## Errata

**Title & Document Type:** **1820C Time Base Operating and Service Manual**

**Manual Part Number:** **01820-90908**

**Revision Date:** **June 1976**

### About this Manual

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

### HP References in this Manual

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

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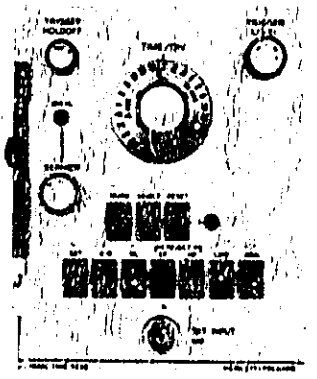
Search for the model number of this product, and the resulting product page will guide you to any available information. Our service centers may be able to perform calibration if no repair parts are needed, but no other support from Agilent is available.

Agilent Technologies

OPERATING AND SERVICE MANUAL

# TIME BASE

## 1820C



HEWLETT hp PACKARD

HP 1820C

## CERTIFICATION

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

## WARRANTY AND ASSISTANCE

This Hewlett-Packard product is warranted against defects in materials and workmanship for a period of one year from the date of shipment. The cathode-ray tube (CRT) in the instrument and any replacement CRT purchased from HP are also warranted against electrical failure for a period of one year from the date of shipment from Colorado Springs. BROKEN TUBES AND TUBES WITH PHOSPHOR OR MESH BURNS, HOWEVER, ARE NOT INCLUDED UNDER THIS WARRANTY. Hewlett-Packard will, at its option, repair or replace products which prove to be defective during the warranty period provided they are returned to Hewlett-Packard, and provided the preventive maintenance procedures in this manual are followed. Repairs necessitated by misuse of the product are not covered by this warranty. NO OTHER WARRANTIES ARE EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. HEWLETT-PACKARD IS NOT LIABLE FOR CONSEQUENTIAL DAMAGES.

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

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

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OPERATING AND SERVICE MANUAL

# MODEL 1820C
# TIME BASE

**SERIAL NUMBERS**

This manual applies directly to instruments with serial numbers prefixed 1518A.

With changes described in Section VII, this manual also applies to instruments with serial numbers prefixed 1209A through 1221A.

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

Manual Part Number 01820-90908
Microfiche Part Number 01820-90808

PRINTED: JUNE 1976

# SAFETY SUMMARY

***The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements.***

**GROUND THE INSTRUMENT.**

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three-conductor ac power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable meet International Electrotechnical Commission (IEC) safety standards.

**DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE.**

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

**KEEP AWAY FROM LIVE CIRCUITS.**

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

**DO NOT SERVICE OR ADJUST ALONE.**

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

**DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT.**

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Hewlett-Packard Sales and Service Office for service and repair to ensure that safety features are maintained.

**DANGERGUS PROCEDURE WARNINGS.**

Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

**WARNING**

**Dangerous voltages, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting.**

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# TABLE OF CONTENTS

## LIST OF ILLUSTRATIONS



## LIST OF TABLES

# SECTION I

# GENERAL INFORMATION

## 1-1. INTRODUCTION.

1-2. This manual provides operating and service information for the Hewlett Packard Model 1820C Time Base. The manual is divided into eight sections, each covering a specific topic or aspect of the instrument. All schematics are located at the rear of the manual and can be unfolded and used for reference while reading any part of the manual.

1-3. This section contains a description of Model 1820C. The instrument specifications are listed in table 1-1. Table 1-2 lists and describes the abbreviations used everywhere in this manual except Section VI. The parts list in Section VI is a computer readout and uses computer-supplied abbreviations.

## 1-4. DESCRIPTION.

1-5. Model 1820C is designed for use in 180-series mainframes and provides 5-nanosecond sweep speeds and triggering to 150 megahertz.

1-6. Twenty-three ranges provide calibrated sweep speeds from 0.05-microsecond per division to 1-second per division in 1, 2, 5 sequence. The slowest sweep range can be extended beyond 2.5 seconds per division and sweep speeds between ranges can be continuously varied by means of a vernier. The fastest sweep speed can be expanded to 5 nanoseconds per division by the horizontal magnifier on the 180-series mainframe.

1-7. Operation is accomplished with pushbutton controls. The automatic sweep mode displays a baseline in the absence of a trigger input signal. A trigger holdoff control allows stable triggering on complex waveforms.

1-8. Standard probes may be used with the external input which reduces circuit loading at trigger pick-off points. The high external input sensitivity of 50 millivolts allows 10:1 probes to be used even with 0.5-volt logic circuits.

## 1-9. WARRANTY.

1-10. The instrument is certified and warranted as stated on the inside front cover of this manual.

CAUTION

The warranty may be void for instruments having a missing or mutilated serial number tag.

## 1-11. AVAILABLE ACCESSORIES.

1-12. A complete line of test probes, connectors, adaptors and other accessory items are available from Hewlett-Packard. For information on specific items, refer to the HP catalog or contact the nearest HP Sales/Service Office.

## 1-13. INSTRUMENT AND MANUAL IDENTIFICATION.

1-14. Attached to the instrument is a serial number plate. The serial number is in the form: 0000A00000. It is in two parts; the first four digits and the letter are the serial prefix and the last five digits are the suffix. The prefix is the same for all identical instruments; it changes only when a change is made to the instrument. The suffix however, is assigned sequentially and is different for each instrument. The contents of this manual apply to instruments with the serial number prefix(es) listed under SERIAL NUMBERS on the title page.

1-15. An instrument manufactured after the printing of this manual may have a serial number prefix that is not listed on the title page. This unlisted serial number prefix indicates the instrument is different from those described in this manual. The manual for this newer instrument is accompanied by a yellow Manual Changes supplement. This supplement contains "change information" that explains how to adapt the manual to the newer instrument.

1-16. Errors in this manual are listed under errata on the enclosed MANUAL CHANGES sheet.

Table 1-1. Specifications

## TIME BASE

### SWEEP

RANGES: 0.05 usec/div to 1 sec/div (23 positions) in 1, 2, 5 sequence.
±3% accuracy with vernier in calibrated position.
VERNIER: Continuously variable between ranges; extends slowest sweep to at least 2.5 sec/div. Uncalibrated light indicates when vernier not in CAL position.
MAGNIFIER: (on mainframe) expands fastest sweep to 5 ns/div.

### SWEEP MODE

NORMAL: sweep is triggered by internal, external or power line signal.
AUTOMATIC: bright baseline displayed in absence of trigger signal. Triggering is same as normal except low frequency limit is 40 Hz.
SINGLE: in normal, sweep occurs once on first trigger after sweep arming; reset pushbutton arms sweep and lights indicator; in auto, sweep occurs once each time reset pushbutton is pressed.

## TRIGGERING

### SOURCE

INTERNAL: refer to vertical amplifier plug-in specification.
EXTERNAL: dc to 50 MHz on signals 50 mV p-p or more, increasing to 100 mV at 100 MHz and 150 mV at 150 MHz.
LINE: power line frequency signal.

### LEVEL

INTERNAL: at any point on the vertical waveform displayed.

EXTERNAL: continuously variable from +2V to −2V on either slope of trigger signal; in ÷10 setting, from +20V to −20V.

### COUPLING

DC: direct coupling.
AC: capacitive coupling, attenuates signals below approx 20 Hz.
HF REJECT: attenuates signals above approx 15 kHz.
LF REJECT: attenuates signals below approx 15 kHz.

### SLOPE

POSITIVE: positive slope of trigger signal initiates sweep.
NEGATIVE: negative slope of trigger signal initiates sweep.

### TRIGGER HOLDOFF

Time between sweeps continuously variable, exceeding one full sweep on all ranges.

## WEIGHT

Net, 3 lb (1,4 kg): shipping, 7 lb (3,2 kg).

## ENVIRONMENT

**TEMPERATURE:** 0 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-in. excursion, 10 to 55 Hz.

## 1-17. INQUIRIES.

1-18. Refer any questions regarding the manual, the change sheet, or the instrument to the nearest HP Sales/Service Office. Always identify the instrument by model number, complete name, and complete serial number in all correspondence. Refer to the inside rear cover of this manual for a world-wide listing of HP Sales/Service Offices.

Table 1-2. Reference Designators and Abbreviations

### REFERENCE DESIGNATORS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| A | = assembly | E | = misc. electrical part | P | = plug | U | = integrated circuit (unrepairable) |
| AT | = attenuator, resistive termination | F | = fuse | PS | = power supply | V | = vacuum tube, neon bulb, photocell, etc. |
| B | = motor, fan | FL | = filter | Q | = transistor | VR | = voltage regulator (diode) |
| BT | = battery | H | = hardware | R | = resistor | W | = cable |
| C | = capacitor | J | = Jack | RT | = thermistor | X | = socket |
| CP | = coupling | K | = relay | S | = switch | Y | = crystal |
| CR | = diode | L | = inductor | T | = transformer | Z | = network |
| DL | = delay line | LS | = speaker | TB | = terminal board | | |
| DS | = device signaling (lamp) | M | = meter | TP | = test point | | |
| | | MP | = mechanical part | | | | |

### ABBREVIATIONS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| A | = ampere(s) | FET | = field-effect transistor(s) | n | = nano ($10^{-9}$) | rfi | = radio frequency interference |
| ampl | = amplifier(s) | | | nc | = normally closed | rms | = root mean square |
| assy | = assembly | | | no. | = normally open | rwv | = reverse working voltage |
| amplitd | = amplitude | G | = giga ($10^{9}$) | npn | = negative-positive-negative | | |
| bd | = board(s) | gnd | = ground(ed) | ns | = nanosecond | SCR | = silicon controlled rectifier |
| bp | = bandpass | H | = henry(ies) | p | = pico ($10^{-12}$) | sec | = second(s) |
| c | = centi ($10^{-2}$) | hr | = hour(s) | pc | = printed (etched) circuit(s) | std | = standard |
| C | = carbon | HP | = Hewlett-Packard | pk | = peak | trmr | = trimmer |
| ccw | = counterclockwise | Hz | = hertz | pnp | = positive-negative-positive | u | = micro ($10^{-6}$) |
| coax. | = coaxial | If. | = intermediate freq. | p/o | = part of | usec | = microsecond |
| coef | = coefficient | intl | = internal | p-p | = peak-to-peak | V | = volts |
| com | = common | k | = kilo ($10^{3}$) | prgm | = program | var | = variable |
| CRT | = cathode-ray tube | lb | = pound(s) | prv | = peak inverse voltage(s) | w/ | = with |
| cw | = clockwise | lpf | = low-pass filter(s) | ps | = picosecond | w/o | = without |
| d | = deci ($10^{-1}$) | m | = milli ($10^{-3}$) | pwv | = peak working voltage | wiv | = working inverse voltage |
| dB | = decibel | M | = mega ($10^{6}$) | rf | = radio frequency | | |
| ext | = external | ms | = millisecond | | | | |
| F | = farad(s) | | | | | | |

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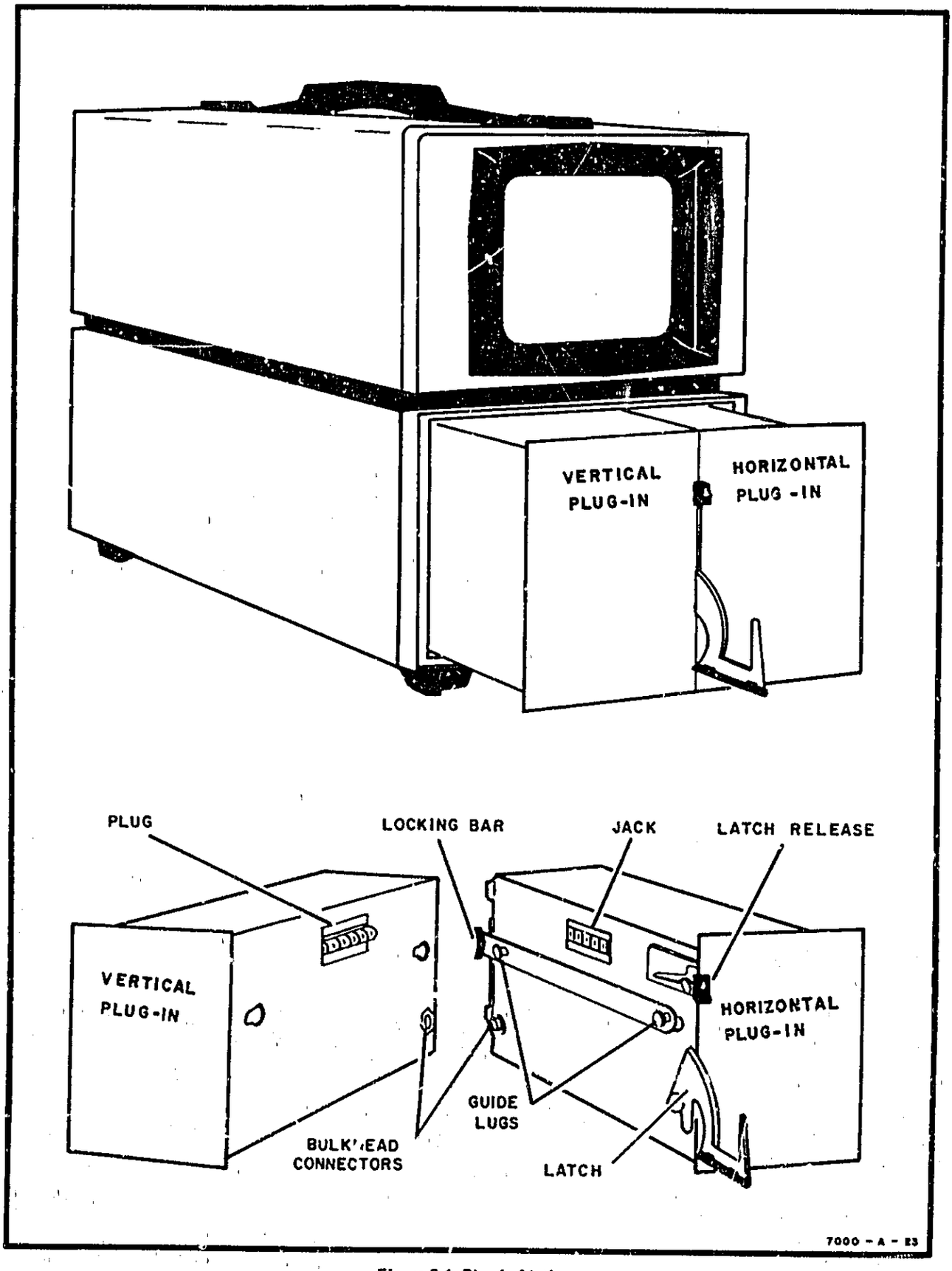



Figure 2-1. Plug-in Mating

# SECTION II

# INSTALLATION

## 2-1. INTRODUCTION.

2-2. This section contains instructions for performing an initial inspection of Model 1820C. 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 the 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 on the inside front cover of this manual. If the instrument does not operate as specified, refer to the claims paragraph in this section.

## 2-6. INSTRUMENT MOUNTING.

2-7. Model 1820C and the vertical plug-in must be locked together before being inserted into the plug-in compartment of a 180-series oscilloscope mainframe. Power for Model 1820C is supplied by the mainframe.

2-8. To install Model 1820C and the vertical plug-in, proceed as follows:

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

b. Mate vertical plug and horizontal jack, making certain bulkhead connectors and guide lugs are aligned and press two plug-ins firmly together.

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

d. Lift up on latch release and rotate latch downward.

e. Slide plug-ins into plug-in compartment in mainframe.

f. Rotate latch upward and push into lock.

## 2-9. INSTRUMENT COMPATIBILITY.

2-10. Model 1820C will mate with any vertical plug-in in the 180-series and will operate in any mainframe in the series.

## 2-11. CLAIMS.

2-12. The warranty statement applicable to this instrument is printed inside the front cover of this manual. If physical damage is found or if operation is not as specified when the instrument is received, notify the carrier and nearest HP 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.

## 2-13. REPACKING FOR SHIPMENT.

2-14. If Model 1820C is to be shipped to an HP 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.

2-15. 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.

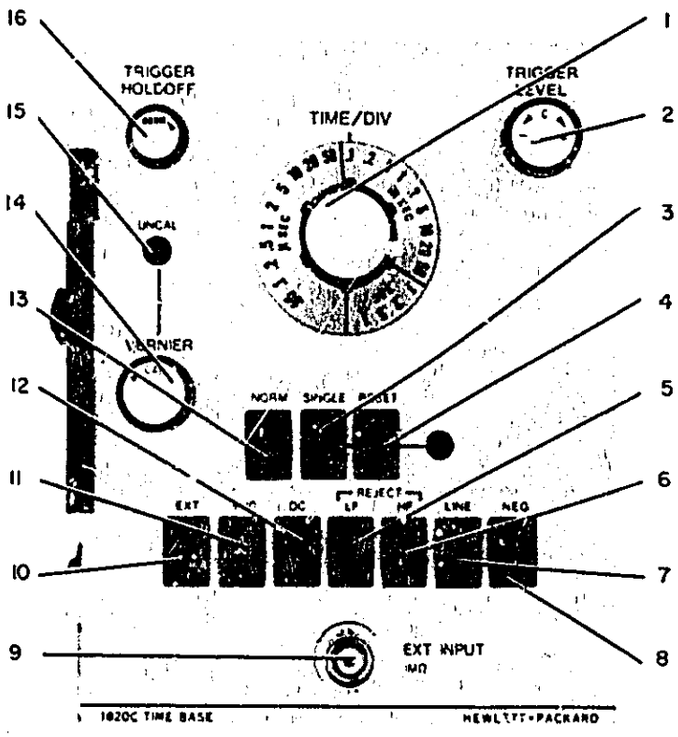
b. Heavy paper or sheets of cardboard to protect all instrument surfaces; use a nonabrasive material such as polyurethane or cushioned paper such as Kimpak around all projecting parts.

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

d. Heavy-duty shipping tape 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 |




1. TIME/DIV. Selects sweep ranges.
2. TRIGGER LEVEL. Selects point on trigger signal that starts sweep.
3. SINGLE. Selects single sweep operation.
4. RESET. Rearms sweep after single sweep operation.
5. LF REJECT. Attenuates signals below 15 kHz.
6. HF REJECT. Attenuates signals above 15 kHz.
7. LINE. Selects line triggering.
8. POS/NEG. Determines whether positive or negative slope of trigger signal starts sweep.
9. EXT INPUT. BNC connector for applying external trigger signal.
10. INT/EXT. Selects trigger signal from vertical plug-in or from EXT INPUT.
11. ÷1/÷10. Selects unattenuated or attenuated trigger signal.
12. AC/DC. Selects direct or capacitive coupling of trigger signal.
13. AUTO/NORM. Selects automatic or triggered sweep start.
14. VERNIER. Permits selection of sweep speeds between calibrated ranges.
15. UNCAL. Indicator lights when vernier is rotated out of CAL position.
16. TRIGGER HOLDOFF. Adjusts time between end of one sweep and arming of next.

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Figure 3-1. Operating Controls and Connectors

# SECTION III

# OPERATION

## 3-1. INTRODUCTION.

3-2. This section contains an explanation of instrument operating controls, available modes of operations, triggering considerations (frequencies, amplitudes, modes), and step-by-step instructions for most applications.

3-3. Necessary oscilloscope and vertical plug-in control settings are mentioned but, due to the variety of different mainframe and plug-in combinations that can be used with Model 1820C, the operating and service manual for the specific instrument should be referred to for supplementary information.

## 3-4. CONTROLS AND CONNECTORS.

3-5. Figure 3-1 shows the instrument front panel and provides functional descriptions of operating controls, indicators, and connectors. The following paragraphs provide detailed descriptions of controls with multiple or complex functions.

### 3-6. TRIGGER CONDITIONING.

3-7. Model 1820C is equipped with pushbutton switches for controlling sweep triggering. Trigger signal requirements are listed in table 3-1. The controls are described in the following paragraphs.

3-8. SWITCH DESCRIPTION. The switches are push-push type which alternate between two positions each time the switch is pressed. The one exception is the RESET switch which does not lock into the depressed position. Each switch is equipped with a blue band which disappears when the switch is in the depressed position. The band is related to the color of the switch designator. If the blue band is showing, the action whose designator is printed in blue is activated. If the blue band is hidden, the action whose designator is printed in black is activated.

3-9. TRIGGER SOURCE. When the INT/EXT switch is in INT, the sweep is synchronized with the vertical deflection signal. In EXT, the sweep will be synchronized to a signal connected to the EXT INPUT connector. In the depressed position, the ÷1/÷10 switch causes the incoming sync signal to be attenuated by a factor of 10. In the depressed position, the LINE switch synchronizes the sweep with a fixed amplitude power line signal regardless of the positions of the INT/EXT and ÷1/÷10 switches.

3-10. SYNC COUPLING. The AC/DC switch selects direct coupling (DC) or capacitive coupling (AC). Direct coupling can be used from dc to greater than 150 megahertz. Capacitive coupling blocks the dc component. Capacitive coupling, however, attenuates signals below approximately 20 hertz. The LF REJECT switch, when depressed, attenuates signals below approximately 15 kilohertz and is used, for instance, to prevent power line frequency ripples from triggering the sweep. The HF REJECT switch, when depressed, attenuates signals above approximately 15 kilohertz and can be used, for instance, to prevent high frequency noise from triggering the sweep.

### 3-11. TRIG LEVEL.

3-12. This control selects the point on the trigger signal that starts the sweep. The triggering point is adjustable over a range of from −2V to +2V along the selected trigger signal slope in the INT, EXT, and LINE position. In the ÷10 position, trigger level is adjustable from −20V to +20V.

### 3-13. HOLDOFF.

3-14. Hold off time is the amount of time between the end of one sweep and the arming for the next. The sweep is started by the first trigger pulse after holdoff time elapses. This time can be varied by rotation of the TRIGGER HOLDOFF control. This feature makes it possible to avoid (in normal operation) triggering of successive sweeps at two or more points on a complex waveform (figure 3-3).

### 3-15. SWEEP MODE.

3-16. In AUTO, the sweep free-runs in the absence of a trigger signal displaying a bright baseline. If a trigger signal of 40 hertz or greater is applied, it overrides free-run operation and triggers the sweep.

3-17. In NORM, a trigger input signal is needed to produce a display. Use NORM if the trigger period exceeds 25 milliseconds or the rate (frequency) is less than 40 hertz.

3-18. In SINGLE sweep mode, one sweep is generated after being triggered. To rearm the sweep, the RESET button must be pushed and released. The RESET lamp lights to indicate that the sweep is armed. In AUTO, one sweep will occur each time RESET is pressed. In NORM, one sweep will occur the first time a trigger is applied after pressing RESET.

### 3-19. SLOPE.

3-20. The POS/NEG switch determines whether the sweep triggers on the positive-going or negative-going portion of the trigger signal.

Table 3-1. Trigger Signal Requirements

| Sweep Mode | Trigger Coupling | Trigger Source | Minimum Trigger Amplitude | Level | | Slope |
|---|---|---|---|---|---|---|
| NORM | | LINE | FIXED | | | SELECTABLE + OR − |
| | DC: dc to 150 MHz<br>AC: 20 Hz to 150 MHz | INT | See Vert. Plug-in Manual | adjustable to any point on displayed waveform | | |
| | | | See Figure 3-2 | In ÷1<br>−2V to +2V | In ÷10<br>−20V to +20V | |
| | | EXT | | | | |
| AUTO | | LINE | FIXED | | | |
| | DC: 40 Hz to 150 MHz<br>AC: 40 Hz to 150 MHz | INT | See Vert. Plug-in Manual | adjustable to any point on displayed waveform | | |
| | | | See Figure 3-2 | In ÷1<br>−2V to +2V | In ÷10<br>−20V to +20V | |
| | | EXT | | | | |
| SINGLE | Single may be selected after setting up any display. | | | | | |

### 3-21. TIME/DIV.

3-22. The TIME/DIV switch determines the amount of time to sweep horizontally one graticule division. Sweep speeds are selectable by the TIME/DIV control in twenty-three ranges from 0.05 microsecond per division to 1 second per division. By switching the oscilloscope Magnifier control to X5 or X10, a display can be magnified up to ten times.

### 3-23. VERNIER.

3-24. Sweep speed is calibrated to TIME/DIV when the VERNIER control is set fully clockwise to the CAL detent position. As the VERNIER control is turned counterclockwise, the UNCAL indicator lights and sweep speed decreases up to at least 2.5 times the TIME/DIV settings. The VERNIER control is useful for making continuous adjustment of sweep speed, however, TIME/DIV readings are uncalibrated.

## 3-25. OPERATING PROCEDURES.

3-26. Figures 3-4 and 3-5 are operating plates giving step-by-step instructions for operating Model 1820C. These instructions are for typical applications and can be modified to adapt the instrument to a variety of unique applications. Refer to the oscilloscope and vertical plug-in operating and service manuals for related operating information.

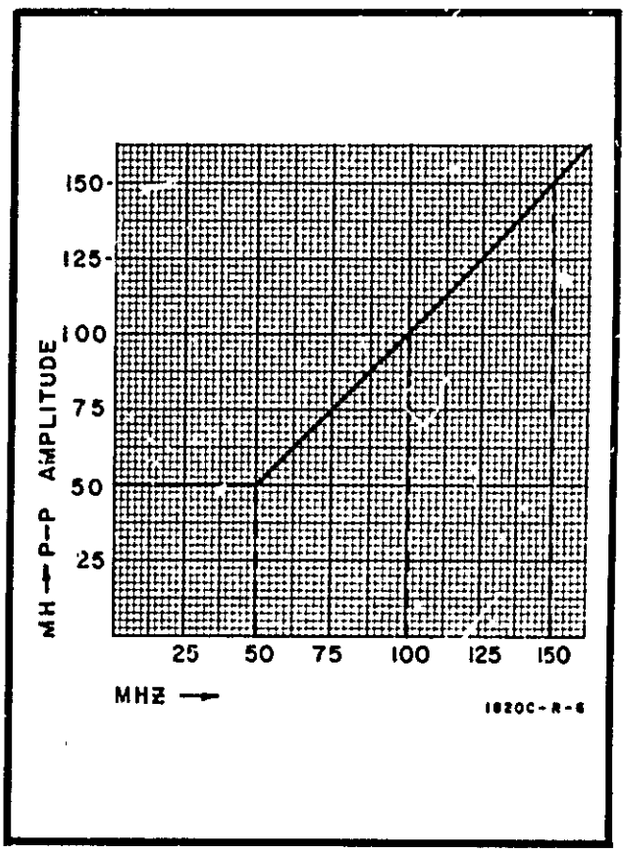



Figure 3-2. External Trigger Requirements

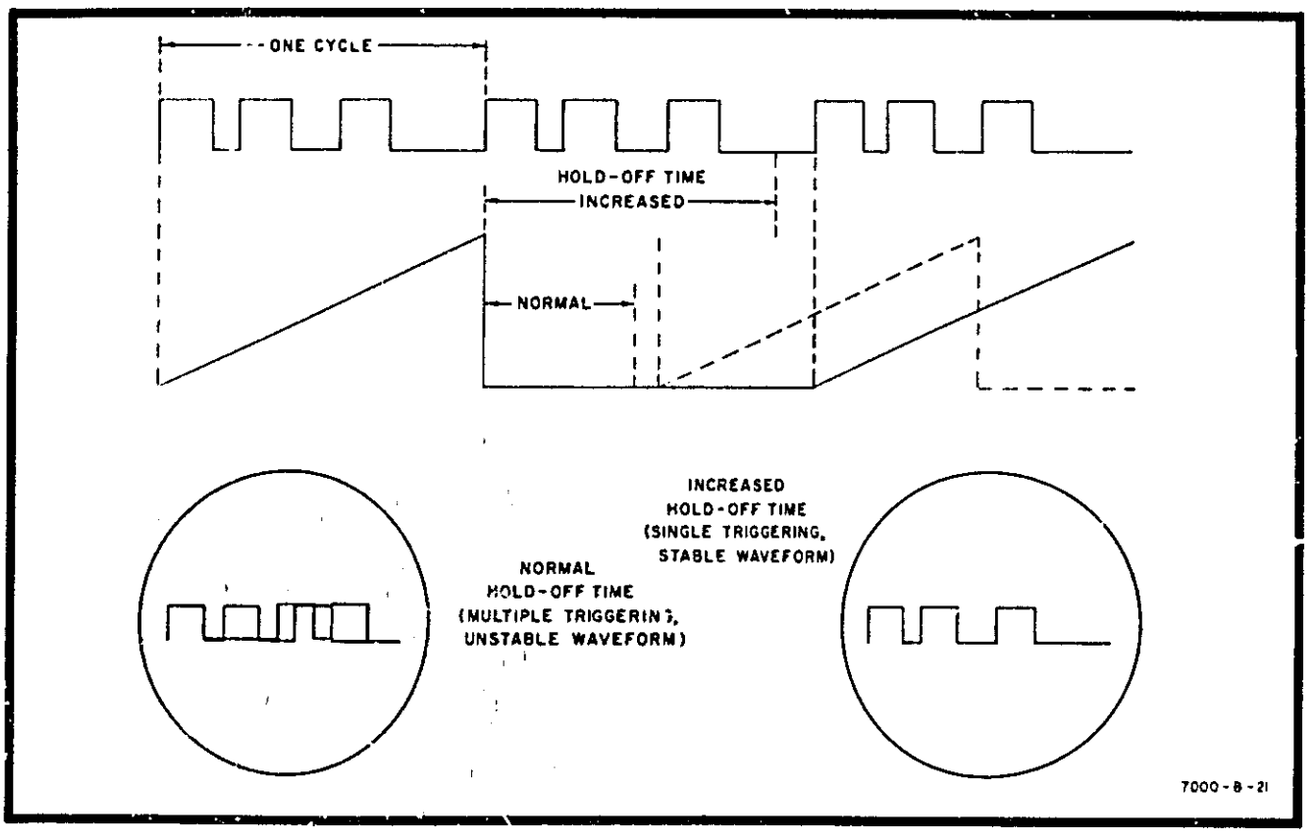
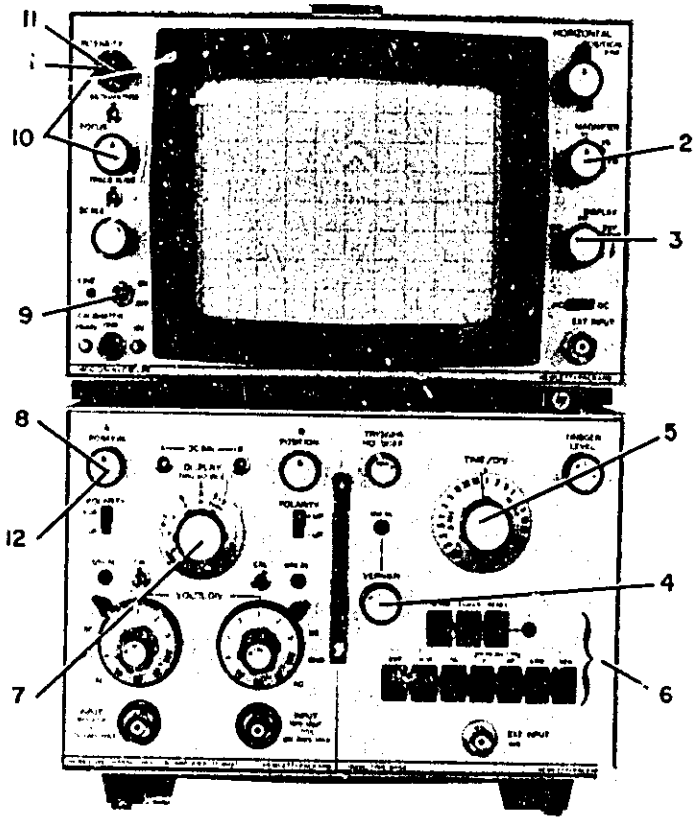



Figure 3-3. Trigger Holdoff




1. Set INTENSITY fully counterclockwise.
2. Set MAGNIFIER to XI.
3. Set DISPLAY to INT.
4. Set VERNIER fully clockwise to CAL.
5. Set TIME/DIV to 1 mSEC.
6. Set all pushbutton switches out. (blue band showing).
7. Set DISPLAY to A.
8. Set A POSITION to midrange.
9. Turn ON-OFF switch to ON.
10. Adjust INTENSITY and FOCUS for sharp, just visible trace.
11. If trace is not visible in step 11 above, press FIND BEAM to locate.
12. Adjust A POSITION to center trace.

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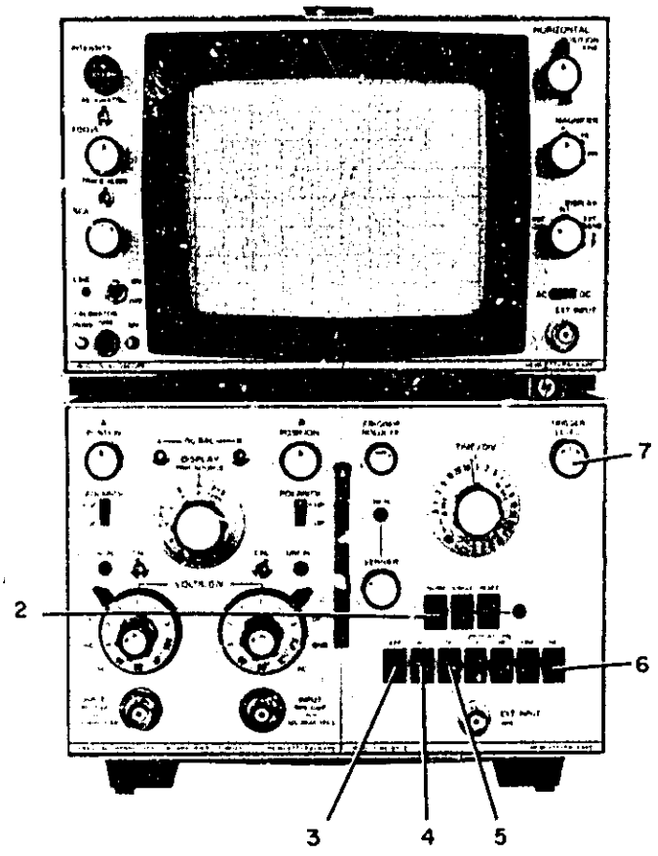
Figure 3-4. Initial Turn-on Procedure (AUTO mode)




1. Perform initial turn-on as shown in Figure 3-4.
2. Set AUTO/NORM to NORM (depressed).
3. Select INT (out) or EXT (depressed) trigger. If EXT is selected, connect trigger signal to EXT INPUT.
4. Select ÷1 (out) or ÷10 (depressed).
5. Select AC (out) or DC (depressed) coupling.
6. Select POS (out) or NEG (depressed) slope.
7. Adjust trigger level for desired trigger point.

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Figure 3-5. NORM Sweep Operation (in X1)

# SECTION IV

# PRINCIPLES OF OPERATION

## 4-1. INTRODUCTION.

4-2. This section contains functional descriptions keyed to an overall block diagram. A detailed explanation of circuit functions, keyed to the schematics, is provided after the block diagram discussion. Following this, complete cycles of operation (for various modes) will be discussed.

4-3. The overall block diagram and the schematics are located at the rear of Section VIII. The circled numbers on the block diagram and schematics are used to identify signals and control voltages. They are frequently referred to in this section. A table containing the names of the signals and control voltages is provided at the left of each block diagram and schematic.

## 4-4. FUNCTIONAL DESCRIPTION.

4-5. The block diagram (figure 8-4) is provided as an aid to understanding the operation of the instrument. Circuit groups have been consolidated into single blocks and logic symbols according to function. This makes it easier to define each group's inputs and outputs and to show relationships between groups.

### 4-6. TRIGGER CONDITIONING.

4-7. The trigger conditioning block contains the switching circuitry required to select and shape the desired trigger.

4-8. A detailed explanation of the trigger conditioning block is provided in paragraph 4-37.

### 4-9. IMPEDANCE CONVERTERS.

4-10. Two impedance converters are employed to provide a means of removing an interfering component from the trigger signal. The HF impedance converter attenuates frequencies below approximately 15 kilohertz. The LF impedance converter attenuates frequencies above approximately 15 kilohertz. An interfering signal can be removed by disabling one of the impedance converters.

4-11. A detailed explanation of the impedance converters is provided in paragraph 4-45.

### 4-12. TRIGGER AMPLIFIER AND POLARITY SWITCH.

4-13. The trigger amplifier and polarity switch group provides a means of amplifying and switching the polarity of the trigger signals. Switching is required in order to permit sweep triggering on the positive or negative slope of the displayed signal, as desired.

4-14. A detailed explanation of the trigger amplifier and polarity switch is provided in paragraph 4-49.

### 4-15. DUAL SCHMITT.

4-16. The dual Schmitt prohibits triggering during a sweep cycle and permits triggering of a new sweep after termination of the sweep cycle.

4-17. A detailed explanation of the dual Schmitt is provided in paragraph 4-54.

### 4-18. INTEGRATOR GATE.

4-19. The integrator gate contains a Schmitt trigger with two inputs. In NORM, the integrator gate prohibits the sweep from free-running in the absence of a trigger signal. In AUTO, sweep free-running is permitted in the absence of a trigger signal, causing a baseline display on the oscilloscope CRT.

4-20. A detailed explanation of the integrator gate is provided in paragraph 4-58.

### 4-21. 10V SCHMITT.

4-22. The 10V Schmitt controls the dual Schmitt and the auto and lockout blocks, assuring a trigger to start the sweep at the proper time.

4-23. A detailed explanation of the 10V Schmitt is provided in paragraph 4-63.

### 4-24. INTEGRATOR.

4-25. The integrator group contains a Miller integrator and the gating circuitry required to clamp and unclamp the integrator, as required. When unclamped, the integrator generates a linear ramp that is used as the time base for the oscilloscope.

4-26. A detailed explanation of the integrator is provided in paragraph 4-65.

### 4-27. HOLDOFF DRIVER AND READER.

4-28. The holdoff driver and reader function as impedance converters. The driver isolates the output of the integrator from the holdoff circuit. The reader prevents loading of the hold off circuit and drives the 10V Schmitt.t.

4-29. A detailed explanation of the auto and lockout group is provided in paragraph 4-73.

### 4-30. TIME/DIV SWITCH AND VERNIER.

4-31. The TIME/DIV switch provides a means of switching the charging circuits (resistor and capacitor) in the integrator, changing sweep rates.

4-32. The VERNIER provides a means of varying the sweep rates between the calibrated sweep ranges.

4-33. A detailed explanation of the TIME/DIV switch and vernier is provided in paragraph 4-76.

## 4-34. DETAILED EXPLANATION.

4-35. The circuits of Model 1820C are diagrammed in schematics located at the rear of the manual. Each explanation will be keyed to one or more of these schematics.

4-36. These explanations are not intended as instruction in basic electronics. For instance, when discussing a Schmitt trigger it will be assumed that the reader knows how a Schmitt trigger operates. The explanation will proceed only to the depth necessary to tie the circuit to the overall operation of the instrument. Unusual circuits will be explained in greater detail.

### 4-37. TRIGGER CONDITIONING.

4-38. The trigger conditioning circuits (schematic 1) consist of pushbutton switches and associated components. External, internal, and line triggers are brought in on lines ① , ② , and ③ , respectively. The outputs are on lines ④ and ⑤ .

4-39. The INT/EXT switch selects a trigger either from an output from the oscilloscope vertical plug-in or a signal that is connected to the EXT INPUT connector on the front panel of Model 1820C.

4-40. The ÷1/÷10 switch connects the selected input directly or through a resistive 10:1 divider.

4-41. The AC/DC switch connects the selected input directly or capacitively to the LF impedance converter. The HF impedance converter is always capacitively coupled through A1C2.

4-42. The LF REJECT switch, when operated, disconnects and grounds the input to the LF impedance converter.

4-43. The HF REJECT switch, when operated, applies a bias to disable the HF impedance converter.

4-44. The LINE switch, when operated, connects line frequency signal from the oscilloscope mainframe via line ③ to the LF impedance converter. It also applies a disabling bias to the HF impedance converter.

### 4-45. IMPEDANCE CONVERTERS.

4-46. The HF impedance converter (schematic 1) is a high impedance input, low impedance output, noninverting amplifier consisting of FET amplifier A1Q1 and grounded collector amplifier A1Q2. Its input is on line ④ and its output is on line ⑦ . The amplifier can be disabled by applying −12.6 volts to the gate of A1Q1 via A1S1E, A1S1C, A1R4, A1R7, and A1R8.

4-47. The LF impedance converter is a high impedance input, low impedance output, inverting amplifier consisting of operational amplifier A2U1 and emitter follower A2Q1. Its input is via line ⑥ and its output is on line ⑧. The amplifier can be disabled by grounding its input via line ⑥ , A1S1F, and A1S1E.

4-48. Because the HF impedance converter attenuates frequencies below approximately 15 kilohertz and the LF impedance converter attenuates frequencies above approximately 15 kilohertz, an interfering signal on the trigger can attenuated by operating A1S5 or A1S6 and disabling the appropriate impedance converter.

### 4-49. TRIGGER AMPLIFIER AND POLARITY SWITCH.

4-50. The trigger amplifier is a two-section differential amplifier with the polarity switch between the two sections (schematic 1).

4-51. The first amplifier section consists of differential amplifier A1U1Q1, and A1U1Q2, with current source A1U1Q3. Inputs are from the impedance converters via lines ⑦ , and ⑧ . Outputs are to the polarity switch via lines ⑨ and ⑩ .

4-52. The polarity switch consists of two common-base amplifiers with common inputs and cross-connected outputs transistors. A1Q3 and A1Q6 are one amplifier. The other differential amplifier contains A1Q4 and A1Q5. Depending on the position of the POS/NEG switch, one amplifier is enabled and the other is disabled. Assume that a positive-going pulse is present on line ⑪ and a negative-going pulse is present on line ⑫ . Because the outputs of the two amplifiers are cross connected, changing the position of the POS/NEG switch will enable the other amplifier and the pulse on line ⑪ will be negative going while the pulse on line ⑫ will be positive going. Thus the pulse polarity on lines ⑪ and ⑫ to the output amplifier section will be switched (reversed).

4-53. The second amplifier section consists of differential amplifier A1U1Q4 and A1U1Q5 with current source A1Q1Q6. Outputs are to the dual Schmitt via lines ⑮ and ⑯.

### 4-54. DUAL SCHMITT.

4-55. The dual Schmitt (schematic 2) consists of A1U2A and A1U2B. It is controlled by pulses on lines ⑮ and ⑯ from the trigger amplifier and polarity switch, and on from the 10V Schmitt.

4-56. In the quiescent state, line (18) from the 10V Schmitt is low and assuming the POS/NEG switch is set to POS, line (15) is high and line (16) is low. As long as one of the three lines into A1U2B is high, line (20) will be high.

4-57. The output of A1U2A will go low when a positive-going trigger pulse causes line (15) to go low. Because of feedback via A1R50 and deliberate current limitations in the output of the trigger amplifier, the output of A1U2A will remain low as long as line (18) is low. When line (16) goes low, all three lines to A1U2B are low so line (20) goes low. This condition will remain until line (18) goes high at the end of the sweep cycle.

4-58. INTEGRATOR GATE.

4-59. The integrator gate (schematic 2) consists of a Schmitt trigger and a current switch. The Schmitt trigger consists of A1Q15 on one side and paralleled A1Q13 and A1Q14 on the other side. The paralleled transistors permit the Schmitt trigger to operate from either of two inputs. The two inputs are on line (20) from the dual Schmitt to the base of A1Q13 and on line (21) from the auto and lockout circuit to the base of A1Q14.

4-60. When the AUTO/NORM switch is set to NORM, +15 volts on line (21) disables A1Q14. The Schmitt changes states only when line (20) goes low and causes the outputs of the integrator gate (lines (22), (23), and (24)) to go low.

4-61. When the AUTO/NORM switch is set to AUTO, A1Q14 is controlled by line (21) from the auto and lockout circuit. This enables the Schmitt (integrator gate) so that the output of the 10V Schmitt causes it to change states in the absence of a trigger.

4-62. The current switch, A1Q16 and A1Q17, serves to shift the dc voltage level of the pulse from the Schmitt trigger to the level required to operate the integrator. The current switch output also provides gate signals to the mainframe.

4-63. 10V SCHMITT.

4-64. The 10V Schmitt (schematic 2) consists of A1Q7 and A1Q8 with A1Q9 as their current source. In the quiescent state, the output on line (18) is low. When the integrator states sweeping, the output from the integrator rises and eventually causes the 10V Schmitt to change states, causing line (18) go high. As long as line (18) is high, further triggering is prohibited.

4-65. INTEGRATOR.

4-66. The integrator group (schematic 2) consists of A1Q20 through A1Q27. The group is made up of a standard Miller integrator (A1Q22 and A1Q23) with a current source (A1Q20), a reset control (A1Q25 and A1Q26), a current switch (A1Q24 and A1Q27), and an emitter follower (A1Q21).

4-67. Assume the circuit to be in the quiescent state. Transistor A1Q27 is off and A1Q24 is on. All the current from the integrating resistor is flowing in A1Q24. A trigger causes line (24) to go low and A1Q27 turns on. A1Q24 turns off and the integrating capacitor starts charging toward the negative charging voltage, causing the ramp at the output of A1Q23 to start rising (positively).

4-68. As the ramp rises, it drives A1Q25 toward cutoff and the decreasing current in A1C25 causes the current in A1Q26 to increase. At a time determined by the upper threshold of the 10V Schmitt, line (24) returns to the high condition. A1Q27 turns off, A1Q24 turns on, and the integrating capacitor starts discharging through A1Q24. This causes the ramp at the collector of A1Q23 to start falling. As the ramp falls, the current in A1Q25 increases while the current in A1Q26 decreases. This change continues until the integrating capacitor has discharged to the point where only (and all of) the current from the integrating resistor is flowing in A1Q24, establishing a condition of equilibrium in A1Q25 and A1Q26. The design of the circuit is such that equilibrium is established when the base voltages of A1Q25 and A1Q26 are equal. Because the base of A1Q26 is tied to ground, equilibrium is established at zero volt. Therefore, the reset voltage of the ramp is also zero volt.

4-69. A1Q21 is used to isolate the integrator from its loads.

4-70. HOLDOFF DRIVER AND READER.

4-71. (See schematic 2). The holdoff driver (A1Q18 and A1Q19) and the holdoff reader (A1Q10 and A1Q11) function as buffers for the holdoff circuit. The holdoff circuit consists of TRIGGER HOLDOFF control R3, A1R48, and the selected holdoff capacitor on A4.

4-72. AUTO AND LOCKOUT.

4-73. The auto and lockout circuit (schematic 2) consists of A1Q12, A1CR8 and A1CR9. When the AUTO/NORM switch is set to NORM, A1Q14 is turned off by +15 volts applied through A1CR9. Therefore, the line (21) input to the integrator gate is disabled.

4-74. In the quiescent state, the NOR output of A1U2B (line (19)) is low. Incoming trigger pulses cause A1U2B to change states and line (19) to go high, charging A1C11. Because the NOR output of A1U2B has no pulldown resistor, A1C11 cannot rapidly discharge. As long as trigger pulses (40 hertz or greater) keep arriving, A1C11 does not discharge enough to permit A1Q12 to enable A1Q14.

4-75. If trigger pulses stop arriving, A1C11 will finally discharge to the point where A1Q12 will allow the next

pulse from the 10V Schmitt to turn A1Q14 on and the resultant pulse on line (14) will initiate a sweep. In this manner, free-running is acheived in the sence of a trigger.

### 4-76. TIME/DIV SWITCH AND VERNIER.

4-77. The TIME/DIV switch (schematic 3) is a four-section rotary switch (A4S1). The vernier circuit consists of A4Q1 and front panel VERNIER control R3. Switch section A4S1A switches calibration resistors, A4S1B switches integrating resistors, A4S1C switches integrating capacitors, and A4S1D switches holdoff capacitors. Integrated circuit A4U1 provides a fixed voltage reference source for the integrating circuit when the VERNIER control is in detent. The VERNIER control provides a variable (uncalibrated) voltage reference source when it is out of detent.

## 4-78. CIRCUIT OPERATION.

4-79. The information in the following paragraphs is provided in order to tie together all the information presented previously in this section. This is accomplished by following certain functions through a complete cycle of operation.

### 4-80. INTEGRATOR OPERATION IN NORM.

4-81. This discussion can be followed on schematic 2 and, in less detail, on the block diagram.

4-82. Setting the AUTO/NORM switch to NORM disables the line (21) input to the dual-input gate (base of A1Q12). Assume all circuits to be in the quiescent state. Line (18) is low and line (16) is high.

4-83. A positive-going trigger pulse is received, causing line (16) to go low. Because both inputs to A1U2A are now low, the output goes low. Then when line (16) goes low, line (20) goes low because all three inputs to A1U2B are low. When line (20) goes low, the integrator gate changes states and line (24) goes low.

4-84. The low condition on line (24) causes A1Q27 to turn on and A1Q24 turns off, permitting the integrator ramp to start rising.

4-85. As the ramp rises, the holdoff reader follows. When the ramp reaches 10 volts, the 10V Schmitt (A1Q7 and A1Q8) changes states.

4-86. Line (18) goes high, causing line (20) to go high. Line (24) goes high causing A1Q27 to turn off and A1Q24 to turn on. The sweep starts resetting.

4-87. The trigger holdoff circuit keeps the output of the holdoff reader high for a length of time determined by the setting of TRIGGER HOLDOFF control R3. During this time, the 10V Schmitt remains in its set state; the high condition on line (18) keeps the dual Schmitt disabled, and retriggering of the sweep is prevented.

4-88. Finally, the holdoff circuit discharges to the point where the output of the holdoff reader passes through the lower threshold of the 10V Schmitt. The 10V Schmitt resets, and line (18) returns to the low condition. The next positive going trigger transition will operate the dual Schmitt and the entire cycle will repeat.

### 4-89. FREE-RUN INTEGRATOR OPERATION.

4-90. The purpose of free-run operation is to provide a visible trace on the oscilloscope CRT in the absence of triggering pulses. To start this discussion, assume that the AUTO/NORM switch is in AUTO, the sweep has just been triggered, but there are no further incoming trigger pulses. Follow this discussion on schematic 2.

4-91. All inputs to the dual Schmitt are low, so line (19) is high. The auto and lockout (A1Q12 is in the high state and applying a disabling bias to the line (21) input to the dual-input gate (base of A1Q4). The ramp rises and causes the 10V Schmitt to change states. Line (18) goes high. The NOR output of A1U2B (line (19) ) has no pulldown resistor so it cannot go low immediately. At the end of the holdoff period, the 10V Schmitt resets and line (18) goes low. The output of auto and lockout (A1Q12) ramps downward on line (21) , finally crossing the threshold of the dual-input gate and causing line (24) to go low. This again starts the ramp. As long as no trigger pulses occur, line (19) cannot go high and the 10V Schmitt continues to trigger the line (21) input to the dual-input gate.

### 4-92. TRIGGERED INTEGRATOR OPERATION IN AUTO.

4-93. See schematic 2. Assume that the circuit is free-running as described in paragraphs 4-90 and 4-91. An incoming trigger causes all inputs to the dual Schmitt to go low and consequently line (19) goes high. When line (19) is high, the auto and lockout circuit disables the line (21) input to the dual-input gate and free-running cannot continue. When one or more inputs to the dual Schmitt goes high, line (19) cannot go low for about 25 milliseconds, the time to charge A1C11 to the low level. As long as trigger pulses keep arriving, the auto and lockout keeps the line (21) input to the dual-input gate disabled. The time constant of the auto and lockput is such that trigger pulse frequencies above approximately 40 Hz will retrigger the sweep before the auto and lockout circuit can initiate a sweep.

### 4-94. SINGLE SWEEP.

4-95. See schematic 2. Normally, the 10V Schmitt is triggered by the rising integrator ramp and reset at the end of holdoff time. When the SINGLE switch is activated, the lower hysteresis limit has been shifted so that it will not reset at the end of holdoff time. Pushing the RESET button will momentarily restore the original lower hysteresis limit and permit the 10V Schmitt to reset.

# SECTION V

# PERFORMANCE CHECK AND ADJUSTMENTS

## 5-1. INTRODUCTION.

5-2. This section contains step-by-step procedures 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 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 5-59 through 5-71. A photograph showing the location of all internal adjustment controls is presented in figure 5-7.

## 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. EQUIPMENT 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. Paragraphs 5-9 through 5-13 contain preliminary operational checks of performance characteristics not specified in table 1-1. Since these characteristics are not specified, stated results are approximate.

Table 5-1 Recommended Test Equipment

| Instrument | | Required Characteristics | Required For |
|---|---|---|---|
| Type | Model | | |
| Oscilloscope Mainframe | HP 180-series | No substitute | Performance checks<br>Adjustments |
| Oscilloscope Vertical | Model 1805A | Dual-channel, 100-MHz | Performance checks<br>Adjustments |
| Monitor Oscilloscope | HP 180-series with plug-ins | General-purpose, 100-MHz | Performance checks |
| Oscillator | HP Model 204C | 40-Hz to 1-kHz | Performance checks<br>Adjustments |
| VHF Oscillator | HP Model 3200B | 150-MHz | Performance checks<br>Adjustments |
| Attenuator | HP 8491A-20 | 20-dB, 150-MHz | Performance checks<br>Adjustments |
| Sampling Voltmeter | HP Model 3406A | 50-mV, 50-kHz to 150-MHz | Performance checks<br>Adjustments |
| Time-mark Generator | HP Model 226A | 50-ns to 1-sec time marks | Performance checks<br>Adjustments |
| Power Divider | HP 11549A | 50-ohm, 150-MHz | Performance checks |

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

| Instrument | | Required Characteristics | Required For |
|---|---|---|---|
| Type | Model | | |
| Sampling Tee | HP 10221A | Accommodate sampling probe, 150-MHz | Performance checks<br>Adjustments |
| 50-ohm Termination | HP 10100C | 50-ohm, 150-MHz | Performance checks |
| 9 in. BNC Cable (2) | HP 10502A | 50-ohm, BNC male to BNC male | Performance checks<br>Adjustments |
| 44 in. BNC Cable (2) | HP 10501A | 50-ohm, BNC male to BNC male | Performance checks<br>Adjustments |
| BNC Tee | HP 1250-0781 | 50-ohm | Performance checks<br>Adjustments |

## 5-9. PRELIMINARY OPERATIONAL CHECKS.

5-10. SPECIFICATION. All basic functions shall be operational.

5-11. DESCRIPTION. Sweep ranges, alternate trigger and chop, and UNCAL light are checked for basic operation.

5-12. EQUIPMENT. Required equipment is as follows:

a. Oscilloscope mainframe.

b. Oscilloscope vertical.

5-13. PROCEDURE. To make sweep generator checks, proceed as follows:

a. Install plug-ins and perform initial turn-on procedures as described in Section III.

b. Rotate TIME/DIV control through all positions. Trace shall be visible at all sweep speeds.

c. Set oscilloscope vertical display switch to alternate and sync source to composite.

d. Set Model 1820C controls as follows:

AUTO/NORM ..... AUTO
INT/EXT ..... INT
TRIGGER LEVEL ..... CW
AC/DC ..... AC

e. Rotate TIME/DIV through all ranges. Two traces shall be visible on all ranges.

f. Set oscilloscope vertical display switch to CHOP.

g. Rotate TIME/DIV through all ranges. Two traces shall be visible on all ranges.

h. Turn VERNIER clockwise out of detent. UNCAL indicator shall light.

i. Set TIME/DIV to 50 mSEC.

j. Depress LINE and SINGLE controls. No display shall be on screen.

k. Push RESET. One sweep shall occur. RESET indicator shall light during sweep.

l. Should any of the above checks fail, refer to Section VIII and appropriate block in troubleshooting block diagram (figure 8-4). Failure to sweep may be caused by faulty triggering or defect in one of integrator or associated circuits. This can usually be determined by switching to AUTO. If sweep occurs in AUTO, trouble is most likely to be in trigger circuitry.

## 5-14. TRIGGER LEVEL BALANCE.

5-15. SPECIFICATION. Triggering shall be stable in both polarities with 100-mV peak-to-peak signal.

5-16. DESCRIPTION. Triggering is checked with TRIGGER LEVEL control centered and with POS/NEG switch in both positions.

5-17. EQUIPMENT. See figure 5-1 for equipment required.

5-18. PROCEDURE. To check trigger level balance, proceed as follows:

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

b. Set oscilloscope vertical controls as follows:

display switch ..... chan A
sync source ..... chan A
chan A sensitivity ..... 0.1 V/div

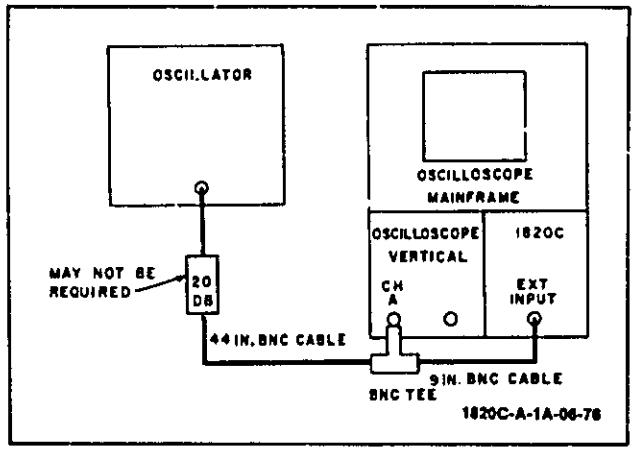



Figure 5-1. Trigger Sensitivity Test Setup

c. Set Model 1820C controls as follows:

TIME/DIV ..... .5 mSEC
AUTO/NORM ..... AUTO
INT/EXT ..... EXT
TRIGGER LEVEL ..... 12:00

d. Adjust oscillator for 1-kHz, 1-div display.

e. Adjust vertical position to center display.

f. Check stability of triggering in both positions of POS/NEG switch.

g. Should above check fail, check voltages at center tap of TRIGGER LEVEL control R2 and inputs and outputs of A2U1 and A2Q1 (schematic 1).

**5-19. LF REJECT.**

5-20. SPECIFICATION. A 750-Hz signal shall be attenuated below triggering level when the LF REJECT control is depressed.

5-21. DESCRIPTION. A stable 750-Hz display is set up. Then an attempt is made to again stabilize the display with the LF REJECT control depressed.

5-22. EQUIPMENT. See figure 5-1 for equipment required.

5-23. PROCEDURE. To check low frequency reject, proceed as follows:

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

b. Set oscilloscope vertical controls as follows:

display switch ..... chan A
sync source ..... chan A
chan A sensitivity ..... .02 V/div

c. Set Model 1820C controls as follows:

TIME/DIV ..... .5 mSEC
AUTO/NORM ..... NORM
INT/EXT ..... EXT

d. Adjust oscillator for 750-Hz, 3-div display.

e. Adjust TRIGGER LEVEL for stable display.

f. Depress LF REJECT.

g. Vary TRIGGER LEVEL. Triggering shall not occur.

h. If triggering occurs, check trigger recognition threshold (paragraph 5-62).

**5-24. HF REJECT.**

5-25. SPECIFICATION. A 300-kHz signal shall be attenuated below triggering level when the HF REJECT control is depressed.

5-26. DESCRIPTION. A stable 300-kHz display is set up. Then an attempt is again made to stabilize the display with the HF REJECT control depressed.

5-27. EQUIPMENT. See figure 5-1 for equipment required.

5-28. PROCEDURE. To check high frequency reject, proceed as follows:

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

b. Set oscilloscope vertical controls as follows:

display switch ..... chan A
sync source ..... chan A
chan A sensitivity ..... .02 V/div

c. Set Model 1820C controls as follows:

TIME/DIV ..... 1 mSEC
AUTO/NORM ..... NORM
INT/EXT ..... EXT

d. Set oscillator for 300-kHz, 3-div display.

e. Adjust TRIGGER LEVEL for stable display.

f. Depress HF REJECT.

g. Vary TRIGGER LEVEL. Triggering shall not occur.

h. If triggering occurs, check trigger recognition threshold (paragraph 5-62).

**5-29. RANGE AND POLARITY.**

5-30. SPECIFICATION. In ÷1, triggering point shall adjust smoothly to both positive and negative extremes of a 4-volt peak-to-peak waveform. Triggering shall occur on appropriate slope as indicated by POS/NEG switch. In ÷10, the peak-to-peak trigger point shall occur over only the center 30 degrees of TRIGGER LEVEL control.

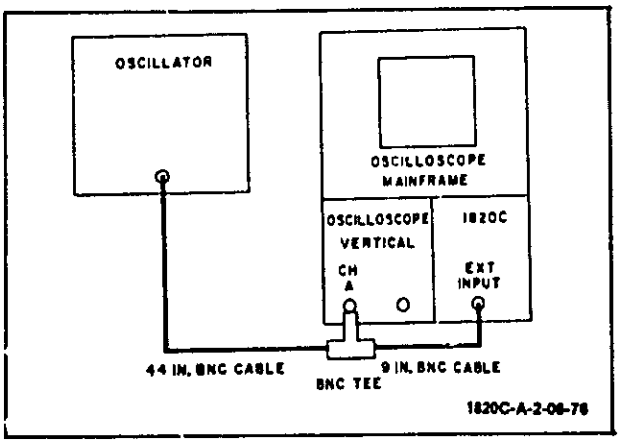



Figure 5-2. Trigger Range Test Setup

5-31. DESCRIPTION. Triggering is observed as TRIGGER LEVEL control is varied over a 4-volt peak-to-peak waveform. Observation is made in both positions of the POS/NEG control and both positions of the ÷1/÷10 control.

5-32. EQUIPMENT. See figure 5-2 for equipment required.

5-33. PROCEDURE. To check range and polarity, proceed as follows:

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

b. Set oscilloscope vertical controls as follows:

display switch . . . . . chan A
sync source . . . . . chan A
chan A sensitivity. . . . . 1 V/div

c. Set Model 1820C control as follows:

TIME/DIV . . . . . .2 mSEC
÷1/÷10 . . . . . ÷1
AUTO/NORM. . . . . NORM
INT/EXT. . . . . EXT
AC/DC . . . . . AC
POS/NEG . . . . . NEG

d. Set oscillator for 1-kHz, 4-div display.

e. Rotate TRIGGER LEVEL. Triggering point shall adjust smoothly along entire negative slope of waveform.

f. Set POS/NEG to POS.

g. Rotate TRIGGER LEVEL. Triggering point shall adjust smoothly along entire positive slope of waveform.

h. Should test in steps e and g above fail, check lines 6 through 22 in troubleshooting block diagram (figure 8-4).

i. Set ÷1/÷10 to ÷10.

CAUTION

Before proceeding to next step, ensure that maximum permissible input to vertical plug-in is at least 40V. If not, install attenuator between BNC tee and vertical input (figure 5-2).

j. Change output of oscillator to 40V p-p.

k. Rotate MAIN TRIGGER LEVEL. Trigger point shall adjust smoothly along entire positive slope of waveform.

l. Should test in preceding step fail, check voltage divider A1R5/A1R6.

5-34. HIGH FREQUENCY TRIGGERING.

5-35. SPECIFICATION. In INT, triggering shall be stable for 1/2 division and greater between dc and 100 MHz. In EXT, triggering shall be stable on 50-mV peak-to-peak signals between dc and 50 MHz, increasing to 100 mV peak-to-peak at 100 MHz and increasing to 150 mV peak-to-peak at 150 MHz.

5-36. DESCRIPTION. Triggering is observed in INT with a 100-MHz, 1/2-div display. Triggering is observed in EXT at frequencies of 50, 100, and 150 MHz at trigger amplitudes of 50 mV, 100 mV and 150 mV respectively.

5-37. EQUIPMENT. See figure 5-3 for equipment required.

5-38. PROCEDURE. To check high frequency triggering, proceed as follows:

a. Connect equipment as shown in figure 5-3.

b. Set oscilloscope vertical controls as follows:

display switch . . . . . chan A
sync source . . . . . chan A
chan A sensitivity . . . . . 1 V/div

c. Set Model 1820C controls as follows:

TIME/DIV . . . . . 50 ns
INT/EXT . . . . . INT
AUTO/NORM . . . . . NORM

d. Set Mainframe X1/X10 to X10.

Note

If upper bandwidth limit of vertical plug-in being used is less than 100 MHz, reduce frequency appropriately for INT trigger check.

e. Set VHF oscillator for 100-MHz, 1/2-div display.

f. Adjust TRIGGER LEVEL. Display shall be stable.

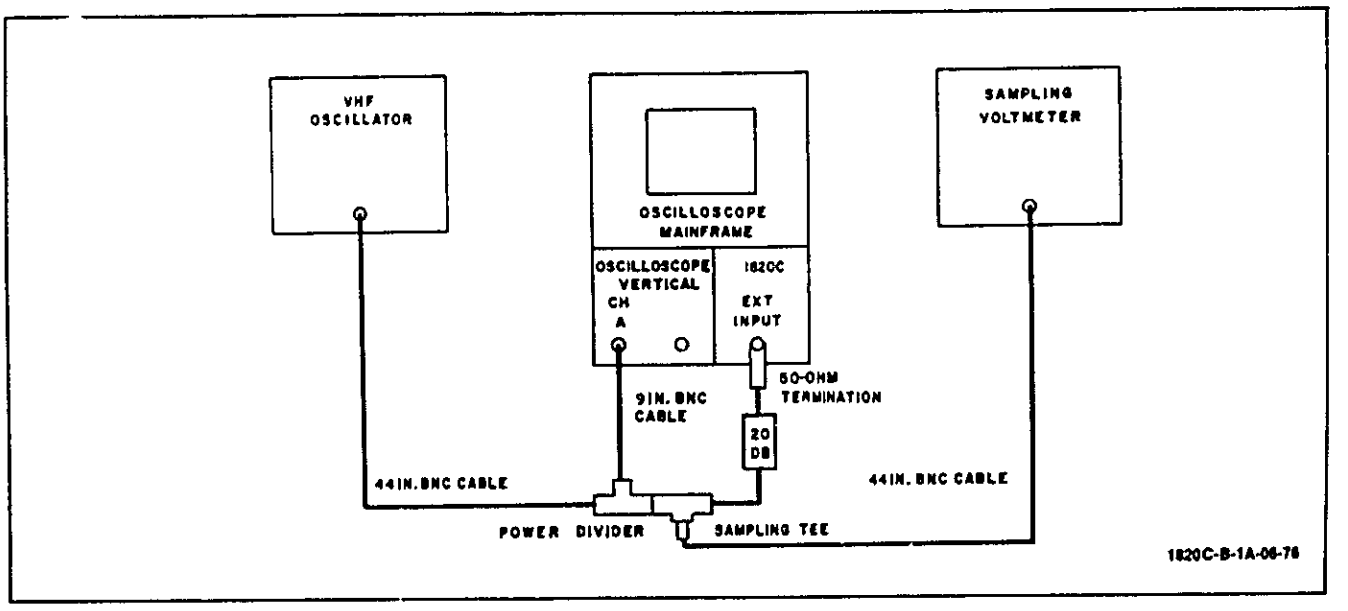



Figure 5-3. High Frequency Triggering Test Setup

g. Change INT/EXT to EXT.

h. Set VHF oscillator to 50 MHz. Adjust amplitude for 180 mV rms (50 mV p-p at EXT INPUT) as read on sampling voltmeter.

i. Adjust TRIGGER LEVEL. Display shall be stable.

j. Set VHF oscillator to 100 MHz. Adjust amplitude for 360 mV rms (100 mV p-p at EXT INPUT) as read on sampling voltmeter.

k. Adjust TRIGGER LEVEL. Display shall be stable.

l. Set VHF oscillator to 150 MHz. Adjust amplitude for 540 mV rms (150 mV p-p at EXT INPUT) as read on sampling voltmeter.

m. Adjust TRIGGER LEVEL. Display shall be stable.

n. Should any of above checks fail, first check trigger recognition threshold (paragraphs 5-62 through 5-66), check high frequency response of HF impedance converter and trigger amplifier (schematic 1).

## 5-39. REAR PANEL GATE AND SWEEP OUTPUTS.

5-40. SPECIFICATION. The amplitude of the rear panel gate and sweep outputs shall be 0.5 volt and 1 volt respectively.

5-41. DESCRIPTION. A display is set up and the rear panel outputs are monitored with the monitor oscilloscope.

5-42. EQUIPMENT. See figure 5-4 for equipment required.

5-43. PROCEDURE. To check rear panel gate and sweep outputs, proceed as follows:

a. Connect equipment as shown in figure 5-4.

b. Set Model 1820C controls as follows:

TIME/DIV ..... 10 uSEC
AUTO/NORM ..... AUTO

c. Monitor main gate output at rear panel of 180-series mainframe. Amplitude of pulses shall be equal to or greater than 0.5 volt peak-to-peak.

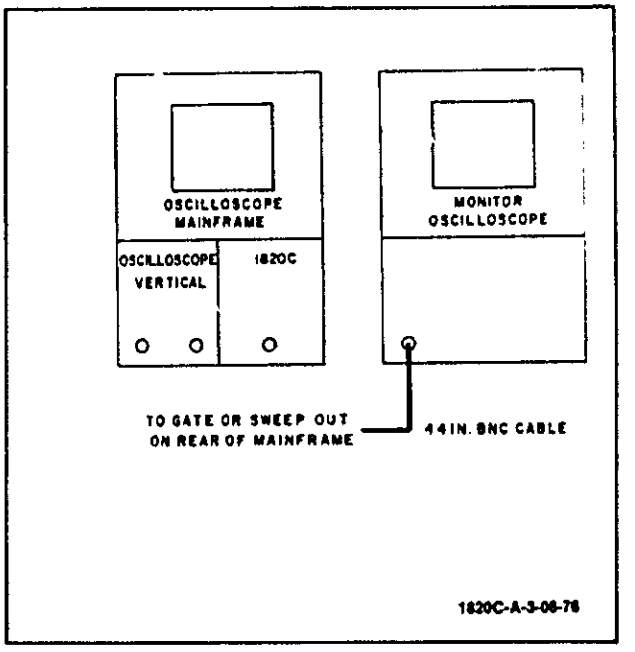



Figure 5-4. Rear Panel Outputs Test Setup

d. Monitor sweep output at rear panel of 180-series mainframe. Amplitude of ramp shall be equal to or greater than 1 volt peak-to-peak.

e. Should tests in steps c and d above fail, trace signals from main assembly A1 (schematic 3) through mainframe connector assembly A5 (schematic 5) through 180-series mainframe cabling to rear panel.

5-44. SWEEP HOLDOFF.

5-45. SPECIFICATION. Sweep holdoff shall be variable from 15 ms ±30% to > 80 ms.

5-46. DESCRIPTION. Sweep output is monitored at rear panel of 180-series mainframe with monitor oscilloscope as TRIGGER HOLDOFF control is varied over its range.

5-47. EQUIPMENT. See figure 5-4 for equipment required.

5-48. PROCEDURE. To check sweep holdoff, proceed as follows:

a. Connect equipment as shown in figure 5-4.

b. Set Model 1820C controls as follows:

TIME/DIV ..... 1 mSEC
AUTO/NORM ..... AUTO
TRIGGER HOLDOFF ..... ccw (detent)

c. Monitor sweep output at rear of 180-series mainframe. Observe time between end of one sweep and beginning of next. Holdoff shall be 15 ms ±30%.

d. Rotate TRIGGER HOLDOFF fully clockwise. Holdoff shall increase to > 80 ms.

e. Should checks in step c and d above fail, check TRIGGER HOLDOFF R3, A1R48 and holdoff reader A3Q18/A3Q19 (schematic 2). Holdoff capacitor can be checked by switching TIME/DIV to another range.

5-49. SWEEP TIME.

5-50. SPECIFICATION. All sweep ranges shall be accurate within ±3%.

5-51. DESCRIPTION. Appropriately timed pulses are applied to the oscilloscope vertical and observed on the CRT for each sweep range.

5-52. EQUIPMENT. See figure 5-5 for equipment required.

5-53. PROCEDURE. To check sweep time, proceed as follows:

a. Connect equipment as shown in figure 5-5.

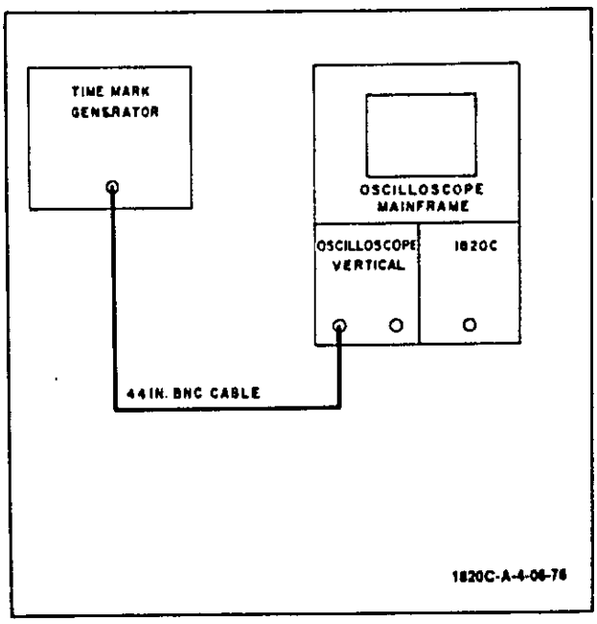



Figure 5-5. Sweep Calibration Test Setup

b. Set oscilloscope vertical controls as follows:

display switch ..... chan A
sync source ..... chan A
chan A sensitivity ..... 1 V/div

c. Set Model 1820C controls as follows:

TIME/DIV ..... .05 mSEC
AUTO/NORM ..... AUTO
INT/EXT ..... INT

d. Set time-mark generator for 50-ns marker output.

e. Adjust display on CRT so start of first time mark is exactly at left edge of graticule. Ensure that eleventh time mark is within ±3% of right edge of graticule.

f. This completes step 1 in table 5-2. Complete remaining steps in table.

g. Should any sweep time checks fail, check appropriate sweep calibration step described in paragraphs 5-67 through 5-71, step s.

5-54. SWEEP VERNIER.

5-55. SPECIFICATION. Vernier shall reduce distance between adjacent pulses between 40% and 80%.

5-56. DESCRIPTION. A display is set up with 10 divisions between adjacent pulses with vernier in detent. Vernier is rotated fully counterclockwise while observing display.

5-57. EQUIPMENT. See figure 5-5 for equipment required.

Table 5-2. Sweep Time Checks

| Time Marks | Sweep TIME/DIV |
|---|---|
| 50 ns | .05 uSEC |
| .1 usec | .1 uSEC |
| .2 usec | .2 uSEC |
| .5 usec | .5 uSEC |
| 1 usec | 1 uSEC |
| 2 usec | 2 uSEC |
| 5 usec | 5 uSEC |
| 10 usec | 10 uSEC |
| 20 usec | 20 uSEC |
| 50 usec | 50 uSEC |
| .1 ms | .1 mSEC |
| .2 ms | .2 mSEC |
| .5 ms | .5 mSEC |
| 1 ms | 1 mSEC |
| 2 ms | 2 mSEC |
| 5 ms | 5 mSEC |
| 10 ms | 10 mSEC |
| 20 ms | 20 mSEC |
| 50 ms | 50 mSEC |
| .1 sec | .1 SEC |
| .2 sec | .2 SEC |
| .5 sec | .5 SEC |
| 1 sec | 1 SEC |

5-58. PROCEDURE. To check sweep vernier, proceed as follows:

a. Connect equipment as shown in figure 5-5.

b. Set oscilloscope vertical as follows:

display switch . . . . . chan A
sync source . . . . . chan A
chan A sensitivity. . . . . 1 V/div

c. Set Model 1820C controls as follows:

TIME/DIV . . . . . 1 mSEC
AUTO/NORM . . . . . AUTO
INT/EXT . . . . . INT

d. Set time-mark generator for 10-ms marker output.

e. Turn VERNIER fully counterclockwise.

f. Observe display. Distance between adjacent pulses shall be between two and four divisions.

g. Should above test fail, check voltages on VERNIER R4 and A4Q1 (schematic 3).

# PERFORMANCE CHECK RECORD
## Model 1820C

Instrument Serial Number _____ Date _____

| Check | Specification | Measured |
|---|---|---|
| **PRELIMINARY OPERATIONAL CHECKS:** | | |
| Sweep ranges | Sweeps, all ranges | |
| Alternate Trigger and Chop | Two traces | |
| UNCAL light | Lamp lights | |
| Single Sweep | One sweep, lamp lights | |
| **TRIGGER LEVEL BALANCE:** | | |
| Positive | Stable display at 100 mV | |
| Negative | Stable display at 100 mV | |
| **LOW FREQUENCY REJECT:** | No triggering at 750 Hz | |
| **HIGH FREQUENCY REJECT:** | No triggering at 300 kHz | |
| **RANGE AND POLARITY:** | | |
| ÷1 | 4V p-p | |
| ÷10 | 30° | |
| **HIGH FREQUENCY TRIGGERING:** | | |
| INT | Stable display at ½ div | |
| EXT 50 MHz | 50 mV p-p | |
| 100 MHz | 100 mV p-p | |
| 150 MHz | 150 mV p-p | |
| **REAR PANEL GATE AND SWEEP OUTPUTS:** | | |
| Gate | ≥ 0.5V | _____ |
| Sweep | ≥ 1.0V | _____ |
| **SWEEP HOLD-OFF** | 60 usec - 1.5 ms ±20% | _____ |

## PERFORMANCE CHECK RECORD (Cont'd)
## Model 1820C

Instrument Serial Number _____ Date _____

| Check | Specification | Measured |
|---|---|---|
| **SWEEP TIME:** (position of last time marker) | | |
| .05 uSEC | 10 ±3% | _____ |
| .1 uSEC | 10 ±3% | _____ |
| .2 uSEC | 10 ±3% | _____ |
| .5 uSEC | 10 ±3% | _____ |
| 1 uSEC | 10 ±3% | _____ |
| 2 uSEC | 10 ±3% | _____ |
| 5 uSEC | 10 ±3% | _____ |
| 10 uSEC | 10 ±3% | _____ |
| 20 uSEC | 10 ±3% | _____ |
| 50 uSEC | 10 ±3% | _____ |
| .1 mSEC | 10 ±3% | _____ |
| .2 mSEC | 10 ±3% | _____ |
| .5 mSEC | 10 ±3% | _____ |
| 1 mSEC | 10 ±3% | _____ |
| 2 mSEC | 10 ±3% | _____ |
| 5 mSEC | 10 ±3% | _____ |
| 10 mSEC | 10 ±3% | _____ |
| 20 mSEC | 10 ±3% | _____ |
| 50 mSEC | 10 ±3% | _____ |
| .1 SEC | 10 ±3% | _____ |
| .2 SEC | 10 ±3% | _____ |
| .5 SEC | 10 ±3% | _____ |
| 1 SEC | 10 ±3% | _____ |
| **SWEEP VERNIER:** (distance between pulses) | 2 - 4 div | _____ |

## 5-59. ADJUSTMENTS.

5-60 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 figure 5-7.

5-61. 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.

### 5-62. TRIGGER RECOGNITION THRESHOLD.

5-63. REFERENCE. table 5-1, figure 5-6, figure 5-7, and schematic 1.

5-64. DESCRIPTION. TRIGGER SENSITIVITY adjustment A1R23 is adjusted while rotating front panel TRIGGER LEVEL control both ways through 0 to that point where trigger recognition is just established.

5-65. EQUIPMENT. See figure 5-6 for equipment required.

5-66. PROCEDURE. To adjust trigger recognition threshold, proceed as follows:

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

b. Set Model 1820C controls as follows:

| | |
|---|---|
| TIME/DIV | 1 mSEC |
| POS/NEG | POS |
| AC/DC | AC |
| INT/EXT | EXT |
| AUTO/NORM | NORM |

c. Set oscillator for 10 MHz, 50 mV rms.

d. Turn TRIGGER SENSITIVITY adjustment A1R23 fully clockwise.

e. Turn TRIGGER LEVEL back and forth through 0 while turning TRIGGER SENSITIVITY adjust A1R23 slowly ccw. Continue turning A1R23 until one sweep occurs when TRIGGER LEVEL is rotated in either direction.

f. Reduce output of oscillator to 42 mV rms.

g. Rotate TRIGGER LEVEL back and forth through 0. Sweep shall occur in only one direction of rotation.

h. Should step g fail, adjust A1R23 cw until sweep occurs in only one direction of rotation.

### 5-67. SWEEP CALIBRATION.

5-68. REFERENCE. table 5-1, figure 5-5, figure 5-7, and schematic 3.

5-69. DESCRIPTION. Appropriate time markers are applied to the oscilloscope vertical and the four adjustable sweep ranges adjusted to divide any error among those sweep ranges controlled by a particular adjustment.

5-70. EQUIPMENT. See figure 5-5 for equipment required.

5-71. PROCEDURE. To calibrate the sweep, proceed as follows:

a. Connect equipment as shown in figure 5-5.

b. Set oscilloscope vertical controls as follows:

| | |
|---|---|
| display switch | chan A |
| sync source | chan A |
| chan A sensitivity | 1 V/div |

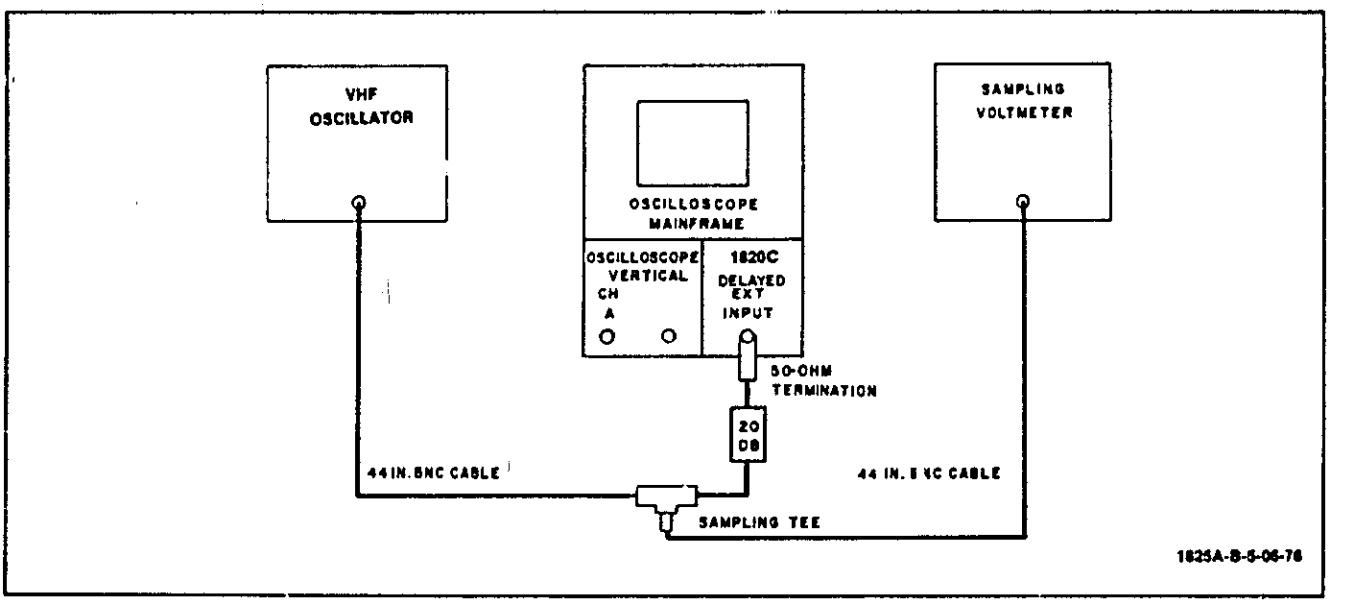



Figure 5-6. Trigger Recognition Threshold Adjustment Setup

c. Set Model 1820C controls as follows:

TIME/DIV ..... .05 uSEC
AUTO/NORM ..... AUTO
INT/EXT ..... INT

d. Set time-mark generator for 50-ns time mark.

e. Adjust Model 1820C to place leading edge of first marker on left edge of graticule.

f. Adjust A4C2 to place eleventh time mark on right edge of graticule.

g. Changing time mark output of time-mark generator appropriately, check calibration of 0.1-usec, 0.2-usec, 0.5-usec, 1-usec, and 2-usec ranges. Readjust A4C2 to divide any error equally among these ranges.

h. Set time-mark generator for 50-ns time mark.

i. Set TIME/DIV to 5 usec.

j. Adjust A4R3 to place eleventh time mark on right edge of graticule.

k. Changing time mark output of time-mark generator appropriately, check calibration of 10-usec, 20-usec, 50-usec, 0.1-ms and 0.2-ms sweep ranges. Readjust A4R3 to divide any error equally among these ranges.

l. Set output of time-mark generator for 0.5-ms time marks.

m. Set TIME/DIV to .5 mSEC.

n. Adjust A4R4 to place eleventh time mark on right edge of graticule.

o. Changing time mark output of time-mark generator appropriately, check calibration of 1-ms, 2-ms, 5-ms, 10-ms and 20-ms sweep ranges. Readjust A4R4 to divide any error equally among these ranges.

p. Set time-mark generator for 50-ms time marks.

q. Set TIME/DIV to 5 mSEC.

r. Adjust A4R5 to place fifth time mark on right edge of graticule.

s. Changing time mark output of time-mark generator appropriately, check calibration of 50-ms, 0.1-sec, 0.2-sec, 0.5-sec, and 1-sec sweep ranges. Readjust A4R5 to divide any error equally among these ranges.

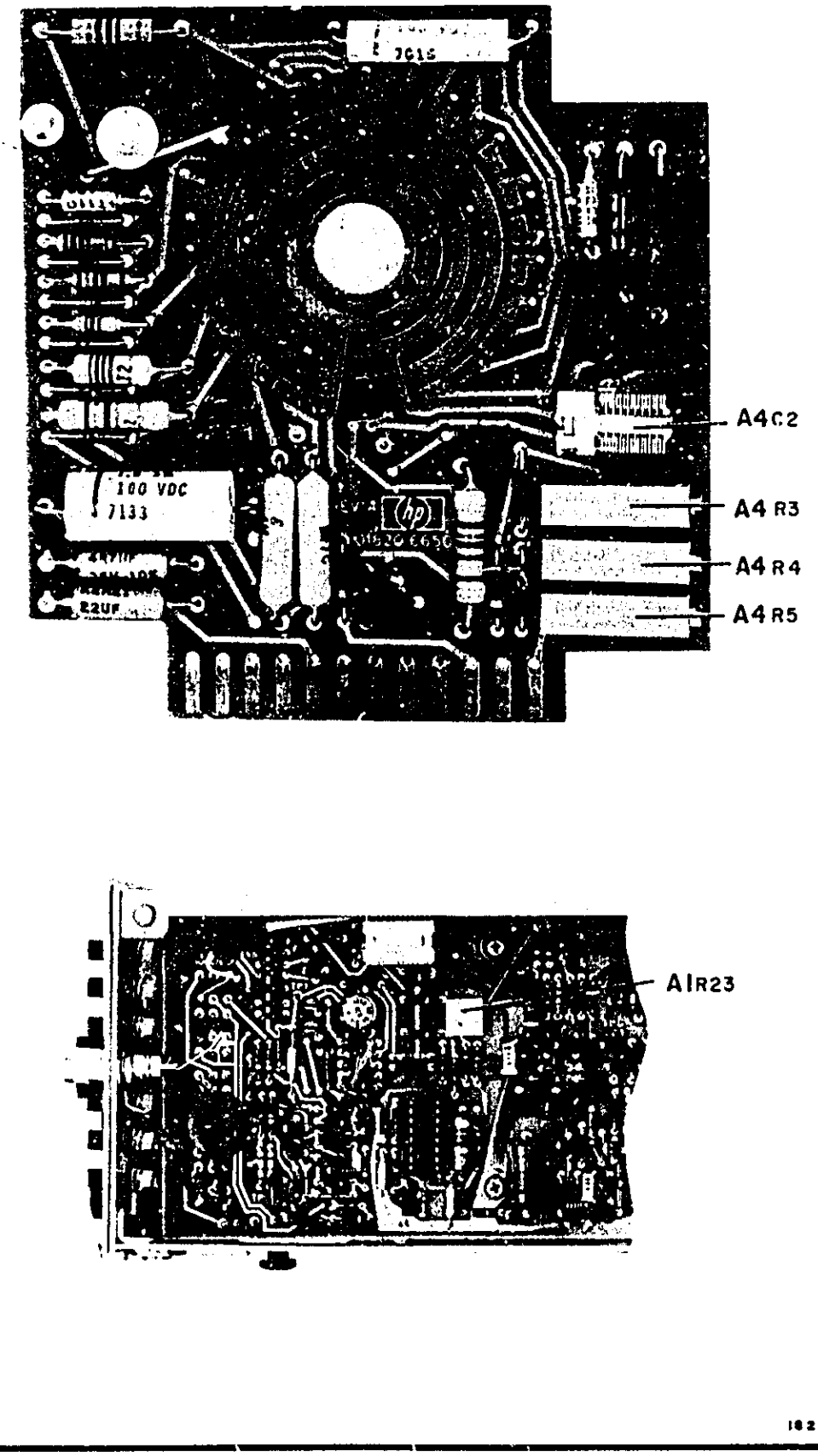



Figure 5-7. Adjustments

# 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) | GRD | = ground(ed) | NPO | = negative positive zero (zero temperature coefficient) | RWV | = reverse working voltage |
| ASSY | = assembly | H | = henry(ies) | NPN | = negative-positive-negative | S-B | = slow-blow |
| BD | = board(s) | HG | = mercury | NSR | = not separately replaceable | SCR | = silicon controlled rectifier |
| BH | = binder head | HP | = Hewlett-Packard | | | SE | = selenium |
| BP | = bandpass | HZ | = hertz | | | SEC | = second(s) |
| C | = centi ($10^{-2}$) | IF | = intermediate freq. | OBD | = order by description | SECT | = section(s) |
| CAR | = carbon | IMPG | = impregnated | OH | = oval head | SI | = silicon |
| CCW | = counterclockwise | INCD | = incandescent | OX | = oxide | SIL | = silver |
| CER | = ceramic | INCL | = include(s) | | | SL | = slide |
| CMO | = cabinet mount only | INS | = insulation(ed) | P | = peak | SP | = single pole |
| COAX | = coaxial | INT | = internal | PC | = printed (etched) circuit(s) | SPL | = special |
| COEF | = coefficient | K | = kilo ($10^{3}$) | PF | = picofarads | ST | = single throw |
| COMP | = composition | KG | = kilogram | PHL | = Phillips | STD | = standard |
| CONN | = connector(s) | LB | = pound(s) | PIV | = peak inverse voltage(s) | TA | = tantalum |
| CRT | = cathode-ray tube | LH | = left hand | PNP | = positive-negative-positive | TD | = time delay |
| CW | = clockwise | LIN | = linear taper | P/O | = part of | TFL | = teflon |
| D | = deci ($10^{-1}$) | LOG | = logarithmic taper | PORC | = porcelain | TGL | = toggle |
| DEPC | = deposited carbon | LPF | = low-pass filter(s) | POS | = position(s) | THYR | = thyristor |
| DP | = double pole | LVR | = lever | POT | = potentiometer(s) | TI | = titanium |
| DT | = double throw | M | = milli ($10^{-3}$) | P-P | = peak-to-peak | TNLDIO | = tunnel diode(s) |
| ELECT | = electrolytic | MEG | = mega ($10^{6}$) | PRGM | = program | TOL | = tolerance |
| ENCAP | = encapsulated | MET FILM | = metal film | PS | = polystyrene | TRIM | = trimmer |
| EXT | = external | MET OX | = metal oxide | PWV | = peak working voltage | U | = micro ($10^{-6}$) |
| F | = farad(s) | MFR | = manufacturer | RECT | = rectifier(s) | V | = volts |
| FET | = field-effect transistor(s) | MINAT | = miniature | RF | = radio frequency | VAR | = variable |
| FH | = flat head | MOM | = momentary | RFI | = radio frequency interference | VDCW | = dc working volt(s) |
| FIL H | = fillister head | MTG | = mounting | RH | = round head or right hand | W | = watt(s) |
| FXD | = fixed | MY | = mylar | RMO | = rack mount only | W/ | = with |
| G | = giga ($10^{9}$) | N | = nano ($10^{-9}$) | RMS | = root mean square | WIV | = working inverse voltage |
| GE | = germanium | N/C | = normally closed | | | W/O | = without |
| GL | = glass | NE | = neon | | | WW | = wirewound |
| | | N/O | = normally open | | | | |

## Table 6-2. Replaceable Parts

| Reference Designation | HP Part Number | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|
| | | | CHASSIS PARTS | | |
| A1 | 01820-66507 | 1 | ASSY: MAIN | 28480 | 01820-66507 |
| A2 | 01824-66502 | 1 | ASSY: MODE | 28480 | 01824-66502 |
| A3 | 01824-66513 | 1 | ASSY: VERTICAL CONNECTOR | 28480 | 01824-66513 |
| A4 | 01820-66506 | 1 | ASSY: INTEGRATOR SWITCH | 28480 | 01820-66506 |
| A5 | 01824-66512 | 1 | ASSY: MAINFRAME CONNECTOR | 28480 | 01824-66512 |
| DS1 | 2140-0063 | 1 | LAMP: INCANDESCENT 10.0V 0.014A | 08806 | 1689D |
| DS2 | 2140-0018 | 1 | LAMP: GLOW 1.0 MILLIAMP 0.1W | 08806 | A9A C(NE-2E1) |
| J1 | 1250-0118 | 1 | CONNECTOR:BNC | 24931 | 28JR 128-1 |
| MP1 | 01820-00208 | 1 | PANEL:FRONT | 28480 | 01820-00208 |
| MP2 | 01824-00204 | 1 | PANEL:SUB | 28480 | 01824-00204 |
| MP3 | 01824-00203 | 1 | PANEL:REAR | 28480 | 01824-00203 |
| MP4 | 01824-01202 | 1 | BRACKET:RIGHT | 28480 | 01824-01202 |
| MP5 | 01841-01202 | 1 | BRACKET:LEFT | 28480 | 01841-01202 |
| MP6 | 01841-01205 | 1 | BRACKET:TOP | 28480 | 01841-01205 |
| MP7 | 01824-61201 | 1 | BRACKET ASSY | 28480 | 01824-61201 |
| MP8 | 01821-01204 | 1 | BRACKET:JACK | 28480 | 01821-01204 |
| MP9 | 01821-04101 | 1 | BRACKET:PLUG | 28480 | 01821-04101 |
| MP10 | 01821-43101 | 1 | GUIDE:LATCH | 28480 | 01821-43101 |
| MP11 | 0510-0091 | 1 | RING:RETAINING SEL EXTERNAL | 79136 | 5103-25-5-MD |
| MP12 | 0510-1101 | 1 | SPRING:RETAINER(PC SWITCH) | 28480 | 0510-1101 |
| MP13 | 01820-23701 | 1 | SHAFT:TIME/DIV | 28480 | 01820-23701 |
| MP14 | 3130-0339 | 1 | ROTOR ASSY:MALE | 28480 | 3130-0339 |
| MP15 | 3130-0340 | 1 | ROTOR ASSY:FEMALE | 28480 | 3130-0340 |
| MP16 | 5060-0451 | 2 | LENS ASSY | 28480 | 5060-0451 |
| MP17 | 5060-0458 | 2 | HEADER:LAMP | 28480 | 5060-0458 |
| MP18 | 5060-0451 | | LENS ASSY | 28480 | 5060-0451 |
| MP19 | 5060-0458 | | HEADER:LAMP | 28480 | 5060-0458 |
| MP20 | 0370-0451 | 10 | BEZEL:PUSHBUTTON KNOB BLK NYLON | 28480 | 0370-0451 |
| MP21 | 00183-67406 | 11 | PUSHBUTTON ASSY | 28480 | 00183-67406 |
| MP22 | 01820-67404 | 1 | KNOB:TIME/DIV | 28480 | 01820-67404 |
| MP23 | 01821-67401 | 1 | KNOB:TRIGGER LEVEL | 28480 | 01821-67401 |
| MP24 | 01822-67401 | 1 | KNOB ASSY:HOLD OFF | 28480 | 01822-67401 |
| MP25 | 01821-67403 | 1 | KNOB ASSY:CAL | 28480 | 01821-67403 |
| P1 | 1250-0898 | 1 | CONNECTOR:RF 75 OHM SUB-MINIAT | 98291 | 52-146-0000 |
| R1 | 0684-1001 | | R:FXD COMP 10 OHM 10% 1/4W | 01121 | CB 1001 |
| R2 | 2100-2635 | 1 | R:VAR COMP 50K OHM 20% LIN 1/2W | 28480 | 2100-2635 |
| R3 | 2100-3174 | 1 | R:VAR COMP 5 MEGOHM 20% 10 CLOG 1/4W | 28480 | 2100-3174 |
| R4 | 2100-3173 | 1 | R:VAR COMP 10K OHM 20% LIN 1/4W | 28480 | 2100-3173 |
| R5 | 0687-8221 | 1 | R:FXD COMP 8200 OHM 10% 1/2W | 01121 | EB 8221 |
| R6 | 0684-4731 | | R:FXD COMP 47K OHM 10% 1/4W | 01121 | CB 4731 |
| S1 | | | PART OF R4 | | |
| W1 | 01824-61601 | 1 | CABLE ASSY:FRONT PANEL | 28480 | 01824-61601 |
| W2 | 01824-61602 | 1 | CABLE ASSY:A1 TO A2 | 28480 | 01824-61602 |
| W3 | 01824-61610 | 1 | CABLE:COAX INTERNAL TRIGGER | 28480 | 01824-61610 |
| W4 | 01824-61607 | 1 | CABLE ASSY:LINE SYNC | 28480 | 01824-61607 |
| W5 | 01824-61608 | 1 | CABLE:POWER | 28480 | 01824-61608 |
| W6 | 01824-61605 | 1 | CABLE ASSY:GATE OUT | 28480 | 01824-61605 |
| W7 | 01824-61606 | 1 | CABLE ASSY:SWEEP TO REAR PANEL | 28480 | 01824-61606 |
| W8 | 01824-61604 | 1 | CABLE ASSY:SWEEP OUT | 28480 | 01824-61604 |
| W9 | 01841-61620 | 1 | CABLE:RIBBON MAIN | 28480 | 01841-61620 |
| | | | ASSEMBLY BREAKDOWN | | |
| A1 | 01820-66507 | 1 | ASSY:MAIN | 28480 | 01820-66507 |
| A1C1 | 0150-0024 | 1 | C:FXD CER 0.02 UF +80-20% 600VDCW | 71590 | TYPE DD 203 |
| A1C2 | 0140-0198 | 1 | C:FXD MICA 200 PF 5% | 72136 | RDM15F201J3C |
| A1C3 | 0160-0300 | 1 | C:FXD MY 0.0027 UF 200VDCW | 56289 | 192P27292-PTS |
| A1C4 | 0180-0291 | 1 | C:FXD ELECT 1.0 UF 10% 35VDCW | 56289 | 1500105X5035A2-DYS |
| A1C5 | | | NOT ASSIGNED | | |
| A1C6 | 0160-2261 | 2 | C:FXD CER 15 PF 5% 500VDCW | 72982 | 301-NPO-15 PF |
| A1C7 | 0160-3451 | 18 | C:FXD CER 0.01 UF +80-20% 100VDCW | 56289 | C0238101F103Z525-CDH |
| A1C8 | 0160-2150 | 1 | C:FXD MICA 33 PF 5% | 28480 | 0160-2150 |
| A1C9 | 0180-0197 | 5 | C:FXD ELECT 2.2 UF 10% 20VDCW | 56289 | 1500225X9020A2-DYS |
| A1C10 | | | NOT ASSIGNED | | |
| A1C11 | 0160-0168 | 2 | C:FXD MY 0.1 UF 10% 200VDCW | 56289 | 192P10492-PTS |
| A1C12 | | | NOT ASSIGNED | | |
| A1C13 | 0160-2240 | | C: FXD CER 2.0 PF 500VDCW | 72982 | 301 000 COK0 200C |
| A1C14 | 0160-3354 | 2 | C:FXD POLY 10 UF +5-15% 100VDCW | 84411 | HEW 247 |
| A1C15 | 0160-3451 | | C:FXD CER 0.01 UF +80-20% 100VDCW | 56289 | C0238101F103Z525-CDH |
| A1C16 | 0160-2261 | | C:FXD CER 15 PF 5% 500VDCW | 72982 | 301-NPO-15 PF |
| A1C17 | 0160-3451 | | C:FXD CER 0.01 UF +80-20% 100VDCW | 56289 | C0238101F103Z525-CDH |

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 |
|---|---|---|---|---|---|
| A1C18 | 0160-3451 | | C:FXD CER 0.01 UF +80-20% 100VDCW | 56289 | C0238101F103Z525-CDH |
| A1C19 | 0160-2207 | 1 | C:FXD MICA 300 PF 5% | 28480 | 0160-2207 |
| A1C20 | 0160-3451 | | C:FXD CER 0.01 UF +80-20% 100VDCW | 56289 | C0238101F103Z525-CDH |
| A1C21 | 0160-3451 | | C:FXD CER 0.01 UF +80-20% 100VDCW | 56289 | C0238101F103Z525-CDH |
| A1C22 | 0160-3451 | | C:FXD CER 0.01 UF +80-20% 100VDCW | 56289 | C0238101F103Z525-CDH |
| A1C23 | 0160-3451 | | C:FXD CER 0.01 UF +80-20% 100VDCW | 56289 | C0238101F103Z525-CDH |
| A1C24 | 0180-0197 | | C:FXD ELECT 2.2 UF 10% 20VDCW | 56289 | 1500225X9020A2-DYS |
| A1C25 | 0160-3451 | | C:FXD CER 0.01 UF +80-20% 100VDCW | 56289 | C0238101F103Z525-CDH |
| A1C26 | 0180-0197 | | C:FXD ELECT 2.2 UF 10% 20VDCW | 56289 | 1500225X9020A2-DYS |
| A1C27 | 0160-3451 | | C:FXD CER 0.01 UF +80-20% 100VDCW | 56289 | C0238101F103Z525-CDH |
| A1C28 | 0160-3451 | | C:FXD CER 0.01 UF +80-20% 100VDCW | 56289 | C0238101F103Z525-CDH |
| A1C29 | 0180-0197 | | C:FXD ELECT 2.2 UF 10% 20VDCW | 56289 | 1500225X9020A2-DYS |
| A1C30 | 0160-3451 | | C:FXD CER 0.01 UF +80-20% 100VDCW | 56289 | C0238101F103Z525-CDH |
| A1C31 | 0150-0168 | | C:FXD MY 0.1 UF 10% 200VDCW | 56289 | 192P10492-MTS |
| A1C32 | 01 0-3451 | | C:FXD CER 0.01 UF +80-20% 100VDCW | 56289 | C0238101F103Z525-CDH |
| A1C33 | 01 9-3354 | | C:FXD POLY 10 UF +5-15% .00VDCW | 84411 | HEM 247 |
| A1CR1 | 1901-0096 | 4 | DIODE:SILICON 120V | 01295 | UG-888 |
| A1CR2 | 1901-0096 | | DIODE:SILICON 120V | 01295 | UG-888 |
| A1CR3 | 1901-0096 | | DIODE:SILICON 120V | 01295 | UG-888 |
| A1CR4 | 1901-0040 | 14 | DIODE:SILICON 30MA 30WV | 07263 | FDG1088 |
| A1CR5 | 1901-0040 | | DIODE:SILICON 30MA 30WV | 07263 | FDG1088 |
| A1CR6 | 1901-0040 | | DIODE:SILICON 30MA 30WV | 07263 | FDG1088 |
| A1CR7 | | | NOT ASSIGNED | | |
| A1CR8 | 1910 0016 | | DIODE: GERMANIUM 100MA/0.85V 60PIV | 93332 | D2361 |
| A1CR9 | | | NOT ASSIGNED | | |
| A1CR10 | | | NOT ASSIGNED | | |
| A1CR11 | | | NOT ASSIGNED | | |
| A1CR12 | 1901-0096 | | DIODE:SILICON 120V | 01295 | UG-888 |
| A1CR13 | 1901-0040 | | DIODE:SILICON 30MA 30WV | 07263 | FDG1088 |
| A1CR14 | 1901-0040 | | DIODE:SILICON 30MA 30WV | 07263 | FDG1088 |
| A1J1 | 1200-0441 | 4 | SOCKET:IC 14 PIN MINIATURE | 28480 | 1200-0441 |
| A1J2 | 1251-0477 | 2 | CONNECTOR:PC 12 FORK TYPE CONTACT | 95354 | 91-6912-1700-00 |
| A1J3 | 1200-0441 | | SOCKET:IC 14 PIN MINIATURE | 28480 | 1200-0441 |
| A1L1 | 9140-0115 | 1 | COIL:FXD RF 22 UH 10% | 99800 | 2150-32 |
| A1L2 | 9170 0029 | | CORE: FERRITE BEAD | 02114 | 56 590-65A2/4A |
| A1Q1 | 1855-0081 | 1 | TSTR:SI FET | 80131 | 2N5245 |
| A1Q2 | 1853 0203 | | TSTR: SI PNP | 28480 | 1853 0203 |
| A1Q3 | 1854-0092 | 4 | TSTR:SI NPN | 80131 | 2N3563 |
| A1Q4 | 1854-0092 | | TSTR:SI NPN | 80131 | 2N3563 |
| A1Q5 | 1854-0092 | | TSTR:SI NPN | 80131 | 2N3563 |
| A1Q6 | 1854-0092 | | TSTR:SI NPN | 80131 | 2N3563 |
| A1Q7 | 1854-0215 | 8 | TSTR:SI NPN | 80131 | 2N3904 |
| A1Q8 | 1854-0215 | | TSTR:SI NPN | 80131 | 2N3904 |
| A1Q9 | 1854-0215 | | TSTR:SI NPN | 80131 | 2N3904 |
| A1Q10 | 1854-0215 | | TSTR:SI NPN | 80131 | 2N3904 |
| A1Q11 | 1853-0086 | 10 | TSTR:SI PNP | 80131 | 2N5087 |
| A1Q12 | 1854 0071 | | TSTR: SI NPN | 28480 | 1854 0071 |
| A1Q13 | 1853-0086 | | TSTR:SI PNP | 80131 | 2N5087 |
| A1Q14 | 1853-0086 | | TSTR:SI PNP | 80131 | 2N5087 |
| A1Q15 | 1853-0086 | | TSTR:SI PNP | 80131 | 2N5087 |
| A1Q16 | 1854-0015 | 1 | TSTR:SI NPN | 28480 | 1854-0015 |
| A1Q17 | 1854-0019 | 1 | TSTR:SI NPN | 28480 | 1854-0019 |
| A1Q18 | 1854-0215 | | TSTR:SI NPN | 80131 | 2N3904 |
| A1Q19 | 1853-0086 | | TSTR:SI PNP | 80131 | 2N5087 |
| A1Q20 | 1853-0086 | | TSTR:SI PNP | 80131 | 2N5087 |
| A1Q21 | 1854-0215 | | TSTR:SI NPN | 80131 | 2N3904 |
| A1Q22 | 1854 0691 | 1 | TSTR:SI NPN | 28480 | 1854 0691 |
| A1Q23 | 1854-0548 | 1 | TSTR:SI NPN | 80131 | 2N5963 |
| A1Q24 | 1853-0244 | 1 | TSTR:SI PNP | 28480 | 1853-0244 |
| A1Q25 | 1853-0086 | | TSTR:SI PNP | 80131 | 2N5087 |
| A1Q26 | 1853-0086 | | TSTR:SI PNP | 80131 | 2N5087 |
| A1Q27 | 1853-0086 | | TSTR:SI PNP | 80131 | 2N5087 |
| A1R1 | 0757-0471 | 1 | R:FXD MET FLM 182K OHM 1% 1/8W | 28480 | 0757-0471 |
| A1R2 | 0757-0488 | 2 | R:FXD MET FLM 909K OHM 1% 1/8W | 28480 | 0757-0488 |
| A1R3 | 0684-1051 | 2 | R:FXD COMP 1MEGOHM 1% 1/4W | 01121 | CB 1051 |
| A1R4 | 0684-1031 | 1 | R:FXD COMP 10K OHM 10% 1/4W | 01121 | CB 1031 |
| A1R5 | 0757-0466 | 1 | R:FXD MET FLM 110K OHM 1% 1/8W | 28480 | 0757-0466 |
| A1R6 | 0757-0488 | | R:FXD MET FLM 909K OHM 1% 1/8W | 28480 | 0757-0488 |
| A1R7 | 0684-1061 | 1 | R:FXD COMP 10 MEGOHM 10% 1/4W | 01121 | CB 1061 |
| A1R8 | 0684 5601 | | R: FXD COMP 56 OHM 10% 1/4W | 01121 | CB 5601 |
| A1R9 | 0684-3321 | 1 | R:FXD COMP 3300 OHM 10% 1/4W | 01121 | CB 3321 |
| A1R10 | 0684-1011 | | R:FXD COMP 100 OHM 10% 1/4W | 01121 | CB 1011 |
| A1R11 | 0698-3159 | 1 | R:FXD MET FLM 26.1K OHM 1% 1/8W | 28480 | 0698-3159 |
| A1R12 | 0757-0290 | 1 | R:FXD MET FLM 6.19K OHM 1% 1/8W | 28480 | 0757-0290 |
| A1R13 | 0757-0280 | 5 | R:FXD MET FLM 1K OHM 1% 1/8W | 28480 | 0757-0280 |

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 |
|---|---|---|---|---|---|
| A1R14 | 0683-2225 | 3 | R:FXD COMP 2.2K OHM 5% 1/4W | 01121 | CB 2225 |
| A1R15 | 0683-2225 | | R:FXD COMP 2.2K OHM 5% 1/4W | 01121 | CB 2225 |
| A1R16 | 0684-3311 | 3 | R:FXD COMP 330 OHM 10% 1/4W | 01121 | CB 3311 |
| A1R17 | 0675-1011 | 4 | R:FXD COMP 100 OHM 10% 1/8W | 01121 | 88-1011 |
| A1R18 | 0675-1011 | | R:FXD COMP 100 OHM 10% 1/8W | 01121 | 88-1011 |
| A1R19 | 0698 3430 | | R: FXD MET FLM 21.5 OHM 1% 1/8W | 28480 | 0698 3430 |
| A1R20 | 0757-0416 | 2 | R:FXD MET FLM 511 OHM 1% 1/8W | 28480 | 0757-0416 |
| A1R21 | 0684-2201 | 2 | R:FXD COMP 22 OHM 10% 1/4W | 01121 | CB 2201 |
| A1R22 | 0757-0124 | 2 | R:FXD MET FLM 39.2K OHM 1% 1/8W | 28480 | 0757-0124 |
| A1R23 | 2100-3175 | 1 | R:VAR CER(MET 100K OHM 10% LIN 1/2W | 28480 | 2100-3175 |
| A1R24 | | | NOT ASSIGNED | | |
| A1R25 | 0757-0280 | | R:FXD MET FLM 1K OHM 1% 1/8W | 28480 | 0757-0280 |
| A1R26 | 0757-0273 | 2 | R:FXD MET FLM 3.01K OHM 1% 1/8W | 28480 | 0757-0273 |
| A1R27 | 0757-0280 | | R:FXD MET FLM 1K OHM 1% 1/8W | 28480 | 0757-0280 |
| A1R28 | 0757-0420 | 2 | R:FXD MET FLM 750 OHM 1% 1/8W | 28480 | 0757-0420 |
| A1R29 | 0675-1011 | | R:FXD COMP 100 OHM 10% 1/8W | 01121 | 88-1011 |
| A1R30 | 0675-1011 | | R:FXD COMP 100 OHM 10% 1/8W | 01121 | 88-1011 |
| A1R31 | 0698 3430 | | R: FXD MET FLM 21.5 OHM 1% 1/8W | 28480 | 0698 3430 |
| A1R32 | 0757-0124 | | R:FXD MET FLM 39.2K OHM 1% 1/8W | 28480 | 0757-0124 |
| A1R33 | 0684-2201 | | R:FXD COMP 22 OHM 10% 1/4W | 01121 | CB 2201 |
| A1R34 | 0698-3153 | 2 | R:FXD MET FLM 3.83K OHM 1% 1/8W | 28480 | 0698-3153 |
| A1R35 | 0698-8140 | 1 | R:FXD MET OX 15K OHM 2.0% 1.0W | 28480 | 0698-8140 |
| A1R36 | 0757-0438 | 2 | R:FXD MET FLM 5.11K OHM 1% 1/8W | 28480 | 0757-0438 |
| A1R37 | 0757-0200 | 1 | R:FXD MET FLM 5.62K OHM 1% 1/8W | 28480 | 0757-0200 |
| A1R38 | 0757 0435 | | R:FXD MET FLM 3.92K OHM 1% 1/8W | 28480 | 0757 0435 |
| A1R39 | 0684-1011 | | R:FXD COMP 100 OHM 10% 1/4W | 01121 | CB 1011 |
| A1R40 | 0757-0442 | 4 | R:FXD MET FLM 10.0K OHM 1% 1/8W | 28480 | 0757-0442 |
| A1R41 | 0757-0280 | | R:FXD MET FLM 1K OHM 1% 1/8W | 28480 | 0757-0280 |
| A1R42 | 0757 0442 | | R: FXD MET FLM 10.0K OHM 1% 1/8W | 28480 | 0757 0442 |
| A1R43 | 0757-0279 | 1 | R:FXD MET FLM 3.16K OHM 1% 1/8W | 28480 | 0757-0279 |
| A1R44 | 0684-1051 | | R:FXD COMP 1MEGOHM 1% 1/4W | 01121 | CB 1051 |
| A1R45 | 0684 1011 | | R: FXD COMP 100 OHM 10% 1/4W | 01121 | CB 1011 |
| A1R46 | 0761-0076 | 1 | R:FXD MET OX 18K OHM 5% 1W | 28480 | 0761-0076 |
| A1R47 | 0683-1825 | 1 | R:FXD COMP 1800 OHM 5% 1/4W | 01121 | CB 1825 |
| A1R48 | 0684-4731 | | R:FXD COMP 47K OHM 10% 1/4W | 01121 | CB 4731 |
| A1R49 | 0757-0476 | 1 | R:FXD MET FLM 301K OHM 1% 1/8W | 28480 | 0757-0476 |
| A1R50 | 0757-0398 | 2 | R:FXD MET FLM 75 OHM 1% 1/8W | 28480 | 0757-0398 |
| A1R51 | 0683-2025 | 2 | R:FXD COMP 2000 OHM 5% 1/4W | 01121 | CB 2025 |
| A1R52 | 0757-0398 | | R:FXD MET FLM 75 OHM 1% 1/8W | 28480 | 0757-0398 |
| A1R53 | 0683-2025 | | R:FXD COMP 2000 OHM 5% 1/4W | 01121 | CB 2025 |
| A1R54 | 0757 0441 | 1 | R:FXD MET FLM 8.25K OHM 1% 1/8W | 28480 | 0757 0441 |
| A1R55 | 0757-0467 | 3 | R:FXD MET FLM 825K OHM 1% 1/8W | 28480 | 0757-0467 |
| A1R56 | 0684 4701 | 1 | R:FXD COMP 47 OHM 10% 1/4W | 01121 | CB 4701 |
| A1R57 | 0698-8139 | 1 | R:FXD MET OX 10K OHM 2.0% 1.0W | 28480 | 0698-8139 |
| A1R58 | 0757-0283 | 3 | R:FXD MET FLM 2.00K OHM 1% 1/8W | 28480 | 0757-0283 |
| A1R59 | 0757-0445 | 1 | R:FXD FLM 13K OHM 1% 1/8W | 28480 | 0757-0445 |
| A1R60 | 0757-0317 | 1 | R:FXD MET FLM 1.33K OHM 1% 1/8W | 28480 | 0757-0317 |
| A1R61 | 0698 3447 | 1 | R:FXD MET FLM 422 OHM 1.0% 1/8W | 28480 | 0698 3447 |
| A1R62 | 0757-0280 | | R:FXD MET FLM 1K OHM 1% 1/8W | 28480 | 0757-0280 |
| A1R63 | 0684-1011 | | R:FXD COMP 100 OHM 10% 1/4W | 01121 | CB 1011 |
| A1R64 | 0764-0021 | 1 | R:FXD MET FLM 9100 OHM 5% 2W | 28480 | 0764-0021 |
| A1R65 | 0684-3311 | | R:FXD COMP 330 OHM 10% 1/4W | 01121 | CB 3311 |
| A1R66 | 0757-0282 | 1 | R:FXD MET FLM 221 OHM 1% 1/8W | 28480 | 0757-0282 |
| A1R67 | 0684-1011 | | R:FXD COMP 100 OHM 10% 1/4W | 01121 | CB 1011 |
| A1R68 | | | NOT ASSIGNED | | |
| A1R69 | 0757 0431 | | R: FXD MET FLM 2.43K OHM 1% 1/8W | 28480 | 0757 0431 |
| A1R70 | 0684-3921 | 2 | R:FXD COMP 3900 OHM 10% 1/4W | 01121 | CB 3921 |
| A1R71 | 0684-3921 | | R:FXD COMP 3900 OHM 10% 1/4W | 01121 | CB 3921 |
| A1R72 | 0684-1011 | | R:FXD COMP 100 OHM 10% 1/4W | 01121 | CB 1011 |
| A1R73 | 0684-1021 | 1 | R:FXD COMP 1000 OHM 10% 1/4W | 01121 | CB 1021 |
| A1R74 | 0698 8140 | 1 | R:FXD MET FLM 15K OHM 1% 1/8W | 28480 | 0698 8140 |
| A1R75 | 0684-1011 | | R:FXD COMP 100 OHM 10% 1/4W | 01121 | CB 1011 |
| A1R76 | 0684-1011 | | R:FXD COMP 100 OHM 10% 1/4W | 01121 | CB 1011 |
| A1R77 | 0684-4721 | 3 | R:FXD COMP 4700 OHM 10% 1/4W | 01121 | CB 4721 |
| A1R78 | 0757-0404 | 1 | R:FXD FLM 130 OHM 1% 1/8W | 28480 | 0757-0404 |
| A1R79 | 0757 0283 | | R: FXD MET FLM 2.00K OHM 1% 1/8W | 28480 | 0757 0283 |
| A1R80 | 0757 0930 | | R: FXD FLM 1800 OHM 2% 1/8W | 28480 | 0757 0930 |
| A1R81 | 0684 1221 | 1 | R:FXD COMP 1.2K OHM 10% 1/4W | 01121 | CB 1221 |
| A1R82 | 0757-0416 | | R:FXD MET FLM 511 OHM 1% 1/8W | 28480 | 0757-0416 |
| A1R83 | 0757-0283 | | R:FXD MET FLM 2.00K OHM 1% 1/8W | 28480 | 0757-0283 |
| A1R84 | 0683-5125 | 1 | R:FXD COMP 5100 OHM 5% 1/4W | 01121 | CB 5125 |
| A1R85 | 0684-1011 | | R:FXD COMP 100 OHM 10% 1/4W | 01121 | CB 1011 |
| A1R86 | 0698-3083 | 1 | R:FXD MET FLM 1.96K OHM 1% 1/8W | 28480 | 0698-0083 |

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 |
|---|---|---|---|---|---|
| A1R87 | 0757-0426 | 1 | R:FXD FLM 1.3K OHM 1% 1/8W | 28480 | 0757-0426 |
| A1R88 | 0757-0415 | 2 | R:FXD MET FLM 475 OHM 1% 1/8W | 28480 | 0757-0415 |
| A1R89 | 0684-1011 | | R:FXD COMP 100 OHM 10% 1/4W | 01121 | CB 1011 |
| A1R90 | 0684 5601 | | R: FXD COMP 56 OHM 10% 1/4W | 01121 | CB 5601 |
| A1R91 | 0684-1001 | | R:FXD COMP 10 OHM 10% 1/4W | 01121 | CB 1001 |
| A1R92 | 0684-1011 | | R:FXD COMP 100 OHM 10% 1/4W | 01121 | CB 1011 |
| A1R93 | 0684-1001 | | R:FXD COMP 10 OHM 10% 1/4W | 01121 | CB 1001 |
| A1R94 | 0684-1011 | | R:FXD COMP 100 OHM 10% 1/4W | 01121 | CB 1011 |
| A1R95 | 0684-1001 | | R:FXD COMP 10 OHM 10% 1/4W | 01121 | CB 1001 |
| A1R96 | 0684-1011 | | R:FXD COMP 100 OHM 10% 1/4W | 01121 | CB 1011 |
| A1R97 | 0684-1001 | | R:FXD COMP 10 OHM 10% 1/4W | 01121 | CB 1001 |
| A1R98 | 0684-2701 | 1 | R:FXD COMP 2.7 OHM 10% 1/4W | 01121 | CB 2701 |
| A1R99 | 0684-1001 | | R:FXD COMP 10 OHM 10% 1/4W | 01121 | CB 1001 |
| A1R100 | 0684-4711 | 1 | R:FXD COMP 470 OHM 10% 1/4W | 01121 | CB 4711 |
| A1S1 | 3101-1660 | 1 | SWITCH:PUSHBUTTON 8 STATION EA. DPDT | 28480 | 3101-1660 |
| A1U1 | 1858-0004 | 1 | TSTR ARRAY:SI NPN DUAL DIFF. AMPL. | 28480 | 1858-0004 |
| A1U2 | 1820-0806 | 1 | IC | 28480 | 1820-0806 |
| A1VR1 | 1902-3002 | 1 | DIODE BREAKDOWN:2.37V 5% | 28480 | 1902-3002 |
| A1VR2 | 1902 3086 | | DIODE BREAKDOWN: 4.75V 2% | 28480 | 1902 3086 |
| A1VR3 | 1902-0041 | 1 | DIODE:BREAKDOWN 5.11V 5% | 04713 | SZ10939-98 |
| A1XU1 | 1200-0438 | 1 | SOCKET:IC 16 CONTACT DUAL TYPE, BROWN | 00779 | 583529-1 |
| A1Z1 | 9100-2247 | | COIL: FXD RF 0.10 UH 10% | 28480 | 9100-2247 |
| A1Z2 | 9100-2247 | | COIL: FXD RF 0.10 UH 10% | 28480 | 9100-2247 |
| A2 | 01824-66502 | 1 | ASSY:MODE | 28480 | 01824-66502 |
| A2C1 | 0160-2257 | | C:FXD CER 10 PF 5% 500VDCW | 72982 | 301-000-COH0-100J |
| A2C2 | 0160-0134 | 1 | C:FXD MICA 220PF 5% 300VDCW | 14655 | RDM15F221J3C |
| A2C3 | 0160-3451 | | C:FXD CER 0.01 UF +80-20% 100VDCW | 56289 | C0238101F103Z525-COH |
| A2C4 | 0160-2247 | 1 | C:FXD CER 3.9 PF 500VDCW | 72982 | 301-NP0-3.9 PF |
| A2C5 | 0160-0153 | | C:FXD MY 0.001 UF 10% 200VDCW | 56289 | 192P10292-PTS |
| A2C6 | 0160-3451 | | C:FXD CER 0.01 UF +80-20% 100VDCW | 56289 | C0238101F103Z525-COH |
| A2C7 | 0180-0197 | | C:FXD ELECT 2.2 UF 10% 20VDCW | 56289 | 1500225X9020A2-DYS |
| A2J1 | 1200-0441 | | SOCKET:IC 14 PIN MINIATURE | 28480 | 1200-0441 |
| A2P1 | 1251-3071 | 1 | CONNECTOR:8 FEMALE RECEPTACLE | 28480 | 1251-3071 |
| A2Q1 | 1854-0215 | | TSTR:SI NPN | 80131 | 2N3904 |
| A2Q2 | 1853-0086 | | TSTR:SI PNP | 80131 | 2N5087 |
| A2R1 | 0757-0408 | 1 | R:FXD MET FLM 243 OHM 1% 1/8W | 28480 | 0757-0408 |
| A2R2 | 0757-0446 | 1 | R:FXD MET FLM 15.0K OHM 1% 1/8W | 28480 | 0757-0446 |
| A2R3 | 0757-0420 | | R:FXD MET FLM 750 OHM 1% 1/8W | 28480 | 0757-0420 |
| A2R4 | 0757-0402 | 1 | R:FXD MET FLM 110 OHM 1% 1/8W | 28480 | 0757-0402 |
| A2R5 | 0757-0415 | | R:FXD MET FLM 475 OHM 1% 1/8W | 28480 | 0757-0415 |
| A2R6 | 0757-0437 | 1 | R:FXD MET FLM 4750 OHM 1% 1/8W | 28480 | 0757-0437 |
| A2R7 | 0757-0487 | | R:FXD MET FLM 825K OHM 1% 1/8W | 28480 | 0757-0487 |
| A2R8 | 0757-0422 | 1 | R:FXD MET FLM 909 OHM 1% 1/8W | 28480 | 0757-0422 |
| A2R9 | 0698-8148 | 1 | R:FXD FLM 1.58 MEGOHM 1.0% 1/4W | 28480 | 0698-8148 |
| A2R10 | 0684 4721 | | H:FXD COMP 4700 OHM 10% 1/4W | 01121 | CB 4721 |
| A2R11 | 0757-0473 | 1 | R:FXD MET FLM 221K OHM 1% 1/8W | 28480 | 0757-0473 |
| A2R12 | 0683-1555 | 1 | R:FXD COMP 470K OHM 10% 1/4W | 01121 | CB 4741 |
| A2R13 | 0757-0438 | | R:FXD MET FLM 5.11K OHM 1% 1/8W | 28480 | 0757-0438 |
| A2R14 | 0684-4721 | | R:FXD COMP 4700 OHM 10% 1/4W | 01121 | CB 4721 |
| A2R15 | 0684 4721 | | R:FXD MET FLM 825K OHM 1% 1/8W | 28480 | 0757-0487 |
| A2R16 | 0757-0442 | | R:FXD MET FLM 10K OHM 1% 1/8W | 28480 | 0757 0442 |
| A2R17 | 0684-3311 | | R:FXD COMP 330 OHM 10% 1/4W | 01121 | CB 3311 |
| A2R18 | 0684-1011 | | R:FXD COMP 100 OHM 10% 1/4W | 01121 | CB 1011 |
| A2R19 | 0684-1011 | | R:FXD COMP 100 OHM 10% 1/4W | 01121 | CB 1011 |
| A2S1 | 3101-1516 | 1 | SWITCH:PUSHBUTTON 3 SECTION | 28480 | 3101-1516 |
| A2U1 | 1826 0086 | | IC: LINEAR OP AMPL | 01263 | UbF/776393 |
| A3 | 01824-66506 | 1 | ASSY:VER[illegible] BL CONNECTOR | 28480 | 01824-66506 |
| A3C1 | | | NOT ASSIGNED | | |
| A3C2 | 0160-3451 | | C:FXD CER 0.01 UF +80-20% 100VDCW | 56289 | C0238101F103Z525-COH |
| A3J1 | 1200-0441 | | SOCKET:IC 14 PIN MINIATURE | 28480 | 1200-0441 |
| A3J2 | 1251-0054 | 1 | CONNECTOR:FEMALE 24-CONTACT | 28480 | 1251-0054 |
| A3L1 | 9140-0115 | | COIL:FXD RF 22 UH 10% | 99800 | 2150-32 |
| A3L2 | 9140-0115 | | COIL:FXD RF 22 UH 10% | 99800 | 2150-32 |
| A4 | 01820-66506 | 1 | ASSY:INTEGRATOR SWITCH | 28480 | 01820-66506 |
| A4C1 | 0160-3451 | | C:FXD CER 0.01 UF +80-20% 100VDCW | 56289 | C0238101F103Z525-COH |
| A4C2 | 0121 0495 | 1 | C:VAR AIR 1.9-15.7 PF | 74970 | 187 0309-105 |
| A4C3 | 0160-3987 | | C: FXD MICA 86 PF 5% 300VDCW | 28480 | 0160-3987 |
| A4C4 | 0160-3641 | 1 | C:FXD POLY 0.01 UF 5% 100VDCW | 84411 | HEW-192 |
| A4C5 | 0160-3324 | 1 | C:FXD MET POLY 1.0 UF 5% 100VDCW | 84411 | HEW-249 |
| A4C6 | 0140-0207 | 1 | C:FXD MICA 330 PF 5% | 28480 | 0140-0207 |
| A4C7 | 0160-0155 | 1 | C:FXD MY 0.0033 UF 10% 200VDCW | 56289 | 192P33292-PTS |
| A4C8 | 0160-0163 | 1 | C:FXD MY 0.033 UF 10% 200VDCW | 56289 | 192P33392-PTS |
| A4C9 | 0180-0195 | 1 | C:FXD ELECT 0.33 UF 20% 35VDCW | 56289 | 1500334X0035A2-DYS |
| A4C10 | 0180-0376 | 1 | C:FXD ELECT 0.47 UF 10% 35VDCW | 56289 | 1500474X9035A2-DYS |

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 |
|---|---|---|---|---|---|
| A4C11 | 0180-0100 | 1 | C:FXD ELECT 4.7 UF 10% 35VDCW | 56289 | 1500475X903582-DYS |
| A4C12 | 0180-0228 | 1 | C:FXD ELECT 22 UF 10% 15VDCW | 56289 | 1500226X901582-DYS |
| A4CR1 | 1901-0040 | | DIODE:SILICON 30MA 30WV | 07263 | FDG1088 |
| A4CR2 | 1901-0040 | | DIODE:SILICON 30MA 30WV | 07263 | FDG1088 |
| A4CR3 | 1901-0040 | | DIODE:SILICON 30MA 30WV | 07263 | FDG1088 |
| A4CR4 | 1901-0040 | | DIODE:SILICON 30MA 30WV | 07263 | FDG1088 |
| A4CR5 | 1901-0040 | | DIODE:SILICON 30MA 30WV | 07263 | FDG1088 |
| A4CR6 | 1901-0040 | | DIODE:SILICON 30MA 30WV | 07263 | FDG1088 |
| A4CR7 | 1901-0040 | | DIODE:SILICON 30MA 30WV | 07263 | FDG1088 |
| A4L1 | 9170-0029 | 1 | CORE:FERRITE BEAD | 02114 | 56-590-65A2/4A |
| A4Q1 | 1853-0036 | | TSTR:SI PNP | 80131 | 2N3906 |
| A4R1 | 0757-0442 | | R:FXD MET FLM 10.0K OHM 1% 1/8W | 28480 | 0757-0442 |
| A4R2 | 0757-0442 | | R:FXD MET FLM 10.0K OHM 1% 1/8W | 28480 | 0757-0442 |
| A4R3 | 2100-3161 | 3 | R:VAR CERMET 20K OHM 10% TYPE P 3/4W | 28480 | 2100-3161 |
| A4R4 | 2100-3161 | | R:VAR CERMET 20K OHM 10% TYPE P 3/4W | 28480 | 2100-3161 |
| A4R5 | 2100-3161 | | R:VAR CERMET 20K OHM 10% TYPE P 3/4W | 28480 | 2100-3161 |
| A4R6 | 0757-0845 | 1 | R:FXD MET FLM 18.2K OHM 1.0% 1/2W | 28480 | 0757-0845 |
| A4R7 | 0684-2211 | 4 | R:FXD COMP 220 OHM 10% 1/4W | 01121 | CB 2211 |
| A4R8 | 0684-2211 | | R:FXD COMP 220 OHM 10% 1/4W | 01121 | CB 2211 |
| A4R9 | 0698-8149 | 1 | R:FXD FLM 40K OHM 0.1% 1/4W | 28480 | 0698-8149 |
| A4R10 | 0698-8147 | 1 | R:FXD FLM 80K OHM 0.1% 1/8W | 28480 | 0698-8147 |
| A4R11 | 0698-8146 | 1 | R:FXD FLM 160K OHM 0.1% 1/8W | 28480 | 0698-8146 |
| A4R12 | 0698-5171 | 1 | R:FXD FLM 400K OHM 0.1% 1/8W | 28480 | 0698-5171 |
| A4R13 | 0698-8159 | 1 | R:FXD FLM 800K OHM 0.1% 1/4W | 28480 | 0698-8159 |
| A4R14 | 0698-8141 | 1 | R:FXD MET FLM 1.6 MEGOHM 0.1% 1/2W | 28480 | 0698-8141 |
| A4R15 | 0698-8142 | 2 | R:FXD MET FLM 4 MEGOHM 0.25% 1/2W | 28480 | 0698-8142 |
| A4R16 | 0698-8142 | | R:FXD MET FLM 4 MEGOHM 0.25% 1/2W | 28480 | 0698-8142 |
| A4S1 | | | CONSISTS OF MP12, MP14, MP15 AND | | |
| A4S1 | | | CONTACT TRACES ON A4. | | |
| A5 | 01824-66505 | 1 | ASSY:MAINFRAME CONNECTOR | 28480 | 01824-66505 |
| A5C1 | 0160-3451 | | C:FXD CER 0.01 UF +80-20% 100VDCW | 56289 | C0238101F1G32525-COH |
| A5J1 | 1251-0136 | 1 | CONNECTOR:32 P.N MALE | 02660 | 26-4100-32P |
| A5P1 | 1251-0477 | | CONNECTOR:PC 12 FORK TYPE CONTACT | 95354 | 91-6912-1700-00 |
| A5R1 | 0687-3951 | 1 | R:FXD COMP 3.9 MEGOHM 10% 1/2W | 01121 | EB 3951 |
| A5R2 | 0698-3153 | | R:FXD MET FLM 3.83K OHM 1% 1/8W | 28480 | 0698-3153 |
| A5R3 | 0698-3460 | 1 | R:FXD MET FLM 422K OHM 1% 1/8W | 28480 | 0698-3460 |
| A5R4 | 0684-1011 | | R:FXD COMP 100 OHM 10% 1/4W | 01121 | CB 1011 |

Table 6-3. List of Manufacturers' Codes

| MFR NO. | MANUFACTURER NAME | ADDRESS | ZIP CODE |
|---|---|---|---|
| | NO MFR DESCRIPTION FOR THIS MFG NUMBER | | |
| 00779 | AMP INC.(AIRCRAFT MARINE PROD.) | HARRISBURG, PA. | 17101 |
| 01121 | ALLEN BRADLEY CO. | MILWAUKEE, WIS. | 53204 |
| 01295 | TEXAS INSTRUMENTS INC. SEMICONDUCTOR COMPONENTS DIV. | DALLAS, TEX. | 75231 |
| 02114 | FERROXCUBE CORP. | SAUGERTIES, N.Y. | 12477 |
| 02660 | AMPHENOL CORP. | BROADVIEW, ILL. | 60153 |
| 04713 | MOTOROLA SEMICONDUCTOR PROD.INC. | PHOENIX, ARIZ. | 85008 |
| 07263 | FAIRCHILD CAMERA & INST. CORP. SEMICONDUCTOR DIV. | MOUNTAIN VIEW, CALIF. | 94040 |
| 14655 | CORNELL DUBLIER ELECT. DIV.FEDERAL PACIFIC ELECT. CO. | NEWARK, N.J. | 07105 |
| 24931 | SPECIALTY CONNECTOR CO. INC. | INDIANAPOLIS, IND. | 46227 |
| 28480 | HEWLETT-PACKARD COMPANY | PALO ALTO, CALIF. | 94304 |
| 56289 | SPRAGUE ELECTRIC CO. | N. ADAMS, MASS. | 01247 |
| 71590 | GLOBE UNION INC. CENTRALAB DIV. | MILWAUKEE, WISC. | 53201 |
| 72136 | ELECTRO MOTIVE MFG. CO. INC. | WILLIMANTIC, CONN. | 06226 |
| 73982 | ERIE TECHNOLOGICAL PROD. INC. | ERIE, PA. | 16512 |
| 74970 | JOHNSON E.F. CO. | WASECA, MINN. | 56093 |
| 75136 | WALDES KOHINOOR INC. | LONG IS. CITY, N.Y. | 11101 |
| 80131 | ELECTRONIC INDUSTRIES ASSOCIATION | WASHINGTON D.C. | 20006 |
| 84411 | TRW CAPACITOR DIV. | OGALLALA, NEBR. | 69153 |
| 95354 | METHODE MFG. CO. | ROLLING MEADOWS, ILL. | 60008 |
| 98291 | SEALECTRO CORP. | MAMARONECK, N.Y. | 10544 |
| 99800 | DELEVAN ELECTRONICS CORP. | E. AURORA, N.Y. | 14052 |

# SECTION VII

# MANUAL CHANGES

## 7-1. INTRODUCTION.

7-2. This section contains information required to backdate or update this manual for a specific instrument.

## 7-3. MANUAL CHANGES.

7-4. This manual applies directly to the instrument having a serial prefix as shown on the manual title page. If the serial prefix of the instrument is not the same as the one on the title page, refer to Table 7-1 for changes necessary to backdate the manual to the instrument. When making changes from Table 7-1, make the change with the highest number first. If the serial prefix of the instrument is not listed either in the title page or in Table 7-1, refer to an enclosed MANUAL CHANGES sheet for updating information. Also, if a MANUAL CHANGES sheet is supplied, make all indicated ERRATA corrections.

Table 7-1. Manual Changes

| Serial Prefix | Make Changes |
|---|---|
| 1221A | 3 |
| 1212A | 3 and 2 |
| 1209A | 3 thru 1 |

### CHANGE 1

Table 6-2,
- A1: Change HP Part No. and Mfr Part No. to 01820-66505.
- A1C13: Change to HP Part No. 0160-2257, C: FXD CER 10 PF 5% 500 VDCW, Mfr Code 72982, Mfr Part No. 301-000-C0G-100J.
- A1Q2: Change to HP Part No. 1853-0036, TSTR: SI PNP, Mfr Code 80131, Mfr Part No. 2N3906.
- A1R8: Change to HP Part No. 0684-1011, R: FXD COMP 100 OHM 10% 1/4W, Mfr Code 01121, Mfr Part No. CB 1011.
- A1R19, A1R31: Change to HP Part No. 0757-0388, R: FXD FLM 30.1 OHM 1% 1/8W, Mfr Code 28480, Mfr Part No. 0757-0388.
- A1Z1, A1Z2: Change to HP Part No. 9100-3332, COIL: FXD SPECIAL, Mfr Code 28480, Mfr Part No. 9100-3332.

Delete: A1L2.

A4C3: Change to HP Part No. 0140-0146, C: FXD MICA 82 PF 5% 300 VDCW, Mfr Code 14655, Mfr Part No. RDM15E820J3S.

Schematic 1,
- Delete A1L2. Connect collector of A1Q2 directly to ground.
- A1R8: Change value to 100.
- A1R19, A1R31: Change value to 30.1.

Schematic 2,
- A1C13: Change value to 10.

Schematic 3,
- A4C3: Change value to 82.

### CHANGE 2

Table 6-2,
- A1Q12: Change to HP Part No. 1854-0215, TSTR: SI NPN, Mfr Code 80131, Mfr Part No. 2N3904.
- Add: A1R68, HP Part No. 0684-6831, R: FXD COMP 68K OHM 10% 1/4W, Mfr Code 01121, Mfr Part No. CB 6831.
- A1R69: Change to HP Part No. 0757-0273, R: FXD MET FLM 3010 OHM 1% 1/8W, Mfr Code 28480, Mfr Part No. 0757-0273.

Schematic 2,
- A1R69: Change value to 3010.
- Add: A1R68 (68K) from −12.6V supply to junction of A1R69/W7.

### CHANGE 3

Table 6-2,
- A3: Change HP Part No. and Mfr Part No. to 01824-66506.
- A5: Change HP Part No. and Mfr Part No. to 01824-66505.
- W5: Change HP Part No. and Mfr Part No. to 01824-61611.

Schematic 5,
- Delete: Connections from A3J1-11 and A3J1-12.
- Label: Connections 115 VAC from A3J1-1 and A3J1-13.

Schematic 6,
- Delete: Connections from A5P1-26 and A5P1-32.
- Label: Connections 115 VAC from A5P1-10 and A5P1-16.

# SECTION VIII

# SCHEMATICS AND TROUBLESHOOTING

## 8-1. INTRODUCTION.

8-2. This section contains schematics, repair and replacement information, component-identification illustrations, waveforms, test conditions, troubleshooting procedures and a troubleshooting block diagram. Table 8-1 defines symbols and conventions used in the schematics.

## 8-3. SCHEMATICS.

8-4. Schematics are printed on foldout pages for easy reference to the text and illustrations 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.

8-5. The schematics are numbered in sequence with a bold number in a box at the lower right-hand corner of each schematic. These numbers are used to cross reference connections between 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 which contains the source or destination of the signal. To find the source or destination of a signal, turn to the indicated schematic and find the circled number in question. The name of the circuit or signal identified by the circled numbers can be found in the table to the left of the schematic. As an aid to signal tracing, the circled numbers are also used to identify troubleshooting paths on the troubleshooting block diagram. No matter where it is found in this section, a particular circled number always identifies the same signal or circuit.

8-6. A table on each schematic lists all components shown on the schematic by reference designations.

8-7. All components within the shaded area of a schematic are physically located on etched circuit boards. Components not physically located on an etched circuit board are shown in the unshaded 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 number. This letter-number combination is the basic reference designation. Components which are not part of an assembly have only the basic reference designation. Components which are part of an assembly have, in addition to the basic reference designation, a prefix designation indicating the assembly of which the component is a part. For instance, resistor R23 on assembly A1 is called A1R23 and resistor R23 on assembly A3 is called A3R23.

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

## 8-12. COMPONENT LOCATIONS.

8-13. Locations of components on assemblies and subassemblies are illustrated in photographs adjacent to the schematics. Components located on the chassis are identified in figure 8-2.

## 8-14. REPAIR AND REPLACEMENT.

8-15. The following paragraphs provide procedures for removal and replacement of assemblies, subassemblies, and components. Special servicing instructions for the printed circuit boards are covered in paragraph 8-25. Section VI provides detailed parts list for use in ordering replacement parts.

### 8-16. SEMICONDUCTOR REPLACEMENT.

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

### 8-18. BOARD CONNECTIONS.

8-19. Soldered connections are identified on circuit boards by the color code of the connecting wire. Connector pins on plugs and jacks are identified by a numeral or a letter. The letters G, I, O, and Q have been omitted. Table 8-1 shows the types of board connections used in the instrument.

### 8-20. BOARD REMOVAL.

8-21. Boards A1, A2, A3, and A5 can be taken out by removing mounting screws, disconnecting jacks and

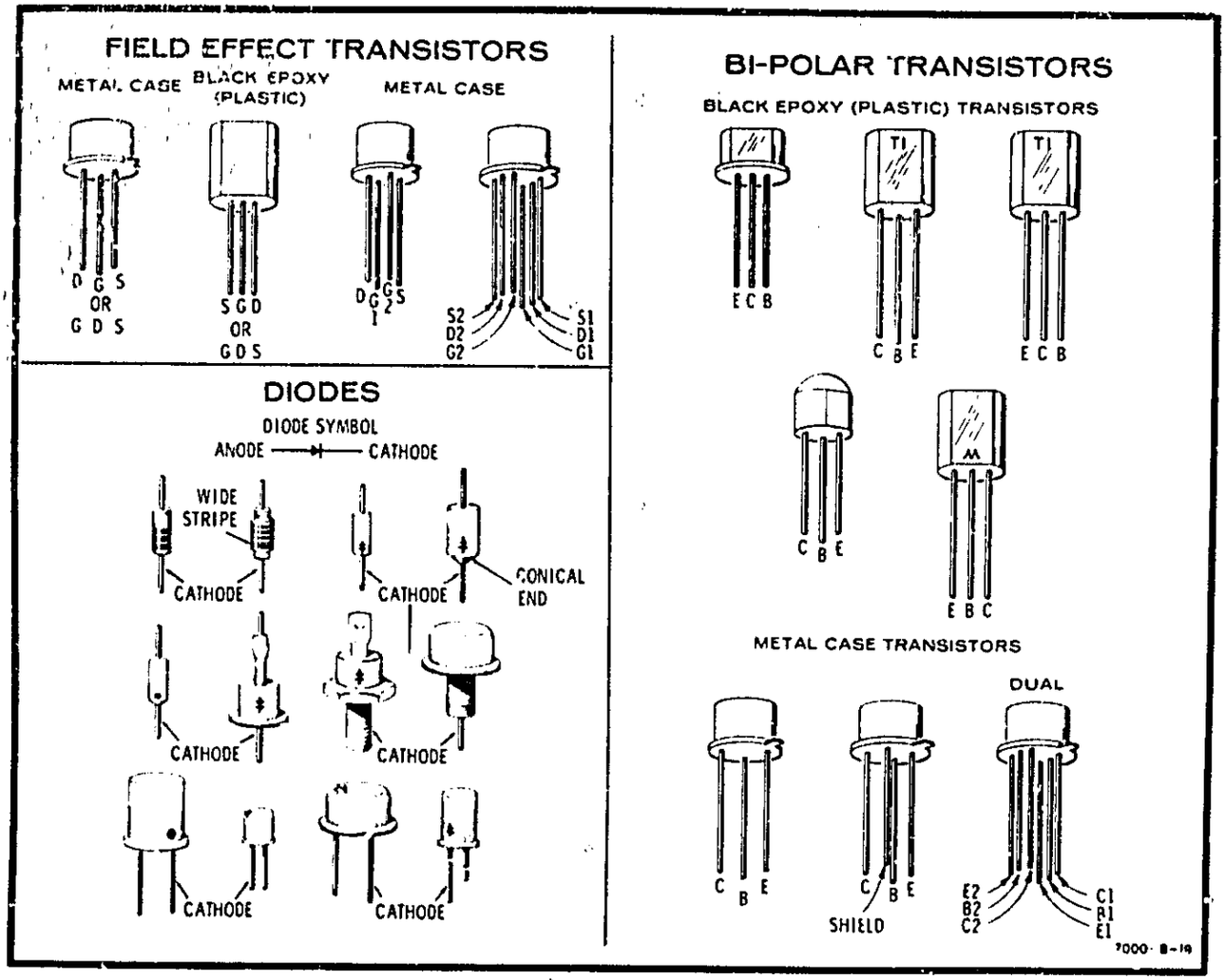



Figure 8-1. Semiconductor Terminal Identification

square pin connectors, and in some cases, unsoldering connecting wires. Before disconnecting any wires, write down wire color codes and note position of wires on the boards.

CAUTION

Miswiring during reassembly can result in damage to instrument components.

8-22. Board A4 can be removed only after removal of the TIME/DIV switch.

8-23. To remove the TIME/DIV switch, proceed as follows:

a. Remove keeper from shaft at rear of front panel.

b. Set TIME/DIV to 0.05 usec.

c. Note position of A4S1.

d. Pull outward on TIME/DIV knob to remove shaft.

e. A4 can now be removed by pulling upward.

8-24. To reinstall the TIME/DIV shaft:

a. Ensure that A4S1 is set in position noted in paragraph 8-23 step c.

b. Insert shaft through front panel and A4S1.

c. Reinstall keeper on shaft.

### 8-25. SERVICING PRINTED CIRCUIT BOARDS.

8-26. This instrument uses printed circuit boards with plated-through component holes. This allows components to be removed or replaced by unsoldering or soldering from either side of the board. When removing large components, such as potentiometers, rotate the soldering iron tip from lead to lead while applying pressure to the part to lift it from the board. HP Service Note M-20E contains additional information on repairs of printed circuit boards.

### 8-27. SWITCH MAINTENANCE.

8-28. Switches A3S1 and A4S1 can be serviced after removal of TIME/DIV switch shaft (paragraph 8-23).

8-29. To disassemble the switch, remove retainer ring (MP12); then the two rotor sections can be separated from the printed circuit board. If the contact areas of the printed circuit board or the two rotors show excessive wear, replace worn parts. For cleaning, spray with a degreaser comparable to MS-180 FREON TF DEGREASER produced by Miller-Stephenson Chemical Co., Inc., and lightly lubricate the contact areas of the printed circuit boards and rotor sections. Lubricate contact areas with a lubricant comparable to LUBRIPLATE FML produced by Fiske Brothers Refining Company, LUBRIPLATE FML is available from Hewlett-Packard. Order HP Part No. 6040-0305.

### 8-30. INTEGRATED CIRCUIT REPLACEMENT.

8-31. The IC (integrated circuits) in this instrument are of two general configurations, plug-in types and those soldered in place. Remove a plug-in IC with a straight pull away from the board. Soldered IC units may be removed with soldering irons which simultaneously heat all connections (available from various manufacturers). Soldering irons with built-in desoldering tools also facilitate quick removal.

CAUTION

Unless an IC has definitely failed, be careful to prevent damage when removing or replacing it.

8-32. Use the following procedure for removing an IC with a standard soldering iron.

a. Heat IC lead solder joint. Use soldering iron with small pencil tip (e.g. Weller No. PT-H7).

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

c. Repeat steps a and b for each IC 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 IC. Dual-in-line type may be removed by gently gripping top and bottom with long-nosed pliers and rolling IC out.

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

g. Insert replacement IC into circuit board and solder it in place.

CAUTION

Be careful not to damage the IC by heat from the soldering iron. Work quickly.

8-33. When replacing an IC, note the mark or notch used for orientation. The component identification photos and the IC pin-location diagrams of this manual show IC orientation.

## 8-34. TROUBLESHOOTING.

8-35. The most important prerequisite for successful troubleshooting is understanding how the instrument is designed to operate and correct use of front-panel controls. Improper control setting or circuit connections can cause apparent malfunctions. Read Section III (Operating Procedure) for an explanation of controls and general operating considerations, and Section IV (Principles of Operation) for an explanation of circuit theory.

8-36 If trouble is suspected, visually inspect the instrument. Look for loose or burned components that might suggest a source of trouble. Check to see that all circuit board connections are making good contact and are not shorting to an adjacent circuit. If no obvious trouble is found, check the power supply voltages from the mainframe. Ensure that auxiliary equipment being used is operating properly.

### 8-37. DC VOLTAGES AND WAVEFORMS.

8-38. All numbered points on the troubleshooting block diagram and corresponding points on the schematics show dc voltages and, if appropriate, waveforms. Table 8-3, adjacent to the block diagram, provides the location of the measurement point and conditions under which the

measurement must be made. Since the conditions for making these measurements differ from one circuit to another, always check the specific condition for a particular measurement.

### 8-39. CHECKING DC VOLTAGES.

8-40. DC voltage troubles, especially shorts, can be difficult to trace because of the large number of stages supplied by a particular dc voltage source. Schematic 4 has been included to make troubleshooting of this type easier by providing complete dc voltage distribution on a single schematic.

### 8-41. CIRCUIT CHECKING.

8-42. The troubleshooting block diagram (figure 8-4) has been provided to enable rapid isolation of a malfunction to a particular circuit group. This is accomplished by making indicated measurements until a block is found whose inputs are normal but whose outputs are abnormal. Once this point is reached, the numbered input and output points are located on the appropriate schematic and progressive troubleshooting techniques (waveform analysis, voltage measurement, resistance measurement, substitution) are employed between the two points to isolate the malfunction to a particular component(s).

8-43. To use the troubleshooting block diagram, proceed as follows:

a. Install Model 1820C as instructed in Section II and perform initial turn-on (as far as malfunction will permit) as instructed in Section III.

b. Make all measurements possible on mother board or directly on leads of components.

c. Ensure that auxiliary equipment is operating properly.

d. Ensure that all power supply voltages are present and within tolerance.

e. Determine effect of all operating controls on output. This will enable logical selection of most direct troubleshooting path to malfunction. Of course, if all else fails, inputs and outputs of each block can be tested to find malfunctioning block.

f. After locating desired measurement point on block diagram, refer to corresponding number on adjacent table 8-3. Table 8-3 provides physical location of measurement and test condition for making indicated measurement. Chassis parts locations are shown in figure 8-2. PC board component locators are adjacent to schematics.

g. Set up Model 1820C and test equipment as shown in figure 8-3.

h. Make measurement and compare waveform or voltage on block diagram.

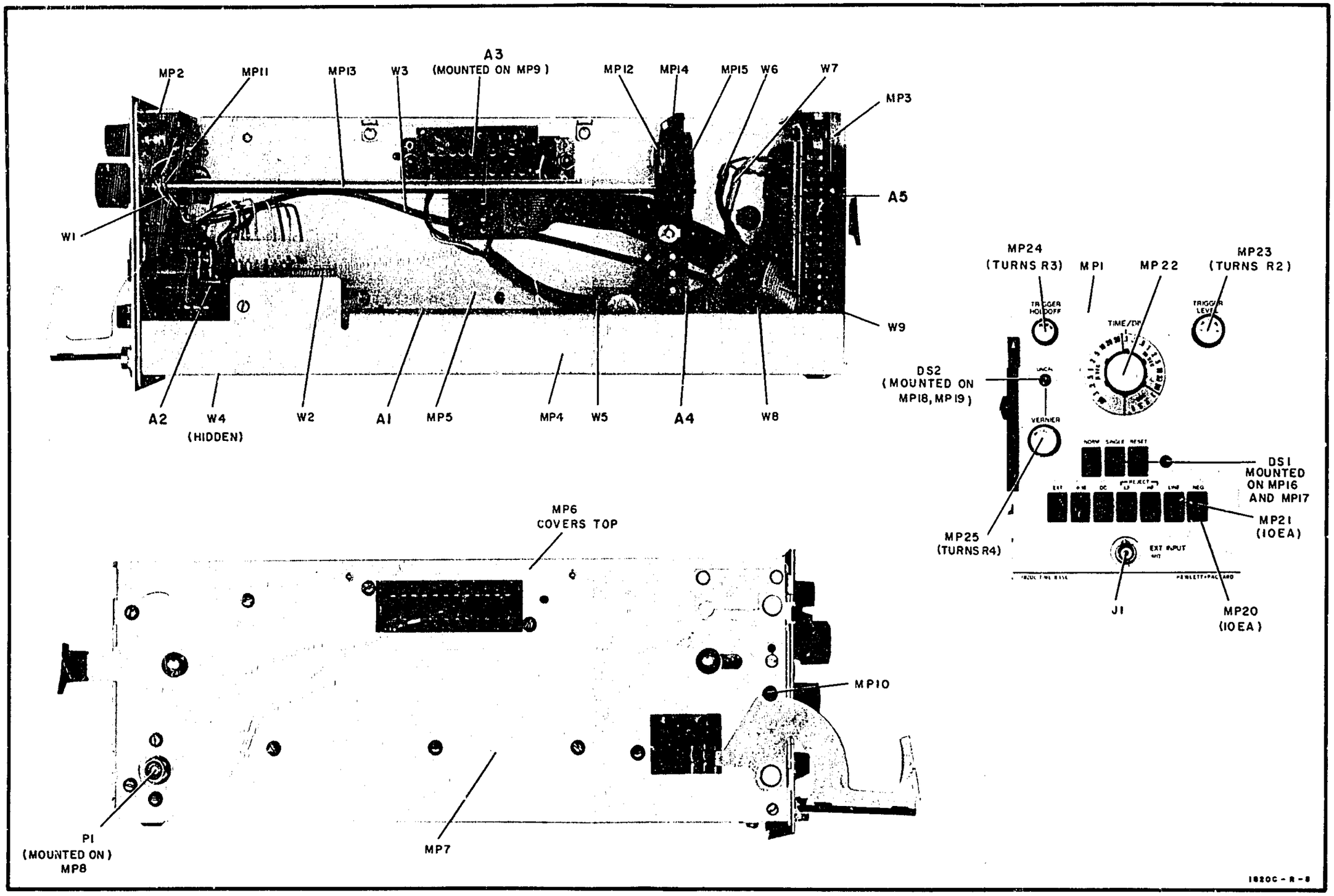



Figure 8-2.
Chassis Parts Locator

## Table 8-1. Schematic Notes

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

= Etched circuit board

= Front-panel marking

= Rear-panel marking

= Front-panel control

= Screwdriver adjustment

P/O = Part of

CW = Clockwise end of variable resistor

NC = No connection

3 = Waveform test point (with number)

A = Common electrical point (with letter) not necessarily ground

= Single-pin connector on board

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

= Coaxial cable connected to snap-on jack

= Coaxial cable connected directly to board

= Wire connected to pressure-fit socket on board

= Main signal path

= Primary feedback path

= Secondary feedback path

G D S = Field-effect transistor (P-type base)

G D S = Field-effect transistor (N-type base)

= Breakdown diode (voltage regulator)

= Tunnel diode

= Step-recovery diode

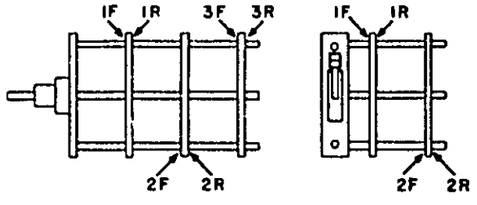
= Circuits or components drawn with dashed lines (phantom) show function only and are not intended to be complete. The circuit or component is shown in detail on another schematic.

(925) = Wire colors are given by numbers in parentheses using the resistor color code

[ (925) is wht-red-grn ]

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

Switch wafers are identified as follows:




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

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

## Table 8-2. Troubleshooting Test Conditions

**TEST CONDITION A**

Connect equipment as shown in Figure 8-3.

Set Model 1820C controls as follows:

TIME/DIV ..... 0.2 mSEC
TRIGGER HOLDOFF ..... detent
TRIGGER LEVEL ..... as required
VERNIER ..... detent
INT/EXT ..... EXT
AC/DC ..... DC
POS/NEG ..... POS

All pushbuttons not mentioned above must be out (blue showing).

**TEST CONDITION B**

Same as A except INT/EXT to INT.

**TEST CONDITION C**

Same as A except LINE depressed.

**TEST CONDITION D**

Same as A except HF depressed.

**TEST CONDITION E**

Same as A except rotate TRIGGER LEVEL cw then ccw.

**TEST CONDITION F**

Same as A except check in both positions of POS/NEG.

**TEST CONDITION G**

Same as A except SINGLE depressed.

**TEST CONDITION H**

Same as A except rotate TRIGGER HOLDOFF ccw then ccw.

**TEST CONDITION I**

Same as A except adjust TRIGGER LEVEL for equal voltages on 10 and 11.

**TEST CONDITION J**

Same as A except rotate VERNIER cw then ccw.

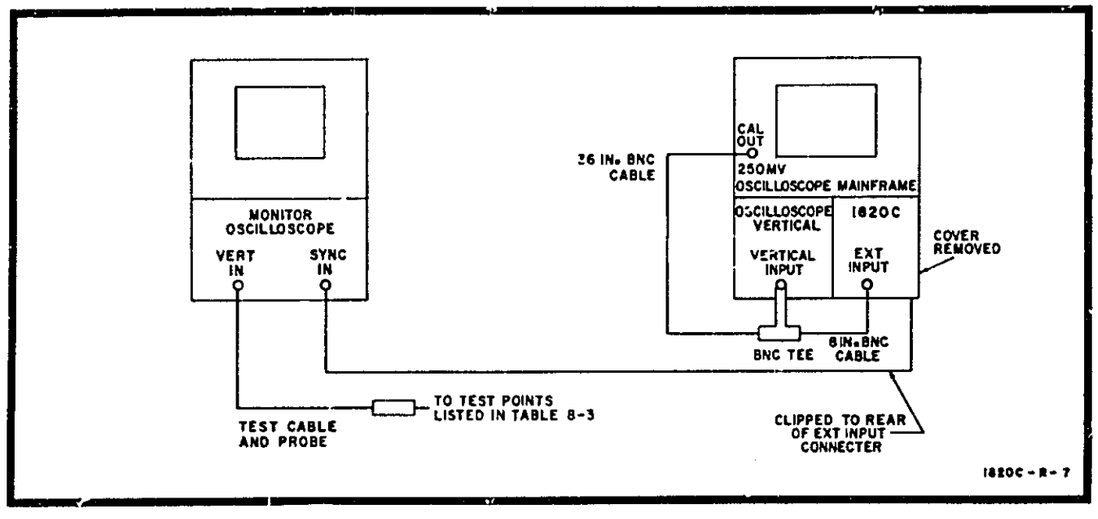



Figure 8-3. Troubleshooting Test Setup

Table 8-3. Test Identification

| No. | Signal Name | Test Point | Test Condition |
|---|---|---|---|
| 1 | External Trigger | Rear of J1 | A |
| 2 | Internal Trigger | W3 | B |
| 3 | Line Trigger | W4 | C |
| 4 | Trigger input, HF impedance converter | Junction A1R8/A1C2 | A |
| 5 | Trigger input, LF impedance coverter | A2U1, pin 2 | A |
| 6 | Trigger level voltage | R2, orange wire | E |
| 7 | Trigger output, HF impedance converter | A1TP1 | A |
| 8 | Trigger output, LF impedance converter | A1TP2 | A |
| 9 | Polarity switch input | Emitter, A1Q3 | F |
| 10 | Polarity switch input | Emitter, A1Q6 | F |
| 11 | Polarity switch output | Collector, A1Q3 | I |
| 12 | Polarity switch output | Collector, A1Q6 | I |
| 13 | Polarity switch control voltage | Base, A1Q3 | F |
| 14 | Polarity switch control voltage | Base, A1Q6 | F |
| 15 | Trigger amplifier positive output | A1U2, pin 9 | A |
| 16 | Trigger amplifier negative output | A1U2, pin 2 | A |
| 17 | Single sweep control voltage | Junction, A1R44/ A1CR6 | G |
| 18 | Trigger enable control voltage | A1TP5 | A |
| 19 | Free-run enable voltage | Base, A1Q12 | A |
| 20 | Dual Schmitt output | A1TP3 | A |
| 21 | Free-run trigger | Base, A1Q14 | A |
| 22 | Rear panel gate output | W6 | A |
| 23 | Mainframe gate output | W7 | A |
| 24 | Integrator control signal | A1TP6 | A |
| 25 | Feedback ramp | A1TP7 | A |
| 26 | Holdoff ramp | Collector, A1Q10 | A |
| 27 | Holdoff control voltage | R3, yellow wire | H |
| 28 | Vernier control voltage | R4, blue wire | J |
| 29 | Ramp output | W8 | A |

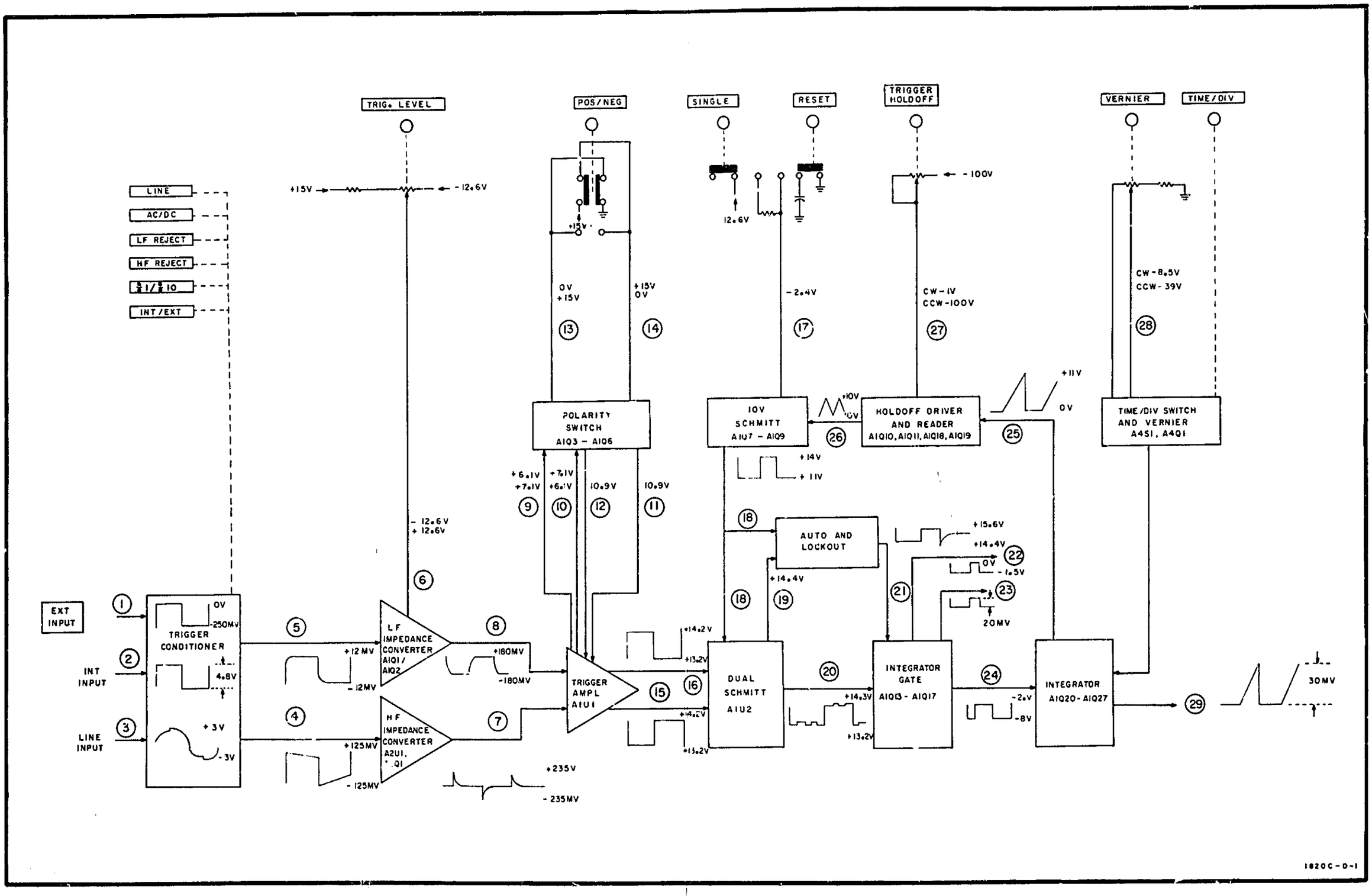
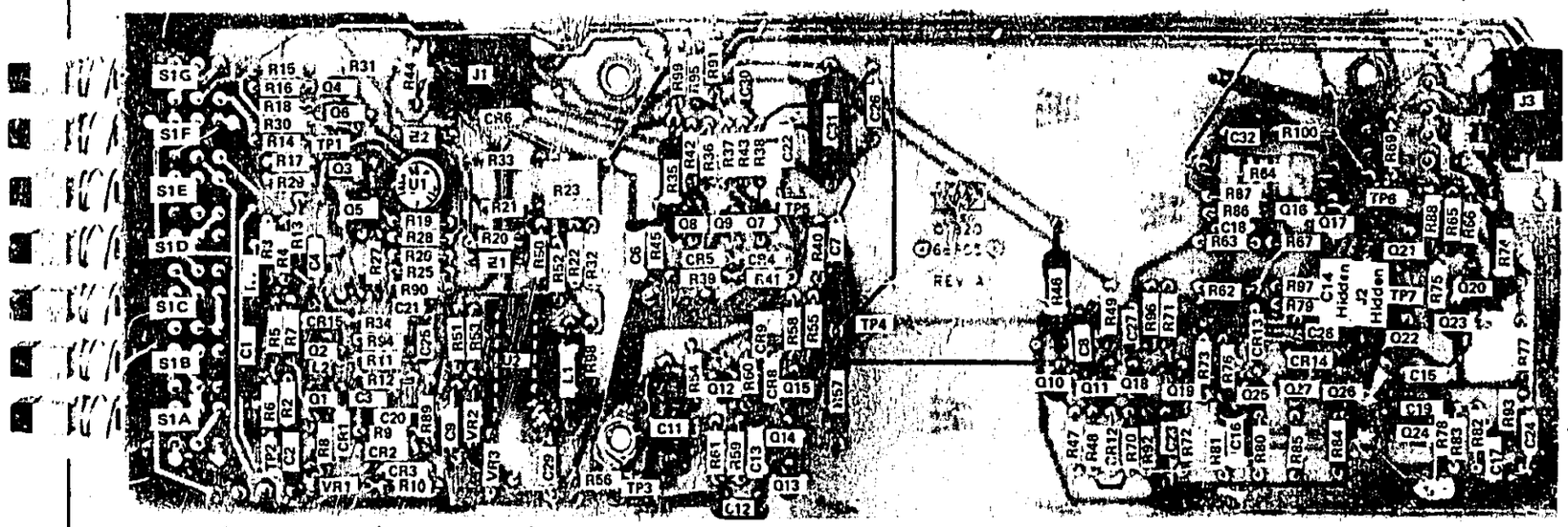



Figure 8-4.
Troubleshooting Block Diagram




A I

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

| REF DESIG | GRID LOC | REF DESIG | GRID LOC | REF DESIG | GRID LOC | REF DESIG | GRID LOC | REF DESIG | GRID LOC | REF DESIG | GRID LOC | REF DESIG | GRID LOC | REF DESIG | GRID LOC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C1 | D-4 | C27 | I-4 | Q3 | D-3 | C27 | J-4 | R25 | E-3 | R49 | I-4 | R73 | J-4 | R97 | J-4 |
| C2 | D-5 | C28 | K-4 | Q4 | D-2 | R1 | D-4 | R26 | E-3 | R50 | F-3 | R74 | L-3 | R98 | F-4 |
| C3 | D-4 | C29 | F-5 | Q5 | D-3 | R2 | D-4 | R27 | D-3 | R51 | E-4 | R75 | K-4 | R99 | F-2 |
| C4 | D-3 | C30 | G-2 | Q6 | D-2 | R3 | D-4 | R28 | E-3 | R52 | F-3 | R76 | J-4 | R100 | J-3 |
| C6 | F-3 | C31 | J-3 | Q7 | G-3 | R4 | D-4 | R29 | D-3 | R53 | F-4 | R77 | L-4 | S1A | C-4 |
| C7 | G-3 | CR1 | D-5 | Q8 | G-3 | R5 | D-4 | R30 | D-3 | R54 | G-4 | R78 | K-5 | S1B | C-4 |
| C8 | I-4 | CR2 | E-5 | Q9 | G-3 | R6 | D-4 | R31 | D-2 | R55 | G-4 | R79 | J-4 | S1C | C-4 |
| C9 | E-4 | CR3 | E-5 | Q10 | I-4 | R7 | D-4 | R32 | F-3 | R56 | F-5 | R80 | J-5 | S1D | C-3 |
| C11 | F-4 | CR4 | G-3 | Q11 | I-4 | R8 | D-5 | R33 | E-3 | R57 | H-4 | R81 | J-5 | S1E | C-3 |
| C12 | G-5 | CR5 | G-3 | Q12 | G-4 | R9 | D-5 | R34 | D-4 | R58 | G-4 | R82 | L-5 | S1F | C-3 |
| C13 | G-5 | CR6 | E-3 | Q13 | G-5 | R10 | E-5 | R35 | F-3 | R59 | G-5 | R83 | K-5 | S1G | C-2 |
| C14 | K-4 | CR8 | G-4 | Q14 | G-5 | R11 | D-4 | R36 | G-3 | R60 | G-4 | R84 | K-5 | U1 | E-3 |
| C15 | K-4 | CR9 | G-4 | Q15 | J-4 | R12 | D-4 | R37 | G-3 | R61 | G-5 | R85 | J-5 | U2 | E-4 |
| C16 | J-5 | CR12 | I-5 | Q16 | J-3 | R13 | D-3 | R38 | G-3 | R62 | J-4 | R86 | I-3 | VR1 | D-5 |
| C17 | L-5 | CR13 | J-4 | Q17 | K-3 | R14 | D-3 | R39 | G-4 | R63 | J-3 | R87 | J-3 | VR2 | E-4 |
| C18 | J-3 | CR14 | K-4 | Q18 | I-4 | R15 | D-2 | R40 | G-3 | R64 | J-3 | R88 | K-3 | VR3 | E-5 |
| C19 | K-4 | CR15 | D-4 | Q19 | J-4 | R16 | D-2 | R41 | G-4 | R65 | K-3 | R89 | E-4 | Z1 | E-3 |
| C20 | E-4 | J1 | E-2 | Q20 | L-4 | R17 | D-3 | R42 | G-3 | R66 | L-3 | R90 | E-4 | Z2 | E-3 |
| C21 | E-4 | J2 | K-4 | Q21 | K-3 | R18 | D-2 | R43 | G-3 | R67 | J-3 | R91 | G-2 | TP1 | D-3 |
| C22 | G-3 | J3 | L-1 | Q22 | K-4 | R19 | E-3 | R44 | E-2 | | | R92 | I-5 | TP2 | D-5 |
| C23 | J-4 | L1 | F-4 | Q23 | K-4 | R20 | E-3 | R45 | F-3 | R69 | K-3 | R93 | L-4 | TP3 | F-5 |
| C24 | L-4 | L2 | D-4 | Q24 | K-5 | R21 | E-3 | R46 | I-4 | R70 | I-5 | R94 | D-4 | TP4 | H-4 |
| C25 | E-4 | Q1 | D-4 | Q25 | J-4 | R22 | F-3 | R47 | I-5 | R71 | J-4 | R95 | G-2 | TP5 | G-3 |
| C26 | H-2 | Q2 | D-4 | Q26 | K-4 | R23 | F-3 | R48 | I-5 | R72 | J-5 | R96 | I-4 | TP6 | K-3 |
| | | | | | | | | | | | | | | TP7 | K-4 |

Figure 8-5. AI Components Locator

## VOLTAGE MEASUREMENT CONDITIONS

Remove signal from EXT INPUT (if any).

Set all pushbuttons out (blue band showing).

Set other controls as follows:

TIME/DIV ..... .2 mSEC
TRIGGER HOLDOFF ..... ccw
TRIGGER LEVEL ..... centered
VERNIER ..... cw (detent)

## WAVEFORM MEASUREMENT CONDITIONS

Test condition A (Table 8-2)

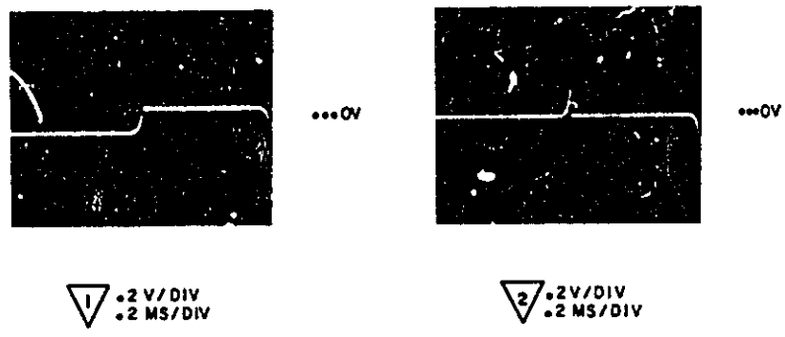
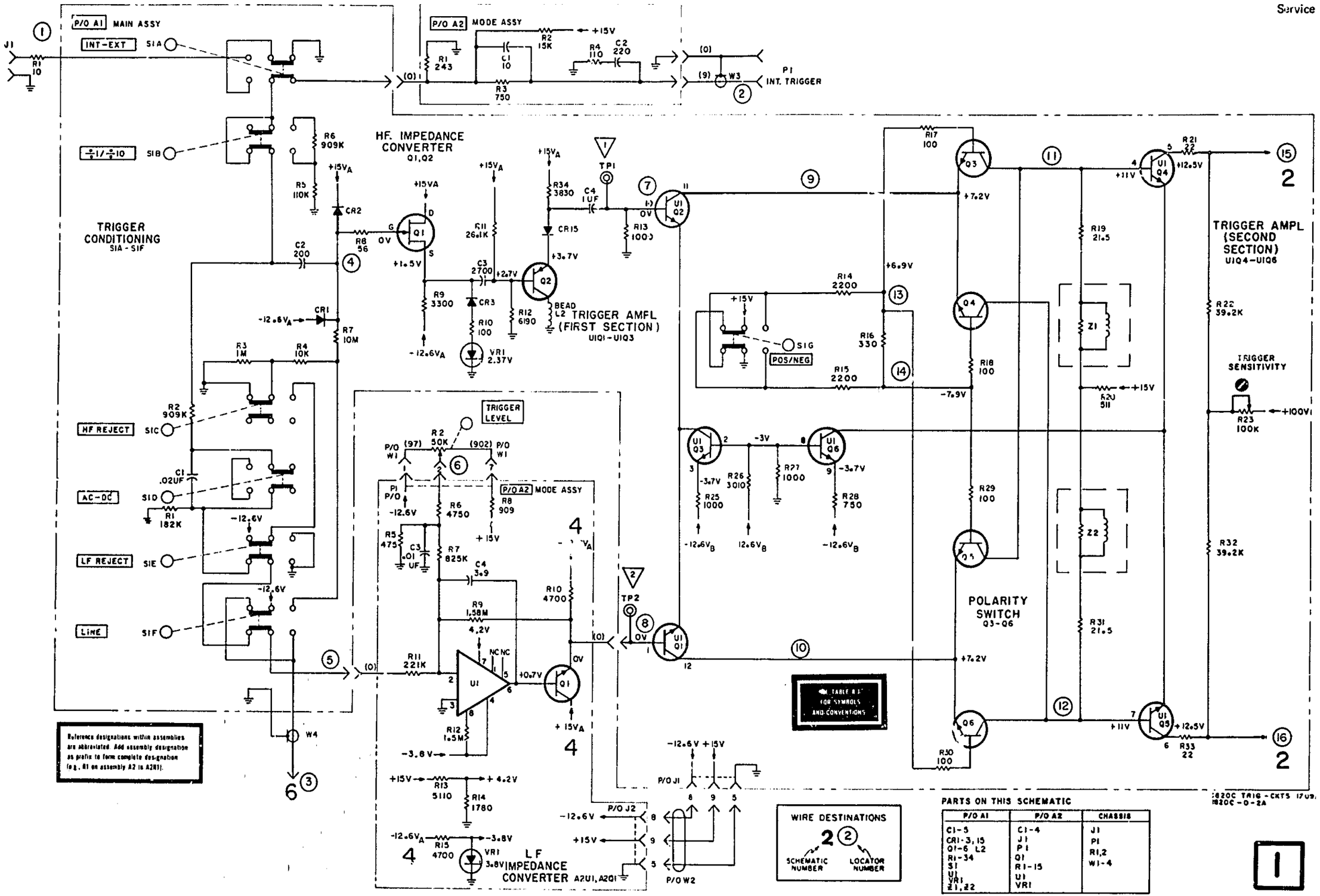



Figure 8-6. Schematic 1 Voltage and Waveform Measurement Conditions

Table 8-4. Schematic 1 Signal Identifier

| No. | Signal Name |
|---|---|
| 1 | External trigger |
| 2 | Internal trigger |
| 3 | Line trigger |
| 4 | Trigger input, HF impedance converter |
| 5 | Trigger input, LF impedance converter |
| 6 | Trigger level voltage |
| 7 | Trigger output, HF impedance converter |
| 8 | Trigger output, LF impedance converter |
| 9 | Polarity switch input |
| 10 | Polarity switch input |
| 11 | Polarity switch output |
| 12 | Polarity switch output |
| 13 | Polarity switch control voltage |
| 14 | Polarity switch control voltage |
| 15 | Trigger amplifier positive output |
| 16 | Trigger amplifier negative output |

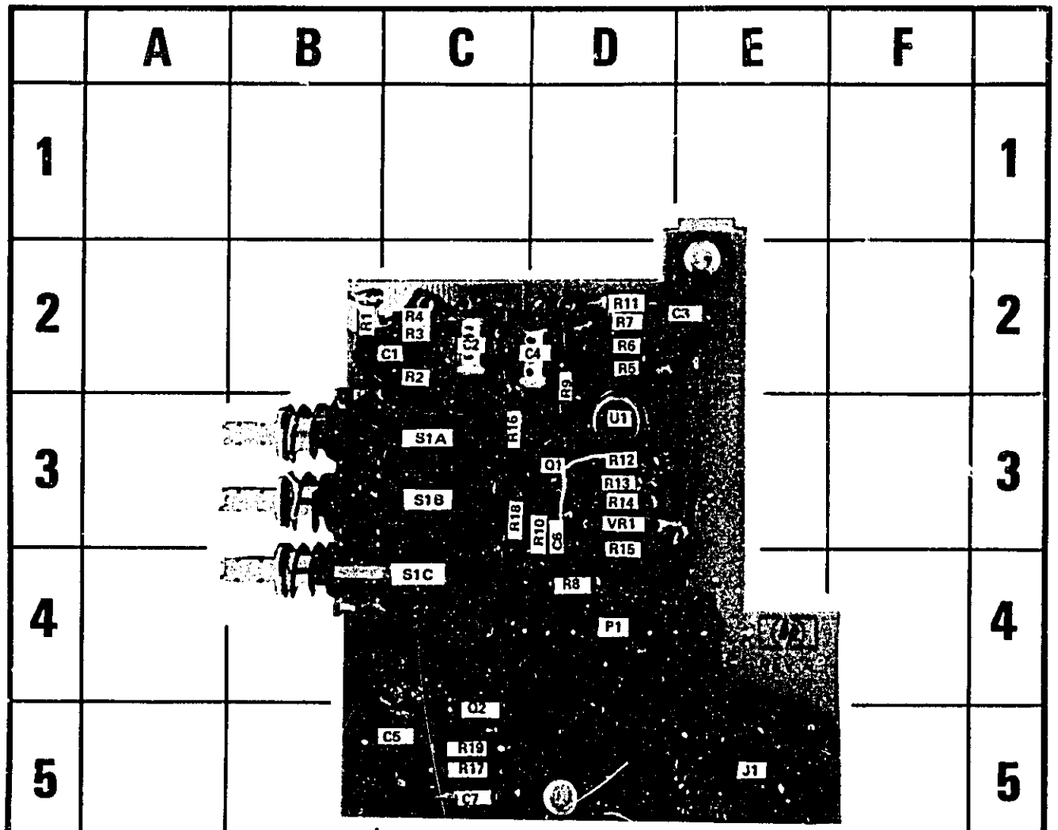



PARTS ON THIS SCHEMATIC

| P/O A1 | P/O A2 | CHASSIS |
|---|---|---|
| C1-5 | C1-4 | J1 |
| CR1-3, 15 | J1 | P1 |
| Q1-6 L2 | P1 | R1,2 |
| R1-34 | Q1 | W1-4 |
| S1 | R1-15 | |
| U1 | U1 | |
| VR1 | VR1 | |
| Z1, Z2 | | |

DELETED A1C5, A1R24

Figure 8-7.
Trigger Circuits Schematic
8-9




| REF DESIG | GRID LOC | REF DESIG | GRID LOC | REF DESIG | GRID LOC |
|---|---|---|---|---|---|
| C1 | C-2 | R2 | C-2 | R14 | D-3 |
| C2 | C-2 | R3 | C-2 | R15 | D-4 |
| C3 | E-2 | R4 | C-2 | R16 | C-3 |
| C4 | D-2 | R5 | D-2 | R17 | C-5 |
| C5 | C-5 | R6 | D-2 | R18 | C-3 |
| C6 | D-4 | R7 | D-2 | R19 | D-5 |
| C7 | C-5 | R8 | D-4 | S1A | C-3 |
| J1 | E-5 | R9 | D-3 | S1B | C-3 |
| P1 | D-4 | R10 | D-3 | S1C | C-4 |
| Q1 | D-3 | R11 | D-2 | U1 | D-3 |
| Q2 | C-5 | R12 | D-3 | VR1 | D-3 |
| R1 | B-2 | R13 | D-3 | | |

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

1820C – R – 11

Figure 8-8. A2 Components Locator

## VOLTAGE MEASUREMENT CONDITIONS

Remove signal from EXT INPUT (if any).

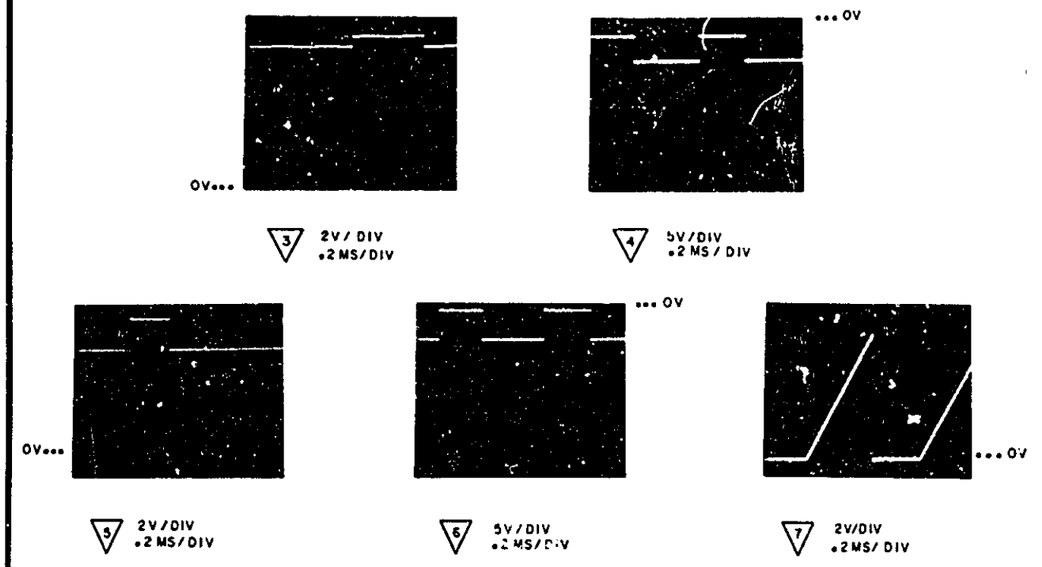
Set all pushbuttons out (blue band showing).

Set other controls as follows:

TIME/DIV ..... .2 mSEC
TRIGGER HOLDOFF ..... ccw
TRIGGER LEVEL ..... centered
VERNIER ..... cw (detent)

## WAVEFORM MEASUREMENT CONDITIONS

Test condition A (Table 8-2)

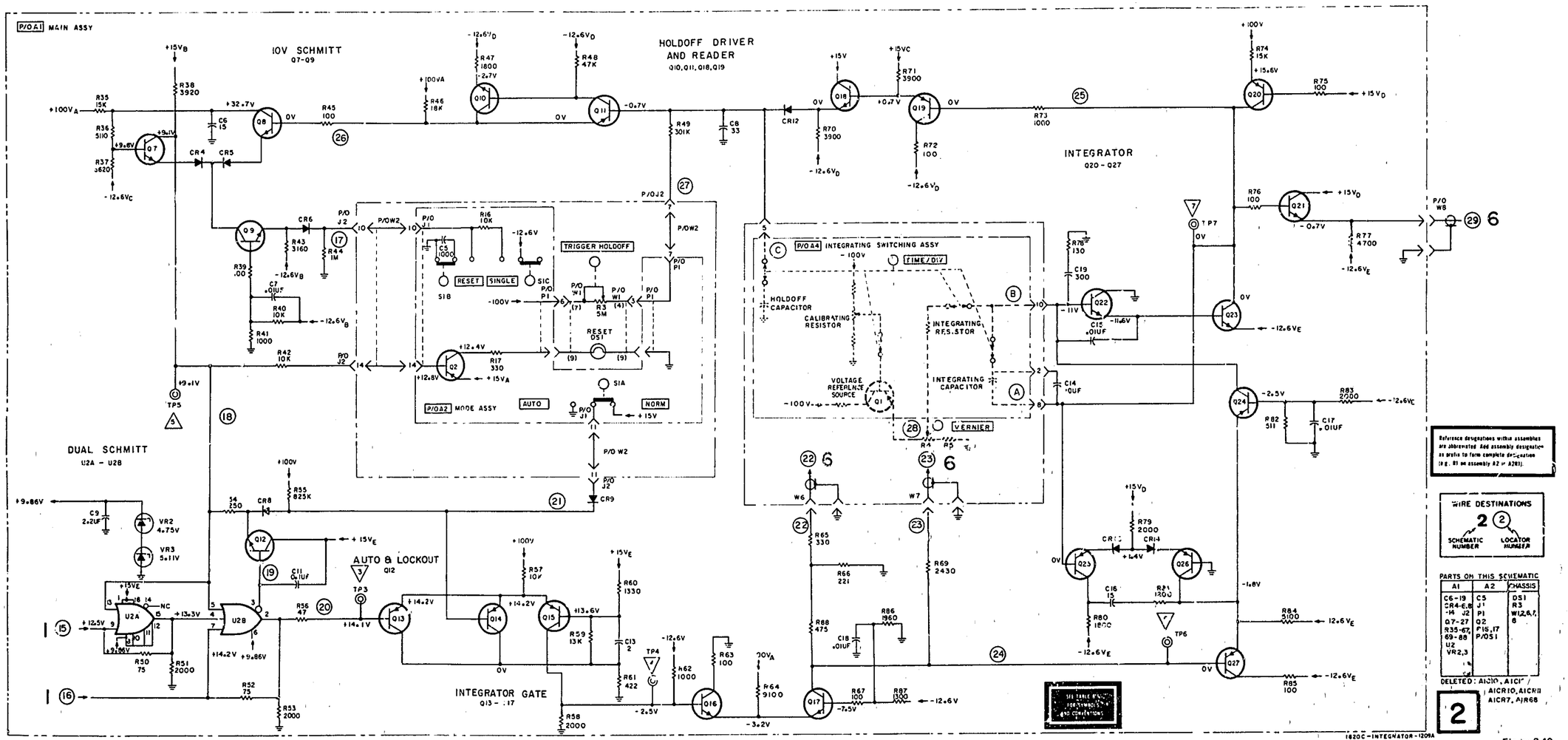



1820C-R-12

Figure 8-9. Schematic 2 Voltage and Waveform Measurement Conditions

Table 8-5. Schematic 2 Signal Identifier

| No | Signal Name |
|---|---|
| 15 | Trigger amplifier positive output |
| 16 | Trigger amplifier negative output |
| 17 | Single sweep control voltage |
| 18 | Trigger enable control voltage |
| 19 | Free-run enable voltage |
| 20 | Dual Schmitt output |
| 21 | Free-run trigger |
| 22 | Rear panel gate output |
| 23 | Mainframe gate output |
| 24 | Integrator control signal |
| 25 | Feedback ramp |
| 26 | Holdoff ramp |
| 27 | Holdoff control voltage |
| 28 | Vernier control voltage |
| 29 | Ramp output |
| A | Integrator to TIME/DIV switch connection (C) |
| B | Integrator to TIME/DIV switch connection (RC) |
| C | Integrator to TIME/DIV switch connection (holdoff C) |




Reference designations within assemblies are abbreviated. Add assembly designation as prefix to form complete designation (e.g., R1 on assembly A2 = A2R1).

WIRE DESTINATIONS

2 (2)

SCHEMATIC NUMBER — LOCATOR NUMBER

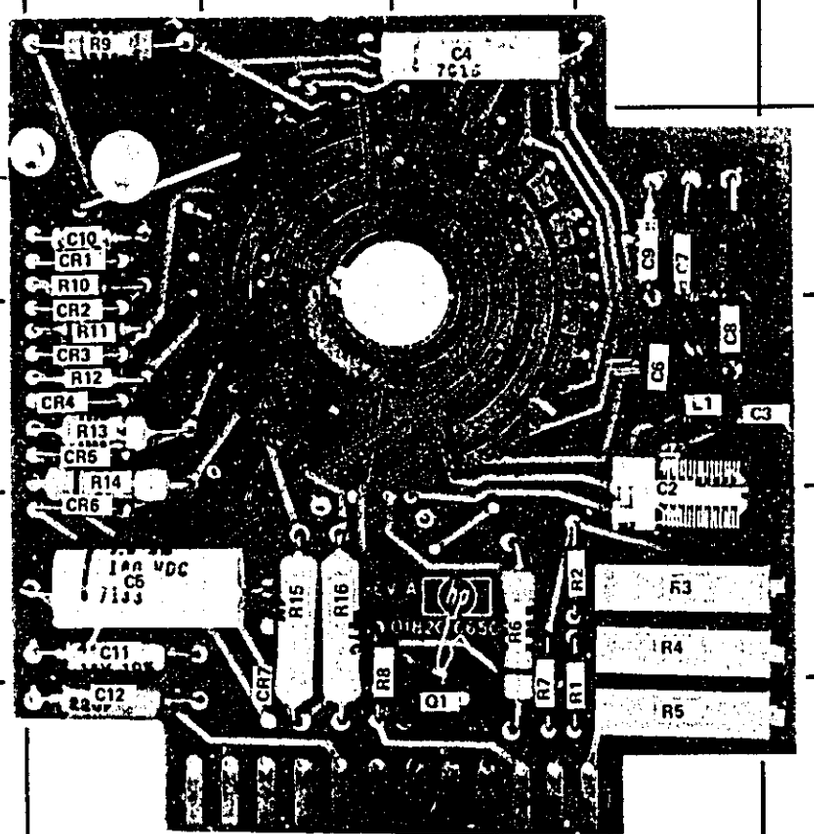
PARTS ON THIS SCHEMATIC

| A1 | A2 | CHASSIS |
|---|---|---|
| C6-19 | C5 | DS1 |
| C84-C86 | J1 | R3 |
| -M -J2 | P1 | W12,6,7, 8 |
| Q7-27 | Q2 | |
| R35-67, 69-88 | P18,17 P/OS1 | |
| U2 | | |
| VR2,3 | | |

DELETED: A1C10, A1C11, A1CR10, A1CR11, A1CR7, A1R68

2

Figure 8-10.
Integrator Schematic
8-11




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

A4

| REF DESIG | GRID LOC | REF DESIG | GRID LOC | REF DESIG | GRID LOC |
|---|---|---|---|---|---|
| C2 | E-4 | CR2 | B-3 | R5 | E-5 |
| C3 | E-3 | CR3 | B-3 | R6 | D-4 |
| C4 | D-1 | CR4 | B-3 | R7 | D-5 |
| C5 | B-4 | CR5 | B-3 | R8 | C-4 |
| C6 | E-3 | CR6 | B-4 | R9 | B-1 |
| C7 | E-2 | CR7 | C-5 | R10 | B-2 |
| C8 | E-3 | L1 | E-3 | R11 | B-3 |
| C9 | E-2 | Q1 | D-5 | R12 | B-3 |
| C10 | B-2 | R1 | D-5 | R13 | B-3 |
| C11 | B-4 | R2 | D-4 | R14 | B-3 |
| C12 | B-5 | R3 | E-4 | R15 | C-4 |
| CR1 | B-2 | R4 | E-4 | R16 | C-4 |

1820C - R - 13

Figure 8-11. A4 Components Locator

Table 8-6. Schematic 3 Signal Identifier

| No | Signal Name |
|---|---|
| 28 | Vernier control voltage |
| A | Integrator to TIME/DIV switch connection (C) |
| B | Integrator to TIME/DIV switch connection (RC) |
| C | Integrator to TIME/DIV switch connection (holdoff C) |

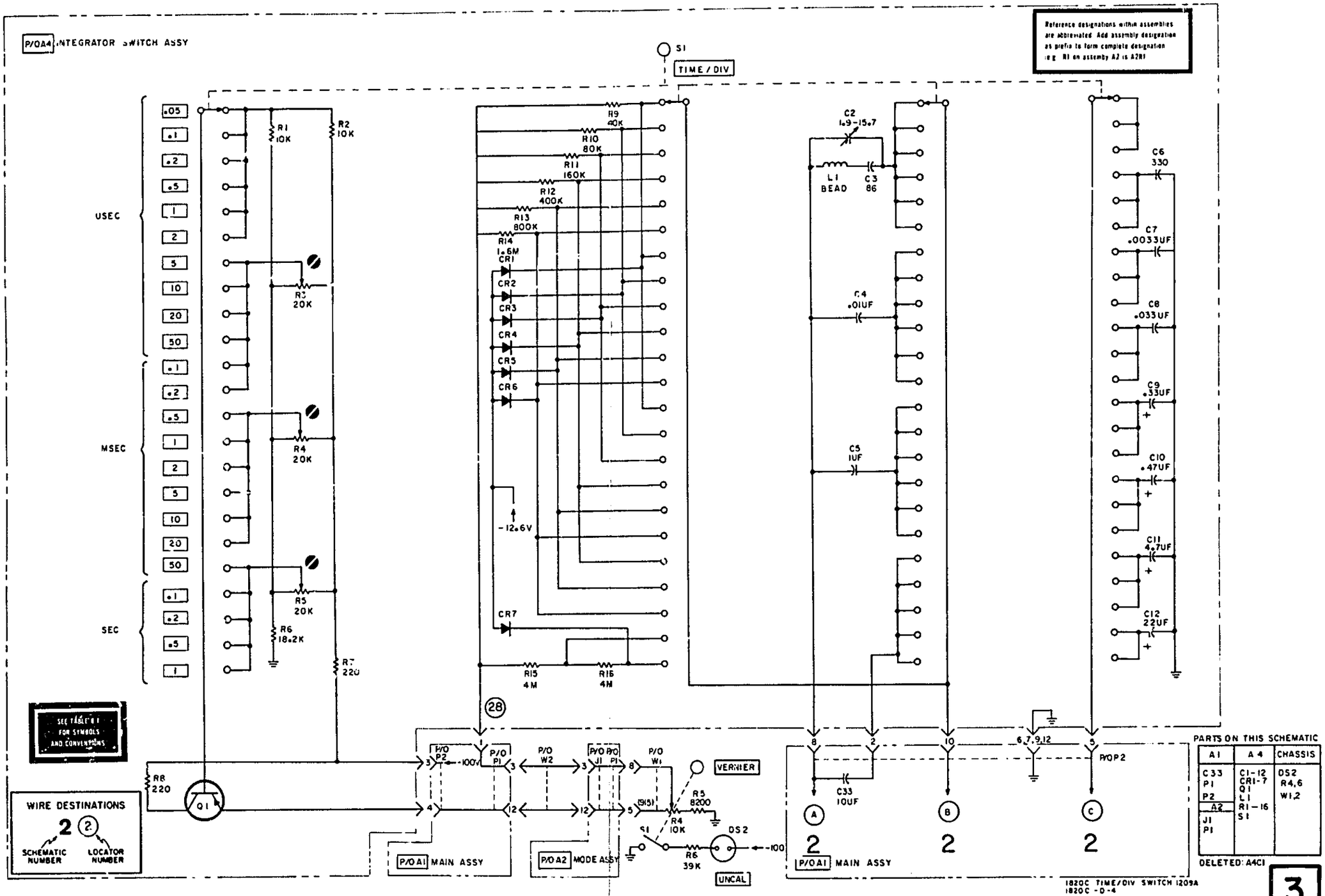



Figure 8-12.
TIME/DIV Switch Schematic

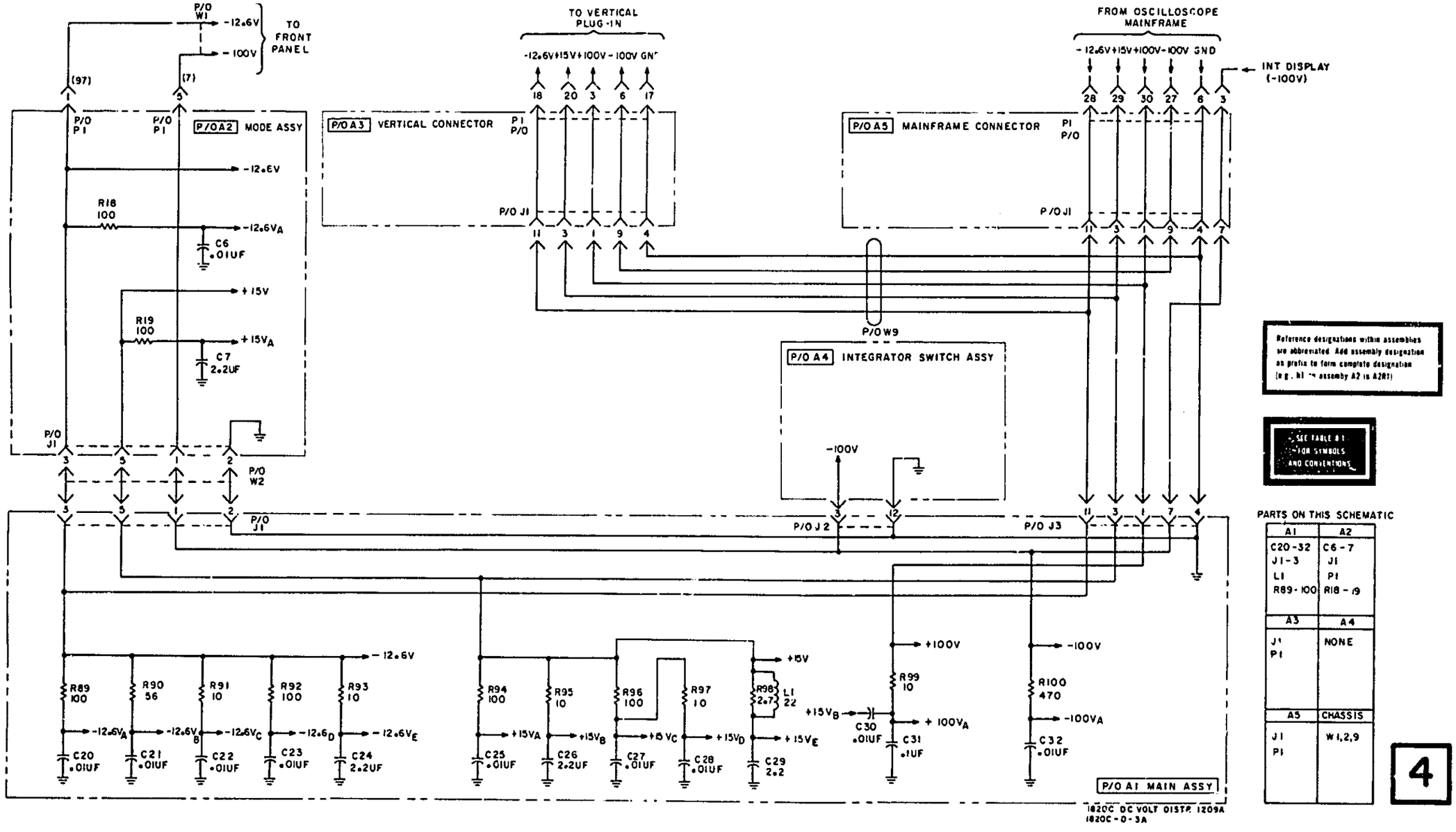



Figure 8-13 Direct Voltage Distribution Schematic

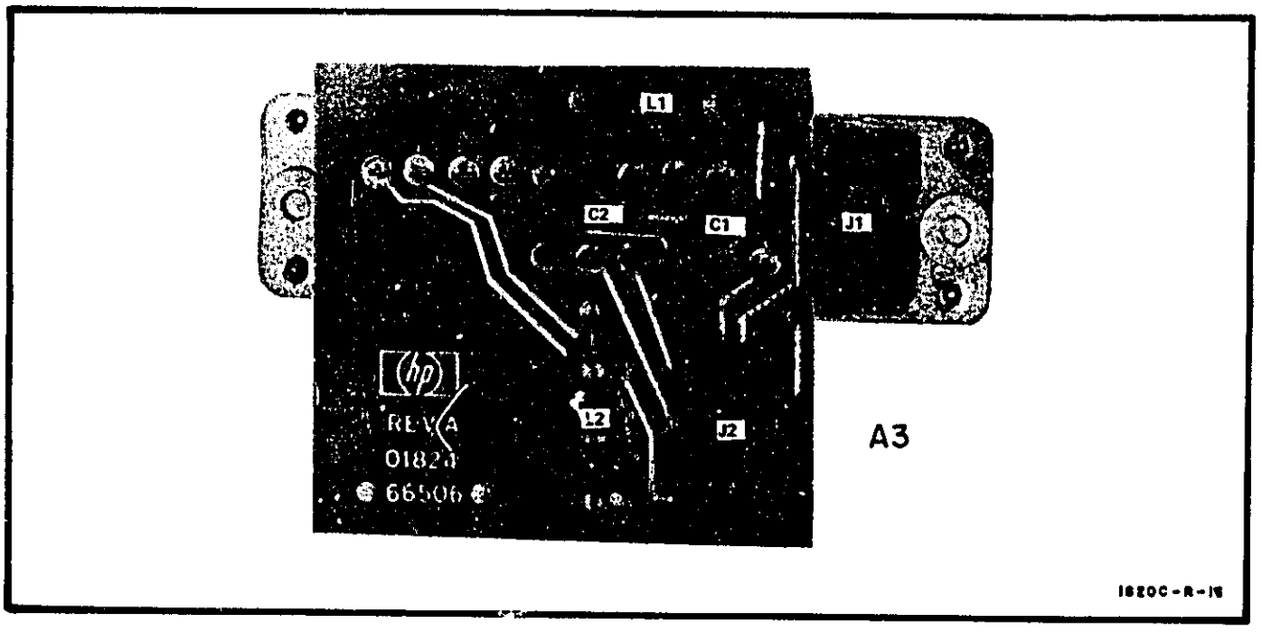



Figure 8-14. A3 Components Locator

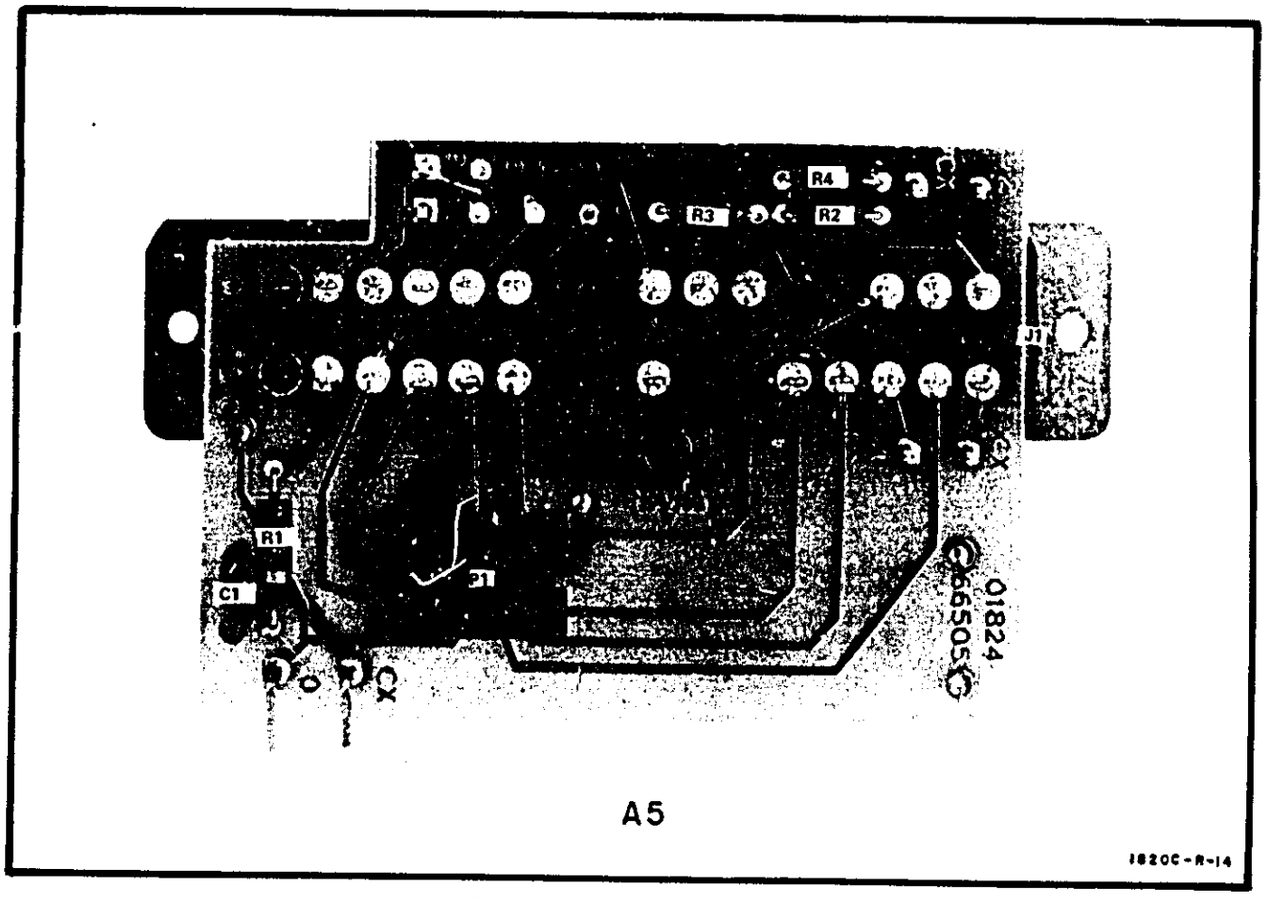



Figure 8-15. A5 Components Locator

Table 8-7. Schematics 5 and 6 Signal Identifier

| No. | Signal Name |
|---|---|
| 22 | Rear panel gate output |
| 23 | Mainframe gate output |
| 29 | Ramp output |
| 31 | Alternate trigger (mainframe to vertical) |
| 32 | Chopped blanking (mainframe to vertical) |
| 33 | Beam finder (mainframe to vertical) |

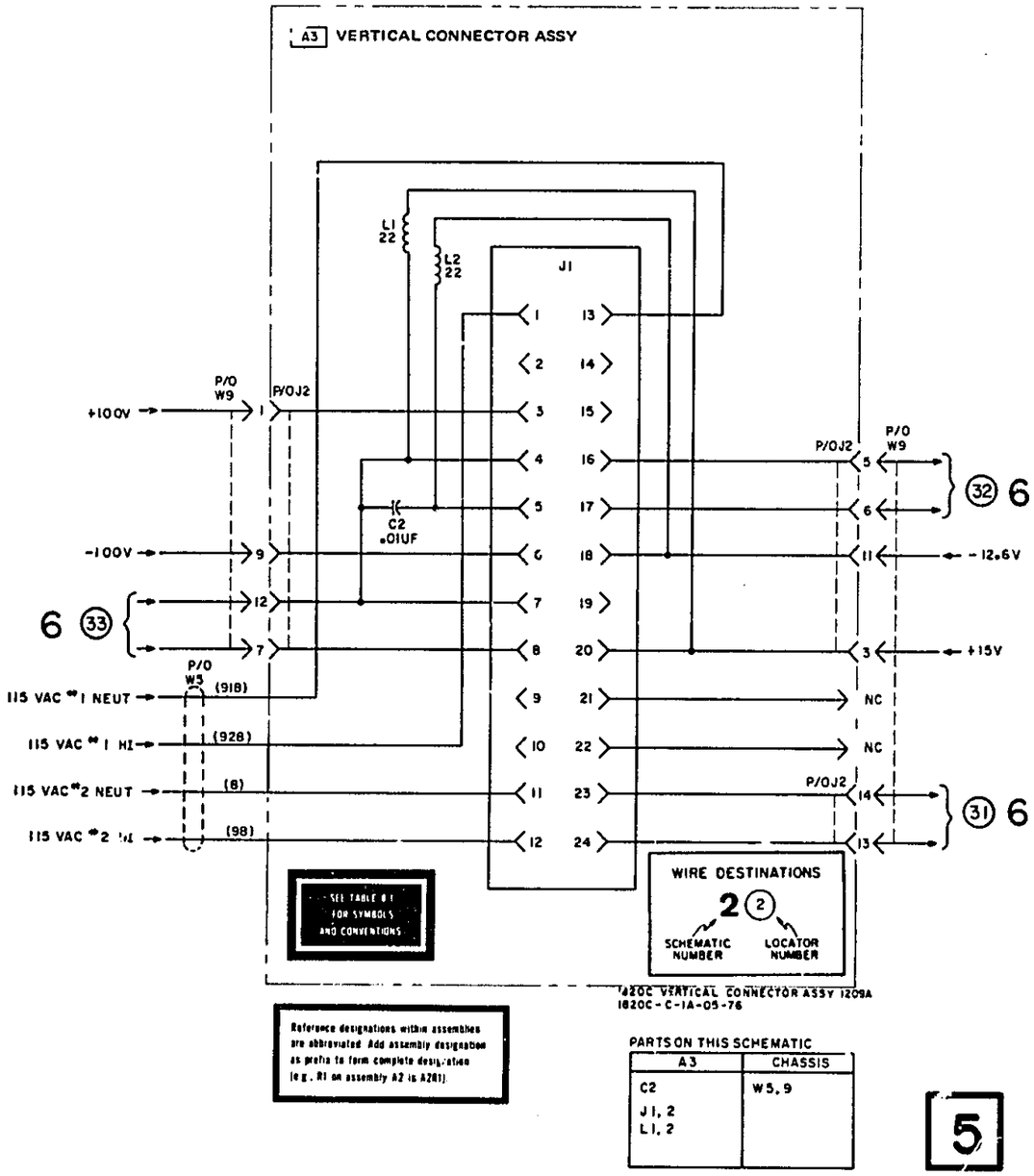



Figure 8-16. Vertical Connector Schematic

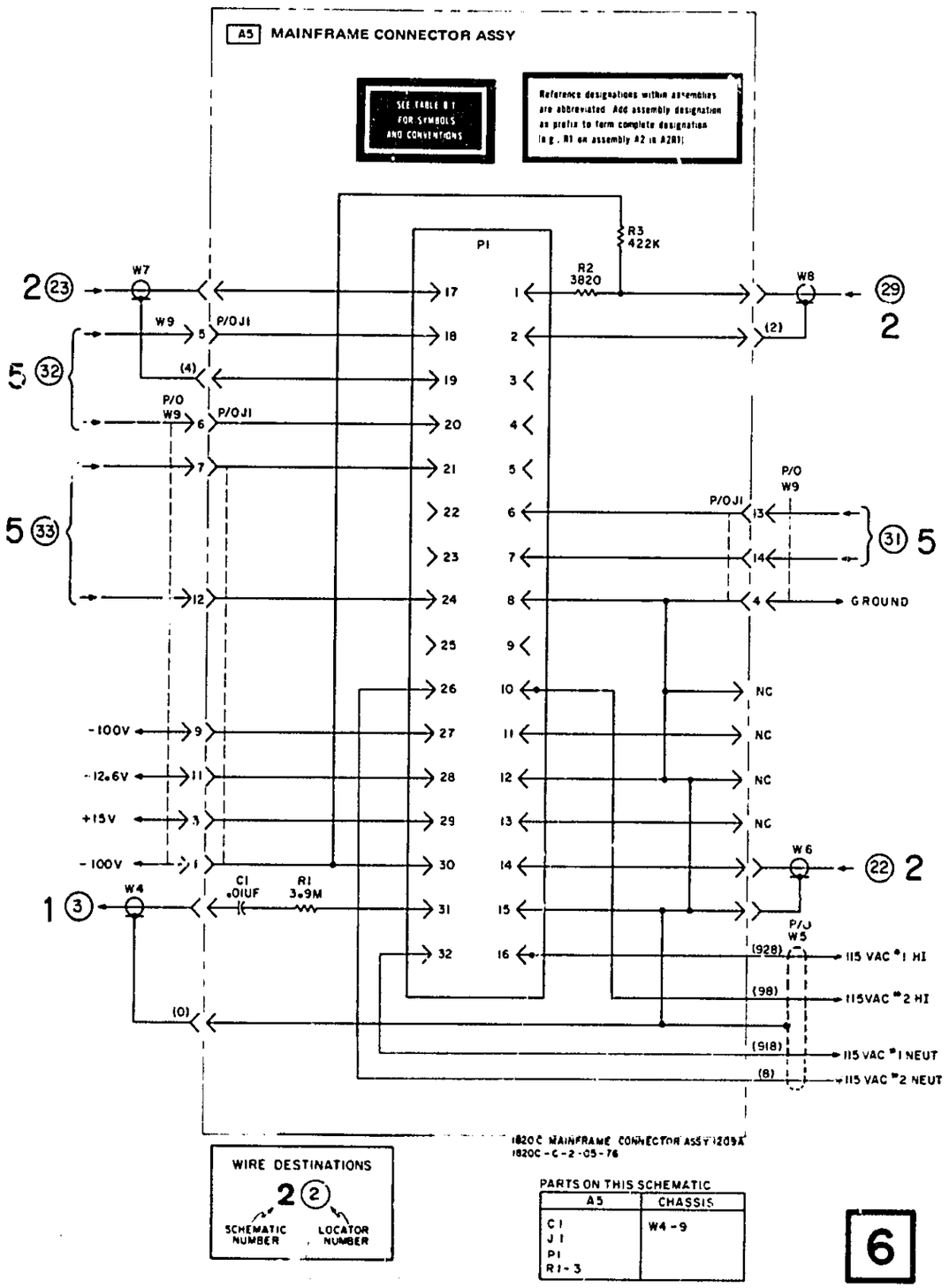



Figure 8-17.
Mainframe Connector Schematic