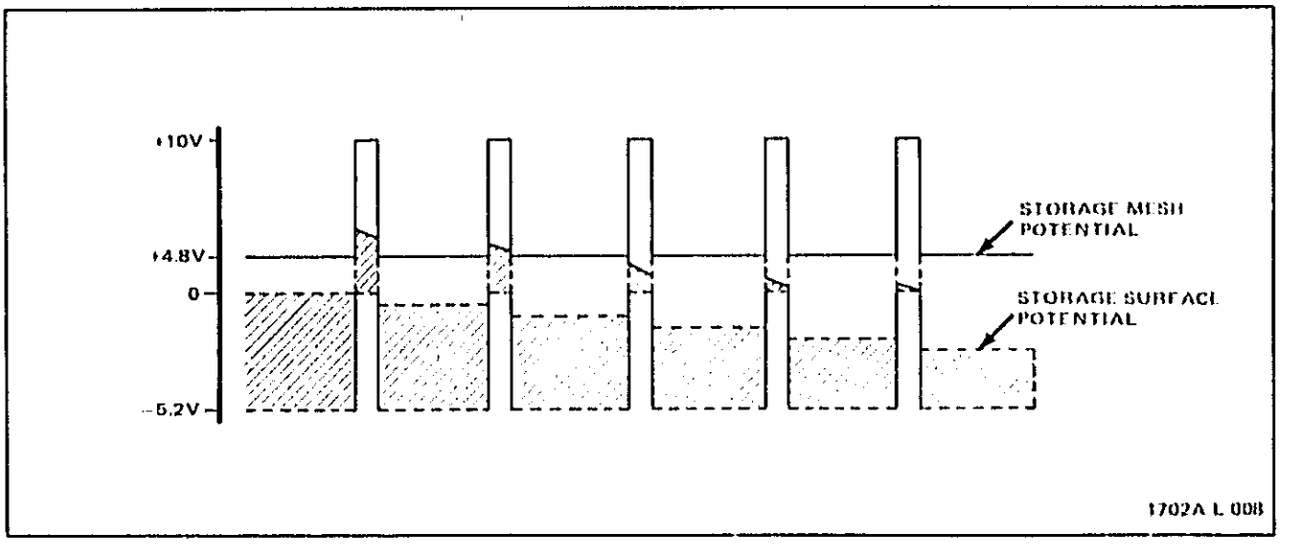

Figure 4-4. Variable Persistence Accomplished Through Pulse Erase

However, trace blooming is not visible during conv operation. Therefore the intensity level should be set just below the blooming point in the std mode before switching to the conv mode of operation.

4-15. Fade positive of the storage surface causing the entire viewing area to be illuminated limits the viewing time of a persisting trace. This effect is caused primarily by flood gun electrons ionizing the residual gas molecules. Fade positive is reduced by turning off the flood gun, except for a brief period during use in the storage mode. These turn-on periods occur frequently at the minimum end of the STORE TIME control (fully ccw) and produce a trace near normal intensity. No turn-on periods occur on the maximum end of the STORE TIME control (fully cw) and the trace is not visible.

4-16. GENERAL THEORY.

4-17. An overall explanation of circuit operation based on block diagrams (schematics 1 and 2) is presented to generate a basic understanding of the instrument. For simplicity, the block diagrams are drawn for function and do not show all circuit details.

Note

For circuit theory, a logic high (1) is a more positive voltage and logic low (0) is less positive voltage.

4-18. This instrument consists of a CRT, storage circuit, line rectifier, gate assembly, external horizontal amplifier, and three modules. The modules are as follows: (1) vertical amplifier module containing attenuators, vertical preamplifier, delay line, vertical output amplifier, and channel A output amplifier; (2) a horizontal amplifier module containing trigger assembly, horizontal mother board, main and delayed integrators, main and delayed sweep time assemblies, holdoff and comparator assembly, horizontal mode assembly, horizontal preamplifier, and horizontal output amplifier; and (3) power supply module containing low voltage mother board, low voltage converter, low voltage rectifier and filter, high voltage oscillator, and high voltage multiplier.

4-19. INPUT ATTENUATOR. (See schematic 1.)

4-20. The attenuators are compensated voltage-divider types. They provide division ratios of 1, 2, 5 10 and 100, giving nine separate sensitivities. Each decade input sensitivity range has an input capacitance adjustment and an attenuator compensation adjustment. Coupling (AC, GND, and DC) is also controlled in the attenuator stages.

4-21. VERTICAL PREAMPLIFIER.

4-22. The vertical preamplifier provides amplification to the input signals for drive to the vertical output amplifier. Channel A sync and composite sync signals originate in the vertical preamplifier. The sync signals are applied to the trigger assembly for internal triggering. Channel switching, chop operation, and display mode are also accomplished in the vertical preamplifier (schematic 7).

4-23. DELAY LINE.

4-24. The delay line provides approximately 100 ns delay to the vertical signal, allowing the horizontal circuits sufficient time to react to the trigger signal so that the event caused by the trigger can be observed on the fastest sweep.

4-25. VERTICAL OUTPUT AMPLIFIER.

4-26. The vertical output amplifier provides drive to the CRT vertical deflection plates.

4-27. CHANNEL A OUTPUT AMPLIFIER.

4-28. The channel A output amplifier provides a gain of 10 to the channel A signal (with channel A VOLTS/DIV set to .01). With the CHANNEL A OUTPUT connected to the channel B INPUT, the Model 1702A vertical sensitivity can be extended to 1 mV/div.

4-29. TRIGGER CIRCUITS.

4-30. The trigger assembly provides the main trigger signal to the integrator. Trigger modes are selectable in this assembly. The trigger circuit provides two outputs to the integrator (schematic 1). One output is the trigger that is generated by the current switch. The output of the current switch is controlled by the inputs to the set-trigger gates. One input to the set-trigger gate is the trigger signal and other input is the reset signal from the integrator. When the reset signal is high, the set-trigger gates are inoperative and no trigger signal is generated. When the reset signal is low, the set-trigger gates are operational and a trigger signal will be generated if there is an internal or external trigger input. The other output is the brightline auto level which is provides only in the auto mode.

4-31. INTEGRATOR.

4-32. The integrator initiates a horizontal sweep from the trigger input. When the trigger signal is applied to the input amplifier, the Miller integrator activates and produces the horizontal sweep ramp. The Miller integrator is connected to the sweep timing components (schematic 12). The TIME/DIV switch controls the ramp output from the Miller integrator. The output of the Miller integrator is amplified and applied to the horizontal amplifier circuits.

4-33. The horizontal sweep is also compared to a 12-volt reference by the ramp comparator which drives

the integrator set-reset multivibrator. The set-reset multivibrator, in conjunction with the holdoff circuit, controls the amplitude and timing sequence of the sweep ramp. When the sweep ramp reaches +12 volts, the ramp comparator turns on and resets the trigger set-trigger gates to a logic high (1). The signal from the holdoff amplifier determines the holdoff time of the circuits and sets the trigger set-trigger gates to a logic low (0) for a new sweep.

4-31. When the bright-line auto circuit is used, the set-reset multivibrator provides a ground for the bright-line auto level and terminates the sweep. This allows the sweep signal to return to its starting point.

4-33. At the same time that the ramp is generated, the alt amplifier provides an output to the vertical preamplifier J-K flip-flop for alt operation.

4-36. HOLDOFF.

4-37. The holdoff establishes the time interval between trigger points. The time interval is adjusted by the TRIGGER HOLDOFF control. A signal from the integrator set-reset multivibrator activates the holdoff circuit. When the holdoff is activated, a ramp, determined by the holdoff amplifier (B) circuits and the TRIGGER HOLDOFF control, is generated. When this ramp reaches a predetermined level, it activates the integrator set-reset multivibrator. The set-reset multivibrator then sets the trigger set-trigger gates low for new sweep.

4-38. TIMING SEQUENCE.

4-40. Figure 4-5 is an illustration representing the time relationship between the trigger and sweep timing circuits. Waveform A represents the input signal to the vertical circuits and the internal sync signal. Waveform B represents the integrator set-reset multivibrator output. Waveform C represents the input to the trigger set-trigger gates and waveform D represents the output. Waveform E represents the main integrator output. Waveform F represents the input to the holdoff amplifier.

4-41. At T_0, the multivibrator output is high, holding the set-trigger gates high, preventing a sweep signal. At T_1, the holdoff time is completed and the multivibrator output goes low, activating the set-trigger gates. At T_2, the trigger signal goes positive and the set-trigger gates output goes low, activating the integrator which produces a horizontal sweep signal.

4-41. At T_3, the sweep is terminated and the set-reset multivibrator output goes high. When the set-reset multivibrator goes high, the holdoff time signal starts and the set-trigger gates are locked high, preventing a sweep. At the completion of holdoff time, the sequence is repeated.

4-42. EXT HORIZ INPUT.

4-43. The sweep display switch (S1) provides selection of the EXT HORIZ INPUT mode of oper-

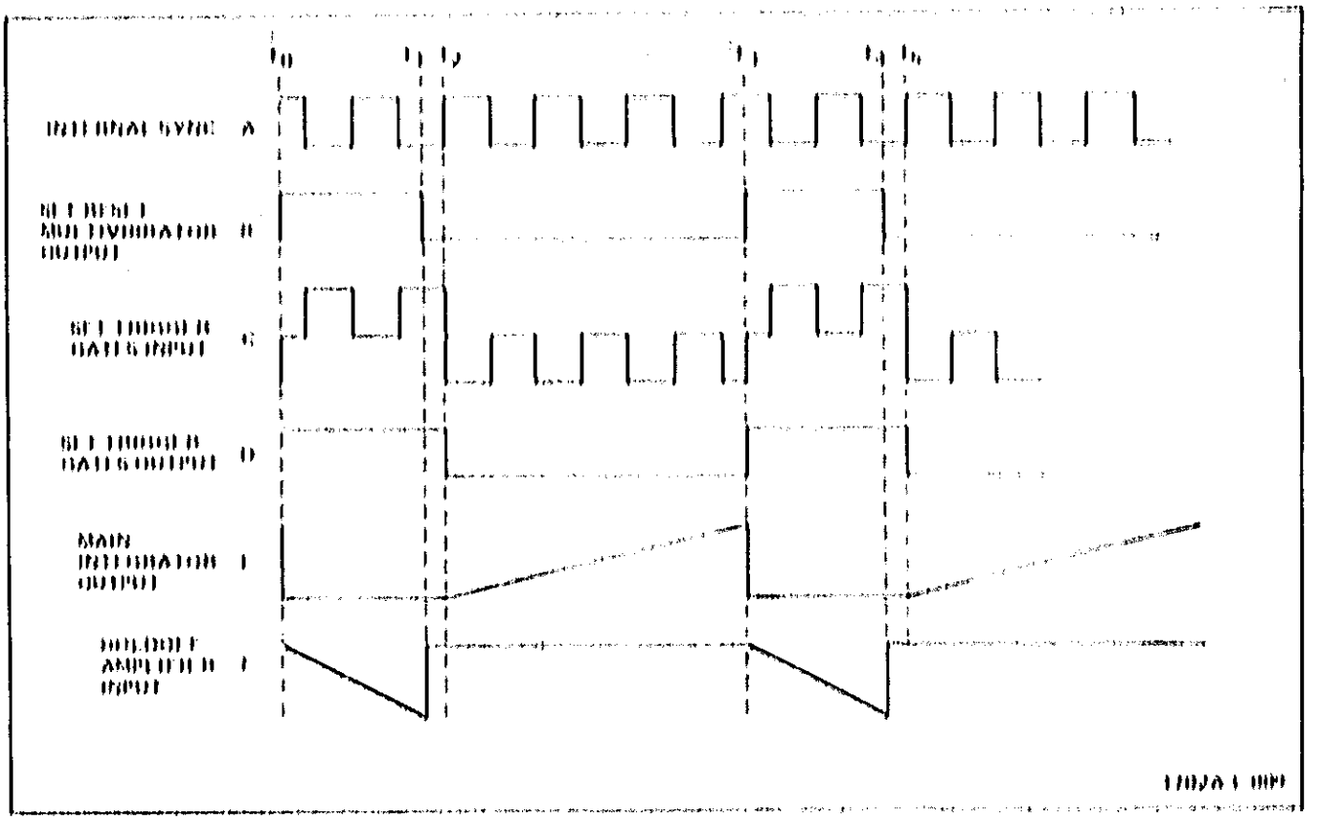

Figure 4-5. Timing Sequence

ation. In the EXT HORIZ INPUT mode, the blanking signal is grounded and the output from the external horizontal amplifier is connected to the horizontal preamplifier.

4-44. LOW VOLTAGE POWER SUPPLY. (See schematic 9.)

4-45. The low voltage power supply operates from three different power sources. The sources are ac line, internal battery or external dc line. The ac line is applied to the input power module which is selectable for 115 or 230 volt operation and has an ac line protection fuse. The ac input is applied to a step down power transformer.

4-46. The line rectifier rectifies and filters the power transformer ac output of approximately 40 volts. This voltage is applied to the voltage regulator and a ripple filter which filters out the 120 hertz ripple.

4-47. The voltage regulator output is applied to the low voltage converter. This stage converts the input dc power to useable output dc of different voltage levels. The low voltage converter oscillates between 10 kHz and 15 kHz, depending upon the input voltage and the output power.

4-48. The voltage coupled from the converter to the low voltage rectifier is filtered and applied to the low voltage mother board which provides low voltage distribution to the power supply module. A portion of the +15 and −15 volts is fed back to the low voltage regulator which determines the frequency and duty cycle of the converter for output voltage regulation.

4-49. The filtered voltages from the low voltage mother board are coupled to the gate board. The gate board provides filtering, fuse protection and distribution of the low voltage supplies to the rest of the Model 1702A circuits.

4-50. HIGH VOLTAGE POWER SUPPLY.

4-51. The high voltage power supply consists of the high voltage oscillator, power transformer, rectifying networks, and high voltage multiplier. When the instrument is turned on, the high voltage oscillator activates, coupling voltages from pins 1 and 2 into the secondary pins 6 and 7, 5, 8, and 9. Pins 11 and 10 are connected to filaments of the CRT. The secondary voltage at pin 7 is connected through a rectifying diode to the control grid of the CRT. Pin 8 of the secondary is connected through a rectifying diode to the cathode. A correction voltage is coupled from this diode back through a resistive divider network, controlling the current source. The current source controls the oscillator amplitude and thus the high voltage oscillator output. The CRT voltages are negative, except for the post-accelerator voltage.

4-52. The CRT cathode voltage is fed back to the current source. If the cathode voltage becomes more negative, less current is supplied to the high voltage flyback oscillator. With less current supplied, the amplitude of the hv oscillator output is reduced and the cathode voltage will return to its normal operating value. If the cathode voltage becomes less negative, more current is supplied to the hv oscillator. The output amplitude now increases and the cathode voltage again returns to its normal operating value. A 1.875 kV peak to peak voltage is present at pin 9 of the high voltage transformer. This voltage is applied to the high voltage multiplier circuit where it is multiplied by 4. The 7.5 kV output is applied to the post accelerator on the CRT.

4-53. GATE AMPLIFIER.

4-54. The gate amplifier has four inputs: one input is from the INTENSITY control, another input is the horizontal mode blanking input, a third input is the vertical preamplifier chop blanking input and fourth input is from the Z-AXIS INPUT. All of these inputs control the intensity or Z-axis of the CRT. The output from the gate amplifier to the CRT grid increases or decreases the intensity of the display.

4-55. STORAGE CIRCUITS.

4-56. Store Operation. During store operation, the blanking circuit and the 40 usec, one shot multivibrator are activated. The blanking circuit output is coupled to the gate amplifier, turning the CRT write gun off. The 40 usec, one shot multivibrator output is applied to the flood gun anode driver. This signal turns the flood gun anode driver on and off. When the flood gun anode driver is off, the flood gun is positive and accelerates the flood gun electrons to the CRT, allowing a stored display to be viewed.

4-57. View Operation. In this mode, the view amplifier turns on, pulling the storage mesh driver output to −10 volts. This voltage causes the storage mesh to act as a control grid to the flood gun electrons and prevents the electrons from reaching the CRT phosphor. Under this condition, the CRT acts as a conventional CRT.

4-58. Std/Fast Operation. In the std mode of operation, the max write memory circuit is activated. The max write pulse amplifier is turned off and the write pulse amplifier is turned on, saturating the amplifier. In the fast mode, the write pulse amplifier is turned off and the max write pulse amplifier is turned on, saturating the amplifier. The amplifier controls the bias of the storage mesh driver, controlling how positive the storage mesh will be pulsed.

4-59. In the std and fast operating modes, the current source supplies between 0 mA (maximum persistence) and 0.5 mA (minimum persistence) to the

[illegible] The output of the [illegible] which prevents negative pulses to the sleeper amplifier. The input to the [illegible] the higher the output frequency of the sleeper amplifier. The sleeper amplified output is applied to the pedestal control circuit that turns the pulse amplifier on and off. When the pulse amplifier is off, the sleeper amplifier input is changed. When the pulse amplifier is on, the sleeper amplifier base voltage is established. The difference between on and off states of the pulse amplifier provides a change in the sleeper pulse output between 1 V and 3 V. The frequency of the input pulse determines the sleeper pedestal and the pulse amplitude determines the sleeper depth.

Fast Recovery Operation. When the [illegible] control is changed, +100 volts is applied to the fast recovery diode, bringing the sleeper anode to the same potential as the collector anode. During this time, the pedestal control circuit is activated, turning the pedestal control circuit off. With the pedestal control circuit off, pedestal pulses are prevented from being applied to the sleeper amplifier.

[illegible] During the time the [illegible] collimator amplifier is activated, turning the collimator switches on and off at [illegible] rate. The collimator switches turn the collimator output amplifier on and off. The collimator amplifier output changes the bias of the blood pump electrode to help create the [illegible] more complete.

[illegible] When the [illegible] control is changed, the pedestal control circuit turns off and the pedestal control circuit turns on. There is a [illegible] between the time the [illegible] control is changed and the time the pedestal control circuit turns off.

4-60. DETAILED CIRCUIT THEORY.

[illegible] The following detailed theory is subdivided according to module and referenced to the foldout schematics in Section VIII. Each schematic is numbered and indexed in the appropriate test for easy location.

4-65. INPUT ATTENUATORS.

[illegible] The [illegible] attenuators A5A1 and A5A2 schematic diagrams provide attenuation, coupling selection, attenuator compensation and input capacitance adjustment. The attenuators are compensated voltage divider type circuits that have cascaded sections. The front section provides attenuation ratios of 1, 10, and 100. The rear section provides attenuation ratios of 1, 2, and 5.

[illegible] A5A1S1 provides choice of coupling. Choices are AC, DC, or GND. A5A1S1 provides a ground for quieter operation in the AC position.

[illegible] A5A1 and A5A2 provide attenuator compensation. Each attenuator is compensated by a frequency response A5A1 and A5A2 provide input capacitance adjustment. The capacitance is adjusted to minimize the attenuator input capacitance. A5A1 provides a ground for the attenuator case. A5A1 and A5A2 provide attenuator outputs to the [illegible] A5A1 and A5A2 provide input impedance matching for the attenuator. A5A1 and A5A2 provide input capacitance adjustment. A5A1 and A5A2 provide the input [illegible] to ground both input resistance of the attenuator and the [illegible] output.

4-68. VERTICAL PREAMPLIFIER.

[illegible] The vertical preamplifier circuit provides the following functions:

a. Amplification of signal from the input attenuators.

b. Provides channel A and channel B signal.

c. A+B and A−B operation.

d. Type of display.

e. Trigger selection.

[illegible] Front panel controls for the vertical preamplifier determine the balance position, calibrated amplification of the amplifier, choice of display, and internal trigger selection.

[illegible] Selection of either channel A and channel B or simultaneously channel A will be displayed in dual. When channel B alone is selected channel A the difference will be displayed.

[illegible] A5A1 and A5A2 provide input capacitance to approximately 47 pF. A5A1R1, A5A1R2, A5A2R1, and A5A2R2 form an overcompensated precision network for the attenuator input voltage. Capacitors C1 and C2 are adjusted, limiting the voltage applied to the input FET's A5A1Q1. The source follower and A5A1R3 form an RF network which presents the input impedance of A5A1Q1 absorbs parasitic and prevents oscillations. If an unbalanced source is connected to the amplifier. A5A1Q1 and A5A1Q2 are matched FET's connected in a source follower configuration. A5A1Q1 and A5A1Q2 offer high input impedance, high percentage loading of circuits under test. A5A1Q1 provides impedance matching and A5A1Q2 provides isolation for the channel A amplifier.

[illegible] Emitter followers A5A1Q3 and A5A1Q4 provide low impedance drive to the remaining active circuits. A5A1 is the pulse amplifier control. When A5A1

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

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CHANNEL A OUTPUT AMPLIFIER

[illegible]

TRIGGER ASSEMBLY

[illegible]

[illegible]

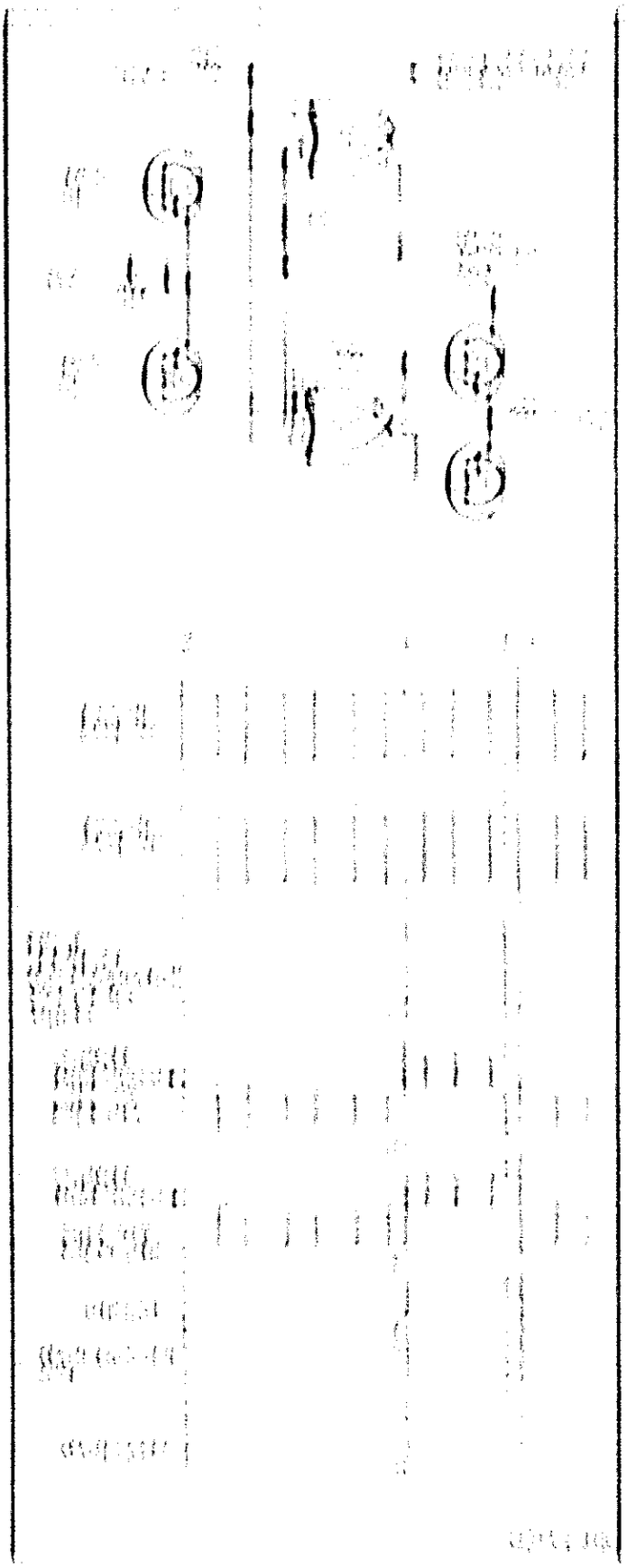
[illegible]

[illegible]

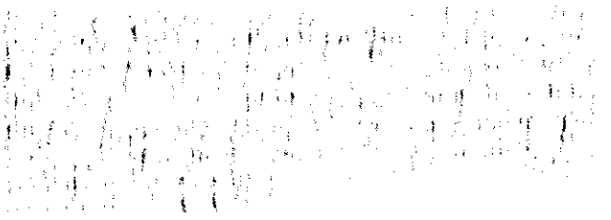
[illegible]

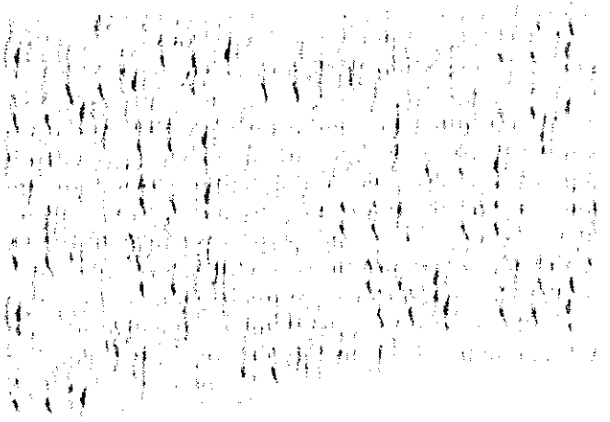
[illegible]

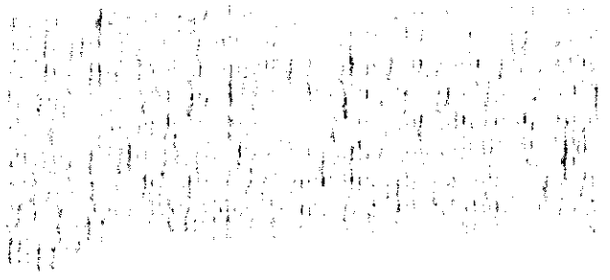
[illegible]

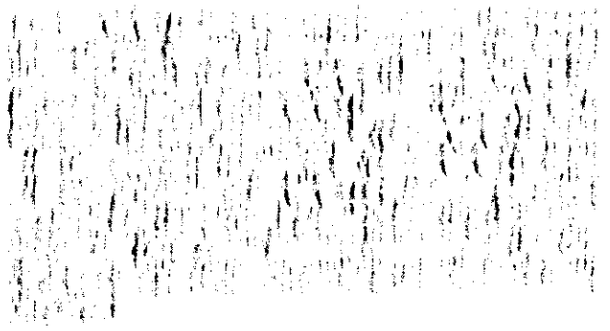


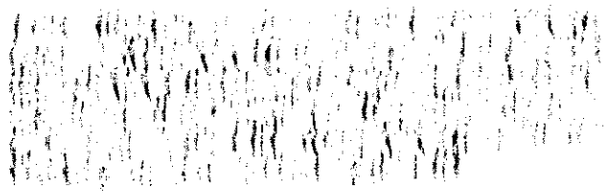
[illegible]

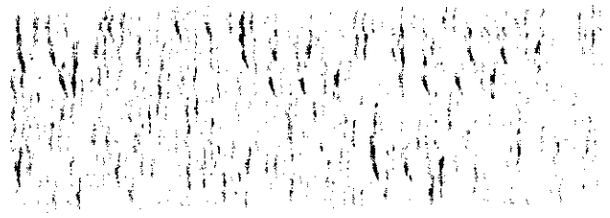


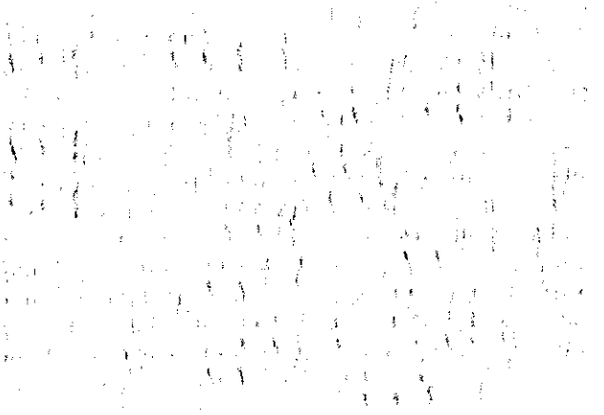


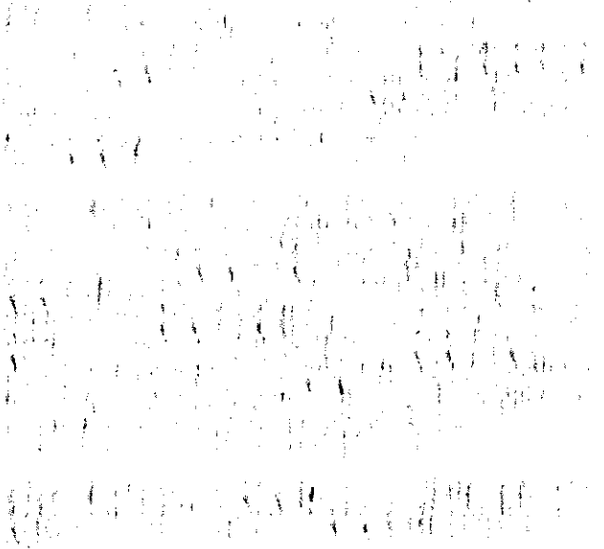


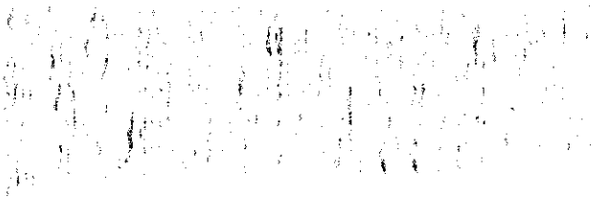


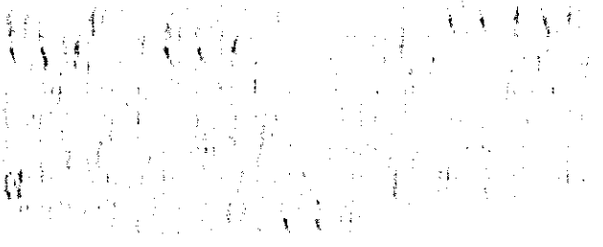












provided to the CRT control grid through A3A4CR7 by the gate assembly. The blanking input completely blanks the CRT. As a less negative voltage is applied to the grid circuit the trace intensity becomes brighter. As more negative voltage is applied, the trace intensity decreases until it is blanked.

4-163. The sine wave signal produced by high oscillator A3Q1 is stepped up by the high voltage transformer, A3A4A1T1, producing a peak-to-peak voltage of approximately 1750 volts between pins 9 and 5. This signal is applied to high voltage multiplier circuit A5, which is a quadrupler circuit. The multiplier assembly rectifies the input voltage, inverts it, and multiplies it to approximately +7000 volts to drive the CRT post accelerator.

4-164. LOW VOLTAGE POWER SUPPLY.

4-165. Schematic 18 contains the power module, line rectifier, part of the low voltage mother board and part of the A4 gate assembly. The A1 power module provides ac input power to the Model 1702A. The A2 line rectifier rectifies the incoming ac and provides some filtering. The trickle charge circuit for the battery is also contained on this board. The A3A1 low voltage mother board provides voltage regulation, filtering, and full charge current to the battery. The A4 gate assembly has the light driver for the scale illumination circuits and the low battery indicator circuit.

4-166. A1F1 is the ac input fuse. A1S1 provides selection between 115- and 230-volt operation. The ac input is applied to T1 which is a 3:1 stepdown transformer.

4-167. Z1 rectifies the incoming signal. A2C1 and A2C2 are ripple filter capacitors. A2R1 and A2CR1 provides a trickle charge of 40 milliamperes to the battery in AC LINE operation. A2R3, A2R4 and A2C3 provide the line sync signal. A3A1Q1 and A3Q2 form a series voltage regulator. A3A1R1 provides current to A3A1VR1 which sets the base reference voltage of A3A1Q1. A3A1R4 provides current limiting. A3A1CR1 is a protection diode for A3A1Q1 and A3Q2. A3A1C1 and A3A1R3 form a ripple filter. A3A1R5 and A3A1CR2 form the full charge circuit for the battery. When the instrument is off, approximately 400 milliamperes is applied to charge the battery. This charging current is always applied with the POWER MODE switch in AC LINE, the ac power connected and the instrument POWER switch set to off.

4-168. POWER MODE switch S2, provides selection for AC LINE, INTERNAL BATTERY or DC LINE. S1 provides for power on or power off. F1 is in the line during all modes of operation. J2 provides for DC LINE input. This input should be limited between 11.5 to 36 volts, 18 watts maximum.

4-169. A4Q2 and associated circuitry form the light driver network. When the instrument is operated in any mode except INTERNAL BATTERY the circuit is off. Current flows through A4R30, A4CR12 and DS1 when the instrument is turned on. When the instrument is operated in INTERNAL BATTERY and the battery voltage drops below 22.5 volts, A4Q2 turns on. DS1, A4R29 and A4C13 form a relaxation oscillator which causes DS1 to flash. This is an indication that the battery is discharged and further operation may damage the battery.

4-170. Schematic 19 contains the low voltage converter protection circuits and the low voltage converter assembly. The protection circuit protects the instrument in the event that the regulator fails, the dc line input is more than 40 volts, or the polarity of the dc input is reverse.

4-171. The A3A2 low voltage converter assembly changes the input dc voltage to usable dc voltages of different levels. The low voltage converter assembly also contains the regulator network which controls the converter output.

4-172. A3A1CR3 protects the instrument against a dc voltage connected with the wrong polarity. If the wrong polarity is connected, A3A1CR3 turns on and the line fuse F1 (schematic 18) opens. If a dc input over 40 volts is connected, A3A1VR3 conducts which turns on A3A1SCR1 and opens F1 (schematic 18).

4-173. If the regulated +15-volt supply goes above approximately 20 volts, bidirectional diode A3A1CR5 turns on. A3A1CR5, A3A1C2 and A3A1R9 form a relaxation oscillator whose output is coupled across A3A1T1, rectified by A3A1CR4 and filtered by A3A1C3. This rectified voltage turns A3A1SCR1 on, opening line fuse F1.

4-174. A3A2Q2 with associated circuitry form the low voltage converter. This circuit changes the incoming dc voltage to useable dc voltages of different magnitudes. A3A2R2 and A3A2VR2 form a voltage source charging A3A2C7 through A3A2R6. A3A2C7 charges to the peak-point emitter voltage of the unijunction transistor A3A2Q1. At this voltage, A3A2Q1 conducts supplying current thru A3A2R12 to the base of A3A2Q2 (figure 4-1). This current turns on A3A2Q2 allowing current to flow in the primary windings of A3A2T1 and A3A2T1 (schematic 19). As the current in these windings increases, primary winding 1 and 2 (A3A2T1) induce voltage into pins 3 and 4, such that A3A2Q2 conducts harder. The primary current continues to increase until the core (A3A2T1) saturates. At this point there is no longer magnetic coupling in A3A2T1 and A3A2Q2 turns off. When A3A2Q2 turns off, an open circuit condition on pins 1 and 2 of A3A3T1 (schematic 20) exists and the energy stored in the primary windings of A3A3T1 causes a fly back voltage to appear on the secondaries

of A3A3T1. This allows the secondary circuits to conduct, charging the capacitors to the required dc voltages.

4-175. A fly back voltage also appears in the secondary windings A3A2T1 pins 3 and 4. This fly back voltage turns on A3A2CR4 charging A3A2C8. When all the energy has left the core, the cycle is repeated with A3A2C8 aiding the turn on of A3A2Q2. The magnetic field in the transformers provide drive for the rest of the operation.

4-176. A3A2VR3 is a protection diode protecting A3A2Q2 from emitter-to-collector breakdown. A3A2C1 and A3A2C2 isolate the power supply from ground. Unijunction transistor A3A2Q1 fires only when the instrument is first turned on. A3A2CR5 provides a discharge path for A3A2C7 preventing A3A2Q1 from being turned on again.

4-177. The low voltage regulator controls the duty cycle of the low voltage converter thus controlling the output voltage. Current into or out of pin 5 of A3A2T1 increases or decreases the duty cycle of the low voltage converter. An increase in current flow from pin 5 decreases the conduction time of A3A2Q2 which lowers the output voltage from the low voltage rectifier and filter network.

4-178. The regulated +15 volts is applied to pin 3 of the low voltage converter assembly. The regulated −15 volts is applied to pin 10. The −15 volts turns on reference diode A3A2VR1. The +15 volts is compared to the voltage reference through A3A2R3 and A3A2R4. The different current, which results in a small voltage variation, is applied to operational amplifier A3A2U1 which is connected in the inverting mode. If the voltage at pin 2 increases, the output at pin 6 decreases. When the output of pin 6 decreases, A3A2Q4 turns on harder, drawing current through pins 6 and 5 of the transformer. This increase in dc current from pin 5 of A3A2T1 lowers the output voltage.

4-179. If +15 volts decreases, the voltage applied to pin 2 decreases causing an increase at the output of A3A2U1. When the voltage increases, A3A2Q3 turns on providing more current into pin 5 and 6 of A3A2T1. The increase in dc current into pin 5 increases the conduction time of A3A2Q2 causing the output voltage to increase.

4-180. A3A2CR1 and A3A2CR2 protect A3A2U1 input. A3A2C10, A3A2R13 and A3A2C12 provides frequency compensation. A3A2U1 operates open loop dc and closed loop ac. The closed loop feedback is provided by A3A2C13 and A3A2R14.

4-181. Schematic 20 contains the low voltage rectifier and filter networks, the low voltage mother board filter networks and the fuse protection circuits for the low voltage power supply.

4-182. A3A3CR1 through A3A3CR8 provides rectification of the input signal from the low voltage converter (schematic 19). A3A3C1 through A3A3C10 provide appropriate filtering.

4-183. A3A1C4 through A3A1C6 and A3A1C8 through A3A1C11 provide further filtering to the low voltage power supplies. A3A1R10 through A3A1R18 and A3A1R20 are bleeder resistors that discharge the capacitors on the low voltage rectifier and filter and the low voltage mother board.

4-184. The A4 gate assembly provides fuse protection, filtering, and distribution of the low voltage to the horizontal module and the vertical module.

Table 5-1. Recommend Test Equipment

Instrument Type	Recommended Model	Required Characteristics	Required For
Voltmeter Calibrator	HP Model H01-738BR	Voltage: 5 mV to 100V Accuracy: to 0.1%	P,A
Oscillator	HP Model 204C	Frequency: 100 kHz Voltage Output: 15 mV	A
Time-mark Generator	HP Model 226A	Time Marks: 0.1 usec to 2 sec in 1, 2, 5 sequence	P, A
Square-wave Generator	HP Model 211B	Frequency: 100 kHz Risetime: <5 ns	P
Multifunction Digital Voltmeter	HP Model 3439A with 3444A	Voltage Range: 1000V Accuracy: ±0.1% Resistance Range: 10 megohms Accuracy: ±0.1%	P, A, T
VHF Signal Generator	HP Model 608E	Frequency: 50 kHz to 75 MHz Voltage Output: 50 mV to 5V p-p	P
LC Meter	HP Model 4332A	Range: 30 pF	A
50-ohm Feedthrough Termination	HP Model 10100C	Resistance: 50 ohms	P, A
50-ohm BNC Cable (1)	RG 213	50-ohms	P, A
BNC Cable (2)	HP Model 10501A Cable Assembly	44 in.	P, A
BNC Cable (2)	HP Model 10502A Cable Assembly	9 in.	P, A
Banana Jack to BNC Adapter	HP Model 10110A	Banana Jack to BNC	P, A
BNC to Binding Post Adapter	HP Model 10111A	BNC to Binding Post	P, A
Test Leads	HP Model 11002A	Test Leads	P, A, T
RF Millivoltmeter	HP Model 411A	Range: 35 mV Accuracy: ±3%	P
10:1 Divider Probe	HP Model 10006B	Divide Ratio: 10:1	A
1000:1 Divider Probe	HP Model K05-3440A	Divide Ratio: 1000:1	A
Monitor Oscilloscope	HP Model 180A, 1801A and 1820A	Bandwidth: 50 MHz	A,T
Screwdriver	HP Part No. 8710-0900	Pozidrive	A, T
Service Kit	HP Part No. 01701-68701	Extender Boards and Board Puller	P, A, T

Note 1. P = Performance Check, A = Adjustment Procedure, T = Troubleshooting.

SECTION V

PERFORMANCE CHECK AND ADJUSTMENTS

5-1. INTRODUCTION.

5-2. This section contains step-by-step procedure for checking the instrument specifications as given in table 1-1 of this manual. The performance check procedure gives troubleshooting suggestions in case the instrument fails to meet any specification tested. A table (performance check record) is provided at the end of the performance check for recording the measurements obtained in the first running of the procedure. This record may be used to compare measurements taken at later dates with the original. The procedures for making all internal adjustments are covered in paragraphs 5-98 through 5-209. A photograph showing the locations of all internal adjustment controls is presented in figure 5-15.

5-3. TEST EQUIPMENT.

5-4. Test equipment required for procedures in this section is listed in table 5-1. Test equipment equivalent to that recommended may be substituted, provided it meets the required characteristics listed in the table. For best results, use recently calibrated test equipment.

5-5. PERFORMANCE CHECK.

5-6. The following subparagraphs describe procedures to determine whether or not the instrument is operating within the specifications of table 1-1. This check can be used as part of an incoming inspection, as a periodic operational test, or to check calibration after repairs or adjustments have been made. Any one of the following checks can be made separately if desired.

5-7. The first time the performance check is made, enter the results on the performance check record at the end of the procedure. Remove the record from the manual and file it for future reference. Be sure to include the instrument serial number on the record for identification.

5-8. FRONT PANEL ADJUSTMENTS.

5-9. Set the instrument up and perform initial adjustments outlined in Section III before proceeding with the performance checks or adjustment procedures.

5-10. FRONT PANEL SETTINGS.

5-11. Begin each performance test and adjustment procedure with the control settings listed below. If a control is to be set to another position, it will be listed in the procedures. After the completion of each performance check or adjustment procedure, the controls should be set back to the original front panel settings.

PERSISTENCE ..... fully cw
INTENSITY ..... fully ccw
WRITING SPEED ..... STD
CHANNEL A VOLTS/DIV ..... .01
channel A coupling ..... AC
channel A vernier ..... CAL
channel A POSITION ..... as required
DISPLAY ..... A
trig ..... NORM TRIG
CHANNEL B VOLTS/DIV ..... .01
channel B coupling ..... AC
channel B vernier ..... CAL
channel B POSITION ..... as required
B POLARITY ..... NORM
HORIZONTAL POSITION ..... as required
VERNIER ..... CAL
TIME/DIV ..... 5 uSEC
AUTO/NORM ..... AUTO
INT/EXT ..... INT
AC/DC ..... DC
slope ..... +
TRIGGER LEVEL ..... as required
TRIGGER HOLDOFF ..... NORM
SWP MAG X1

5-12. PERFORMANCE TESTS.

5-13. DEFLECTION FACTOR.

Table 5-2. Deflection Factor Accuracy

Voltmeter Calibrator Settings (volts p-p)	VOLTS/DIV Settings	Vertical Display (div)
0.1	.02	5 ±0.15
0.3	.05	6 ±0.18
0.5	.1	5 ±0.15
1	.2	5 ±0.15
3	.5	6 ±0.18
5	1	5 ±0.15
10	2	5 ±0.15
30	5	6 ±0.18

5-14. Specification. Ranges: from 10 mV/div to 5 V/div (9 ranges) in 1, 2, 5 sequence. Accuracy: ±3% with vernier in CAL position. Vernier: continuously variable between all ranges, extends maximum deflection factor to at least 12.5 volts/div. vernier uncal light indicates when vernier is not in CAL position.

5-15. Description. The deflection factor is checked by applying a 400-Hz, voltage-calibrated signal to the input. The display signal is compared against the voltage standard.

5-16. Equipment.

a. Voltmeter Calibrator.

b. Banana Jack to BNC Adapter.

c. BNC Cable, 44 in.

5-17. Procedure.

a. Connect instruments as shown in figure 5-1.

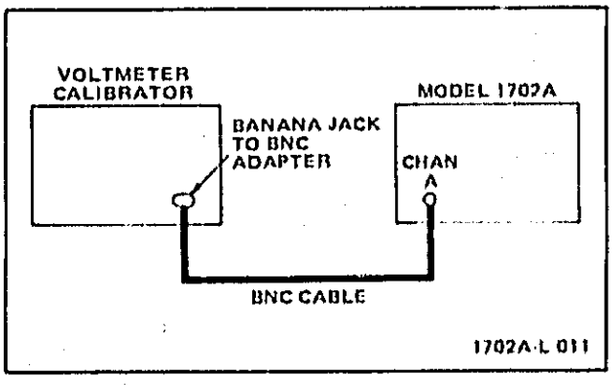


Figure 5-1. Deflection Factor Test Setup

b. Set Model 1702A TIME/DIV to .5 mSEC.

c. Set voltmeter calibrator controls for 50-mV p-p output signal.

d. Observe CRT. Display should be 5 vertical div ±3%.

e. Observe vertical deflection factors specified in table 5-2.

f. Set voltmeter calibrator output for 30V.

g. Set CHANNEL A VOLTS/DIV to 5.

h. Rotate channel A vernier control fully cew. VERNIER UNCAL light turns on. Display reduction should be equal to or less than 2.4 div.

i. Rotate channel A vernier control fully cw into CAL detent.

j. Connect voltmeter calibrator output to channel B INPUT.

k. Set DISPLAY to B.

l. Repeat steps b through i for channel B.

m. Remove test equipment.

n. To return to initial settings, set Model 1702A controls as follows:

CHANNEL A and B VOLTS/DIV ..... .01
TIME/DIV ..... 5 uSEC

o. Refer to schematic 3 if any deflection factor is not within specifications.

5-18. CALIBRATOR.

5-19. Specification. Type 1-kHz ± 10% square wave. Voltage: 1V p-p ±1%.

5-20. Description. The frequency is checked by the Model 1702A. The calibrator amplitude is checked by comparing the calibrator amplitude against a known 0.1%, 1V p-p signal.

5-21. Equipment.

a. Voltmeter Calibrator.

b. Banana Jack to BNC Adapter.

c. BNC Cable, 44 in.

d. Test Lead.

5-22. Procedure.

a. Connect instruments as shown in figure 5-2.

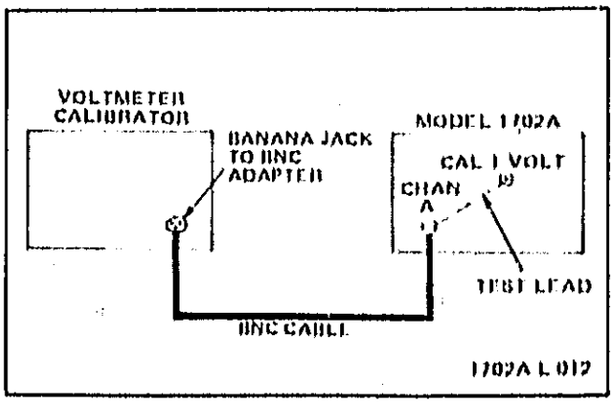


Figure 5-2. Calibrator Test Setup

b. Set Model 1702A controls as follows:

CHANNEL A VOLTS/DIV 1
channel A coupling ..... DC
TIME/DIV ..... .2 mSEC

c. Set voltmeter calibrator controls for 1V p-p output signal.

d. Adjust channel A vernier so display is exactly 6 div of vertical amplitude.

e. Disconnect voltmeter calibrator.

f. Connect CAL. 1 VOLT output to channel A INPUT with test lead. Display should be 6 div of vertical amplitude ±0.06 div and 1 kHz ±10%.

g. Remove test lead.

h. To return to initial settings, set Model 1702A controls as follows:

CHANNEL A VOLTS/DIV ..... .01
channel A vernier..... CAL.
TIME/DIV ..... 5 uSEC

i. Refer to paragraph 5-171 and schematic 10 if test limits are incorrect.

5-23. RISETIME.

5-24. Specification. Risetime is less than 10 ns; direct or with Model 10006B Probe. Risetime is measured from 10% to 90% with 6-div input step from a terminated 50-ohm source.

5-25. Description. A 100-kHz signal, with a risetime of less than 5 ns, is applied to the vertical input of the instrument. The risetime displayed on the CRT is then checked to see that it is less than 10 ns. This measurement is made direct but may be made with Model 10006B Probe.

5-26. Equipment.

a. Squarewave Generator.

b. 50-ohm Feedthrough Termination.

c. BNC Cable, 44 in.

5-27. Procedure.

a. Connect instruments as shown in figure 5-8.

b. Set TIME/DIV to .1 uSEC.

c. Set squarewave generator controls for 60 mV, 100-kHz output signal.

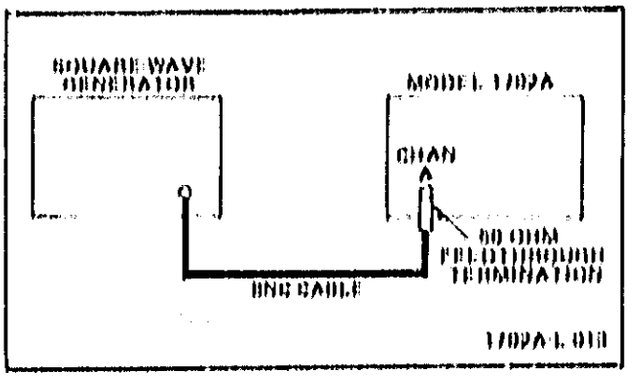


Figure 5-8. Risetime Test Setup

d. Adjust HORIZONTAL POSITION control so risetime portion of signal is in center of CRT.

e. Set SWP MAG to X10.

f. Measure pulse risetime between 10% and 90% points (dotted lines on CRT). Risetime should be less than 10 ns.

g. Connect squarewave generator output to channel B INPUT.

h. Set DISPLAY to B.

i. Repeat steps b through f for channel B risetime.

j. Remove test equipment.

k. To return to initial settings, set Model 1702A controls as follows:

DISPLAY..... A
TIME/DIV ..... 5 uSEC
SWP MAG..... X1

l. Refer to paragraph 5-180 and schematics 8, 4, 5, and 6 if risetime specifications are not met.

5-28. BANDWIDTH.

5-29. Specification. (Direct or with Model 10006B Probe, 3dB down from 50 kHz, 6div reference signal from a terminated 50-ohm source.) DC coupled: dc to 35 MHz, AC coupled: 10 Hz to 35 MHz.

5-30. Description. To check bandwidth, a constant-amplitude signal generator is used to apply a 6-div, 50-kHz reference signal to the Model 1702A input. The constant-amplitude signal generator frequency is increased to 35 MHz. The signal amplitude displayed on the CRT must always be equal to or greater than 4.3 div to meet bandwidth specifications. This measurement is made direct but may be made with Model 10006B Probe.

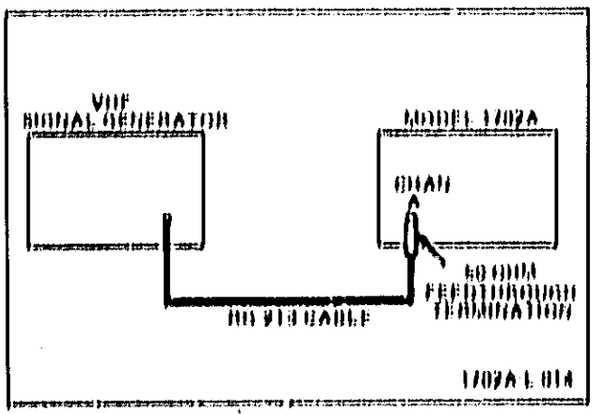


Figure 6-4. Bandwidth Test Setup

6-31. Equipment.

a. VHF Signal Generator.

b. BNC 910 Cable.

c. 50-ohm Feedthrough Termination.

6-32. Procedure.

a. Connect instruments as shown in figure 6-4.

b. Set VHF signal generator controls for 60 mV, 1 kHz output signal.

c. Adjust TRIGGER LEVEL for stable display.

d. Adjust VHF signal generator voltage vernier for 6-div vertical display.

e. Set VHF generator controls for frequency output of 40 MHz. Vertical display on CRT should be equal to or greater than 4.8 div.

f. Connect VHF signal generator to channel B.

g. Set DISPLAY to B.

h. Repeat steps b through e for channel B.

i. Remove test equipment.

j. To return to initial settings, set DISPLAY to A.

k. Refer to schematics 6 through 7 if either channel does not meet bandwidth specification.

6-33. INPUT RESISTANCE.

6-34. Specification. This input is 1 megohm ±2% shunted by approximately 27 pF.

6-35. Description. The input resistance is measured with an ohmmeter to verify resistance.

6-36. Equipment.

a. Multifunction Digital Voltmeter.

b. BNC Cable, 11 in.

c. Banana-jack to BNC Adapter.

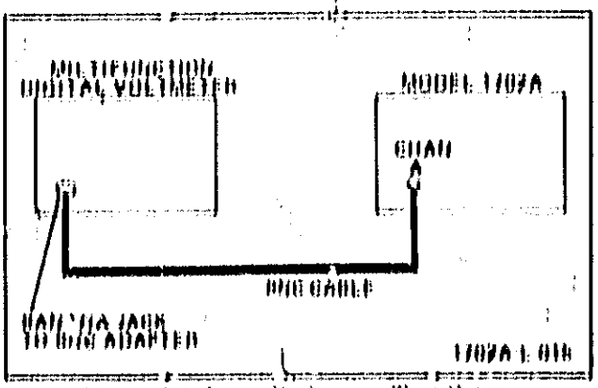


Figure 6-5. Input Resistance Test Setup

6-37. Procedure.

a. Connect instruments as shown in figure 6-5.

b. Set Model 1702A controls as follows:

channel A coupling ..... DC
channel B coupling ..... DC

c. Set multifunction digital voltmeter controls to measure 10 megohms.

Note

Use a digital voltmeter range having an output voltage less than 0.6V. The input circuit is protected against voltages in excess of 0.6V and will give a lower resistance reading if this voltage is exceeded.

d. Connect BNC cable to channel A INPUT. Multifunction digital voltmeter should indicate 1 megohm ±2%.

e. Check all CHANNEL A VOLTS/DIV ranges per table 6-6.

f. Move BNC cable from channel A to channel B. Multifunction digital voltmeter should indicate 1 megohm ±2%.

g. Check all CHANNEL B VOLTS/DIV ranges per table 6-6.

Table 6-6. Input Resistance

VOLTS DIV Setting	Min	Actual	Max
.01	0.98 megohm		1.02 megohm
.05	0.98 megohm		1.02 megohm
.1	0.98 megohm		1.02 megohm
.5	0.98 megohm		1.02 megohm
1	0.98 megohm		1.02 megohm
5	0.98 megohm		1.02 megohm
10	0.98 megohm		1.02 megohm
50	0.98 megohm		1.02 megohm

h. Remove test equipment.

i. To return to initial settings, set Model 1709A controls as follows:

CHANNEL A VOLTS DIV ..... .01
CHANNEL B VOLTS DIV ..... .01
channel A coupling ..... AC
channel B coupling ..... AC

j. Refer to schematic 8 and CRT input resistance specification is not met.

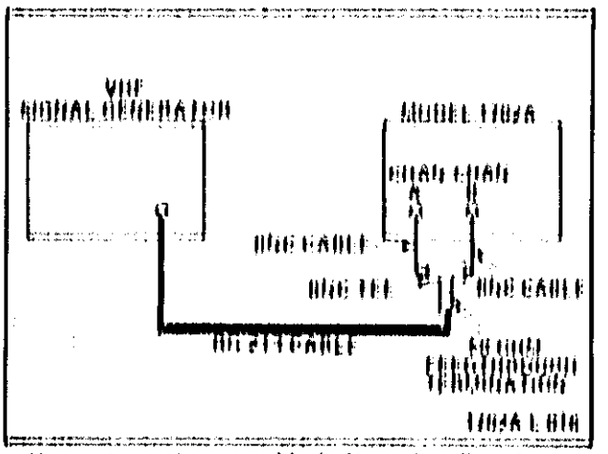


Figure 6-6. Common Mode Rejection Test Setup

6-38. COMMON MODE REJECTION RATIO (CMRR).

a. Specification. Frequency shall be 1 MHz. CMRR at least 10 dB on 10 mV div range, at least 20 dB on all other ranges with controls set for optimum rejection. Common mode signal amplitude equal to 10 div.

b. Description. This measurement is made by applying identical signals to channel A and channel B, and operating in the A+B CH POLARITY INVT mode. The signal display on the CRT will be the common mode signal.

c. Equipment.

a. VHF Signal Generator.

b. BNC Cable, 6 in.

c. BNC Tee.

d. BNC Cable.

e. 50-ohm Feedthrough Termination.

d. Procedure.

a. Connect instruments as shown in figure 6-6.

b. Set CHANNEL A VOLTS DIV to .05.

c. Set VHF signal generator controls for 50 MHz, 0.8V p-p signal as viewed on Model 1709A CRT.

d. Set DISPLAY switch to A+B.

e. Set CHANNEL A VOLTS DIV to .01.

f. Set B POLARITY to INVT. Display should be less than 0.2 div.

g. Increase VHF signal generator frequency to 1 MHz. Display should be less than 0.2 div.

h. For all other vertical sensitivity ranges (VOLTS DIV), 10 div of signal at 1 MHz applied to channel A and channel B INPUT will result in a deflection factor equal to or less than 2 div. Deflection factor to be with channel A and channel B controls adjusted for optimum rejection.

i. Remove test equipment.

j. To return to initial settings, set Model 1709A controls as follows:

DISPLAY ..... A
B POLARITY ..... NORM
channel A coupling ..... DC
channel B coupling ..... DC

k. Refer to schematic 8 through 11 if CMRR specification is not met.

6-43. CASCADED AMPLIFIER GAIN.

a. Specification. Amplifier gain shall be 10 ±1%.

b. Description. Gain is checked by connecting channel A OUTPUT to channel B INPUT, inserting a known amplitude, 1 MHz signal into channel A INPUT and observing CRT deflection.

5-16. Equipment

a. Voltmeter Calibrator

b. BNC Cable, 11 in.

c. BNC Cable, 8 in.

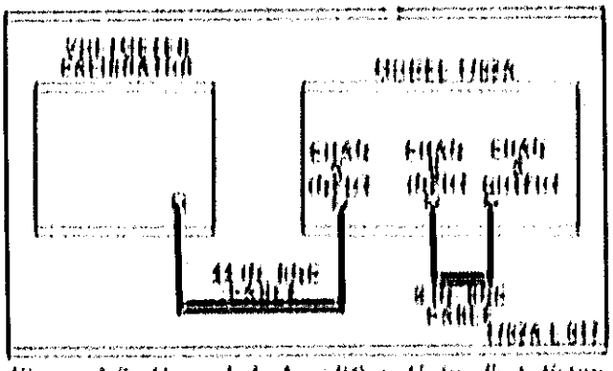


Figure 5-7. Cascaded Amplifier Gain Test Setup

5-17. Procedure

a. Set instruments up as shown in figure 5-7.

b. Set Model 1706A controls as follows:

DISPLAY ..... B
mode TIME/DIV ..... To observe equivalent number of cycles

c. Set voltmeter calibrator controls for 6 mV signal.

d. Observe CRT. Vertical deflection shall be 6 div ±0.6 div.

e. Remove test equipment.

f. To return to initial settings, set Model 1706A controls as follows:

mode TIME/DIV ..... 0.5 MSEC
DISPLAY ..... A

g. Refer to paragraph 5-18 and schematic 6 if specification is not met.

5-18. CASCADED AMPLIFIER BANDWIDTH

5-19. Specification. Cascaded bandwidth shall be 6 MHz.

5-20. Description. Bandwidth is checked by inserting first a 60 kHz signal, and then a 6 MHz signal into channel A (CH1) and comparing output deflection on the CRT.

5-21. Equipment

a. VHF Signal Generator

b. BNC 50-Ω Cable

c. Feedthru Feedthrough Termination

d. BNC Cable, 6 in.

5-22. Procedure

a. Connect instruments as shown in figure 5-8.

b. Set Model 1706A controls as follows:

DISPLAY ..... B
mode TIME/DIV ..... To observe equivalent number of cycles

c. Set VHF signal generator controls for 60 kHz output signal.

d. Adjust VHF signal generator output amplitude for 6 div of trace deflection.

e. Change VHF signal generator frequency to 6 MHz. Observe CRT; deflection shall be 4.2 div or greater.

f. Remove test equipment.

g. To return to initial settings, set Model 1706A controls as follows:

mode TIME/DIV ..... 0.5 MSEC
DISPLAY ..... A

h. Refer to schematic 6 if specification is not met.

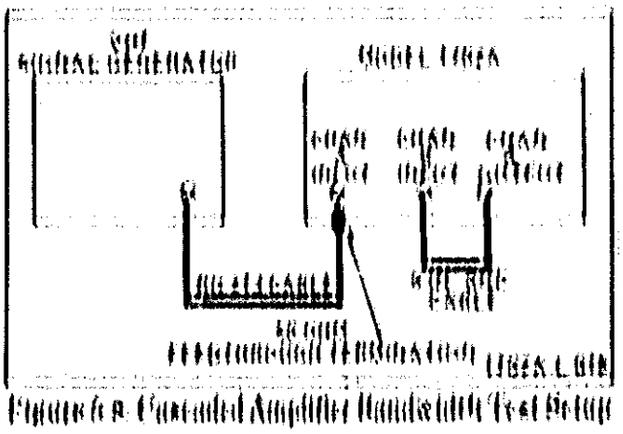


Figure 5-8. Cascaded Amplifier Bandwidth Test Setup

6-43. SWEEP TIME:

a. Specifications. From 0.1 sec/div to 1 sec/div the accuracy is ±3% with VERNIER in CAL position. Vernier continuously variable between all ranges, extends sweep rates to at least 2.5 times the setting. Vernier in CAL position indicates when VERNIER is set to calibrated sweep rate. Expands all ranges by a factor of 10 and extends the fastest sweep speed to 10 ns/div. Accuracy is ±3% including ±1% accuracy of time base.

b. Description. The instrument time base is triggered against a time mark generated to create specific calibrations.

c. Equipment.

a. Time mark generator

b. BNC Cable 11 cm

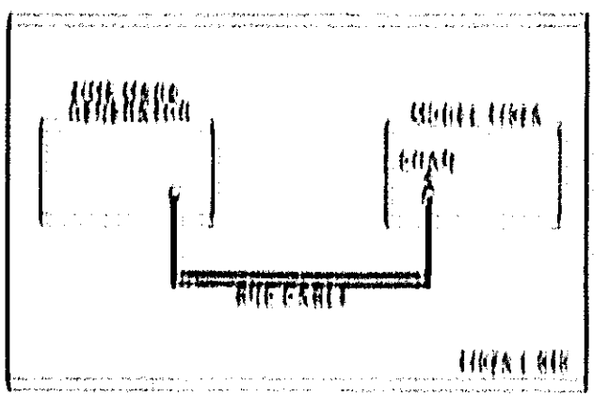


Figure 6-11. Sweep Time Test Setup

d. Procedure.

a. Connect instruments as shown in figure 6-11.

b. Set Model 1706A controls as follows:

CHANNEL A VOLTS/DIV ..... as required for recognizable display

TIME/DIV ..... 1 μsec

c. Set time mark generator controls for 0.1 usec time mark output.

d. Adjust HORIZONTAL POSITION control so first marker is aligned with first left-hand graticule division. Eleven markers should be present on CRT.

e. Check each of TIME/DIV settings using table 6-6.

Table 6-6. Sweep Performance Check

Time mark generated	TIME/DIV
0.1 usec	1 μsec
0.2 usec	2 μsec
0.5 usec	5 μsec
1 usec	10 μsec
2 usec	20 μsec
5 usec	50 μsec
10 usec	100 μsec
20 usec	200 μsec
50 usec	500 μsec
0.1 msec	1 msec
0.2 msec	2 msec
0.5 msec	5 msec
1 msec	10 msec
2 msec	20 msec
5 msec	50 msec
10 msec	100 msec
20 msec	200 msec
50 msec	500 msec
0.1 sec	1 sec
0.2 sec	2 sec
0.5 sec	5 sec
1 sec	10 sec

1. Set TIME/DIV switch to 1 μsec.

2. Set time mark generator for 1 usec time mark output.

3. Adjust HORIZONTAL POSITION control so first time mark is aligned with first left-hand graticule line. Eleven time marks should appear on CRT.

4. Rotate VERNIER fully ccw. VERNIER LED (CAL light) should be off. Only period between time marks should be less than 9 div.

5. Return VERNIER to CAL position.

6. Set time mark generator for 1 usec time mark output. Eleven time marks should appear on CRT.

7. Set TIME/DIV to 0.1 μsec.

8. Adjust HORIZONTAL POSITION control until left-most time mark aligns with first graticule. Time marks should be in the upper right corner.

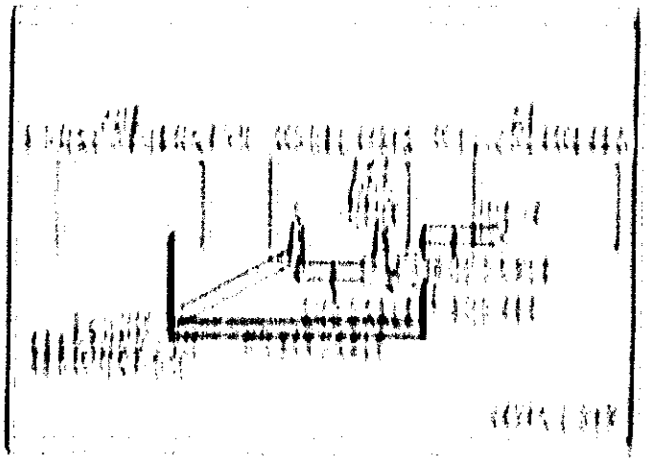
f. Increase test equipment.

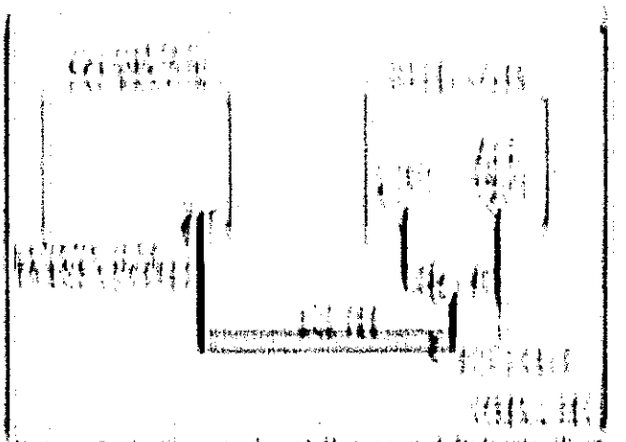
a. To return to initial settings, set Model 1706A controls as follows:

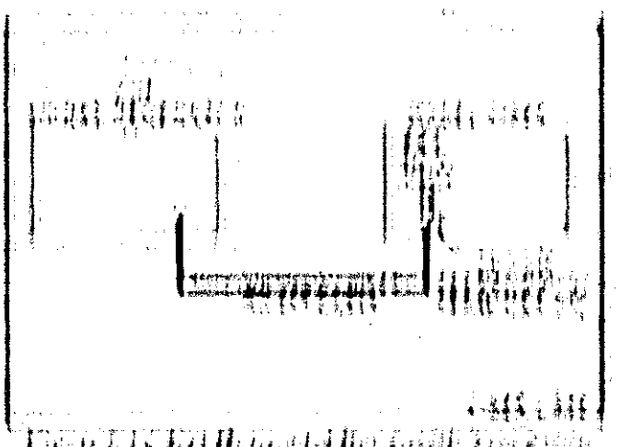
CHANNEL A VOLTS/DIV ..... as required

TIME/DIV ..... 5 msec

SWP MAG ..... ×1







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PERFORMANCE CHECK RECORD

Instrument Serial Number _____ Date _____

Check	Specification	Measured Chan A	Measured Chan B
DEFLECTION FACTOR			
.01 VOLTS/DIV	5 div ±0.15 div		
.02 VOLTS/DIV	5 div ±0.15 div		
.05 VOLTS/DIV	6 div ±0.18 div		
.1 VOLTS/DIV	5 div ±0.15 div		
.2 VOLTS/DIV	5 div ±0.15 div		
.5 VOLTS/DIV	6 div ±0.18 div		
1 VOLTS/DIV	5 div ±0.15 div		
2 VOLTS/DIV	5 div ±0.15 div		
5 VOLTS/DIV	6 div ±0.18 div		
Channel A Vernier	<2.4 div		
Channel B Vernier	<2.4 div		
CALIBRATOR			
Calibrator Amplitude	6 div ±0.06 div		
Calibrator Frequency	1 kHz ±10%		
RISETIME			
Channel A Risetime	<10 ns		
Channel B Risetime	<10 ns		
BANDWIDTH			
Channel A Bandwidth	>4.3 div		
Channel B Bandwidth	>4.3 div		
INPUT RESISTANCE			
Channel A Resistance			
.01 VOLTS/DIV	1±0.02 megohm		
.02 VOLTS/DIV	1±0.02 megohm		
.05 VOLTS/DIV	1±0.02 megohm		
.1 VOLTS/DIV	1±0.02 megohm		
.2 VOLTS/DIV	1±0.02 megohm		
.5 VOLTS/DIV	1±0.02 megohm		
1 VOLTS/DIV	1±0.02 megohm		
2	1±0.02 megohm		
5 VOLTS/DIV	1±0.02 megohm		

PERFORMANCE CHECK RECORD

Instrument Serial Number _____ Date _____

Check	Specification	Measured
Channel B Resistance		
.01 VOLTS/DIV	1±0.02 megohm	_____
.02 VOLTS/DIV	1±0.02 megohm	_____
.05 VOLTS/DIV	1±0.02 megohm	_____
.1 VOLTS/DIV	1±0.02 megohm	_____
.2 VOLTS/DIV	1±0.02 megohm	_____
.5 VOLTS/DIV	1±0.02 megohm	_____
1 VOLTS/DIV	1±0.02 megohm	_____
2 VOLTS/DIV	1±0.02 megohm	_____
5 VOLTS/DIV	1±0.02 megohm	_____
COMMON MODE REJECTION RATIO (CMRR)		
CMRR (50 kHz/0.01 volts/div)	<0.3 div	_____
CMRR (1 MHz/0.01 volts/div)	<0.3 div	_____
CASCADED AMPLIFIER GAIN	5.0 ±0.15 div	_____
CASCADED AMPLIFIER BANDWIDTH	>4.3 div	_____
SWEEP TIME		
.1 uSEC	11 in 10 div ±0.3 div	_____
.2 uSEC	11 in 10 div ±0.3 div	_____
.5 uSEC	11 in 10 div ±0.3 div	_____
1 uSEC	11 in 10 div ±0.3 div	_____
2 uSEC	11 in 10 div ±0.3 div	_____
5 uSEC	11 in 10 div ±0.3 div	_____
10 uSEC	11 in 10 div ±0.3 div	_____
20 uSEC	11 in 10 div ±0.3 div	_____
50 uSEC	11 in 10 div ±0.3 div	_____
.1 mSEC	11 in 10 div ±0.3 div	_____
.2 mSEC	11 in 10 div ±0.3 div	_____
.5 mSEC	11 in 10 div ±0.3 div	_____
1 mSEC	11 in 10 div ±0.3 div	_____
2 mSEC	11 in 10 div ±0.3 div	_____
5 mSEC	11 in 10 div ±0.3 div	_____
10 mSEC	11 in 10 div ±0.3 div	_____
20 mSEC	11 in 10 div ±0.3 div	_____
50 mSEC	11 in 10 div ±0.3 div	_____
.1 SEC	11 in 10 div ±0.3 div	_____
.2 SEC	11 in 10 div ±0.3 div	_____
.5 SEC	11 in 10 div ±0.3 div	_____
1 SEC	11 in 10 div ±0.3 div	_____
2 SEC	11 in 10 div ±0.3 div	_____

PERFORMANCE CHECK RECORD

Instrument Serial Number _____ Date _____

Check		Specification	Measured
Main Vernier Check		≤2 div	
SWP MAG (X10) Check		10 div ±0,5 div	
TRIGGERING			
Internal Triggering (35 MHz)		✓	
External Triggering (35 MHz)		✓	
Chop Triggering (300 kHz)		✓	
Line Triggering		✓	
TRIGGER LEVEL RANGE AND POLARITY			
Int Trigger Level (+)		✓	
Int Trigger Level (—)		✓	
Ext Trigger Level (+)		—1,2V to +1,2V	
Ext Trigger Level (—)		—1,2V to +1,2V	
EXT HORIZONTAL BANDWIDTH		≥7,2 div	
EXT HORIZONTAL DEFLECTION FACTOR	X1	10 ±0,5 div	
	X10	10 ±0,5 div	
VARIABLE PERSISTENCE			
Minimum Persistence		≤1 div	
Maximum Persistence		≥1 min	
STANDARD WRITING SPEED			
Visible Trace		≥1 min.	
STANDARD STORE TIME			
Visible Trace		≥1 hr	
FAST WRITING SPEED			
Visible Trace		≥15 sec	
MAX STORE TIME			
Visible Trace		≥5 min.	

5-98. ADJUSTMENTS.

5-99. The following paragraphs describe procedures to calibrate the instrument so that it will perform as specified in table 1-1. The entire adjustment procedure can be done in sequence, or any separate adjustment can be calibrated by following the steps outlined in the appropriate paragraph. The locations of adjustment controls are shown in a photograph included at the end of the section on a foldout page.

5-100. Use a nonmetallic screwdriver and recently calibrated test equipment with characteristics as specified in table 5-1. After adjustments are complete, check instrument performance by doing the performance check procedure at the beginning of this section.

5-101. Set Model 1702A front panel controls to those positions given in paragraph 5-10. Remove top and bottom covers.

5-102. ADJUSTMENT PROCEDURES.

5-103. LOW VOLTAGE POWER SUPPLY ADJUST.

5-104. Reference. Schematics 18, 19, and 20 figures 5-15, 8-38, 8-39, and 8-40.

5-105. Description. The +15V is the only regulated voltage in this instrument. The rest of the voltages in this instrument are referenced to +15V. The voltage accuracy is set by using a digital voltmeter to monitor the +15V.

5-106. Equipment.

a. Digital Voltmeter.

b. Test Leads.

5-107. Procedure.

a. Connect digital voltmeter to XA4 (gate) pin 6.

WARNING

Power is present in the line rectifier (A2) and low voltage mother board (A3A1) when POWER-ON switch is off.

b. Turn instrument on.

c. Adjust A3A2R3, LOW VOLTAGE ADJ, for voltmeter indication of +15V ±10 mV.

d. Check rest of low voltage power supply output voltages as shown in table 5-5.

Table 5-5. Power Supply Voltage Limits

Supply	Test Point	Limits
+15V	XA4 Pin 6	+14.99V +15.01V
−15V	XA4 Pin 8	−14.5 V −15.75V
+5V	XA4 Pin 10	+5.1 V +5.0 V
+50V	XA4 Pin 4	+47 V +52 V
−50V	XA4 Pin 12	−47 V −52 V
+80V	XA4 Pin 5	+80 V +80 V
+100V	XA4 Pin 2	+150 V +180 V

5-108. HIGH VOLTAGE POWER SUPPLY ADJUST.

5-109. References. Schematic 17, figures 5-15 and 8-36.

5-110. Description. The high voltage is adjusted to −1850V by comparing it against a known calibrated voltage standard.

5-111. Equipment.

a. Digital Voltmeter.

b. Voltmeter Calibrator.

c. 1000:1 Divider Probe.

5-112. Procedure.

a. Turn power off.

b. Remove A3 power supply module cover.

c. Turn instrument on.

d. Connect digital voltmeter through 1000:1 divider probe to voltmeter calibrator.

e. Set voltmeter calibrator to −100-volt output.

f. Note voltmeter indication.

g. Multiply indication in step f by 18.5.

h. Monitor high voltage on red wire (2) from A3A4 using 1000:1 divider probe and digital voltmeter.

i. Adjust A3A4R1, HIGH VOLTAGE ADJ, for value calculated in step g.

j. Turn instrument off.

k. Disconnect test equipment and replace A3 power supply module cover.

l. Check high voltage power supply circuits on schematic 17 if adjustment cannot be made.

5-118. INTENSITY LIMIT ADJUST.

5-114. Reference. Schematics 11 and 17, figures 5-15 and 8-30.

5-115. Description. The intensity limit adjustment is set so the front panel INTENSITY control has complete range. This range is from extinguished to complete brightness.

5-116. Equipment.

a. Monitor Oscilloscope.

b. 10:1 Divider Probe.

5-117. Procedure.

a. Set Model 1702A TIME/DIV to 1 mSEC.

b. Obtain free-running trace (figure 8-30).

c. Connect monitor oscilloscope to gate output (wire color 1) with 10:1 divider probe.

d. Set monitor oscilloscope controls for slow 10V signal.

e. Set INTENSITY control for 10V pep signal as viewed on monitor oscilloscope.

f. Adjust A9A4R10, INTENSITY LIMIT ADJ, until trace is just extinguished.

g. Turn INTENSITY control cw and verify trace is visible.

h. Disconnect test equipment.

i. Set Model 1702A TIME/DIV to 5 uSEC.

j. Check high voltage power supply circuit on schematic 17 if adjustment cannot be made.

5-118. Y-AXIS ALIGNMENT ADJUSTMENT.

5-118. Reference. Schematic 11, figures 5-15 and 8-30.

5-120. Description. The internal orth adjust is set to align the trace on the Y-axis.

5-121. Equipment.

a. Oscillator.

b. BNC cable, 44 in.

Note

Make sure the horizontal trace is properly aligned before proceeding with this adjustment.

5-122. Procedure.

a. Connect oscillator set for 100kHz, 6-div output to channel A INPUT.

b. Set sweep display to EXT HORIZ INPUT.

c. Adjust HORIZONTAL POSITION until vertical line is centered on CRT screen.

d. Adjust A4R95, orth adjust, until vertical line is aligned on major Y-axis graticule.

e. Disconnect oscillator.

f. Set sweep display to MAIN SWEEP.

g. Refer to schematic 11 if adjustment cannot be made.

5-123. PATTERN ADJUST.

5-124. Reference. Schematic 17, and figure 5-15.

5-125. Description. The CRT geometry is set for minimum barrelling or pincushioning.

5-126. Equipment.

a. Oscillator.

b. BNC cable, 11 in.

5-127. Procedure.

Note

Make sure trace align (paragraph 5-67) is properly set before performing this adjustment.

a. Set Model 1702A controls as follows:

PERSISTENCE ..... CCW
TIME/DIV ..... 1 mSEC
CHANNEL A VOLTS/DIV 1

b. Connect oscillator output to channel A INPUT.

c. Set oscillator controls for 100kHz output signal.

d. Adjust oscillator amplitude control for 5.6 div display on CRT.

e. Adjust INTENSITY control for normal viewing level.

f. Engage CONV pushbutton.

g. Adjust A16R7, pattern adj, for best compromise between distortion of vertical and horizontal edges of CRT display.

h. Disconnect test equipment.

i. To return to initial settings, set Model 1702A controls as follows:

CHANNEL A VOLTS/DIV ..... .01
TIME/DIV ..... 5 MSEC

j. Refer to schematic 17 if adjustment cannot be made.

5-128. GATE AMPLIFIER RESPONSE ADJUST.

5-129. Reference: Schematic 11, figures 5-15 and 8-31.

5-130. Description. The gate amplifier is adjusted for optimum response.

5-131. Equipment:

a. Monitor Oscilloscope.

b. 10:1 Divider Probe.

5-132. Procedure:

a. Set TIME/DIV to 1 MSEC.

b. Connect 10:1 divider probe from monitor oscilloscope to wire (1) on A1 gate assy.

c. Set monitor oscilloscope controls as follows:

coupling ..... DC
all others ..... normal display

d. Adjust INTENSITY control for 20V amplitude pulse as displayed on oscilloscope.

e. Adjust A16R8, gate response adj, for fastest risetime and flattest pulse of positive-going signal.

f. Disconnect test equipment.

g. Set TIME/DIV to 5 MSEC.

h. Set channel A coupling to AC.

i. Refer to schematic 11 if adjustment cannot be made.

5-133. POSITION CENTERING ADJUST.

5-134. Reference: Schematics 1, 5, 6, and 7, figures 5-15 and 5-19.

5-135. Description. Internal controls are adjusted to center the display. This adjustment varies the amplifier dc reference, thus establishing position.

Note

Be sure channel A and channel B DC BAL are properly adjusted (figure 5-7).

5-136. Procedure:

a. Set DISPLAY to B.

b. Center channel B POSITION control.

c. Adjust A6A1R10, B pos centering adj, for no vertical trace shift as B POLARITY switch is changed from NORM to INVT.

d. Adjust A6A1R10, B pol bal adj, to center trace vertically.

e. Set DISPLAY to A.

f. Center channel A POSITION control.

g. Adjust A6A1R10, A pos centering adj, to center trace vertically.

h. Set DISPLAY to A + B.

i. Adjust A6A1R10, A + B bal, to center trace.

j. Set DISPLAY to A.

k. Refer to schematics 1, 5, 6, and 7 if adjustment cannot be made.

5-137. TRIGGER AMPLIFIER BALANCE AND DC LEVEL ADJUST.

5-138. Reference: Schematics 1 and 5, figures 5-15 and 5-19.

5-139. Description. The composite sync adj and channel A sync adj are set so the instrument triggers at the same point on all signals.

5-140. Equipment:

a. Oscillator.

b. BNC Cable, 11 in.

3.111. *Procedure*

a. Connect oscillator to channel A INPUT.

b. Set CHANNEL A VOLTS DIV to 1.

c. Set oscillator to 60 kHz, 6 div output.

d. Set TIME DIV as necessary.

e. Adjust channel A POSITION to center the pulse.

f. Adjust TRIGGER LEVEL until stable triggering at center graticule.

g. Adjust A&A filter, complete steps a through f, until stable triggering at same point as in step f.

h. Set up to A ONLY TRIG.

i. Adjust A&A filter, channel A alone, until stable triggering at same point as in step f.

j. Disconnect test equipment.

k. To return to initial settings, set Model 1709A controls as follows:

CHANNEL A VOLTS DIV	10
TRIGGER MODE	AUTO

l. Refer to schematic 1 and 6 if adjustment cannot be made.

3-149. TRIGGER SENSITIVITY ADJUST.

3.111. *Reference.* Schematic 6, figures 6-16 and 6-24.

3.111. *Description.* Trigger sensitivity is adjusted with a calibrated input to optimize triggering across the entire specified frequency range.

3.113. *Equipment.*

a. Oscillator.

b. BNC Cable, 11 in.

3.114. *Procedure.*

a. Set Model 1709A controls as follows:

CHANNEL A VOLTS DIV	0.1
TIME DIV	As required
TRIGGER MODE	A ONLY TRIG

b. Connect oscillator output to channel A INPUT.

c. Set oscillator controls for 60 kHz, 1 div, sine wave output.

d. Adjust main TRIGGER LEVEL and A&A filter for longest stable trace. Check for obtaining stable triggering on entire range of positive slope without double triggering.

Note

There is a small area at the range of rotation for A&A filter where slope is indeterminate. If optimum high frequency sensitivity is desired, rotate A&A filter to the most counterclockwise position within the allowable range. If optimum low frequency stability is desired, rotate A&A filter to the most clockwise position within the allowable range. The longest sensitivity is set at the factory for optimum high frequency. Longer sensitivity should not cause double triggering within the allowable range.

e. Recheck performance in accordance with paragraph 3.114. Readjust A&A filter if necessary.

f. Disconnect test equipment.

g. To return to initial settings, set Model 1709A controls as follows:

TIME DIV	As required
CHANNEL A VOLTS DIV	0.1
TRIGGER MODE	Desired mode

h. Refer to schematic 6 and 16 if adjustment cannot be made.

3-147. SWEEP LENGTH ADJUST.

3.115. *Reference.* Schematic 14, figures 6-15 and 6-20.

3.116. *Description.* The horizontal preamplifier is gain adjusted to set for a sweep length of 11 divisions.

3.117. *Procedure.*

a. Adjust A&A filter for display length of 11 divisions. This is accomplished by adjusting A&A filter for display length of 10 divisions, then positioning right end of display 1 division to left and readjusting A&A filter for 11 division display length of 1 division.

b. Refer to schematic 14 if adjustment cannot be made.

6-151. SWEEP TIMING ADJUST

a. (1) Refer to schematic 11 (pages 5-15 and 5-16).

(2) Use equipment that accept light signal inputs and have a sweep time reference light to provide a calibrated sweep.

(3) Equipment

(a) Time mark generator

(b) 0931 Cable (11 in)

(4) Procedure

1. Connect time mark generator to channel A input.

2. Set Model 17054 controls as follows:

[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

3. Set time mark generator for 0.1 sec time mark output.

4. Adjust A SWEEP coil adjust for 11 time mark to left edge.

5. Adjust sweep length per table 5-6.

6. Interpolate final equipment.

7. Terminate initial settings of Model 17054 controls as follows:

[illegible]	[illegible]
[illegible]	[illegible]

8. Refer to schematic 11 of adjustment number to right

6-152. X10 GAIN ADJUST

a. (1) Refer to schematic 10 (pages 5-15 and 5-16).

(2) Use equipment that accept light signal inputs and have a sweep time reference light to provide a calibrated sweep.

(3) Equipment

(a) Time mark generator

(b) 0931 Cable (11 in)

(4) Procedure

1. Connect time mark generator to channel A input.

2. Set Model 17054 controls as follows:

[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

3. Set time mark generator for 0.1 sec time mark output.

4. Adjust A SWEEP coil adjust for 11 time mark to left edge.

5. Adjust sweep length per table 5-6.

6. Interpolate final equipment.

7. Terminate initial settings of Model 17054 controls as follows:

[illegible]	[illegible]
[illegible]	[illegible]

8. Refer to schematic 11 of adjustment number to right

6-153. MAG CENTERING ADJUST

a. (1) Refer to schematic 10 (pages 5-15 and 5-16).

(2) Use equipment that accept light signal inputs and have a sweep time reference light to provide a calibrated sweep.

(3) Equipment

(a) Time mark generator

(b) 0931 Cable (11 in)

(4) Procedure

1. Connect time mark generator to channel A input.

2. Set Model 17054 controls as follows:

[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

3. Set time mark generator for 0.1 sec time mark output.

4. Adjust A SWEEP coil adjust for 11 time mark to left edge.

5. Adjust sweep length per table 5-6.

6. Interpolate final equipment.

7. Terminate initial settings of Model 17054 controls as follows:

[illegible]	[illegible]
[illegible]	[illegible]

8. Refer to schematic 11 of adjustment number to right

Table 5-6. Sweep Time Adjustment

Time Mark	[illegible]	Adjustment	Time Mark
[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

a. [illegible]

b. [illegible]

[illegible]

a. [illegible]

b. [illegible]

[illegible]

c. [illegible]

d. [illegible]

e. [illegible]

f. [illegible]

g. [illegible]

h. [illegible]

[illegible]

i. [illegible]

[illegible] HORIZONTAL LINEARITY ADJUST

[illegible]

[illegible]

[illegible]

a. [illegible]

b. [illegible]

[illegible]

a. [illegible]

b. [illegible]

[illegible]

c. [illegible]

d. [illegible]

[illegible]

e. [illegible]

f. [illegible]

[illegible]

g. [illegible]

[illegible] CALIBRATION ADJUST

[illegible]

[illegible]

[illegible]

a. [illegible]

b. [illegible]

c. [illegible]

[illegible]

a. [illegible]

b. [illegible]

c. [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

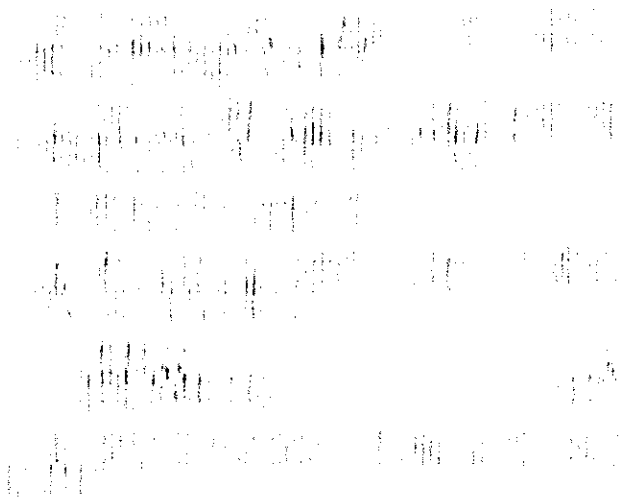
[illegible]

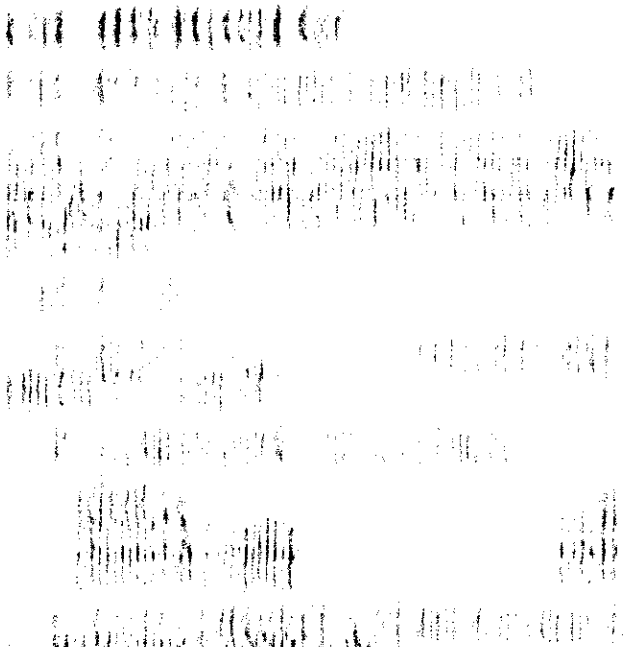
[illegible]

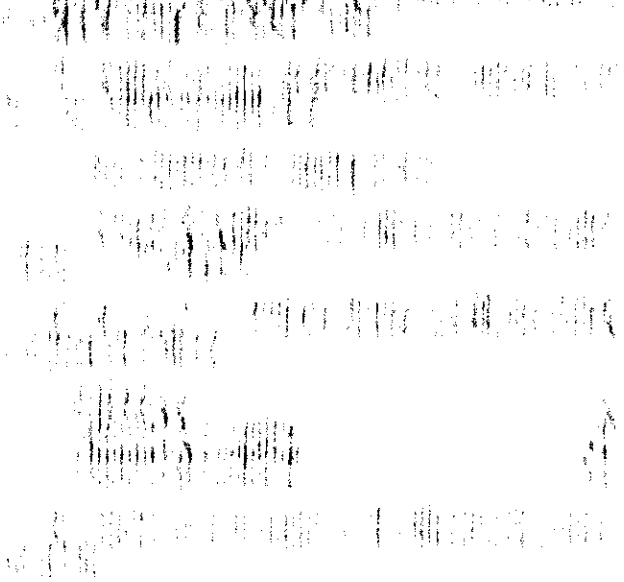
[illegible]

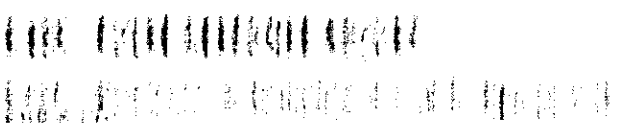
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

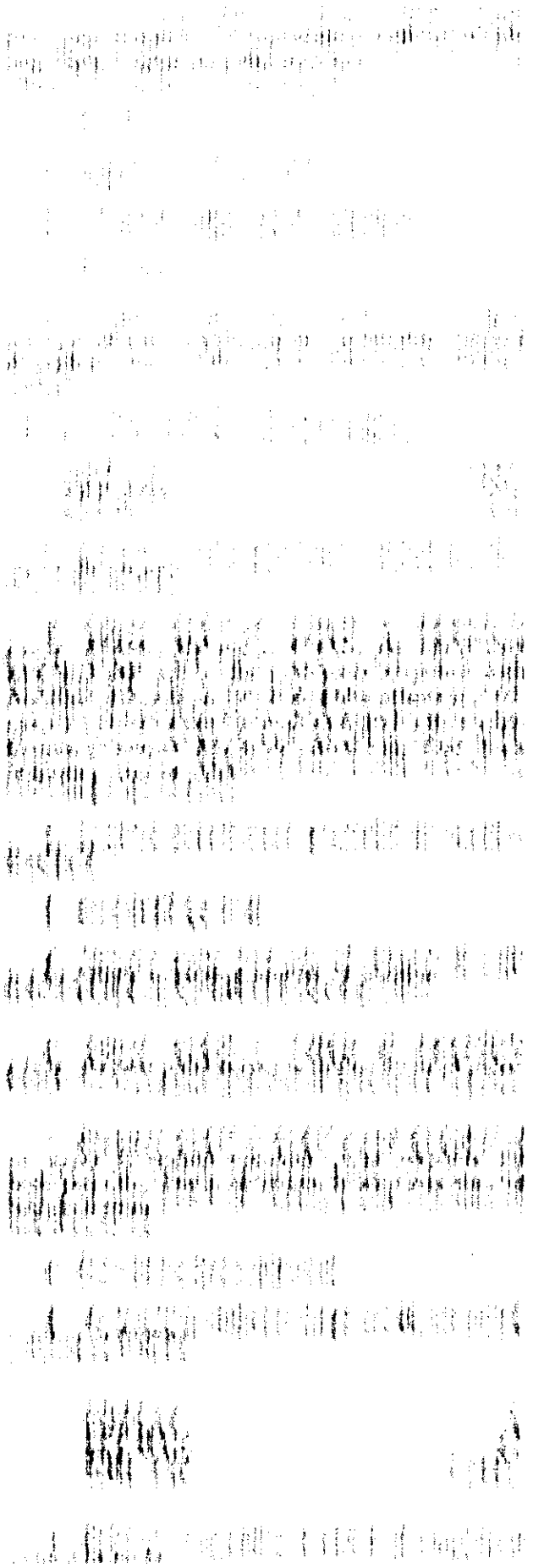
[illegible]











Note

If display fades positive too fast, adjust A8R16, FAST ERASE, cw slightly and repeat steps aa through dd. If display is not stored over entire area, adjust A8R16, FAST ERASE, ccw slightly and repeat steps aa through dd.

ee. Remove test equipment.

ff. To return to initial settings, set Model 1702A controls as follows:

CHANNEL A VOLTS/DIV	.01
TIME/DIV	5 uSEC
WRITING SPEED	STD

gg. Refer to schematics 15 and 16 if adjustment cannot be made.

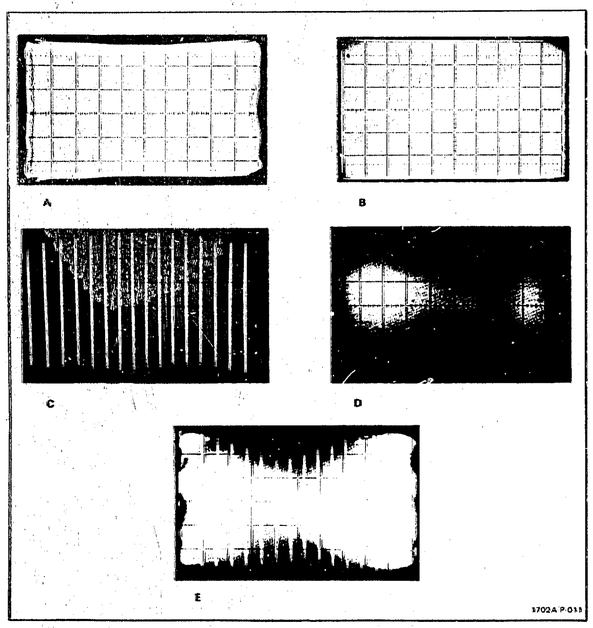


Figure 5-14. Typical CRT Displays

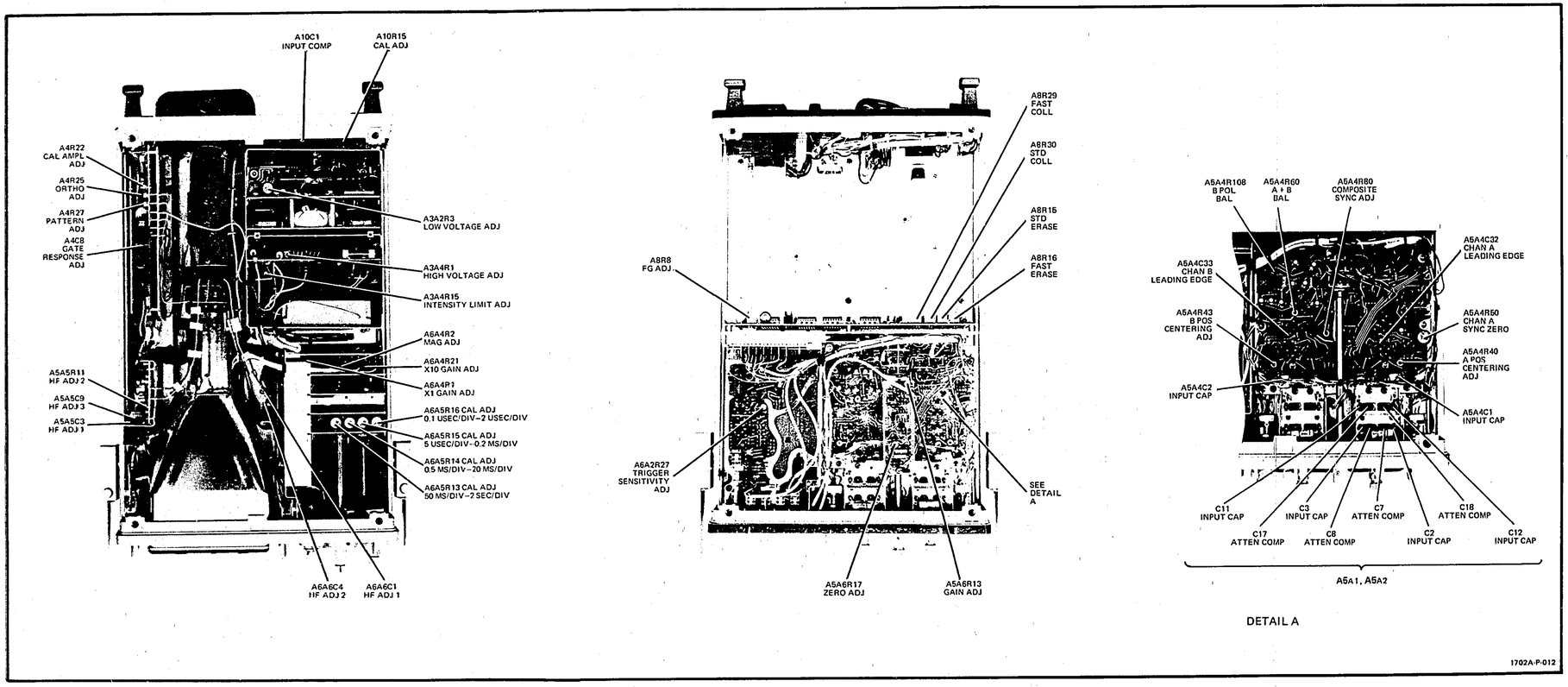


Figure 5-15. Adjustment Locations

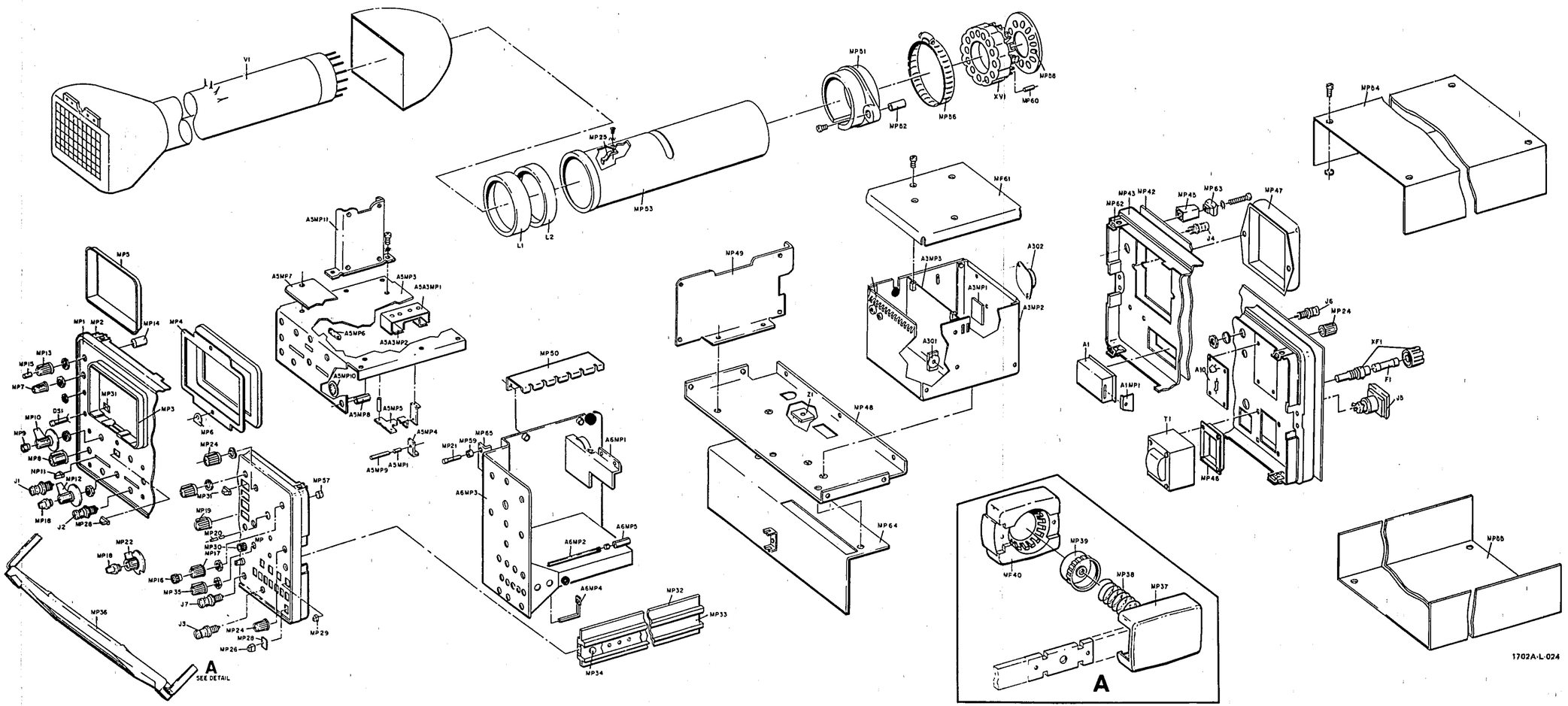


Figure 6-1. Chassis Parts Identification

SECTION VI

REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. The abbreviations used in the parts list are described in table 6-1. Table 6-2 lists the parts in alphanumeric order by reference designator and includes the manufacturer and manufacturer's part number. Table 6-3 contains the list of manufacturers' codes.

6-3. ORDERING INFORMATION.

6-4. To obtain replacement parts from Hewlett-Packard, address order or inquiry to the nearest Hewlett-Packard Sales/Service Office and supply the following information:

a. Instrument model and serial number.

b. HP part number of item(s).

c. Quantity of part(s) desired.

d. Reference designator of part(s).

6-5. To order a part not listed in the table, provide the following information:

a. Instrument model and serial number.

b. Description of the part, including function and location in the instrument.

c. Quantity desired.

Table 6-1. Abbreviations for Replaceable Parts List

A	AMPERE(S)	H	HENRY(IES)	NPN	NEGATIVE POSITIVE NEGATIVE	RWV	REVERSE WORKING VOLTAGE
ASSY	ASSEMBLY	HG	MERCURY	NSR	NOT SEPARATELY REPLACEABLE	SB	SLOW-BLOW
BD	BOARD(S)	HP	HEWLETT-PACKARD			SCR	SILICON CONTROLLED RECTIFIER
BH	BINDER HEAD	HZ	HERTZ			SE	SELENIUM
BP	BANDPASS	IF	INTERMEDIATE FREQ	OBD	ORDER BY DESCRIPTION	SEC	SECOND(S)
		IMPG	IMPREGNATED	OH	OVAL HEAD	SECT	SECTION(S)
C	CENTI (10^{-2})	INCD	INCANDESCENT	OX	OXIDE	SI	SILICON
CAR	CARBON	INCL	INCLUDE(S)			SIL	SILVER
CCW	COUNTERCLOCKWISE	INS	INSULATION(IZED)	P	PEAK	SL	SLIDE
CER	CERAMIC	INT	INTERNAL	PC	PRINTED (ETCHED) CIRCUIT(S)	SP	SINGLE POLE
CMO	CABINET MOUNT ONLY					SPL	SPECIAL
COAX	COAXIAL	K	KILO (10^{3})	PF	PICOFARADS	ST	SINGLE THROW
COEF	COEFFICIENT	KG	KILOGRAM	PHL	PHILLIPS	STD	STANDARD
COMP	COMPOSITION			PIV	PEAK INVERSE VOLTAGE(S)	TA	TANTALUM
CONN	CONNECTOR(S)	LB	POUND(S)	PNP	POSITIVE NEGATIVE POSITIVE	TD	TIME DELAY
CRT	CATHODE-RAY TUBE	LH	LEFT HAND	P/O	PART OF	TFL	TEFLON
CW	CLOCKWISE	LIN	LINEAR TAPER	PORC	PORCELAIN	TGL	TOGGLE
		LOG	LOGARITHMIC TAPER	POS	POSITION(S)	THYR	THYRISTOR
D	DECI (10^{-1})	LPF	LOW-PASS FILTER(S)	POT	POTENTIOMETER(S)	TI	TITANIUM
DEPC	DEPOSITED CARBON	LVR	LEVER	P-P	PEAK-TO-PEAK	TNLDIO	TUNNEL DIODE(S)
DP	DOUBLE POLE			PRGM	PROGRAM	TOL	TOLERANCE
DT	DOUBLE THROW	M	MILLI (10^{-3})	PS	POLYSTYRENE	TRIM	TRIMMER
		MEG	MEGA (10^{6})	PWV	PEAK WORKING VOLTAGE	U	MICRO (10^{-6})
ELECT	ELECTROLYTIC	MET FILM	METAL FILM				
ENCAP	ENCAPSULATED	MET OX	METAL OXIDE			V	VOLTS
EXT	EXTERNAL	MFR	MANUFACTURER	RECT	RECTIFIER(S)	VAR	VARIABLE
		MINAT	MINIATURE	RF	RADIO FREQUENCY	VDCW	DC WORKING VOLTS
F	FARAD(S)	MOM	MOMENTARY	RFI	RADIO FREQUENCY INTERFERENCE	W	WATT(S)
FET	FIELD-EFFECT TRANSISTOR(S)	MTG	MOUNTING	RH	ROUND HEAD OR RIGHT HAND	W/	WITH
FH	FLAT HEAD	MY	MYLAR	RMO	RACK MOUNT ONLY	WIV	WORKING INVERSE VOLTAGE
FIL H	FILLISTER HEAD	N	NANO (10^{-9})	RMS	ROOT-MEAN-SQUARE	W/O	WITHOUT
FXD	FIXED	N/C	NORMALLY CLOSED			WW	WIREWOUND
		NE	NEON				
G	GIGA (10^{9})	N/O	NORMALLY OPEN				
GE	GERMANIUM	NOP	NEGATIVE POSITIVE ZERO (ZERO TEMPER ATURE COEFFICIENT)				
GL	GLASS						
GRD	GROUNDED						

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

See introduction to this section for ordering information

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

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

See introduction to this section for ordering information

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

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number

For information on how to order parts, see introduction to this section.

Table [illegible]. Replaceable Parts (Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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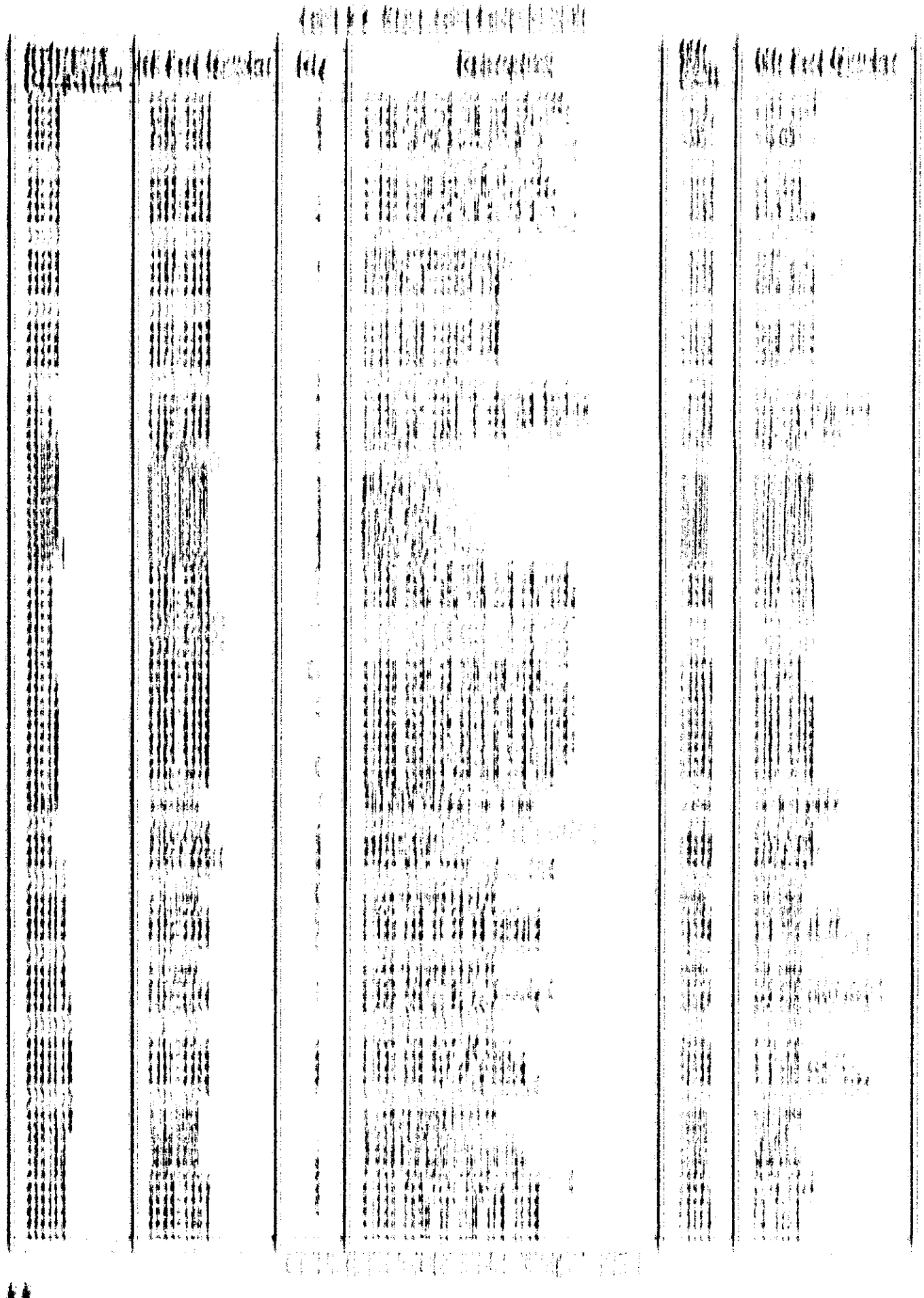

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Table 6-2. Replaceable Parts (Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A5A4R40	2100-2497		R:VAR WW 2000 OHM 10% 6PC LZ4W	28480	2100-2497
A5A4R41	0757-0438		R:FXD MET FLM 4750 OHM 1% .4W F	28480	0757-0438
A5A4R42	0686-1021		R:FXD COMP 1000 OHM 10% .5W	01121	CB 1021
A5A4R43	0686-1021		R:FXD COMP 1000 OHM 10% .5W	01121	CB 1021
A5A4R44	0686-1015		R:FXD COMP 150 OHM 10% .5W	01121	CB 1515
A5A4R45	0757-1094	2	R:FXD MET FLM 2.49K OHM 1% .4W F	28480	0757-1094
A5A4R46	0757-0410	2	R:FXD MET FLM 301 OHM 1% .4W F	28480	0757-0410
A5A4R47	0757-0410		R:FXD MET FLM 301 OHM 1% .4W F	28480	0757-0410
A5A4R48	0757-1094		R:FXD MET FLM 2.49K OHM 1% .4W F	28480	0757-1094
A5A4R49	0757-0282	1	R:FXD MET FLM 422 OHM 1% .4W F	28480	0757-0282
A5A4R50	0686-3901		R:FXD COMP 39 OHM 10% .5W	01121	CB 3901
A5A4R51	0686-3901		R:FXD COMP 39 OHM 10% .5W	01121	CB 3901
A5A4R52	0686-3901		R:FXD COMP 39 OHM 10% .5W	01121	CB 3901
A5A4R53	0686-3901		R:FXD COMP 39 OHM 10% .5W	01121	CB 3901
A5A4R54	0686-3901		R:FXD COMP 39 OHM 10% .5W	01121	CB 3901
A5A4R55	0686-3901		R:FXD COMP 39 OHM 10% .5W	01121	CB 3901
A5A4R56	0686-3901		R:FXD COMP 39 OHM 10% .5W	01121	CB 3901
A5A4R57	0757-0283		R:FXD MET FLM 2.00K OHM 1% .4W F	28480	0757-0283
A5A4R58	0686-3901		R:FXD COMP 39 OHM 10% .5W	01121	CB 3901
A5A4R59	0698-3136	1	R:FXD MET FLM 17.4K OHM 1% .4W F	28480	0698-3136
A5A4R60	2100-2030		R:VAR WW 20K OHM 10% 6PC LZ4W	28480	2100-2030
A5A4R61	0757-0463	3	R:FXD MET FLM 392 OHM 1% .4W F	28480	0757-0463
A5A4R62	0757-0452	1	R:FXD MET FLM 27.4K OHM 1% .4W F	28480	0757-0452
A5A4R63	0686-3901		R:FXD COMP 39 OHM 10% .5W	01121	CB 3901
A5A4R64	0757-0279		R:FXD MET FLM 3.01K OHM 1% .4W F	28480	0757-0279
A5A4R65	0686-3321		R:FXD COMP 3300 OHM 10% .5W	01121	CB 3321
A5A4R66	0757-0419	1	R:FXD MET FLM 681 OHM 1% .4W F	28480	0757-0419
A5A4R67	0757-0417	1	R:FXD MET FLM 562 OHM 1% .4W F	28480	0757-0417
A5A4R68	0686-1001		R:FXD COMP 100 OHM 10% .5W	01121	CB 1011
A5A4R69	0686-2201		R:FXD COMP 220 OHM 10% .5W	01121	CB 2211
A5A4R70	0757-0434	2	R:FXD MET FLM 3.09K OHM 1% .4W F	28480	0757-0434
A5A4R71	0757-0402	1	R:FXD MET FLM 910 OHM 1% .4W F	28480	0757-0402
A5A4R72	0686-2201		R:FXD COMP 220 OHM 10% .5W	01121	CB 2211
A5A4R73	0757-0442		R:FXD MET FLM 10.0K OHM 1% .4W F	28480	0757-0442
A5A4R74	0757-0400	1	R:FXD MET FLM 90.9 OHM 1% .4W F	28480	0757-0400
A5A4R75	0686-1531		R:FXD COMP 15K OHM 10% .5W	01121	CB 1531
A5A4R76	0686-1531	2	R:FXD COMP 510 OHM 5% .5W	01121	CB 5115
A5A4R77	0686-1531		R:FXD COMP 15K OHM 10% .5W	01121	CB 1531
A5A4R78	0686-3321		R:FXD COMP 3300 OHM 10% .5W	01121	CB 3321
A5A4R79	0686-3321		R:FXD COMP 3300 OHM 10% .5W	01121	CB 3321
A5A4R80	0686-1025	2	R:FXD COMP 1000 OHM 5% .5W	01121	CB 1025
A5A4R81	0686-1021		R:FXD COMP 1000 OHM 10% .5W	01121	CB 1021
A5A4R82	0686-4721		R:FXD COMP 4700 OHM 10% .5W	01121	CB 4721
A5A4R83	0686-1021		R:FXD COMP 1000 OHM 10% .5W	01121	CB 1021
A5A4R84	0686-4721		R:FXD COMP 4700 OHM 10% .5W	01121	CB 4721
A5A4R85	0757-0438		R:FXD MET FLM 4.75K OHM 1% .4W F	28480	0757-0438
A5A4R86	0686-5621	1	R:FXD COMP 5.6K OHM 10% .5W	01121	CB 5621
A5A4R87	0686-5621		R:FXD COMP 5.6K OHM 10% .5W	01121	CB 5621
A5A4R88	2100-2068	1	R:VAR WW 200 OHM 10% 6PC LZ4W	28480	2100-2068
A5A4R89	0757-0400		R:FXD MET FLM 90.9 OHM 1% .4W F	28480	0757-0400
A5A4U1	1820-0044	1	IC:DGTL QUAD 2-INPUT GATE	04713	SG4010BN
A5A4U2	1820-0810	1	IC:DGTL CLOCKED RS MLTSBR	07263	UA9N565DX
A5A4U3	1820-3044	1	IC:DGTL INVERTER/DRIVER 3-INPUT OR	28480	1902-3048
A5A4U4	1820-0760	1	IC:DGTL NONINVERTING D-SRCUSR W CONTACT	01295	SN54ALS50-3A
A5A4U5	1820-0760		IC:DGTL NONINVERTING D-SRCUSR W CONTACT	01295	SN74ALS50-3A
A5A5	0370-0507	1	BOARD ASSY:VOLTMETER BOARD	28480	01702-66503
A5A5C1	0160-3459		C:FXD CER 0.005 UF +80-20% 100VDCW	56289	C023A101E502Z525-COM
A5A5C2	0160-2204	4	C:FXD CER 0.20 UF 500VDCW	72982	301-000-COH0-104C
A5A5C3	0121-0164	4	C:VAR ASM 3-40 24-5 PF 350VDCW	28480	0121-0164
A5A5C4	0140-0193	1	C:FXD MICA 82 PF 5%	28480	0140-0193
A5A5C5	0160-0168	1	C:FXD MY 0.068 UF 10% 200VDCW	56289	192PA682-MRS
A5A5C6	0160-2204		C:FXD CER 0.20 UF 500VDCW	72982	301-000-COH0-104C
A5A5C7	0160-2201		C:FXD CER 200 PF 5% 500VDCW	72982	301-NP0-201 PF
A5A5C8	0180-2203	5	C:FXD TA 22 UF 10% 35VDC	72136	HDM15F106K3C
	or				
	0180-0103		C:FXD MICA 82 PF 5% (FACTORY SELECTED)	28480	0140-0193
A5A5C9	0121-0164		C:VAR ASM 3-40 24-5 PF 350VDCW	28480	0121-0164
A5A5C10	0160-3459		C:FXD CER 0.005 UF +80-20% 100VDCW	56289	C023A101E502Z5525-COH
A5A5C11	0160-3459		C:FXD CER 0.005 UF +80-20% 100VDCW	56289	C023A101E502Z5525-COH
			MTR ASSEMBLED		
A5A5C12	0160-3459		C:FXD CER 0.005 UF +80-20% 100VDCW	56289	C023A101E502Z5525-COH
A5A5C13	0160-3459		C:FXD CER 0.005 UF +80-20% 100VDCW	56289	C023A101E502Z5525-COH
A5A5Q1	1853-0041		TRANSISTOR PNP	80131	2N3640
A5A5Q2	1853-0041		TRANSISTOR PNP	80131	2N3640
A5A5Q3	1853-0203		TRANSISTOR PNP	28480	1853-0203
A5A5Q4	1853-0203		TRANSISTOR PNP	28480	1853-0203
A5A5Q5	1854-0215	4	TRANSISTOR NPN	80131	2N3904

See introduction to this section for ordering information

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

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A5A5Q6	1854-0233		TSTR:SI NPN	80131	2N3866
A5A5Q7	1854-0233		TSTR:SI NPN	80131	2N3866
A5A5Q8	1854-0233		TSTR:SI NPN	80131	2N3866
A5A5R1	0684-1001		R:FXD COMP 1K OHM 10% 1/4W	01121	CB 1021
A5A5R2	0757-0400		R:FXD MET FLM 90.9 OHM 1% 1/8W	28480	0757-0400
A5A5R3	0684-1001		R:FXD COMP 1K OHM 10% 1/4W	01121	CB 1021
A5A5R4	0757-0418	3	R:FXD MET FLM 619 OHM 1% 1/8W	28480	0757-0418
A5A5R5	0684-1001		R:FXD COMP 1K OHM 10% 1/4W	01121	CB 1021
A5A5R6	0757-0732	2	R:FXD MET FLM 909 OHM 1% 1/4W	28480	0757-0732
A5A5R7	0684-3901		R:FXD COMP 39 OHM 10% 1/4W	01121	CB 3901
A5A5R8	0757-0817	4	R:FXD MET FLM 750 OHM 1% 1/2W	28480	0757-0817
A5A5R9	0757-0817		R:FXD MET FLM 750 OHM 1% 1/2W	28480	0757-0817
A5A5R10	0757-0426	1	R:FXD MET FLM 750 OHM 1% 1/8W	28480	0757-0426
A5A5R11	2100-1984	1	R:VAR FLM 10K OHM 10% LIN 1/2W	28480	2100-1984
A5A5R12	0757-0438		R:FXD MET FLM 5.11K OHM 1% 1/8W	28480	0757-0438
A5A5R13	0757-0290		R:FXD MET FLM 6.19K OHM 1% 1/8W	28480	0757-0290
A5A5R14	0698-3430	2	R:FXD MET FLM 21.5 OHM 1% 1/8W	28480	0698-3430
A5A5R15	0757-0400		R:FXD MET FLM 90.9 OHM 1% 1/8W	28480	0757-0400
A5A5R16	0757-0799	1	R:FXD MET FLM 121 OHM 1% 1/2W	28480	0757-0799
A5A5R17	0757-0334	1	R:FXD MET FLM 301 OHM 1% 1/4W	28480	0757-0334
A5A5R18	0698-3430		R:FXD MET FLM 21.5 OHM 1% 1/8W	28480	0698-3430
A5A5R19	0757-0413		R:FXD MET FLM 392 OHM 1% 1/8W	28480	0757-0413
A5A5R20	0757-0290		R:FXD MET FLM 6.19K OHM 1% 1/8W	28480	0757-0290
A5A5R21	0684-1011		R:FXD COMP 100 OHM 10% 1/4W	01121	CB 1011
A5A5R22	0684-1011		R:FXD COMP 100 OHM 10% 1/4W	01121	CB 1011
A5A5R23	0757-0400		R:FXD MET FLM 90.9 OHM 1% 1/8W	28480	0757-0400
A5A5R24			NOT ASSIGNED		
A5A5R25	0757-0418		R:FXD MET FLM 619 OHM 1% 1/8W	28480	0757-0418
A5A5R26			NOT ASSIGNED		
A5A5R27	0684-3901		R:FXD COMP 39 OHM 10% 1/4W	01121	CB 3901
A5A5R28	0757-0817		R:FXD MET FLM 750 OHM 1% 1/2W	28480	0757-0817
A5A5R29	0757-0817		R:FXD MET FLM 750 OHM 1% 1/2W	28480	0757-0817
A5A5R30	0684-1001		R:FXD COMP 1K OHM 10% 1/4W	01121	CB 1021
A5A5R31	0684-1001		R:FXD COMP 1K OHM 10% 1/4W	01121	CB 1021
A5A5R32	0757-0732		R:FXD MET FLM 909 OHM 1% 1/4W	28480	0757-0732
A5A5VR1	1902-0048	3	DIODE:BREAKDOWN 5.11V 5%	04713	SZ10939-98
A5A5VR2	1902-0041		DIODE:BREAKDOWN 5.11V 5%	04713	SZ10939-44
A5A6	01701-66626		BOARD ASSY:CHANNEL A OUTPUT	28480	01701-66626
A5A6C1	0180-0374	3	C:FXD TANT, 10 UF 10% 20VDCW	56289	150D106X902082 DYS
A5A6C2	0180-0374		C:FXD TANT, 10 UF 10% 20VDCW	56289	150D106X902082 DYS
A5A6C3	0160-3443		C:FXD CER 0.1 UF +80-20% 50VDCW	72982	8131-050-651-104Z
A5A6C4	0160-3443		C:FXD CER 0.1 UF +80-20% 50VDCW	72982	8131-050-651-104Z
A5A6Q1	1855-0086		TSTR:FET (MATCHED PAIR)	28480	1855-0086
A5A6Q2	1855-0086		TSTR:FET (MATCHED PAIR)	28480	1855-0086
A5A6Q3	1853-0036		TSTR:SI PNP	80131	2N3906
A5A6Q4	1854-0215		TSTR:SI NPN	80131	2N3904
A5A6R1	0684-2211		R:FXD COMP 220 OHM 10% 1/4W	01121	CB 2211
A5A6R2	0684-2211		R:FXD COMP 220 OHM 10% 1/4W	01121	CB 2211
A5A6R3	0684-1021		R:FXD COMP 1000 OHM 10% 1/4W	01121	CB 1021
A5A6R4	0757-0438		R:FXD MET FLM 5.11K OHM 1% 1/8W	28480	0757-0438
A5A6R5	0757-0454		R:FXD MET FLM 33.2K OHM 1% 1/8W	28480	0757-0454
A5A6R6	0757-0446	9	R:FXD MET FLM 15.0K OHM 1% 1/8W	28480	0757-0446
A5A6R7	0684-2231	38	R:FXD COMP 22K OHM 10% 1/4W	01121	CB 2231
A5A6R8	0757-0446		R:FXD MET FLM 15.0K OHM 1% 1/8W	28480	0757-0446
A5A6R9	0684-1541	4	R:FXD COMP 150K OHM 10% 1/4W	01121	CB 1541
A5A6R10	0684-5621		R:FXD COMP 5.5K OHM 10% 1/4W	01121	CB 5621
A5A6R11	0684-5621		R:FXD COMP 5.6K OHM 10% 1/4W	01121	CB 5621
A5A6R12	0684-3001		R:FXD COMP 30 OHM 10% 1/4W	01121	CB 3001
A5A6R13	2100-2061		R:VAR FLM 200 OHM 10% LIN 1/2W	01121	2100-2061
A5A6R14	0757-0410		R:FXD MET FLM 301 OHM 1% 1/8W	28480	0757-0410
A5A6R15	0684-3001		R:FXD COMP 30 OHM 10% 1/4W	28480	CB 3001
A5A6U1	1820-0216	1	IC:OP. AMP. AVOL=50K MIN.	01121	1820-0216
A6	01702-65802	1	HORIZONTAL AMPLIFIER MODULE	28480	01702-65804
A6DS1	1450-0709		LIGHT:INDICATOR 9V VDC	28480	01702-65804
A6DS2	1450-0709		LIGHT:INDICATOR 9V VDC	72765	6140-1006-003
A6MP1	01701-00609	1	SHIELD: HOLDOFF	72765	6140-1006-003
A6MP2	01701-23706	1	SHAFT: SWITCH EXTENSION	28480	01701-00609
A6MP3	01701-60602	1	SHIELD ASSY: HORIZ	28480	01701-23706
A6MP4	01701-63703	2	SHAFT ASSY: PUSHBUTTON EXTENSION	28480	01701-60602
A6MP5	01830-23201	1	COUPLER: SWITCH EXTENSION	28480	01701-63703
A6R1	2100-1841	1	R:VAR 10K OHM 20% LIN 1/3W	28480	01830-23201
A6R2	2100-3014	1	R:VAR COMP DUAL 2K OHM 20% LIN	28480	2100-1841
A6R3	2100-3015	1	R:VAR COMP 20K OHM 20% 2/1GW	28480	2100-3014
A6R4	2100-3009	1	R:VAR COMP 2K OHM 20% LIN	28480	2100-3015
A6R5	0757-0435	2	R:FXD MET FLM 3.92K OHM 1% 1/8W	28480	2100-3009
A6R6	0757-0283		R:FXD MET FLM 2K OHM 1% 1/8W	28480	0757-0435
A6W1	01701-61006	1	CABLE ASSY:COAX	28480	0757-0283
A6W2	01701-61010	2	CABLE ASSY:COAX	28480	01701-61006
A6A1	01700-66631	1	BOARD ASSY:HORIZONTAL MOTHER	28480	01701-61010
A6A1C1	0160-2207	1	CAPACITOR: FXD 300 PF +5% 300 WVDC	28480	01700-66631
A6A1Q1	1854-0087	1	TSTR:SI NPN	28480	0160-2207
A6A1R1	0757-0433	1	R:FXD MET FLM 3.32K OHM 1% 1/8W	80131	2N3417
				28480	0757-0433

See introduction to this section for ordering information

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

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A6A1R2	0684-3331		R: FXD COMP 33K OHM 10% 1/4W	01121	CB 3331
A6A1R3	0684-1041		R:FXD COMP 100K OHM 10% 1/4W	01121	CB 1041
A6A1R4	0684-1041		R:FXD COMP 100K OHM 10% 1/4W	01121	CB 1041
A6A1R5	0757-0418		R:FXD MET FLM 619 OHM 1% 1/8W	28480	0757-0418
A6A1R6	0757-0283		R:FXD MET FLM 2.00K OHM 1% 1/8W	28480	0757-0283
A6A1R7	0757-0413		R:FXD MET FLM 392 OHM 1% 1/8W	28480	0757-0413
A6A1R8	0684-2221		R:FXD COMP 2200 OHM 10% 1/4W	01121	CB 2221
A6A1R9	0684-1031		R: FXD COMP 10K OHM 10% 1/4W	01121	CB 1031
A6A1R10	0684-2231		RESISTOR: FXD 22K 10% .25W CC TUBULAR	01121	CB 2231
A6A1S1	3101-1410	1	SWITCH:PUSHBUTTON DPDT	71590	PB 1
A6A1S2	3101-1397	1			
A6A1S3			NSS, PART OF A6A1S2		
A6A1S4			NSS, PART OF A6A1S2		
A6A1XA1			NOT ASSIGNED		
A6A1XA2			NOT ASSIGNED		
A6A1XA3	1251-1626	3	CONNECTOR:PC (2 X 12) 24 CONTACT	71785	252-12-30-300
A6A1XA4			NOT ASSIGNED		
A6A1XA5	1251-1626		CONNECTOR:PC (2 X 12) 24 CONTACT	71785	252-12-30-300
A6A1XA6			NOT ASSIGNED		
A6A1XA7	1251-1626		CONNECTOR:PC (2 X 12) 24 CONTACT	71785	252-12-30-300
A6A2	01702-66507	1	BOARD ASSY:TRIGGER	50439	01700-66507
A6A2C1	0170-0043		C:FXD MY 0.1/.22UF 10% 400VDCW	24446	64FDA223
A6A2C2	0140-0203	2	C:FXD MICA 30 PF 5%	28480	0140-0203
A6A2C3	0160-3451		C:FXD CER 0.01 UF +80 -20% 100VDCW	56289	CU23B101F1032525-CDH
A6A2C4	0160-2204		C:FXD MICA 100PF 5%	72136	RDM15F101J3C
A6A2C5	0140-2197	1	C:FXD MICA 10 PF 5%	72136	RDM15C100J3C
A6A2C6	0140-2264		C:FXD MICA 100PF 5%	72136	RDM15F101J3C
A6A2C7	0160-3451		C:FXD CER 0.01 UF +80 -20% 100VDCW	56289	CU23A101L5032525-CDH
A6A2C8	0180-0197		C:FXD ELECT 2.2 UF 10% 20VDCW	56289	1500225X9020A2-DYS
A6A2C9	0160-3453		C:FXD CER 0.05 UF +80 -20% 100VDCW	56289	CU23A101L5032525-CDH
A6A2C10	0160-3453		C:FXD CER 0.05 UF +80 -20% 100VDCW	56289	CU23A101L5032525-CDH
A6A2C11	0160-3453		C:FXD CER 0.05 UF +80 -20% 100VDCW	56289	CU23A101L5032525-CDH
A6A2C12	0160-2514	1	C:FXD CER 0.1 UF +80 -20% 50VDCW	56289	1233C20-CDH-104Z
A6A2CR1	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A6A2CR2	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A6A2CR3	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A6A2CR4	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A6A2CR5	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A6A2CR6	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A6A2CR7	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A6A2CR8	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A6A2Q1	1855-0085		TSTR:FET (MATCHED PAIR)	28480	1855-0085
A6A2Q2			P/O MATCHED PAIR LISTED UNDER A6A2Q1		
A6A2Q3	1854-0296		TSTR:SI NPN	28480	1854-0296
A6A2Q4	1854-0296		TSTR:SI NPN	28480	1854-0296
A6A2Q5	1854-0296		TSTR:SI NPN	28480	1854-0296
A6A2Q6	1854-0296		TSTR:SI NPN	28480	1854-0296
A6A2Q7	1853-0015		TSTR:SI PNP	80131	2N3640
A6A2Q8	1853-0015		TSTR:SI PNP	80131	2N3640
A6A2Q9	1854-0296		TSTR:SI NPN	28480	1854-0296
A6A2Q10	1854-0296		TSTR:SI NPN	28480	1854-0296
A6A2Q11	1853-0036		TSTR:SI PNP	80131	2N3906
A6A2Q12	1853-0036		TSTR:SI PNP	80131	2N3906
A6A2Q13	1853-0036		TSTR:SI PNP	80131	2N3906
A6A2Q14	1853-0036		TSTR:SI PNP	80131	2N3906
A6A2Q15	1854-0215		TSTR:SI NPN	80131	2N3904
A6A2Q16	1853-0049	3	TSTR:SI PNP	28480	1853-0049
A6A2Q17	1853-0049		TSTR:SI PNP	28480	1853-0049
A6A2Q18	1853-0039	1	TSTR:SI PNP	80131	2N3638A
A6A2R1	0684-1041		R:FXD COMP 100K OHM 10% 1/4W	01121	CB 1041
A6A2R2	0757-0367	1	R:FXD MET FLM 10K OHM 1% 1/2W	28480	0757-0367
A6A2R3	0757-0488	3	R:FXD MET FLM 909K OHM 1% 1/8W	28480	0757-0488
A6A2R4	0684-3901		R:FXD COMP 39 OHM 10% 1/4W	01121	CB 3901
*A6A2R5	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A6A2R6	0684-3901		R:FXD COMP 39 OHM 10% 1/4W	01121	CB 3901
A6A2R7	0684-1031		R:FXD COMP 10K OHM 10% 1/4W	01121	CB 1031
A6A2R8	0684-3901		R:FXD COMP 39 OHM 10% 1/4W	01121	CB 3901
A6A2R9	0684-3321		R:FXD COMP 3300 OHM 10% 1/4W	01121	CB 3321
A6A2R10	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A6A2R11	0684-2221		R:FXD COMP 2200 OHM 10% 1/4W	01121	CB 2221
A6A2R12	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A6A2R13	0757-0273		R:FXD MET FLM 3.01K OHM 1% 1/8W	28480	0757-0273
A6A2R14	0698-3446	1	R:FXD MET FLM 383 OHM 1% 1/8W	28480	0698-3446
A6A2R15	0684-3901		R:FXD COMP 39 OHM 10% 1/4W	01121	CB 3901
*A6A2R16	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A6A2R17	0684-3901		R:FXD COMP 39 OHM 10% 1/4W	01121	CB 3901
A6A2R18	0684-1031		R:FXD COMP 10K OHM 10% 1/4W	01121	CB 1031
A6A2R19	0684-3901		R:FXD COMP 39 OHM 10% 1/4W	01121	CB 3901
A6A2R20	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401

See introduction to this section for ordering information

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

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A6A2R21	0757-0401		RESISTOR 100 OHM 1% 1/8W	28480	0757-0401
A6A2R22	0684-3901		RESISTOR 39 OHM 10% 1/4W	01121	CB 3901
A6A2R23	0757-0468	6	RESISTOR 5.11K OHM 1% 1/8W	28480	0757-0468
A6A2R24	0757-0488		RESISTOR 49.9K OHM 1% 1/8W	28480	0757-0488
A6A2R25	0757-0465		RESISTOR 10.0K OHM 1% 1/8W	28480	0757-0465
A6A2R26	0684-2221		RESISTOR 220 OHM 10% 1/4W	01121	CB 2201
A6A2R27	2100-2216	1	RESIST VAR 5K OHM 10% LIN 1/2W	28480	2100-2216
A6A2R28	0757-0429	1	RESISTOR 464K OHM 1% 1/8W	28480	0757-0429
A6A2R29	0757-0401		RESISTOR 100 OHM 1% 1/8W	28480	0757-0401
A6A2R30	0757-0401		RESISTOR 100 OHM 1% 1/8W	28480	0757-0401
A6A2R31	0757-0438		RESISTOR 5.11K OHM 1% 1/8W	28480	0757-0438
A6A2R32	0684-2231	35	RESISTOR 220 OHM 10% 1/4W	01121	CB 2201
A6A2R33	0684-1831		RESISTOR 180 OHM 10% 1/4W	01121	CB 1831
A6A2R34	0698-3361	1			
A6A2R35	0684-2221		RESISTOR 220 OHM 10% 1/4W	01121	CB 2201
A6A2R36	0757-0465		RESISTOR 10.0K OHM 1% 1/8W	28480	0757-0465
A6A2R37	0684-1031		RESISTOR 10K OHM 10% 1/4W	01121	CB 1031
A6A2R38	0684-1011		RESISTOR 100 OHM 10% 1/4W	01121	CB 1011
A6A2R39	0684-1C31		RESISTOR 10K OHM 10% 1/4W	01121	CB 1C31
A6A2R40	0684-3321		RESISTOR 3300 OHM 10% 1/4W	01121	CB 3321
A6A2R41	0684-3901		RESISTOR 39 OHM 10% 1/4W	01121	CB 3901
A6A2R42	0684-1001		RESISTOR 1K OHM 10% 1/4W	01121	CB 1001
A6A2R43	0684-1001		RESISTOR 1K OHM 10% 1/4W	01121	CB 1001
A6A2R44	0684-6811		R-FXD COMP 680 OHM 10% 1/4W	01121	CB 6811
A6A2R45	0757-0401	1	R-FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A6A3	5170I-66614	1	BOARD ASSY:INTERFACE	28480	5170I-66614
A6A3C1	0180-0230		CAPACITOR-FXD TA 10UF 20% 20VDC	56289	150D106X9020B2-DYS
A6A3C2	0180-0230		CAPACITOR-FXD TA 10UF 20% 20VDC	56289	150D106X9020B2-DYS
A6A3C3	0180-0230		CAPACITOR-FXD TA 10UF 20% 20VDC	56289	150D106X9020B2-DYS
A6A3C4	0160-0230		CAPACITOR-FXD TA 10UF 20% 20VDC	56289	150D106X9020B2-DYS
A6A3C5	0160-3451		CAPACITOR-FXD CER DI 470PF 20% 100VDC	56289	1C4230-X7R-P332B26-CDH
A6A3C6	0160-3451		CAPACITOR-FXD CER DI 470PF 20% 100VDC	56289	1C4230-X7R-P332B26-CDH
A6A3C7	0160-2468	1	CAPACITOR-FXD CER DI 1000PF 10% 100VDC	56289	1C4278-Z5U-102A1B2-CDH
A6A3C8	0160-2264	1	CAPACITOR-FXD CER DI 22PF 5% 500VDC	72982	301-000-C0G-220J
A6A3C9	0160-3451		CAPACITOR-FXD CER DI 470PF 20% 100VDC	56289	1C4230-X7R-P332B26-CDH
A6A3C10	0160-2257		CAPACITOR-FXD CER DI 1PF 5% 500VDC	72982	301-000-C0G-1R0J
A6A3C11	0160-2257		CAPACITOR-FXD CER DI 1PF 5% 500VDC	72982	301-000-C0G-1R0J
A6A3CR1	1901-0040		DIODE-SWITCHING 30MA 30NS	07263	FDH108B
A6A3CR2	1901-0040		DIODE-SWITCHING 30MA 30NS	07263	FDH108B
A6A3CR3	1901-0040		DIODE-SWITCHING 30MA 30NS	07263	FDH108B
A6A3CR4	1901-0535	4	DIODE-SWITCHING MOD CAPABLE	28480	1901-0535
A6A3CR5	1901-0040		DIODE-SWITCHING 30MA 30NS	07263	FDH108B
A6A3CR6	1901-0040		DIODE-SWITCHING 30MA 30NS	07263	FDH108B
A6A3CR7	1901-0040		DIODE-SWITCHING 30MA 30NS	07263	FDH108B
A6A3CR8	1901-0040		DIODE-SWITCHING 30MA 30NS	07263	FDH108B
A6A3CR9	1901-0040		DIODE-SWITCHING 30MA 30NS	07263	FDH108B
A6A3CR10	1901-0040		DIODE-SWITCHING 30MA 30NS	07263	FDH108B
A6A3CR11	1901-0040		DIODE-SWITCHING 30MA 30NS	07263	FDH108B
A6A3CR12	1901-0040		DIODE-SWITCHING 30MA 30NS	07263	FDH108B
A6A3CR13	1901-0040		DIODE-SWITCHING 30MA 30NS	07263	FDH108B
A6A3U1	1854-0052		TSTR-SI NPN	80131	2N3563
A6A3U2	1853-0036		TSTR-SI PNP	80131	2N3906
A6A3U3	1854-0092		TSTR-SI NPN	80131	2N3563
A6A3U4	1854-0092		TSTR-SI NPN	80131	2N3563
A6A3U5	1853-0036		TSTR-SI PNP	80131	2N3906
A6A3U6	1853-0276	1	TSTR-SI PNP	28480	1853-0276
A6A3U7	1855-0057	1	TSTR-SI FET N-CHANNEL	28480	1855-0057
A6A3U8	1854-0215		TSTR-SI NPN	80131	2N3904
A6A3U9	1854-0215		TSTR-SI NPN	80131	2N3904
A6A3R1	0684-3901		RESISTOR 39 OHM 10% 1/4W	01121	CB 3901
A6A3R2	0684-3901		RESISTOR 39 OHM 10% 1/4W	01121	CB 3901
A6A3R3	0684-3901		RESISTOR 39 OHM 10% 1/4W	01121	CB 3901
A6A3R4	0684-3901		RESISTOR 39 OHM 10% 1/4W	01121	CB 3901
A6A3R5	0684-1221		RESISTOR 220 OHM 10% 1/4W	01121	CB 2201
A6A3R6	0684-1221		RESISTOR 220 OHM 10% 1/4W	01121	CB 2201
A6A3R7	0684-1031		RESISTOR 10K OHM 10% 1/4W	01121	CB 1031
A6A3R8	0684-2231		RESISTOR 220 OHM 10% 1/4W	01121	CB 2201
A6A3R9	0757-0446	9	RESISTOR 1.62K OHM 1% 1/8W	28480	0757-0446
A6A3R10	0684-1021		RESISTOR 1K OHM 10% 1/4W	01121	CB 1021
A6A3R11	0684-1011		RESISTOR 100 OHM 10% 1/4W	01121	CB 1011
A6A3R12	0684-1011		RESISTOR 100 OHM 10% 1/4W	01121	CB 1011
A6A3R13	0684-2231		RESISTOR 220 OHM 10% 1/4W	01121	CB 2231
A6A3R14	0684-1221		RESISTOR 1.62K OHM 10% 1/4W	01121	CB 1221
A6A3R15	0684-1011		RESISTOR 100 OHM 10% 1/4W	01121	CB 1011
A6A3R16	0684-1031		RESISTOR 10K OHM 10% 1/4W	01121	CB 1031
A6A3R17	0684-2211		RESISTOR 210 OHM 10% 1/4W	01121	CB 2211
A6A3R18	0684-3901		RESISTOR 39 OHM 10% 1/4W	01121	CB 3901

See introduction to this section for ordering information

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

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

See introduction to this section for ordering information

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

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

See introduction to this section for ordering information

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

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]

See introduction to this section for ordering information

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

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number

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

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]

Table 6-3. List of Manufacturers' Codes

Mfr No.	Manufacturer Name	Address	Zip Code
[illegible]	[illegible]	[illegible]	[illegible]

SECTION VII

MANUAL CHANGES AND OPTIONS

7-1. INTRODUCTION.

7-2. This section contains information required to backdate or update this manual for a specific instrument. Descriptions of special options and standard options are also in this section.

7-3. MANUAL CHANGES.

7-4. This manual applies directly to instruments having the same serial prefix shown on the manual title page. If the serial prefix of the instrument is not the same as the one on the title page or covered by an enclosed MANUAL CHANGES sheet, order a copy of Supplement B to the instrument manual (HP Part No. 01702-90904). Supplement B carries information for backdating this manual to cover older instruments. If a MANUAL CHANGES sheet is supplied, make all indicated ERRATA corrections.

7-5. SPECIAL OPTIONS.

7-6. Most customer special application requirements and/or specifications can be met by factory modification of a standard instrument. A standard instrument modified in this way will carry a special option number, such as Model 0000A/Option C01.

7-7. An operating and service manual and a manual insert are provided with each special option instrument. The operating and service manual contains information about the standard instrument. The manual insert for the special option describes the factory modifications required to produce the special option instrument. Amend the operating and service manual by changing it to include all manual insert information. When these changes are made, the operating and service manual will apply to the special option instrument.

7-8. If you have ordered a special option instrument and the manual insert is missing, notify the nearest Hewlett-Packard Sales/Service Office. Be sure to give a full description of the instrument, including the complete serial number and special option number.

7-9. STANDARD OPTIONS.

7-10. Standard options are modifications installed on HP instruments at the factory and are available on request. Table 7-1 lists the Model 1702A standard options.

Table 7-1. Model 1702A Standard Options

Option	Description	HP Part No.
001	Instrument set at factory for 230V operation: Fuse, .25 ASB for 230-volt operation.	Fuse: 2110-0018
012	Standard Model 1702A with Model 10103B Battery Pack.	Model 10103B Battery Pack

SECTION VIII

SCHEMATICS AND TROUBLESHOOTING

8-1. INTRODUCTION.

8-2. This section contains schematics, repair and replacement information, component-identification illustrations, waveforms, and test conditions. Table 8-3 defines symbols and conventions used on the schematics. A disassembly procedure for removing the CRT and instrument modules for repair and replacement is also contained in this section.

8-3. SCHEMATICS.

8-4. Schematics are printed on foldout pages for easy reference to the text and figures in other sections. The schematics are drawn to show the electronic function of the circuits. Any one schematic may include all or part of several different physical assemblies. Non MIL-standard symbols and conventions used in the schematics are defined in table 8-3.

8-5. The schematics are numbered in sequence with a bold number in a box at the lower right-hand corner of each page. These numbers are used to cross reference signal connections between the schematics. At each circuit breaking point, a number in a circle is shown, followed by another number in bold type. The circled number indicates the signal or circuit and the bold number indicates the associated schematic that contains the source or destination of the signal. To find the source or destination of the signal, turn to the indicated schematic and find the circled number in question.

8-6. A table on each schematic lists all components shown on the schematic by reference designation. Component reference designators that have been deleted from the schematic are listed below the table.

8-7. All components within the bordered areas of the schematic are physically located on etched circuit boards. Components not physically located on an etched circuit board are shown in the unbordered areas of the schematic.

8-8. REFERENCE DESIGNATIONS.

8-9. The unit system of reference designations used in this manual is in accordance with the provisions of USA Standard Y32.16-1968, Reference Designations for Electrical and Electronics Parts and Equipments, dated March 1, 1968. Minor variations from the standard, due to design and manufacturing practices, may be noted.

8-10. Each electrical component is assigned a class letter and a number. This letter-number combination is the basic reference designation. Components which are part of an assembly have, in addition to the basic designation, a prefix designation indicating the assembly of which the component is a part. For instance, resistor R23 on assembly A1 is called A1R23.

8-11. Assemblies are numbered consecutively. If an assembly reference designation is assigned and later deleted, that number is not reused.

8-12. COMPONENT LOCATIONS.

8-13. Locations of components on assemblies and subassemblies are illustrated on photographs adjacent to the schematics. Since the schematics are drawn to show function, portions of a particular assembly may appear on several different schematics. The component-location photograph is printed next to the schematic that shows most of the circuitry on the assembly. In some cases, a particular component-location photograph may appear adjacent to more than one schematic.

8-14. Components located on the chassis are identified in figures 8-4 and 8-5. The locations of all adjustments are shown in Section V.

8-15. PREVENTIVE MAINTENANCE.

8-16. Preventive maintenance consists of periodic performance checks, calibration, mechanical inspection, lubrication, and other services designed to prevent breakdown and failure. Performance checks and calibration are covered in Section V of this manual. The other preventive maintenance services are covered in the following paragraphs.

8-17. MECHANICAL INSPECTION.

8-18. Periodically inspect the instrument for damaged components, excess grease, dirt, and corrosion. Look for loose and misaligned assemblies. Ensure that all screws and fasteners are tight and serviceable.

8-19. Refer to the paragraphs in this section on repair and replacement for instructions on replacing damaged components.

8-20. Painted surfaces can be cleaned with a commercial, spray-type, window cleaner or with a mild

soap and water solution. Excess grease can be removed with a degreaser such as M-180 FREON TF DEGREASER produced by Miller-Stevenson Company.

8-21. Corroded spots are best removed with soap and water. Stubborn residues can be removed with a fine abrasive. When using abrasives, be careful that fine particles do not fall into the instrument. Such areas should be protected from further corrosion by an application of a silicone resin such as GE DRI-FILM 88.

8-22. SWITCH MAINTENANCE.

8-23. The pushbutton switches used in this instrument have been designed for long, trouble-free service. In the event that one of these switches becomes defective, replacement rather than repair is recommended.

8-24. The rotary switches in this instrument can easily be serviced after removal of the assembly on which the switch is mounted. In the case of the TIME/DIV switch, the TIME/DIV switch shaft must be removed. Refer to the paragraphs on repair and replacement in this section for instructions on disassembly of the modules in the instrument.

8-25. Conventional rotary switches are serviced by cleaning the contacts with a degreaser such as M-180 FREON TF DEGREASER produced by Miller-Stevenson Chemical Company. The contact surfaces are then lubricated with a lubricant comparable to LUBRIPLATE FML produced by the Fiske Brothers Refining Company. LUBRIPLATE FML is available from the Hewlett-Packard Company. Order HP Part No. 6040-0305.

8-26. The switches on the sweep time assembly and holdoff assembly can be serviced as follows:

a. Remove TIME/DIV knob and shaft (paragraph 8-39).

b. Remove printed circuit board keeper from top of assemblies.

c. Remove assembly or assemblies to be serviced. See figure 8-5 for assembly locations.

d. Note orientation of open part of rotor section.

Note

The following steps use the sweep time assembly (figure 8-24) as an example.

e. Remove retainer ring MP1.

f. Separate two rotor sections, S1MP1 and S1MP2, from etched circuit board.

g. Check contact area of etched circuit board. If contact area shows excessive wear, replace etched circuit board.

h. Check contacts on two rotor sections. If contacts show excessive wear, replace rotor.

i. Clean and lubricate contacts on etched circuit board and rotors as described in paragraph 8-25.

j. Place rotor sections on etched circuit board and reinstall retainer ring MP1.

k. Position open part of rotor section as noted in step d.

l. Reinstall TIME/DIV shaft and knob assembly.

8-27. REPAIR AND REPLACEMENT.

8-28. The following paragraphs provide procedures for removal and replacement of assemblies, subassemblies, and components. Special servicing instructions for the etched circuit boards are provided in paragraph 8-54. Section VI provides a detailed parts list for use in ordering replacement parts. Refer to table 8-2 for the location of a particular assembly.

8-29. CRT REMOVAL AND REPLACEMENT.

WARNING

To prevent personal injury, wear a face mask or goggles when handling the CRT. Wear protective gloves and handle the CRT carefully.

8-30. To remove and replace the CRT, proceed as follows:

a. Remove instrument top and bottom covers.

b. Remove rear panel CRT socket cover.

c. Remove two screws from rear of CRT shield.

d. Remove CRT socket.

e. Remove CRT shock mounting screws.

f. Remove CRT clamp.

g. Remove leads from CRT neck.

h. Remove two screws holding vertical output amplifier shield and tilt to one side.

i. Remove two screws holding A9 high voltage connector assembly.

j. Remove flexible leads from A9 high voltage connector assembly.

k. Unplug snap on CRT.

l. Rotate shock mount 45 degrees and remove.

m. Place one hand on front of CRT and use other hand to slide CRT toward rear of instrument until CRT can be raised upward and out of instrument.

n. Remove CRT from CRT shield.

o. To reinstall, reverse removal procedure.

8-31. VERTICAL AMPLIFIER MODULE REMOVAL AND REPLACEMENT.

8-32. To remove the vertical amplifier module, proceed as follows:

a. Using allen wrench, loosen allen screws in POSITION, VOLTS/DIV, and DISPLAY control knobs.

b. Remove control knobs.

c. Pull plastic covers from coupling switches.

d. Remove top and bottom covers from instrument.

e. Disconnect main harness wires from vertical preamplifier assembly.

f. Disconnect two wires from delay line to vertical output amplifier.

g. Remove two screws holding vertical output amplifier to vertical amplifier module.

h. Remove vertical output amplifier assembly.

i. Hold vertical preamplifier assembly.

j. Remove nuts on VOLTS/DIV and POSITION controls.

k. Gently lift vertical module assembly out.

l. To reinstall vertical amplifier module, reverse removal procedure.

8-33. DELAY LINE REMOVAL AND REPLACEMENT.

8-34. To remove the delay line from the vertical amplifier module, proceed as follows:

a. Remove vertical amplifier module as described in paragraph 8-31.

b. Unsolder two wires (red, blue) from end of delay line to vertical preamplifier assembly. Mark locations of wires to facilitate correct reassembly.

c. Remove two center screws from bottom side of vertical module (C, figure 8-1).

d. Rotate delay line slightly and remove.

Note

The two wires to the vertical output amplifier assembly go through a rubber grommet. These two wires must be carefully brought through the grommet during removal of the delay line.

e. To reinstall delay line, reverse removal procedure.

8-35. ATTENUATOR REMOVAL AND REPLACEMENT.

8-36. To remove the attenuator assemblies from the vertical amplifier module, proceed as follows:

a. Remove vertical amplifier module as described in paragraph 8-31.

b. Remove locking nuts (A, figure 8-1).

c. Remove six screws on bottom side of vertical amplifier module (B and C, figure 8-1).

d. Remove delay line as described in paragraph 8-33.

e. Unsolder C1 from BNC input connectors (figure 8-2).

f. Remove nuts holding BNC connectors to shield.

g. Remove BNC connectors.

h. Slide vertical preamplifier back from shield.

i. Raise vertical preamplifier up and unsolder components connected between attenuators and vertical preamplifier board.

j. Remove two screws for each attenuator from top side of preamplifier board.

k. Lift attenuators from board.

l. To reinstall attenuators, reverse removal procedure.

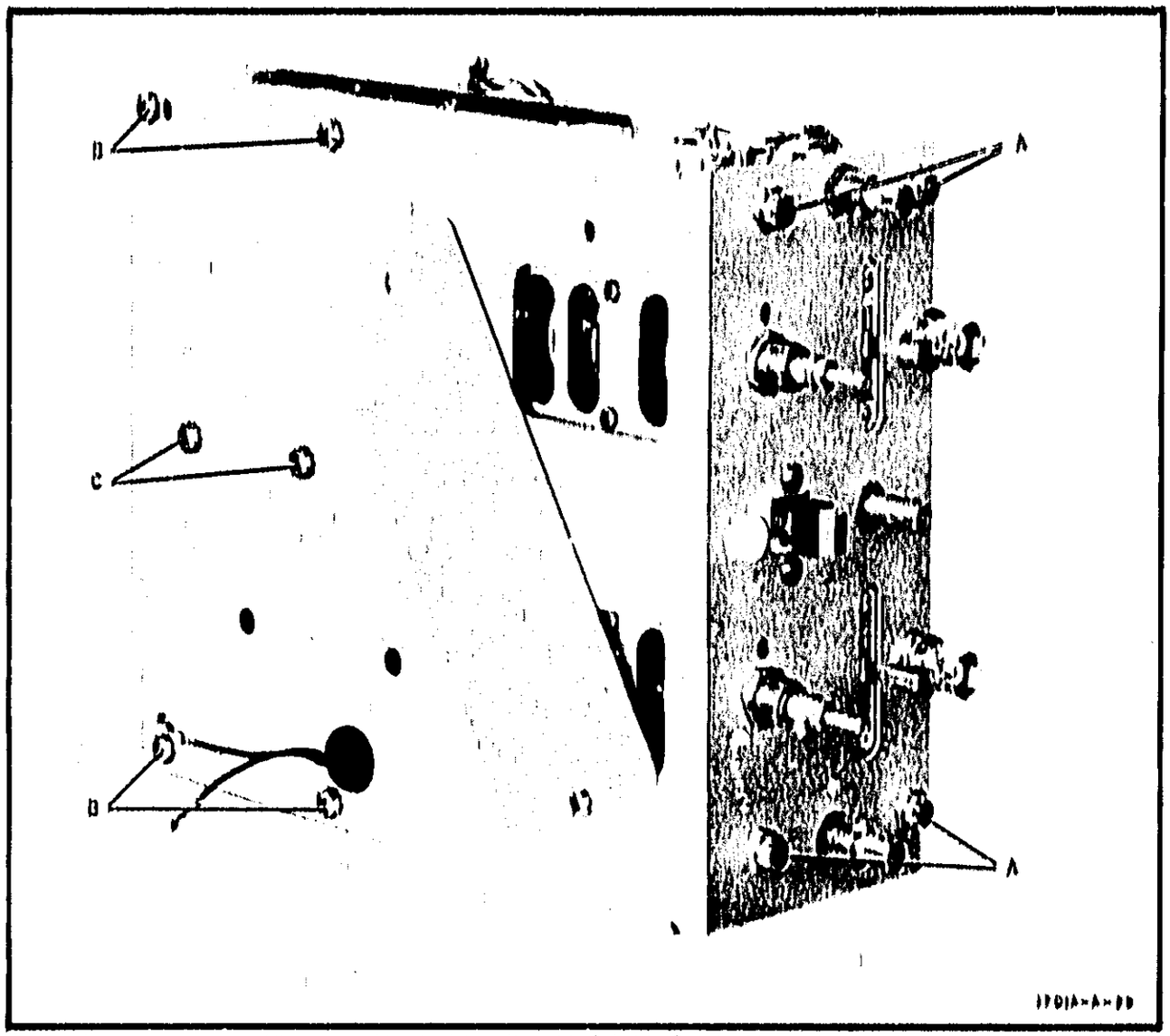


Figure 8-1. Vertical Amplifier Module Mechanical Parts Removal

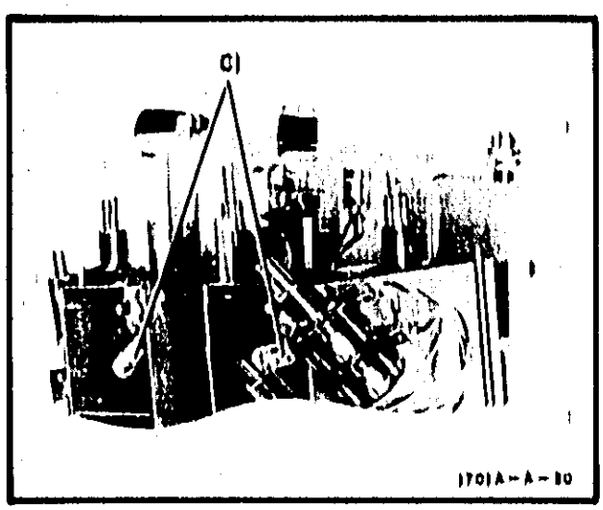


Figure 8-2. Attenuator Removal

8-37. REMOVAL AND REPLACEMENT OF ASSEMBLIES IN HORIZONTAL AMPLIFIER MODULE.

8-38. The following paragraphs provide information required to remove and replace the various assemblies in the horizontal amplifier module.

8-39. *TIME/DIV Switch Removal and Replacement.* To remove the TIME/DIV switch, proceed as follows:

a. Set TIME/DIV to .2 SEC.

b. Loosen locking collar setscrew on inside front panel of instrument.

c. Pull TIME/DIV shaft out.

d. To reinstall TIME/DIV shaft, reverse removal procedure.

8-10. Plug-In Assemblies Removal and Replacement. After removal of the TIME/DIV shaft, the three plug-in assemblies in the horizontal amplifier module can be removed as follows:

a. Remove etched circuit board keeper from top of assemblies.

b. Gently rock assemblies from side to side while pulling upward to remove from sockets.

c. To reinstall assemblies, reverse removal procedure.

8-11. Trigger Assembly and Horizontal Mother Board Removal and Replacement. To remove the trigger assembly and horizontal mother board, proceed as follows:

a. Remove TIME/DIV shaft as described in paragraph 8-9b.

b. Remove three assemblies as described in paragraph 8-10.

c. Disconnect wires (top and bottom) to horizontal preamplifier board.

d. Remove two screws from horizontal preamplifier board.

e. Disconnect wires to trigger assembly.

f. Separate horizontal amplifier from trigger assembly and horizontal mother board.

g. Remove horizontal preamplifier board.

h. Hold trigger assembly and remove four screws that hold assembly.

i. Carefully remove trigger assembly.

j. Horizontal mother board can be removed by disconnecting wires connected to it.

k. To reinstall, reverse removal procedure.

8-12. POWER SUPPLY MODULE REMOVAL AND REPLACEMENT.

8-13. To remove power supply module from instrument, proceed as follows:

a. Turn instrument off and remove power cord.

b. Remove top and bottom covers.

c. Unplug postaccelerator lead.

Note

Do not attempt to remove lead from CRT glass.

d. Turn instrument on its side.

e. Remove battery if instrument is Option 19.

f. Unplug A6J1 connecting power supply to main cable.

g. Using #1 Pozidriv screwdriver, remove two flathead screws directly in front of power transformer T1.

h. To reinstall power supply module, reverse removal procedure.

8-14. POWER SUPPLY MODULE DISASSEMBLY AND REASSEMBLY.

8-15. To disassemble power supply module, proceed as follows:

a. Remove power box cover.

b. Using board puller furnished with service kit, hook on inside of staybolts between two low voltage boards and pull straight out.

c. Disconnect CR from low voltage mother board.

d. Disconnect CR leads from high voltage oscillator.

e. Remove high voltage oscillator.

f. Turn instrument over.

g. Remove four screws holding power supply module to battery deck.

h. Turn instrument over.

i. Remove high voltage oscillator shield.

j. Remove two screws holding low voltage mother board.

k. Remove low voltage mother board.

l. To reinstall, reverse removal procedure.

8-16. SEMICONDUCTOR REMOVAL AND REPLACEMENT.

8-17. Figure 8-1 is included to help identify the leads on the common shapes and sizes of semiconductor devices. When removing a semiconductor, use long-nosed pliers as a heat sink between the device and

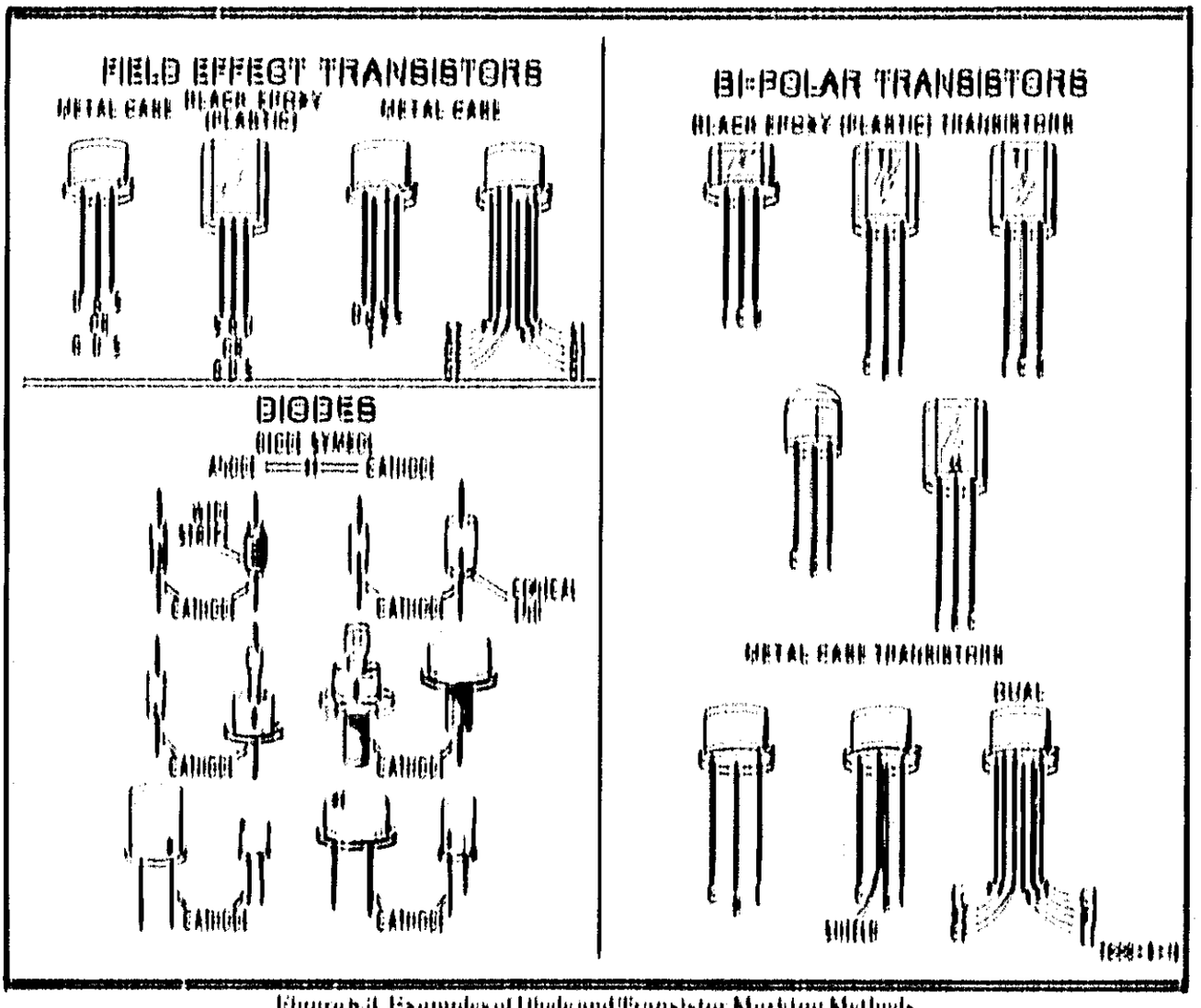


Figure 8-1. Examples of Diode and Transistor Marking Methods

the soldering iron. When replacing a semiconductor, ensure sufficient lead length to dissipate the soldering heat by using the same length of exposed lead as used for the original part.

8-48. ATTENUATOR SERVICING.

8-49. A metal plate provides access to the attenuators. The plate is located under the front of the CRT. Service for the attenuators is accomplished by removing the CRT (paragraph 8-30) and metal plate. After the attenuators have been serviced, replace the metal plate and CRT.

8-50. CIRCUIT BOARDS.

8-51. The following paragraphs provide information regarding servicing procedures for etched circuit boards, use of heat sinks, and special soldering considerations.

8-52. BOARD CONNECTIONS.

8-53. Square pin connections are identified on circuit boards by the color code of the connecting wire. Connector pins or plugs and jacks are identified by either a numeral or a letter. The letters O, I, O, and Q have been omitted. Table 8-3 shows the types of board connections used in the instrument.

8-54. SERVICING ETCHED CIRCUIT BOARDS.

8-55. This instrument uses etched circuit boards with plated-through component holes. This allows components to be removed or replaced by unsoldering on soldering from either side of the board. When removing large components, such as pots, transistors, rotate the soldering iron tip from lead to lead while applying pressure to the part to lift it from the board. The Service Note Manual contains additional information of repair of etched circuit boards.

8-66. INTEGRATED CIRCUIT REPLACEMENT.

8-67. The integrated circuits in this instrument are of two general configurations, plug-in type and those soldered in place. Removal of plug-in integrated circuit with a straight pull away from the board. Soldered integrated circuits can be removed with soldering irons which simultaneously heat all connections. These irons are available from various manufacturers. Soldering irons with built-in desoldering tools also facilitate quick removal.

CAUTION

Unless an integrated circuit has defective leads, be careful to prevent damage when removing or replacing it.

8-68. Use the following procedure for removing an integrated circuit with a standard soldering iron.

a. Heat lead solder joint. Use small tip such as an Weller No. PT-117 tool.

b. When solder is liquid, remove with desoldering tool such as deluxe Model Soldapullt manufactured by Edsyn Company of California.

c. Repeat steps a and b for each lead until all leads are free.

d. Grasp each lead with long-nosed pliers and check that it is mechanically free from circuit board.

e. When all leads are free, carefully remove integrated circuit. Small integrated circuits can be removed by gently prodding top and bottom with long-nosed pliers and lifting integrated circuit out.

f. Use desoldering tool or toothpick to remove all remaining solder from circuit board holes.

g. Insert replacement integrated circuit into circuit board and solder in place.

CAUTION

Be careful not to damage the integrated circuit with excessive heat. Work quickly.

8-69. When replacing an integrated circuit, note the angle of notch used for orientation. The rear panel identification photographs and the integrated circuit pin location diagrams in this manual show the correct orientation.

8-68. SERVICE KIT.

8-70. The service kit order by Section II consists of three extender boards and a board puller. The extenders can be used with the plug-in circuit boards. They permit a circuit board to remain connected to the instrument, yet raised to a convenient level for circuit checks and adjustments. The board puller is used to remove the low voltage connector assembly A16A3 and the low voltage rectifier and filter assembly A16A1. Expand the hook portion of the board puller around the metal standoffs that connect the two assemblies and pull the assemblies out.

8-69. SOLDERING TOOL, SOLDER, AND AIDS.

8-71. Table 8-1 contains a list of soldering tools, solder, and soldering aids. These items of equipment should be used to obtain the very best results when repairing and replacing soldered-in components on etched circuit boards.

Table 8-1. Etched Circuit Soldering Equipment

Item	Use	Specification	Most Recommended
Soldering tool	Soldering/Desoldering	Wattage rating: 37.5 Tip Temp: [illegible] degrees	Weller [illegible] Soldering Gun
Soldering Tip	Soldering	Pencil chisel	Weller PTP-117
Desoldering aid	To remove molten solder from circuit board	Suction device	Soldapullt by Edsyn Co., Xenia, California
Heat Shunt Material	Remove excess flux from soldered area before application of protective coating	Must not dissolve etched circuit base board material or radiate too much heat	Freon Acetone Alcohol Distilled Water
Solder	Component replacement Circuit board repair Wiring	Resin cored type, high tin content, 60-40 or 63-37 preferred	
Protective Coating	Contamination, Corrosion protection	Good electrical insulation and moisture prevention properties	Silicone Spray such as [illegible]

8-64. HEAT SINK REMOVAL.

8-65. [illegible]

a. Remove transistor from circuit board.

b. Grasp cooling fins with long-nose pliers.

c. Remove nut with ¼-inch wrench.

CAUTION

When replacing heat sinks, especially the [illegible] type, support the bottom of the transistor to avoid lead damage caused by downward pressure.

8-66. TROUBLESHOOTING.

8-67. The most important prerequisite for successful troubleshooting is understanding how the instrument is designed to operate and correct use of front panel controls. [illegible]

8-68. [illegible]

8-69. DC VOLTAGES.

8-70. [illegible]

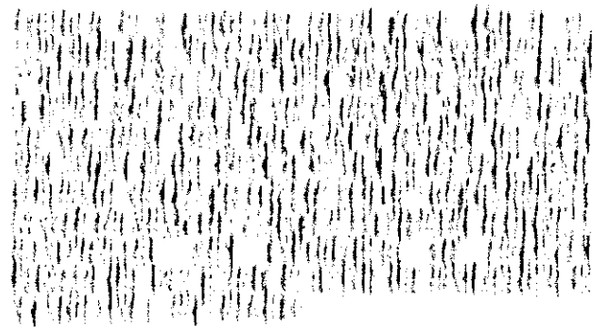
8-71. WAVEFORMS.

8-72. [illegible]

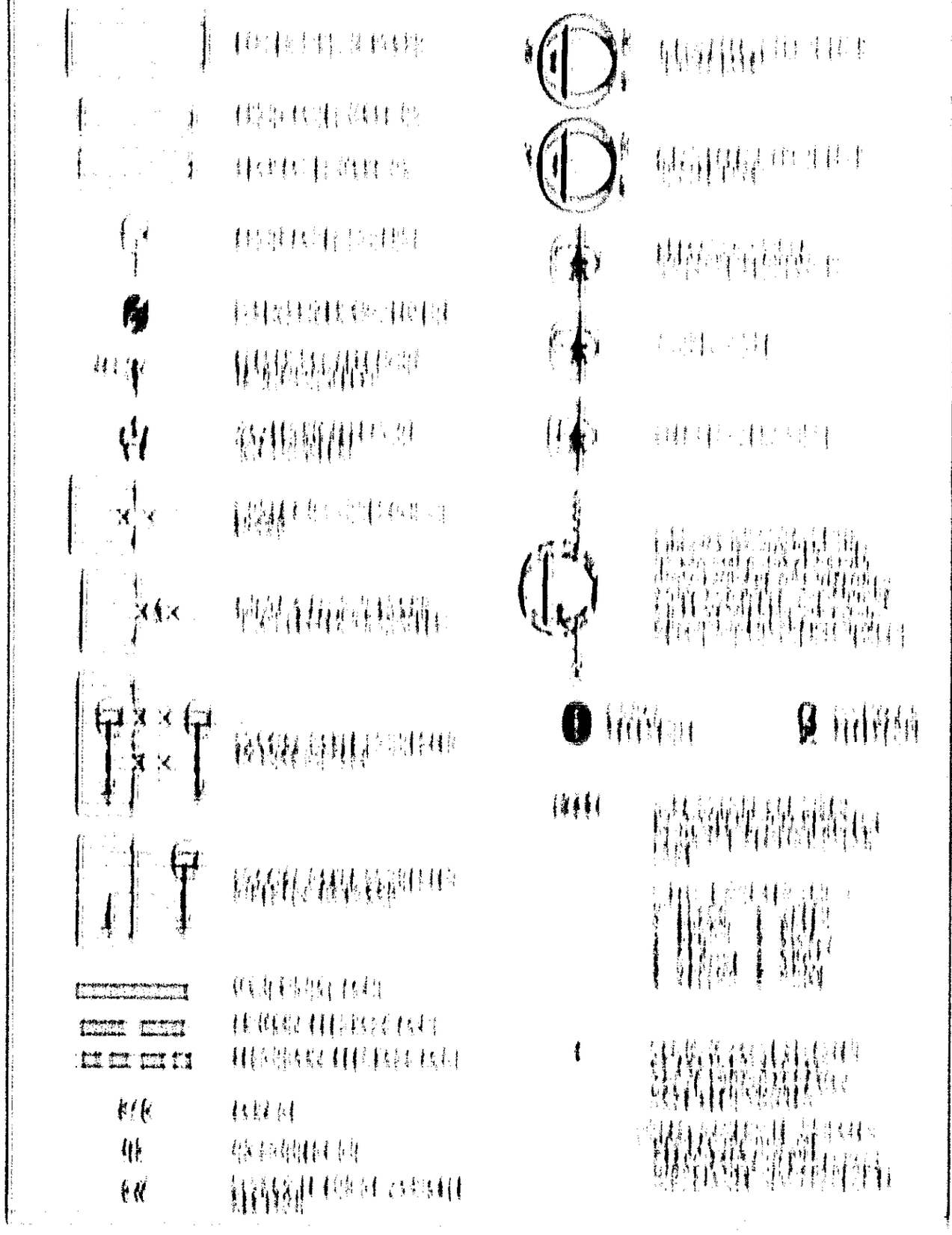
Table 8-4. Model [illegible] Assembly Locations

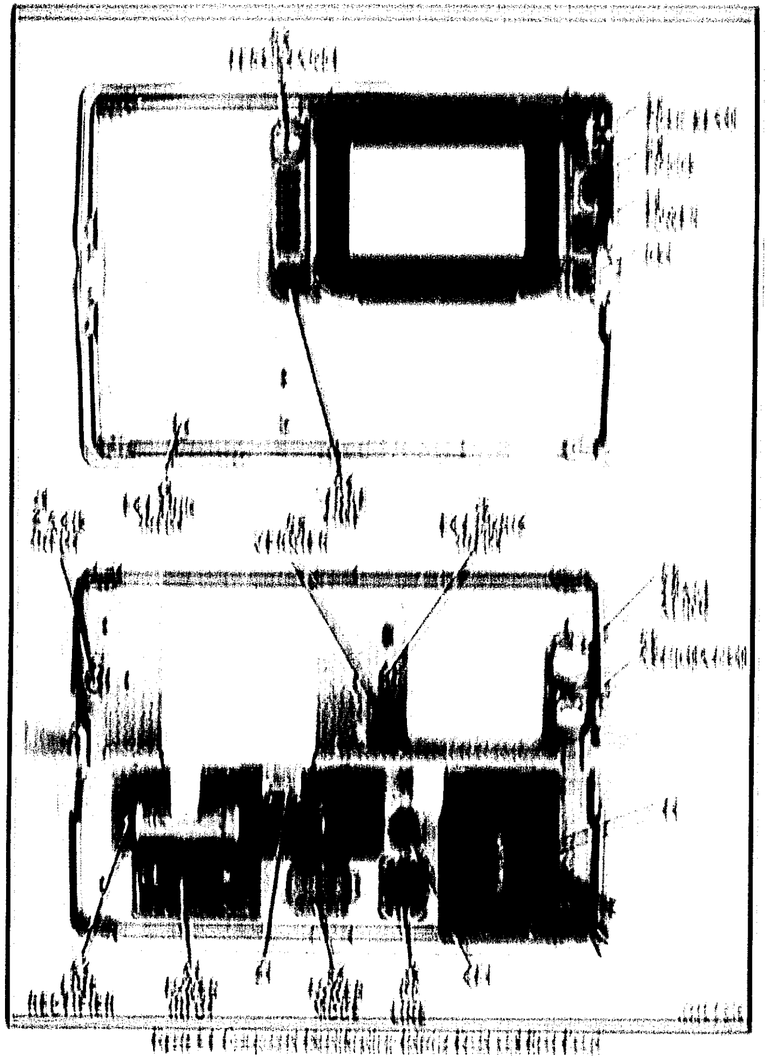
Assembly	Description	Schematic Number	Figure No.
A2	Line Rectifier	19	8-[illegible]
A3A1	Low Voltage Mother Board	19, 20, 21	8-[illegible]
A3A2	Low Voltage Converter	20	8-[illegible]
A3A3	Line Rectifier and Filter	21	8-[illegible]
A3A4	High Voltage Oscillator	17	8-[illegible]
A5A5	Vertical Output Amplifier	8	8-[illegible]
A6A1	Horizontal Mother Board	10, 11, 14, 21	8-[illegible]
A6A2	Trigger	9, 10	8-[illegible]
A6A3	Integrator	10	8-[illegible]
A6A4	Horizontal Preamplifier	9, 10, 11, 14, 21	8-[illegible]
A6A5	Sweep Time	11	8-[illegible]
A6A6	Horizontal Output Amplifier	11	8-[illegible]
A6A7	Holdoff	14	8-[illegible]
A6A8	Storage [illegible]	15, 16	8-[illegible]
A9	Storage Circuit	15, 16	[illegible]

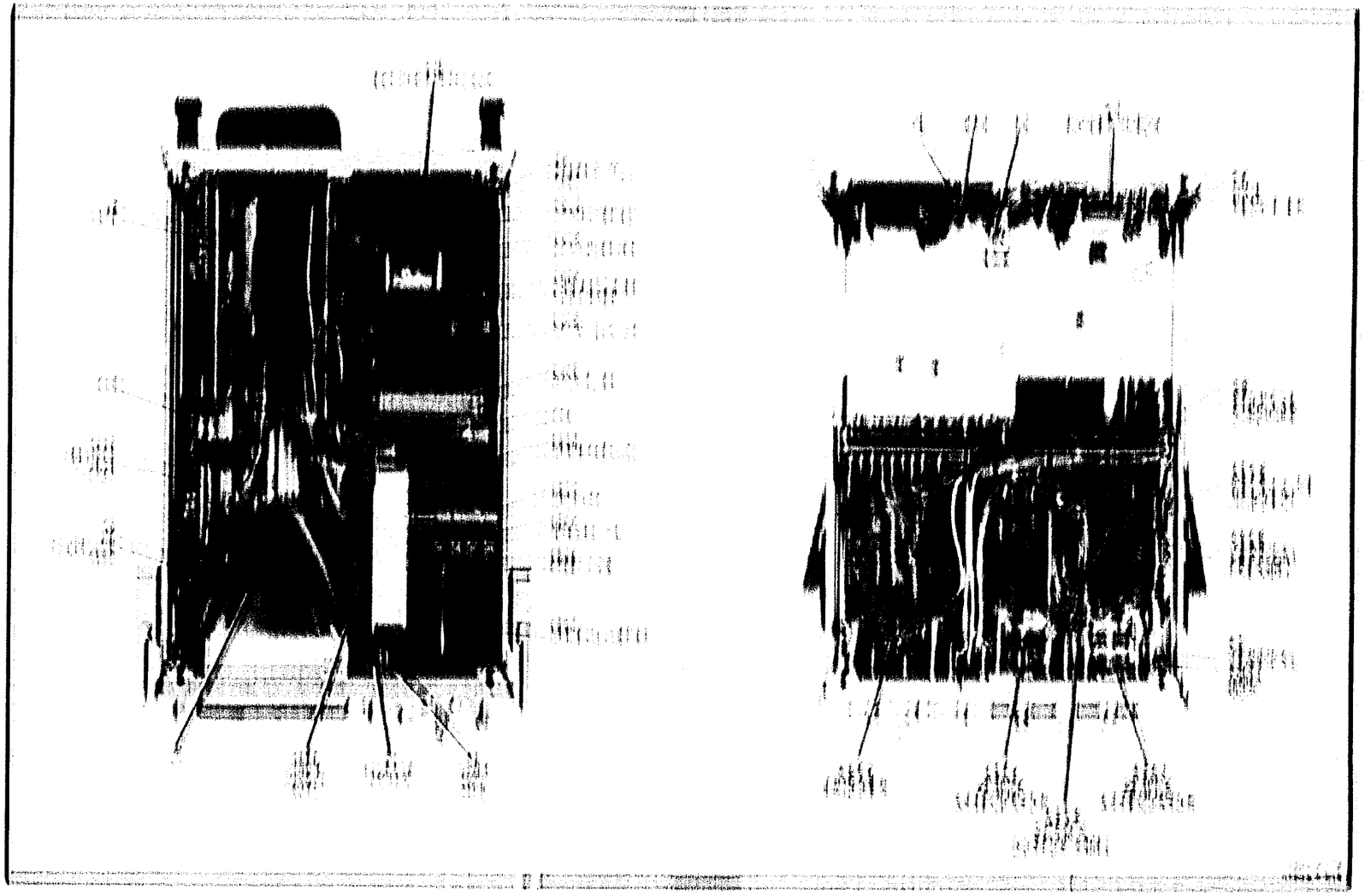
[illegible]



[illegible]







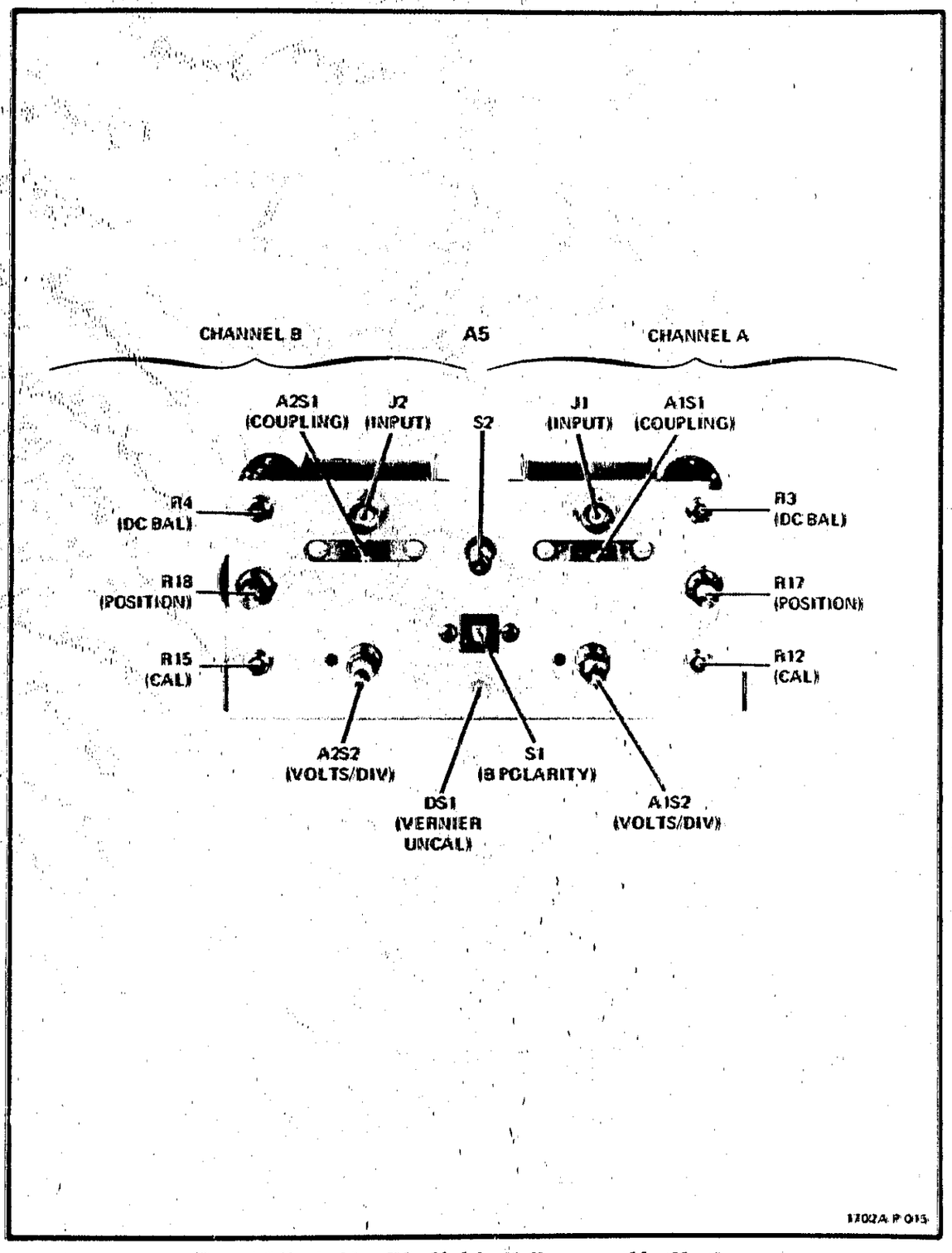


Figure 8-6. Vertical Amplifier Module, A5, Component Identification

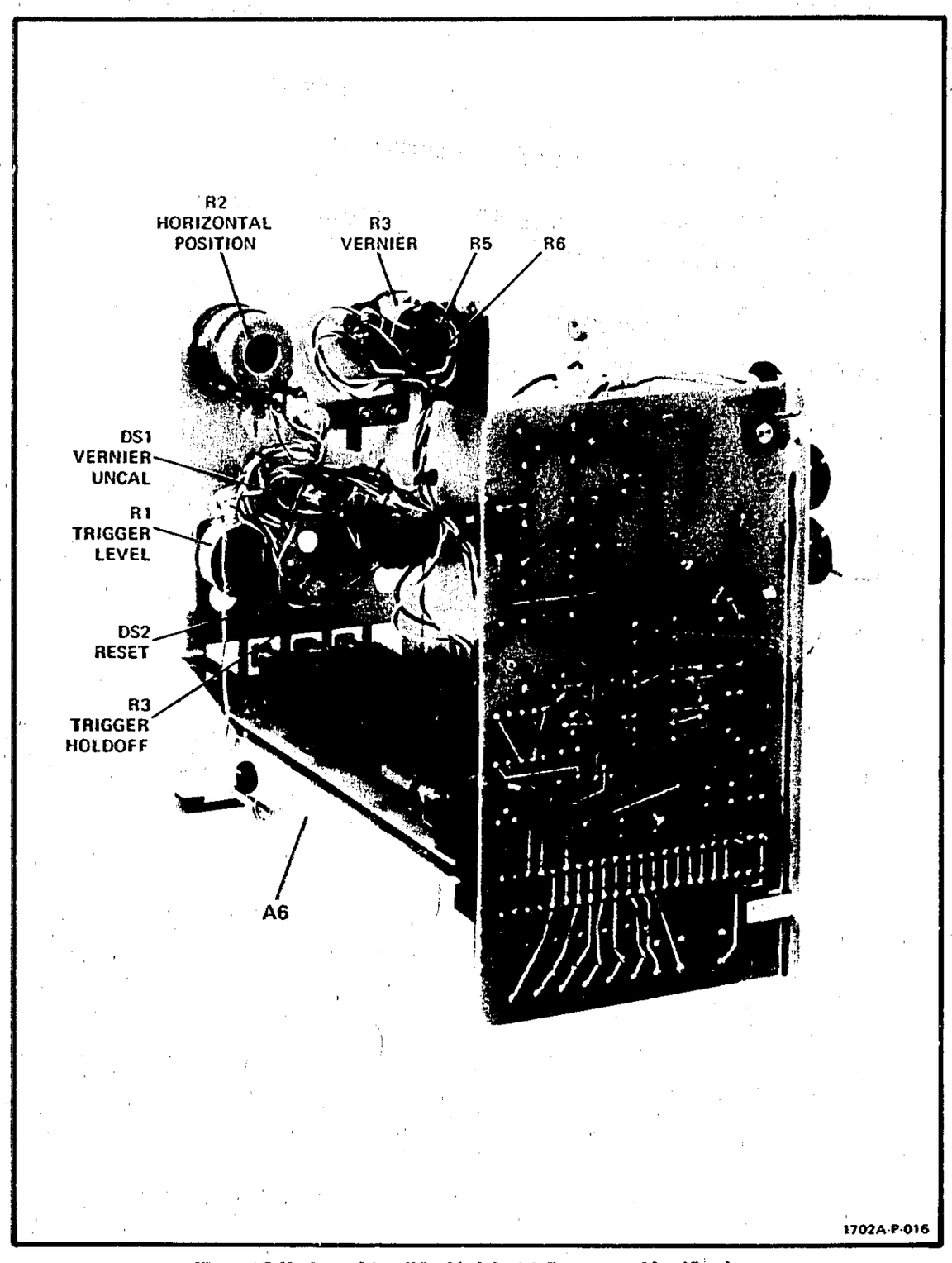
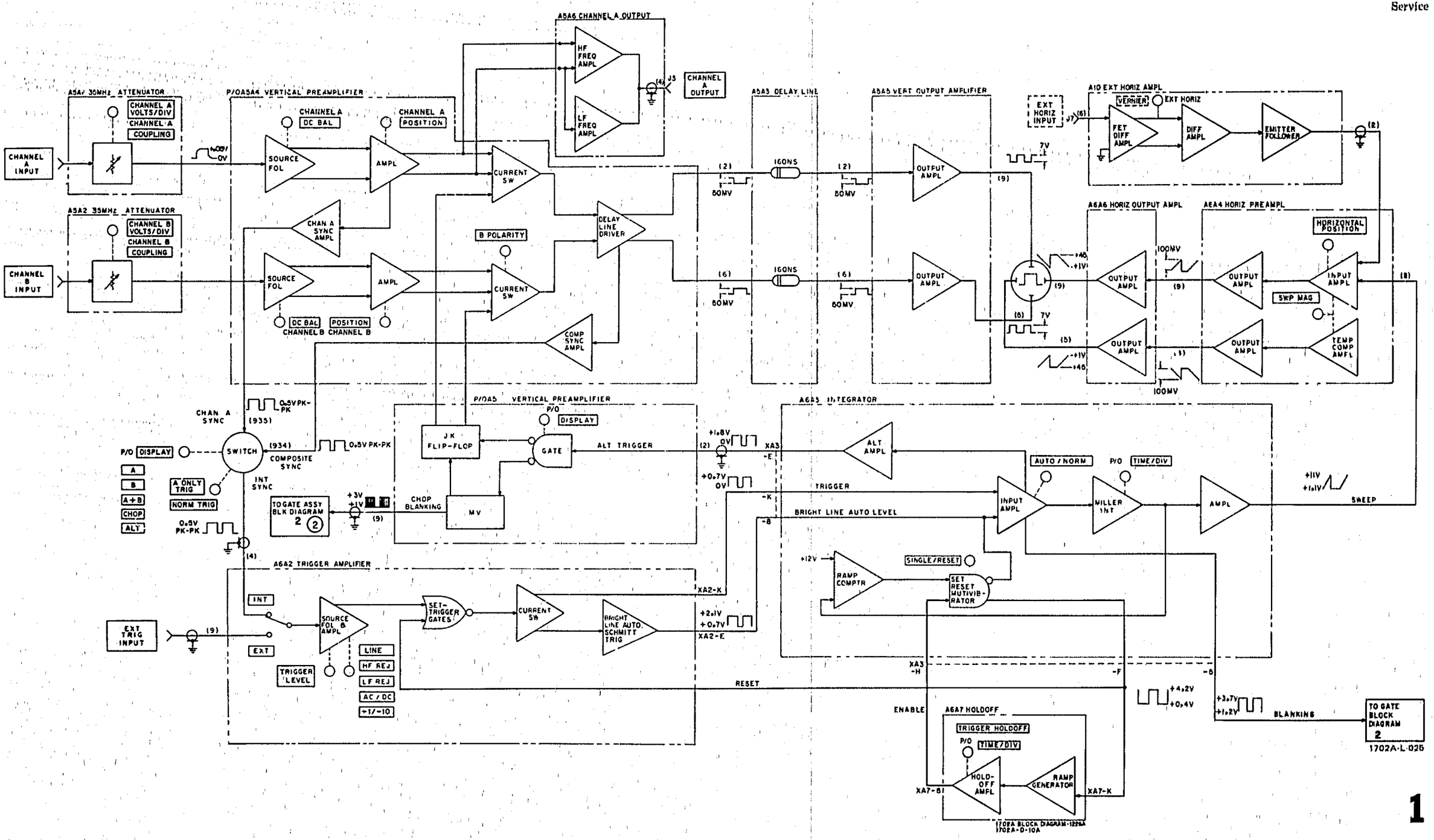


Figure 8-7. Horizontal Amplifier Module, A6, Component Identification



1

Figure 8-8.
Main Block Diagram
8-13/8-14

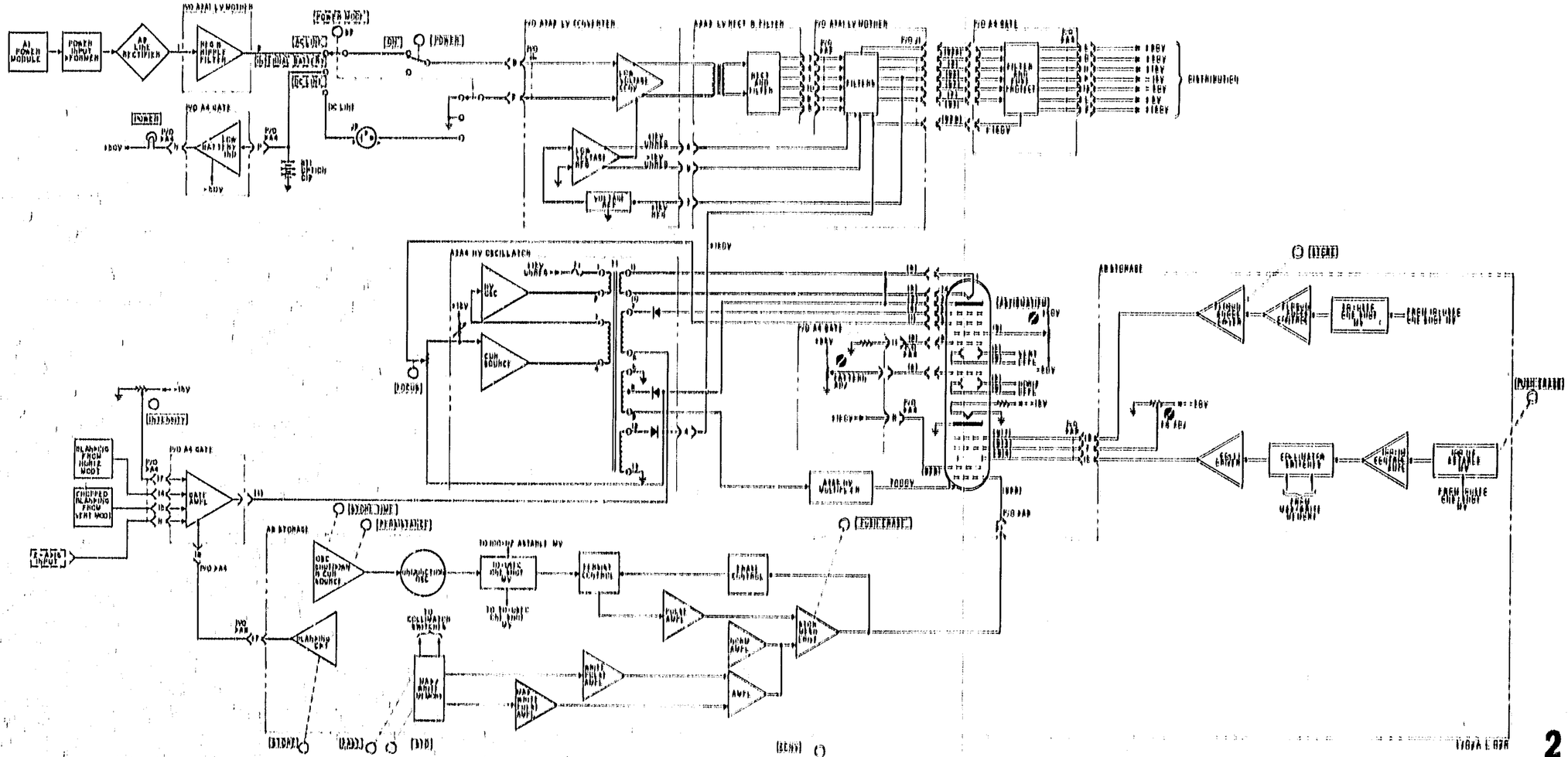


Figure 6-9.
Power Supply and Storage Circuit Block Diagram
8-16/8-18

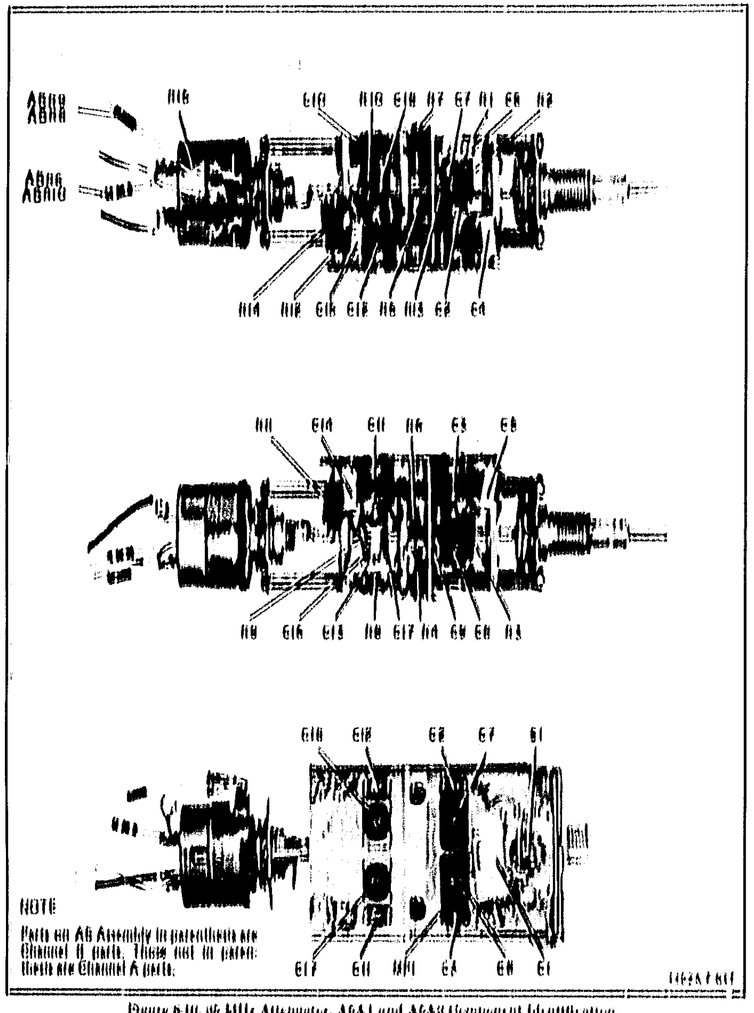
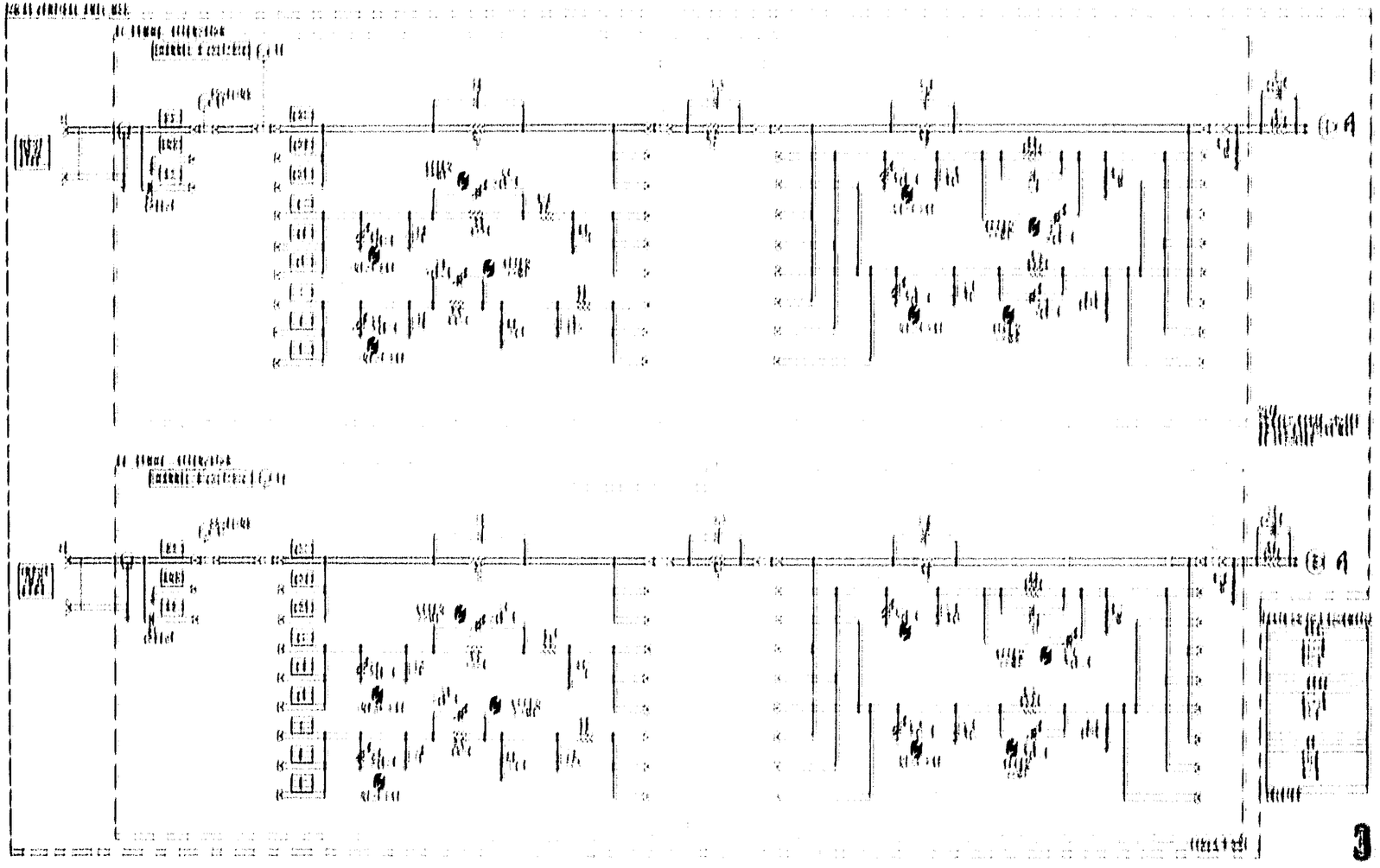


Figure 8-10. 85 MHz Attenuator, A6A1 and A6A2 Component Identification



85 MHz Attenuator, A6A1 and A6A2 Schematic

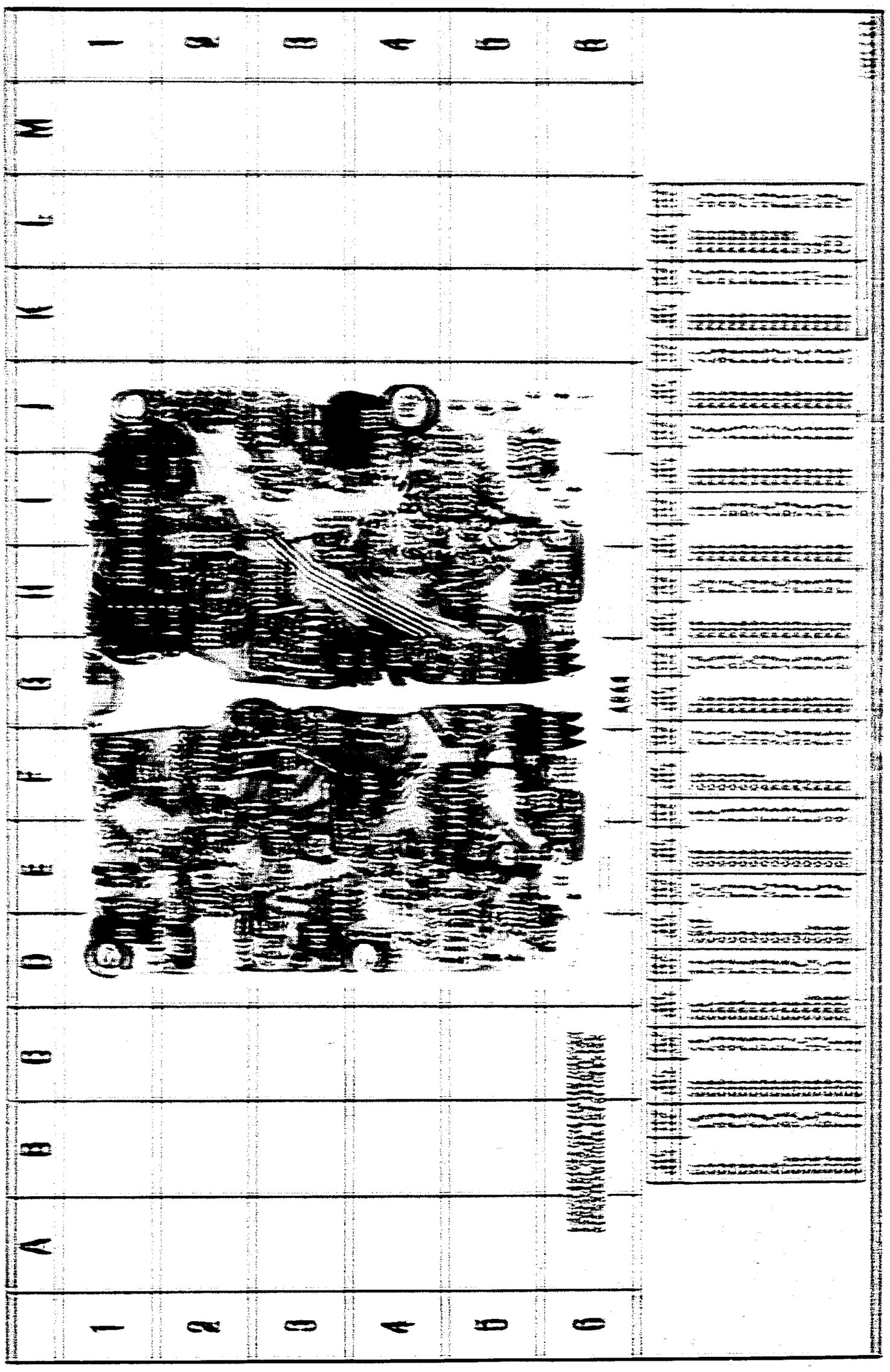


Table 8-4. Channel A Preamplifier Measurement Conditions and Waveforms

DC VOLTAGE MEASUREMENT CONDITIONS

A. Set:
DISPLAY..... A
channel A POSITION..... midrange
channel A vernier..... CAL
channel A VOLTS/DIV..... .2
channel A coupling ..... GND

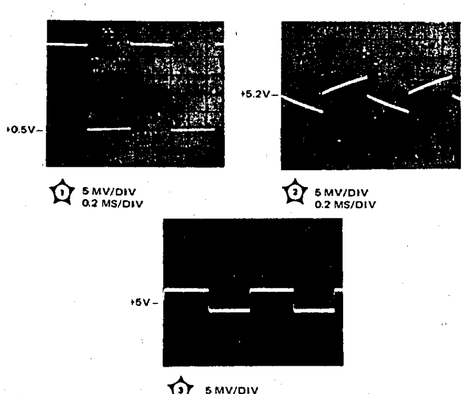
B. All voltages are referenced to chassis ground. All indications are nominal and may vary slightly.

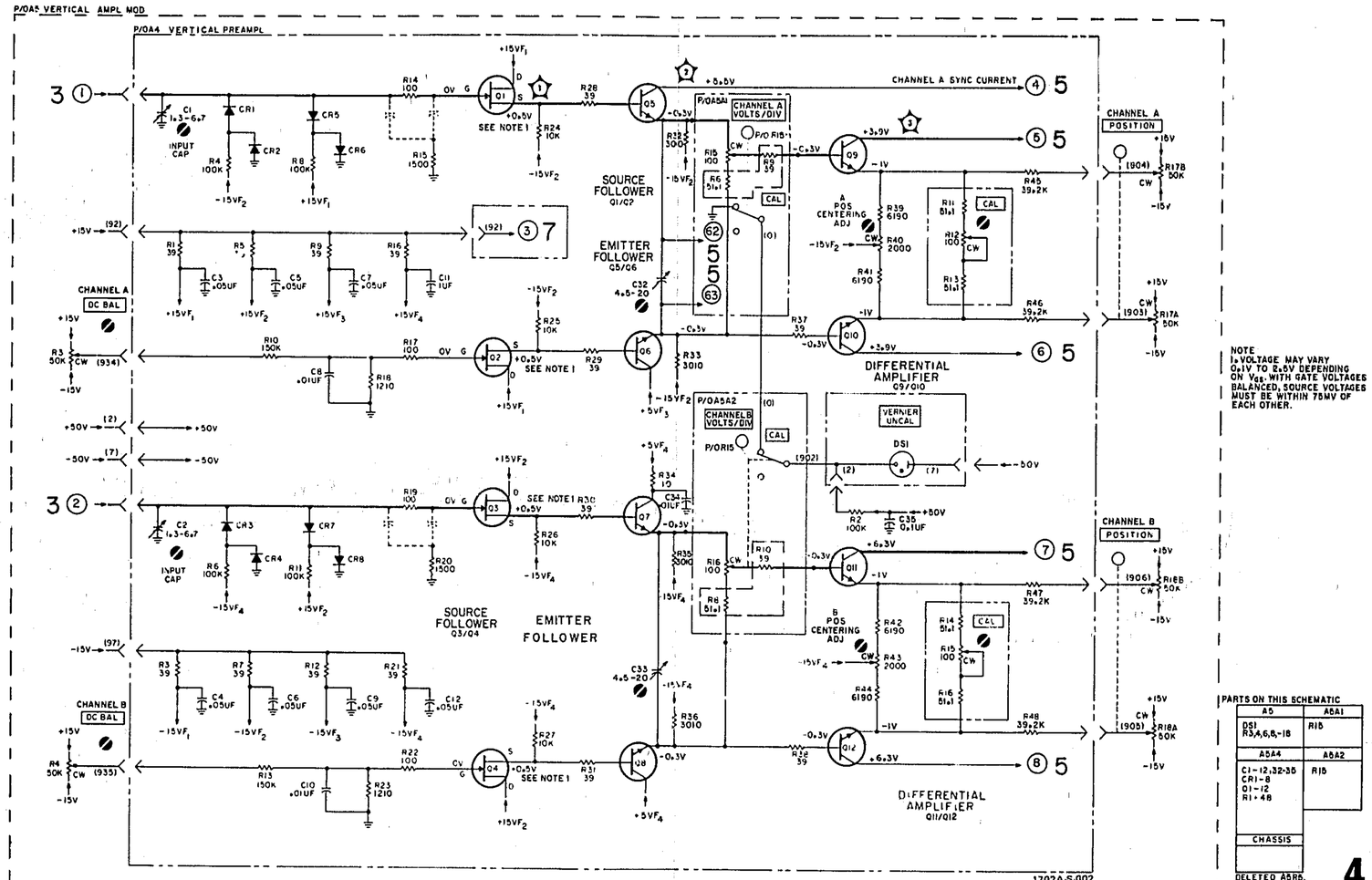
WAVEFORM MEASUREMENT CONDITIONS

A. Set:
DISPLAY..... A
channel A POSITION..... midrange
channel A vernier..... CAL
channel A VOLTS/DIV..... .2
channel A coupling ..... AC
channel B coupling ..... GND

B. Connect CAL 1 VOLT signal to channel A INPUT.

C. All waveforms are referenced to chassis ground. The monitor oscilloscope's vertical sensitivity (using a 1:1 probe) and sweep speed settings are shown below on each waveform photograph.





NOTE
1. VOLTAGE MAY VARY 0.1V TO 2.5V DEPENDING ON V_{BE}. WITH GATE VOLTAGES BALANCED, SOURCE VOLTAGES MUST BE WITHIN 75MV OF EACH OTHER.

PARTS ON THIS SCHEMATIC

A5	A5A1
DS1 R3,4,6,8-18	R15
A5A4	A5A2
C1-12,32-35 CR1-8 Q1-12 R1-48	R15
CHASSIS	

DELETED A5R5, A5R7, A5R19

Figure 8-13.
Vertical Preamplifier A5A4, Schematic (1 of 4)

Table 8-5. Channel A Preamplifier Measurement Conditions and Waveforms

DC VOLTAGE MEASUREMENT CONDITIONS

A. Set:
DISPLAY ..... A
channel A POSITION ..... midrange
channel A vernier ..... CAL
channel A VOLTS/DIV 2
channel A coupling ..... GND

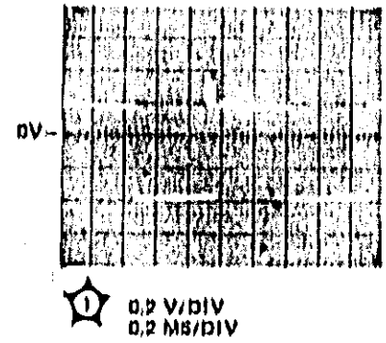
B. All voltages are referenced to chassis ground. All indications are nominal and may vary slightly.

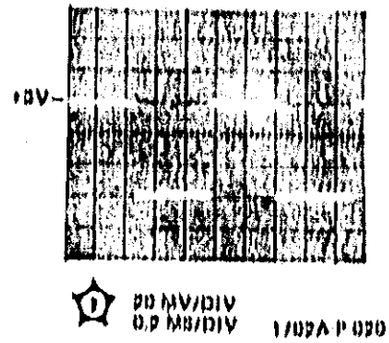
WAVEFORM MEASUREMENT CONDITIONS

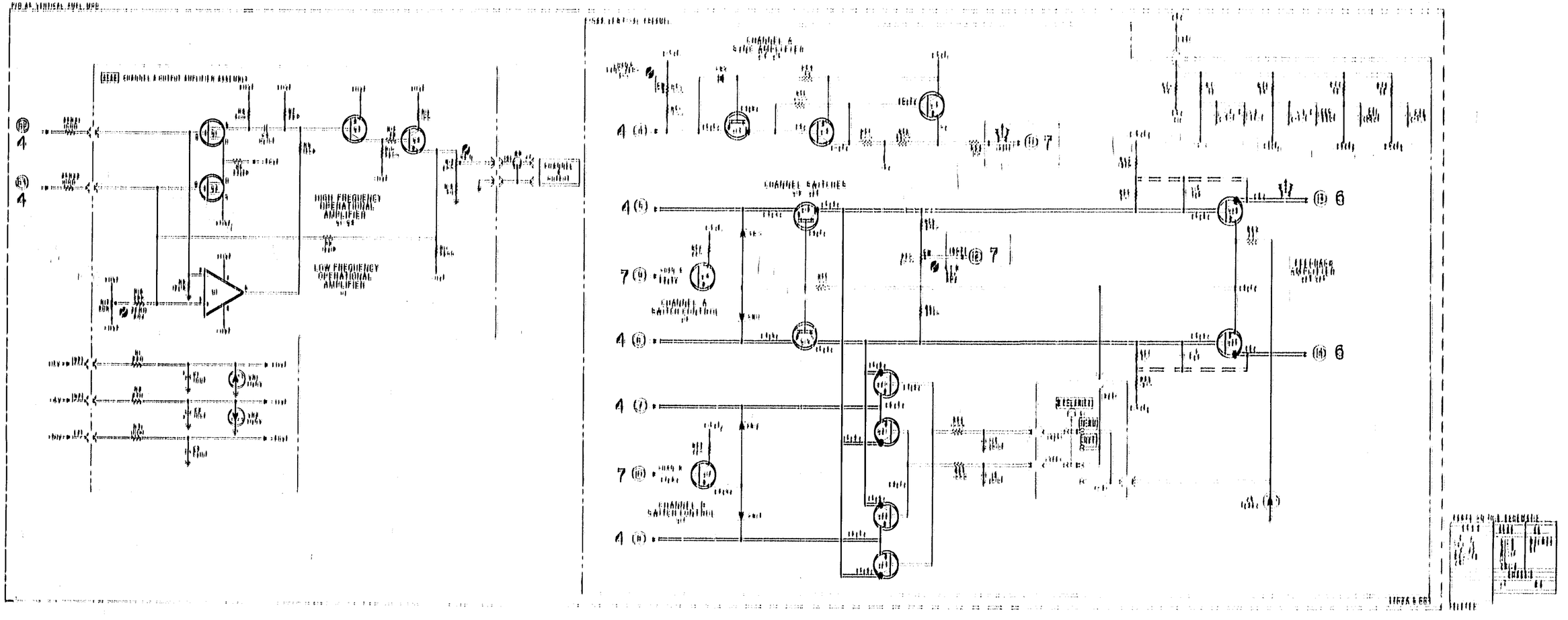
A. Set:
DISPLAY ..... A
channel A POSITION ..... midrange
channel A vernier ..... CAL
channel A VOLTS/DIV 2
channel A coupling ..... AC

B. Connect CAL 1 VOLT to channel A INPUT.

C. All waveforms are referenced to chassis ground. The monitor oscilloscope's vertical sensitivity (using a 1:1 probe) and sweep speed settings are shown below on each waveform photograph.







5

Figure 8-11
Vertical Preamplifier, A6A1, Schematic (2 of 2)
8-21

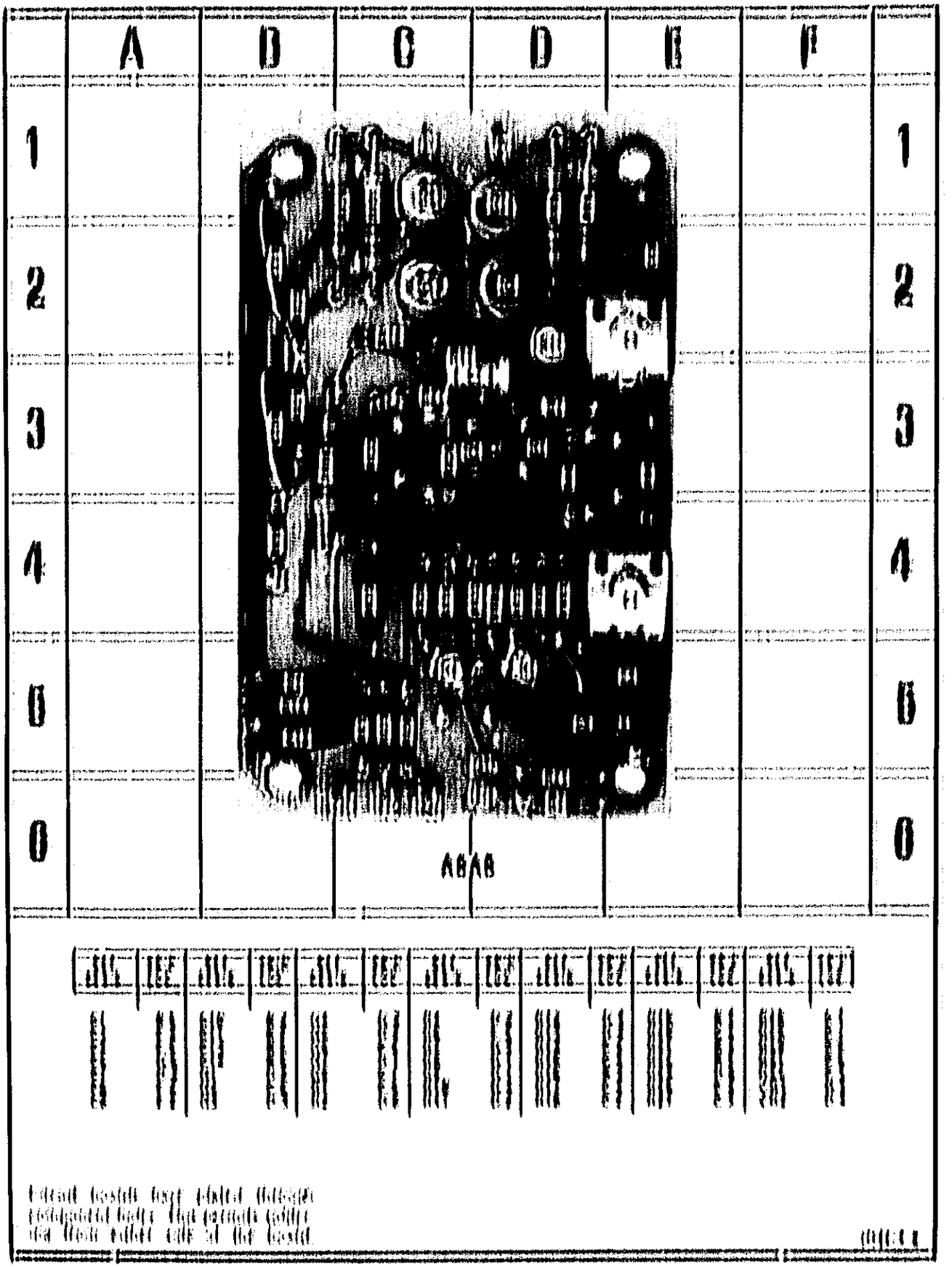
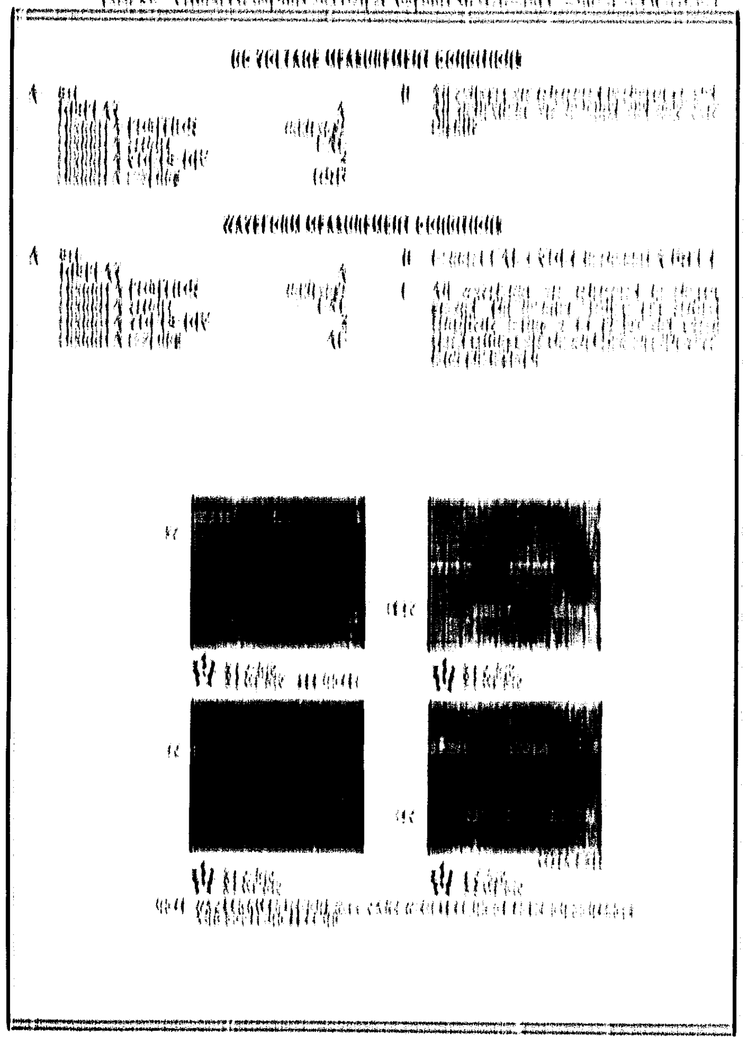


Figure 8-16. Vertical Output Amplifier A8A8 Component Identification



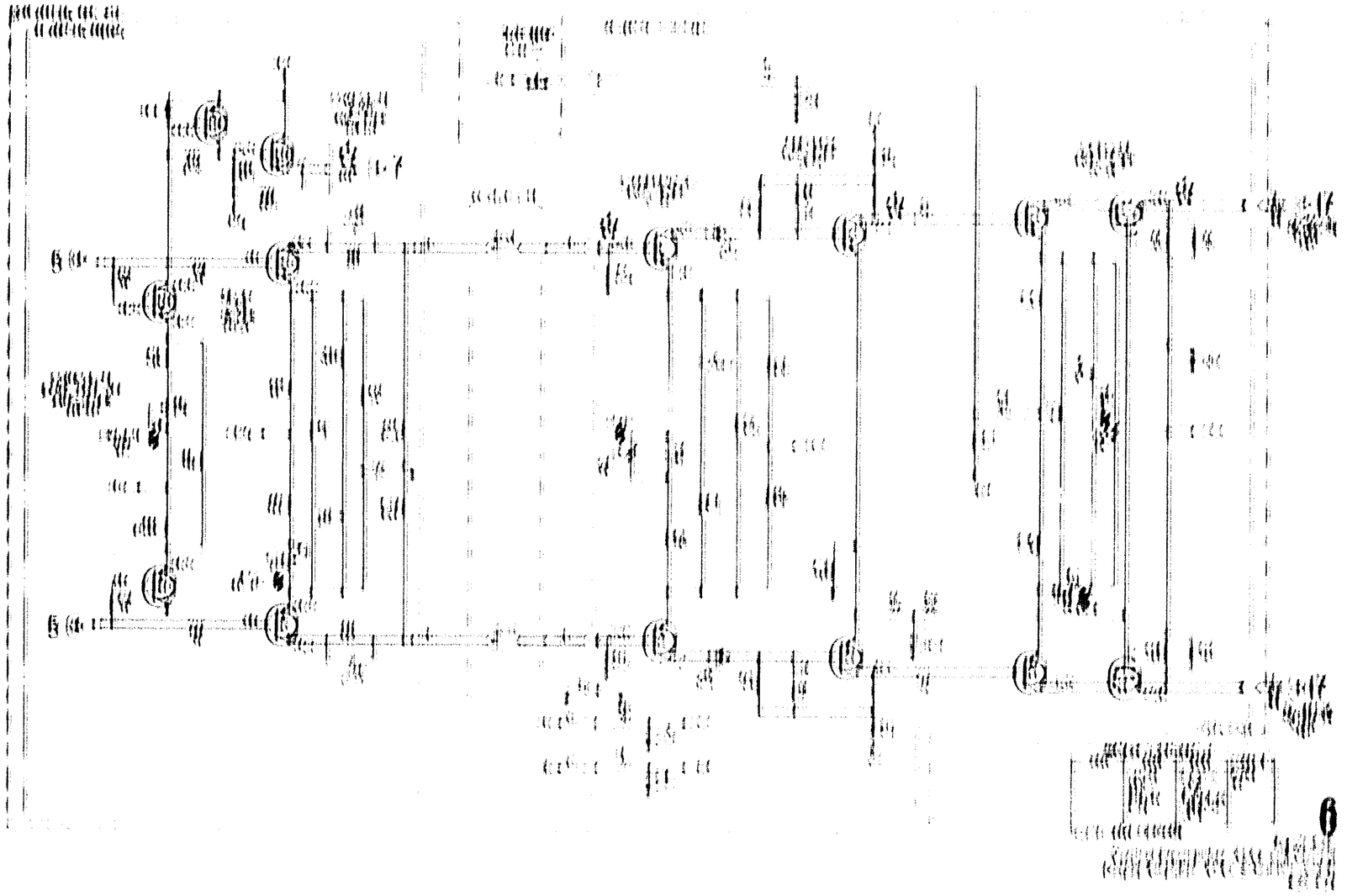


Table 8-7. Vertical Preamplifier Measurement Conditions and Waveforms

DC VOLTAGE MEASUREMENT CONDITIONS

A. Set:
DISPLAY ..... A
channel A POSITION ..... midrange
channel A vernier ..... CAL
channel A VOLTS/DIV 2
channel A coupling ..... GND

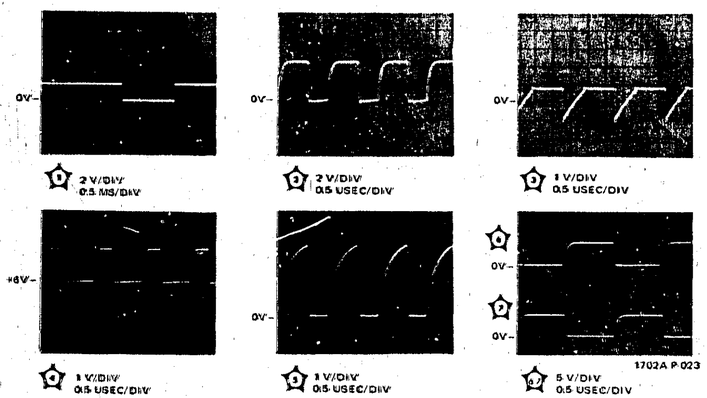
B. All voltages are referenced to chassis ground. All indications are nominal and may vary slightly.

WAVEFORM MEASUREMENT CONDITIONS

A. Set:
DISPLAY ..... CHOP
channel A POSITION ..... midrange
channel A vernier ..... CAL
channel A VOLTS/DIV 2
channel A coupling ..... AC
INT/EXT ..... INT
TIME/DIV ..... .2 mSEC
AUTO/NORM ..... AUTO

B. Connect CAL 1 VOLT to channel A INPUT.

C. All waveforms are referenced to chassis ground. The monitor oscilloscope's vertical sensitivity (using a 1:1 probe) and sweep speed settings are shown below on each waveform photograph.



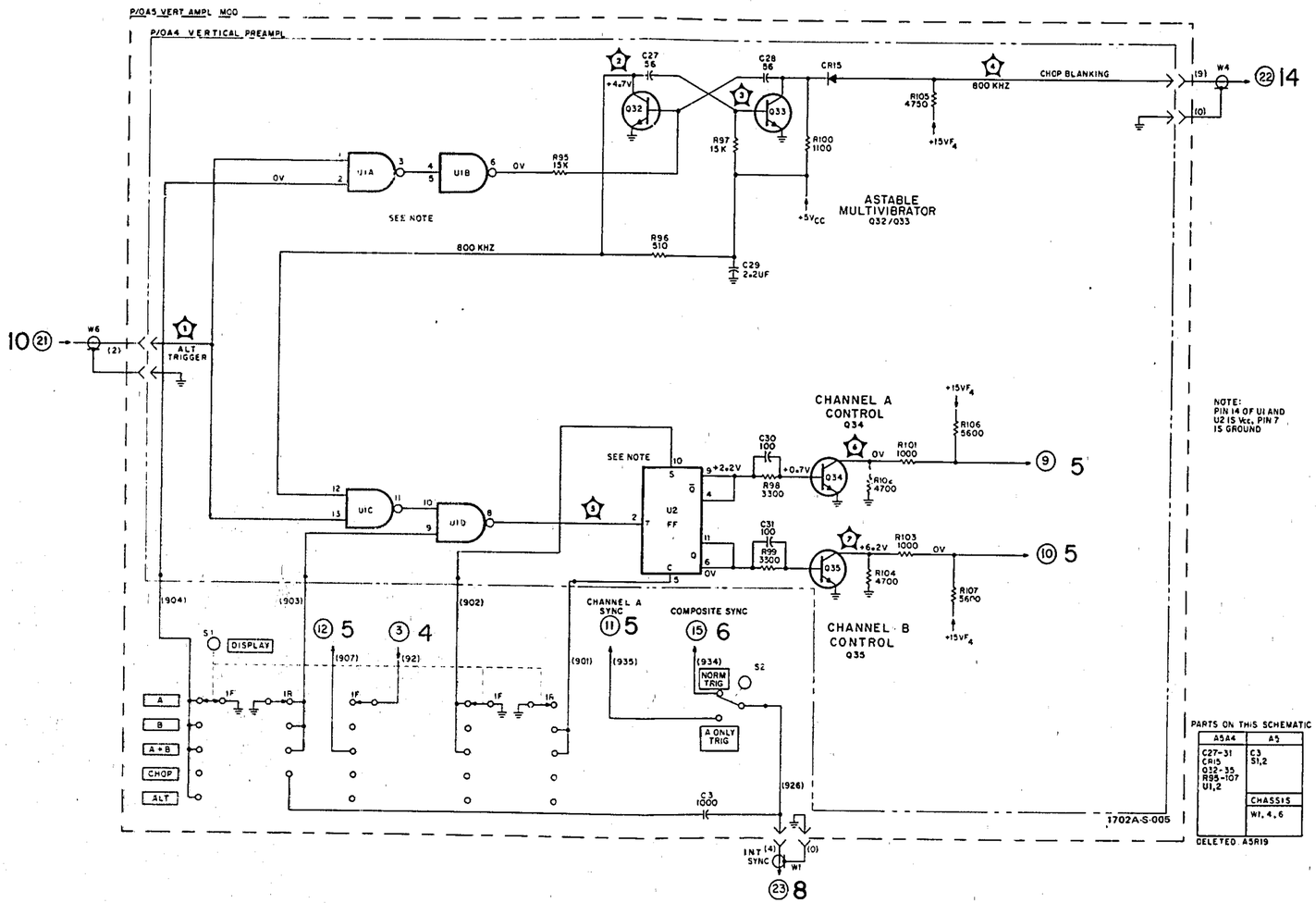
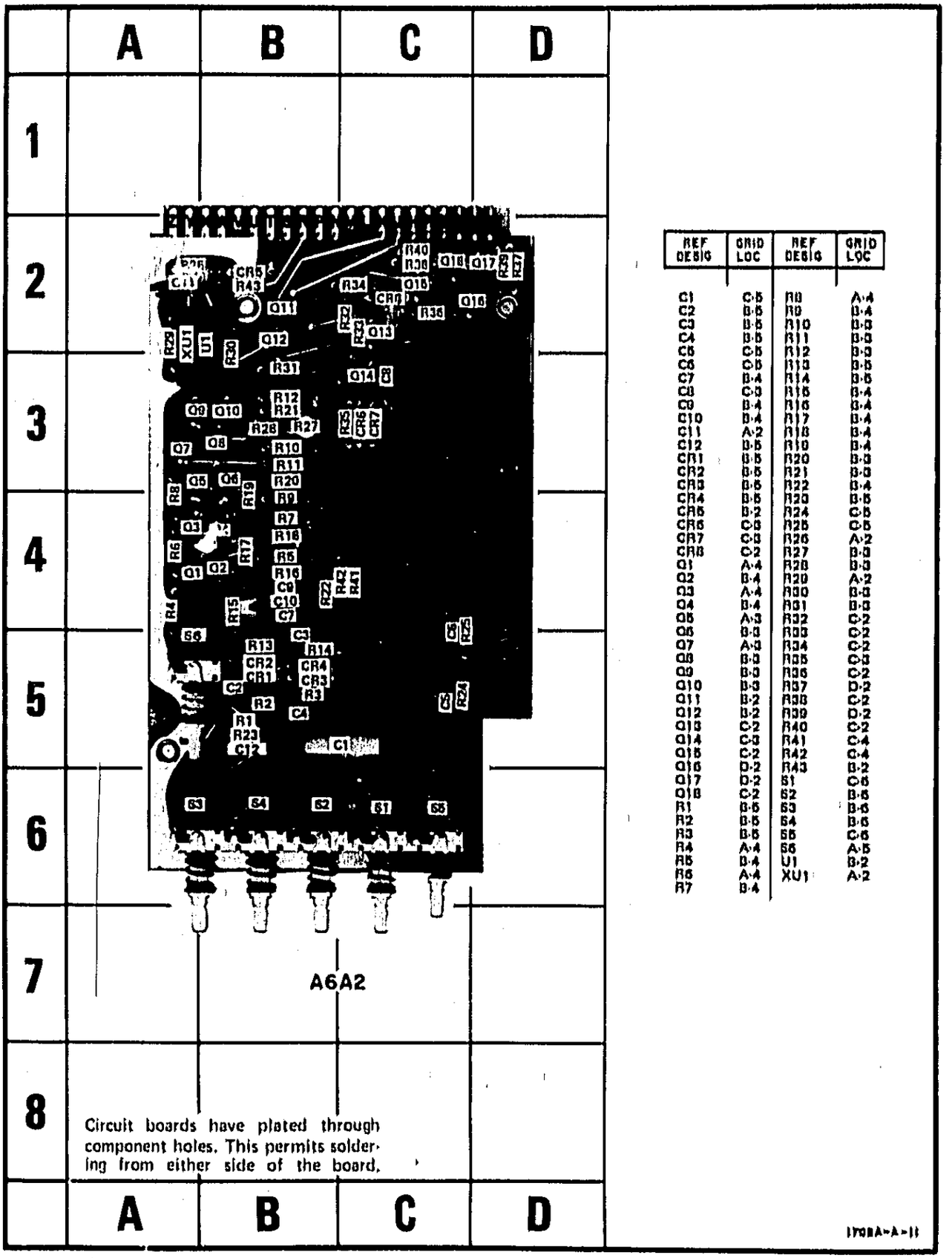


Figure 8-17.
Vertical Preamplifier, A5A4, Schematic (4 of 4)



REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	C-5	R8	A-4
C2	B-5	R9	B-4
C3	B-5	R10	B-3
C4	B-5	R11	B-3
C5	C-5	R12	B-3
C6	C-5	R13	B-5
C7	B-4	R14	B-5
C8	C-3	R15	B-4
C9	B-4	R16	B-4
C10	B-4	R17	B-4
C11	A-2	R18	B-4
C12	B-5	R19	B-4
CR1	B-5	R20	B-3
CR2	B-5	R21	B-3
CR3	B-5	R22	B-4
CR4	B-5	R23	B-5
CR5	B-2	R24	C-5
CR6	C-3	R25	C-5
CR7	C-3	R26	A-2
CR8	C-2	R27	B-3
Q1	A-4	R28	B-3
Q2	B-4	R29	A-2
Q3	A-4	R30	B-3
Q4	B-4	R31	B-3
Q5	A-3	R32	C-2
Q6	B-3	R33	C-2
Q7	A-3	R34	C-2
Q8	B-3	R35	C-3
Q9	B-3	R36	C-2
Q10	B-3	R37	D-2
Q11	B-2	R38	C-2
Q12	B-2	R39	D-2
Q13	C-2	R40	C-2
Q14	C-3	R41	C-4
Q15	C-2	R42	C-4
Q16	D-2	R43	B-2
Q17	D-2	S1	C-6
Q18	C-2	S2	B-6
R1	B-5	S3	B-6
R2	B-5	S4	B-6
R3	B-5	S5	C-6
R4	A-4	S6	A-5
R5	B-4	U1	B-2
R6	A-4	XU1	A-2
R7	B-4		

Figure 8-18. Trigger, A6A2, Component Identification

Table 8-8. Channel A Output Amplifier Measurement Conditions and Waveforms

DC VOLTAGE MEASUREMENT CONDITIONS

A. Set:
AUTO/NORM ..... AUTO
SWP MAG X1
INT/EXT ..... EXT
slope ..... +
TIME/DIV ..... .2 mSEC
TRIGGER LEVEL ..... 12 o'clock position

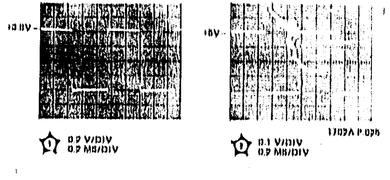
B. Connect CAL 1 VOLT signal to EXT TRIG INPUT.

C. All waveforms are referenced to chassis ground. The monitor oscilloscope's vertical sensitivity (using a 10:1 probe) and sweep speed settings are shown below on each waveform photograph.

WAVEFORM MEASUREMENT CONDITIONS

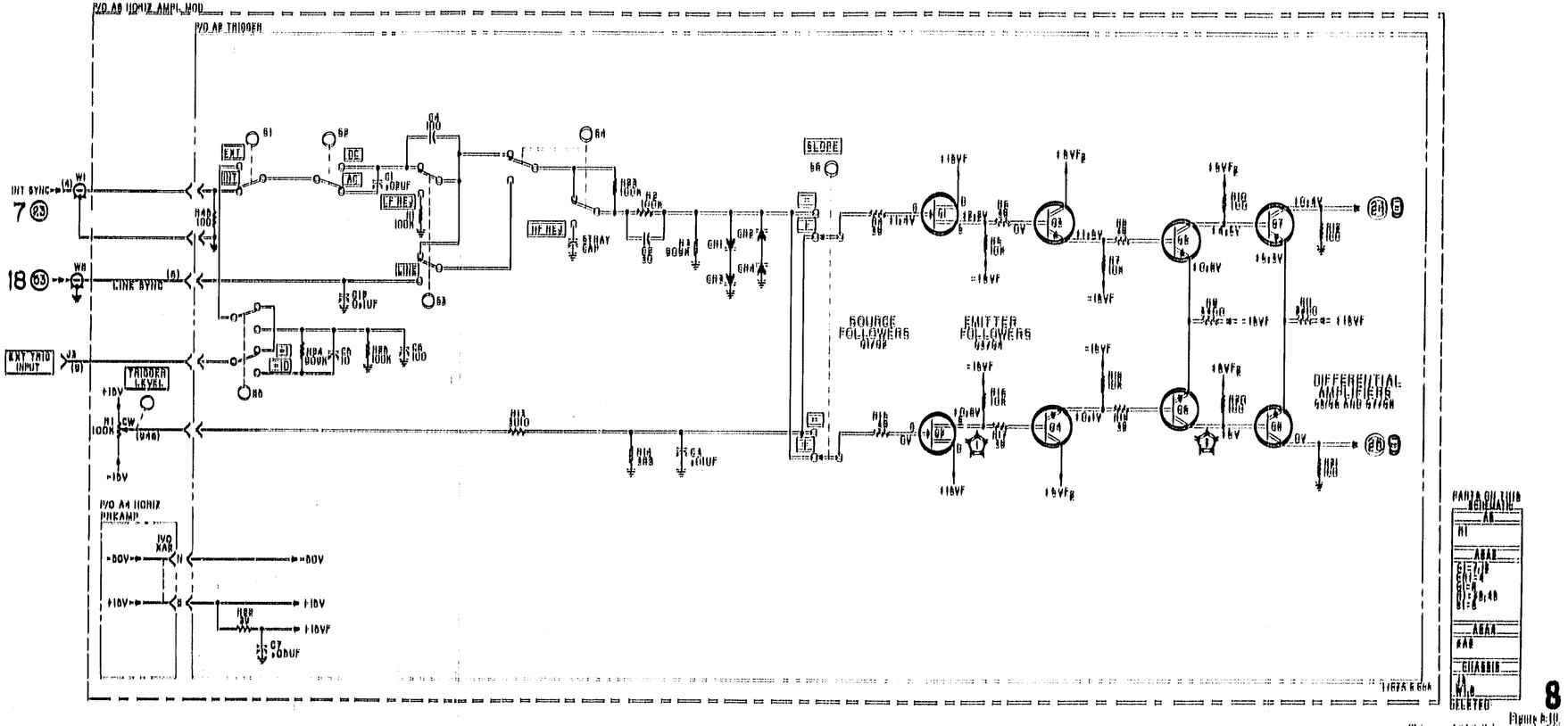
A. Set:
AUTO/NORM ..... AUTO
SINGLE ..... engaged
SWP MAG X1
INT/EXT ..... INT
TRIGGER LEVEL ..... cw
slope ..... +

B. All voltages are referenced to chassis ground. All indications are nominal and may vary slightly.



1 0.2 V/DIV
0.2 MS/DIV

2 0.1 V/DIV
0.2 MS/DIV



PARTS ON THIS SCHEMATIC
A8
A8A1
A8A2
CHASSIS
DELETED

8

Figure 8-10
Trigger, A8A1, Schematic (1 of 2)
8-17/8-18

Table 6-6 Typical Characteristic Curves and Waveforms

DC VOLTAGE MEASUREMENT CONDITIONS

A

B

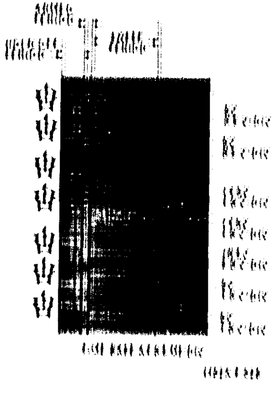
C

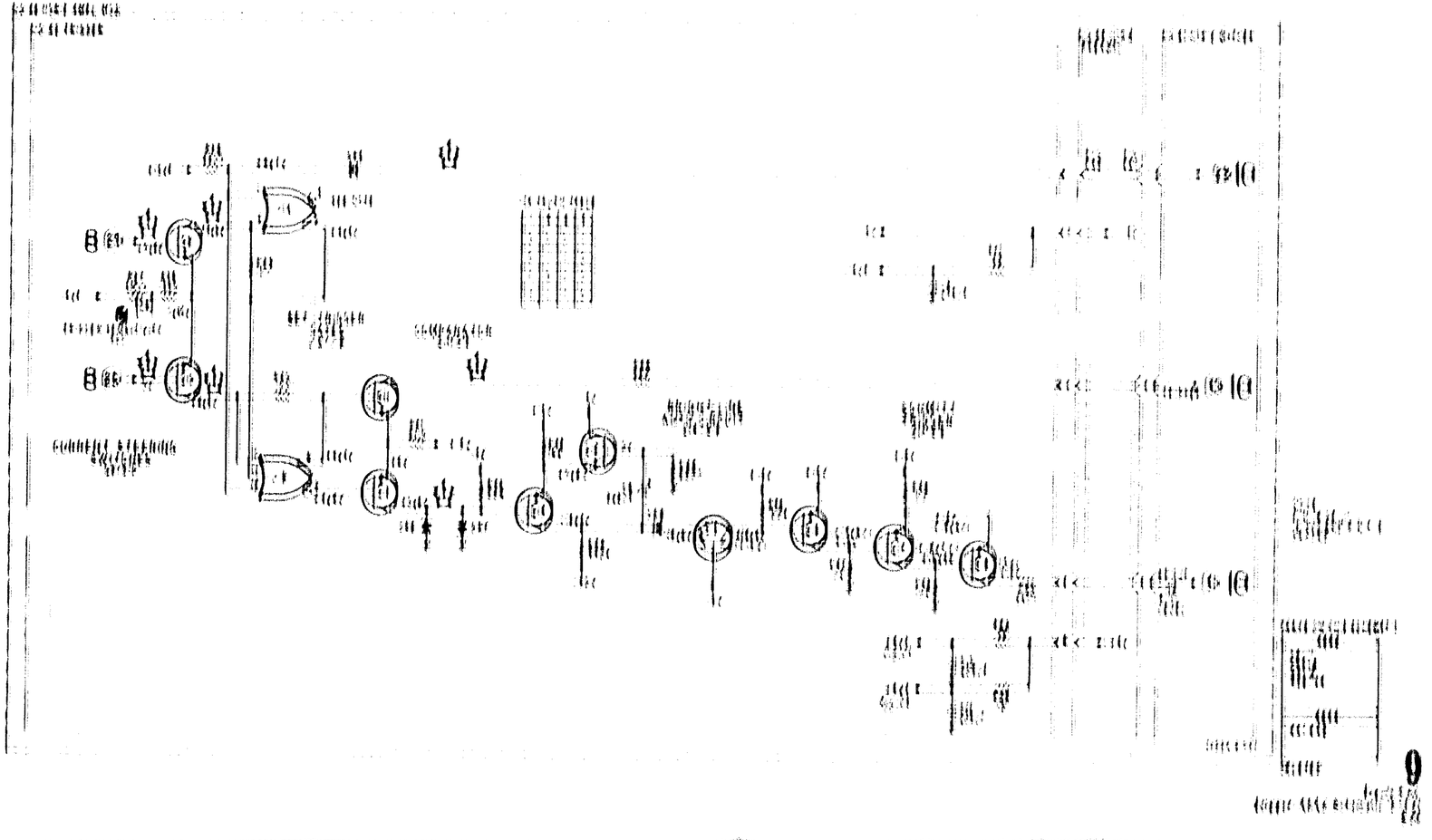
WAVEFORM MEASUREMENT CONDITIONS

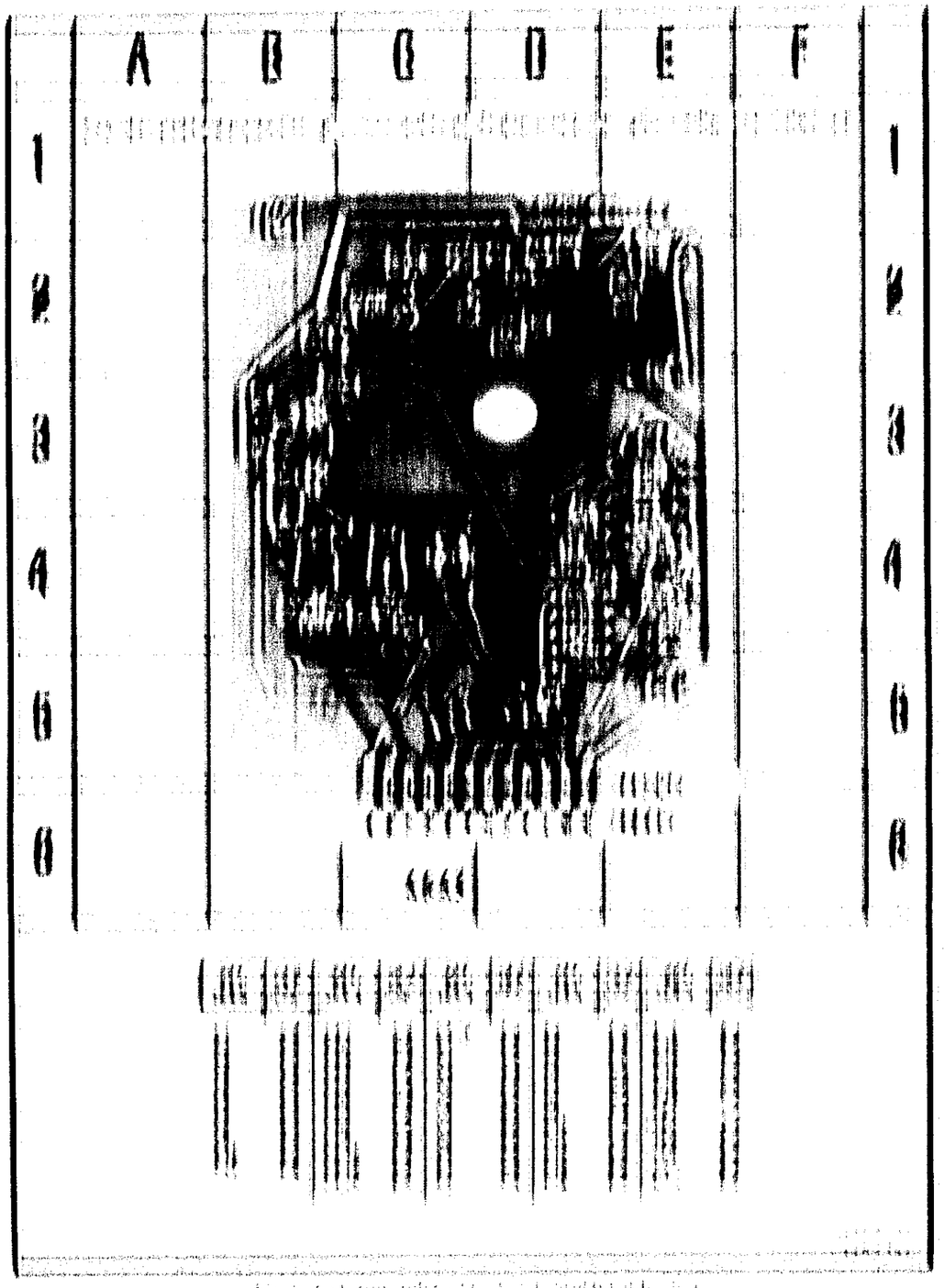
A

B

C






A
B
C
D
E
F
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2
3
4
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6

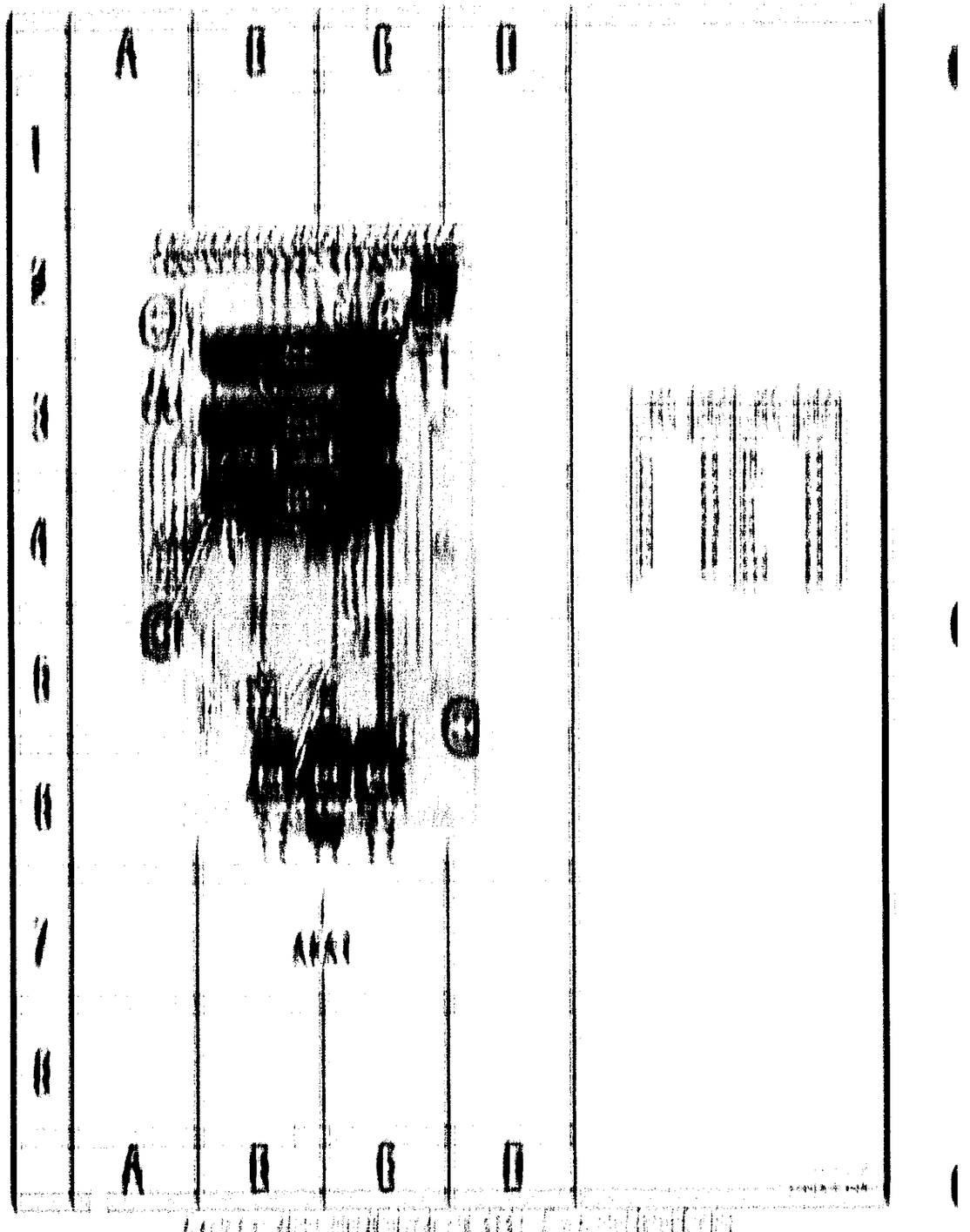

A
B
C
D
1
2
3
4
5
6
7
8

Table 8-10. Integrator Measurement Conditions and Waveforms

DC VOLTAGE MEASUREMENT CONDITIONS

A. Set:

AUTO/NORM	AUTO
INT/EXT	INT
TRIGGER LEVEL	cw
SINGLE	engaged

B. Voltages in ( ) are measured with AUTO/NORM set to NORM and SINGLE disengaged.

C. All voltages are referenced to chassis ground. All indications are nominal and may vary slightly.

WAVEFORM MEASUREMENT CONDITIONS

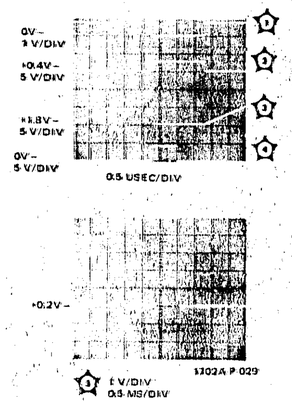
A. Set:

AUTO/NORM	NORM
INT/EXT	EXT
slope	+
TIME/DIV	.2 mSEC

B. Connect CAL 1 VOLT to EXT TRIG INPUT.

C. All waveforms are referenced to chassis ground. The monitor oscilloscope's vertical sensitivity (using a 1:1 probe) and sweep speed settings are shown below on each waveform photograph.

D. All waveforms are time related.



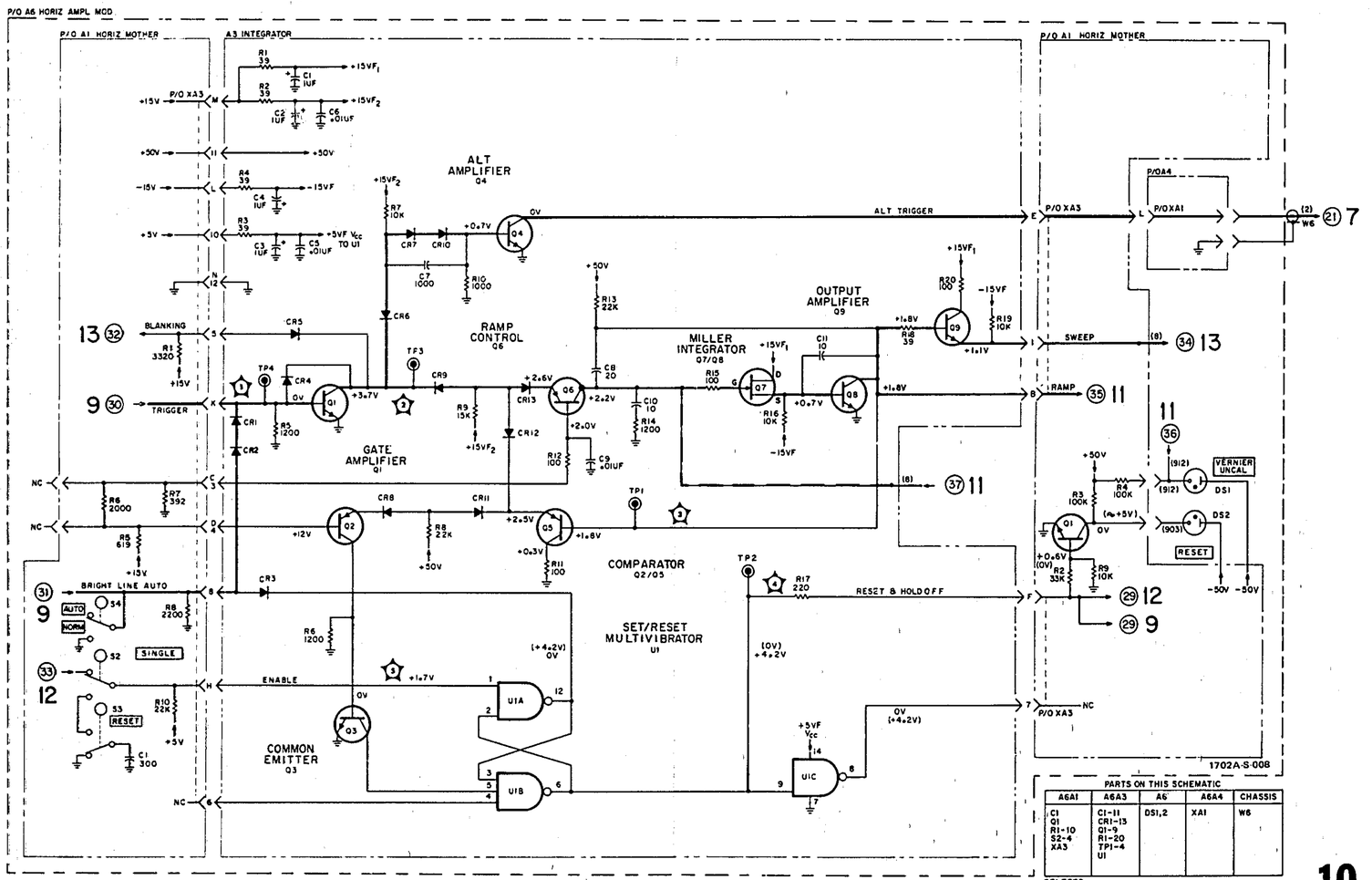
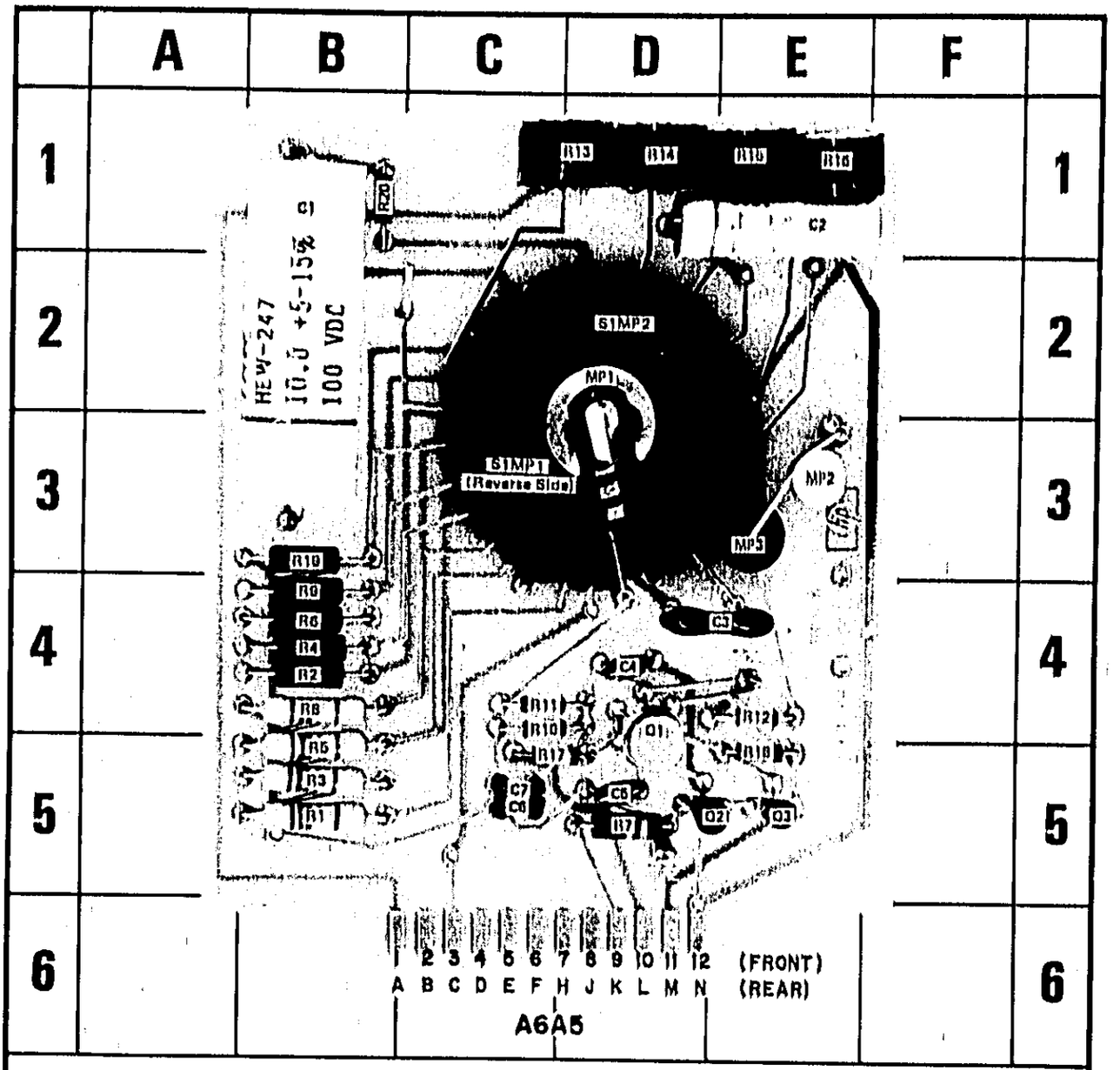


Figure 8-23. Integrator, A6A3, Schematic



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	B-1	MP1	D-2	R2	B-4	R9	B-4	R16	E-1
C2	E-1	MP2	E-3	R3	B-5	R10	C-4	R17	C-5
C3	E-4	MP3	E-3	R4	B-4	R11	C-4	R18	E-5
C4	D-4	Q1	D-4	R5	B-5	R12	E-4	R19	B-3
C5	D-5	Q2	E-5	R6	B-4	R13	D-1	R20	B-1
C6	C-5	Q3	E-5	R7	D-5	R14	D-1	S1MP1	C-3
C7	C-5	R1	B-5	R8	B-4	R15	E-1	S1MP2	D-2

Circuit boards have plated through component holes. This permits soldering from either side of the board.

1702A-8-2

Figure 8-24. Sweep Time, A6A5, Component Identification

Table 8-11. Sweep Time Measurement Conditions

DC VOLTAGE MEASUREMENT CONDITIONS

A. Set:

AUTO/NORM..... AUTO
INT/EXT..... INT

B. All voltages are referenced to chassis ground. All indications are nominal and may vary slightly.

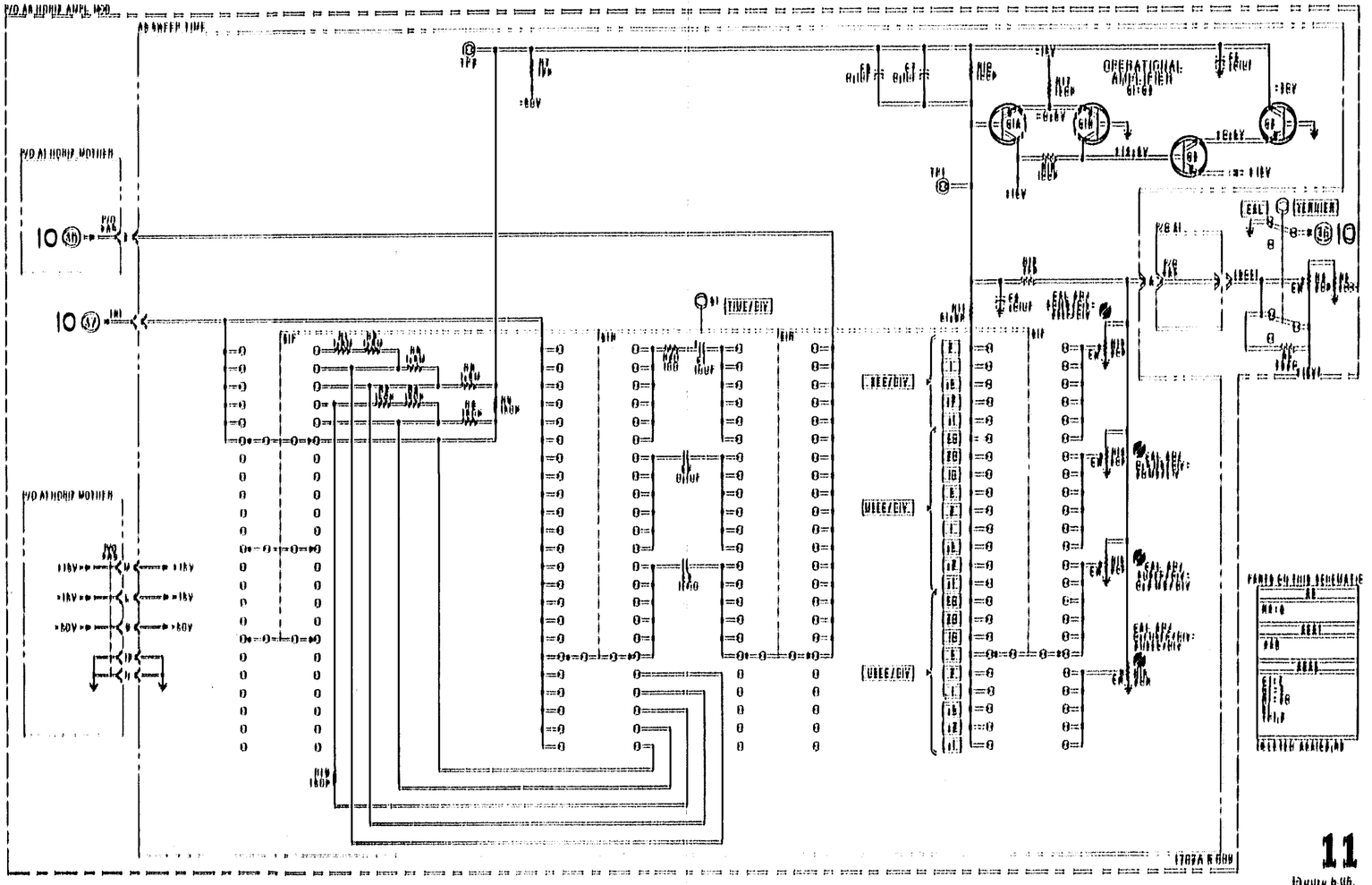


Figure 8-15.
Sweep Time, A6A5, Schematic

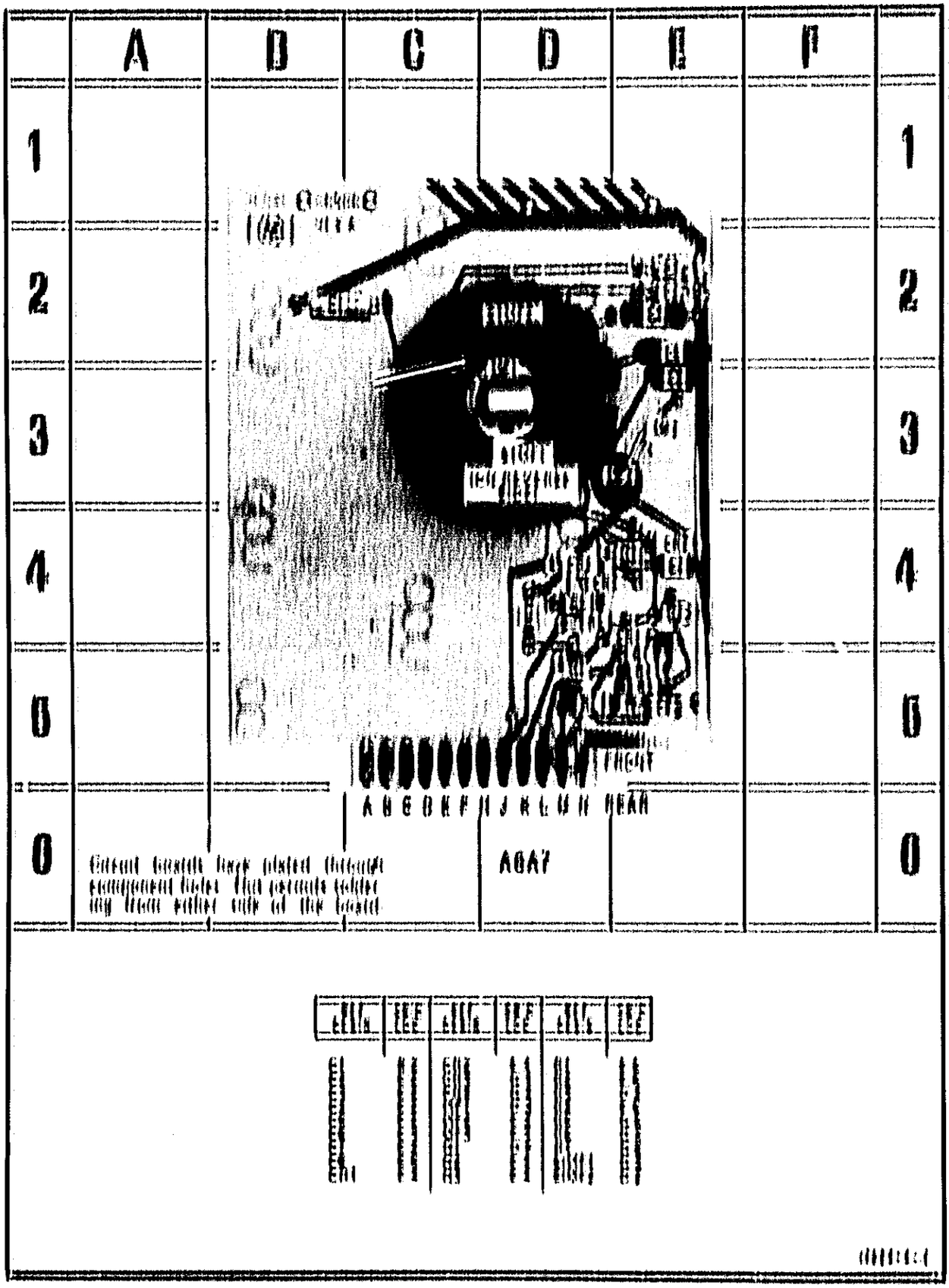


Figure 8-16. Model 1760A Component Identification

Table 6-[illegible] [illegible] Environmental Conditions and Waveforms

DC VOLTAGE MEASUREMENT CONDITIONS

A [illegible]

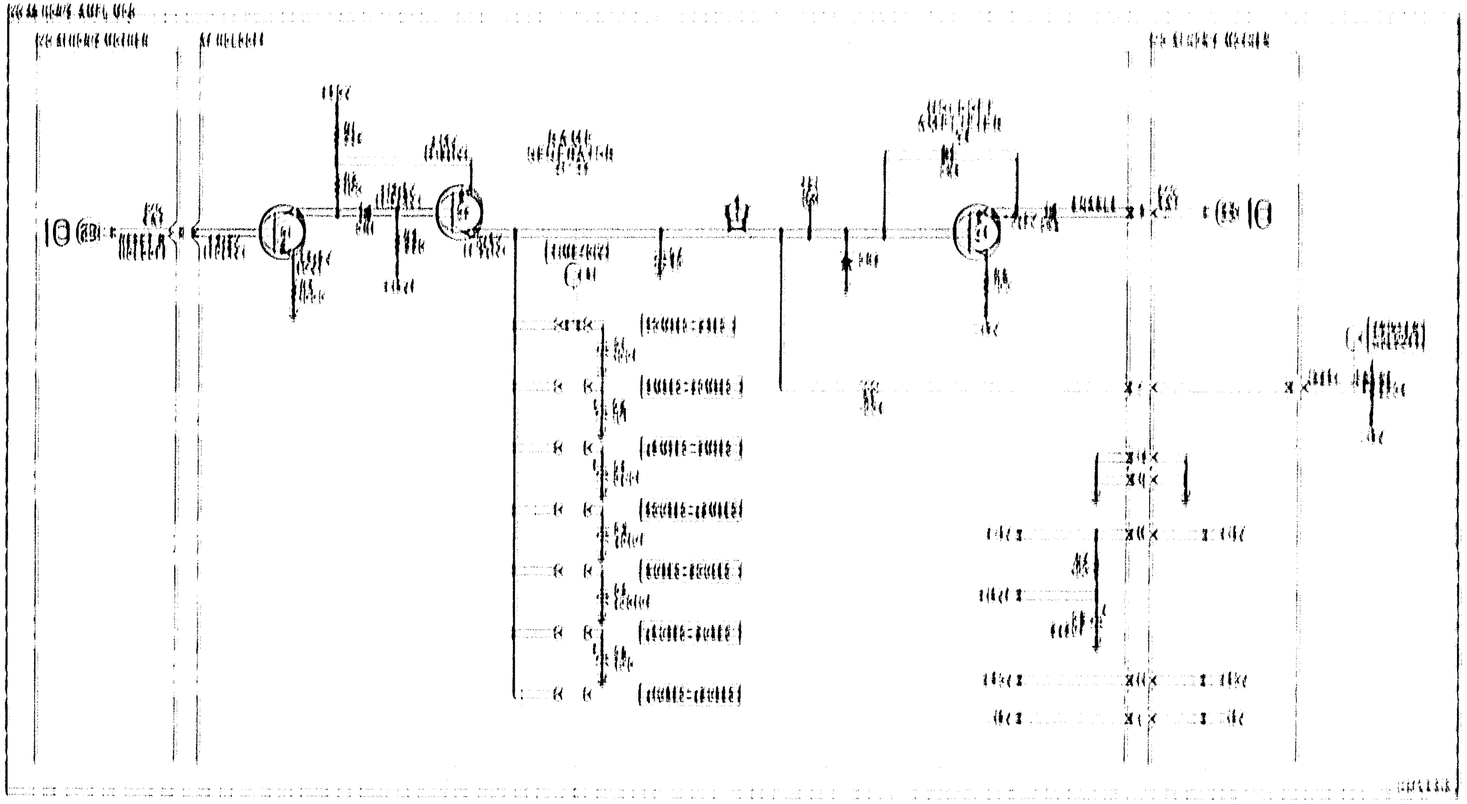
B [illegible]

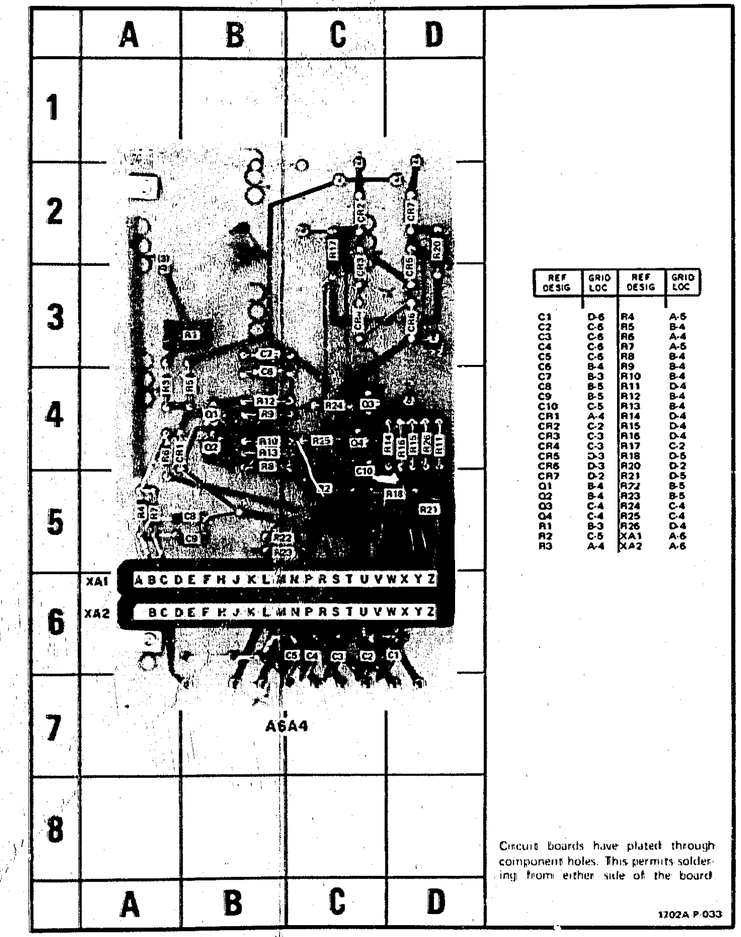
C [illegible]

WAVEFORM MEASUREMENT CONDITIONS

A [illegible]

B [illegible]



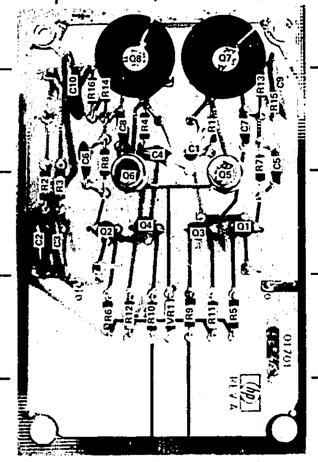


REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	D-6	R4	A-5
C2	C-6	R5	B-4
C3	C-5	R6	A-4
C4	C-6	R7	A-5
C5	C-5	R8	B-4
C6	B-4	R9	B-4
C7	B-3	R10	B-4
C8	B-5	R11	D-4
C9	B-5	R12	B-4
C10	C-5	R13	B-4
CR1	A-4	R14	D-4
CR2	C-2	R15	D-4
CR3	C-3	R16	D-4
CR4	C-3	R17	C-2
CR5	D-3	R18	D-5
CR6	D-3	R20	D-2
CR7	D-2	R21	D-5
Q1	B-4	R22	B-5
Q2	B-4	R23	B-5
Q3	C-4	R24	C-4
Q4	C-4	R25	C-4
R1	B-3	R26	D-4
R2	C-5	XA1	A-6
R3	A-4	XA2	A-6

Circuit boards have plated through component holes. This permits soldering from either side of the board.

1702A P 033

Figure 8-28. Horizontal Preamplifier, A6A4, Component Identification



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	D-2	C8	C-2	Q5	D-3	R4	C-2	R11	D-4
C2	B-3	C9	E-2	Q6	C-3	R5	D-4	R12	C-4
C3	C-3	C10	C-2	Q7	D-1	R6	C-4	R13	E-2
C4	D-2	Q1	D-3	Q8	C-1	R7	E-2	R14	C-2
C5	E-2	Q2	C-3	R1	D-2	R8	C-2	R15	E-2
C6	C-2	Q3	D-3	R2	B-3	R9	D-4	R16	C-2
C7	D-2	Q4	C-3	R3	C-3	R10	C-4	VR1	D-4

Circuit boards have plated through component holes. This permits soldering from either side of the board.

1702A-P-034

Figure 8-29. Horizontal Output Amplifier, A6A6, Component Identification

Table 8-13. Horiz Preamp and Output Ampl Measurement Conditions and Waveforms

DC VOLTAGE MEASUREMENT CONDITIONS

A. Set:

AUTO/NORM ..... AUTO
INT/EXT ..... INT
SINGLE ..... engaged
TIME/DIV ..... .2 mSEC
HORIZONTAL POSITION ..... centered

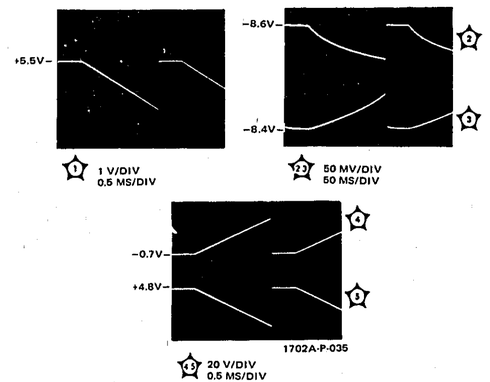
B. All voltages are referenced to chassis ground. All indications are nominal and may vary slightly.

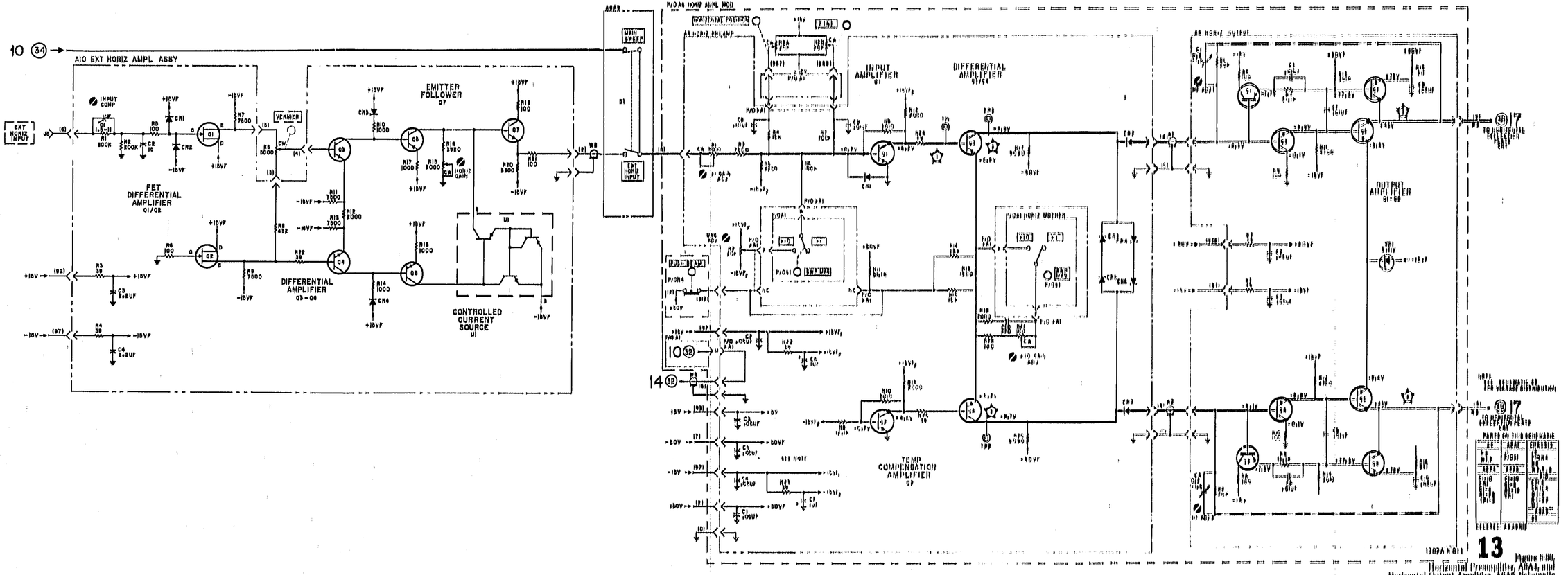
WAVEFORM MEASUREMENT CONDITIONS

A. Set:

AUTO/NORM ..... AUTO
INT/EXT ..... INT
slope ..... +
TIME/DIV ..... .2 mSEC

B. All waveforms are referenced to chassis ground. The monitor oscilloscope's vertical sensitivity (using a 1:1 probe) and sweep speed settings are shown below on each waveform photograph.





13 Figure 8-10. Horizontal Preamplifier, A8A1, and Horizontal Output Amplifier, A8A8, Schematic

8-17

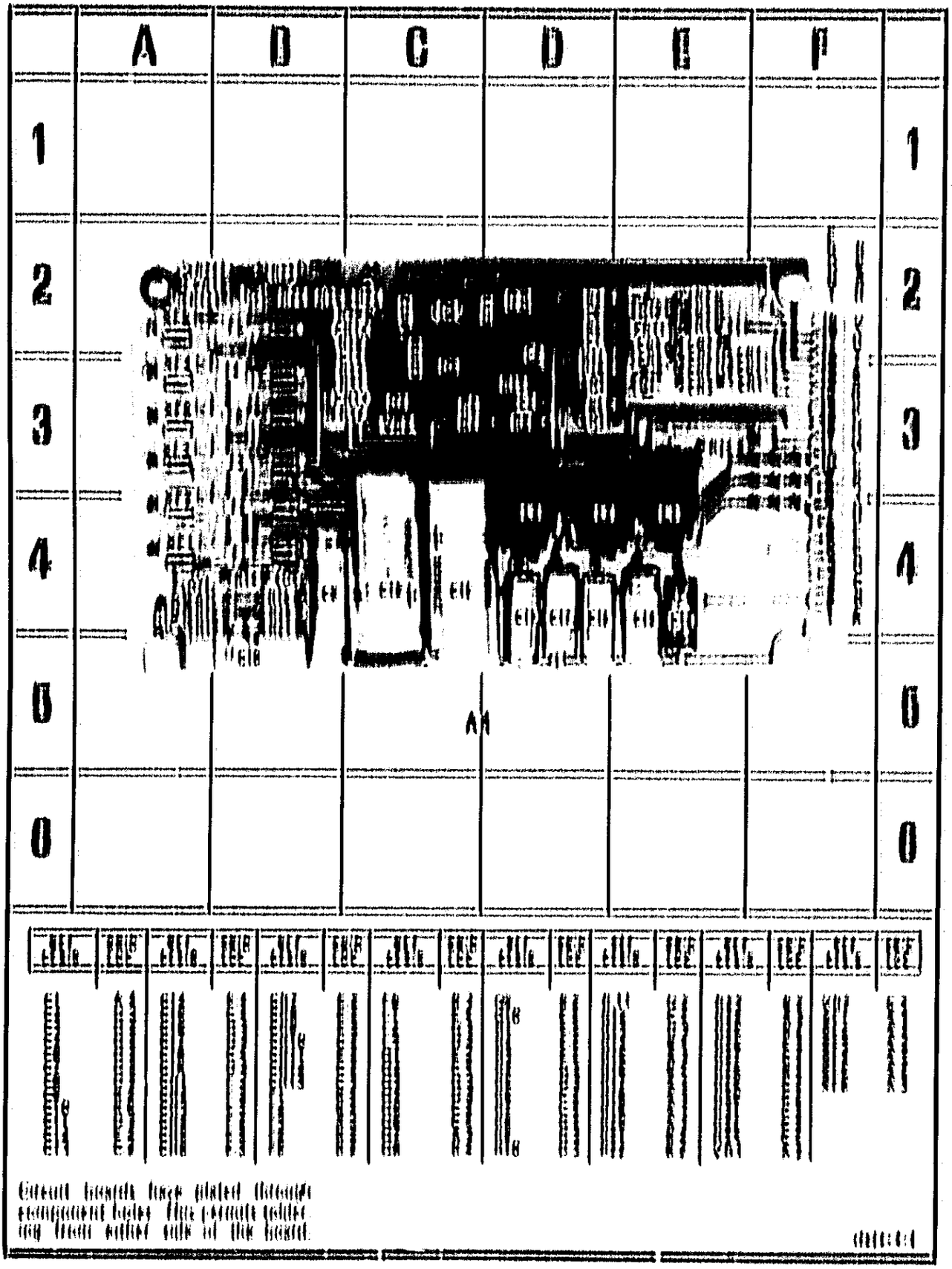


Figure 8-11. Slide A1, Component Identification

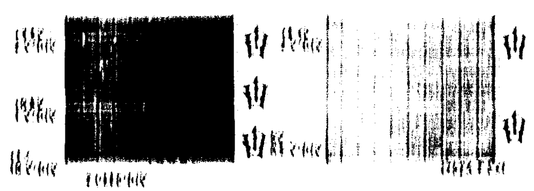
Table 5-11 Data Measurement Conditions and Waveforms

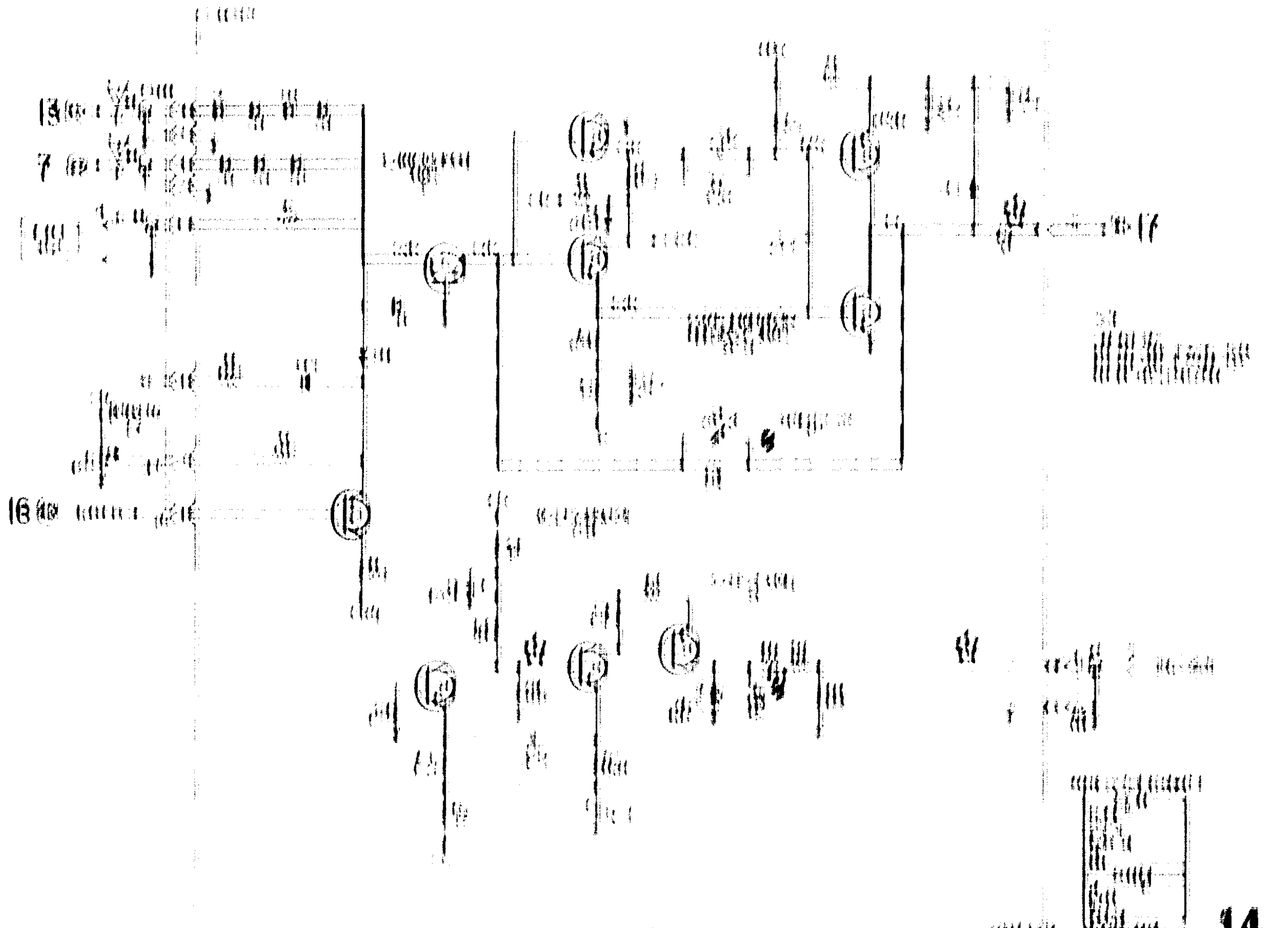
DC VOLTAGE MEASUREMENT CONDITIONS

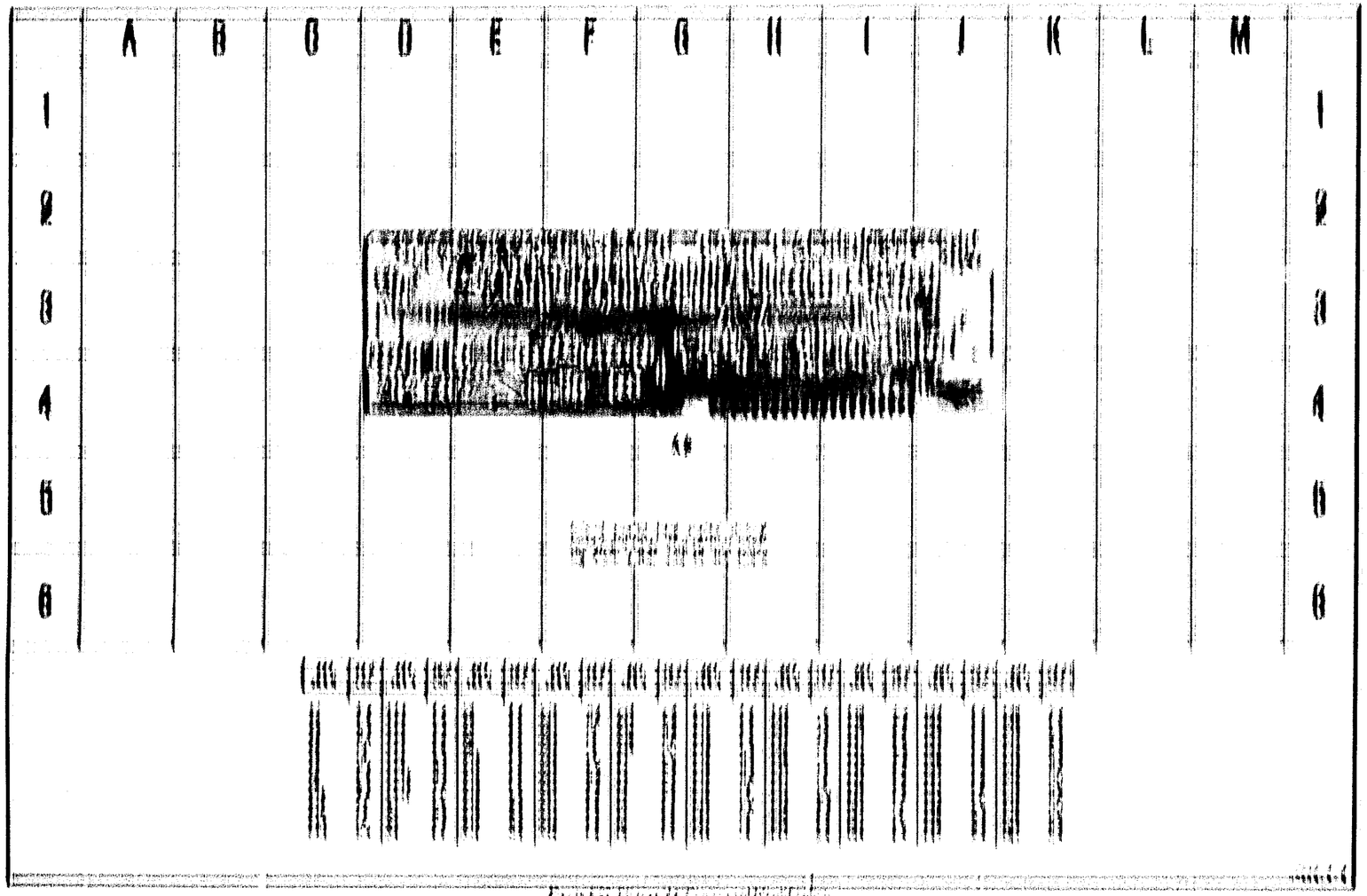
A	B
[illegible]	[illegible]

WAVEFORM MEASUREMENT CONDITIONS

A	B
[illegible]	[illegible]



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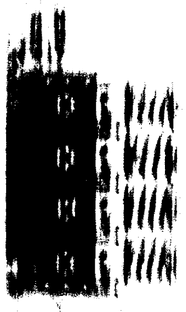


Table 8-15 and 8-16. Storage Circuit Measurement Conditions and Waveforms

WAVEFORM TEST POINT	STD	FAST	CONV	STORE	ERASE
①	+50V level	+50V dc level	+50V dc level	Frequency depends on setting of store time pot R7	No change from previous mode selected.
②	Level depends on setting of Std Erase pot R15  Frequency depends on setting of Persistence pot 8.	Level depends on setting of Fast Erase pot R16 	−50V dc level	+2.4V dc level	Level depends on setting of Std or Fast Erase pots.  Occurs in std or Fast mode only, otherwise no change from previous mode selected
③	+21V dc level approx.	+74V dc level approx.	+21V dc or +74V dc level approx. Depends on whether Std or Fast was used last.	+21V dc or +74V dc level approx. Depends on whether Std or Fast was used last.	Occurs in Std or Fast Mode only, otherwise no change from previous mode selected.  Level depends on whether Std or Fast was used last.
④	−1.4V dc level	−1.4V dc level	−1.4V dc level	+0.8V dc level	+0.8V dc level in STD or FAST only. Otherwise no change from previous mode selected.

Table 8-15 and 8-16. Storage Circuit Measurement Conditions and Waveforms (Cont'd)

WAVEFORM TEST POINT	STD	FAST	CONV	STORE	ERASE
⑤	Frequency depends on PERSISTENCE setting.	Same as STD mode.	+4.3V dc level	Frequency depends on STORE TIME setting.	No change from mode selected.
⑥	+0.8V dc level	+0.8V dc level	+0.8V dc level	+0.8V dc level	Occurs in Std or Fast mode only. Otherwise no change from previous mode selected.

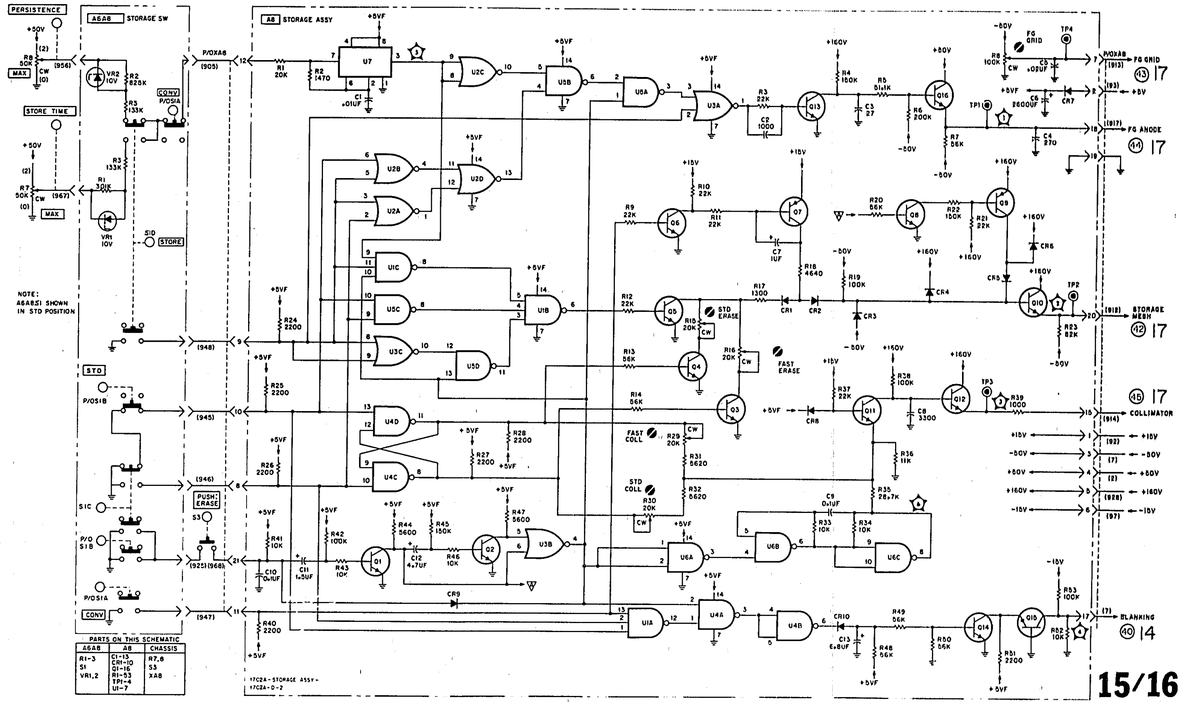
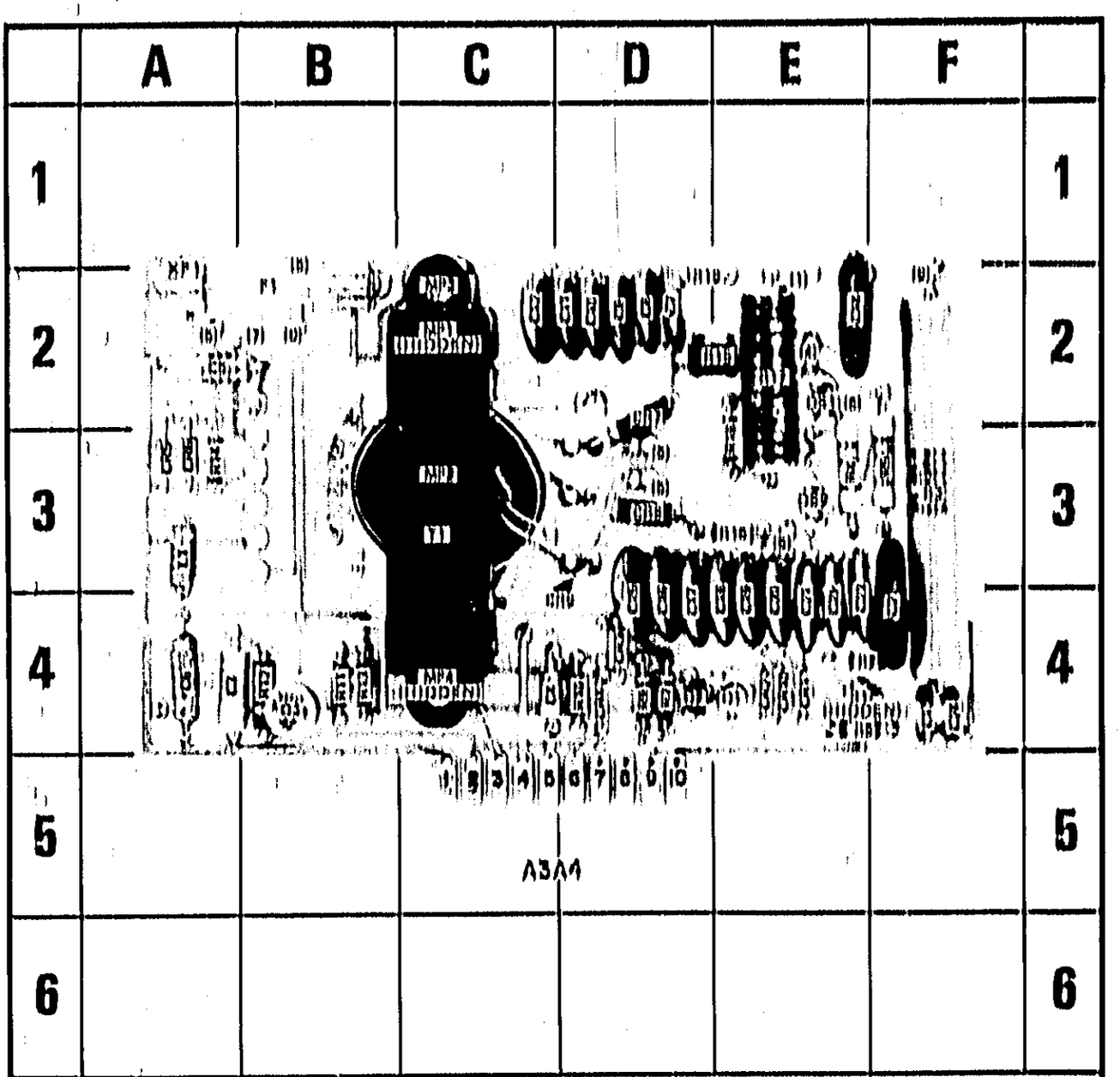


Figure 8-35. Storage Circuit A8 Schematic



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
C1	F-4	C11	D-2	CR1	E-4	C16	A-2	MP1	C-2	R9	F-2	R16	D-4
C2	F-4	C12	D-2	CR2	E-4	C17	D-2	MP2	C-2	R14	F-2	R17	A-2
C3	A-4	C14	D-2	CR3	E-4	C18	D-2	MP3	C-2	R15	F-2	R18	E-2
C4	C-4	C15	D-4	CR4	E-4	C19	D-2	MP4	D-4	R16	F-2	R19	E-2
C5	A-2	C16	D-4	C11	E-4	C110	E-2	Q1	D-4	R17	D-4	R110	E-2
C6	A-4	C17	D-4	C18	E-4	CR1	E-2	Q2	D-4	R18	D-4	R111	E-2
C7	D-2	C18	D-4	C19	D-4	CR2	E-2	Q3	D-4	R19	D-4	R112	D-2
C8	D-2	C19	D-4	C110	D-4	F1	D-2	R1	D-4	R110	D-4	T1	D-2
C9	D-2	C20	D-4	C116	A-2	L1	A-2	R2	D-4	R119	D-4	XF1	A-1
C10	D-2												

Circuit boards have plated through component holes. This permits soldering from either side of the board.

1709A P 040

Figure 8-80. High Voltage Oscillator A3A4, Component Identification

Table 8-17. High Voltage Oscillator Measurement Conditions and Waveforms

DC VOLTAGE MEASUREMENT CONDITIONS

A. Set

POWER ..... ON
INTENSITY ..... cw

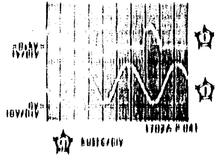
B. All voltages are referenced to chassis ground. All indications are nominal and may vary slightly.

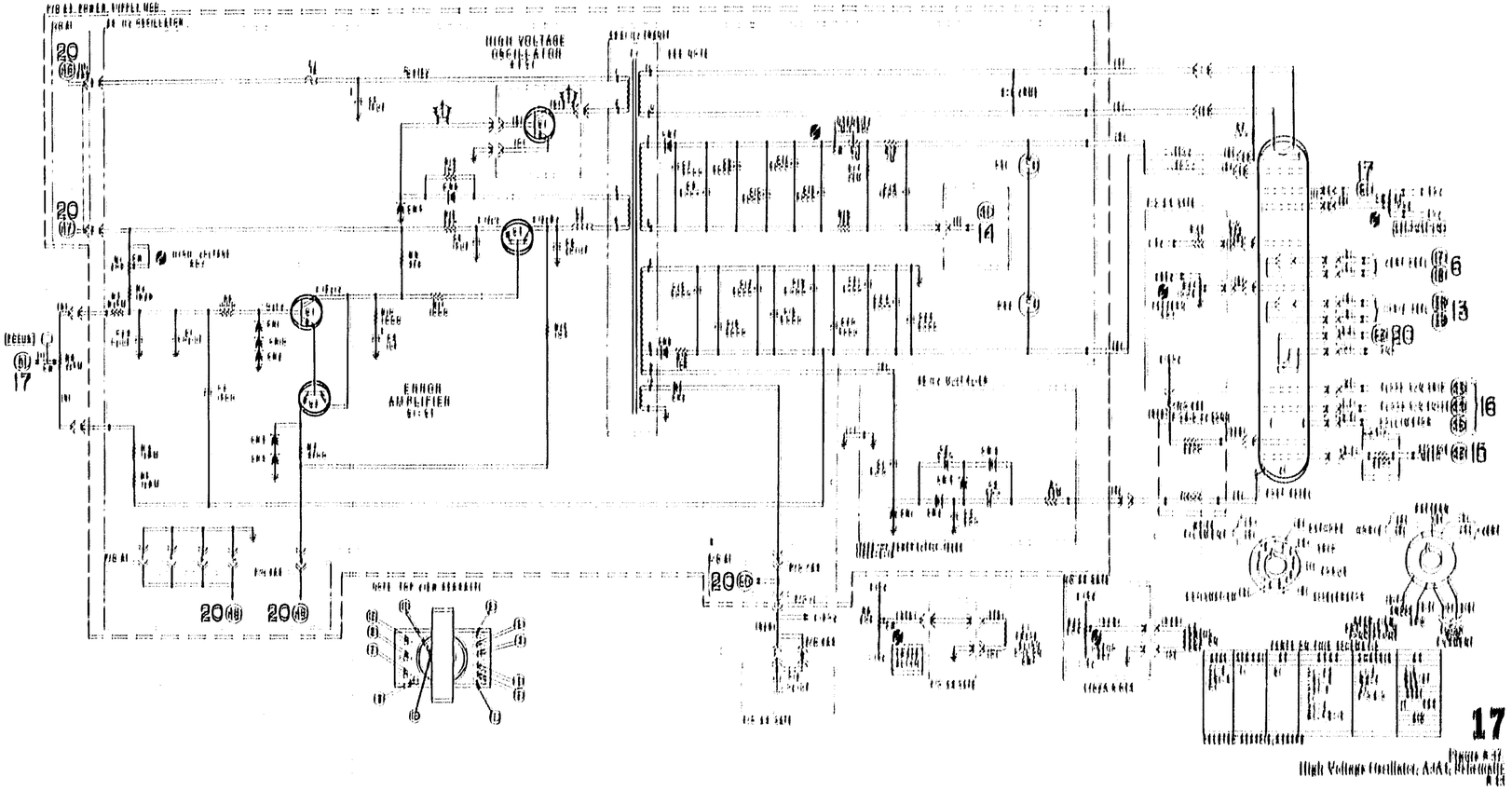
WAVEFORM MEASUREMENT CONDITIONS

A. Set

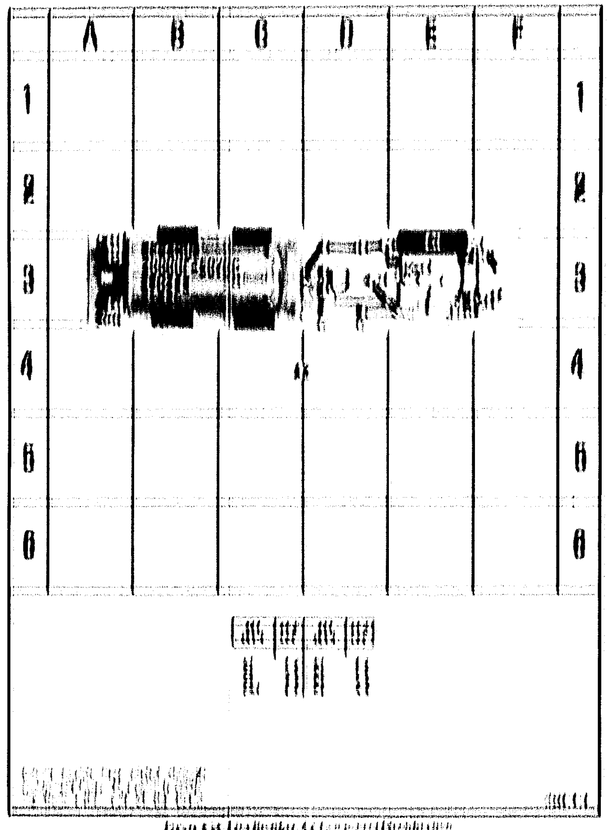
POWER ..... ON
INTENSITY ..... cw

B. All waveforms are referenced to chassis ground. The monitor oscilloscope's vertical sensitivity using a 1:1 probe and sweep speed settings are shown below on each waveform photograph.





High Voltage Oscillator, A14A1


A
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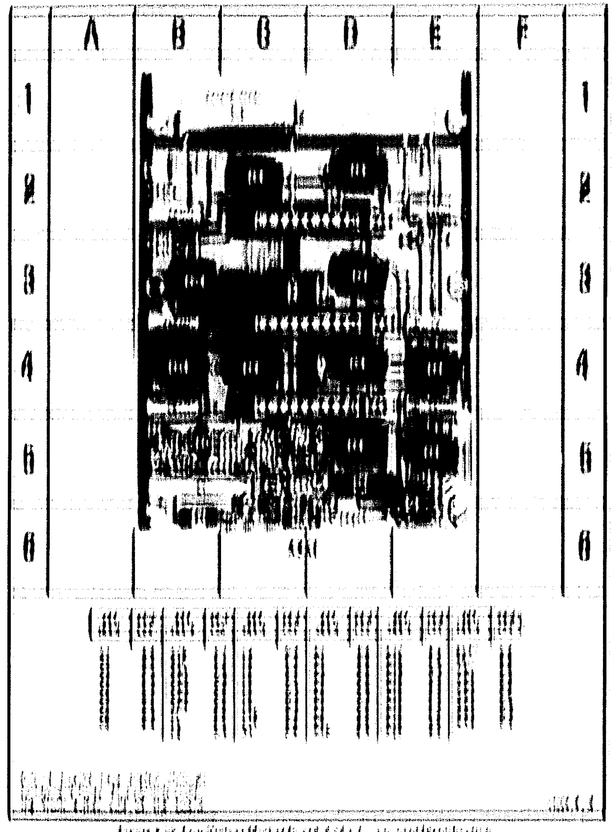
A
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C
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F
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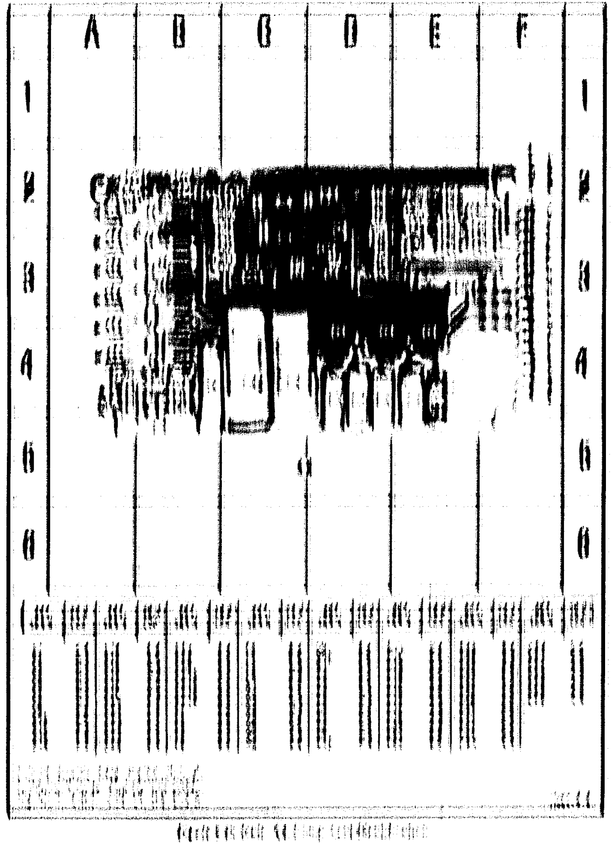
A
B
C
D
E
F
1
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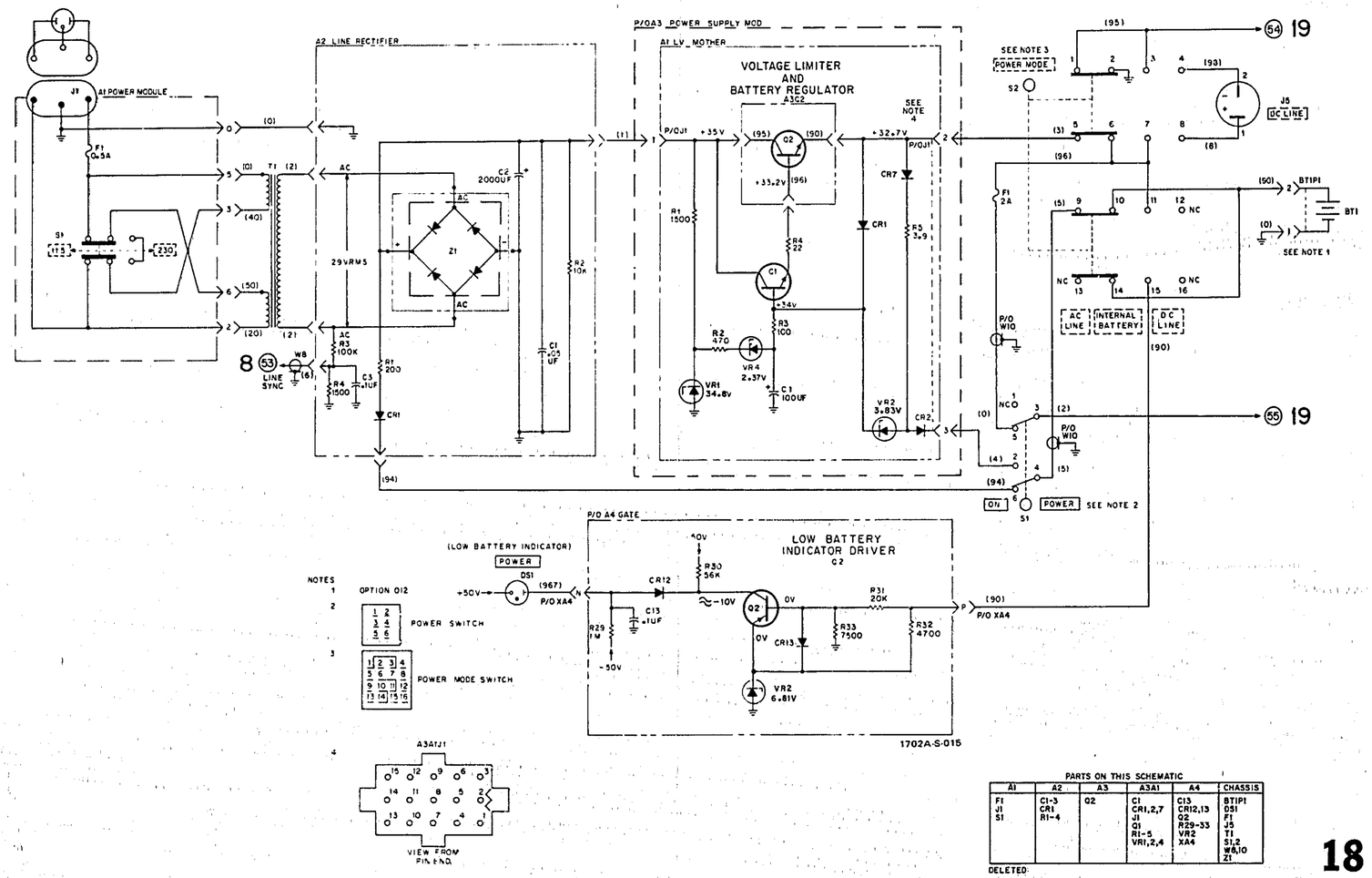
6

Table 8-18. Low Voltage Power Supply Measurement Conditions

DC VOLTAGE MEASUREMENT CONDITIONS	
A. Set:	B. All voltages are referenced to chassis ground. All indications are nominal and may vary slightly.
POWER MODE ..... AC LINE	
POWER ..... ON	

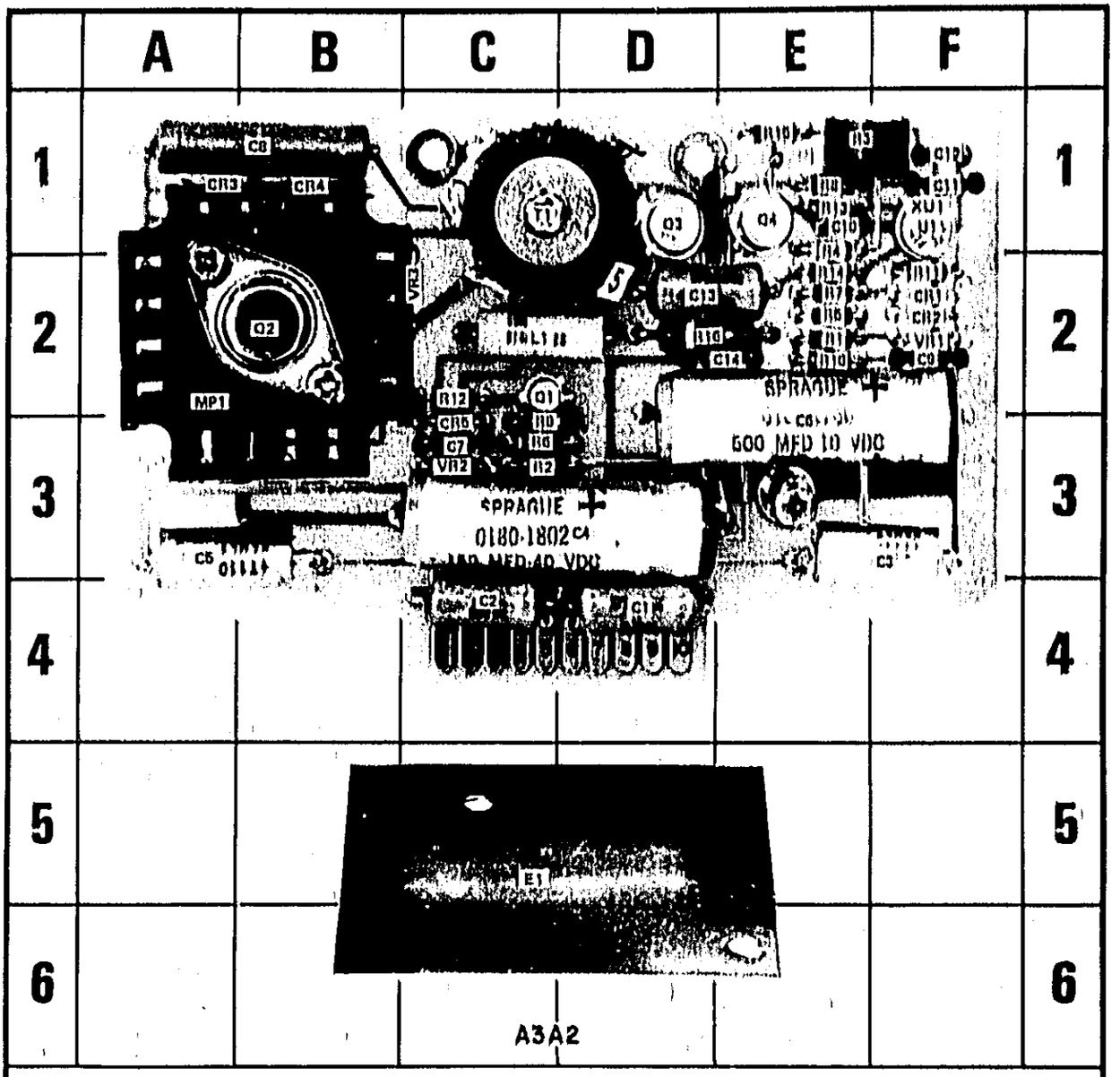


PARTS ON THIS SCHEMATIC

A1	A2	A3	A3A1	A4	CHASSIS
F1 J1 S1	C1-3 CR1 R1-4	Q2	C1 CR1,2,7 J1 Q1 R1-5 VR1,2,4	C13 CR12,13 Q2 R29-33 VR2 XA4	BT1P1 DS1 F1 J5 T1 S1,2 W8,10 Z1

DELETED:

Figure 8-41.
Power Input and Line Rectifier Schematic



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	D-4	C9	F-2	CR3	A-1	Q3	D-1	R7	E-2	R15	E-1
C2	C-4	C10	E-1	CR4	B-1	Q4	E-1	R8	E-1	R16	D-2
C3	F-3	C11	F-1	CR5	C-3	R1	E-2	R9	C-3	U1	F-1
C4	D-3	C12	F-1	E1	C-5	R2	C-3	R10	E-2	T1	C-1
C5	A-3	C13	D-2	L1	C-2	R3	E-1	R11	F-2	VR1	F-2
C6	E-3	C14	E-2	MP1	A-2	R4	E-1	R12	C-2	VR2	C-3
C7	C-3	CR1	F-2	Q1	C-2	R5	E-2	R13	E-1	VR3	C-2
C8	B-1	CR2	F-2	Q2	B-2	R6	C-3	R14	E-2	XU1	F-1

Circuit boards have plated through component holes. This permits soldering from either side of the board.

17021A-8-7

Figure 8-42. Low Voltage Converter, A3A2, Component Identification

Table 8-10. Low Voltage Converter Measurement Conditions and Waveforms

DC VOLTAGE MEASUREMENT CONDITIONS

A. Set:

POWER ..... ON
POWER MODE ..... DC LINE

B. Connect:

DC LINE ..... 30 Vdc

Measure (1)

C. Connect:

DC LINE ..... 24 Vdc

Measure (2)

D. Connect:

DC LINE ..... 11.5 Vdc

Measure (3)

E. All voltages are referenced to chassis ground. All indications are nominal and may vary slightly.

WAVEFORM MEASUREMENT CONDITIONS

A. Set:

POWER ..... ON
POWER MODE ..... DC LINE

B. Connect:

DC LINE ..... 30 Vdc

Measure (1)

C. Connect:

DC LINE ..... 24 Vdc

Measure (2)

D. Connect:

DC LINE ..... 11.5 Vdc

Measure (3)

E. All waveforms are referenced to chassis ground. The monitor oscilloscope's vertical sensitivity (using a 10:1 probe) and sweep speed settings are shown below on each waveform photograph.

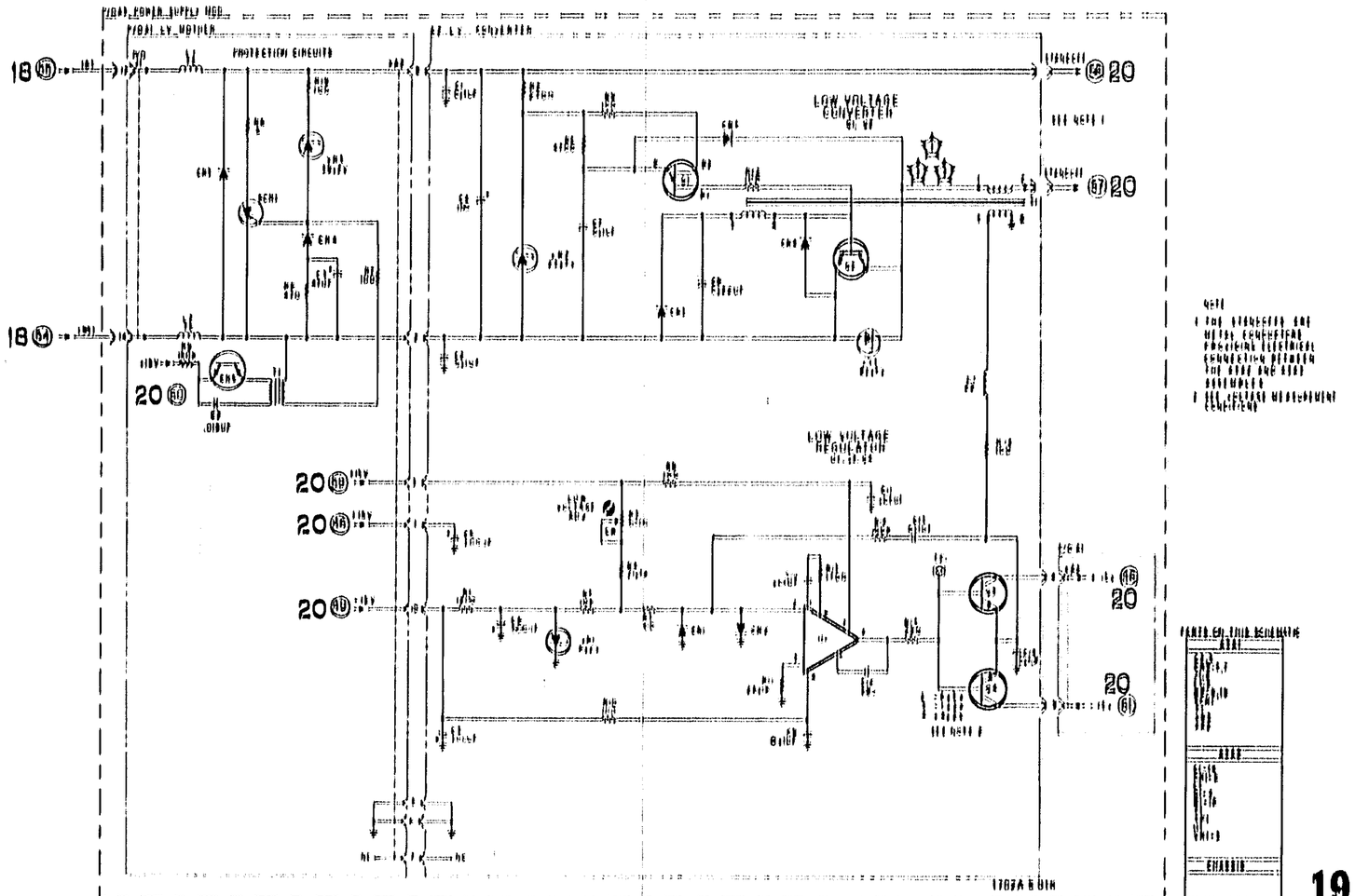


Figure 8-10.
Low Voltage Converter, A8A2, Schematic
8-17

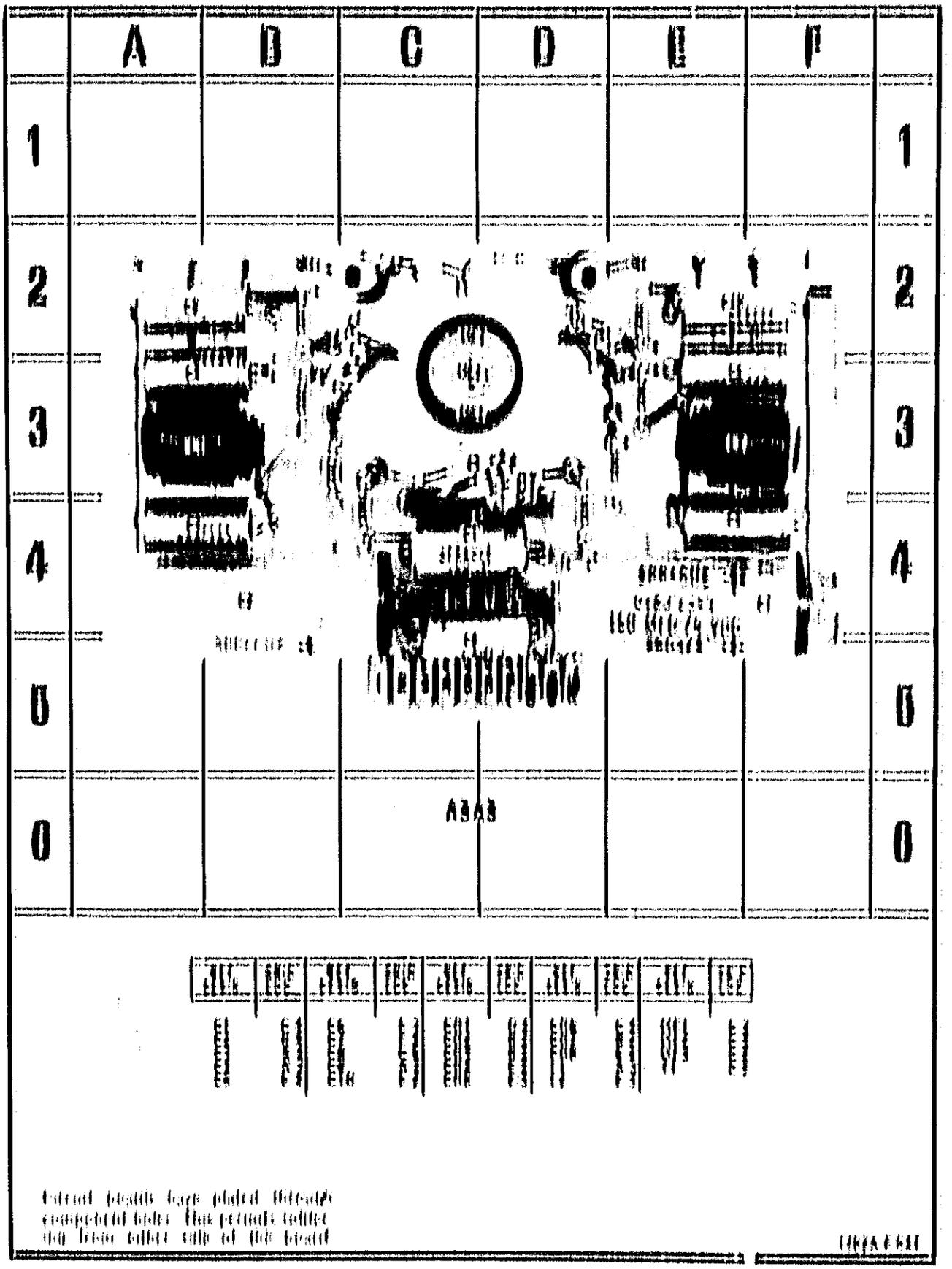


Figure B-11. Line Decoder and Filter A363 Component Identification

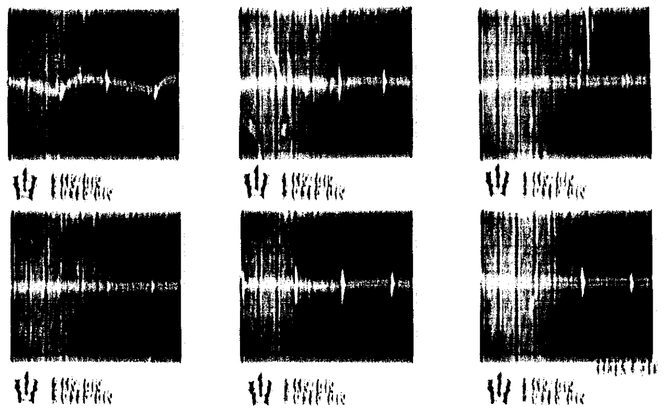
Table 2-20 Static Measurement Conditions and Waveforms

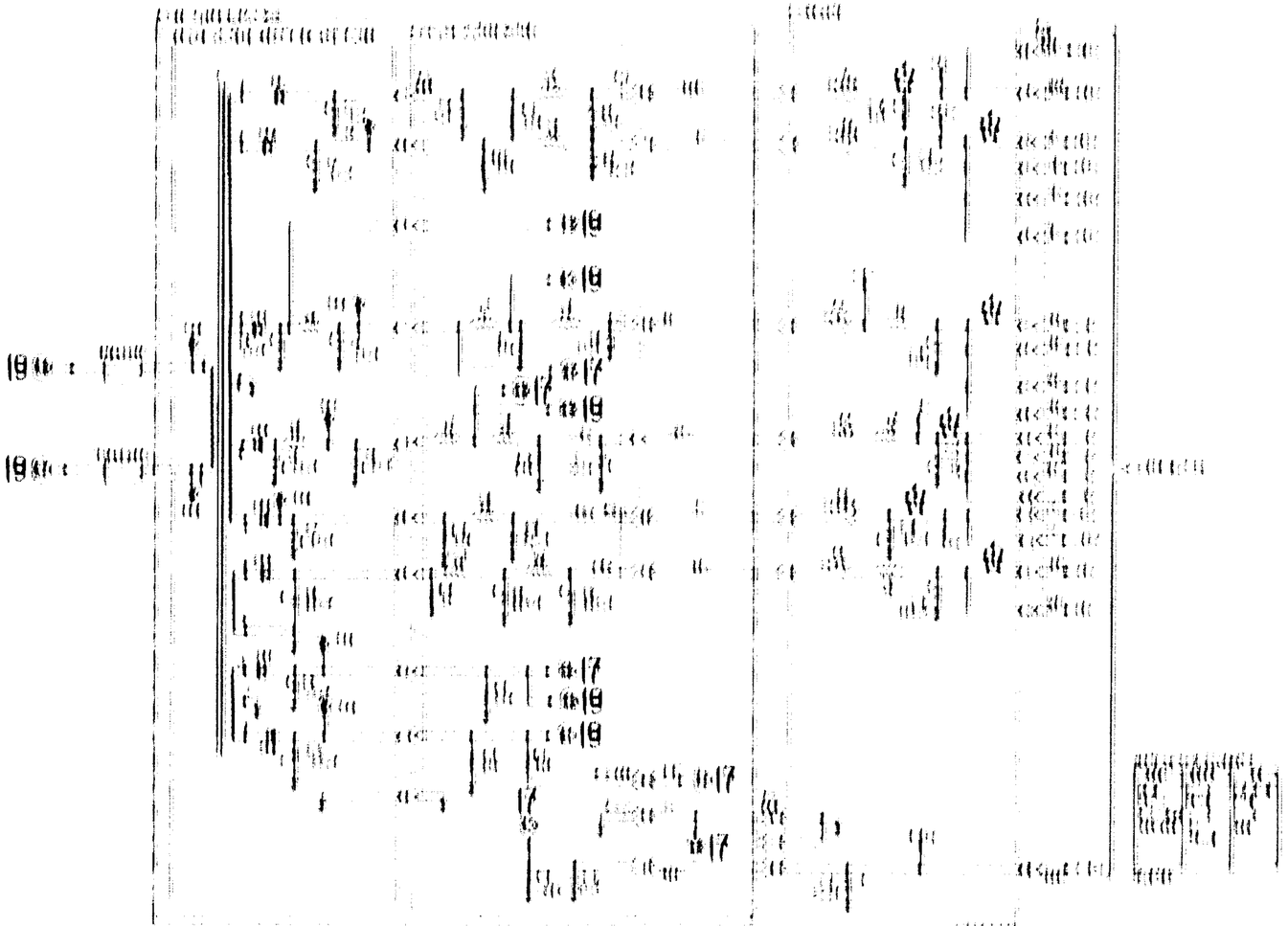
DC VOLTAGE MEASUREMENT CONDITIONS

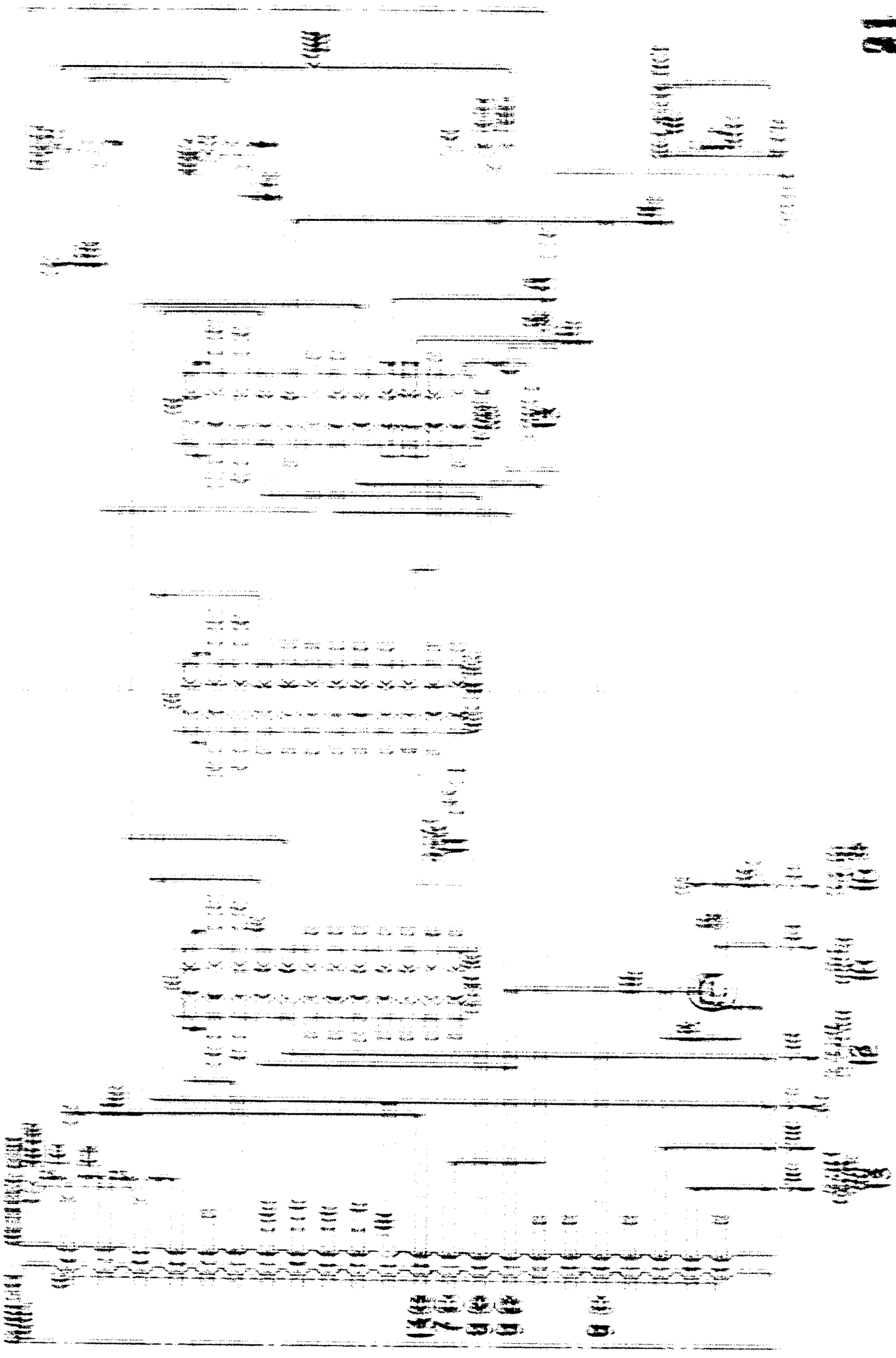
A	B
[illegible]	[illegible]

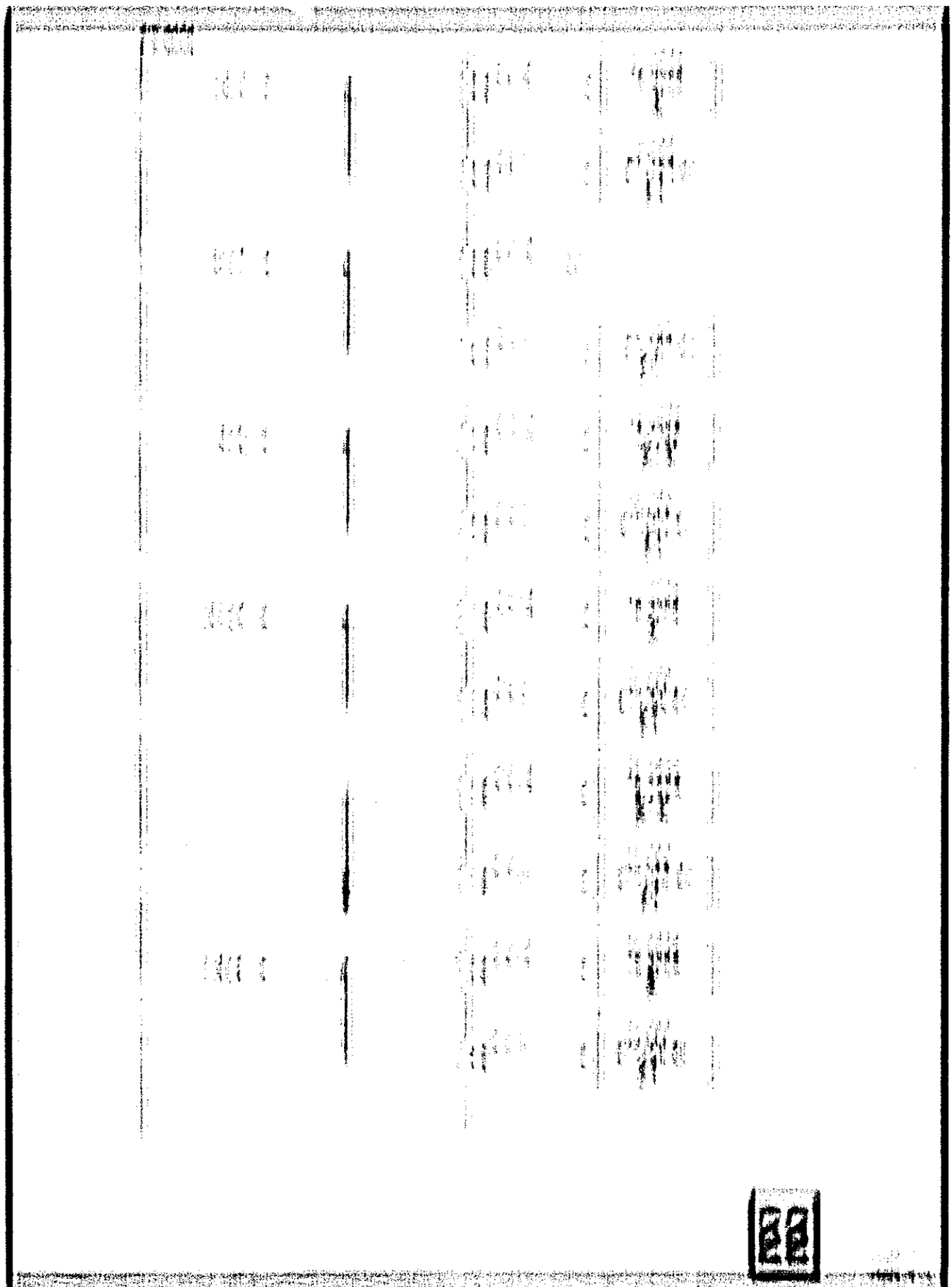
WAVEFORM MEASUREMENT CONDITIONS

A	B
[illegible]	[illegible]









MANUAL CHANGES

MODEL 1702A

OSCILLOSCOPE

Manual Serials Prefixed: 1406A
Manual Printed: FEB 1974

Make all changes listed below as Errata. Check the following table for your instrument serial prefix and/or serial number and make listed change(s) to the manual:

Serial Prefix or Number	Make Changes	Serial Prefix or Number	Make Changes
1422A	1		
1508A	1, 2		
1520A	1 Thru 3		

ERRATA

Page 1-0, figure 1-1,
Replace with figure 1-1 attached to this manual changes sheet.

Page 1-6, table 1-2,
Under ACCESSORIES FURNISHED:
Change 10006B to read 10006D, and delete the dc power plug. The dc power plug is not furnished with the standard Model 1702A instrument but may be ordered separately (HP Part No. 1251-2614).

Page 5-21, paragraph 5-204,
Delete: A5A5C3 from steps d, h, and i.

Page 6-0, figure 6-1,
Replace the corresponding parts of figure 6-1 with the parts illustrated in figure 1 of this manual changes sheet.

Table 6-2,
A5A6 (page 6-2): Add Mfr Code 28480.
Δ Add: DS1, HP Part No. 1450-0709, LIGHT-IND NEON WHT TP LENS, Mfr Code 72765, Mfr Part No. 6140-000-603.
MP23: Delete Mfr Code and Mfr Part No.
MP32: Change to HP Part No. 01703-23701, RAIL:SIDE, Mfr Code 28480, Mfr Part No. 01703-23701.
MP34: Change to HP Part No. 01701-64101, COVER ASSY:RAIL FRONT, Mfr Code 28480, Mfr Part No. 01701-64101.
MP35: Change to HP Part No. 0050-1757, GEAR: SUPPORT, Mfr Code 28480, Mfr Part No. 0050-1757.

Table 6-2 (Cont'd),
MP36: Change to HP Part No. 01701-25002, HANDLE:ARM LEFT, Mfr Code 28480, Mfr Part No. 01701-25002.
Add: MP36H1, HP Part No. 01701-23707, SHAFT: PAWL, Mfr Code 28480, Mfr Part No. 01701-23707.
MP37: Change to HP Part No. 01701-25001, HANDLE:ARM RIGHT, Mfr Code 28480, Mfr Part No. 01701-25001.
MP38: Change to HP Part No. 01701-64901, HANDLE ASSY, Mfr Code 28480, Mfr Part No. 01701-64901.
MP40: Change to HP Part No. 7120-3042, NAME-PLATE:HANDLE, Mfr Code 28480, Mfr Part No. 7120-3042.
Add: MP41, HP Part No. 01701-07201, INSERT: HANDLE FRONT, Mfr Code 28480, Mfr Part No. 01701-07201.
MP42: Change to HP Part No. 01701-07202, INSERT:HANDLE REAR, Mfr Code 28480, Mfr Part No. 01701-07202.
MP43: Change to HP Part No. 01701-27401, BUTTON, Mfr Code 28480, Mfr Part No. 01701-27401.
MP45: Change to HP Part No. 0510-0091, RING:RETAINING STL EXTERNAL, Mfr Code 79136, Mfr Part No. 5103-25-S-MD.
MP46: Change to HP Part No. 3050-0253, WASHER: SPRING, Mfr Code 28480, Mfr Part No. 3050-0253.
MP47: Change to HP Part No. 0510-0956, RING: RETAINING 0.188 IN. SHAFT, Mfr Code 79136, Mfr Part No. 5133-18-MD.

19 May 1975
Δ = Latest additions to this change sheet.
This change sheet supersedes all prior change sheets for this manual.

Supplement A for
01702-90904

ERRATA (Cont'd)

Table 6-2 (Cont'd),

MP48: Change to HP Part No. 0050-1758, PAWL, Mfr Code 28480, Mfr Part No. 0050-1758.

MP49: Change to HP Part No. 2190-0924, WASHER: WAVE SPRING, Mfr Code 28480, Mfr Part No. 2190-0924.

MP50: Change to HP Part No. 0050-1756, GEAR:HANDLE, Mfr Code 28480, Mfr Part No. 0050-1756.

MP51: Change to HP Part No. 1460-0295, SPRING: COMPRESSION, Mfr Code 00000, Mfr Part No. OBD.

MP57: Change HP Part No. and Mfr Part No. to 1500-0364.

R4: Change to HP Part No. 2100-0583, R:VAR COMP 2.5 MEGOHM 10% LIN 1/2W, Mfr Code 21697, Mfr Part No. 382VX.

S1: Change HP Part No. to 3101-0940.

S2: Change Description to read, SWITCH:PART OF REAR PANEL (SEE MP42 PWR MODE).

W1: Change HP Part No. and Mfr Part No. to 01703-61615.

W7 (01701-61620): Delete.

W8 (01702-61602): Change reference designator to W13.

W12: Change HP Part No. and Mfr Part No. to 01703-61611.

A1MP1: Change HP Part No. to 5000-5085.

A3Q1: Change to HP Part No. 1854-0609, TRANSISTOR:NPN SI PD = 83.6W FT = 4MHZ, Mfr Code 04713, Mfr Part No. SJE974.

Add: A3W1, HP Part No. 5060-0585, CABLE: Q1 CONNECTOR, Mfr Code 28480, Mfr Part No. 5060-0585.

Δ A3A1R7: Change to HP Part No. 0757-0908, R:FXD MET FLM 220 OHM 2% 1/8W, Mfr Code 28480, Mfr Part No. 0757-0908.

Δ A3A1R19: Change to HP Part No. 0683-2705, R:FXD COMP 27 OHM 5% 1/4W, Mfr Code 01121, Mfr Part No. CB2705.

Add: A3A2MP1, HP Part No. 1205-0227, HEAT DISSIPATOR:SEMICONDUCTOR, Mfr Code 28480, Mfr Part No. 1205-0227.

Add: A3A4A1, HP Part No. 01703-61104, TRANSFORMER ASSY:HIGH VOLTAGE, Mfr Code 28480, Mfr Part No. 01703-61104.

A3A4C7 through A3A4C12: Change to HP Part No. 0160-3801, C:FXD CER 5000 PF 20% 3K VDCW, Mfr Code 56289, Mfr Part No. 44C148A1.

A3A4C15 through A3A4C23: Change to HP Part No. 0160-3801, C:FXD CER 5000 PF 20% 3K VDCW, Mfr Code 56289, Mfr Part No. 44C148A1.

A3A4CR9: Change to HP Part No. 1901-0669, DIODE:SILICON 200-1A, Mfr Code 28480, Mfr Part No. 1901-0669.

Table 6-2 (Cont'd),

A3A4R15: Change to HP Part No. 2100-3359, R:VAR CERMET 2 MEGOHM 20% TYPE V 1/2W, Mfr Code 73138, Mfr Part No. 72XR2M.

Delete: A3A4T1.

A3A5: Change to HP Part No. 01703-61103, ASSY:HIGH VOLTAGE MULTIPLIER, Mfr Code 28480, Mfr Part No. 01703-61103.

A4Q1: Change to HP Part No. 1854-0215, TQ1, TSTR:SI NPN, Mfr Code 80131, Mfr Part No. 2N3904.

A5A1C7: Change to HP Part No. 0121-0407, C:VAR TRIMMER 0.7-3.0 PF, Mfr Code 72982, Mfr Part No. 536-016.

A5A1C8: Change to HP Part No. 0121-0407, C:VAR TRIMMER 0.7-3.0 PF, Mfr Code 72982, Mfr Part No. 536-016.

A5A1C17: Change to HP Part No. 0121-0407, C:VAR TRIMMER 0.7-3.0 PF, Mfr Code 72982, Mfr Part No. 536-016.

A5A1C18: Change to HP Part No. 0121-0407, C:VAR TRIMMER 0.7-3.0 PF, Mfr Code 72982, Mfr Part No. 536-016.

Add: A5A4L1, HP Part No. 01701-66541, COIL: FXD 10 UH, Mfr Code 28480, Mfr Part No. 01701-66541.

A5A4R95: Change to HP Part No. 0684-1231, R:FXD COMP 12K OHM 10% 1/4W, Mfr Code 01121, Mfr Part No. CB 1231.

A5A4R97: Change to HP Part No. 0684-1831, R:FXD COMP 18K OHM 10% 1/4W, Mfr Code 01121, Mfr Part No. CB 1831.

Delete: A5A5C3.

Δ A5A5Q1: Change HP Part No. and Mfr Part No. to 1853-0203.

Δ A5A5Q2: Change HP Part No. and Mfr Part No. to 1853-0203.

Δ A5A5Q3: Change HP Part No. and Mfr Part No. to 1853-0015.

Δ A5A5Q4: Change HP Part No. and Mfr Part No. to 1853-0015.

A5A6: Change HP Part No. and Mfr Part No. to 01707-66503 (affects pages 6-2 and 6-12).

A5A6C4: Change Mfr Part No. to 8131-050-651-104Z.

A5A6Q1: Change Mfr Part No. to 1855-0085.

A5A6Q2: Change Mfr Part No. to 1855-0085.

A5A6Q3: Change Mfr Part No. to 2N3906.

A5A6Q4: Change Mfr Part No. to 2N3904.

A5A6R1: Change Mfr Part No. to CB2211.

A5A6R2: Change to HP Part No. 0684-2711, R:FXD COMP 270 OHM 10% 1/4W, Mfr Code 01121, Mfr Part No. CB2711.

A5A6R3: Change Mfr Part No. to CB1021.

A5A6R4: Change Mfr Part No. to 0757-0438.

A5A6R5: Change Mfr Part No. to 0757-0454.

A5A6R6: Change to HP Part No. 0757-0444, R:FXD MET FLM 12.1K OHM 1% 1/8W, Mfr Code 28480, Mfr Part No. 0757-0444.

ERRATA (Cont'd)

Table 6-2 (Cont'd),
A5A6R7: Change Mfr Part No. to CB2231.
A5A6R8: Change to HP Part No. 0757-0444, R:FXD MET FLM 12.1K OHM 1% 1/8W, Mfr Code 28480, Mfr Part No. 0757-0444.
A5A6R9: Change Mfr Part No. to CB1541.
A5A6R10: Change Mfr Part No. to CB5621.
A5A6R11: Change Mfr Part No. to CB5621.
A5A6R12: Change to HP Part No. 0684-1011, R:FXD COMP 100 OHM 10% 1/4W, Mfr Code 01121, Mfr Part No. CB1011.
A5A6R13: Change Mfr Part No. to 2100-2026.
A5A6R14: Change to HP Part No. 0757-0416, R:FXD MET FLM 511 OHM 1% 1/8W, Mfr Code 28480, Mfr Part No. 0757-0416.
A5A6R15: Change Mfr Part No. to CB3901.
Add: A5A6R16, HP Part No. 0684-6831, R:FXD COMP 68K OHM 10% 1/4W, Mfr Code 01121, Mfr Part No. CB6831.
Add: A5A6R17, HP Part No. 2100-2031, R:VAR 50K OHM 10% LIN 1/2W, Mfr Code 28480, Mfr Part No. 2100-2031.
A5A6U1: Change Mfr Part No. to 1820-0216.
Add: A5A6VR1, HP Part No. 1902-3171, DIODE: BREAKDOWN 11.0V 5%, Mfr Code 28480, Mfr Part No. 1902-3171.
Add: A5A6VR2, HP Part No. 1902-3171, DIODE: BREAKDOWN 11.0V 5%, Mfr Code 28480, Mfr Part No. 1902-3171.
A6 (Page 6-12): Change HP Part No. to 01702-66804.
A6A1S2: Change to HP Part No. 3101-1397, SWITCH:PUSHBUTTON 2-POLE 3-STATION, Mfr Code 28480, Mfr Part No. 3101-1397.
A6A2R34: Change to HP Part No. 0684-3341, R:FXD COMP 330K OHM 10% 1/4W, Mfr Code 01121, Mfr Part No. CB3341.
Δ Add: A6A3CR14, HP Part No. 1901-0040, DIODE: SILICON 30MA 30WV, Mfr Code 07263, Mfr Part No. FDG 1088.
A6A6 (page 6-2 only): Change HP Part No. and Mfr Part No. to 01703-66510.
A6A6C2: Change to HP Part No. 0160-3670, C:FXD CER 0.1 UF 20% 200VDCW, Mfr Code 72982, Mfr Part No. 8131-M200-651-104M.
A6A6C7: Change to HP Part No. 0160-3665, C:FXD CER 0.01 UF +80-20% 500VDCW, Mfr Code 56289, Mfr Part No. C023A501J103ZS25-CDH.
A6A6C8: Change to HP Part No. 0160-3665, C:FXD CER 0.01 UF +80-20% 500VDCW, Mfr Code 56289, Mfr Part No. C023A501J103ZS25-CDH.
A6A6C9: Change to HP Part No. 0160-3670, C:FXD CER 0.1 UF 20% 200VDCW, Mfr Code 72982, Mfr Part No. 8131-M200-651-104M.
A6A6C10: Change to HP Part No. 0160-0370, C:FXD CER 0.1 UF 20% 200VDCW, Mfr Code 72982, Mfr Part No. 8131-M200-651-104M.

Schematic 3,
A5A1C7: Change value to 0.7-3.0.
A5A1C8: Change value to 0.7-3.0.
A5A1C17: Change value to 0.7-3.0.
A5A1C18: Change value to 0.7-3.0.
A5A2C7: Change value to 0.7-3.0.
A5A2C8: Change value to 0.7-3.0.
A5A2C17: Change value to 0.7-3.0.
A5A2C18: Change value to 0.7-3.0.
Page 8-18, figure 8-12,
Replace with figure 8-17 supplied with this manual changes sheet.
Page 8-20,
Add: Figure 8-13A supplied with this manual changes sheet.
Schematic 5,
A5R21: Change reference designator to A5R20 and value to 909.
A5R22: Change reference designator to A5R21 and value to 909.
W8: Change reference designator to W13.
Schematic 6,
Delete: A5A5C3.
Schematic 7,
Add: A5A4L1 (10 UH) between junction of A5A4CR15/A5A4R105 and cable W4.
A5A4R95: Change value to 12K.
A5A4R97: Change value to 18K.
Δ Schematic 10,
A6A3Q6: Change collector voltage to read −1.2V.
Add: A6A3CR14 in signal path between A6A3CR2 and junction of A6A3CR3/pin 8. Connect cathode to A6A3CR2.
Schematic 13,
A6A6R13: Show applied power of +80VF.
A6A6R14: Show applied power of +80VF.
W8: Delete reference designator.
A6A6C2: Change value to 0.1 UF.
A6A6C9: Change value to 0.1 UF.
A6A6C10: Change value to 0.1 UF.
Page 8-40, figure 8-33,
Replace with figure 8-33 included with this manual changes sheet.
Schematic 15/16,
Wire color (956) to P/O A6A8: Change to wire color (967).
Wire color (967) to P/O A6A8: Change to wire color (956).
Delete: A6A8R3 connected from A6A8S1A to junction of A6A8R1/A6A8VR1. Replace with straight wire connection.
Schematic 17,
A3A4R15: Change value to 2M.
Schematic 18,
Delete: Wire color (0) from ground pin of A1J1.
Add: Wire color (45) from ground pin of A1J1 to chassis ground.

ERRATA (Cont'd)

A Schematic 10,
A3A1: Replace this portion of the schematic with figure 2 supplied with this manual changes sheet.

Page 6-40, figure 6-44,
MP2: Relocate next to L1.
Delete: MP3.

CHANGE 1

Table 6-2,
A3A6: Change HP Part No. and Mfr Part No. to 01703-61106.

Schematic 17,
A3A6R11: Change value to 6.8M.
Add: A3A6R12 (22M) between A3A6R1 and junction of A3A6CR4/A3A6C4.
Add: A3A6C6 (500 PF) between junction of A3A6R1/A3A6R2 and ground.

Δ CHANGE 2

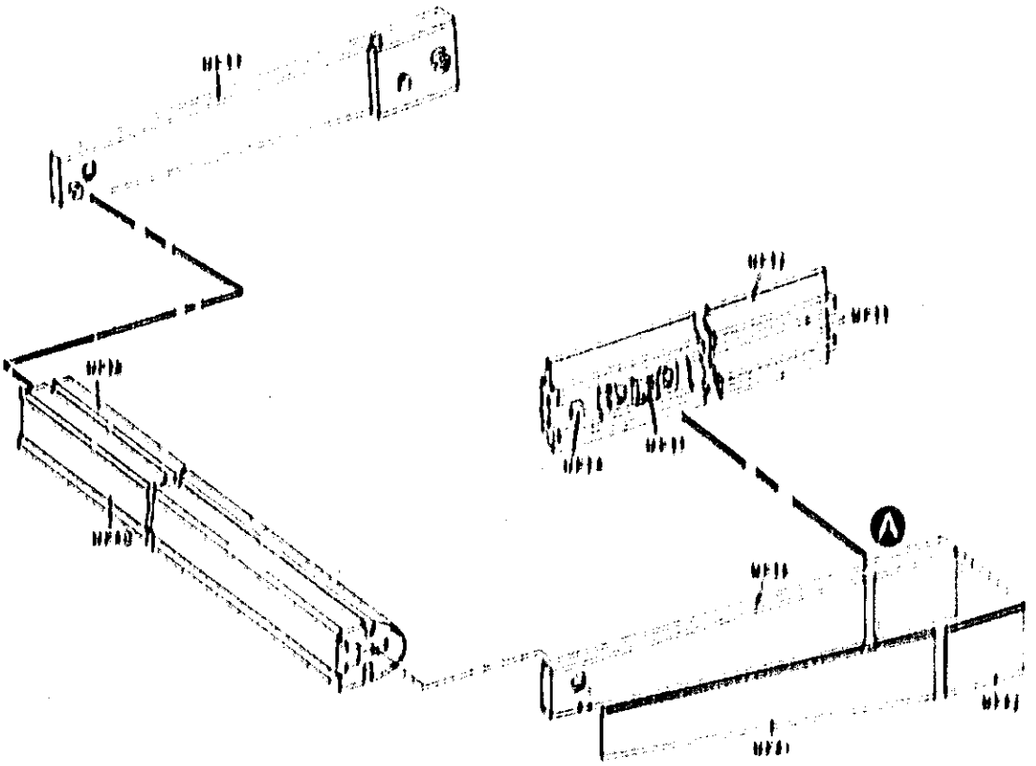
Table 6-2,
MP43: Change HP Part No. and Mfr Part No. to 5001-1050.
W12: Change HP Part No. and Mfr Part No. to 01703-61613.

Schematic 18,
S2: Disconnect wire from pin 14 to junction pin 10 and BT1P1. Connect wire color (2) from pin 14 to S1, pin 3.

Δ CHANGE 3

Page 1-6, table 1-2,
Under ACCESSORIES FURNISHED, Change: Model 10101B to read Accessory Pouch (HP Part No. 5040-0202).
Page 6-0, figure 6-1,
Delete: MP18 designator associated with MP22. Knob is part of MP22.
Table 6-2,
MP22: Change HP Part No. and Mfr Part No. to 01700-67405.

Table 6-2 (Cont'd),
MP34: Change HP Part No. and Mfr Part No. to 01707-04102.
MP64: Change HP Part No. and Mfr Part No. to 01703-04105.
Add: MP69, HP Part No. 5040-0516, COVER: PANEL FRONT, Mfr Code 28480, Mfr Part No. 5040-0516.
Add: MP70, HP Part No. 1540-0202, POUCH: ACCESSORY, Mfr Code 28480, Mfr Part No. 1540-0202.



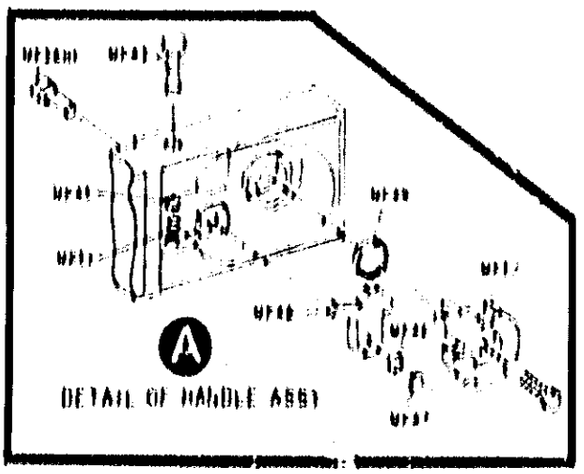


Figure 1. Exploded View Changes

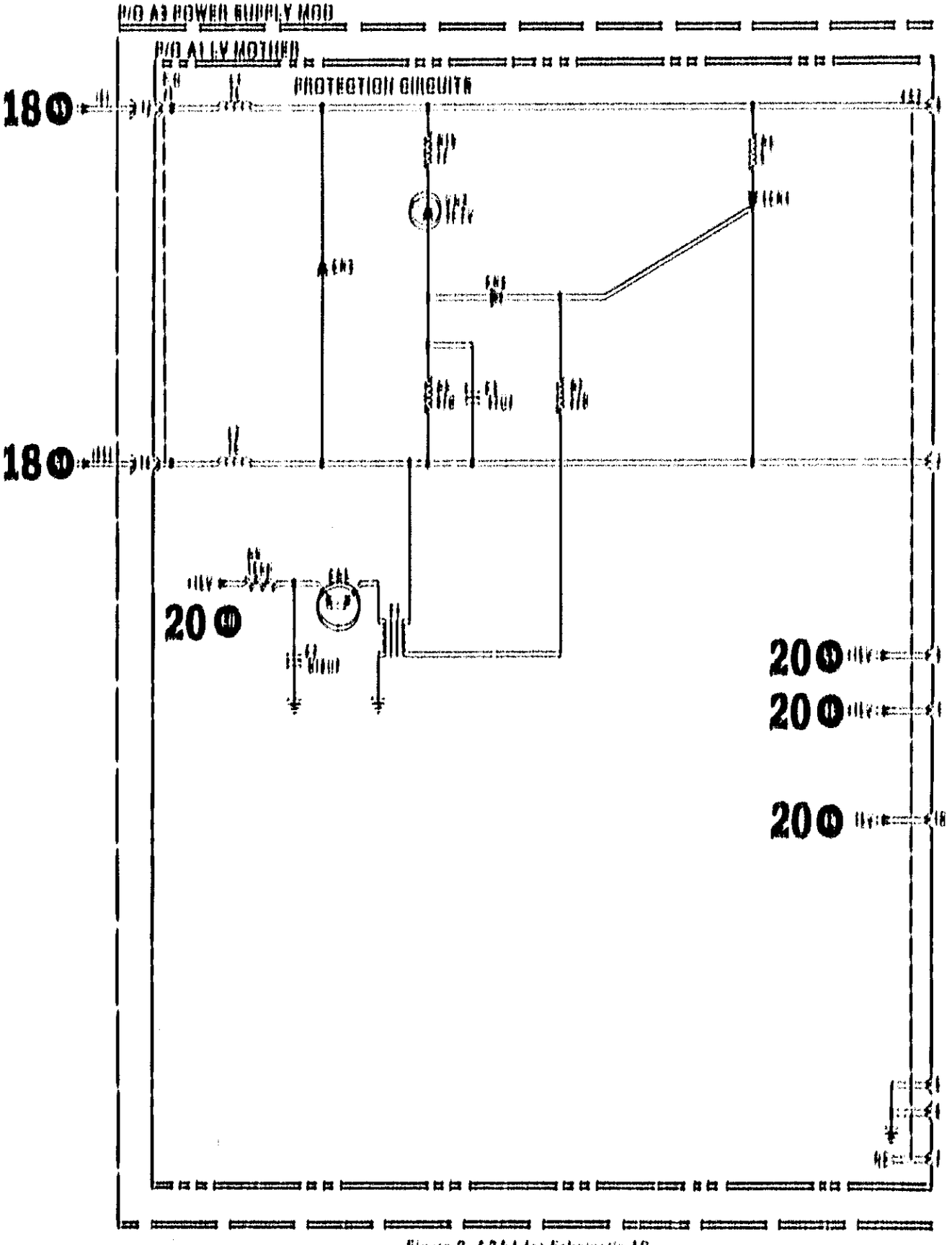


Figure 8. A3A1 for Schematic 18

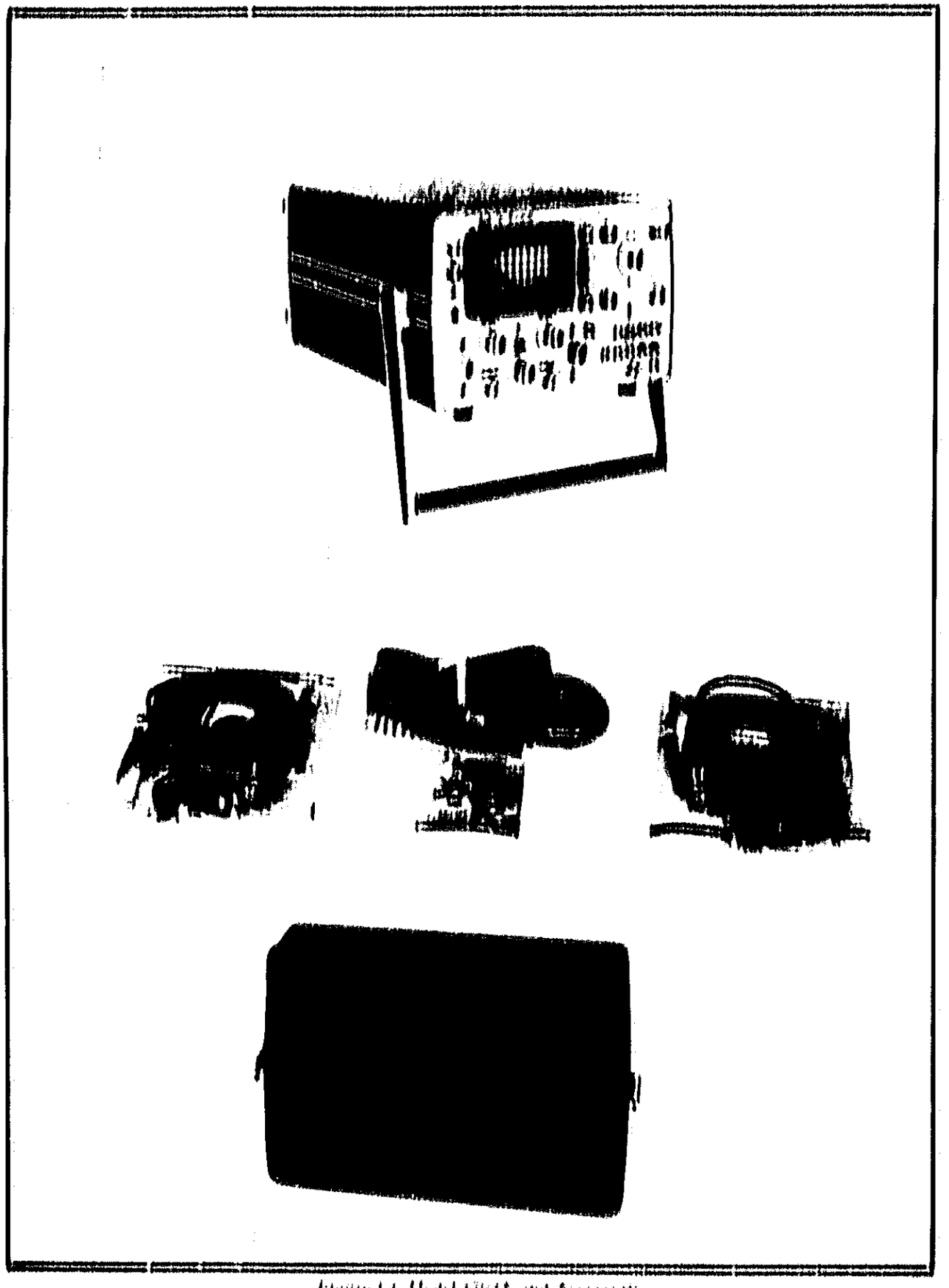
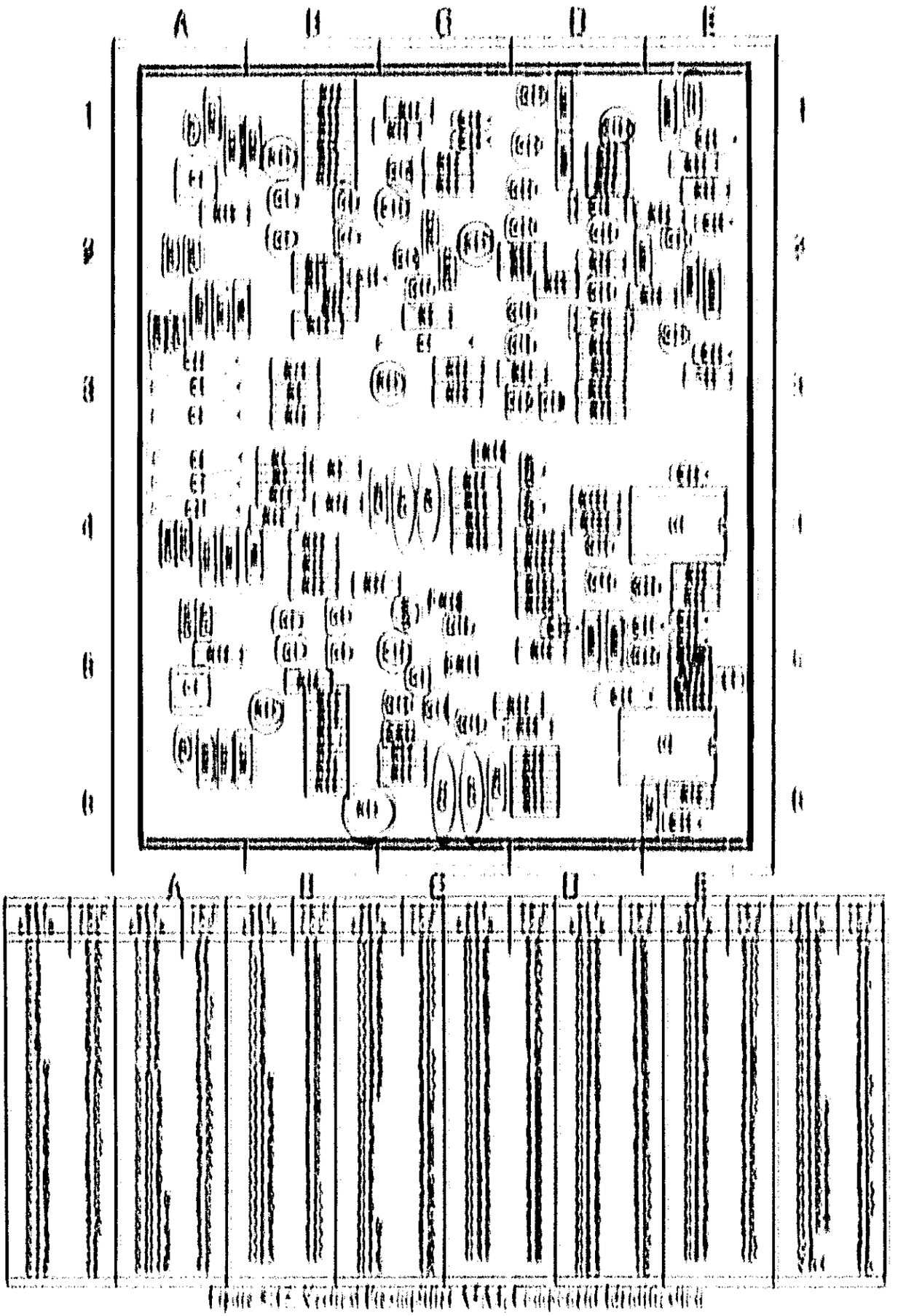


Figure 1-1. Model 1760A and Accessories


A
B
C
D
E
1
2
3
4
5
6