Errata

Title & Document Type: 1815A / 1815B / 1817A TDR/Sampler Group Operating and Service Manual

Manual Part Number: 01815-90001

Revision Date: January 1969

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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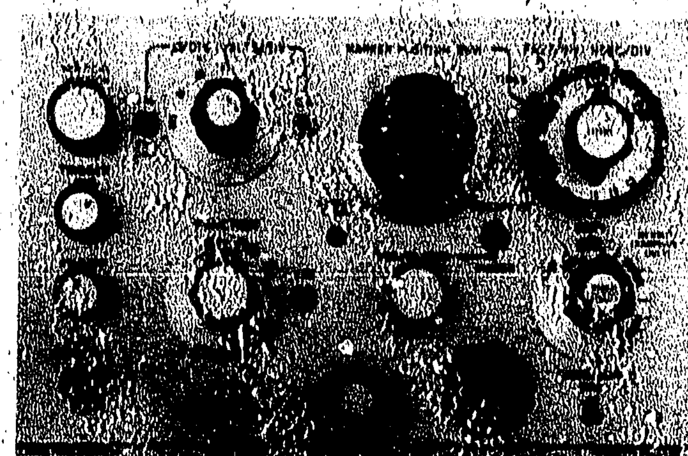
Agilent Technologies

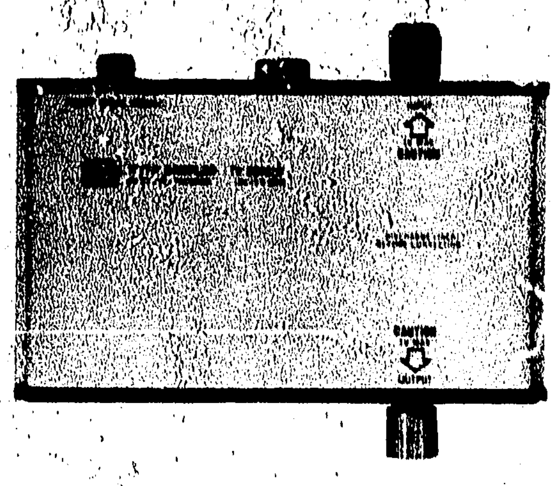
OPERATING AND SERVICE MANUAL

TDR/SAMPLER GROUP

1815A
1815B



1817A



HEWLETT hp PACKARD

HP1815A/1815B/1817A

CERTIFICATION

The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

WARRANTY AND ASSISTANCE

This Hewlett-Packard product is warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed in the operating manual, for the specified period. We will repair or replace products which prove to be defective during the warranty period provided they are returned to Hewlett-Packard. No other warranty is expressed or implied. We are not liable for consequential damages.

Service contracts or customer assistance agreements are available for Hewlett-Packard products that require maintenance and repair on-site.

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

OPERATING AND SERVICE MANUAL

MODELS
1815A/1815B/1817A
TDR/SAMPLER GROUP

1815A SERIALS PREFIXED: 851-

1815B SERIALS PREFIXED: 901-

1817A SERIALS PREFIXED: 851-

Refer to Section VII For Instruments With Other Serial Prefixes

Two sets of overlays are provided inside the rear cover of this manual. These overlays permit direct readout of ρ/division (reflection coefficient) for 50-ohm and 75-ohm system TDR tests.

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

02658-1

PRINTED: JAN 1969

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Table 1-1. Specifications

TDR/SAMPLER 1815A OR 1815B

Unless indicated otherwise, TDR and sampling performance specifications are same. Where applicable, TDR specification is given first, followed by Sampler specification in parentheses.

VERTICAL

SCALE: reflection coefficient ρ (volts) from 0.005/div to 0.5/div in 7 calibrated ranges; 1, 2, 5 sequence.

ACCURACY: ±3%; TDR only, ±5% on 0.01/div and 0.005/div in signal average mode.

VERNIER: provides continuous adjustment between ranges; extends scale to greater than 0.002/div.

SIGNAL AVERAGE: reduces noise and jitter approx. 2:1.

HORIZONTAL

SCALE: round-trip time or distance (time) in four calibrated decade ranges of 1/div, 10/div, 100/div, and 1000/div. Concentric expand control provides direct read-out in 28 calibrated steps in 1, 2, 5 sequence from 0.01 ns/div to 1000 ns/div or from 0.01 feet/div to 1000 feet/div (0.01 ns/div to 1000 ns/div).

ACCURACY: time, ±3%; distance, TDR only, ±3% ± variations in propagation velocity.

MARKER POSITION: ten-turn dial, calibrated in divisions; provides direct read-out of round-trip time or distance (time), number of divisions X decade range in units/div.

MARKER ZERO: ten-turn control provides variable reference for marker position dial; allows direct read-out of round-trip time or distance (time) between two or more displayed events.

ZERO FINDER: permits instant location of marker reference.

DIELECTRIC, TDR ONLY: calibrated for air, $\epsilon = 1$, and for polyethylene, $\epsilon = 2.25$. Also provides variable settings for dielectric constants from $\epsilon = 1$ to ϵ = approx 4.

TRIGGERING SAMPLING ONLY:

PULSES: less than 50 mV for pulses 5 ns or wider for jitter < 20 ps.

CW: signals from 500 kHz to 500 MHz require at least 80 mV for jitter less than 2% of signal period plus 10 ps; usable to 1 GHz. CW triggering may be extended to 18 GHz with HP Models 1104A/1106A trigger countdown.

RECORDER OUTPUTS: approx. 100 mV/div; vertical and horizontal outputs at BNC connectors on rear panel of mainframe.

DISPLAY MODES: repetitive scan, normal or detail; single scan; manual scan; record.

WEIGHT: net, 5 lbs (2,3 kg); shipping, 10 lbs (4,5 kg).

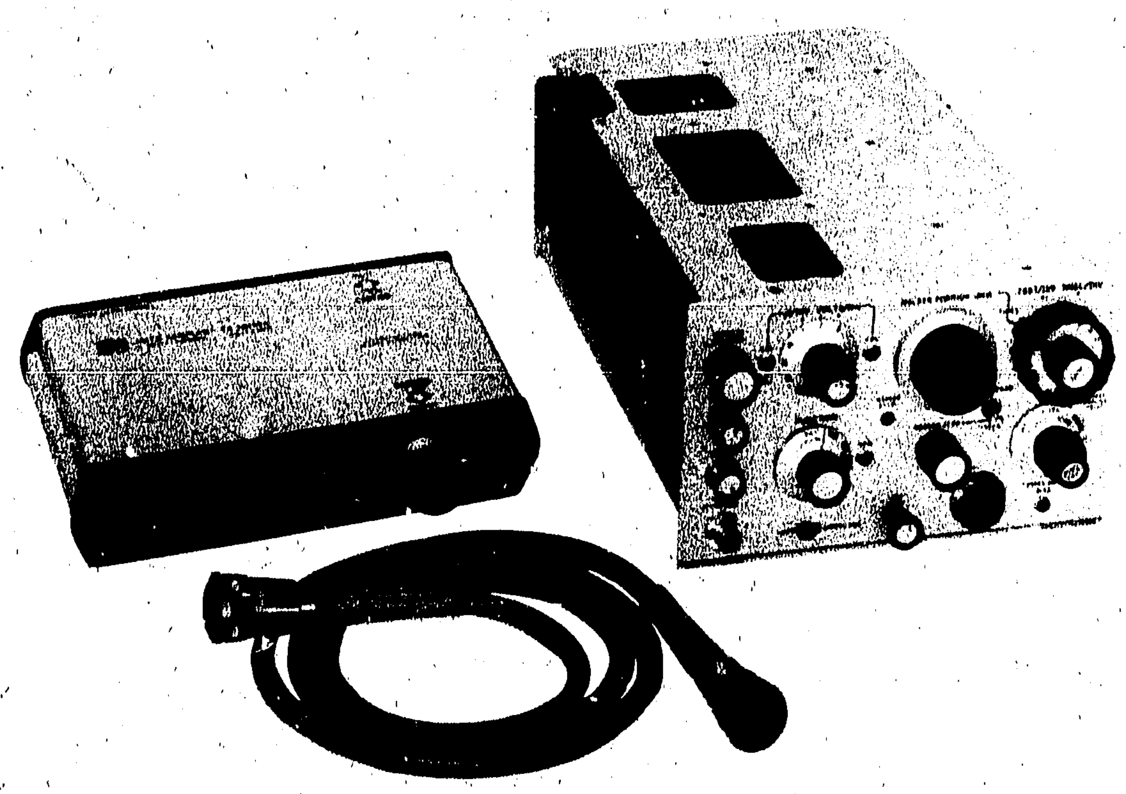


Figure 1-1. TDR/Sampler Group

SECTION I

GENERAL INFORMATION

1-1. SCOPE OF MANUAL.

1-2. This manual provides operating and servicing information for the HP Model 1815A and 1815B TDR/Samplers and the Model 1817A Remote Sampler. The manual is divided into eight sections, each section 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. DESCRIPTION.

1-4. The Model 1815A or B TDR/Sampler is designed as a double-sized plug-in for use with the Model 180-series Oscilloscopes in time-domain reflectometry and signal sampling measurements. A remote sampler (Model 1817A) is used with the TDR/Sampler. The Model 1815A or B provides the drive voltages for the oscilloscope horizontal amplifiers to position each sample dot on the CRT. In the vertical domain, the TDR/Sampler takes samples of the incoming signals and supplies the drive voltages directly to the oscilloscope CRT. The Model 1815A and 1815B units are identical except that horizontal oscilloscope TDR sensitivities are in feet per division with the Model 1815A and meters per division with the Model 1815B.

1-5. The Model 1817A Remote Sampler is a single-channel, 50-ohm feed through sampler. The remote sampler provides bias and trigger signals for operating tunnel-diode pulse generators such as the Model 1106A when used as a time-domain reflectometer.

1-6. In addition to the above functions, the Model 1815A or B provides the required blanking pulses to the CRT. A marker pulse is supplied to the control grid of the CRT to

Table I-I. Specifications (Cont'd)

SAMPLER 1817A WITH TUNNEL-DIODE 1106A

TDR SYSTEM

SYSTEM RISETIME: less than 35 ps incident as measured with Model 1106A.

OVERSHOOT: less than ±5%.

INTERNAL REFLECTIONS: less than 10% with 45 ps TDR; use reflected pulse from shorted output.

JITTER: less than 15 ps; with signal averaging, typically 5 ps.

INTERNAL PICKUP: $\rho \leq 0.01$.

NOISE: measured tangentially as a percentage of the incident pulse when terminated in 50Ω and operated in signal averaging mode. Less than 1% on 0.005/div to 0.02/div; less than 3% on 0.05/div to 0.5/div.

LOW-FREQUENCY DISTORATION: ≤±3%.

MAXIMUM SAFE INPUT: 1 volt.

SAMPLER SYSTEM

RISETIME: less than 28 ps.

INPUT: 50Ω feed-through.

DYNAMIC RANGE: 1 volt.

MAXIMUM SAFE INPUT: ±3 volts.

LOW-FREQUENCY DISTORATION: ≤± 3%.

NOISE:

NORMAL:, less than 8 mV tangential noise on 0.01 V/div to 0.5 V/div. Noise decreases automatically on 0.005 V/div.

SIGNAL AVERAGE: reduces noise and jitter approx. 2:1.

TUNNEL DIODE MOUNT: direct connection for Model 1106A tunnel diode mount for TDR system.

WEIGHT: net, 3 lbs (1,4 kg); shipping, 7 lbs (3,2 kg).

TUNNEL-DIODE MOUNT 1106A

Tunnel-diode mount connects directly to remote sampler for TDR system.

AMPLITUDE (BOTH): greater than 200 mV into 50Ω.

RISETIME: 20 ps approx.

OUTPUT IMPEDANCE: 50Ω ±2%.

SOURCE REFLECTION: less than 10% with 45 ps TDR.

WEIGHT: net, 1 lb (0,5 kg); shipping, 3 lbs (1,4 kg).

intensify the presentation of one dot. The horizontal position of the marker dot is established by the front-panel MARKER POSITION control, calibrated in horizontal divisions. The marker function is normally used to make accurate measurements in distance or time between points on the display. When the display is to be expanded, the marker is used to select the event about which expansion will occur.

1-7. A signal-averaging function is provided which reduces noise and jitter by a ratio of 4:1 or more. The signal averaging function does not degrade system performance.

1-8. The calibrated TDR system allows analysis of broadband microwave components, identifying discontinuities as close as 0.25 inch apart. Typical components that can be analyzed are connectors, adapters, strip lines, coaxial to circuit board transitions, loads, etc. In TDR tests, the TDR/Sampler provides for direct indications of reflection coefficient on the vertical scale and time or physical distance on the horizontal scale for cables having dielectric constants between 1 and 4.

Note

> The Model 1815A and 1815B units are identical except for six component value changes described herein. All information described for the Model 1815A will apply to the Model 1815B except where noted.

1-9. EQUIPMENT REQUIRED BUT NOT SUPPLIED.

1-10. A tunnel-diode pulse generator is required for use with the Model 1817A Remote Sampler when TDR tests are performed. The Hewlett-Packard Model 1106A Tunnel-diode Pulse Generator is the only pulse generator available that will enable the system to achieve the specifications listed in Table 1-1.

1-11. INSTRUMENT IDENTIFICATION.

1-12. This manual applies directly to Model 1815A, 1815B and 1817A instruments with serial prefixes as listed on the title page. The serial prefix is the first three digits of the eight-digit serial number (000-00000) used to identify each HP instrument.

1-13. MANUAL CHANGES.

1-14. As changes or refinements are made in the Models 1815A, 1815B or 1817A,, newer instruments may have higher serial prefixes assigned. Check the serial prefix of the instrument (serial tag usually located on rear of chassis). If the serial prefix of the instrument is a number higher than listed on the title page, a MANUAL CHANGES sheet will be provided to update the manual to correspond with the newer instrument. If the serial prefix of the instrument is a number lower than listed, refer to Section VII for backdating information.

1-15. Any known corrections to the manual due to errors that existed when it was printed are called errata. These corrections (if any) will also appear on a MANUAL CHANGES sheet.

1-16. INQUIRIES.

1-17. Refer any questions regarding MANUAL CHANGES sheets, the manual, or the instrument in general to the nearest HP Sales/Service Office. Always identify the instrument by both model number and complete serial number (8 digits) in all correspondence. Refer to the inside rear cover of the manual for a world-wide listing of HP Sales and Service Offices.

SECTION II

INSTALLATION

2-1. INITIAL INSPECTION.

2-2. MECHANICAL CHECK. Inspect the instruments upon receipt for any damage which may have occurred in transit. Check for external damage such as broken connectors, and dents or scratches on the panel surface. If damage is found, refer to Paragraph 2-6 for recommended claim procedure. Retain packing material for possible future use.

2-3. ELECTRICAL CHECK. Check the electrical performance of the instruments as soon as possible after receipt (refer to Section 5 for recommended performance checks). These checks verify that the instruments are operating within the specifications listed in Table 1-1. The performance check is a good test procedure for incoming quality-control inspection. Initial performance and accuracy of the instruments are certified as stated on the inside front cover of this manual. If the instruments do not operate as specified, refer to Paragraph 2-6 for the claim procedure.

2-4. PREPARATION FOR USE.

2-5. To prepare the TDR/Sampler and the remote sampler for use, proceed as follows:

a. Install the TDR/Sampler in the 180-series oscilloscope mainframe and lock it in place with the front-panel lock screw.

b. Connect one end of the sampler cable to the front-panel connector on the Model 1815A. Connect the other end to the appropriate connector on the Model 1817A.

c. Refer to Section III for information regarding setups for performing specific test.

2-6. CLAIMS.

2-7. The warranty statement applicable to all Hewlett-Packard Company instruments and products is provided inside the front cover of this manual. If physical damage is found or if operation is not as specified when the instruments are first received, notify the carrier and the nearest Hewlett-Packard Sales/Service Office immediately (see list in back of manual for addresses). The HP Sales/Service Office will arrange for repair or replacement without waiting for settlement of the claim with the carrier.

2-8. REPACKAGING FOR SHIPMENT.

2-9. If the instruments are to be shipped to a Hewlett-Packard Sales/Service Office for service or repair, attach a tag showing owner (with address), instrument serial numbers (all eight digits), and a description of the service or repair required.

2-10. The original shipping carton and packaging material may be reusable. The HP Sales/Service Office will provide information and recommendations on materials to be used if the original packaging material is not available. Materials used for shipping an instrument should include the following:

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

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

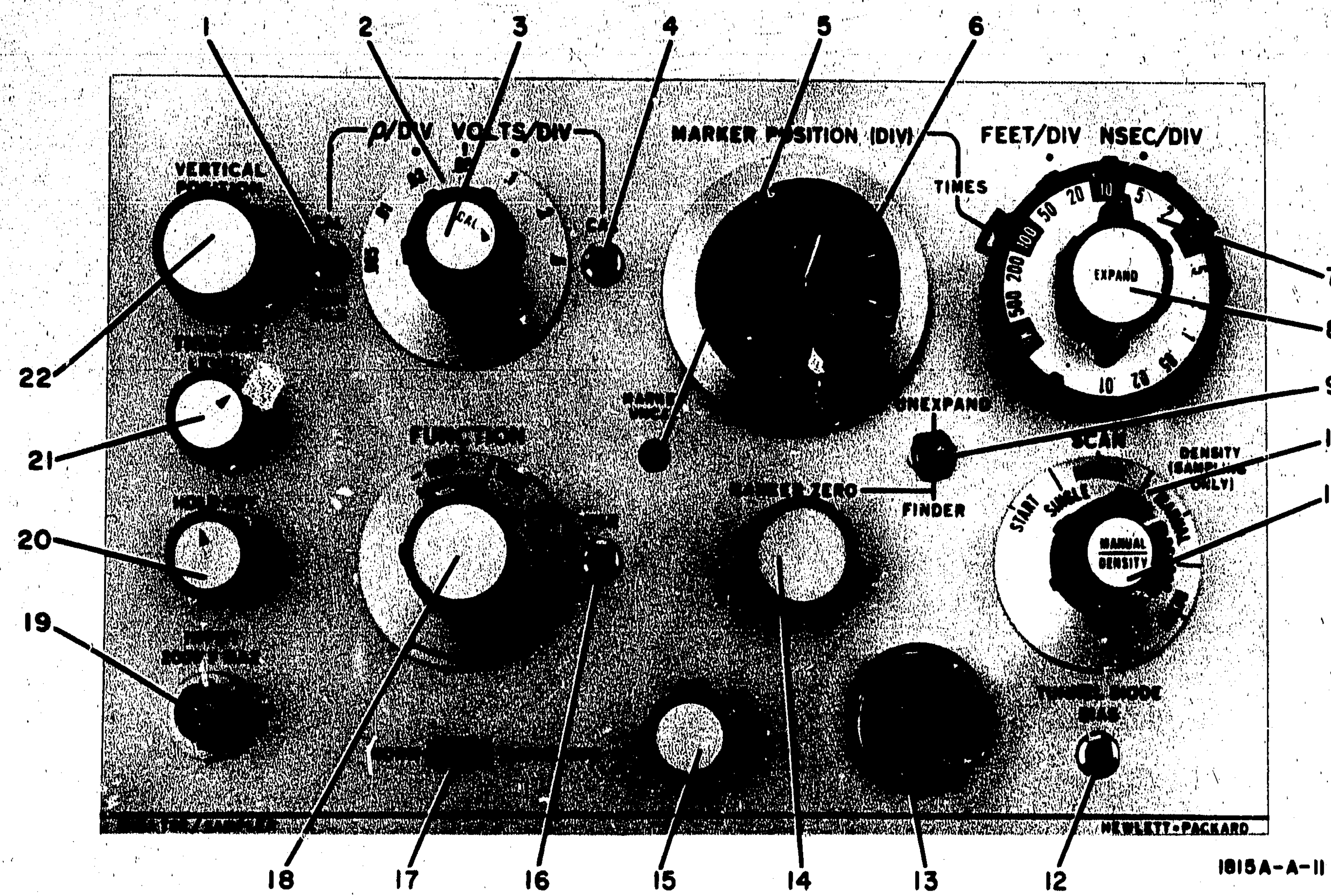
c. At least 4 inches of tightly-packed, industry-approved shock-absorbing material such as extra-firm polyurethane foam.

d. Heavy-duty shipping tape for securing outside of carton.

Table 2-1. Shipping Carton Test Strengths.

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

OPERATION



1. ρ/DIV CAL - Screwdriver adjustment used to set the incident step amplitude for exactly 5 divisions on the .2 ρ/DIV range. This calibrates the dial for indications in ρ/DIV. (See Figure 3-4 for procedure.)

2. ρ/DIV, VOLTS/DIV - Dual-purpose vertical-sensitivity switch that selects direct sensitivities of volts/div during sampling operations and reflection coefficient (ρ) during TDR operations.

3. CAL - Vernier that provides for adjustment between the fixed sensitivities on the ρ/DIV, VOLTS/DIV switch. In the detent position, the positions on the associated switch are calibrated.

4. VOLTS/DIV CAL - Screwdriver adjustment used to calibrate the VOLTS/DIV switch sensitivities. (See Figure 3-4 for procedure.)

5. MARKER UNCAL - Red indicator lamp (normally off) that lights when the combined settings of the MARKER POSITION and MARKER ZERO controls exceed the calibrated region of the horizontal sensitivity.

6. MARKER POSITION - Ten-turn potentiometer used to determine distance between two points on the display. Also used to select the area of a display to be expanded in EXPANDED modes. (See Figures 3-6 and 3-8 for procedures.)

7. FEET/DIV, NSEC/DIV - Dual purpose switch that provides four basic horizontal sensitivities either in distance or time per division. In the Model 1815A, the distance is in FEET. In the Model 1815B, the distance is in METERS.

8. EXPAND - Rotary switch that selects horizontal sensitivities greater than the four basic sensitivities. A pointer indicates the horizontal display sensitivity selected.

9. UNEXPAND/FINDER - A three-position, spring-loaded-to-center toggle switch providing two functions. When held in UNEXPAND, any magnification selected by the EXPAND switch is returned to the basic scale. When held in FINDER, the bright dot is returned to the reference point selected by the MARKER ZERO control.

10. SCAN - Rotary switch that selects between five different modes of operation. (Refer to Paragraph 3-13 for detailed descriptions.)

11. MANUAL/DENSITY - Potentiometer that functions as a manual scan control in the MANUAL mode of operation. It controls the number of samples taken per scan in the NORMAL and DETAIL modes of

Figure 3-1. Controls, Indicators and Connectors

SECTION III

OPERATION

3-1. INTRODUCTION.

3-2. This section includes an explanation of front-panel controls and adjustments, available modes of operation, triggering considerations (frequencies, amplitude, modes) and operating instructions for most applications. Information in this section applies directly to the Model 1815A. When operating a Model 1815B, all information applies except that distance sensitivities on the CRT will be in METERS/DIV rather than in FEET/DIV.

CAUTION

Make certain not to connect more than the maximum safe input (1 volt pk-pk) to the connectors of the remote sampler. When used in TDR operations, discharge all lines and associated equipment before connection to avoid sampling diode damage from static charge. A voltage well above the maximum input is required to destroy both sampling diodes. When both sampling diodes are destroyed in the remote sampler, repair charges will be assessed to the customer regardless of the equipment warranty period.

3-3. CONTROLS, INDICATORS, AND CONNECTORS.

3-4. The operating controls, indicators, and connectors of the Model 1815A are described and illustrated in Figure 3-1. The following paragraphs provide additional information for the more complex controls and connector.

3-5. FUNCTION. Rotary switch that selects either the TDR or sampling mode of operation. If sampling is selected, two positions are provided for selecting the desired slope of the trigger input. If TDR is selected, four positions are provided, one for time and three for distance. Two of the three distance positions have fixed calibrations for testing lines with air and polyethylene dielectrics. The third position is adjustable at the front panel for dielectrics ranging from one to four.

3-6. ρ/DIV, VOLTS/DIV. Rotary switch (outer black knob) that selects calibrated vertical sensitivities. Calibrated sensitivities may be selected to provide vertical displays in either voltage or ρ per division. Indicator lamps associated with the notations light to indicate the particular sensitivity function in use. Two adjacent potentiometers (CAL and CAL 5 DIV ON .2) are used to calibrate the vertical circuitry for the two sensitivity functions. A potentiometer (inner black knob) provides adjustment control within the ranges selected by the switch.

3-7. FEET/DIV, NSEC/DIV. Switch pair used to select the horizontal sensitivity for the display. Whether the horizontal sensitivity will be in feet (meters in 1815B) or

operation. The DENSITY function is disabled in TDR operations as density is automatically controlled.

12. TUNNEL DIODE BIAS - Screwdriver adjust that controls the current to the external tunnel diode pulse generator. The adjustment is made to derive stable triggering.

13. 18-pin connector - Connnection point for mating the Model 1815A with the remote sampler.

14. MARKER ZERO - Potentiometer that controls the location of the bright dot on the trace in conjunction with the MARKER POSITION control. (See Figure 3-6 for procedure.)

15. LOCK - Screw-lock that secures the Model 1815A in the oscilloscope mainframe.

16. VAR - Allows the horizontal sensitivity to be calibrated for any cable with a dielectric constant between 1 and 4. (See Figure 3-7 for procedure.)

17. NORM, SIGNAL AVG - Slide switch that selects between two display resolutions. The SIGNAL AVG position reduces system jitter and noise approximately 2:1.

18. FUNCTION - Rotary switch that selects between sampling and TDR modes of operation. (Refer to Paragraph 3-5 for details.)

19. INPUT - Single-conductor electrical connector used for connection of external trigger inputs.

20. HOLD OFF - Potentiometer that provides minor adjustment of sweep repetition rate to allow stable triggering from complex trigger waveforms.

21. TRIGGER LEVEL - Selects the amplitude point on an external trigger signal where triggering will occur.

22. VERTICAL POSITION - Potentiometer that controls the vertical position of the display on the oscilloscope CRT.

Figure 3-1. Controls, Indicators and Connectors (Con't) nanoseconds per division will depend upon the mode of operation of the system. Normally displays will be in FEET/DIV when operating in a TDR mode except when the TIME position has been selected on the FUNCTION switch. NSEC/DIV is used in sampling operations. Indicator lamps associated with the FEET/DIV and NSEC/DIV notations light to signify the horizontal display function in use.

3-8. The outer switch selects the horizontal sensitivity in units per division. The inner EXPAND switch selects expanded modes with direct indications of the expanded display sensitivity. The switch pair is calibrated so that accurate measurements can be made along a line in any combination of switch positions.

3-9. MARKER POSITION. Ten-turn calibrated potentiometer used to measure the distance between two points on the horizontal axis. As the MARKER POSITION control is adjusted, a bright dot moves horizontally across the display. Two pointers on the MARKER POSITION control indicate the distance in feet or nanoseconds between the instantaneous position of the bright marker dot and the selected zero point of the marker dot. The units between the marker dot and the selected zero point (feet or nanoseconds) are dependent upon the controlling horizontal function (FEET/DIV or NSEC/DIV) and are calibrated for the unexpanded senistivity selected.

3-10. In unexpanded display modes, the bright dot of the MARKER POSITION control also indicates the area of the trace that will be displayed if the system is switched to an expanded mode. Adjustment to any expanded horizontal display does not affect the calibration of the MARKER POSITION control. Expanded modes are often used for greater accuracy of measurements. See Figure 3-6 for procedure.

3-11. MARKER ZERO. Potentiometer that is adjusted to select the reference point for the MARKER POSITION control. The MARKER POSITION control adjusts the bright dot to some distant point and the exact distance between the two points (MARKER ZERO and MARKER POSITION) is indicated by the dial of the MARKER POSITION control.

3-12. UNEXPAND-FINDER. Toggle switch (three-position, spring-loaded to center) used with the MARKER controls in the FINDER function and with the FEET/DIV, NSEC/DIV switches in the UNEXPAND function. The marker dot will instantly reposition to the zero point selected by the MARKER ZERO control during the time that the switch is held in the FINDER position. Should the operator be using the system with some expanded display mode, the toggle switch can be set to UNEXPAND to momentarily observe the entire (unexpanded) display.

3-13. SCAN. Rotary switch that selects the mode of oscilloscope scanning. All outputs selected by the SCAN switch are available for monitoring at the rear-panel (record) output terminals. The following subparagraphs provide information concerning the operation in each of the SCAN switch positions.

a. START. A spring-loaded, momentary-contact position which starts one oscilloscope scan. From the START position, the SCAN switch returns to the SINGLE position.

b. SINGLE. This is the position to which the SCAN switch returns when generation of a single trace at detailed scan speed is selected.

c. NORMAL. In this position, the display is continuously presented at normal scan speed. The density of the scan is selected by the MANUAL/DENSITY potentiometer in the center of the SCAN control for sampling mode. In the TDR mode a fixed density is used to maintain optimum display characteristics and the MANUAL/DENSITY control is inoperative.

d. DETAIL. This position is used to check or improve display accuracy when observing rapidly fluctuating waveshapes (within approximately .1 division). The DETAIL position is normally used in TDR mode only. The DETAIL sweep speed may be slower than the NORMAL sweep speed.

e. MANUAL. When this position is selected, the MANUAL/DENSITY potentiometer moves a single dot across the CRT screen (sampling continues at the normal rate but only in the position selected by the MANUAL/DENSITY potentiometer). The MANUAL position may be used to drive an X-Y recorder or to set up the limits for recording.

f. RECORD. This position is used to provide a very slow sweep speed (60 seconds approx.) suitable for driving an X-Y recorder. A pair of connection points on the oscilloscope rear-panel allow access to levels proportional to the X (main sweep output) and Y (delayed gate output) positions on the CRT for the X-Y recorder. The record sweep may be started from either the MANUAL or RESET positions.

g. RESET. In this position the display is held at the left-hand edge of the CRT screen. This position is normally used prior to selecting the RECORD scan.

3-14. MANUAL/DENSITY. Poteniometer in the center of the SCAN control which positions the sampled dot on the face of the CRT during MANUAL scanning, and establishes the dot density in the sampling mode during NORMAL, DETAIL, or SINGLE scanning.

Note

Very low dot density will reduce system resolution and therefore display accuracy. Very high dot density will have display accuracy but it will cause the display to flicker. In sampling operations, the MANUAL/DENSITY control must be adjusted to obtain the best compromise between resolution and flicker. In TDR operations, density is automatically controlled for optimum resolution and flicker.

3-15. TUNNEL DIODE BIAS. Screwdriver adjust potentiometer that establishes the trigger point for the tunnel-diode pulse generator (Models 1106A or 1108A). The potentiometer is adjusted for minimum jitter of the incident pulses.

3-16. NORM, SIGNAL AVG. Slide switch that selects between normal input amplifier sensitivity (NORM) and a reduced sensitivity (SIGNAL AVG) for use when the input signal has excessive noise. When in SIGNAL AVG, the system takes several samples at each point before advancing. This allows time for the system to correct to a high degree of accuracy and provide a display before advancing so that risetime and resolution are not degraded. Signal averaging also reduces system jitter. The only undesireable characteristic about the SIGNAL AVG position is that the trace on the CRT may flicker with the sweep speed reduced.

3-17. TRIGGER LEVEL. Potentiometer that adjusts the trigger point on an incoming trigger signal. The trigger INPUT connector and the TRIGGER LEVEL control are used only in the sampling modes.

3-18. INPUT 200MV MAX. Input connector for the trigger signal used during sampling operations. The trigger circuit will respond to signal levels from 50 to 200 millivolts and is most sensitive to fast-rise pulses. The circuit may be triggered on smaller amplitudes when fast-rise pulses are used.

3-19. TRIGGER HOLD OFF. Potentiometer that is adjusted to obtain a stable display during sampling operations (normally used with a countdown unit such as the HP Model 1104A).

3-20. OPERATION AS A TDR SYSTEM.

3-21. TEST SETUP FOR TDR.

3-22. Make the equipment interconnections illustrated in Figure 3-2. The HP Model 1106A Tunnel-diode Pulse Generator is the only pulse generator that provides the input parameters necessary for operation of the Model 1815A/1817A system at full rated specifications. Other pulse generators may be used but may not allow full bandwidth attainment, etc.

Note

The shielded cable connected between the tunnel-diode bias and the pulse generator has a 1-nanosecond delay per each 8 inches of line. Connecting additional cable will increase the delay before triggering of the pulse generator. With excessive delay, the incident step may not appear on the CRT display.

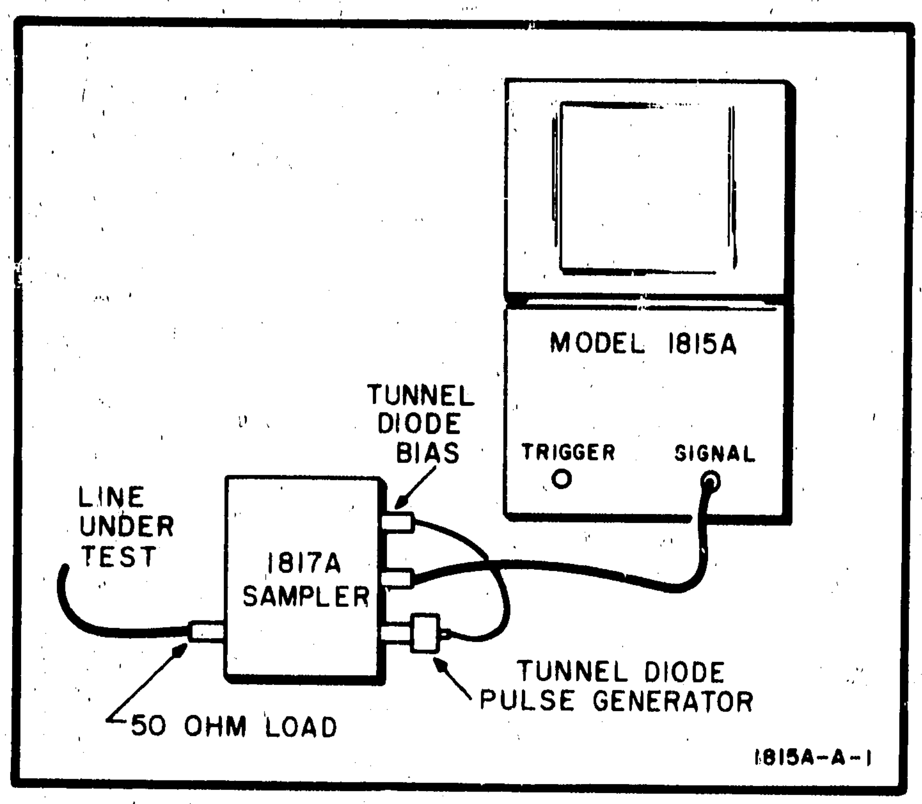


Figure 3-2. TDR Operation Setup

3-23. The bright marker dot function may be disabled if desired by use of an internal switch. To disable the marker dot circuit, remove the Model 1815A from the oscilloscope and set the slide switch on board assembly A5 to OFF.

3-24. Adjust the TUNNEL DIODE BIAS control in an unexpanded display mode for proper firing on the TDR input signal. Select an expanded display and readjust the TUNNEL DIODE BIAS control for minimum jitter.

3-25. Disconnect the 50-ohm load and connect the line to be tested.

Note

Two sets of overlays are included in an envelope inside the rear cover of this manual. These overlays allow direct interpretation of displays from 50-ohm and 75-ohm systems for the vertical sensitivities available.

Note (Con't)

A slide-rule calculator (TIME DOMAIN REFLECTOMETER CALCULATOR) is also included with this manual to allow calculation of all TDR parameters from the displayed information.

3-26. The system may also be used with the tunnel-diode pulse generator in a stimulus-response mode. In this mode, the output of the tunnel-diode pulse generator is applied to one end of the circuit or line under test. The signal at the other end is connected to the remote sampler INPUT and the OUTPUT is terminated in 50 ohms.

Note

When using the stimulus-response mode for TDR tests, the zero offset current function should be disabled. This is accomplished by removing the Model 1815A from the oscilloscope and setting the NORM/OFF switch S1 on board assembly A1 to OFF. Return S1 to the NORM position at the end of the stimulus-response test.

3-27. OPERATION AS A SAMPLING SYSTEM.

3-28. TRIGGERING.

3-29. The (TDR/Sampler) system requires an input trigger from an external source for normal signal sampling. The synchronous pulse output from a pulse generator may be used when the pulse generator output is to be observed. The trigger may also be derived from the actual signal to be sampled. The system will accept trigger levels from 50 to 200 millivolts peak-to-peak.

3-30. The oscilloscope must be triggered at least 55 nanoseconds before application of the pulse to be observed. When triggering on a sine-wave input, the delay may not be necessary because the signal is repetitive.

3-31. When selecting a trigger input, remember that the input must be synchronized with the pulse to be observed. Jitter of the display is likely when adjacent pulses are used to synchronize each other. When the pulse to be displayed is used also as the trigger pulse, and a long time delay is used before application of the pulse to the remote sampler, the risetime of the delay line will degrade the risetime of the pulse.

3-32. The bright marker dot function may be disabled if desired by use of an internal switch. To disable the marker dot circuit, remove the Model 1815A from the oscilloscope and set the slide switch on board assembly A5 to OFF.

3-33. The sampling system may also be used with a tunnel-diode pulse generator (Model 1106A) in a stimulus-response mode. In this mode, the output of the tunnel-diode pulse generator is applied to one end of the circuit or line under test. The signal at the other end is connected to the remote sampler in the conventional manner and the remote sampler is terminated in 50 ohms. In this mode, the TRIGGER LEVEL control is adjusted for free-run operation.

3-34. TEST SETUP FOR SAMPLING.

3-35. Make the equipment interconnections illustrated in Figure 3-3. The connectors for the 50-ohm load and input signal to be sampled are in parallel and may be reversed if desired.

CAUTION

The signal at the input connector must never exceed 1.0 volt.

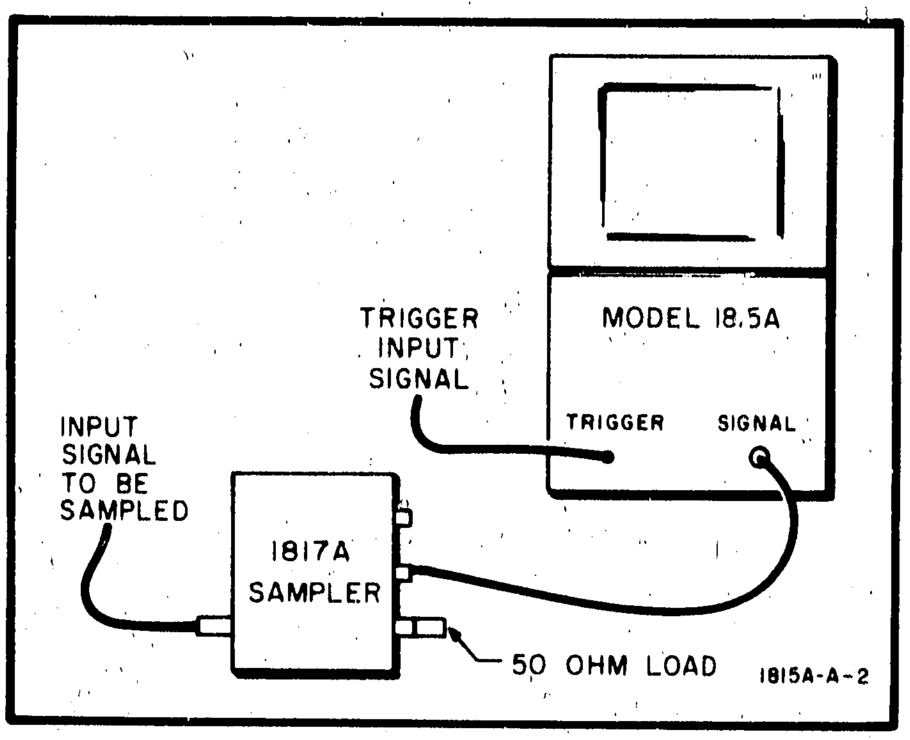


Figure 3-3. Sampling Operation Setup

3-36. Connect the trigger signal to the trigger INPUT connector on the Model 1815A. The trigger pulse must be delivered ahead of the signal to be observed by at least 55 nanoseconds.

3-37. RESOLUTION AND FLICKER CONTROL.

3-38. During NORMAL and DETAIL scans, the MANUAL/DENSITY control on the SCAN switch selects the number of samples to be taken on each trace in sampling modes. The sampling rate is normally slaved to the sampling trigger. Control of the number of samples taken per trace allows selection of optimum balance between resolution and flicker. The repetition rate in TDR is a fixed factor. Optimum balance between resolution and flicker is automatically controlled during TDR operations and the MANUAL/DENSITY control is disabled.

3-39. Countdown modes select the number of times that each point on a display will be sampled before the system will advance to the next point. Countdown allows time for the Model 1815A circuitry to correct and display the true input level at each point on a trace. The following switch conditions select various countdown rates.

a. When the NORM, SIGNAL AVG slide switch is set to SIGNAL AVG, vertical channel noise and jitter are reduced while display accuracy is maintained.

b. The NORMAL and DETAIL positions of the SCAN switch select countdown rates which provide proper sweep speeds for the selected scans. DETAIL is used to observe rapid signal fluctuations within approximately one-tenth of one CRT division.

c. The FUNCTION and ρ/DIV, VOLTS/DIV switches select various countdown rates for sensitive positions to improve signal noise conditions.

d. All of the above switches work in combination to select a countdown rate that is compatable with all switch settings.

Note

Occasionally, when viewing a pulse display in a countdown mode, the fast transition times of the pulse will appear to be composed of a series of steps. These occur while the countdown circuit is correcting to each sampled level on the fast transition. This is a normal condition and may be improved by switching the NORM, SIGNAL AVG switch to NORM or by increasing the scan density (adjusting MANUAL/DENSITY clockwise).

3-40. WAVEFORM RECORDS.

3-41. SINGLE-SCAN PHOTOGRAPHING OPERATIONS.

3-42. The SINGLE position of the SCAN switch is normally used during waveform photography. It is most useful when the sweep time and camera shutter speeds are related in such a way as to cause unbalanced trace intensity on the photo (when the shutter is open for a time different from the time required for sweep completion). To use the SINGLE position for photography, proceed as follows:

a. Set the SCAN switch to SINGLE and open the camera shutter.

b. Momentarily set the SCAN switch to START. The switch will return to the SINGLE position, and the oscilloscope will provide one complete trace across the CRT.

c. Close the camera shutter.

3-43. Several displays may be recorded on one photo using the SINGLE mode. This is accomplished by leaving the camera shutter open and single-scanning several traces at different vertical positions on the CRT.

3-44. X-Y RECORDER OPERATIONS.

3-45. X-Y records are less expensive than oscilloscope photos. Their large size also makes measurements more easily read. Displays may be recorded on X-Y recorders using signals available on the record output connectors on the rear of the oscilloscope. The horizontal voltage is available on the MAIN SWEEP OUTPUT terminal and the vertical voltage is available on the DELAYED GATE OUTPUT terminal. The RECORDER or MANUAL positions of the SCAN switch are used for obtaining X-Y plots. The sensitivity of the recorder outputs are approximately 100 mV/CRT DIV.

a. Set the SCAN switch to MANUAL.

b. Adjust the MANUAL/DENSITY potentiometer between its clockwise and counterclockwise extremes and adjust the X-Y recorder controls to derive the horizontal scan sensitivity desired.

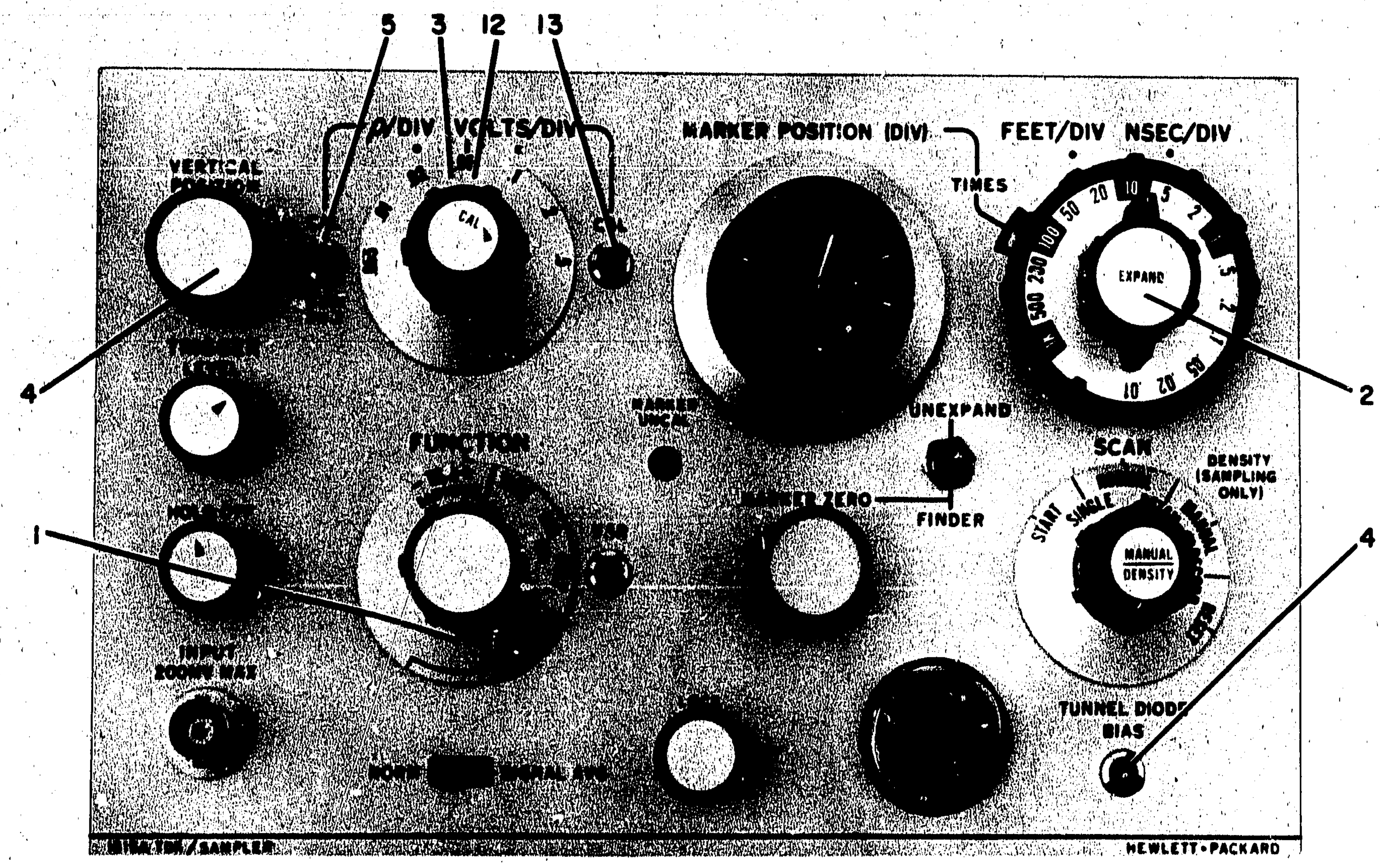
c. Set the ρ/DIV, VOLTS/DIV switch and potentiometer to derive the desired veritcal sensitivity on the X- Y recorder.

d. Set the SCAN switch to RESET. This sets the recorder to start at the left-hand edge of the trace. Use the MANUAL position if the start of the plot is not to be at the left-hand edge.

e. Set the SCAN switch to RECORD. This starts one automatic recorder sweep. The recording cycle is complete after approximately 60 seconds.

Note

Additional recording detail may be obtained by setting the SCAN switch to MANUAL and rotating the MANUAL/DENSITY control very slowly, particularly on portions of the display with fast risetime or sharp corners.



1815A-A-12

The vertical axis may be calibrated for use in TDR and sampling applications. Calibration of the vertical axis in terms of reflection coefficient allows interpretation of results directly in units of ρ/division for TDR tests. To make the ρ/DIV calibration of the vertical axis for a 50-ohm system, proceed as follow:

1. Set the FUNCTION switch to TIME.

2. Set the EXPAND switch to display the unexpanded display sensitivity selected on the FEET/DIV, NSEC/DIV switch.

3. Set the ρ/DIV switch to .2.

4. Adjust the VERTICAL POSITION and TUNNEL DIODE BIAS controls to obtain a display of TDR pulse.

5. Adjust the CAL 5 DIV ON .2 screwdriver potentiometer to obtain a deflection of five vertical divisions on the oscilloscope display.

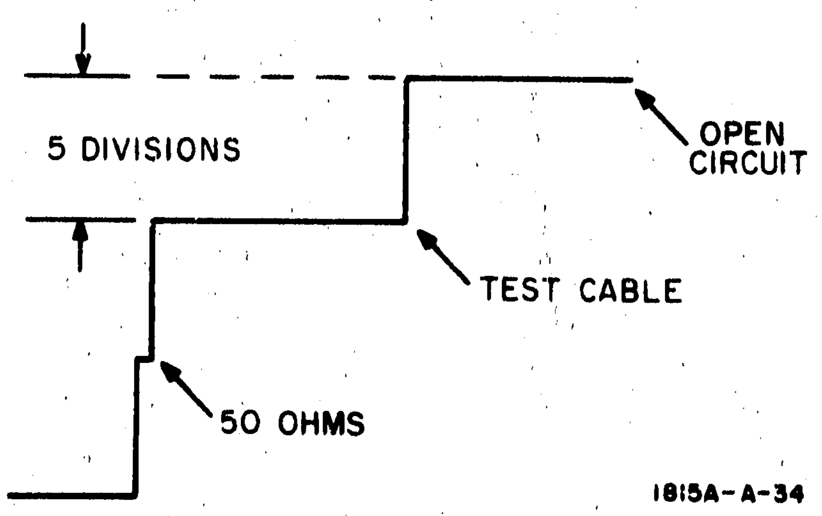
To make the ρ/DIV calibration of the vertical axis for a line other than 50 ohms, proceed as follows:

6. Connect a suitable adapter to match the impedance of the line to the remote sampler OUTPUT. Connect a length of the test line to the adapter.

7. Set the FUNCTION switch to TIME and ρ/DIV switch to .2, and adjust the VERTICAL POSITION and TUNNEL DIODE BIAS controls to obtain a display of TDR pulse.

8. Adjust the VERTICAL POSITION control to place the baseline of the test line on a convenient horizontal grid line.

9. Adjust the CAL 5 DIV ON .2 screwdriver potentiometer to obtain a deflection of 5 vertical divisions on the oscilloscope display of the transition from the test line to the open circuit level.



1815A-A-34

Figure 3-4. Vertical Axis Calibration

Figure 3-4. Vertical Axis Calibration (Con't)

10. Disconnect the signal generator and termination (50-ohm load) from the remote sampler.

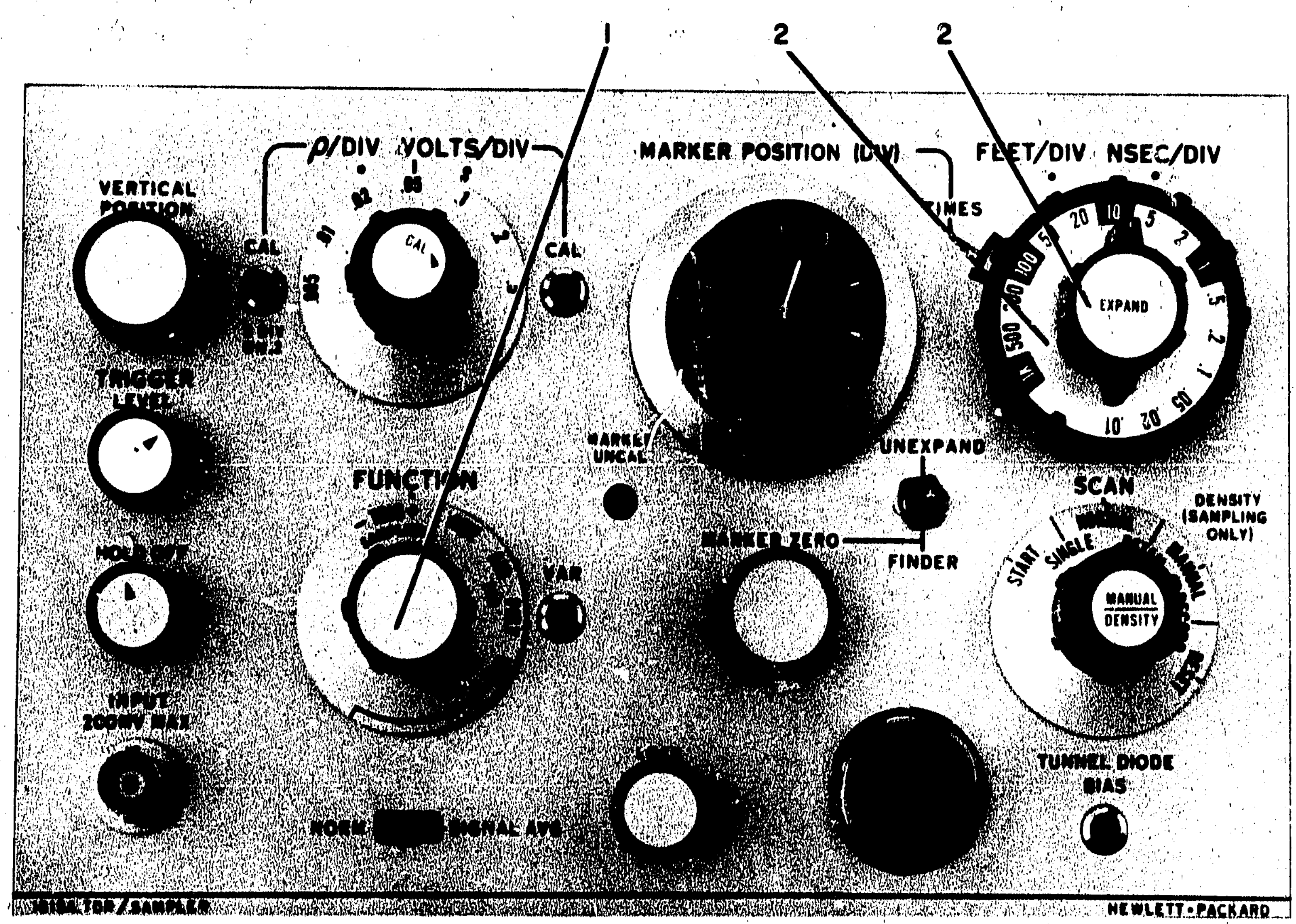
11. Connect the 250-millivolt calibration signal from the Model 180 oscilloscope mainframe to the remote sampler INPUT.

12. Set the VOLTS/DIV switch to .05.

13. Adjust the VOLTS/DIV CAL potentiometer for five divisions of vertical deflection.

CAUTION

Do not select the 10-volt calibration signal. That voltage will destroy the diodes in the remote sampler.



1815A-A-13

The horizontal axis has been calibrated to allow rapid physical location of points of interest. To check the calibration of the horizontal axis, proceed as follows:

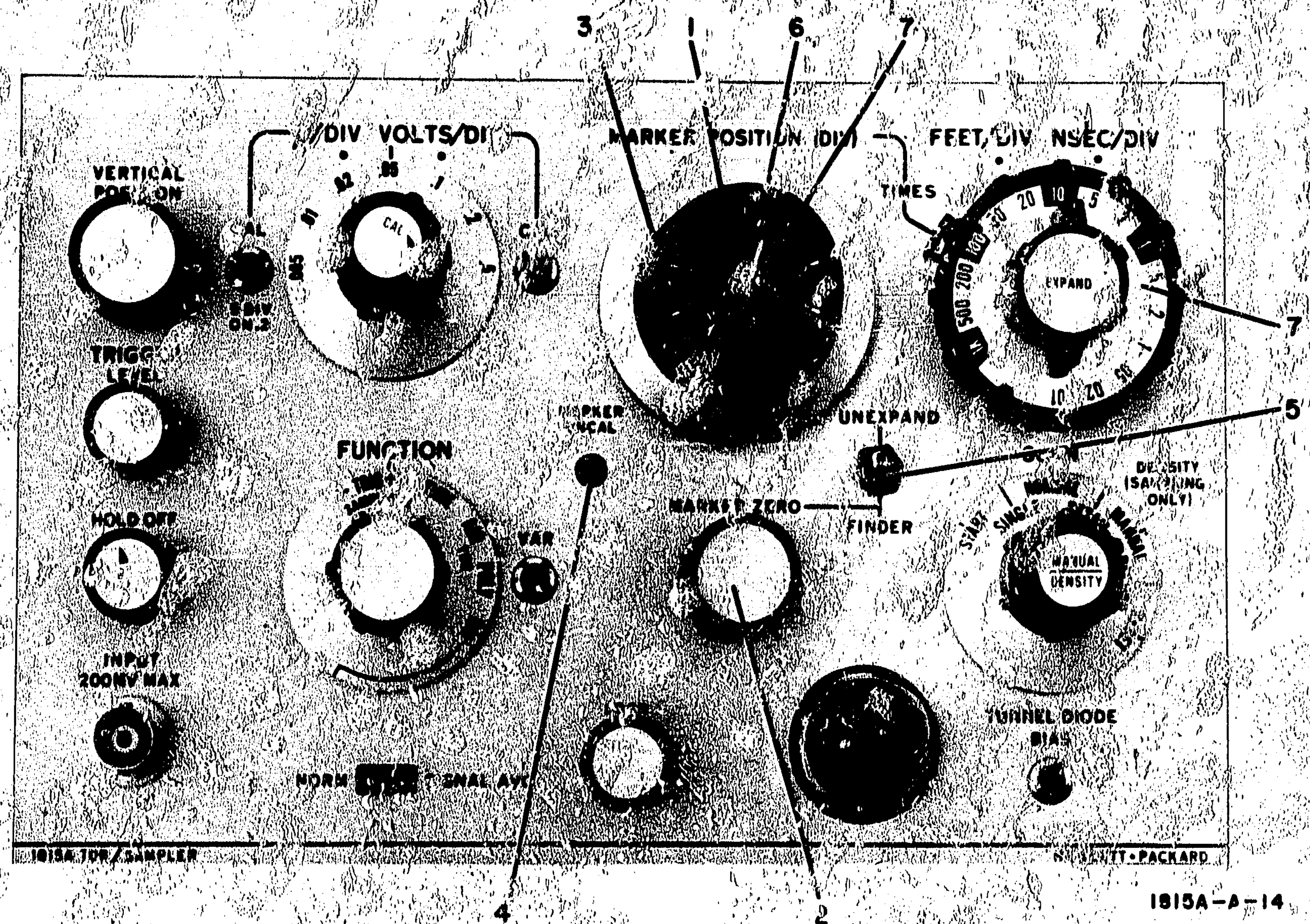
1. Set the FUNCTION switch to TRIG+.

2. Set the NSEC/DIV and EXPAND switch pair to 100.

3. Connect a time-mark generator to the remote sampler INPUT. Set the time-mark generator for a .1-usec output.

4. The oscilloscope should provide a display of one pulse per division ±3%.

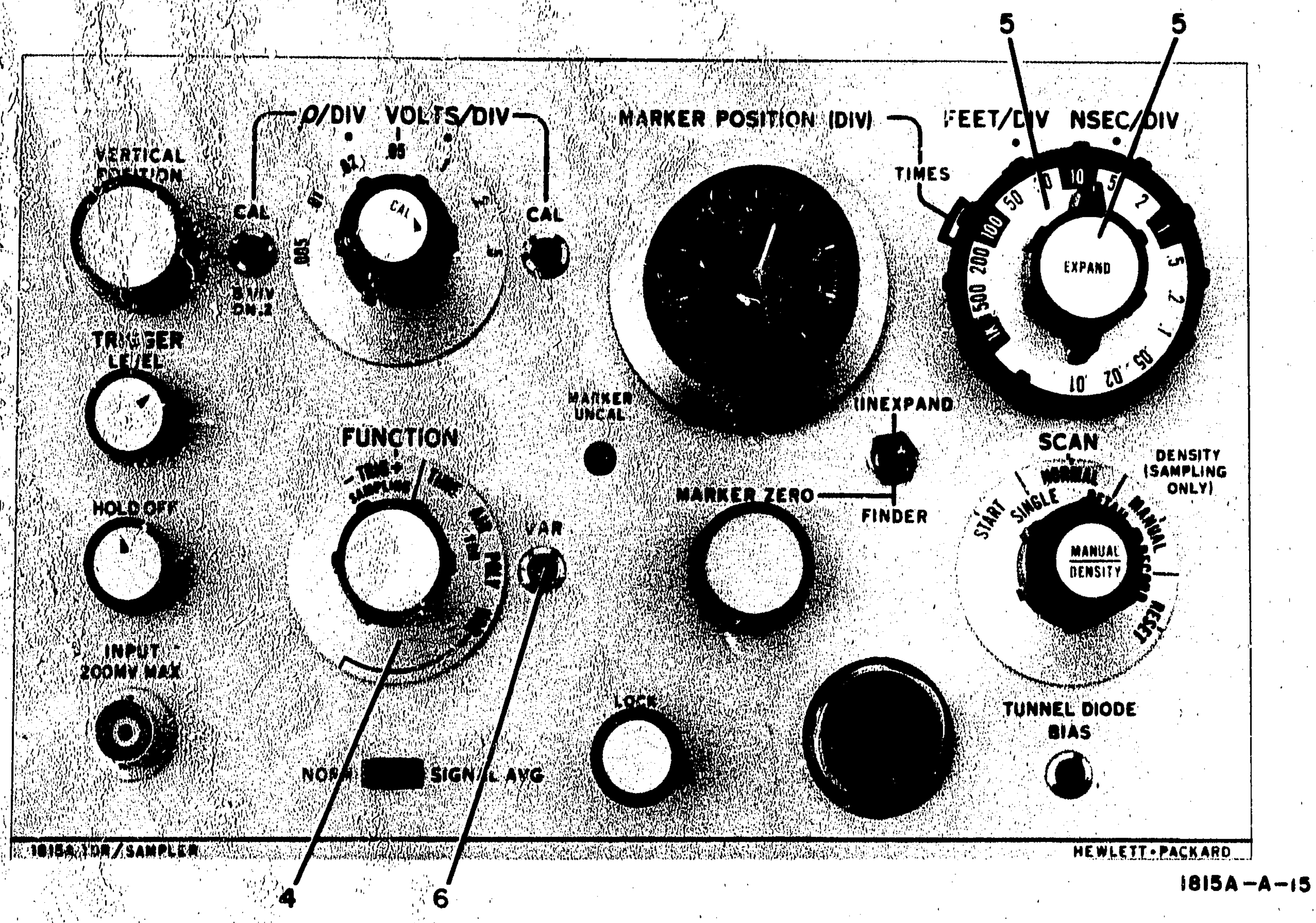
Figure 3-5. Horizontal Axis Calibration



The Model 1815A enables direct measurements in feet or nanoseconds between any two points on a trace. To make measurements along a line under test, proceed as follows:

1. Set the MARKER POSITION control to 0.00.
2. Adjust the MARKER ZERO control to place the bright dot at a known (reference) point on the horizontal trace.
3. Adjust the MARKER POSITION control to place the bright dot on the distant point on the horizontal trace.
4. Check the MARKER UNCAL indicator lamp. The MARKER UNCAL lamp lights when the combined adjustment of the MARKER ZERO and MARKER POSITION controls exceeds the calibrated range of the measurement circuitry. Under these conditions, the MARKER POSITION indications may be incorrect.
5. Hold the UNEXPAND/FINDER switch in the FINDER position to recheck the true position of the zero reference point selected by the MARKER ZERO control. Adjust the MARKER ZERO control as necessary to select the exact measurement reference desired.
6. Release the UNEXPAND/FINDER switch and readjust the MARKER POSITION control to place the bright dot exactly upon the distance to be measured.
7. Multiply the indication of the MARKER POSITION control by the horizontal sensitivity selected on the FEET/DIV, NSEC/DIV switch. Disregard the position of the EXPAND switch. The result is the direct distance in feet or nanoseconds between the zero reference point and the MARKER POSITION point.

Figure 3-6. Distance/Time Measurements



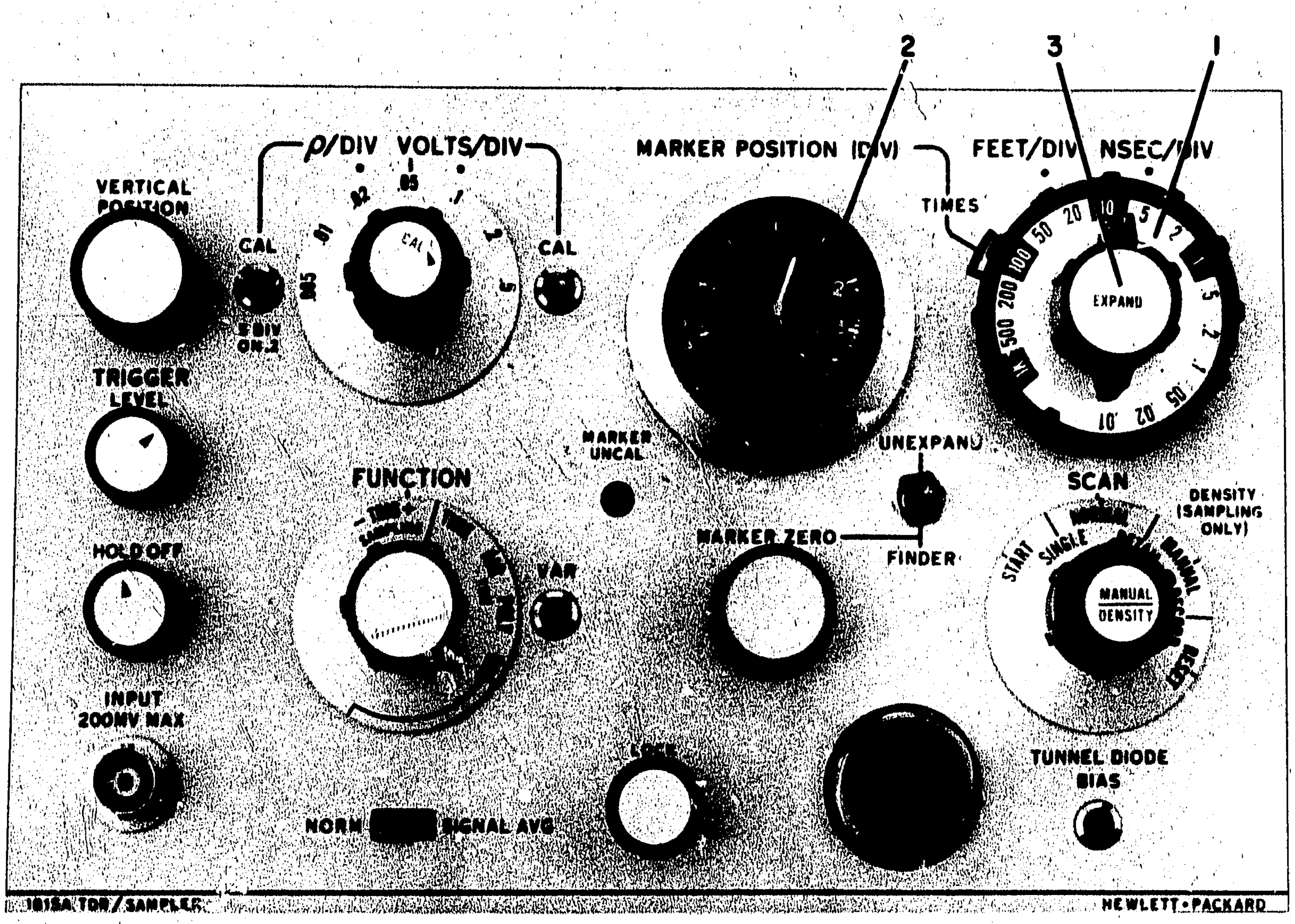
The FUNCTION switch selects calibrated display sensitivities for measurements along lines with polyethylene and air dielectrics. The VAR control of the FUNCTION switch enables selection of other calibrated display sensitivities for lines with dielectric constants between 1 (air) and 4. To adjust the VAR control for a dielectric constant, proceed as follows:

1. Perform the TDR OPERATION procedures described in paragraph 3-20.
2. Cut a length of the type of line to be tested.
3. Connect the line to the remote sampler output.
4. Set the FUNCTION switch to VAR.
5. Set the FEET/DIV and EXPAND switch pair to obtain the horizontal sensitivity required to measure the line connected. If the test line is exactly 2 feet long, the display will be two horizontal divisions on the 1 range.
6. Adjust the VAR potentiometer to derive the correct length of horizontal trace for the line connected.

Note

Be careful to determine the exact start point of the test cable so that the sampler connectors, adaptors, etc., are not included in the VAR adjustment.

Figure 3-7. Dielectric Constant Selections



Expanded modes of operation are selected to vary the horizontal sensitivity of the Model 1815A to observe small areas on a trace. The following procedure illustrates the uses of expanded operation.

1. Set the outer FEET/DIV, NSEC/DIV switch to select the desired decade range of horizontal sensitivity.

2. When expansion of a particular point on a trace is desired, adjust the MARKER POSITION control to place the bright dot on the waveform to be expanded. (The expansion modes display the area of a trace around the bright dot.)

3. Set the center EXPAND switch to select the expanded sensitivity desired. The marker pointer on the EXPAND switch will indicate the exact horizontal sensitivity of the display.

Note

DISTANCE and TIME measurements may be accomplished in expanded modes as described in Figure 3-6. When performing these measurements, watch the MARKER UNCAL lamp to avoid taking measurements beyond the calibrated range of the marker circuitry.

Figure 3-8. Expanded Display Operations

THEORY

SECTION IV

PRINCIPLES OF OPERATION

4-1. INTRODUCTION.

4-2. This section provides circuit theory analysis of the Model 1815A TDR/Sampler and Model 1817A Remote Sampler. The difference between the Model 1815A and 1815B TDR/Samplers is also described.

4-3. Due to the complexity of the instruments, circuit theory will first be covered on a general theory basis, followed by a block-diagram explanation and circuit details referenced to the schematics. The detailed block diagram and the schematics are located in Section V (rear of manual). Refer to the applicable diagrams while reading the text.

4-4. GENERAL THEORY.

4-5. THE TDR TEST METHOD.

4-6. Time-domain reflectometry (TDR) is a test method where an incident step (voltage pulse) is propagated into a circuit or cable under test and the reflections (echos) from the test system are plotted on a CRT with respect to time. Reflected voltages isolate (in time) changes in the impedance of the circuit or cable under test. The position of a reflected waveform (time function) on the display indicates the physical location of the reflection-causing condition (discontinuity). The shape and amplitude of a reflection waveform can be accurately measured to determine the type (resistive, inductive or capacitive) and magnitude of a discontinuity.

4-7. The Model 1815A uses the signal-sampling method to perform TDR tests because of the greater bandwidth, dynamic range and sensitivity available with sampling techniques. Signal sampling differs from conventional oscilloscope operation in that instead of presenting a complete display for each input waveform, voltage samples are taken at discrete points along many input waveforms and plotted as a series of dots on the face of the oscilloscope CRT.

4-8. A conventional oscilloscope uses a linear ramp to sweep a beam horizontally across a CRT. The horizontal drive signal in sampling circuitry is provided by a scan generator and is normally a staircase waveform. Each time that a TDR incident step is propagated into a test system, one signal sample is taken and the staircase voltage level is increased by one increment. Sampling and display of the reflection voltage takes place at the point on the display corresponding to the instantaneous staircase voltage level. A new incident step is generated for the taking of each new sample. Each step of the staircase voltage represents one sampled point and the entire staircase represents one scan across the CRT. At the end of a scan, the scan generator is reset and the process is repeated.

4-9. TIME BASE.

4-10. The sampling process is initiated by a trigger circuit. The trigger circuit output starts operation of a fast-ramp generator. The fast-ramp generator output is a linear-rising ramp sent as one input to a voltage comparator. The other input to the voltage comparator is a dc level equal to the present level of the staircase voltage. The ramp voltage rises until it is equal to the staircase voltage. At this point, the comparator fires. The comparator pulse is sent as a take-a-sample command to the remote sampler, and it is also sent to the scan generator to increase the staircase voltage by one increment.

4-11. On the first sample of a scan, the staircase voltage is at the minimum voltage level. Each time that the scan generator receives a trigger from the comparator, it increases the staircase voltage by one increment. The increasing staircase voltage levels are sent to the comparator. By generating a new ramp for each sample and comparing it to the increasing staircase voltage levels, samples are taken at progressively later points in time. (See Figure 4-1.)

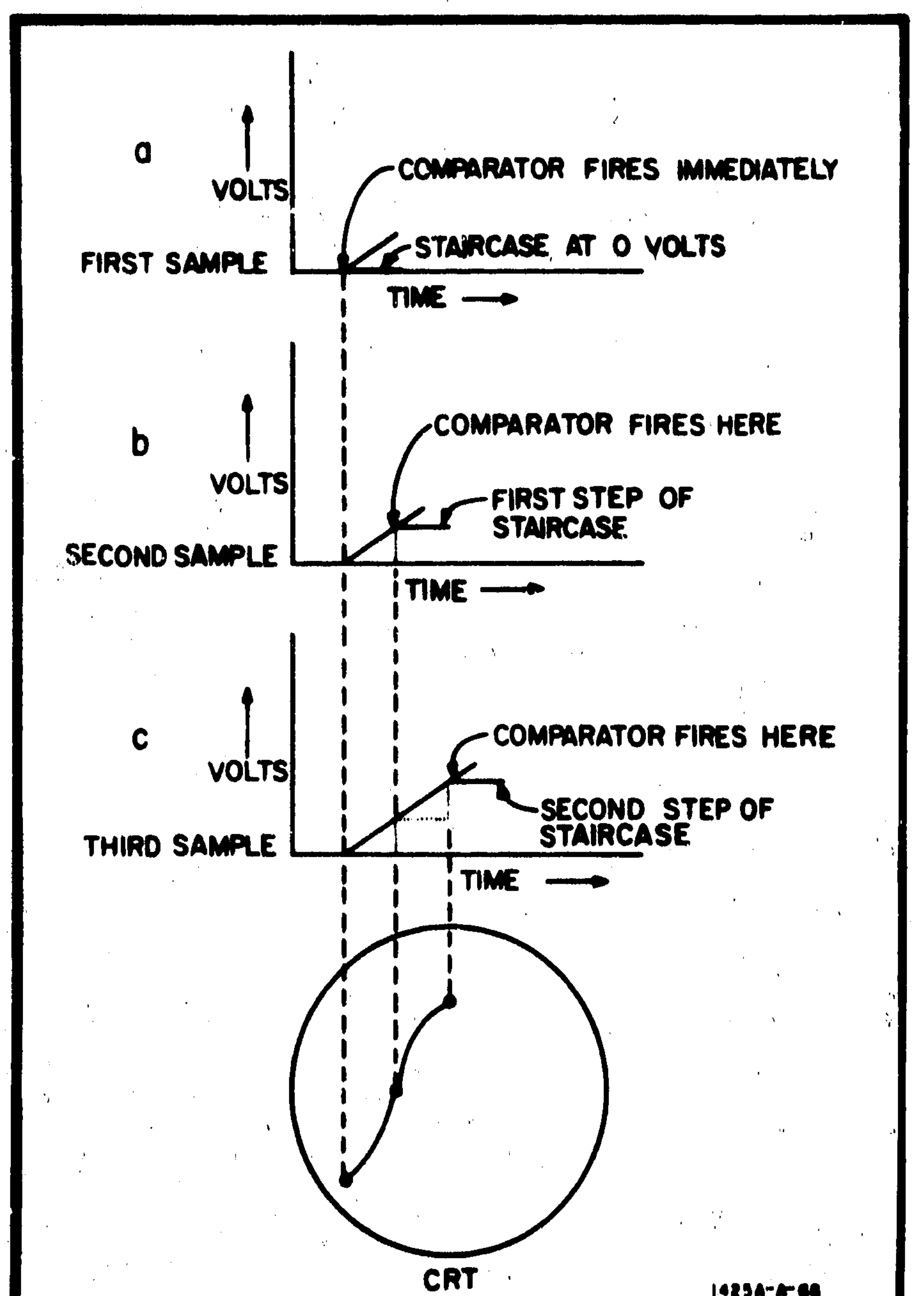


Figure 4-1. Comparator Operation

4-12. TDR/SAMPLING BASIC CIRCUITRY.

4-13. VERTICAL.

4-14. A basic sampling circuit is shown in Figure 4-2. It consists of a sampling switch, a series resistor, and a shunt capacitor to ground. At the instant that the switch is closed, the capacitor begins to charge. The switch is closed for such a brief period that the capacitor only charges to approximately 5 percent of the actual signal amplitude.

4-15. Figure 4-3 shows a sampler circuit with a vertical amplifier and feedback circuit added. Sampling is accomplished by momentarily closing the sampling switch. Some voltage, determined by the RC time constant of the input resistance and capacitance and instantaneous signal amplitude, is transferred to the input capacitor. This voltage is amplified and sent to the stretcher switch. The stretcher switch is closed at the same time that the sampling switch is closed, but remains closed for a much longer period of time. As a result, the stretcher capacitor has time to charge to the full voltage output of the ac amplifier. This voltage stored on the stretcher capacitor is applied to the vertical amplifier where it is amplified sufficiently to drive the vertical deflection plates of the CRT. This new level is also returned through a feedback attenuator to the input capacitor. The gain of the ac amplifier and reverse attenuation are normally adjusted so that the voltage sent back to the input capacitor will represent 100 percent of the sampled signal voltage.

4-16. TIME BASE.

4-17. The horizontal circuitry of a sampling oscilloscope differs greatly from that of a conventional oscilloscope. The primary function of the sampling time base is to

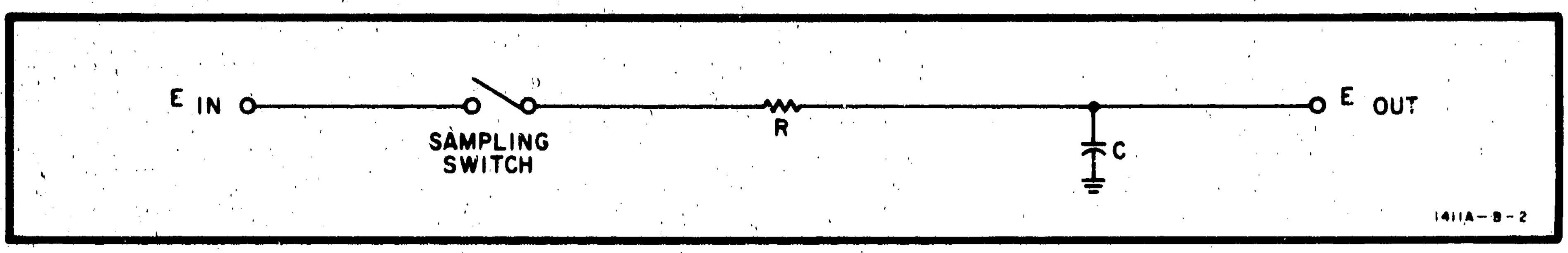


Figure 4-2. Basic Sampling Circuit

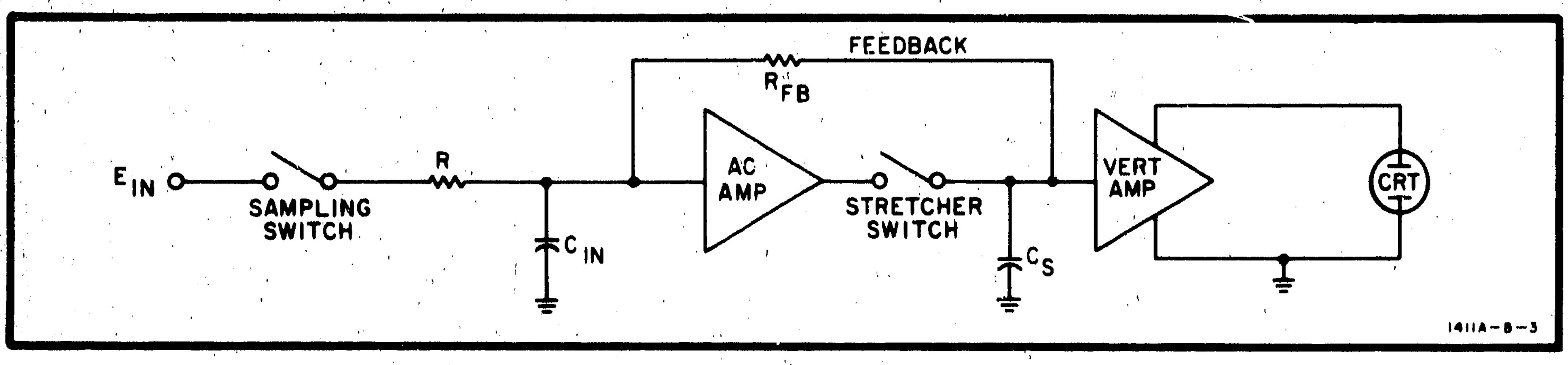


Figure 4-3. Basic Sampler and Vertical Amplifier

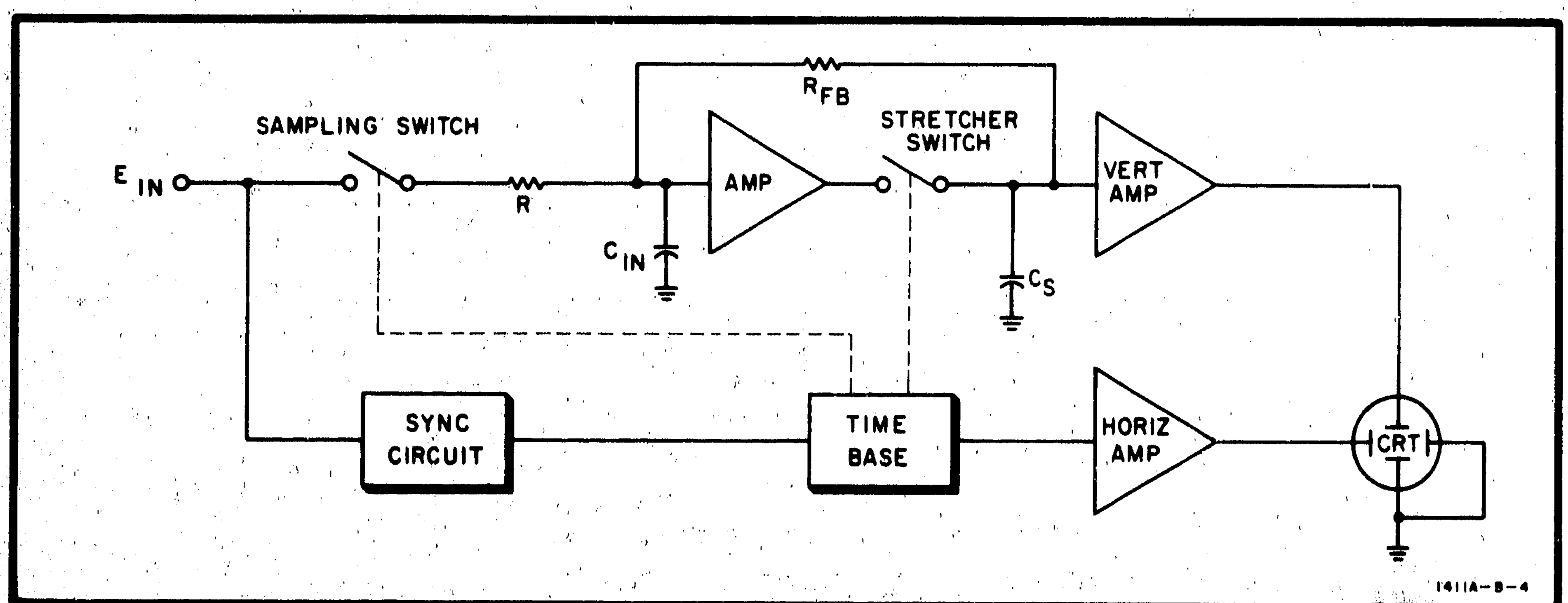


Figure 4-4. Complete Sampling System

generate a sampling command trigger for the vertical circuits and to move the dots across the screen in uniform increments of time. Figure 4-4 shows an entire sampling system.

4-18. To plot the dots (samples) across the CRT relative to the sample times, the staircase voltage is also applied to the oscilloscope horizontal deflection amplifier. Each staircase step is translated into a horizontal position on the CRT related to the sampled instant. Since each step is one voltage increment above the previous step, the samples are plotted progressively across the CRT screen.

4-19. VARIATIONS IN PRESENTATION.

4-20. The number of samples plotted in a scan is determined by the number of staircase steps that are produced in the scan. Changing the scan density varys the number of samples taken in each scan without affecting the horizontal time scale. (See Figure 4-5.) Scan density can be varied in sampling mode only. (In the TDR mode, the scan density is automatically controlled.) Increasing scan density improves display resolution. Decreasing scan density reduces trace flicker. By varying the number of dots on the CRT, the display can be optimized for best display definition and minimum flicker.

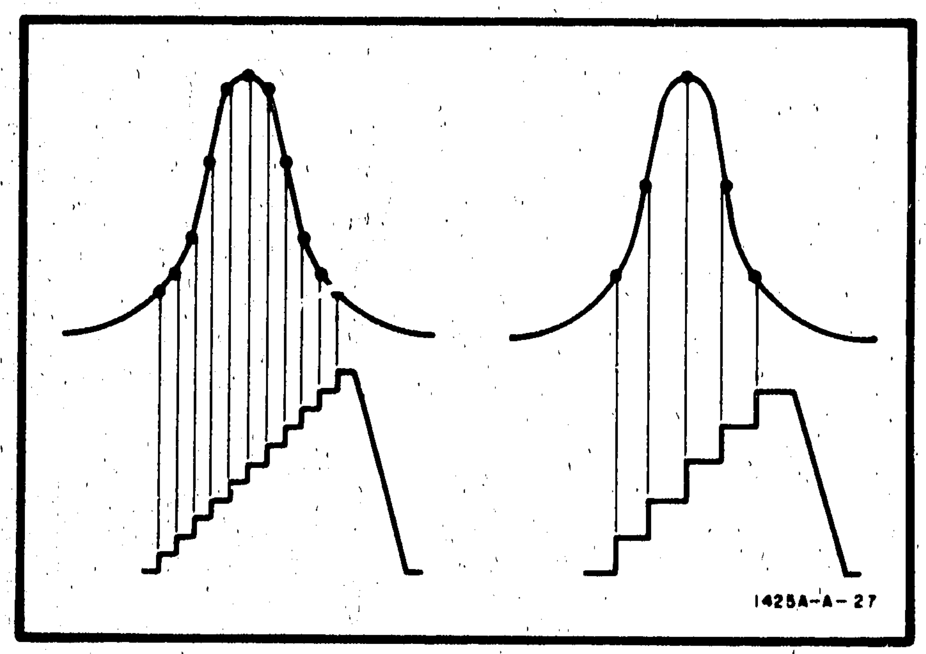


Figure 4-5. Scan Density

4-21. The horizontal time scale of the presentation can be varied in two ways. The slope of the timing ramp may be changed, and/or the staricase voltage to the strobe comparator may be attenuated. (The staircase voltage to the horizontal amplifier is not attenuated.) Decreasing the size of the staircase by attenuation has the same effect as increasing the slope of the timing ramp; expanding the display on the face of the CRT (see Figures 4-6 and 4-7).

4-22. The slope of the timing ramp is changed to make decade changes in the horizontal time scale. For each decade change, a different timing capacitor is switched into the fast ramp generator by the FEET/DIV, NSEC/DIV switch. Staircase attenuation is used for establishing intermediate ranges within the decades selected, and to provide faster ranges on the fastest decade. Staircase attenuation is accomplished using the EXPAND switch and can expand the horizontal scale up to a factor of 100.

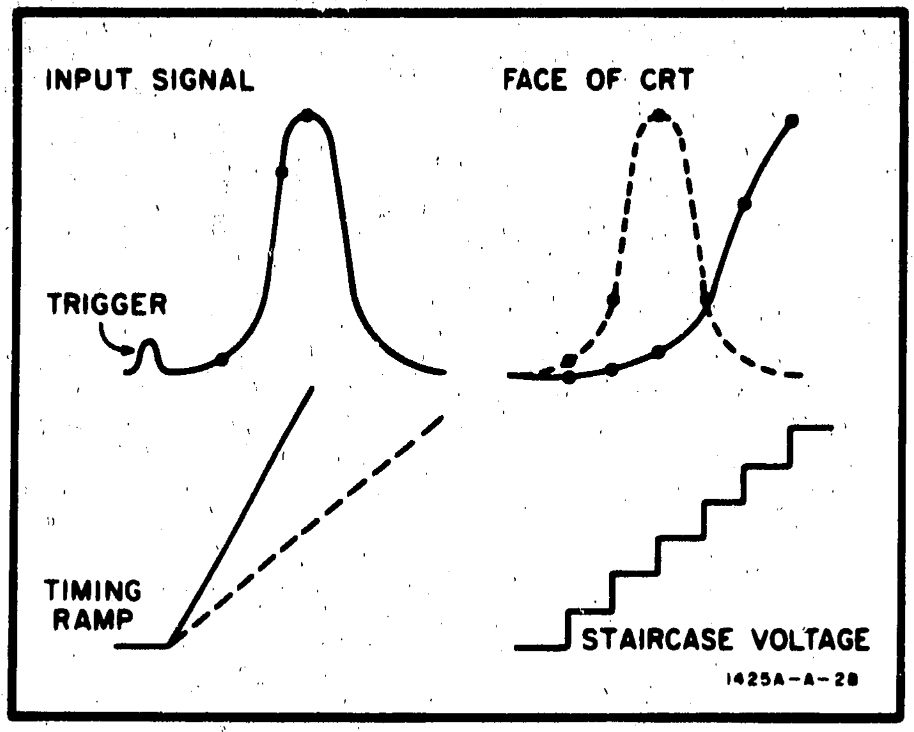


Figure 4-6. Ramp Slope

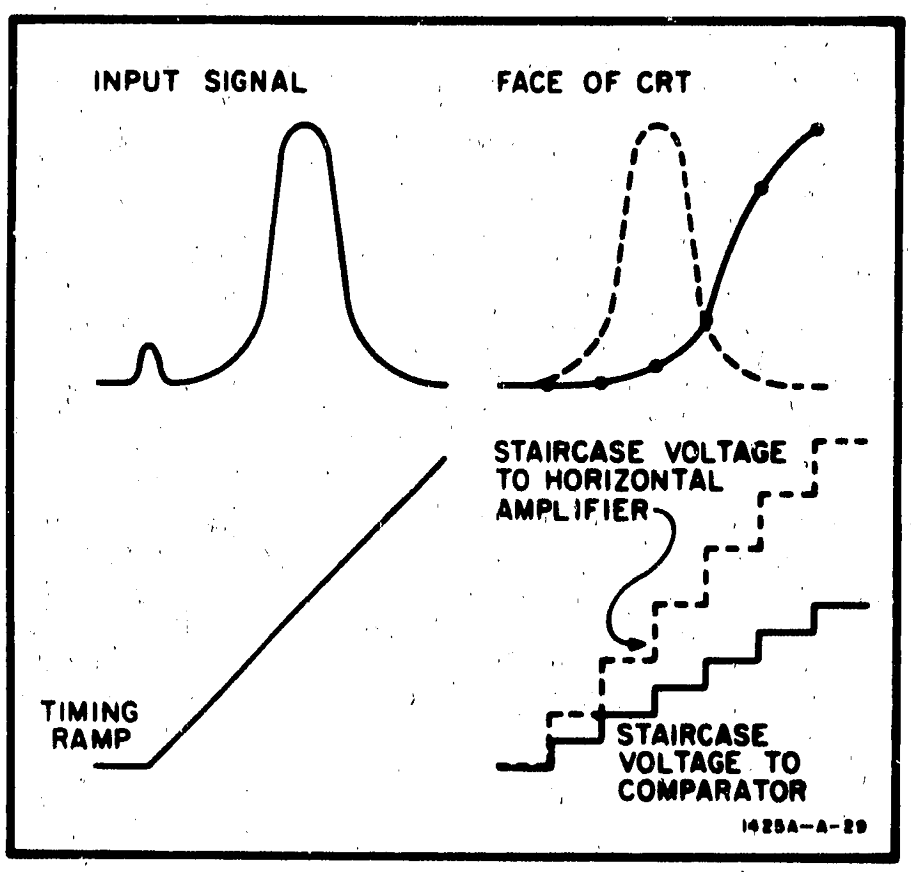


Figure 4-7. Staircase Attenuation

4-23. When the time scale is expanded and the scanning signal consequently attenuated, only a fraction of the decade timing ramp is scanned. The fraction of the timing ramp which is scanned is displayed, giving in effect a decreased time or distance scale. In the expanded condition, the scanning waveform may be positioned anywhere within the decade ramp by a voltage adjusted by the MARKER POSITION control (see Figure 4-8). Using expanded operation and the MARKER POSITION control, an expanded time window can be positioned anywhere within the decade range.

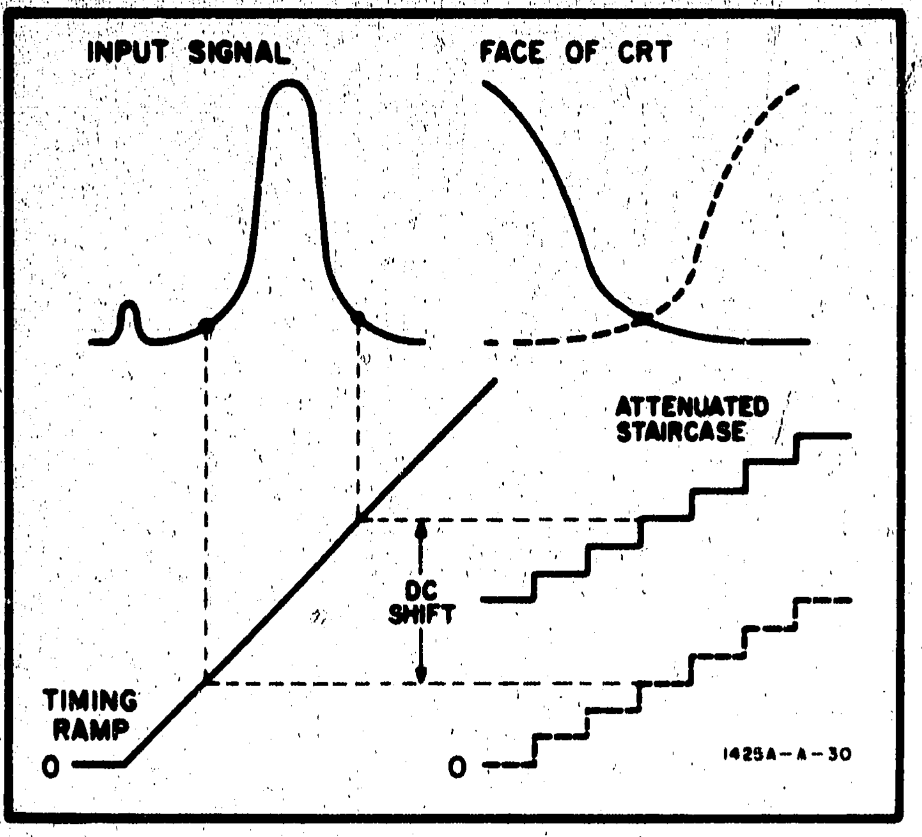


Figure 4-8. Expanded Position

4-24. BLOCK DIAGRAM DISCUSSIONS.

4-25. TDR MODE.

4-26. Figure 4-9 is a block diagram of the TDR/Sampling system used in the TDR mode of operation. Each TDR cycle begins with a trigger output from the trigger circuit biased to free-running operation. The trigger is operated as a clock and its output is applied simultaneously to two identical ramp gate circuits (the step and strope ramp gates).

4-27. The step ramp gate starts a linear-rising ramp output when triggered. The ramp is applied to the step comparator where it is compared to a dc level set by the STEP DELAY internal potentiometer. The STEP DELAY potentiometer is adjusted to delay the generation of the TDR incident step so that it always starts a fixed number of CRT divisions after the beginning of the trace.

4-28. The output from the step comparator is applied to

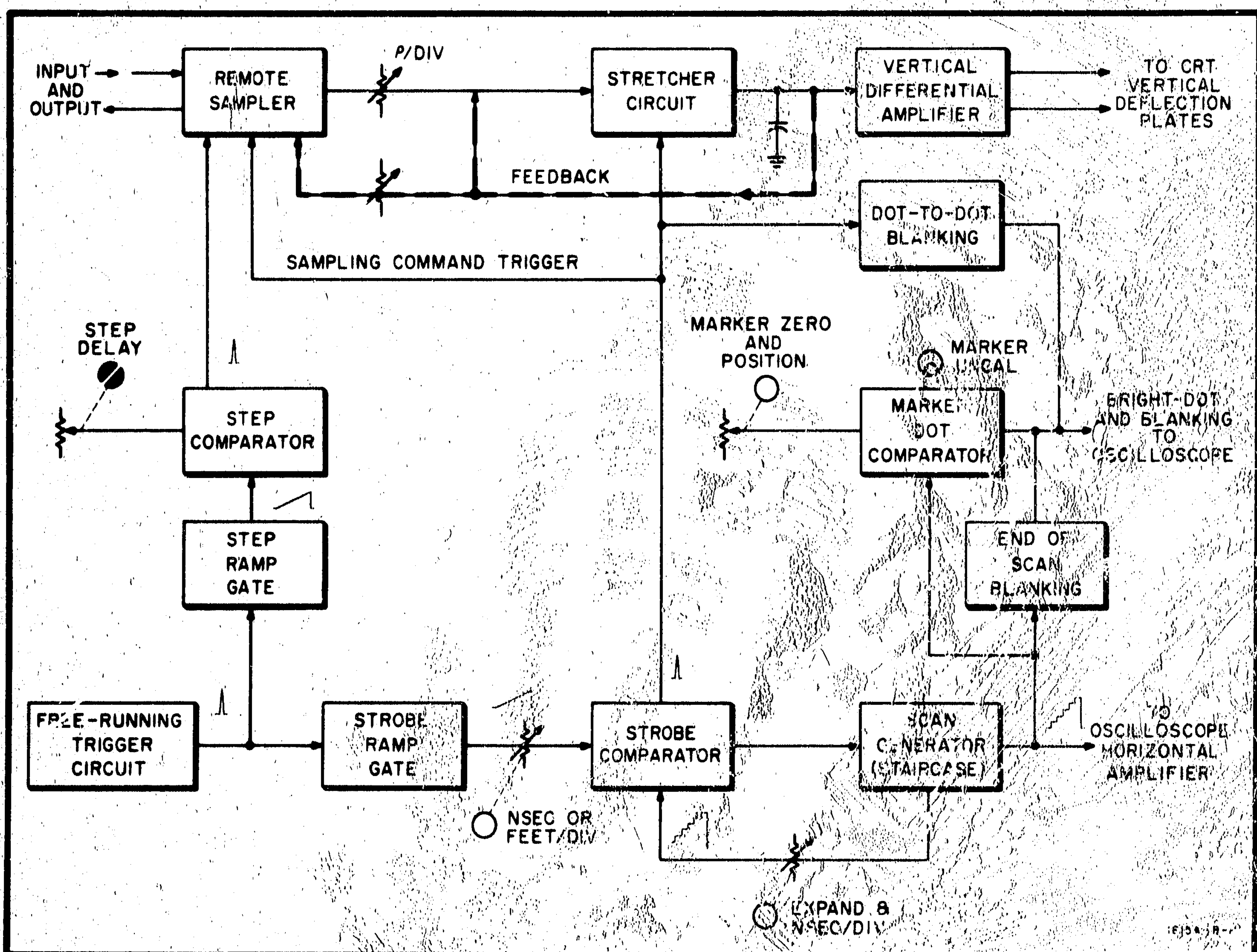


Figure 4-9. TDR Mode

the step generator circuit in the remote sampler. The comparator spike triggers generation of one incident-step pulse from the tunnel-diode mount each time comparison occurs.

4-29. When triggered, the strobe ramp gate simultaneously starts a second linear-rising ramp which drives one input of the strobe comparator. The other input to the strobe comparator is referenced to the level of the staircase voltage from the scan generator. When coincidence occurs, the strobe comparator generates a trigger signal. This trigger signal is sent to the remote sampler and causes a sample to be taken. The stretcher circuit and the countdown circuit also receive triggers. On command, a sampling gate in the remote sampler is biased on for a very short interval and takes a sample of the instantaneous signal voltage at the remote sampler. This voltage is applied through the ρ/DIV attenuator to the stretcher circuit.

4-30. The sampling command trigger also biases the stretcher circuit on. The stretcher circuit charges a stretcher capacitor to a value referenced to the input voltage at the remote sampler for the vertical sensitivity selected. The sampled voltage stored on the stretcher capacitor is applied to the vertical deflection amplifier which places the new sample value on the CRT.

4-31. The voltage stored on the stretcher capacitor is also fed back to stabilize the stretcher circuit gain and to compensate the remote sampler circuit. The actual sampling period in the remote sampler is so short that the sampler circuit is only able to charge to approximately 5 percent of the actual value of the input signal. The sampling feedback circuit corrects the standing charge on the remote sampler circuitry to the actual value of the voltage sampled when operated for 100-percent loop efficiency. With this correction, the remote sampler will only respond to the difference between the new value at its input and the true previous value when the next sampling command trigger is received.

4-32. The output from the strobe comparator is also applied to the dot-to-dot blanking circuit where it blanks the presentation on the CRT while the vertical circuitry is correcting to a new sample level. The strobe comparator trigger is also applied to the scan generator. The scan generator increases the voltage level of the staricase by one increment when the strobe comparator trigger is received. This new staircase voltage is applied to one input of the strobe comparator to delay generation of the next strobe comparator trigger by one increment when the next fast ramp is received.

4-33. The unattenuated staircase voltage is used as the drive signal in the oscilloscope horizontal amplifier. When the staircase voltage from the scan generator reaches the maximum value (full-scale CRT deflection), the staircase is automatically reset. At this time, a circuit responds to the reset function and blanks the CRT presentation for a period sufficient to allow full reset of the circuitry.

4-34. A dc voltage representing the combined settings of the MARKER POSITION and MARKER ZERO controls is applied to one input of the marker-dot comparator. The other input to the marker-dot comparator is the instantaneous value of the staircase. When the staircase reaches the value of the MARKER voltage, the comparator provides an output which increases the intensity of the CRT screen for the display of one sample dot. Adjustment of the MARKER POSITION and MARKER ZERO controls establish the position of the brightened dot (marker) on screen and the point about which the trace will be expanded in EXPAND modes. A comparator resets the marker-dot circuit with generation of the next sampled step to ensure that the marker dot will be brightened at only one point on the CRT.

4-35. A separate over-range circuit in the marker-dot comparator monitors the dc voltage from the combined MARKER POSITION and MARKER ZERO controls and lights a front-panel lamp when the combined positions of the two controls exceed the calibrated range of the MARKER POSITION control.

4-36. SAMPLING MODE.

4-37. Figure 4-10 is a block diagram of the TDR/Sampling system used in the sampling mode of operation. Much of the circuit performance for the TDR and sampling modes is the same. The following paragraphs will describe only the differences between the two modes of operation.

4-38. In signal sampling the trigger circuit functions as a monostable or astable depending on the TRIGGER LEVEL control setting. The TRIGGER LEVEL control adjusts the trigger circuit to respond to the amplitude of the input signal in the monostable mode. It also controls the countdown rate for cw triggering in the astable mode.

4-39. The step ramp gate and associated circuitry operate normally in the sampling mode. The step generator output may be used to stimulate external circuits. The strobe comparator, staircase generator, vertical channel and all associated circuitry function as described for the TDR mode of operation. The only exceptions to this are that the gain of the vertical deflection amplifier in the vertical channel ensures a display on the CRT in values of volts per division instead of ρ per division and the current drive for the fast ramp ensures a horizontal presentation in values of time per division rather than feet (or meters 1815B).

4-40. DETAILED BLOCK DIAGRAM.

4-41. A detailed block diagram of the TDR/Sampler system is provided ahead of the schematics in Section VIII. The following paragraphs are intended only to expand the information previously given to describe the greater details of the block diagram in Section VIII.

4-42. The trigger amplifier output (free-running or monostable) is applied through a ramp-gate driver amplifier to the step and strobe ramp gates. At generation

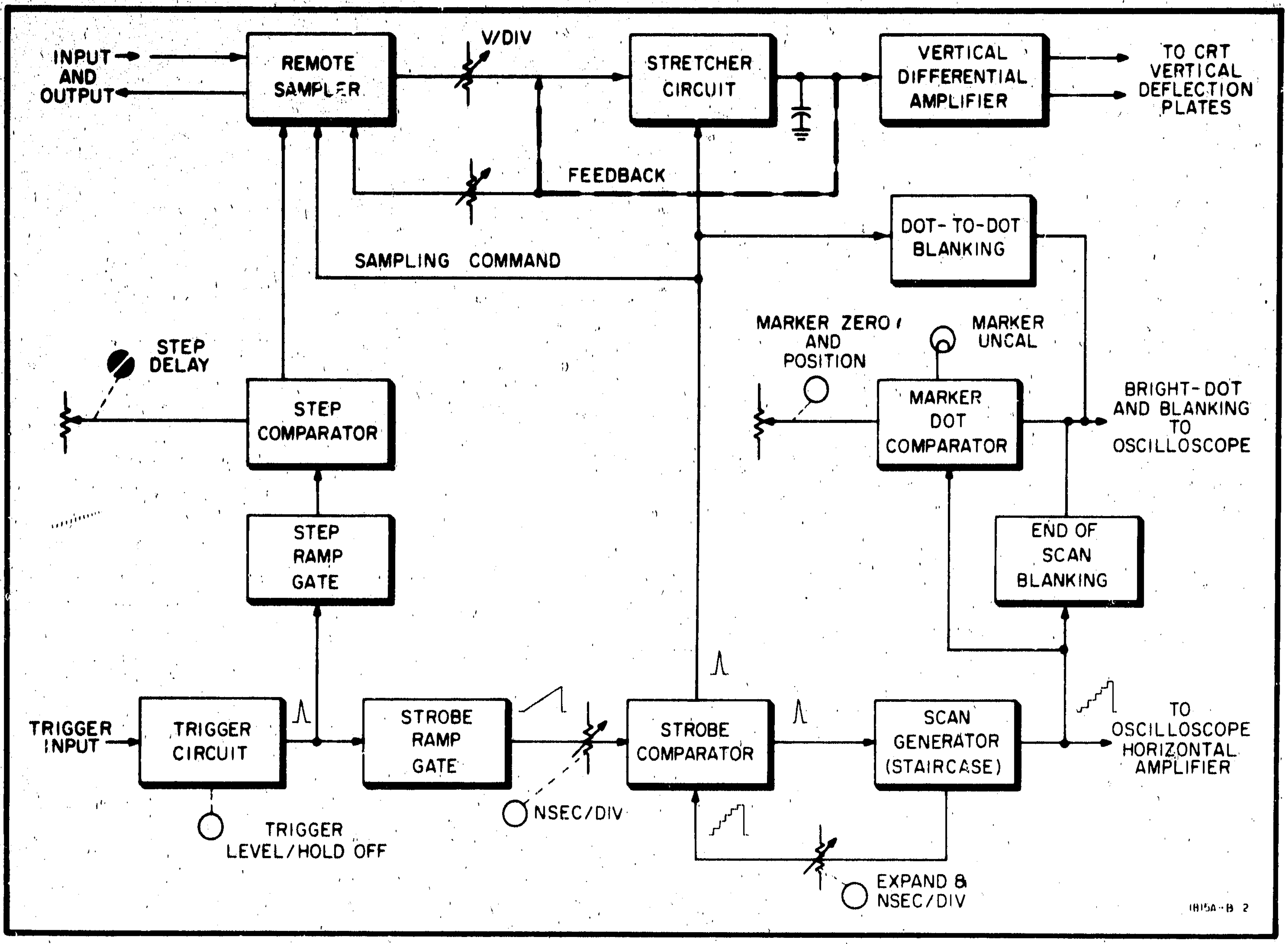


Figure 4-10. Sampling Mode

of a trigger, a hold-off circuit prevents generation of further triggers until the TDR/Sampler circuitry has completed all functions.

4-43. The output from the strobe comparator is used as described in the mode block diagrams except that before it appears at the staircase monostable, it is connected through a countdown circuit. In certain positions of the ρ/DIV, VOLTS/DIV, NORM, SIGNAL AVG, SCAN, and FUNCTION switches, several samples may be taken at each position of the staircase to derive a display with reduced noise and jitter. Depending upon the settings of the four front-panel switches, a countdown between 10 and 250 may be included with the strobe comparator trigger.

4-44. The staircase voltage is connected through attenuator networks before it appears at the strobe comparator. These attenuator networks derive the required horizontal sensitivity to obtain expanded displays. The output from the scanning amplifier to the oscilloscope horizontal amplifier is never attenuated as that would shorten the scan on the CRT display.

4-45. When the scanning amplifier output reaches the staircase maximum voltage (approximately 10 volts), a reset detector drives a reset switch to return the level on the staircase capacitor to the start voltage (approximately 0 volt). The reset pulse also drives a reset blanking amplifier which blanks the CRT display during the reset period.

4-46. At receipt of the strobe comparator trigger, the remote sampler circuitry is enabled for a short period. For the sample period, the circuitry charges toward the voltage standing at the input. After the sample period, the sampled voltage is supplied through an attenuator and amplifier network to the stretcher gate. The stretcher gate period is much longer than the sample period, and the width of the stretcher gate allows the stretcher capacitor to change to the full sampled voltage, determined by the vertical sensitivity and the input signal.

4-47. The stretcher voltage is applied to a differential amplifier which drives the oscilloscope vertical deflection plates. The stretcher voltage also returns through a feedback circuit to charge the sampler assembly to the true level of the sampled voltage for 100-percent sampling efficiency. When the sampling loop is operated at less than 100-percent efficiency, the input circuits do not reach the true sampled level. This may occur in certain operating ranges of vertical sensitivity, FUNCTION (TDR or sampling), SCAN (NORMAL or DETAIL), and signal averaging. The countdown circuit corrects for these conditions and allows the sampler to take enough samples at each point to gain the desired loop efficiency. When the sampling loop is operated at less than 100-percent efficiency, the displayed noise and jitter are reduced.

4-48. MODEL 1815A CIRCUIT DESCRIPTION.

4-49. STRETCHER VERTICAL AMPLIFIER.

4-50. The input voltage (proportional to the sampled amplitude) from the remote sampler is applied to connection J1-H and to the two input attenuators of the ρ/DIV, VOLTS/DIV switch. One attenuator selects sampling-loop efficiencies for ρ per division while the other provides sampling-loop efficiencies for volts per division. The FUNCTION switch selects between the two attenuators for displays consistant with the mode of operation.

4-51. Transistors Q1 and Q2 comprise a two-stage ac amplifier with a gain of three and a risetime of approximately 200 nanoseconds. The output signal is capacitively coupled to transistors Q3 and Q4, a second ac amplifier stage. Resistors R11 and R13 establish a nominal gain of 40 for the second ac stage. The SMOOTH potentiometer (R11) adjusts the gain of the second ac amplifier stage between 10 and 60. It is adjusted for 100-percent sampling-loop efficiency. The risetime of the second amplifier stage is approximately 250 nanoseconds. The NORM, SIGNAL AVG switch (S2) selects resistor R1 in SIGNAL AVG to reduce the gain of the second ac stage to about 20 percent of the original gain. The SIGNAL AVG position is used to reduce displayed sampling noise and jitter.

4-52. Transistors Q6 and Q7 comprise an emitter-follower pair which supplies the proper current to drive the stretcher-gate comparator. Field-effect transistor Q8 is the stretcher-gate transistor. During the stretcher-gate period, Q8 applies the sample voltage to stretcher capacitor C19.

4-53. Transistor Q9 and associated circuitry comprise the stretcher-gate shaper amplifier. The strobe trigger is coupled through capacitor C16 to the base of transistor Q9. The circuit associated with voltage-regulator diode VR1 supplies a negative dc bias to the collector of transistor Q9 which keeps Q8 off. The base is biased to cut-off through STRCH GATE potentiometer R30.

4-54. At receipt of the negative pulse, transistor Q9 saturates and remains saturated until the leakage current across potentiometer R30 returns the transistor base to cut-off. The positive 27-volt pulse output of Q9 (during saturation) is the stretcher-gate pulse. Potentiometer R30 is normally adjusted for a pulse width of 420 nanoseconds.

4-55. The STRCH GATE potentiometer (R30) is adjusted to allow the stretcher capacitor to change to a full value proportional to the input signal for the vertical sensitivity selected. The pulse reverse biases diode CR4. Diode CR4 isolates stretcher transistor Q9 from field-effect transistor Q8, allowing the field-effect transistor to conduct and apply the emitter follower output to stretcher capacitor C19.

4-56. Two field-effect transistors isolate the stretcher capacitor to avoid capacity leakage and maintain the accuracy of the charge over a long period of time. Transistors Q10 and Q11 form the stretcher-amplifier stage. Feedback resistor R39 establishes a nominal gain of unity for the two-stage amplifier. In the quiescent condition, the positive voltage across potentiometer R35 is adjusted for stretcher offset. Diode CR5 limits signal amplitude to transistor Q11 for off-screen signals.

4-57. In order to adjust STRCH BAL R35 and STRCH GAIN R33, a signal must be present on the display. As the NORM, SIGNAL AVG switch is set from NORM to SIGNAL AVG, potentiometers R33 and R35 are adjusted so that no change in gain (R33) and/or change in offset (R35) is noted.Potentiometer R33 adjusts the gain of the two-stage amplifier. The output signal is applied to vertical differential amplifier transistors Q12 and Q13.

4-58. A feedback circuit from the collector of transistor Q11 through resistor R31 to the base of Q6 and Q7 sets the proper dc level of the stretcher charging circuitry. A second feedback circuit is connected across an attenuator impedance network. The feedback voltage receives a dc offset from VERTICAL POSITION potentiometer R2 (by injecting a current into a constant impedance feedback attenuator) and is applied to emitter follower Q5. Diodes CR2 and CR3 and the associated voltage dividers establish the signal excursion limits in the feedback circuit to avoid large (off screen) signals. The emitter follower output is connected to the remote sampler where it charges the input sampler circuit to the true level of the sampled signal for 100-percent sampling loop efficiency.

4-59. The Y-axis drive signal for application to an X-Y recorder appears on one deck of the FUNCTION switch. The switch selects between sampling and TDR outputs. For sampling, resistor R40 establishes a recorder plot in volts per recorder division with a sensitivity of approximately 100 mV/div. For TDR recording, the signal from stretcher amplifier Q11 is supplied directly to the FUNCTION switch with a sensitivity of 100 mV/div.

4-60. VERTICAL OUTPUT DRIVER.

4-61. Transistors Q12 and Q13 and associated circuitry comprise a single-stage differential vertical amplifier (refer to the schematic in Section VIII). The differential output voltage is applied directly to the vertical deflection plates of the oscilloscope CRT. The gain of the differential amplifier is established by adjustment of front-panel CAL potentiometer R4 or R5. Either potentiometer R4 or R5 will be in shunt with A8R27 depending on the mode of operation (TDR or sampling). Potentiometer A8R27 adjusts the gain of the vertical amplifier between the ranges. Potentiometers R4 and R5 adjust circuit gain to derive accurate vertical displays in either units of ρ or volts per CRT division.

4-62. Transistors Q14 and Q15 comprise a differential current source. Current values are equalized by adjustment of potentiometer R51 in the common-emitter circuit. During normal output operation, a low negative voltage from the mainframe supply is connected through P1-21 and applied to the base of the current amplifiers. When the mainframe beam finder switch is pressed, the negative voltage is removed, and the bases of Q14 and Q15 drop to approximately -90 volts through diode VR2 and resistor R53. The VR2 voltage limits the current source outputs. The limited current reduces the dynamic range of the vertical amplifier enough to bring the beam into view from any vertical point beyond the CRT screen.

4-63. The circuit associated with TUNNEL DIODE BIAS potentiometer R3 controls the operating point of the external tunnel-diode pulse generator. Pin N of J1 receives a positive voltage from the remote sampler. Pin M of J1 is connected to the step-generator assembly in the remote sampler. When the FUNCTION switch is in one of the TDR modes, the positive voltage on pin N enables control of the sensitivity of the step generator from the TUNNEL DIODE BIAS control. When the FUNCTION switch is in a sampling mode, the BIAS BAL potentiometer allows the tunnel diode to fire without readjustment of the TUNNEL DIODE BIAS control.

4-64. During the TDR mode of operation, the tunnel-diode pulse generator is normally biased near the peak-point current when in the low-voltage state. The pulse generator incident step starts at this peak point level. This slight offset voltage produces a constant offset current. Pin T of connector J1 is also connected to the remote sampler assembly. The ZERO ADJ potentiometer (R42) is adjusted to cancel the offset current from the tunnel-diode pulse generator to eliminate display offset when different loads are applied to the remote sampler. Switch S1 can be used to remove the ZERO ADJ function when stimulus-response tests are performed. With S1 set to NORM in stimulus-response tests, the offset current would load the entire circuit or line under test. During sampling operation, the FUNCTION switch disconnects the ZERO ADJ function.

4-65. COUNTDOWN CIRCUITRY.

4-66. The countdown circuit is electrically located between the strobe comparator and the staircase monostable multivibrator. The trigger signal from the strobe comparator is applied to the base of transistor Q16. A portion of the signal is applied to the stretcher gate amplifier as the stretcher trigger. The emitter signal from Q16 is applied to the junction of capacitors C28 through C30.

4-67. The signal coupled through capacitor C28 is applied to transistor Q17, the dot-to-dot blanking amplifier. The portion of the signal coupled through capacitors C29 and C30 becomes the staircase trigger. When the operating control selections require no countdown, a positive 15-volt bias is connected through terminal color (91) and through resistor R61 to forward bias diode CR6. Diode CR6 completes a signal path for the strobe comparator output through capacitors C29 and C32 to the base of emitter-follower transistor Q23. Positive voltage across diode CR7 prevents conduction in transistor Q18.

4-68. When the mode selector switches are set to require a countdown, the positive 15-volt bias is removed from resistor R61. The negative 12.6-volt bias across resistor R62 back biases diodes CR6 and CR7. When conduction through diode CR7 stops, transistor Q18 becomes operational. For countdown, the input signal is coupled through capacitor C30 to the base of transistor Q18.

4-69. Transistors Q18 and Q19 and the RC-coupling network (R65 and C30) generate a 1-microsecond pulse for each strobe comparator trigger. The 1-microsecond pulse is direct coupled to the base of transistor Q20.

4-70. The emitter of transistor Q20 receives a positive 15-volt dc through the countdown emitter network selected by the four associated front-panel switches. With each strobe trigger, transistor Q20 conducts the current value (limited by the selected emitter network) for 1 microsecond.

4-71. Capacitor C36 is the countdown voltage capacitor. At the start of the countdown cycle, capacitor C36 has discharged to negative 12.6 volts. With each input pulse, the countdown current is applied to the countdown capacitor through diode CR8 for 1 microsecond. Diode CR9 remains back biased by the negative level standing on capacitor C36. With each successive input pulse, an additional charge current of 1-microsecond duration is applied to the capacitor.

4-72. The base of transistor Q21 is connected to a voltage near ground potential. When the voltage on capacitor C36 reaches approximately 0 volt, diode CR9 is forward biased and transistor Q21 is switched on. Transistors Q21 and Q22 comprise a regenerative amplifier which saturates at turn-on. When the transistors saturate, they generate a negative pulse that is dc coupled to the base of transistor Q23, the staircase trigger emitter follower.

4-73. At turn-on, the regenerative pair also provide a short circuit path around capacitor C36, and the capacitor discharges back to the negative 12.6-volt level.

4-74. The regenerative circuit returns sharply to the non-conducting state when capacitor C36 has discharged fully and the circuit is reset. The selected countdown resistor determines the number of strobe pulses required to produce one staircase trigger. Countdown ratios vary between 10 and 250 to 1. Staircase trigger emitter follower Q23 responds to the trigger impulse from the countdown circuit or from the bypass circuit and supplies a pulse to the staircase monostable multivibrator.

4-75. INPUT TRIGGER CIRCUIT DESCRIPTION.

4-76. The trigger signal is applied to the trigger INPUT connector during sampling operations. The FUNCTION switch selects either triggering on the positive or negative slope of the input signal through inverting transformer T1. The input signal is applied to the base of trigger preamplifier transistor Q2. The trigger preamplifier has a current gain of approximately 2. It provides isolation for tunnel diode CR3 and a 50-ohm load for transformer T1. The trigger signal is coupled from the collector of Q2 to diode CR3 through capacitor C5. Tunnel diode CR3 operates in either a monostable or astable mode for pulse or CW triggering respectively. The current from current source Q1 determines the mode of operation of tunnel diode CR3 and is adjusted by TRIGGER LEVEL potentiometer R7. The LEVEL RANGE potentiometer (R8) centers the range of R7 so that diode CR3 operates monostably over the first half of the rotation of R7 and astably over the last half. Diode CR3 synchronizes to the input signal and provides sharp negative spikes to tunnel diode CR4.

4-77. A spike from CR3 switches tunnel diode CR4 to the high-voltage state and diode CR4 drives transistor Q7 into saturation. The output of Q7 is applied to ramp-gate driver transistor Q8, driving it into saturation. Saturated transistor Q8 triggers the strobe and step ramp gate circuits. Tunnel diode CR4 is held in the high-voltage state by bias current through resistor R23 and diode CR5. Transistor Q8 remains in saturation until CR4 switches back to the low-voltage state.

4-78. With tunnel diode CR4 in the high-voltage state, transistor Q7 is saturated and supplies current to hold-off integrator Q6 which is normally off. The current supplied to the base of Q6 is varied by TRIGGER HOLD OFF potentiometer R9 to vary the length of the hold-off period by approximately 5 percent. In the quiescent state, transistor Q3 is normally conducting and its conduction establishes the start level of the integrator through CR6 and voltage divider resistors R18 through R20, R22, R25 and R26. (Transistor Q3 also keeps diode CR8 in the low-voltage state by supplying a current of approximately 3.5 milliamperes through resistors R22, R25 and R26.) Transistors Q4 and Q5 are both normally off.

4-79. When triggered, the voltage on the collector of integrator transistor Q6 decreases linearly from about 27 volts at a rate determined by integrator capacitor C9 or capacitors C9 and C10 in parallel, depending upon the setting of switch A6S1. As the collector voltage of Q6 decreases, transistor Q3 is turned off and the 3.5-milliampere bias current is supplied to tunnel diode CR8, setting CR8 just below its peak-point current. Thermistor RT1 provides temperature compensation for CR8. When the voltage on the collector of transistor Q6 drops below 5 volts, transistor Q4 begins to conduct, supplying additional current to tunnel diode CR8. Tunnel diode CR8 switches to the high-voltage state and drives reset clamp Q5 into saturation. Saturation current of Q5 back biases diode CR5, causing tunnel diode CR4 to switch to the low-voltage state which cuts off Q7. Transistor Q8 is cut off and this results in resetting the strobe and step ramp circuits. This condition is mid-way through the hold-off period.

4-80. With transistor Q7 cut off, the current to the base of integrator transistor Q6 reverses, causing the integrator to start charging toward 27 volts. Transistor Q4 cuts off as the integrator begins to charge, but diode CR8 remains in the high-voltage state since bias current from resistors R25 and R26 is above the diode valley-point current. As the collector of Q6 approaches 27 volts, transistor Q3 begins to conduct, drawing the current from resistors R25 and R26, and resetting diode CR8 to its low-voltage state. When CR8 resets, transistor Q5 is cut off. With Q5 off, diode CR4 is again biased near its peak-point current through diode CR5 and is ready to accept a new input trigger. In the TDR mode, diode CR4 is biased beyond the peak-point current through resistor R11 and the FUNCTION switch, causing the hold-off circuit to free-run.

4-81. In quiescent operation, transistor Q9 is saturated and applies a positive voltage to the step generator reset output. When transistor Q7 saturates and the hold-off period begins, transistor Q9 is cut off. Transistor Q9 remains cut off until diode CR4 is reset at the middle of the hold-off period. Transistor Q9 switches on to provide a step-generator reset pulse. The step generator reset function is used to reset the pulse generator differential amplifier in the remote sampler which resets the tunnel diode pulse generator.

4-82. Transistors Q11 and Q12 and associated circuitry comprise a unity-gain non-inverting feedback amplifier. This buffer amplifier provides a high load impedance for the staircase expand attenuator A6S1 and a low source impedance for the strobe comparator. Transistor Q10 is a current source which drives the input to the buffer amplifier. The current from transistor Q10 offsets the output of the buffer amplifier to establish a delay between the time that the strobe ramp starts and the first sample is taken. The MIN DLY potentiometer (R32) sets the minimum delay on the fastest decade range. In the other ranges, the delay if fixed by voltage divider R33 and R34. Transistors Q14 and Q15 comprise a unity-gain non-inverting feedback amplifier which functions as a buffer between the step-delay voltage and the step comparator. The step-delay voltage is a dc level set by potentiometer R49 which sets the time that the tunnel diode pulse generator will be triggered with respect to the start of the step ramp. Transistor Q13 is a current source for the step buffer amplifier and serves the same purpose as Q10.

4-83. The two buffer amplifiers and delay current sources in conjunction with the step and strobe ramps track each other so that the step appearing on screen from the tunnel-diode pulse generator will always start at the same relative position regardless of the decade selected.

4-84. STROBE AND STEP COMPARATORS CIRCUIT DESCRIPTION.

4-85. Operation of the strobe and step ramp gate circuits is identical. Only the strobe ramp circuit will be discussed. Transistor Q26 is a voltage source. RAMP ADJ. potentiometer R81 is adjusted to set the magnitude of the equal currents through transistors Q24 and Q25. The magnitude of the currents also depends on the setting of the FUNCTION switch. In the quiescent condition, all current from transistor Q24 is dropped across normally-conducting transistor Q22. When the ramp trigger from Q8 appears, it turns off transistor Q22 and the current from Q24 is applied to a timing capacitance selected by the FEET/DIV, NSEC/DIV switch. The voltage across the timing capacitor (the strobe ramp) rises linearly at a rate determined by the selected capacitance and the current output from transistor Q24.

4-86. Transistors Q16 through Q18 comprise the strobe comparator. The scanning signal from the unity-gain amplifier is applied to the base of Q16. The base of transistor Q17 is driven by the rising strobe ramp voltage. When the comparator is in the quiescent condition, transistor Q16 and diode CR11 are conducting and supply all of the current to current source Q18. Because the positive scan voltage is always higher than the ramp starting voltage, diode CR12 is back-biased, and conduction through transistor Q17 is by emitter resistor R59.

4-87. When the ramp and scan voltages are equal, transistor Q17 forward biases diode CR12 and begins to rapidly supply current to transistor Q18. The comparator switches. Transistors Q19 and Q20 comprise a regenerative amplifier. As transistor Q17 conducts (when comparison occurs) transistor Q20 is biased on. The pair regenerate and saturate very rapidly to produce a fast strobe trigger. The strobe trigger through connector J1 (pin F) triggers the strobe generator in the remote sampler and causes a sample to be taken. Transistor Q21 inverts the strobe trigger. The output of Q21 advances the staircase through the countdown circuit and triggers the stretcher gate.

4-88. Transistor Q22 is again turned on mid-way through the hold-off period and resets the strobe ramp. Transistors Q22 and Q23 are prevented from saturating by clamp diodes CR14 and CR16 respectively.

4-89. The step ramp is started exactly when the strobe ramp starts. The step ramp has the same slope as the strobe ramp and turns on the step comparator when the ramp reaches the step delay level. When the step comparator switches, the step trigger generator regenerates and provides a very fast trigger to the remote sampler through J1-L. This trigger is used to operate the tunnel-diode pulse generator.

4-90. SCAN GENERATOR CIRCUIT DESCRIPTION.

4-91. The following description assumes that the SCAN switch is in the NORMAL position. Transistors Q1 and Q2 comprise a monostable multivibrator. In the quiescent condition, transistor Q1 is off and Q2 is saturated. The base of Q1 is triggered through diode CR1 and capacitor C1 by a pulse from the countdown circuit. Upon receipt of a trigger, the monostable multivibrator changes state (Q1 saturates and Q2 is turned off). The multivibrator remains in this state for about 2 microseconds as determined by capacitor C2 and resistor R1. In the quiescent state, current switch Q3 is on. Its base is held near zero volt by the collector of Q2 and the collector of Q3 draws current through diodes CR5 and CR6, holding CR7 off.

4-92. Transistor Q4 and associated circuitry comprise a current source. The emitter network (selected by the SCAN and FUNCTION switches) determines the value of current through Q4. When a monostable pulse turns off current switch Q3, current from Q4 is connected through steering diode CR7 to charge staircase capacitor C8 for 2 microseconds. The MANUAL/DENSITY control (A7R2), operational only in the sampling mode, may be used to adjust the current in Q4 to control the staircase step height (scan density) for improved resolution or minimum flicker. In the TDR mode, the scan density is fixed.

4-93. Scanning amplifier transistors Q5 through Q8 form a unity-gain, non-inverting, complimentary source follower. The dc voltage offset of the amplifier is adjusted near zero by STRCS OFFSET potentiometer R20. Everytime the monostable multivibrator is triggered, the increasing charge on C8 generates a new step in the staircase waveform. Field-effect transistor Q5 provides a very high input impedance to avoid leakage of the charge on staircase capacitor C8. Transistor Q6 operates as a common-base amplifier driven by the drain of transistor Q5. The base of Q6 is connected through a zener diode to the output of the scanning amplifier to maintain a constant drain-to-source voltage of transistor Q5.

4-94. Darlington pair Q7 and Q8 form the output of the scanning amplifier. The output is fed back to the STRCS OFFSET potentiometer (source of Q5). The feedback circuit establishes unity gain in the scanning amplifier and provides an output impedance of approximately 2 ohms. When the staircase voltage at the output of the scanning amplifier exceeds 10 volts, diode VR3 starts to conduct and supply current to tunnel diode CR11. When tunnel diode CR11 switches to the high-voltage state, transistor Q11 saturates and turns on reset transistors Q9 and Q10, a regenerative pair. Staircase capacitor C8 discharges through conducting switch CR9 and Q9 and CR10. When the staircase begins to reset, diode VR3 stops conducting, resetting tunnel diode CR11. Transistors Q11, Q9 and Q10 remain saturated until C8 is discharged. This condition readys the circuit to generate a new staircase waveform.

4-95. The scan generator operates exactly the same way whether in NORMAL or DETAIL with the FUNCTION switch providing variable scan density in the sampling mode and fixed density in the TDR mode. The SINGLE scan mode is the same as the NORMAL and DETAIL modes except that the staircase does not reset at the end of a scan. Setting the scan switch to the start position triggers reset switch transistors Q9 and Q10, causing the staircase to reset. The reset switch (Q9 and Q10) is disconnected for the MANUAL, RECORD and RESET modes.

4-96. Diode CR8 is biased off in all positions of the SCAN switch except MANUAL, RECORD, and RESET. In these modes, current switch Q3 is disconnected from current source Q4 causing the current to flow continuously through diode CR7. In the MANUAL mode, diode CR8 is connected to the wiper of MANUAL/DENSITY potentiometer A7R2B. Capacitor C8 charges or discharges depending on the difference between the currents through diodes CR7 and CR8. Adjustment of A7R2B causes the output voltage from the scanning amplifier to vary between 0 and 10 volts. Capacitor C9 prevents the scan level from changing to rapidly.

4-97. In the RECORD mode, capacitor C9 is charged linearly by a greatly reduced current from Q4. Generation of the ramp in this mode takes about 60 seconds. Clamp diode A7CR1 prevents the ramp from rising beyond 10 volts in the RECORD mode. The RESET position is used to discharge record capacitor C9 before starting another RECORD ramp.

4-98. The staircase voltage through switch S1 is the reference voltage to the marker-dot generator circuit. Switch S1 is mounted directly on circuit board assembly A5. The switch may be used to disable the marker-dot generator when a marker-dot is not desired.

4-99. The scanning signal for the strobe comparator is connected to one side of the FEET/DIV, NSEC/DIV attenuator network. The other end of the attenuator network is driven by the delay voltage from the marker-position amplifier. The attenuation expands the display when the Model 1815A or 1815B is used in an expanded mode. The UNEXPAND position of the UNEXPAND/FINDER switch is used to bypass the attenuator and provide a quick reference to the unexpanded display when an operator is observing an expanded waveform. In the expanded condition, the attenuated scan signal can be positioned over the entire strobe ramp (decade range) by the delay voltage from the marker-position amplifier.

4-100. The unattenuated staircase voltage for the oscilloscope horizontal amplifier is connected across resistor R22 to connector P1-1. The unattenuated scan is also connected through resistor R14 and P1-11 for use as an X-axis recorder signal.

4-101. Transistor Q12 is the reset blanking amplifier. Each time that the reset driver generates a reset trigger, the trigger is also applied to the base of amplifier transistor Q12. During unblanked operation, pin P1-17 normally has a slight negative current due to the voltage divider action of resistors R30 through R34. When reset-blanking transistor Q12 conducts, it decreases negative current at pin P1-17 to blank the display.

4-102. The dot-to-dot blanking pulse is applied to the base of transistor Q13. The output of Q13 is dropped across resistor R33 to P1-17 to blank the CRT after presentation of each dot.

4-103. Resistor R32 forms a part of the internal/external horizontal source selection circuit. When the oscilloscope horizontal amplifier is to be driven by the internal scan generator, a negative 100-volt level is supplied by P1-3. When external horizontal control is selected, the negative 100-volt dc is removed from P1-3, and the voltage from the external control source is used as the blanking voltage.

4-104. MARKER-DOT CIRCUIT DESCRIPTION.

4-105. The MARKER POSITION and MARKER ZERO potentiometers (R10 and R11) select the marker-dot position on the CRT and provide the marker-delay voltage to the expand attenuator. The marker-position voltage drives the input of the marker position buffer amplifier Q14 through Q17, a unity-gain, low output impedance amplifier. The amplifier supplies a dc level (delay voltage) to one side of the marker-dot comparator, and the delay voltage to the EXPAND attenuator.

4-106. The delay voltage sets the point on the CRT where marker-dot presentation will occur. The other side of the marker comparator is driven through diode CR16 by the unattenuated scan signal from the scan generator. When the scan level is equal to the marker-position level, the comparator switches and triggers the bistable marker mulitivibrator which causes one dot on the CRT display to intensify. The next time the scan generator monostable multivibrator (Q1 and Q2) is triggered, it sends a pulse to the marker multivibrator through capacitor C25 to reset the circuit to normal dot intensity.

4-107. The MARKER POSITION potentiometer (R10) and MARKER ZERO potentiometer (R11) are connected in series and supplied with current from current source

Q24. The marker-position voltage is the sum of the voltages across potentiometers R10 and R11. Either potentiometer R10 or R11 is capable of generating a marker-position voltage in excess of 10 volts and either can move the marker dot over a 10-division range. The UNEXPAND/FINDER switch shorts out the MARKER POSITION control to determine the marker reference point as set by MARKER ZERO potentiometer R11.

4-108. MARKER OVER-RANGE CIRCUITRY.

4-109. When the sum of the voltages across R10 and R11 causes the marker to move beyond 10 divisions, the calibration of MARKER POSITION potentiometer R10 is invalid. A current source (Q25) supplies a current equal to that supplied by Q24 to resistors R62 and R63. The OVER RANGE CAL potentiometer (R62) is normally set so that the sum of R62 and R63 is 5000 ohms. The voltage developed across R62 and R63 is equal to the maximum marker-position voltage allowed for calibrated operation. The voltage is applied to one input of the over-range comparator transistor Q26. The other comparator input (Q27) is driven by the marker-position voltage. Transistor Q26 is normally conducting. When the marker-position voltage exceeds the calibrated range, the comparator switches. Transistor Q27 conducts, draws current through tunnel diode CR22 which switches to the high-voltage state, and transistor Q28 saturates. Current through Q28 turns on MARKER UNCAL lamp DS1.

4-110. MODEL 1817A SAMPLER CIRCUIT DESCRIPTION.

4-111. SAMPLING TRIGGER CIRCUITS.

4-112. The strobe trigger from the TDR/Sampler is used to trigger the sampling gate in the Model 1817A. The strobe trigger is a positive pulse ac coupled to the base of transistor Q1. Transistors Q1 and Q2 comprise a switch which saturates when the strobe trigger appears. The negative output step from the saturated circuit is coupled through capacitors C4 and C5.

4-113. The signal component coupled through capacitor C5 is applied to the base of transistor Q3. Transistors Q3 and Q4 comprise a second saturating switch. When the second pair saturates, the output is coupled through capacitor C6 as a positive current into step-recovery diode CR1 on assembly A2. The charge current is injected into diode A2CR1 for approximately 6 nanoseconds.

4-114. The pulse from the trigger amplifier on assembly A1 is also coupled through capacitor A1C4 to delay line DL1. The negative current from DL1 arrives 4 nanoseconds after the set pulse from trigger amplifier A1Q3 and Q4. The large reverse current from delay line DL1 removes charge from A2CR1. As soon as the stored charge has been removed, diode CR1 changes from a low impedance to a high impedance, causing a large negative fast voltage pulse. Step-recovery diode CR2 has a dc forward current from potentiometer A2R1 at all times. The large negative pulse from diode CR1 removes the quiescent charge from CR2 and a faster negative pulse is generated as CR2 changes to a high impedance. This pulse is coupled to the shield circuit of the sampler assembly to momentarily forward bias sampling diodes A7CR1 and A7CR2.

4-115. The voltage regulator networks associated with A1VR1 and A1VR2 establish the required biasing for operation of the saturating trigger amplifiers. Potentiometer A2R1 is adjusted to establish the proper operating forward current for step-recovery diode CR2.

4-116. DEVELOPING THE SAMPLE.

4-117. In the quiescent condition, voltage divider network R7 through R15 applies an approximate 1.5-volt back bias to the sampler diodes. When the trigger is applied to the sampler assembly and sampling diodes A7CR1 and A7CR2 are momentarily forward biased, sampling capacitors A7C1 and A7C2 charge toward the voltage standing on the line between J2 and J3. After the sample period, the charge on A7C1 and A7C2 is applied through the voltage divider network to the input amplifier on assembly A3.

4-118. When the external tunnel-diode pulse generator is connected to INPUT J2, it loads the sampler assembly with a quiescent current. This current acts as an offset to the display on the CRT and causes the display to change whenever the test load is changed. To eliminate the offset, a dc voltage is supplied through J1-T and the circuit associated with A3Q1, A3L8 and A7R3. The value of the dc current nulls the offset current from the tunnel-diode pulse generator.

4-119. LOW-FREQUENCY DISTORTION.

4-120. Since the sampling diodes (A7CR1 and A7CR2) have finite capacitance, high-frequency signal components at the input to the sampler will affect the sampling loop even though the diodes are reverse biased. This capacitance coupling causes low-frequency distortion. To eliminate the distortion, a component of the input signal is dropped across resistor R3 through a capacitive divider network to transistor Q2A in the differential emitter follower. This network is adjusted to simulate the sampler diodes so that frequency components through the back-biased sampler diodes appear as common mode voltages to the amplifier (Q2A, Q2B and MC1).

4-121. Transistors A3Q2A and B form a dual-differential emitter-follower network which provides isolation to the input terminals of microcircuit MC1. When the sampling occurs, the voltages from the sampler capacitors are applied through the voltage divider to the base of transistor Q2B. The sampled voltage unbalances the dual emitter-follower circuit. Microcircuit MC1, an operational amplifier offering gain and good common-mode rejection, amplifies the differential voltages. Emitter follower Q3 provides isolation for the output from the microcircuit and sufficient current to drive the sampler cable and input attenuator in the Model 1815A. The output from Q3 is connected through J1-H. The overall gain of the sampling preamplifier is approximately 15.

4-122. The feedback from the Model 1815A vertical amplifier is applied to pin J1-D. The feedback is proportional to the voltage stored on the stretcher circuit of the Model 1815A and is applied to a voltage divider between the bases of Q2A and Q2B. When the system is operating at 100-percent sampling efficiency, the feedback loop charges the sampler circuit to the true level of the sampled input during the instant of sampling. Otherwise, in the countdown mode, the feedback charges the sampler circuit toward the true value of the sampled input.

4-123. When the two transistor biases and the sampling capacitors (A7CR1 and A7CR2) are fully charged, the next sampled level will appear as a difference between the voltage stored on the sampler capacitors and the new voltage accepted. Microcircuit MC1 will respond to the difference voltage and change the voltage stored within the vertical amplifier circuitry of the Model 1815A only by the amplitude of the difference detected.

4-124. As the signal level changes, feedback from the vertical amplifier will cause the bias level on the sampling diodes to shift correspondingly. See Figure 4-11. The bias level shift keeps the sampling diodes (A7CR1 and A7CR2) centered electrically on the incoming signal. If the signal varies more than ±1 volt from the level on the sampling diodes, one of the diodes will conduct. This factor limits the dynamic range of the sampler to ±1 volt.

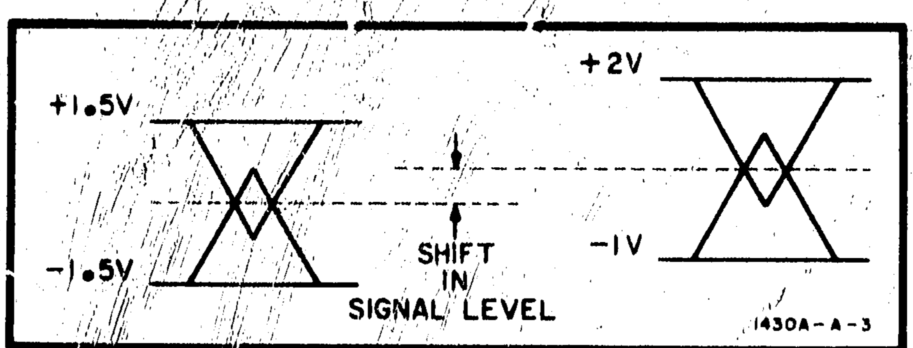


Figure 4-11. Signal Level Shift

4-125. Adjusting RESPONSE potentiometer A3R16 changes the bias voltage applied to the sampling diodes, affecting the sampling time. See Figure 4-12. Decreasing the sampling time increases bandwidth (improving risetime) but decreases sampling efficiency. Increasing sampling efficiency slows the risetime but decreases noise.

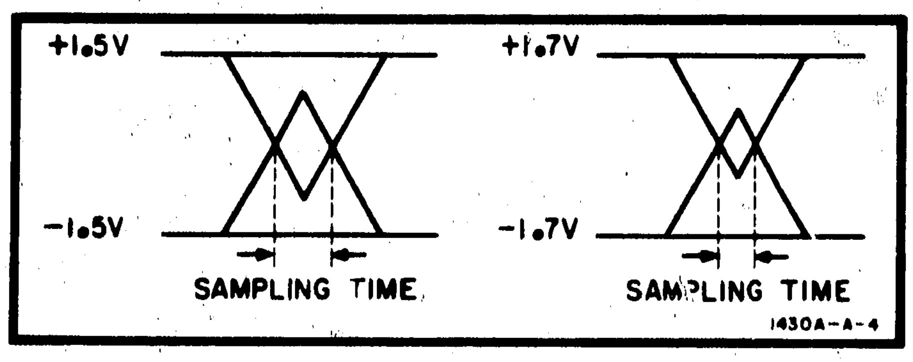


Figure 4-12. RESPONSE Adjustment of Sampling Time

4-126. Potentiometer A3R16 is adjusted to reverse bias sampling diodes A7CR1 and A7CR2 at a level that will allow the sampling gate to provide the proper system risetime. The CEN BIAS potentiometer (R14) is adjusted for optimum balance of sampling gate pulses. Capacitor A3C6 is adjusted for optimum common-mode rejection of the feedback signal at test point TP1. Capacitance C3 (screw on chassis) is adjusted for optimum low-frequency common-mode distortion.

4-127. STEP TRIGGER GENERATION.

4-128. Assemblies A4 and A5 are normally used to trigger a tunnel-diode pulse generator. In sampling operations, they may be used to generate a sync pulse. The step trigger from the step comparator of the Model 1815A is applied to pin J1-L. Transistors Q1 and Q2 form a differential amplifier. The step trigger is amplified and coupled through diode A4CR1 to trigger the external tunnel-diode pulse generator at J4. Tunnel diode A4CR2 sharpens the trigger pulse.

4-129. The reset pulse is derived from the Model 1815A trigger hold-off circuit at the middle of the hold-off period. The reset pulse appears ahead of the next step trigger and is applied to the base of transistor A5Q1. The pulse output from A5Q1 is coupled through A5Q2 and A4Q3 to reset the external tunnel-diode pulse generator. Voltage regulator A4VR1 limits the amplitude of the reset pulse to a safe operating level. Diode A4CR1 blocks the reset transition from the differential amplifier to prevent generation of a second trigger pulse when the external tunnel-diode pulse generator resets. Transistor A5Q2 controls the bias level on the external tunnel-diode pulse generator for optimum TDR triggering. A bias voltage from the Model 1815A controls current through A5Q2 and the external tunnel diode for minimum jitter in the TDR pulse.

PERFORMANCE CHECK

Table 5-1. Recommended Test Equipment

Instrument		Required	Required for
Type	Model	Characteristics	
Test Power Supply	HP Harrison 6111A	.05 to 2 V ±.01% Less than 1 ohm output impedance	Sensitivity calibration. Performance Check.
Tunnel-diode Pulse Generator	HP1106A		Risetime and overshoot, step delay and adjust, stretcher balance, sensitivity cal., Bias adj. Performance Check.
Square-wave Generator	HP211B or HP222A	100 kHz, 2 V p-p, 50-ohm output, 60 ns pretrigger	Common-mode rejection, low-frequency distortion, Minimum delay adj. Performance Check.
Monitor Oscilloscope	140A 1421A 1402A or 180A 1820A 1801A		Stretcher gate width, Diode Bias adjust, common-mode rejection adj, Staircase offset adjust.
DC VTVM	HP412A		Vertical balance adjust.
Signal generator	HP612A HP606B HP608D	500 MHz, 140 mV p-p 500 kHz to 5 MHz at 160 mV p-p 10 MHz to 420 MHz at 160 mV p-p	Diode bias adj. only. Performance check only. Performance check only.
Time-mark Generator	Tek Type 184		Time/div cal. Performance Check.
X10 Attenuator			Time/div cal. Performance Check.
Short (APC-7)			Zero adj. Performance Check.
Power divider			Time/div cal., Minimum delay adj. Performance Check.
60 NS Delay Line			Minimum delay adj. Performance Check.
50-ohm Termination			Adjustment procedures. Performance Check.

SECTION V

PERFORMANCE CHECK AND ADJUSTMENTS

5-1. INTRODUCTION.

5-2. This section provides adjustment procedures and a performance check for the Model 1815A/B and 1817A TDR/Sampling group. The performance check may be used as an incoming inspection, or after repairs or adjustments have been made, to verify that the instruments meet the specifications listed in Table 1-1. When the initial performance check is made, record the indications on the Performance Check Record. These indications may be useful for comparisons with equipment performance at a later date. Refer to Paragraph 5-19 for adjustment procedures.

5-3. REQUIRED TEST EQUIPMENT.

5-4. Test equipment recommended for both the performance check and adjustments is listed in Table 5-1. Similar equipment may be substituted, provided it has the required characteristics as listed in the table.

5-5. PERFORMANCE CHECK.

5-6. Install the Model 1815A or B in the oscilloscope and allow at least 10 minutes for warm-up. Perform the checks and adjustments in the same sequence as they are listed. Succeeding steps are dependent upon the control settings and results of previous steps.

5-7. MODES OF OPERATION.

a. Set the Model 1815A controls as follows:

SCAN	NORMAL
MANUAL/DENSITY	mid-range
FUNCTION	TRIG +
MARKER POSITION	0.00
MARKER ZERO	ccw
NORM, SIGNAL AVG	NORM
VOLTS/DIV	.5
TRIGGER LEVEL	2-3 o'clock
NSEC/DIV	1
NSEC/DIV EXPAND	1
VOLTS/DIV CAL vernier	CAL (detent)

b. Rotate TRIGGER LEVEL control over its range. A free-running trace should be present for all settings cw from 12 o'clock and for no setting ccw from 12 o'clock.

c. Set the NORM, SIGNAL AVG switch to SIGNAL AVG. The sweep rate of the display should slow. Reset the NORM, SIGNAL AVG switch to NORM.

d. Set the SCAN switch to START and release it to SINGLE. One sweep should occur.

e. Set the SCAN switch to MANUAL and turn the MANUAL/DENSITY control. A single dot should move from left to right across the display as MANUAL/DENSITY is adjusted clockwise.

f. Set the SCAN switch to RESET and then to RECORD. A single sample dot should move from the left to the right of the display. The total time for one excursion should be between 1 and 2 minutes.

g. Set the SCAN switch to NORMAL.

h. Set the VOLTS/DIV switch to .005.

i. Observe the trace and set the SCAN switch to DETAIL. The sweep rate should slow.

j. Set the SCAN switch to NORMAL.

k. Set the VOLTS/DIV switch to .5.

m. Adjust the VERTICAL POSITION control over its range. The displayed baseline should travel equally up and down on the display about 2 divisions from the center graticule line.

5-8. MARKER DOT.

a. Adjust the HORIZONTAL POSITION control on the oscilloscope mainframe to align the bright dot with the far left graticule.

b. Set the MARKER POSITION control to 10.0 (fully cw). The bright dot should be exactly on the right-hand graticule line.

c. Hold the UNEXPAND/FINDER toggle switch in the FINDER position. The bright dot should reset to the left-hand graticule line. Release the switch.

d. Adjust the MARKER ZERO control cw. The MARKER UNCAL lamp should light as the bright dot travels beyond the right-hand graticule line (lights before dot is 5 mm beyond the line).

e. Reset the MARKER ZERO control ccw. The MARKER UNCAL lamp should go out before the bright dot returns to the right-hand graticule line.

TABLE 5-2. INDICATOR LAMP CHECKS

FUNCTION SWITCH	V/DIV	ρ/DIV	INDICATOR LAMP CONDITIONS NSEC/DIV	FEET/DIV
SAMPLING TRIG+ TRIG–	ON	OFF	ON	OFF
TDR TIME	OFF	ON	ON	OFF
TDR AIR, POLY or VAR	OFF	ON	OFF	ON

5-9. INDICATOR LAMPS.

5-10. Set the FUNCTION switch to the positions indicated in Table 5-2. Check for the indicator lamp conditions described in the table.

5-11. VERTICAL SENSITIVITY.

a. Set the Model 1815A controls as follows:

FUNCTION .... TRIG+
TRIGGER LEVEL .... 2 o'clock
SCAN .... NORMAL
MANUAL/DENSITY .... mid-range
NORM, SIGNAL AVG .... NORM
NSEC/DIV 1
VOLTS/DIV vernier .... CAL (detent)

CAUTION

If similar equipment is substituted for the HP Harrison Model 6111A Power Supply, it must have an extremely low output impedance (less than 1 ohm). If a power supply or voltmeter calibrator with a high output impedance is used, damage to the sampler and/or power supply may occur.

In substituted equipment, voltage transients may be present that exceed the maximum safe input of the sampler. These transients will occur between switch positions on the voltage or multiplier range switches. To avoid damage to the sampler, disconnect the input before changing voltage or multiplier settings.

b. Connect the test power supply to the remote sampler INPUT.

c. Set the VOLTS/DIV switch and adjust the power supply as indicated in Table 5-3. Check for the deflections indicated in the table. Alternately connect and disconnect the power supply to make the tests.

Note

For tests beyond the .05 range, connect a 1-uF, 200-V filter capacitor to each of the two terminals adjacent to test point TP6 on board assembly A1. See Figure 5-1.

TABLE 5-3. VERTICAL SENSITIVITY TESTS

VOLTS/DIV	POWER SUPPLY SETTING	DEFLECTION
.5	1 V (do not exceed)	2 div ±3%
.2	1 V (do not exceed)	5 div ±3%
.1	.8 V	8 div ±3%
.05	.4 V	8 div ±3%
.02	160 mV	8 div ±3%
.01	80 mV	8 div ±3%
.005	40 mV	8 div ±3%

d. Disconnect the test power supply and remove the filter capacitors.

e. Set the Model 1815A controls as follows:

FUNCTION .... TIME
ρ/DIV 2

f. Connect the 50-ohm termination to the remote sampler OUTPUT.

g. Connect an external tunnel-diode pulse generator for TDR operations.

h. Adjust TUNNEL DIODE BIAS to observe a TDR step on the oscilloscope if necessary.

Figure 5-1. Filter Capacitor Connection

i. Adjust the ρ/DIV CAL potentiometer for exactly 5 divisions of vertical step amplitude.

j. Disconnect the tunnel-diode pulse generator.

5-12. HORIZONTAL DEFLECTION.

a. Connect the Time-mark Generator to the remote sampler as shown in Figure 5-2.

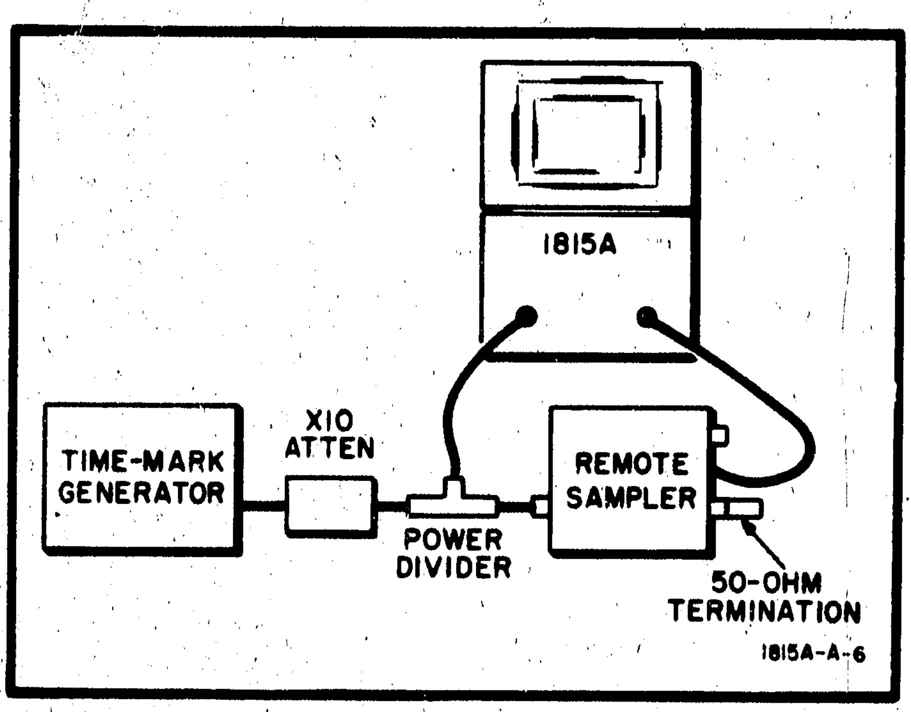


Figure 5-2. TIME/DIV Test Setup

Table 5-4. Horizontal Deflection Tests With Time-mark Generator

NSEC/DIV	EXPAND	Time-mark Generator	DEFLECTION
1 K	1 K	1 uSEC	1 mark/div ±3%
1 K	500	.5 uSEC	1 mark/div ±3%
1 K	200	.1 uSEC	2 marks/div ±3%
100	100	.1 uSEC	1 mark/div ±3%
100	50	50 ns	1 cycle/div ±3%
100	20	20 ns	1 cycle/div ±3%
10	10	10 ns	1 cycle/div ±3%
10	5	5 ns	1 cycle/div ±3%
10	2	2 ns	1 cycle/div ±3%
10	1	2 ns	1 cycle/2 div ±3%

b. Set the FUNCTION switch to TRIG+.

c. Set the NSEC/DIV switch pair and the Time-mark Generator as required in Table 5-4. Adjust the TRIGGER LEVEL control for a stable display.

d. Disconnect the Time-mark Generator and connect the Signal Generator.

e. Perform the remainder of the horizontal deflection tests (Table 5-5) with the Signal Generator connected.

f. Disconnect the Signal Generator.

g. Set the FUNCTION switch to TIME.

h. Connect a Model 1106A Pulse Generator to the remote sampler for TDR tests.

i. Connect an open-ended cable or air line to the remote sampler OUTPUT. The length of the line should be between 10 and 50 centimeters.

Table 5-5. Horizontal Deflection Tests With Signal Generator

NSEC/DIV	EXPAND	SIGNAL GEN	DEFLECTION
10	.5	1 GHz	1 cycle/2 div ±3%
10	.2	1 GHz	3 + peaks/10 div ±3% (2 complete cycles)
10	.1	1 GHz	2 + peaks/10 div ±3% (1 complete cycle)
1	1	1 GHz	1 cycle/div ±3%

j. Adjust the TUNNEL DIODE BIAS control for a display of a TDR pulse if necessary.

k. Adjust the μSEC/DIV switch pair so that the length of the line displayed is from 5 to 10 divisions. See Figure 5-3.

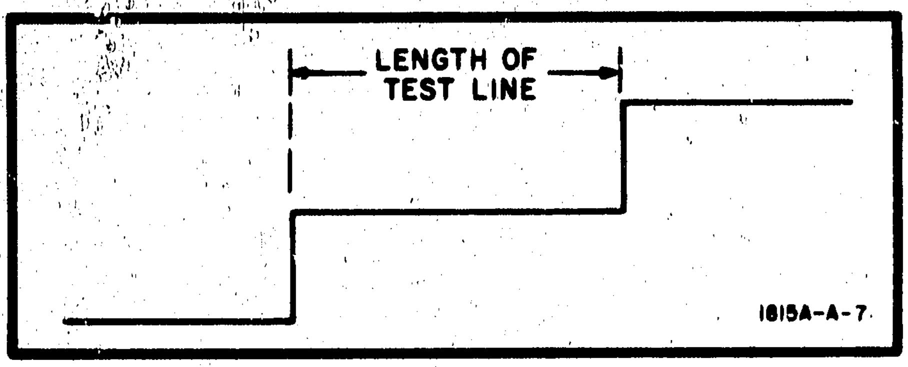


Figure 5-3. Test Line Measurements

m. Record the length of the line adjusted in the step above.

n. Set the FUNCTION switch to AIR. The horizontal length of the line should be half ±5% of the length obtained in the TIME postion.

p. Set the FUNCTION switch to POLY. The horizontal length of the line should be one-third ±5% of the length obtained in the TIME position.

q. Set the FUNCTION switch to VAR. Adjust the VAR potentiometer over its range. The horizontal length of the line should vary between the length measured in AIR position and that measured in POLY position.

r. Disconnect the test cable and connect a 50-ohm termination to the remote sampler OUTPUT.

5-13. RISETIME AND NOISE.

a. Set the FUNCTION switch to TIME. The oscilloscope should display a risetime of 35 ps or less with less than 5% overshoot when using an HP Model 1106A Tunnel-diode Pulse Generator.

b. Disconnect the 50-ohm termination and connect the short to the remote sampler OUTPUT. Observe the trace following the shorted return. Reflections should be less than ±10% (1 division when on the .1 ρ/DIV range).

c. Set the FUNCTION switch to TRIG+.

d. Remove the short and reconnect the 50-ohm termination.

e. Remove the external tunnel-diode pulse generator.

f. Set the VOLTS/DIV switch to .01 and vernier to CAL (detent).

g. Set the MANUAL/DENSITY control fully clockwise.

h. Set the TRIGGER LEVEL control for a free-running trace. Displayed noise should be less than 8 mV (excluding random dots). To determine noise, visually measure the peak-to-peak amplitude of the baseline (including random dots) and take two-thirds of the measured value.

5-14. DYNAMIC RANGE.

a. Connect a square-wave or pulse generator to the remote sampler INPUT. (Refer to Table 5-1.)

b. Connect the pulse generator trigger to the Model 1815A INPUT connector.

c. Set the Model 1815A VOLTS/DIV control to .2.

d. Set the pulse generator to supply a frequency of from 100 kHz to 1 MHz.

e. Adjust the controls of the Model 1815A for a stable display of two or three pulses.

CAUTION

Do not exceed a 1-volt peak-to-peak input to the remote sampler.

f. Slowly increase the amplitude from the pulse generator up to 1 volt peak-to-peak. The displayed pulse should remain undistorted and unbroken.

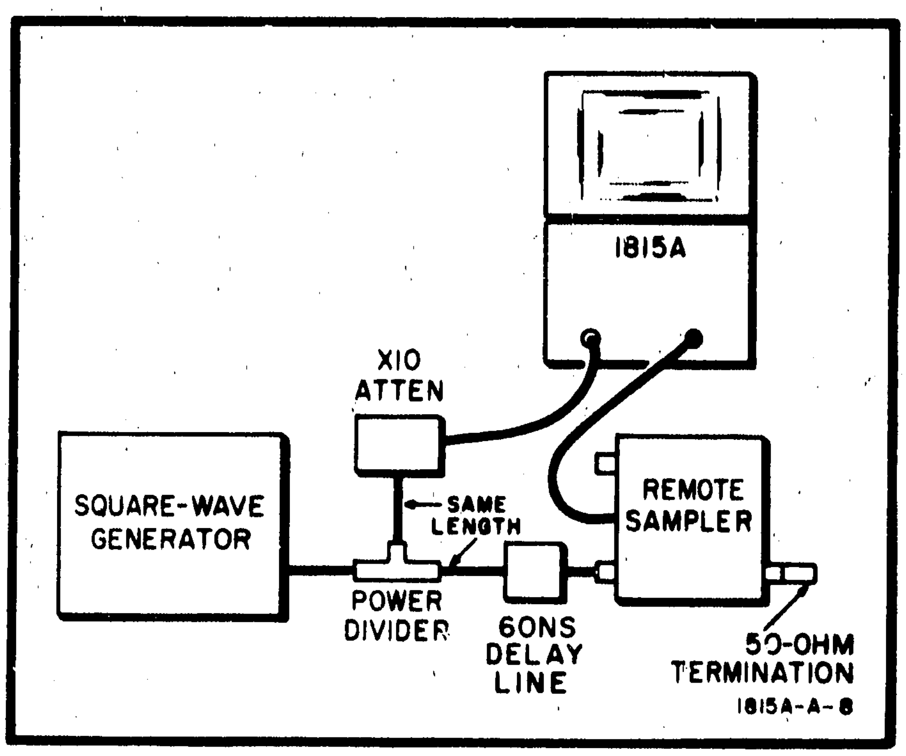


Figure 5-4. Pulse Triggering Test Setup

5-15. PULSE TRIGGERING.

a. Connect the equipment as illustrated in Figure 5-4.

b. Set the FUNCTION switch to TRIG+.

c. Adjust the square-wave or pulse generator amplitude for a 500-mV pulse displayed on the oscilloscope. (This sets the trigger input to 50 mV).

d. Vary the generator frequency between 50 kHz and 10 MHz. By adjusting TRIGGER LEVEL, stable triggering should obtained at all frequencies. (Reset NSEC/DIV as necessary when changing frequencies. Vary MANUAL/DENSITY at low frequencies to check for false displays.)

e. Disconnect the square-wave or pulse generator.

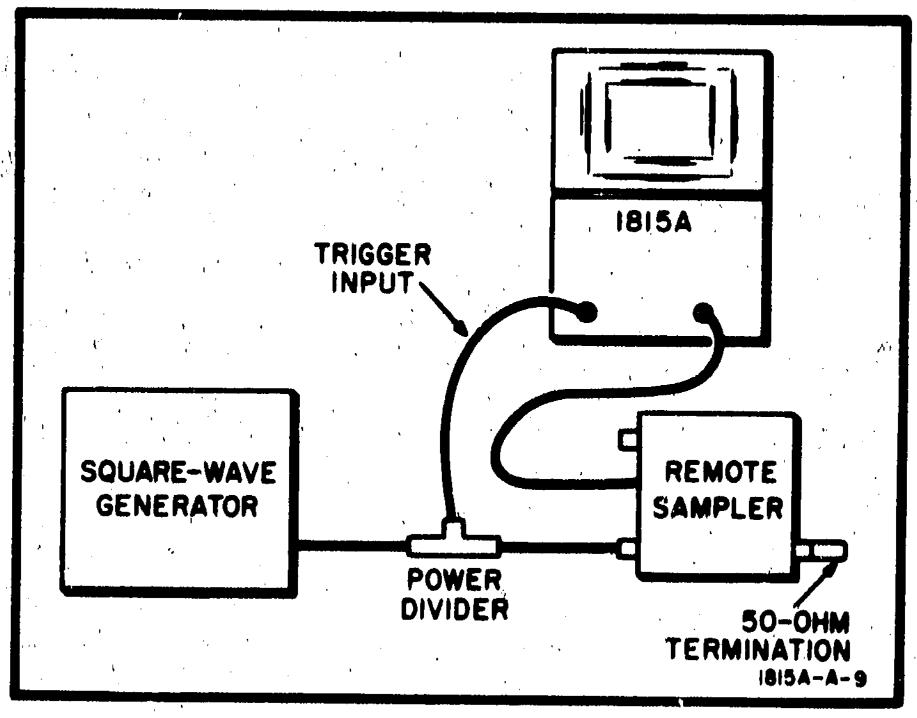


Figure 5-5. CW Triggering Test Setup

5-16. CW TRIGGERING.

a. Connect the equipment as illustrated in Figure 5-5.

b. Adjust the signal generator for an 80-mV peak-to-peak trigger to the Model 1815A INPUT.

c. Adjust the Model 1815A TRIGGER LEVEL control for stable triggering.

d. Set the controls and check the jitter as described in Table 5-6.

e. Jitter at any frequency should be less than 2% of signal period plus 10 ps when signal amplitude is at least 80 mV.

f. Disconnect the signal generator.

Table 5-6. CW Triggering Tests

OSC	FREQ	NSEC/DIV	MAX JITTER
606B	500 kHz	50	40 ns
606B	1 MHz	20	20 ns
606B	5 MHz	5	4 ns
608D	10 MHz	1	2 ns
608D	50 MHz	.5	510 ps
608D	100 MHz	.2	210 ps
608D	200 MHz	.1	115 ps
608D	420 MHz	.05	55 ps

5-17. TDR JITTER.

a. Connect the Model 1106A Pulse Generator to the remote sampler INPUT for TDR use.

b. Set the FUNCTION switch to TIME.

c. Set the NSEC/DIV switch to 1.

d. Adjust TUNNEL DIODE BIAS if necessary to obtain a TDR step display.

e. Set the NSEC/DIV EXPAND switch to .01.

f. Set the ρ/DIV switch to .01.

g. The jitter on the leading edge of the pulse should be less than 15 ps.

5-18. ADJUSTMENT PROCEDURE.

5-19. PRELIMINARY SETTINGS.

a. Set the Model 1815A controls as follows:

FUNCTION .... TRIG+
VOLTS/DIV 5
NSEC/DIV and EXPAND 1
SCAN .... NORMAL
MARKER POSITION 0.00
MARKER ZERO .... fully ccw
NORM, SIGNAL AVG .... NORM
TRIGGER LEVEL .... fully cw
HOLD OFF .... fully cw
MANUAL DENSITY .... mid-range
TUNNEL DIODE BIAS .... mid-range
ρ/DIV and VOLTS/DIV CAL pots ... mid-range
ρ/DIV, VOLTS/DIV CAL vernier . detent (CAL)

b. Remove the bottom side covers from the Model 180 Oscilloscope and turn the oscilloscope upside-down.

c. Remove the covers from the remote sampler.

d. If major repairs have been made to the Model 1815A and remote sampler, center all internal adjustment controls in both units. If only slight repairs have been made, leave the adjustment controls as they are and proceed to the next step.

e. Set BIAS ADJ potentiometer A2R1 in the remote sampler approximately 1/6-turn from fully ccw.

f. Connect a monitor oscilloscope to test point A1TP5 in the Model 1815A.

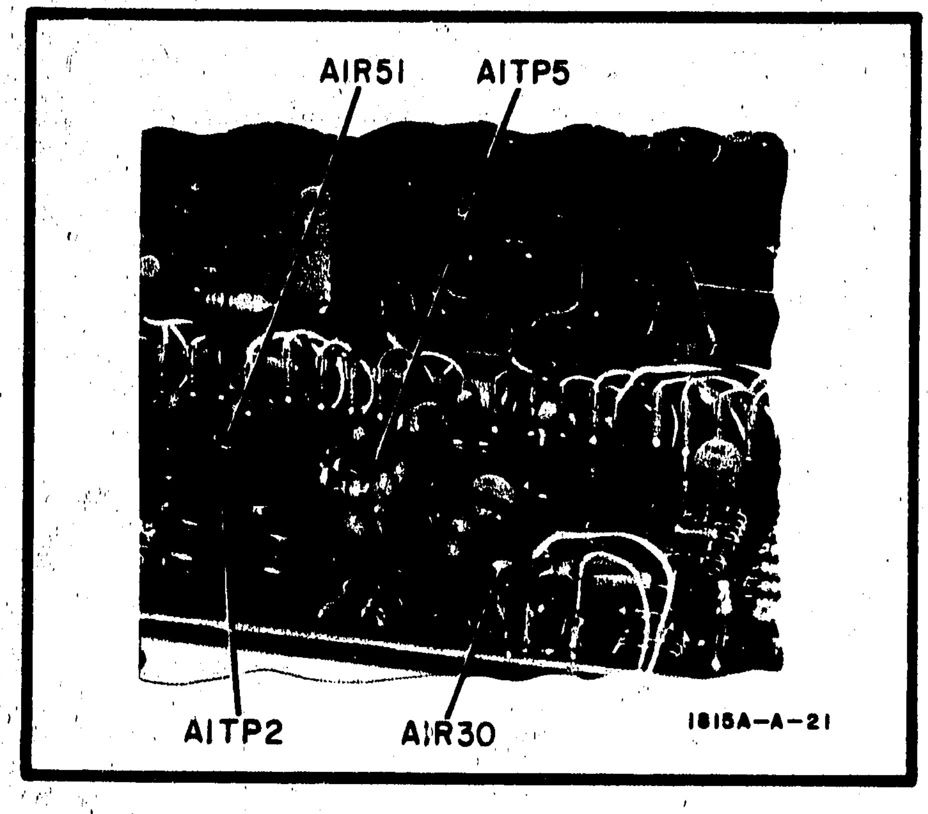


Figure 5-6. Preliminary Adjustments

g. Adjust STRCH GATE potentiometer A1R30 for a pulse width of 400 ns on the monitor oscilloscope.

h. Disconnect the monitor oscilloscope.

i. Connect a DC VTVM to test point A1TP2.

j. Set the VOLTS/DIV control to .01.

k. Adjust the Model 1815A VERTICAL POSITION control for a 0-volt indication on the DC VTVM. (The trace on the oscilloscope will be approximately on the center of the CRT.)

m. Adjust VERT BAL potentiometer A1R51 to set the baseline on the center graticule of the CRT.

n. Disconnect the DC VTVM.

5-20. DIODE BIAS ADJ.

a. Connect a signal generator to the sampler INPUT. Set the signal generator to provide a sinewave of 140 mV at approximately 450 MHz.

b. Connect a 50-ohm termination to the remote sampler OUTPUT.

c. Set the Model 1815A TRIGGER LEVEL control so that the time base free-runs (cw from 12 o'clock).

d. Connect a jumper from A3TP1 in the remote sampler to ground (trace on CRT will be incoherent).

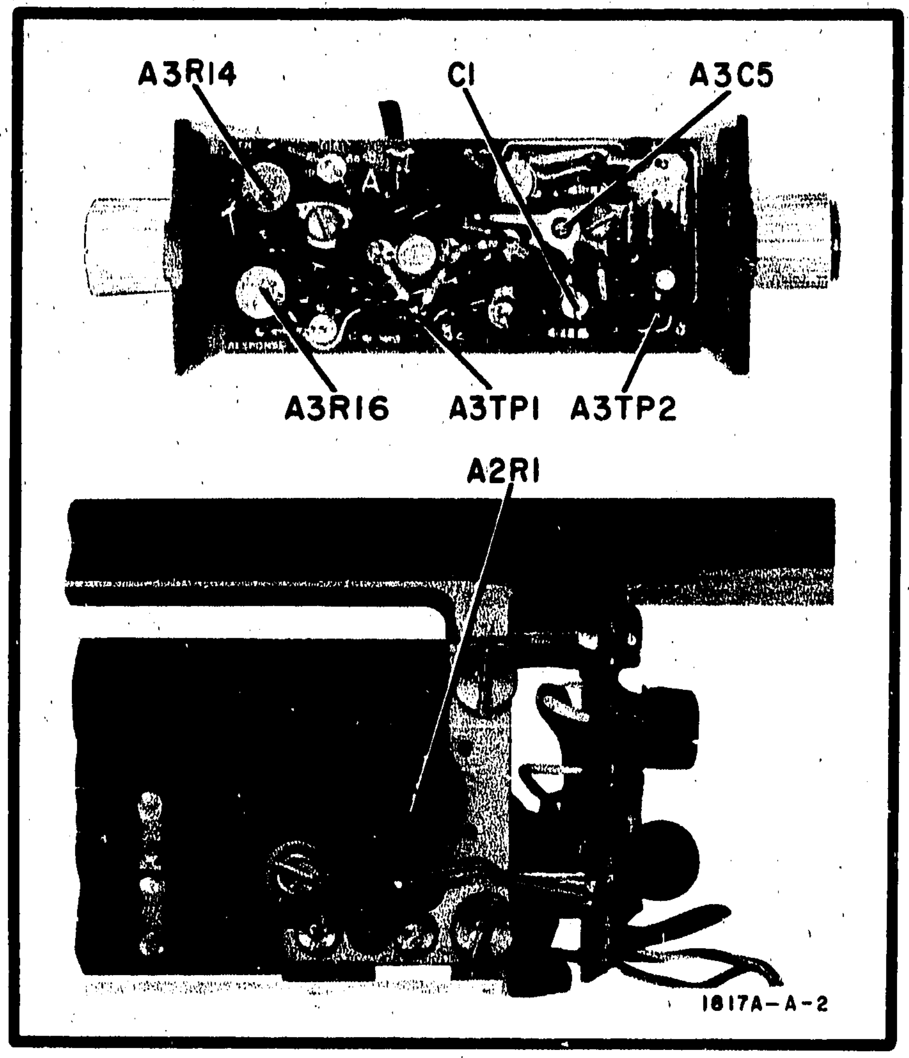


Figure 5-7. Remote Sampler Adjustments

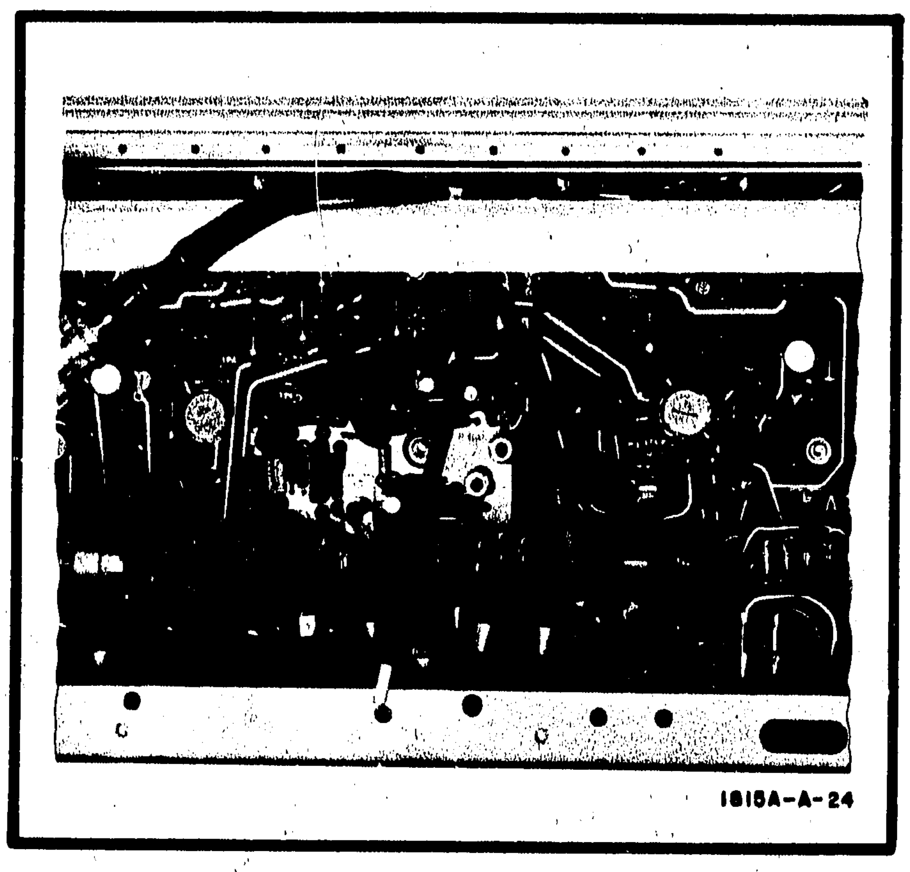


Figure 5-8. Stretcher Gate Triggering

e. Connect the monitor oscilloscope to A3TP2 in the remote sampler. Trigger the monitor oscilloscope from the stretcher gate signal at A1TP5 in the Model 1815A as shown in Figure 5-8.

f. Set the monitor oscilloscope sweep time to .2 usec/cm.

g. Set BIAS ADJ potentiometer A2R1 in the remote sampler fully ccw. Slowly adjust A2R1 to achieve the maximum peak-to-peak amplitude of the envelope observed on the monitor oscilloscope (maximum point is normally 1/4-turn from ccw).

h. Adjust CEN BIAS potentiometer A3R14 in the remote sampler to obtain a waveform on the oscilloscope most like waveform 2 in Figure 5-9.

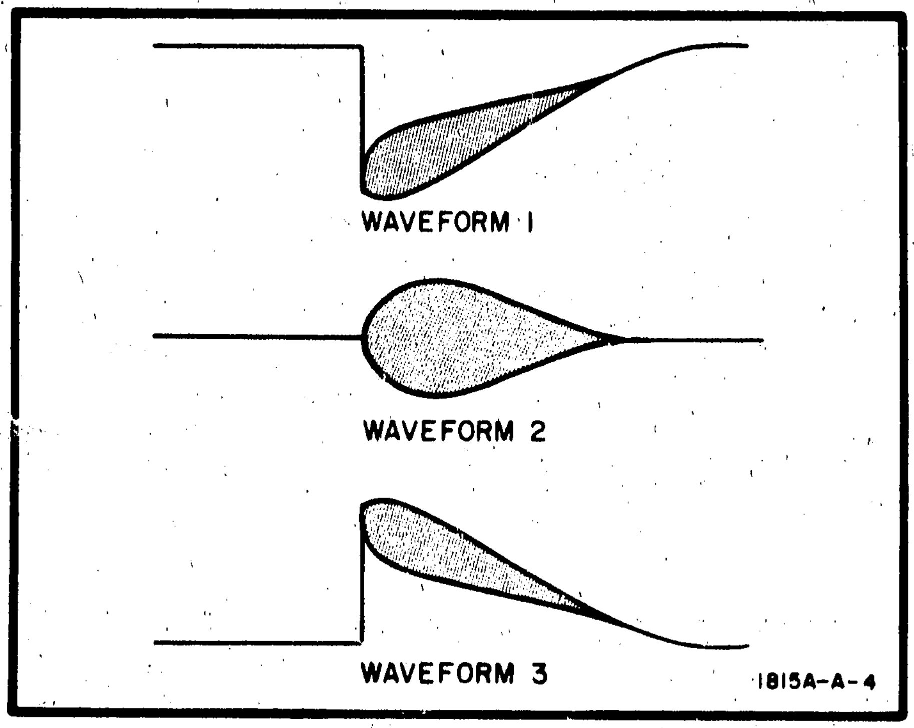


Figure 5-9. Diode Bias Waveforms

i. Disconnect all test equipment. Leave the 50-ohm termination connected.

5-21. COMMON-MODE REJECTION ADJ.

a. Connect a square-wave generator, set for 50 mV at 100 kHz, to A3TP1 (feedback) in the remote sampler.

b. Connect the monitor oscilloscope to test point A3TP2 in the remote sampler.

c. Set the Model 1815A TRIGGER LEVEL control fully counterclockwise.

d. Use an insulated screwdriver to adjust capacitor A3C6 in the remote sampler for a minimum amplitude display on the monitor oscilloscope. Hold the covers in place on the remote sampler to check the adjustment of A3C6.

5-22. RISETIME AND OVERSHOOT.

a. Connect a tunnel-diode pulse generator to the remote sampler INPUT.

b. Set the Model 1815A TRIGGER LEVEL control clockwise until the time base free-runs.

c. Set the NSEC/DIV EXPAND switch to .01.

d. Adjust VOLTS/DIV and CAL vernier for an eight-division amplitude. (If the step is not displayed, adjust TUNNEL DIODE BIAS slightly.)

e. Set the Model 1815A NORM, SIGNAL AVG switch to SIGNAL AVG.

f. Adjust Response potentiometer A3R16 in the remote sampler for an oscilloscope display of 33 ps risetime. Overshoot should be less than 5%.

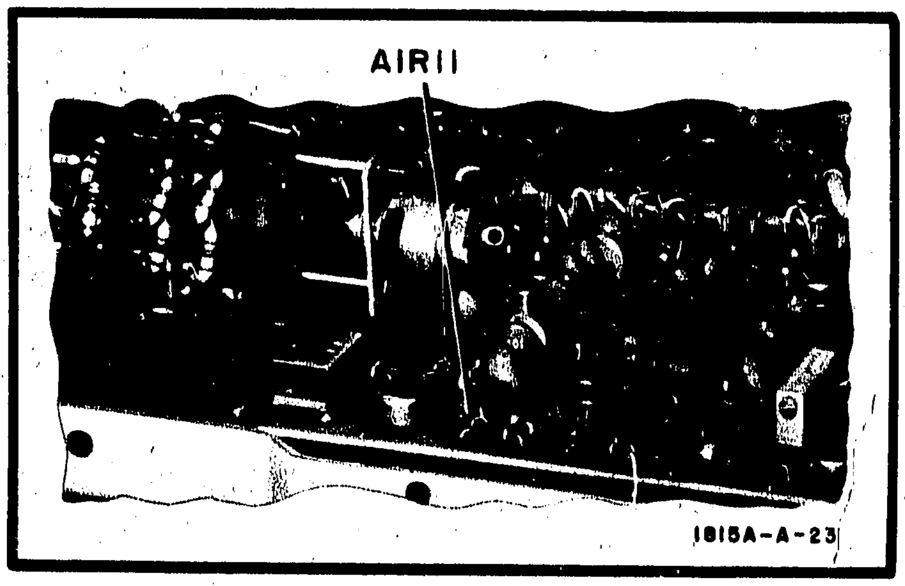


Figure 5-10. Sampling Efficiency Adjustments

g. Set the Model 1815A controls as follows:

NORM, SIGNAL AVG .... NORM
MANUAL/DENSITY .... full ccw
NSEC/DIV EXPAND 1
VOLTS/DIV CAL vernier .... CAL (detent)

h. Adjust SMOOTH potentiometer A1R11 in the Model 1815A for greater than 100% sampling efficiency (see Figure 5-11).

i. Adjust STRCH GATE potentiometer A1R30 (shown in Figure 5-6) in the Model 1815A for maximum sampling efficiency (max dot separation).

j. Readjust SMOOTH potentiometer A1R11 for 100% sampling efficiency and recheck Steps d through j.

k. Disconnect the tunnel-diode pulse generator.

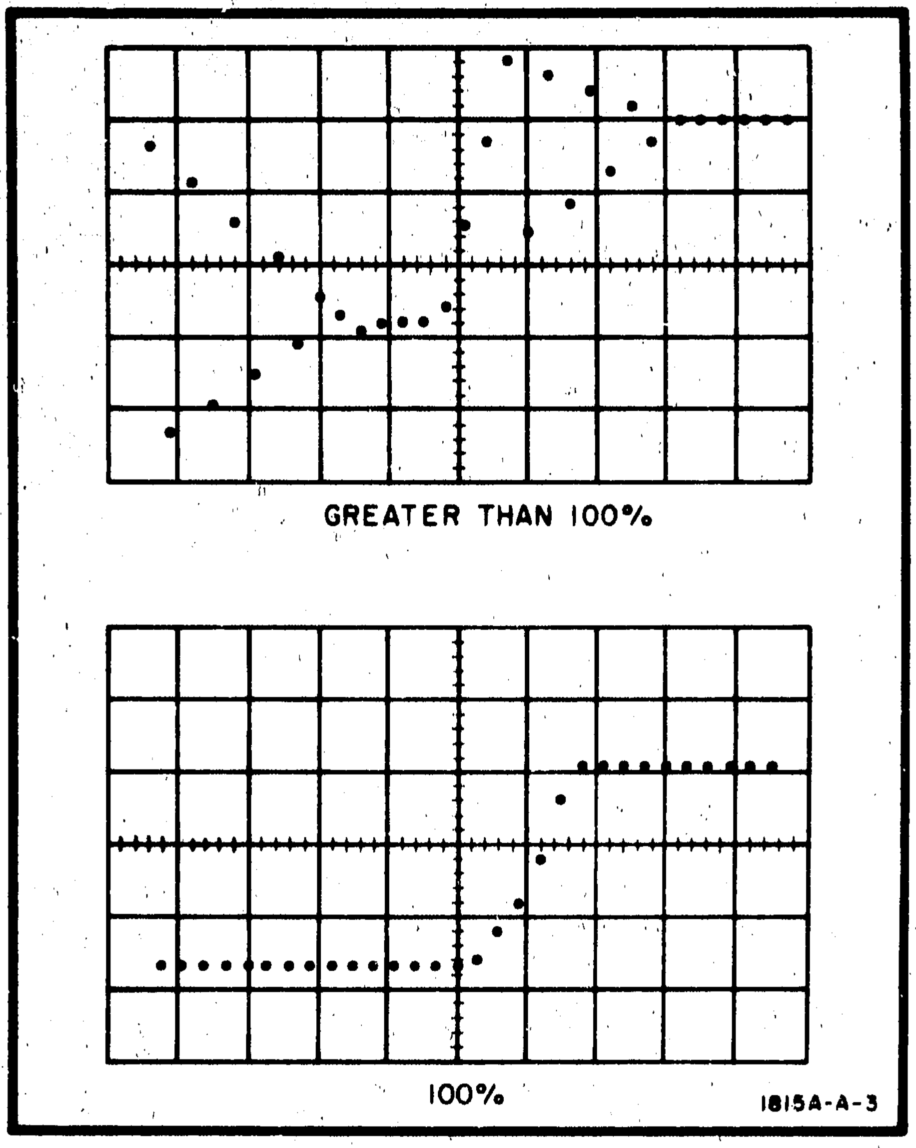


Figure 5-11. Sampling Efficiency Displays

5-23. BIAS CENTERING.

a. Set the Model 1815A TRIGGER LEVEL control so that the time base free-runs.

b. Set the VOLTS/DIV switch to .5.

c. Rotate the VERTICAL POSITION control over its range and adjust CEN BIAS potentiometer A3R14 in the remote sampler for equal swing up and down from the center graticule (typically 1.5 divisions each way).

5-24. LOW-FREQUENCY DISTORTION.

a. Connect the square-wave generator to the remote sampler INPUT. Set the square-wave generator to supply a 0.5-volt pulse at 100 kHz. (If using a Model 222A, adjust for a square-wave output.)

b. Connect the trigger output from the square-wave generator to the INPUT 200MV MAX connector on the Model 1815A.

c. Set the FUNCTION switch to select the trigger polarity in use.

d. Set the NSEC/DIV and EXPAND switch pair to 1K.

e. Adjust the TRIGGER LEVEL control for a stable display.

f. Set the Model 1815A VOLTS/DIV switch and CAL vernier to derive an eight-division display of pulse amplitude.

g. Adjust capacity C3 (machine screw) on the remote sampler for a display of pulse shape most like waveform 2 of Figure 5-12. Do not run the screw in to where it breaks the pickoff assembly.

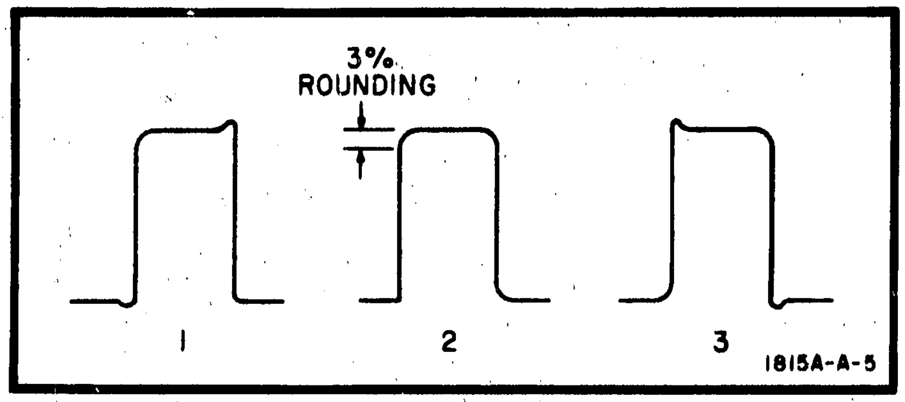


Figure 5-12. Low-frequency Distortion Waveforms

h. Hold the covers in place on the remote sampler to check the accuracy of the adjustment of C3 above.

i. Disconnect all test equipment.

j. Replace the covers on the remote sampler.

5-25. LEVEL AND BIAS ADJ.

a. Set the Model 1815A controls as follows:

FUNCTION .... TRIG+
NSEC/DIV and EXPAND 100
TRIGGER LEVEL .... fully ccw

b. Set the TD BIAS internal potentiometer A2R24 fully counterclockwise. Readjust A2R24 until a baseline just appears. Set A2R24 approximately 25 degrees counterclockwise from the baseline point.

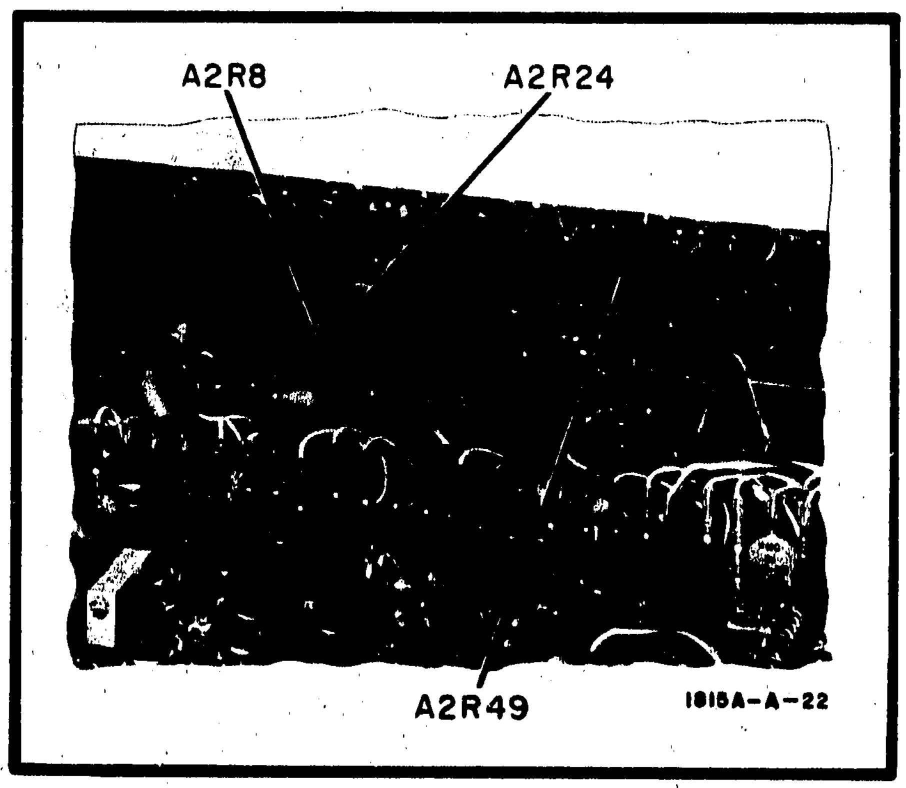


Figure 5-13. Bias and Level Adjustments

c. Set the TRIGGER LEVEL control to 12 o'clock.

d. Set LEVEL RANGE potentiometer A2R8 fully counterclockwise. Readjust A2R8 until the baseline just free-runs.

e. Rotate the TRIGGER LEVEL control to see that the time base free-runs for all positions cw and no position ccw from 12 o'clock. If not, repeat Steps b through e and reset TD BIAS less than 25 degrees.

5-26. STAIRCASE OFFSET ADJ.

a. Set TRIGGER LEVEL so that the time base free-runs.

b. Connect the monitor oscilloscope (dc-coupled) to test point A5TP3 in the Model 1815A.

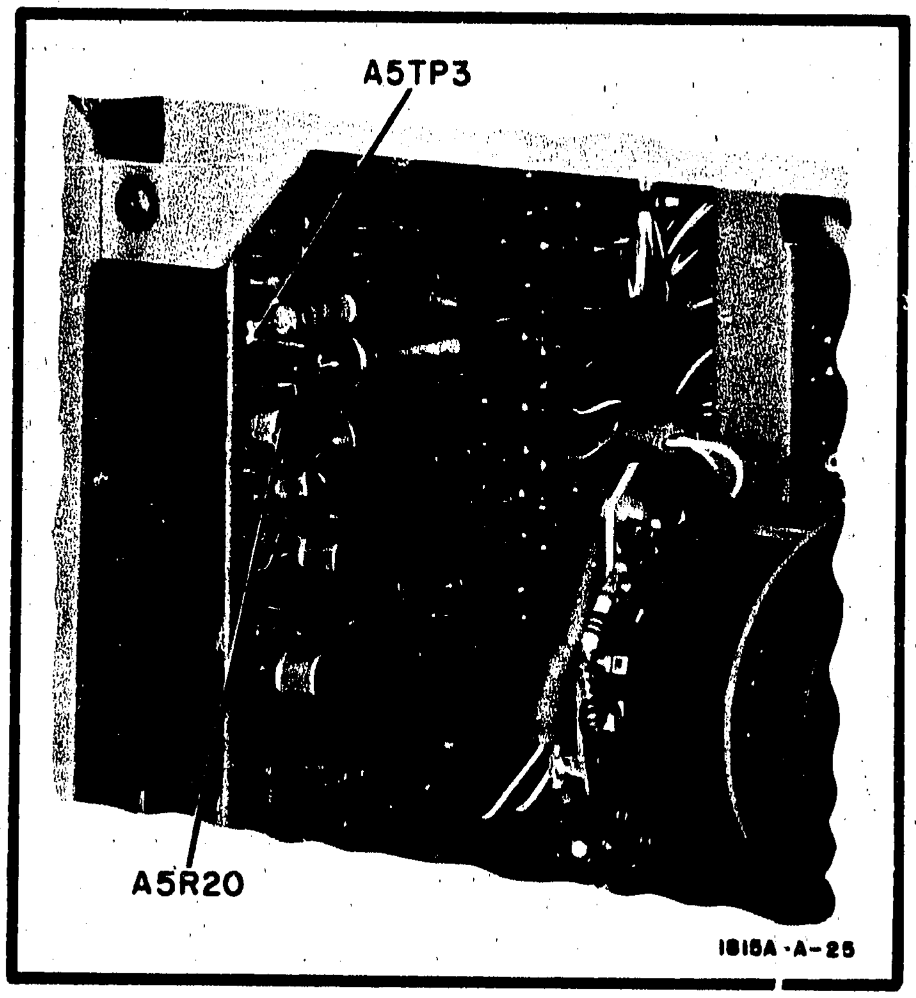


Figure 5-14. Staircase Offset Adjustment

c. Set the Model 1815A MANUAL/DENSITY control in the SCAN switch fully ccw.

d. Adjust STRCS OFFSET potentiometer A5R20 so that the staircase ramp starts at -0.3 volt on the monitor oscilloscope.

e. Remove all test equipment.

5-27. MARKER POSITION ADJ.

a. Set the Model 1815A controls as follows:

FUNCTION .... TIME
MARKER ZERO .... fully ccw
MARKER POSITION 0.00

b. Adjust the HORIZONTAL POSITION control on the Model 180A Oscilloscope to position the bright dot at the first graticule line. If the bright dot is not visable, adjust MARKER ZERO until the bright dot just appears.

c. Set the MARKER POSITION control to 10.00.

d. Adjust MARKER CAL potentiometer A5R57 to set the bright dot on the last graticule line.

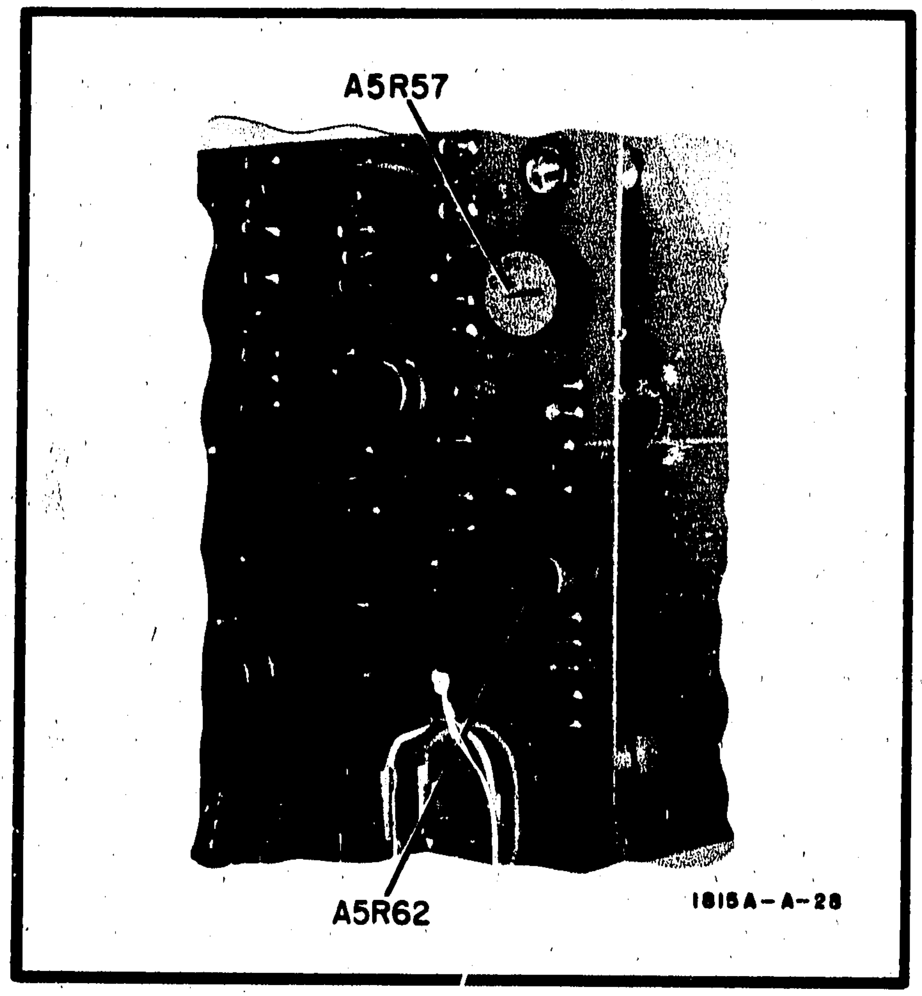


Figure 5-15. Marker Adjustments

e. Hold the UNEXPAND/FINDER switch in the FINDER position and adjust the HORIZONTAL POSITION potentiometer to place the bright dot exactly on the first graticule line.

f. Release the UNEXPAND/FINDER switch and adjust MARKER CAL potentiometer A5R57 to set the bright dot at the last graticule line.

g. The adjustments in Steps e and f interact. Repeat the two steps until both conditions are obtained without further adjustment.

5-28. MARKER UNCAL ADJUST.

a. Adjust the MARKER ZERO control to place the bright dot approximately 4 mm past the last graticule line.

b. Adjust OVER RANGE potentiometer A5R62 to the point where the MARKER UNCAL lamp just lights.

c. Reset the MARKER ZERO control ccw and check that the MARKER UNCAL lamp goes out before the bright dot reaches the last graticule line.

5-29. TIME/DIV CAL.

a. Connect the time-mark generator and X10 attenuator as shown in Figure 5-16.

b. Set the Model 1815A controls as follows:

NSEC/DIV and EXPAND 1K
FUNCTION .... TRIG+
MANUAL/DENSITY .... mid-range

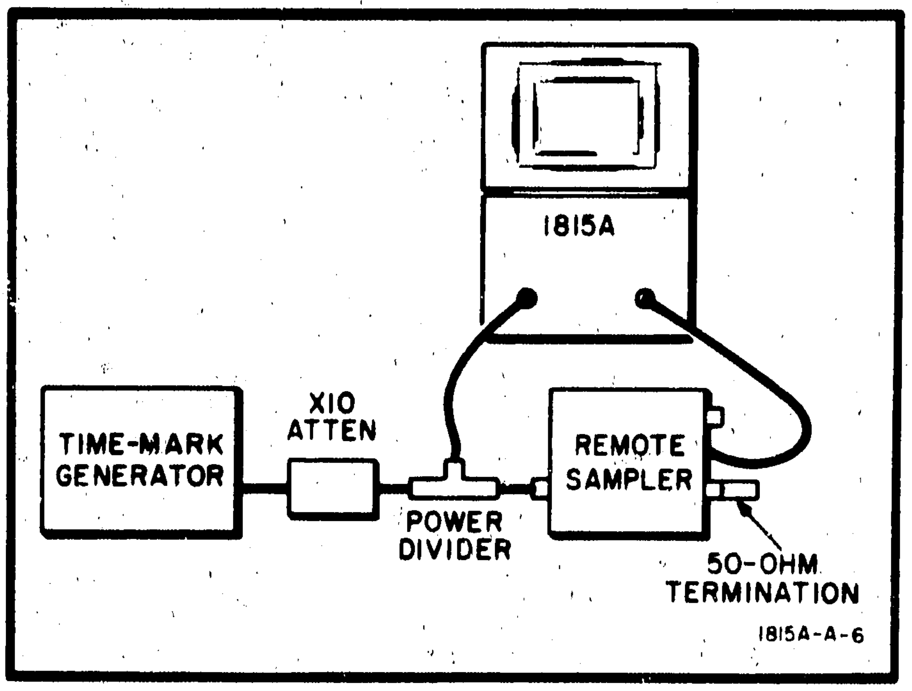


Figure 5-16. TIME/DIV Test Setup

c. Set the time-mark generator for 1-usec markers.

d. Adjust the Model 1815A TRIGGER LEVEL control for stable triggering.

e. Adjust RAMP ADJ potentiometer A2R81 in the Model 1815A to obtain exactly one marker per CRT division.

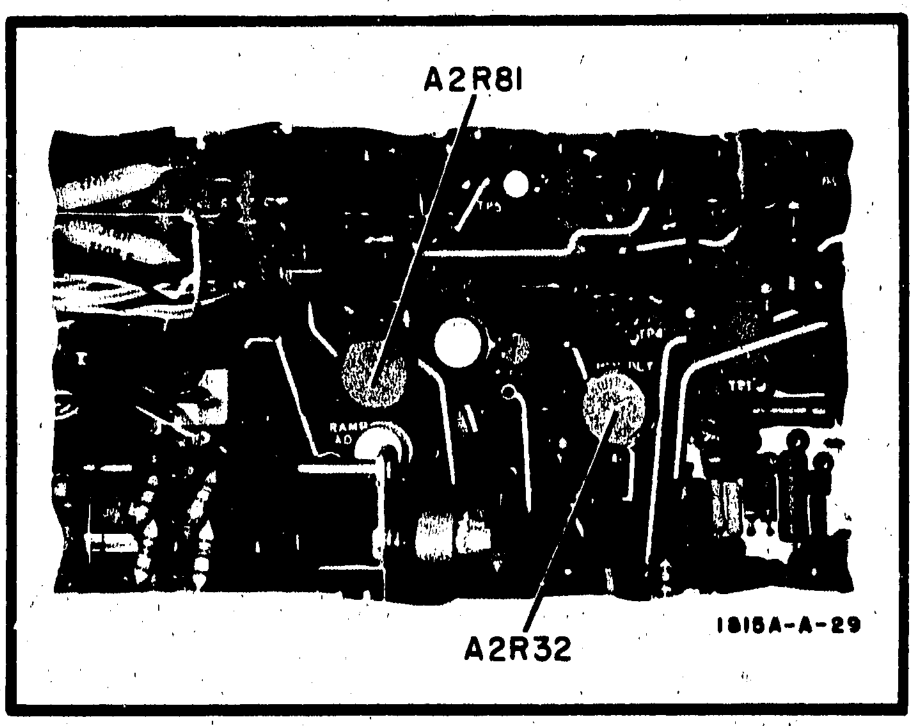


Figure 5-17. Time and Delay Adjustments

f. Set the NSEC/DIV and EXPAND switch pair to 100.

g. Set the time-mark generator for 0.1-usec markers.

h. Adjust capacitor A6C6 in the Model 1815A for exactly one marker per CRT division.

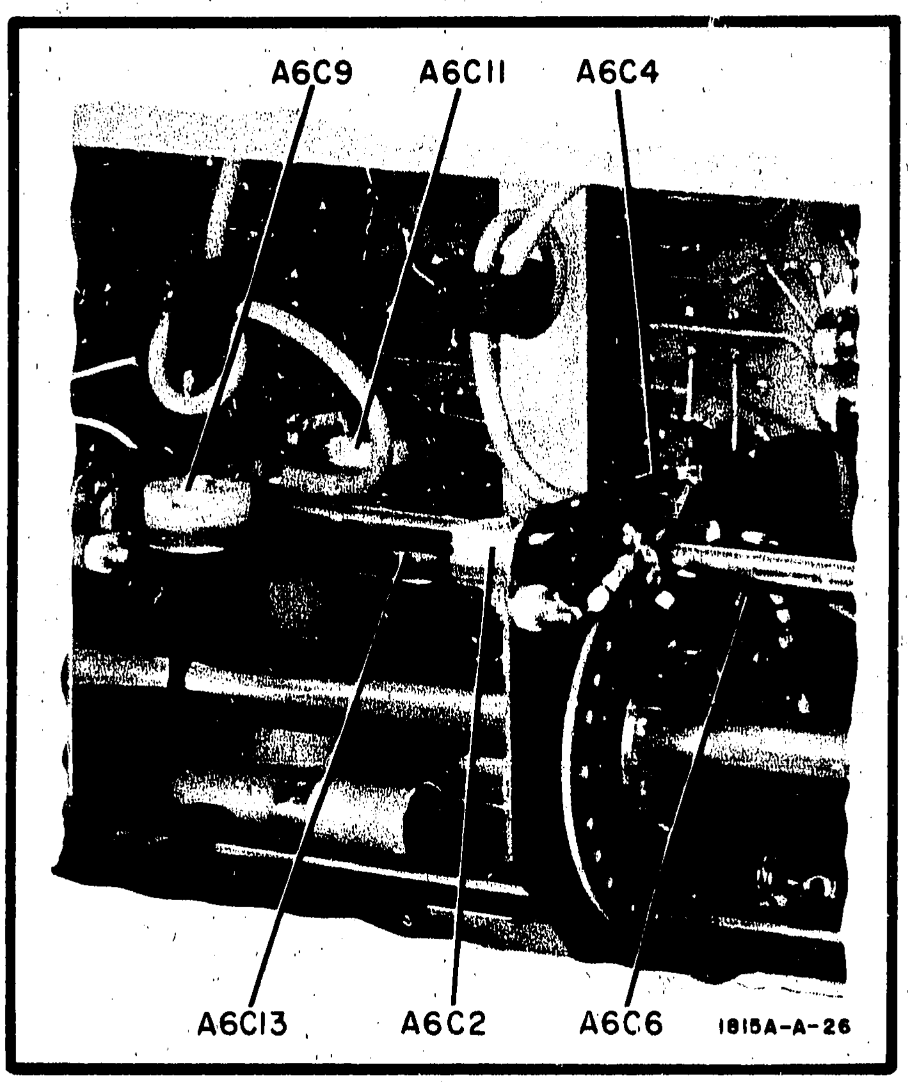


Figure 5-18. Time/Division Capacities

i. Set the NSEC/DIV and EXPAND control pair to 10.

j. Set the time-mark generator for a 10-ns sinewave.

k. Adjust capacitor A6C4 in the Model 1815A for exactly one positive peak per CRT division.

m. Set the NSEC/DIV and EXPAND switch pair to 1.

n. Disconnect the marker output and reconnect to the greater than 0.3 V output on the time-mark generator.

p. Set the time-mark generator for a 2-ns sinewave.

q. Adjust capacitor A6C2 in the Model 1815A for exactly one positive peak per two CRT divisions.

r. Remove all test equipment.

5-30. MINIMUM DELAY.

a. Connect equipment as shown in Figure 5-19.

b. Set the pulse generator for a .5-volt square-wave at 100 kHz.

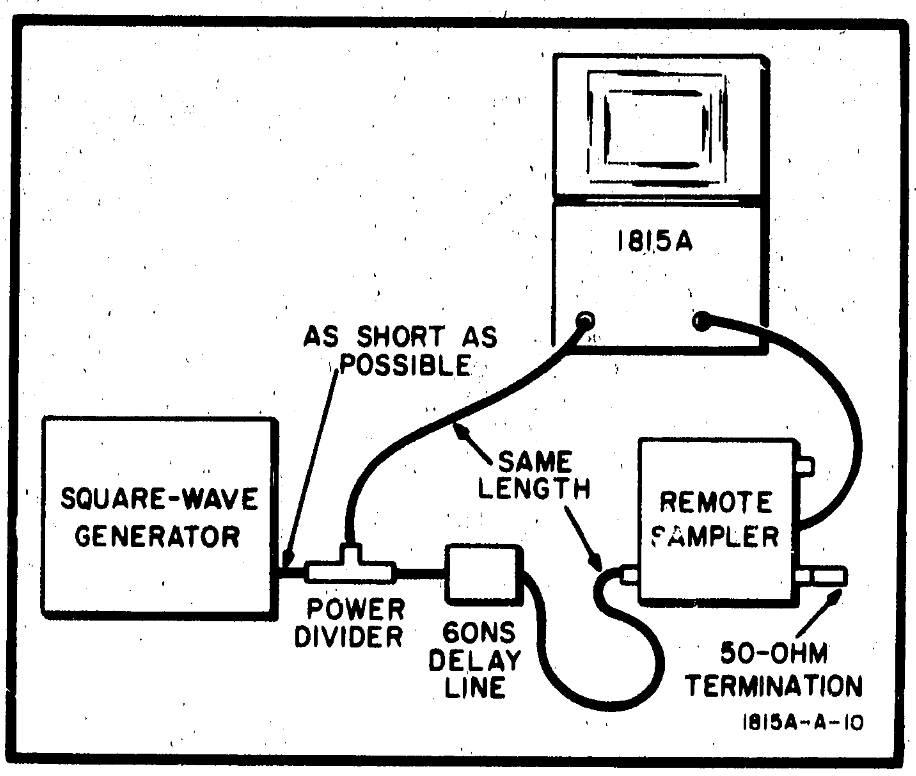


Figure 5-19. Minimum Delay Test Setup

c. Set the NSEC/DIV switch to 1.

d. Adjust the Model 1815A TRIGGER LEVEL control for a stable display.

e. Adjust MIN DLY potentiometer A2R32 so that the start of the leading edge of the first pulse occurs at approximately the third graticule line. (See Figure 5-17 for location of A2R32.)

f. Disconnect all test equipment.

5-31. STEP DELAY ADJ.

a. Connect the tunnel-diode pulse generator to the remote sampler and terminate the sampler output into 50 ohms.

b. Set the Model 1815A controls as follows:

FUNCTION .... TIME
NSEC/DIV and EXPAND 1K
ρ/DIV 2

c. Set the HORIZONTAL POSITION control on the Model 180A oscilloscope to begin the trace at the left-hand graticule line.

d. Adjust the Model 1815A TUNNEL DIODE BIAS control if necessary to obtain a step display.

e. Adjust STEP DLY potentiometer A2R49 to position the step on the third graticule line (two divisions). (See Figure 5-13 for location of A2R49.)

f. Set the NSEC/DIV and EXPAND switch pair to 100.

g. Adjust capacitor A6C13 to position the step on the third graticule line. (See Figure 5-18 for location of C13.)

h. Set the NSEC/DIV and EXPAND switch pair to 10.

i. Adjust capacitor A6C11 to position the step on the third graticule line.

j. Set the NSEC/DIV and EXPAND switch pair to 1.

k. Adjust capacitor A6C9 to position the step on the third graticule line.

5-32. STRETCHER BALANCE.

a. Adjust the ρ/DIV and CAL vernier to obtain a display amplitude of from 5 to 6 divisions.

b. Adjust SMOOTH potentiometer A1R11 for 100% sampling efficiency.

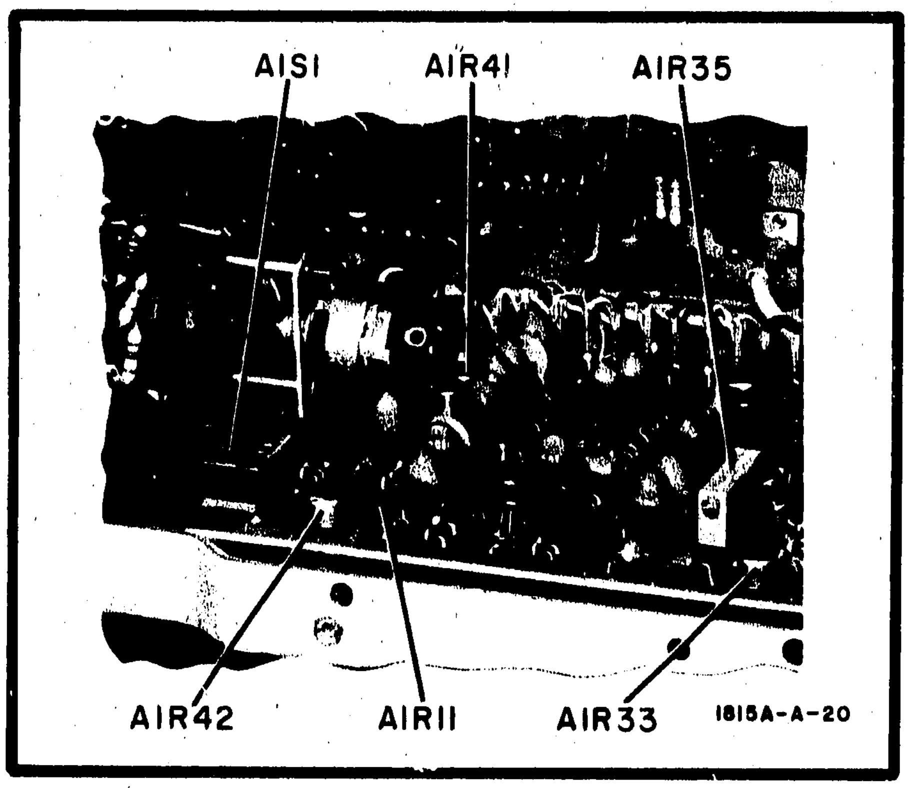


Figure 5-20. Vertical Adjustments

c. Alternately switch between NORM and SIGNAL AVG.

d. Adjust STRCH BAL potentiometer A1R35 so that the display does not shift vertically when the NORM, SIGNAL AVG switch is operated.

5-33. STRETCHER GAIN.

a. Adjust STRCH GAIN potentiometer A1R33 so that the step amplitude does not change when the NORM, SIGNAL AVG switch is operated.

b. Repeat the STRETCHER BALANCE and GAIN procedures until no further adjustment is necessary for either requirement.

c. Disconnect the tunnel-diode pulse generator and 50-ohm termination from the remote sampler.

5-34. SENSITIVITY CAL.

a. Set slide switch A1S1 to off.

b. Set the ρ/DIV switch to .2.

c. Adjust the VERTICAL POSITION control to set the trace on the bottom graticule line.

d. Adjust the test power supply to provide 250 mVdc.

e. Connect the test power supply to the remote sampler INPUT.

CAUTION

If similar equipment is substituted for the HP Harrison 6111A Power Supply, it must have an extremely low output impedance (less than 1 ohm). If a power supply or voltmeter calibrator with a high output impedance is used, damage to the sampler and/or power supply may occur.

In substituted equipment, voltage transients may be present that exceed the maximum safe input of the sampler. These transients will occur between switch positions on the voltage or multiplier range switches. To avoid damage to the sampler, disconnect the input before changing voltage or multiplier settings.

f. Alternately connect and disconnect the test power supply and adjust the Model 1815A ρ/DIV CAL 5 DIV ON .2 potentiometer for exactly 5 divisions of vertical deflection.

g. Connect a 1-uF, 200-V filter capacitor from ground to each of the two terminals adjacent to test point TP6 on board assembly A1. See Figure 5-1.

h. Set the ρ/DIV switch to .01.

i. Reset the test power supply for a 12.5-mVdc output.

j. Adjust the VERTICAL POSITION control to place the trace on the bottom graticule line.

k. Alternately connect and disconnect the test power supply and adjust STRCH GAIN potentiometer A1R33 for exactly 5 divisions of deflection. Repeat steps f through k until no further adjustment is necessary.

m. Remove the 1-uF filter capacitors.

n. Set the FUNCTION switch to TRIG+.

p. Adjust the TRIGGER LEVEL control to cause the time base to free-run.

q. Set the VOLTS/DIV switch to .05.

r. Set the test power supply to provide 400 mVdc.

s. Adjust the VERTICAL POSITION control to place the trace on the bottom graticule line.

t. Alternately connect and disconnect the power supply and set the VOLTS/DIV CAL potentiometer to obtain exactly eight divisions of vertical deflection.

u. Disconnect the test power supply.

v. Set the FUNCTION switch to TIME.

w. Set the ρ/DIV switch to .2.

x. Connect the tunnel-diode pulse generator that will be used with the system in TDR operations to the remote sampler INPUT. Terminate the OUTPUT in 50 ohms.

y. Set slide switch A1S1 to NORM.

z. Readjust the ρ/DIV CAL 5 DIV ON .2 potentiometer for a step amplitude of exactly 5 divisions. (If pulse is not displayed, adjust TUNNEL DIODE BIAS slightly.)

5-35. BIAS ADJ.

a. Alternately switch the FUNCTION selector between TRIG+ and TIME.

b. The pulse should remain on screen in both positions with adjustment of the TUNNEL DIODE BIAS control. If not, adjust BIAS BAL internal potentiometer A1R41.

5-36. ZERO ADJ.

a. Set the FUNCTION switch to TIME.

b. Set the ρ/DIV switch to .2.

c. Remove the 50-ohm termination from the remote sampler OUTPUT.

d. Adjust the Model 1815A VERTICAL POSITION control to center the baseline on the CRT.

e. Alternately short and open the remote sampler OUTPUT using the short recommended in the test equipment table.

f. Adjust ZERO ADJ potentiometer A1R42 until no baseline shift occurs between the open and shorted output. See Figure 5-20 for location.

g. Remove all test equipment.

h. Replace the covers on the Model 180A Oscilloscope.

1815A or B/1817A PERFORMANCE CHECK RECORD

Instrument Serial Numbers

(1815A/B) ______ (1817A) ______

Para. Ref.	Check	Limit
5-8	MODES OF OPERATION f. SCAN TIME	______
5-13	HORIZONTAL DEFLECTION i. line length k. TIME n. AIR p. POLY q. VAR	______ ______ ______ ______ ______
5-14	RISETIME AND NOISE a. 35 ps, <5% b. Reflections < 10% h. Noise < 8 mV	______ ______ ______
5-17	CW TRIGGERING e. jitter	______
5-18	TDR JITTER g. < 15 ps	______

CUT ALONG DOTTED LINE

PARTS LIST

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-2 lists the parts in alphanumeric order by reference designation. All chassis-mounted parts (assemblies, and parts not mounted on assemblies) appear first, followed by each assembly with sub-assemblies (if any) and components mounted on that assembly. Reference designations for groups of identical items may be shown as TP1-TP9 followed by a single part number and description indicating that TP1 through TP9 are separate but identical parts.

6-3. Parts consisting of several smaller, yet separately replaceable parts such as jacks or relays have all sub-parts listed so that partial replacement of these items can be accomplished. Miscellaneous parts which are not assigned reference designations appear at the end of the chassis parts listing and at the end of each assembly listing.

6-4. ORDERING INFORMATION.

6-5. Many parts used in Hewlett-Packard equipment are manufactured by HP or are selected by HP under specifications more rigid than the manufacturer's standard specifications. These parts must be ordered directly from Hewlett-Packard Company. Information concerning standard replaceable parts will be supplied upon request to allow procurement directly from the manufacturers. Contact the local HP Sales/Service Office for details.

6-6. To obtain replacement parts from HP, address order or inquiry to the nearest Hewlett-Packard Sales/Service Office (names and addresses in rear of manual), and supply the following information:

a. HP Part Number of item(s).

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

c. Quantity of part(s) desired.

6-7. To order a part not listed in the table, provide the following information:

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

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

Table 6-1. Reference Designators and Abbreviations

REFERENCE DESIGNATORS

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

ABBREVIATIONS

A	= ampere(s)	Ge	= germanium	minat	= miniature	s-b	= slow-blow
ampl	= amplifier(s)	G	= giga (10^9)	mom.	= momentary	Se	= selenium
assy	= assembly	gl	= glass	mtg	= mounting	sect	= section(s)
bd	= board(s)	grd	= ground(ed)	my.	= mylar	semicon	= semiconductor(s)
bp	= bandpass	H	= henry(ies)	n	= nano (10^{-9})	Si	= silicon
c	= centi (10^{-2})	Hg	= mercury	n/c	= normally closed	sil	= silver
car.	= carbon	hr	= hour(s)	Ne	= neon	sl	= slide
ccw	= counterclockwise	HP	= Hewlett-Packard	n/o	= normally open	sp	= single pole
cer	= ceramic	Hz	= hertz	npo	= negative positive zero (zero temperature coefficient)	spl	= special
coax.	= coaxial	if.	= intermediate freq	nsr	= not separately replaceable	st	= single throw
coef	= coefficient	impg	= impregnated	obd	= order by description	std	= standard
com	= common	incd	= incandescent	ox	= oxide	Ta	= tantalum
comp	= composition	incl	= include(s)	p	= pico (10^{-12})	td	= time delay
conn	= connector(s)	ins	= insulation(ed)	pc	= printed (etched) circuit(s)	TD	= tunnel diode(s)
CRT	= cathode-ray tube	int	= internal	PGM	= program	tgl	= toggle
cw	= clockwise	k	= kilo (10^3)	piv	= peak inverse voltage(s)	Ti	= titanium
d	= deci (10^{-1})	lb	= pound(s)	p/o	= part of	tol	= tolerance
depc	= deposited carbon	lev	= lever	poly	= polystyrene	trim.	= trimmer
dp	= double pole	lin	= linear taper	porc	= porcelain	u	= micro (10^{-6})
dt	= double throw	log.	= logarithmic taper	pos	= position(s)	V	= volt(s)
elect.	= electrolytic	lpf	= low-pass filter(s)	pot.	= potentiometer(s)	var	= variable
encap	= encapsulated	m	= milli (10^{-3})	pk-pk	= peak-to-peak	W	= watt(s)
ext	= external	M	= mega (10^6)	rect	= rectifier(s)	w	= with
F	= farad(s)	metflm	= metal film	rf	= radio frequency	w o	= without
fet	= field-effect transistor(s)	metox	= metal oxide			wVdc	= dc working volt(s)
fxd	= fixed					ww	= wirewound

Table 6-2. Model 1815A/B Replaceable Parts

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			CHASSIS PARTS
A1	01815-66501	1	A: board assy: vertical
A2	01815-66502	1	A: board assy: horizontal
A3	01815-66503	1	A: board assy: horizontal sensitivity indicator
A4	01815-66504	1	A: board assy: vertical sensitivity indicator
A5	01815-66505	1	A: board assy: staircase
A6	01815-61901	1	A: switch assy: horizontal sensitivity
A7	01815-61902	1	A: switch assy: scan
A8	01815-61903	1	A: switch assy: vertical sensitivity
A9	01815-61904	1	A: switch assy: function
A10	01801-26506	1	A: etched board: connector
DS1	2140-0016	5	DS: lamp incandescent: marker uncal
J1	1251-1990	1	J: conn, 18-pin
P1	1251-0136	1	P: conn 32-pin
R1	0757-0941	4	R: fxd metflm 5100 ohms 2% 1/4 W
R2	2100-0820	1	R: var ww lin 10-turn 50 k ohms 20%
R3	2100-2063	1	R: var comp lin 1 k ohms 10% 1/2 W
R4	2100-2066	1	R: var comp lin 2 k ohms 20% 1/2 W
R5	2100-2492	2	R: var carbon 5 k ohms 20% 1/2 W
R6	2100-2488	1	R: var comp lin 10 k ohms 20% 1/2 W (1815A)
	2100-2634	1	R: var comp lin 25 k ohms 20% 1/2 W (1815B)
R7	2100-2492		R: var ww lin 5 k ohms 20% 1/2 W
R8	0698-0082	1	R: fxd metflm 464 ohms 1% 1/8 W
R9	2100-2062	1	R: var carbon 500 ohms 10% 1/2 W
R10	2100-1559	1	R: var ww lin 10-turn 5 k ohms 5% 1 1/2 W
R11	2100-2481	1	R: var ww lin 10-turn 5 k ohms 3% 2 W
S1	3101-1204	1	S: switch toggle dpdt
S2	3101-0199	1	S: switch slide dpdt .5A 125 V
T1	01815-61619	1	T: balun transformer w/cable
W1	01815-61601	1	W: cable main
W2	01815-61617	1	W: cable assy blu 5 1/2 in.
W3	01815-61618	1	W: cable assy blu 12 1/4 in.
			CHASSIS MISCELLANEOUS
	00222-24101	2	Retainer, torroid
	01815-00101	1	Cover plate, alum .063
	01815-00201	1	Panel sub, alum .063
	01815-00202	1	Panel, front alum .063 (1815A)
	01815-00205	1	Panel, front alum .063 (1815B)
	01815-00203	1	Panel, rear
	01815-01204	1	Bracket, switch
	01815-01205	2	Bracket, corner
	01815-09101	1	Spring

Table 6-2. Model 1815A/B Replaceable Parts (Con't)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			CHASSIS MISCELLANEOUS CON'T
	01815-21201	1	Bracket, mounting alum
	01815-21202	1	Support, bottom
	01815-22301	1	Yoke
	01815-23101	1	Retainer, yoke
	01815-23701	1	Shaft, latch
	01815-67401	1	A: knob assy: function
	01815-67402	1	A: knob assy: ρ/div, volts/div
	01815-67403	1	A: knob assy: feet/div, nsec/div
	01815-67404	1	A: knob assy: scan
	01815-67405	1	A: knob assy: expand
	01815-67406	2	A: knob assy: marker zero, vert pos.
	01815-67407	1	A: knob assy: cal
	01815-67408	2	A: knob assy: trig level, hold off
	01815-67409	1	A: knob assy: manual/density
	01815-67410	1	A: knob assy: lock
			A1
A1	01815-66501		A: Board Assy: Vertical
C1	0160-2959	10	C: fxd cer 1000 p -0 +100% 600 wVdc
C2	0180-2255	35	C: fxd Ta elect 2.2 uF 20% 20 wVdc
C3	0160-2959		C: fxd cer 1000 pF -0 +100% 600 wVdc
C4	0180-2255		C: fxd Ta elect 2.2 uF 20% 20 wVdc
C5	0180-2255		C: fxd Ta elect 2.2 uF 20% 20 wVdc
C6	0160-2930	18	C: fxd cer .01 uF -20 +80% 100 wVdc
C7	0140-0151	1	C: fxd mica 820 pF 2% 300 wVdc
C8	0180-2255		C: fxd Ta elect 2.2 uF 20% 20 wVdc
C9	0160-2959		C: fxd cer 1000 pF -0 +100% 600 wVdc
C10	0180-2255		C: fxd Ta elect 2.2 uF 20% 20 wVdc
C11	0180-2255		C: fxd Ta elect 2.2 uF 20% 20 wVdc
C12	0160-0161	4	C: fxd mylar .01 uF 10% 200 wVdc
C13	0180-2255		C: fxd Ta elect 2.2 uF 20% 20 wVdc
C14	0180-2255		C: fxd Ta elect 2.2 uF 20% 20 wVdc
C15	0180-2255		C: fxd Ta elect 2.2 uF 20% 20 wVdc
C16	0140-0200	2	C: fxd mica 390 pF 5% 300 wVdc
C17	0180-2255		C: fxd Ta elect 2.2 uF 20% 20 wVdc
C18	0180-2255		C: fxd Ta elect 2.2 uF 20% 20 wVdc
C19	0140-0200		C: fxd mica 390 pF 5% 300 wVdc
C20	0180-2255		C: fxd Ta elect 2.2 uF 20% 20 wVdc
C21	0180-2255		C: fxd Ta elect 2.2 uF 20% 20 wVdc
C22	0180-2255		C: fxd Ta elect 2.2 uF 20% 20 wVdc
C23	0140-0204	3	C: fxd mica 47 pF 5% 500 wVdc
C24	0160-2930		C: fxd cer .01 uF -20 +80% 100 wVdc
C25	0180-2255		C: fxd Ta elect 2.2 uF 20% 20 wVdc

Table 6-2. Model 1815A/B Replaceable Parts (Con't)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			A1 (con't)
C26	0180-2255		C: fxd Ta elect 2.2 uF 20% 20 wVdc
C27	0170-0024	1	C: fxd mylar .022 uF 20% 200 wVdc
C28	0140-0204		C: fxd mica 47 pF 5% 500 wVdc
C29	0160-2930		C: fxd cer .01 uF -20 +80% 100 wVdc
C30	0160-2257	2	C: fxd cer 10 pF 5% 500 wVdc
C31	0160-0153	1	C: fxd mylar 1000 pF 10% 200 wVdc
C32	0160-2930		C: fxd cer .01 uF -20 +80% 100 wVdc
C33	0180-2255		C: fxd Ta elect 2.2 uF 20% 20 wVdc
C34	0180-2255		C: fxd Ta elect 2.2 uF 20% 20 wVdc
C35	0180-2255		C: fxd Ta elect 2.2 uF 20% 20 wVdc
C36	0160-0165	1	C: fxd mylar .056 uF 10% 200 wVdc
C37	0180-2255		C: fxd Ta elect 2.2 uF 20% 20 wVdc
C38	0160-2930		C: fxd cer .01 uF -20 +80% 100 wVdc
C39	0180-0155	6	C: fxd Ta elect 2.2 uF 20% 20 wVdc
C40	0180-0155		C: fxd Ta elect 2.2 uF 20% 20 wVdc
C41	0180-0155		C: fxd Ta elect 2.2 uF 20% 20 wVdc
C42	0180-0155		C: fxd Ta elect 2.2 uF 20% 20 wVdc
C43	0180-0155		C: fxd Ta elect 2.2 uF 20% 20 wVdc
C44	0180-0155		C: fxd Ta elect 2.2 uF 20% 20 wVdc
CR1	1901-0040	37	CR: Si
CR2	1901-0040		CR: Si
CR3	1901-0040		CR: Si
CR4	1901-0040		CR: Si
CR5	1901-0040		CR: Si
CR6	1901-0040		CR: Si
CR7	1901-0040		CR: Si
CR8	1901-0376	2	CR: Si
CR9	1901-0376		CR: Si
CR10	1901-0040		CR: Si
CR11	1901-0040		CR: Si
CR12	1901-0040		CR: Si
CR13	1901-0040		CR: Si
CR14	1901-0040		CR: Si
CR15	1901-0040		CR: Si
CR16	1901-0040		CR: Si
CR17	1901-0040		CR: Si
L1	9140-0137	1	L: 1 uH
L2	9100-2276	4	L: 100 uH
L3	9100-2276		L: 100 uH
L4	9100-2276		L: 100 uH
L5	9140-0210	12	L: 100 uH

Table 6-2. Model 1815A/B Replaceable Parts (Con't)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			A1 (con't)
Q1	1853-0020	23	Q: Si pnp
Q2	1854-0071	12	Q: Si npn
Q3	1853-0020		Q: Si pnp
Q4	1854-0071		Q: Si npn
Q5	1854-0360	1	Q: Si npn dual
Q6	1853-0020		Q: Si pnp
Q7	1854-0071		Q: Si npn
Q8	1855-0022	3	Q: Si FET
Q9	1853-0020		Q: Si pnp
Q10	1855-0022		Q: Si FET
Q11	1853-0050	1	Q: Si pnp
Q12	1854-0022	5	Q: Si npn
Q13	1854-0022		Q: Si npn
Q14	1854-0022		Q: Si npn
Q15	1854-0022		Q: Si npn
Q16	1853-0020		Q: Si pnp
Q17	1853-0020		Q: Si pnp
Q18	1853-0020		Q: Si pnp
Q19	1853-0020		Q: Si pnp
Q20	1853-0020		Q: Si pnp
Q21	1853-0020		Q: Si pnp
Q22	1854-0019	4	Q: Si npn
Q23	1853-0020		Q: Si pnp
R1	0757-0959	5	R: fxd metflm 30 k ohms 2% 1/4 W
R2	0757-0911	5	R: fxd metflm 300 ohms 2% 1/4 W
R3	0757-0931	14	R: fxd metflm 2000 ohms 2% 1/4 W
R4	0757-0948	24	R: fxd metflm 10 k ohms 2% 1/4 W
R5	0757-0929	2	R: fxd metflm 1600 ohms 2% 1/4 W
R6	0757-0948		R: fxd metflm 10 k ohms 2% 1/4 W
R7	0757-0939	5	R: fxd metflm 4300 ohms 2% 1/4 W
R8	0757-0924	12	R: fxd metflm 1000 ohms 2% 1/4 W
R9	0757-0911		R: fxd metflm 300 ohms 2% 1/4 W
R10	0757-0920	1	R: fxd metflm 680 ohms 2% 1/4 W
R11	2100-2216	3	R: var cer 5 k ohms 30 % 1/2 W
R12	0757-0905	1	R: fxd metflm 160 ohms 2% 1/4 W
R13	0757-0959		R: fxd metflm 30 k ohms 2% 1/4 W
R14	0757-0923	3	R: fxd metflm 910 ohms 2% 1/4 W
R15	0757-0936	1	R: fxd metflm 3300 ohms 2% 1/4 W
R16	0757-0917	3	R: fxd metflm 510 ohms 2% 1/4 W
R17	0757-0930	1	R: fxd metflm 1800 ohms 2% 1/4 W
R18	0757-0928	1	R: fxd metflm 1500 ohms 2% 1/4 W
R19	0757-0910	4	R: fxd metflm 270 ohms 2% 1/4 W
R20	0757-0910		R: fxd metflm 270 ohms 2% 1/4 W

Table 6-2. Model 1815A/B Replaceable Parts (Con't)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			A1 (con't)
R21	0757-0935	10	R: fxd metflm 3 k ohms 2% 1/4 W
R22	0757-0965	7	R: fxd metflm 51 k ohms 2% 1/4 W
R23	0757-0965		R: fxd metflm 51 k ohms 2% 1/4 W
R24	0757-0907	2	R: fxd metflm 200 ohms 2% 1/4 W
R25	0757-0948		R: fxd metflm 10 k ohms 2% 1/4 W
R26	0757-0941		R: fxd metflm 5100 ohms 2% 1/4 W
R27	0757-0923		R: fxd metflm 910 ohms 2% 1/4 W
R28	0761-0074	1	R: fxd metox 15 k ohms 5% 1 W
R29	0757-0948		R: fxd metflm 10 k ohms 2% 1/4 W
R30	2100-1986	3	R: var cer 1000 ohms 30% 1/2 W
R31	0757-0931		R: fxd metflm 2000 ohms 2% 1/4 W
R32	0757-0900	7	R: fxd metflm 100 ohms 2% 1/4 W
R33	2100-2650	1	R: var cer lin 200 k ohms 30% 1/2 W
R34	0757-0948		R: fxd metflm 10 k ohms 2% 1/4 W
R35	2100-2813	1	R: var cer lin 15-turn 200 k ohms 10% 3/4 W
R36	0757-0959		R: fxd metflm 30 k ohms 2% 1/4 W
R37	0757-0900		R: fxd metflm 100 ohms 2% 1/4 W
R38	0761-0004	1	R: fxd metox 20 k ohms 5% 1 W
R39	0757-0924		R: fxd metflm 1000 ohms 2% 1/4 W
R40	0757-0951	2	R: fxd metflm 13 k ohms 2% 1/4 W
R41	2100-1788	1	R: var cer 500 ohms 30% 1/2 W
R42	2100-2497	1	R: var cer 2000 ohms 30% 1/2 W
R43	0757-0948		R: fxd metflm 10 k ohms 2% 1/4 W
R44	0757-0931		R: fxd metflm 2000 ohms 2% 1/4 W
R45	0757-0893	7	R: fxd metflm 51 ohms 2% 1/4 W
R46	0757-0953	2	R: fxd metflm 16 k ohms 2% 1/4 W
R47	0757-0924		R: fxd metflm 1000 ohms 2% 1/4 W
R48	0757-0927	3	R: fxd metflm 1300 ohms 2% 1/4 W
R49	0757-0948		R: fxd metflm 10 k ohms 2% 1/4 W
R50	0758-0020	2	R: fxd metflm 22 k ohms 5% 1/2 W
R51	2100-1738	1	R: var cer 10 k ohms 30% 1/2 W
R52	0757-0938	2	R: fxd metflm 3900 ohms 2% 1/4 W
R53	0757-0969	2	R: fxd metflm 75 k ohms 2% 1/4 W
R54	0758-0020		R: fxd metflm 22 k ohms 5% 1/2 W
R55	0757-0953		R: fxd metflm 16 k ohms 2% 1/4 W
R56	0757-0927		R: fxd metflm 1300 ohms 2% 1/4 W
R57	0757-0948		R: fxd metflm 10 k ohms 2% 1/4 W
R58	0757-0931		R: fxd metflm 2000 ohms 2% 1/4 W
R59	0757-0924		R: fxd metflm 1000 ohms 2% 1/4 W
R60	0757-0948		R: fxd metflm 10 k ohms 2% 1/4 W
R61	0757-0931		R: fxd metflm 2000 ohms 2% 1/4 W
R62	0757-0938		R: fxd metflm 3900 ohms 2% 1/4 W
R63	0757-0931		R: fxd metflm 2000 ohms 2% 1/4 W
R64	0757-0941		R: fxd metflm 5100 ohms 2% 1/4 W
R65	0757-0965		R: fxd metflm 51 k ohms 2% 1/4 W

Table 6-2. Model 1815A/B Replaceable Parts (Con't)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			A1 (con't)
R66	0757-0916	1	R: fxd metflm 470 ohms 2% 1/4 W
R67	0757-0931		R: fxd metflm 2000 ohms 2% 1/4 W
R68	0757-0948		R: fxd metflm 10 k ohms 2% 1/4 W
R69	0757-0931		R: fxd metflm 2000 ohms 2% 1/4 W
R70	0757-0931		R: fxd metflm 2000 ohms 2% 1/4 W
R71	0757-0948		R: fxd metflm 10 k ohms 2% 1/4 W
R72	0757-0948		R: fxd metflm 10 k ohms 2% 1/4 W
R73	0757-0424	1	R: fxd metflm 1100 ohms 1% 1/4 W
R74	0757-0415	1	R: fxd metflm 475 ohms 1% 1/8 W
R75	0698-0085	2	R: fxd metflm 2610 ohms 1% 1/8 W
R76	0757-0446	1	R: fxd metflm 15 k ohms 1% 1/8 W
R77	0757-0439	1	R: fxd metflm 6810 ohms 1% 1/8 W
R78	0757-0279	1	R: fxd metflm 3160 ohms 1% 1/8 W
S1	3101-0973	2	S: slide
VR1	1902-0184	1	VR: Si breakdown 16.2 V 5% 400 mW
VR2	1902-3416	1	VR: Si breakdown 90.9 V 5% .4 W
			A1 MISCELLANEOUS
XQ5	1200-0777	5	XQ: socket
XQ5	0340-0060	2	XQ: teflon standoff
			A2
A2	01815-66502		A: Board Assy: Horizontal Board (1815A)
	01815-66506		A: Board Assy: Horizontal Board (1815B)
C1	0160-0161		C: fxd mylar .01 uF 10% 200 wVdc
C2	0160-0161		C: fxd mylar .01 uF 10%200 wVdc
C3	0160-0378	1	C: fxd mica 27 pF 5% 300 wVdc
C4	0170-0040	1	C: fxd mylar .047 uF 10% 200 wVdc
C5	0160-0161		C: fxd mylar .01 uF 10% 200 wVdc
C6	0160-2204	1	C: fxd mica 100 pF 5% 300 wVdc
C7	0160-0134	2	C: fxd mica 220 pF 5% 300 wVdc
C8	0140-0176	6	C: fxd mica 100 pF 2% 300 wVdc
C9	0140-0198	1	C: fxd mica 200 pF 5% 300 wVdc (1815A)
	0160-2217	1	C: fxd mica 910 pF 5% 300 wVdc (1815B)
C10	0160-2228	1	C: fxd mica 2700 pF 5% 300 wVdc (1815A)
	0160-2331	1	C: fxd mica 8200 pF 1% 100 wVdc (1815B)

Table 6-2. Model 1815A/B Replaceable Parts (Con't)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			A2 (con't)
C11	0160-2930		C: fxd cer .01 uF -20 +80% 100 wVdc
C12	0160-2218	1	C: fxd mica 1000 pF 5% 300 wVdc
C13	0160-2257		C: fxd mica 10 pF 5% 500 wVdc
C14	0180-2255		C: fxd Ta 2.2 uF 20% 20 wVdc
C15	0180-2255		C: fxd Ta 2.2 uF 20% 20 wVdc
C16	0180-2255		C: fxd Ta 2.2 uF 20% 20 wVdc
C17	0140-0204		C: fxd mica 47 pF 5% 300 wVdc
C18	0160-2930		C: fxd cer .01 uF -20 +80% 100 wVdc
C19	0160-2930		C: fxd cer .01 uF - 20 +80% 100 wVdc
C20	0140-0196	1	C: fxd mica 150 pF 5% 300 wVdc
C21	0180-2255		C: fxd Ta 2.2 uF 20% 20 wVdc
C22	0180-2255		C: fxd Ta 2.2 uF 20% 20 wVdc
C23	0180-2255		C: fxd Ta 2.2 uF 20% 20 wVdc
C24	0180-2255		C: fxd Ta 2.2 uF 20% 20 wVdc
C25	0180-2255		C: fxd Ta 2.2 uF 20% 20 wVdc
C26	0150-0052	6	C: fxd cer .05 uF 20% 500 wVdc
C27	0160-2959		C: fxd cer .001 uF -0 +100% 600 wVdc
C28	0160-2930		C: fxd cer .01 uF -20 +80% 100 wVdc
C29	0160-2959		C: fxd cer .001 uF -0 +100% 600 wVdc
C30	0160-2917	2	C: fxd cer .05 uF -20 +80% 100 wVdc
C31	0160-2930		C: fxd cer .01 uF -20 +80% 100 wVdc
C32	0180-2255		C: fxd Ta 2.2 uF 20% 20 wVdc
C33	0150-0052		C: fxd cer .05 uF 20% 500 wVdc
C34	0140-0176		C: fxd mica 100 pF 2% 300 wVdc
C35	0140-0176		C: fxd mica 100 pF 2% 300 wVdc
C36	0150-0059	2	C: fxd cer 3.3 pF ±25% 500 wVdc
C37	0150-0059		C: fxd cer 3.3 pF ±25% 500 wVdc
C38	0180-2255		C: Ta 2.2 uF 20% 20 wVdc
C39	0180-2255		C: Ta 2.2 uF 20% 20 wVdc
C40	0160-2930		C: fxd cer .01 uF -20 +80% 100 wVdc
C41	0160-2959		C: fxd cer .001 uF -0 +100% 600 wVdc
C42	0160-2917		C: fxd cer .05 uF -20 +80% 100 wVdc
C43	0160-2959		C: fxd cer .001 uF -0 +100% 600 wVdc
C44	0150-0052		C: fxd cer .05 uF -20 +80% 500 wVdc
C45	0150-0052		C: fxd cer .05 uF -20 +80% 500 wVdc
C46	0180-2255		C: fxd Ta 2.2 uF 20% 20 wVdc
C47	0160-2930		C: fxd cer .01 uF -20 +80% 100 wVdc
C48	0160-0134		C: fxd mica 220 pF 5% 300 wVdc
CR1	1901-0347	2	CR: hot carrier
CR2	1901-0347		CR: hot carrier
CR3	1912-0012	2	CR: tunnel
CR4	1912-0012		CR: tunnel
CR5	1901-0179	7	CR: Si

Table 6-2. Model 1815A/B Replaceable Parts (Con't)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			A2 (con't)
CR6	1901-0040		CR: Si
CR7	1901-0040		CR: Si
CR8	1912-0002	3	CR: tunnel
CR9	1901-0040		CR: Si
CR10	1901-0040		CR: Si
CR11	1901-0179		CR: Si
CR12	1901-0179		CR: Si
CR13	1901-0040		CR: Si
CR14	1901-0179		CR: Si
CR15	1901-0179		CR: Si
CR16	1901-0179		CR: Si
CR17	1901-0179		CR: Si
CR18	1901-0040		CR: Si
CR19	1901-0040		CR: Si
CR20	1901-0040		CR: Si
L1	9170-0029		L: bead
L2	9100-2269	1	L: fxd 27 uH
L3	9170-0029		L: bead
L4	9170-0029		L: bead
L5	9100-2259	1	L: fxd 1.5 uH
L6	9170-0029		L: bead
L7	9100-2276		L: fxd 100 uH
L8	9140-0210		L: fxd 100 uH
L9	9140-0146	2	L: fxd rf 10 uH
L10	9140-0210		L: fxd 100 uH
L11	9140-0146		L: fxd 10 uH
L12	9140-0210		L: fxd 100 uH
L13	9140-0210		L: fxd 100 uH
L14	9140-0210		L: fxd 100 uH
L15	9140-0210		L: fxd 100 uH
L16	9140-0210		L: fxd 100 uH
L17	9170-0029		L: bead
L18	9170-0029		L: bead
L19	9170-0029		L: bead
L20	9170-0029		L: bead
L21	9140-0210		L: fxd 100 uH
L22	9140-0210		L: fxd 100 uH
L23	9170-0029		L: bead
L24	9170-0029		L: bead
L25	9140-0210		L: fxd 100 uH
Q1	1854-0045	1	Q: Si npn
Q2	1854-0296	1	Q: Si npn
Q3	1853-0036	9	Q: Si pnp 2N3906
Q4	1854-0215	5	Q: Si npn 2N3904
Q5	5080-0483	2	Q: selected

Table 6-2. Model 1815A/B Replaceable Parts (Con't)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			A2 (con't)
Q6	1854-0215		Q: Si npn 2N3904
Q7	5080-0483		Q: selected
Q8	1854-0019		Q: npn
Q9	1853-0036		Q: Si pnp 2N3906
Q10	1853-0036		Q: Si pnp 2N3906
Q11	1853-0020		Q: Si pnp
Q12	1854-0221	4	Q: Si dual npn
Q13	1853-0036		Q: Si pnp 2N3906
Q14	1853-0020		Q: Si pnp
Q15	1854-0221		Q: Si dual npn
Q16	1854-0241	4	Q: Si npn
Q17	1854-0241		Q: Si npn
Q18	1854-0071		Q: Si npn
Q19	1854-0215		Q: Si npn
Q20	1853-0010	4	Q: Si pnp
Q21	1854-0071		Q: Si npn
Q22	1854-0019		Q: npn
Q23	1854-0019		Q: npn
Q24	1853-0010		Q: Si pnp
Q25	1853-0010		Q: Si pnp
Q26	1854-0039	2	Q: Si npn 2N3053
Q27	1854-0241		Q: Si npn
Q28	1854-0241		Q: Si npn
Q29	1854-0071		Q: Si npn
Q30	1853-0010		Q: Si pnp
Q31	1854-0215		Q: Si npn
R1	0757-0893		R: fxd metflm 51 ohms 2% 1/4 W
R2	0757-0893		R: fxd metflm 51 ohms 2% 1/4 W
R3	0698-3430	2	R: fxd metflm 21.5 ohms 1% 1/8 W
R4	0698-3430		R: fxd metflm 21.5 ohms 1% 1/8 W
R5	0757-0933	1	R: fxd metflm 2400 ohms 2% 1/4 W
R6	0757-0924		R: fxd metflm 1000 ohms 2% 1/4 W
R7	0757-0931		R: fxd metflm 2000 ohms 2% 1/4 W
R8	2100-2216		R: var cer 5000 ohms 1/2 W
R9	0758-0054	2	R: fxd metflm 330 ohms 5% 1/2 W
R10	0757-0346	2	R: fxd metflm 10 ohms 1% 1/8 W
R11	0757-0972	6	R: fxd metflm 100 k ohms 2% 1/4 W
R12	0757-0346		R: fxd metflm 10 ohms 1% 1/8 W
R13	0757-0948		R: fxd metflm 10 k ohms 2% 1/4 W
R14	0757-0934	5	R: fxd metflm 2700 ohms 2% 1/4 W
R15	0757-0948		R: fxd metflm 10 k ohms 2% 1/4 W

Table 6-2. Model 1815A/B Replaceable Parts (Con't)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			A2 (con't)
R16	0757-0917		R: fxd metflm 510 ohms 2% 1/4 W
R17	0758-0039	3	R: fxd metflm 20 k ohms 5% 1/2 W
R18	0757-0455	1	R: fxd metflm 36.5 k ohms 1% 1/8 W
R19	0757-0442	1	R: fxd metflm 10 k ohms 1% 1/8 W
R20	0698-0085		R: fxd metflm 2610 ohms 1% 1/8 W
R21	0757-0900		R: fxd metflm 100 ohms 2% 1/4 W
R22	0757-0911		R: fxd metflm 300 ohms 2% 1/4 W
R23	0757-0924		R: fxd metflm 1000 ohms 2% 1/4 W
R24	2100-1986		R: var cer 1000 ohms 30% 1/2 W
R25	0757-0276	1	R: fxd metflm 61.9 ohms 1% 1/8 W
R26	0757-0436	1	R: fxd metflm 4320 ohms 1% 1/8 W
R27	0757-0900		R: fxd metflm 100 ohms 2% 1/4 W
R28	0757-0959		R: fxd metflm 30 k ohms 2% 1/4 W
R29	0757-0945	3	R: fxd metflm 7500 ohms 2% 1/4 W
R30	0757-0951		R: fxd metflm 13 k ohms 2% 1/4 W
R31	0757-0941		R: fxd metflm 5100 ohms 2% 1/4 W
R32	2100-1776	1	R: var ww 10 k ohms 30% 1/2 W
R33	0757-0940	5	R: fxd metflm 4700 ohms 2% 1/4 W
R34	0757-0943	2	R: fxd metflm 6200 ohms 2% 1/4 W
R35	0757-0948		R: fxd metflm 10 k ohms 2% 1/4 W
R36	0757-0893		R: fxd metflm 51 ohms 2% 1/4 W
R37	0698-7304	2	R: fxd metflm 500 k ohms 2% 1/2 W
R38	0757-0965		R: fxd metflm 51 k ohms 2% 1/4 W
R39	0757-0931		R: fxd metflm 2000 ohms 2% 1/4 W
R40	0757-0931		R: fxd metflm 2000 ohms 2% 1/4 W
R41	0757-0961	4	R: fxd metflm 36 k ohms 2% 1/4 W
R42	0757-0961		R: fxd metflm 36 k ohms 2% 1/4 W
R43	0758-0074	2	R: fxd metox 27 k ohms 5% 1/2 W
R44	0757-0948		R: fxd metflm 10 k ohms 2% 1/4 W
R45	0757-0893		R: fxd metflm 51 ohms 2% 1/4 W
R46	0698-7304		R: fxd metflm 500 k ohms 2% 1/2 W
R47	0757-0943		R: fxd metflm 6200 ohms 2% 1/4 W
R48	0757-0964	1	R: fxd metflm 47 k ohms 2% 1/4 W
R49	2100-1775	2	R: var ww 5000 ohms 30% 1/2 W
R50	0757-0948		R: fxd metflm 10 k ohms 2% 1/4 W
R51	0757-0935		R: fxd metflm 3000 ohms 2% 1/4 W
R52	0757-0948		R: fxd metflm 10 k ohms 2% 1/4 W
R53	0758-0039		R: fxd metox 20 k ohms 5% 1/2 W
R54	0757-0909	6	R: fxd metflm 240 ohms 2% 1/4 W
R55	0757-0972		R: fxd metflm 100 k ohms 2% 1/4 W
R56	0757-0918	2	R: fxd metflm 560 ohms 2% 1/4 W
R57	0757-0935		R: fxd metflm 3000 ohms 2% 1/4 W
R58	0757-0935		R: fxd metflm 3000 ohms 2% 1/4 W
R59	0757-0972		R: fxd metflm 100 k ohms 2% 1/4 W
R60	0757-0972		R: fxd metflm 100 k ohms 2% 1/4 W

Table 6-2. Model 1815A/B Replaceable Parts (Con't)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			A2 (con't)
R61	0757-0909		R: fxd metflm 240 ohms 2% 1/4 W
R62	0757-0900		R: fxd metflm 100 ohms 2% 1/4 W
R63	0757-0909		R: fxd metflm 240 ohms 2% 1/4 W
R64	0811-2729	2	R: fxd ww 5000 ohms 3% 3 W
R65	0757-0948		R: fxd metflm 10 k ohms 2% 1/4 W
R66	0757-0961		R: fxd metflm 36 k ohms 2% 1/4 W
R67	0757-0948		R: fxd metflm 10 k ohms 2% 1/4 W
R68	0757-0924		R: fxd metflm 1000 ohms 2% 1/4 W
R69	0757-0931		R: fxd metflm 2000 ohms 2% 1/4 W
R70	0757-0893		R: fxd metflm 51 ohms 2% 1/4 W
R71	0757-0934		R: fxd metflm 2700 ohms 2% 1/4 W
R72	0757-0939		R: fxd metflm 4300 ohms 2% 1/4 W
R73	0757-0910		R: fxd metflm 270 ohms 2% 1/4 W
R74	0757-0939		R: fxd metflm 4300 ohms 2% 1/4 W
R75	0811-2731	2	R: fxd ww 6240 ohms .5% 3 W
R76	0811-2731		R: fxd ww 6240 ohms .5% 3 W
R77	0757-0934		R: fxd metflm 2700 ohms 2% 1/4 W
R78	0757-0939		R: fxd metflm 4300 ohms 2% 1/4 W
R79	0757-0910		R: fxd metflm 270 ohms 2% 1/4 W
R80	0757-0939		R: fxd metflm 4300 ohms 2% 1/4 W
R81	2100-1775		R: var ww 5000 ohms 30% 1/2 W
R82	0757-0060	1	R: fxd metflm 24.3 k ohms 1% 1/2 W
R83	0757-0935		R: fxd metflm 3000 ohms 2% 1/4 W
R84	0757-0952	1	R: fxd metflm 15 k ohms 2% 1/4 W
R85	0757-0918		R: fxd metflm 560 ohms 2% 1/4 W
R86	0757-0935		R: fxd metflm 3000 ohms 2% 1/4 W
R87	0757-0935		R: fxd metflm 3000 ohms 2% 1/4 W
R88	0757-0972		R: fxd metflm 100 k ohms 2% 1/4 W
R89	0757-0900		R: fxd metflm 100 ohms 2% 1/4 W
R90	0757-0909		R: fxd metflm 240 ohms 2% 1/4 W
R91	0757-0972		R: fxd metflm 100 k ohms 2% 1/4 W
R92	0757-0909		R: fxd metflm 240 ohms 2% 1/4 W
R93	0811-2729		R: fxd ww 5000 ohms 3% 3 W
R94	0757-0909		R: fxd metflm 240 ohms 2% 1/4 W
R95	0757-0961		R: fxd metflm 36 k ohms 2% 1/4 W
R96	0757-0948		R: fxd metflm 10 k ohms 2% 1/4 W
R97	0757-0893		R: fxd metflm 51 ohms 2% 1/4 W
RT1	0837-0059	1	RT: fxd thermistor
VR1	1902-3096	1	VR: breakdown 5.23 V 5% 400 mW
VR2	1902-0047	1	VR: breakdown 17.8 V 2% .4 W
VR3	1902-3224	2	VR: breakdown 17.8 V 5% .4 W
VR4	1902-3224		VR: breakdown 17.8 V 5% .4 W

Table 6-2. Model 1815A/B Replaceable Parts (Con't)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			A2 MISCELLANEOUS
	1205-0203	1	Heat dissipator
	1460-1037	4	Spring, diode mount
XQ12	1200-0777		XQ: socket
XQ15	1200-0777		XQ: socket
			A3
A3	01815-66503	1	A: Board assy: Horizontal sensitivity indicator
DS1	2140-0016		DS: lamp
DS2	2140-0016		DS: lamp
R1	0757-0170	1	R: fxd metflm 75 ohms 2% 1/2 W
			A4
A4	01815-66504		A: Board assy: Vertical Sensitivity indicator
DS1	2140-0016		DS: lamp
DS2	2140-0016		DS: lamp
			A5
A5	01815-66505		A: Board assy: staircase
C1	0140-0176		C: fxd mica 100 pF 1% 300 wVdc
C2	0140-0176		C: fxd mica 100 pF 1% 300 wVdc
C3	0140-0203	1	C: fxd mica 30 pF 1/2% 500 wVdc
C4	0180-2255		C: fxd Ta elect 2.2 uF 20% 20 wVdc
C5	0150-0052		C: fxd cer .05 uF 20% 400 wVdc
C6	0150-0052		C: fxd cer .05 uF 20% 400 wVdc
C7	0160-2930		C: fxd cer .01 uF -20 +80% 100 wVdc
C8	0160-0168	1	C: fxd mylar .1 uF 10% 200 wVdc
C9	0180-0098	1	C: fxd Ta 100 uF 20% 20 wVdc
C10	0160-2228	1	C: fxd mica 2700 pF 5% 300 wVdc
C11	0180-0230	1	C: fxd Ta 1 uF 20% 50 wVdc
C12	0140-0205	1	C: fxd mica 62 pF 5% 300 wVdc
C13	0160-2959		C: fxd cer 1000 pF 10% 600 wVdc
C14	0160-2959		C: fxd cer 1000 pF 10% 600 wVdc
C15	0160-2959		C: fxd cer 1000 pF 10% 600 wVdc
C16	0160-2930		C: fxd cer .01 uF -20 +80% 100 wVdc
C17	0160-2930		C: fxd cer .01 uF -20 +80% 100 wVdc
C18	0180-2255		C: fxd Ta 2.2 uF 20% 20 wVdc
C19	0160-2930		C: fxd cer .01 uF -20 +80% 100 wVdc
C20	0160-2930		C: fxd cer .01 uF -20 +80% 100 wVdc

Table 6-2. Model 1815A/B Replaceable Parts (Con't)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			A5 (con't)
C21	0160-2930		C: fxd cer .01 uF -20 +80% 100 wVdc
C22	0140-0193	2	C: fxd mica 82 pF 5% 300 wVdc
C23	0140-0193		C: fxd mica 82 pF 5% 300 wVdc
C24	0180-2255		C: fxd Ta elect 2.2 uF 20% 20 wVdc
C25	0140-0176		C: fxd mica 100 pF 2% 300 wVdc
CR1	1901-0040		CR: Si
CR2	1901-0040		CR: Si
CR3	1901-0040		CR: Si
CR4	1901-0040		CR: Si
CR5	1901-0040		CR: Si
CR6	1901-0040		CR: Si
CR7	1901-0033	3	CR: Si 13 pF 100 mA 180 V
CR8	1901-0033		CR: Si 13 pF 100 mA 180 V
CR9	1901-0033		CR: Si 13 pF 100 mA 180 V
CR10	1901-0040		CR: Si
CR11	1912-0002		CR: tunnel
CR12	1901-0040		CR: Si
CR13			CR: selected with CR16
CR14	1910-0016	1	CR: Si
CR15	1912-0002		CR: tunnel
CR16	5080-0457	1	CR: selected with CR13
CR17	1901-0040		CR: Si
CR18	1901-0040		CR: Si
CR19	1901-0040		CR: Si
CR20	1901-0040		CR: Si
CR21	1901-0040		CR: Si
CR22	1912-0007	1	CR: tunnel
L1	9140-0210		L: fxd 100 uH
Q1	1853-0036		Q: Si pnp 2N3906
Q2	1853-0036		Q: Si pnp 2N3906
Q3	1854-0215		Q: Si npn 2N3904
Q4	1853-0036		Q: Si pnp 2N3904
Q5	1855-0022		Q: FET
Q6	1854-0022		Q: npn
Q7	1853-0020		Q: Si pnp
Q8	1853-0020		Q: Si pnp
Q9	1853-0020		Q: Si pnp
Q10	1854-0039		Q: npn
Q11	1854-0071		Q: npn
Q12	1853-0020		Q: Si pnp
Q13	1854-0071		Q: npn
Q14	1854-0221		Q: Si dual npn
Q15	1854-0071		Q: npn

Table 6-2. Model 1815A/B Replaceable Parts (Con't)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			A5 (con't)
Q16	1853-0020		Q: Si pnp
Q17	1853-0020		Q: Si pnp
Q18	1854-0221		Q: Si dual npn
Q19	1854-0071		Q: Si npn
Q20	1853-0020		Q: Si pnp
Q21	1853-0020		Q: Si pnp
Q22	1853-0020		Q: Si pnp
Q23	1853-0020		Q: Si pnp
Q24	1853-0036		Q: Si pnp 2N3906
Q25	1853-0036		Q: Si pnp 2N3906
Q26	1854-0071		Q: Si npn
Q27	1854-0071		Q: Si npn
Q28	1850-0101	1	Q: pnp
R1	0757-0931		R: fxd metflm 2000 ohms 2% 1/4 W
R2	0757-0447	1	R: fxd metflm 16.2 k ohms 1% 1/8 W
R3	0757-0976	1	R: fxd metflm 150 k ohms 2% 1/4 W
R4	0698-7302	3	R: fxd metflm 300 k ohms 2% 1/4 W
R5	0757-0949	1	R: fxd metflm 11 k ohms 2% 1/4 W
R6	0757-0948		R: fxd metflm 10 k ohms 2% 1/4 W
R7	0757-0960	3	R: fxd metflm 33 k ohms 2% 1/4 W
R8	0757-0924		R: fxd metflm 1000 ohms 2% 1/4 W
R9	0757-0924		R: fxd metflm 1000 ohms 2% 1/4 W
R10	0758-0039		R: fxd metflm 20 k ohms 5% 1/2 W
R11	0683-5655	1	R: fxd comp 5.6 megohms 5% 1/4 W
R12	0757-0477	1	R: fxd metflm 332 k ohms 1% 1/8 W
R13	0757-0845	1	R: fxd metflm 18.2 k ohms 1% 1/2 W
R14	0757-0956	1	R: fxd metflm 22 k ohms 2% 1/4 W
R15	0757-0969		R: fxd metflm 75 k ohms 2% 1/4 W
R16	0757-0955	3	R: fxd metflm 20 k ohms 2% 1/4 W
R17	0698-7302		R: fxd metflm 300 k ohms 2% 1/4 W
R18	0757-0898	2	R: fxd metflm 82 ohms 2% 1/4 W
R19	0757-0955	1	R: fxd metflm 20 k ohms 2% 1/4 W
R20	2100-2216		R: var cer 5000 ohms 30% 1/2 W
R21	0761-0072	1	R: fxd metox 11 k ohms 5% 1 W
R22	0757-0435	1	R: fxd metflm 3920 ohms 1% 1/8 W
R23	0758-0074		R: fxd metflm 27 k ohms 5% 1/2 W
R24	0683-1055	1	R: fxd carb comp 1 megohm 5% 1/4 W
R25	0757-0907		R: fxd metflm 200 ohms 2% 1/4 W
R26	0757-0898		R: fxd metflm 82 ohms 2% 1/4 W
R27	0757-0935		R: metflm 3000 ohms 2% 1/4 W
R28	0757-0911		R: metflm 300 ohms 2% 1/4 W
R29	0757-0946	1	R: metflm 8200 ohms 2% 1/4 W
R30	0757-0924		R: metflm 1000 ohms 2% 1/4 W

Table 6-2. Model 1815A/B Replaceable Parts (Con't)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			A5 (con't)
R31	0757-0945		R: metflm 7500 ohms 2% 1/4 W
R32	0757-0093	1	R: metflm 39 k ohms 2% 1/2 W
R33	0757-0945		R: metflm 7500 ohms 2% 1/4 W
R34	0757-0940		R: fxd metflm 4700 ohms 2% 1/4 W
R35	0757-0900		R: fxd metflm 100 ohms 2% 1/4 W
R36	0698-7305	1	R: fxd metflm 820 k 2% 1/2 W
R37	0698-7303		R: fxd metflm 430 k ohms 2% 1/2 W
R38	0761-0073	1	R: fxd metflm 13 k ohms 5% 1 W
R39	0698-7302		R: fxd metflm 300 k ohms 2% 1/4 W
R40	0757-0948		R: fxd metflm 10 k ohms 2% 1/4 W
R41	0757-0935		R: fxd metflm 3000 ohms 2% 1/4 W
R42	0757-0935		R: fxd metflm 3000 ohms 2% 1/4 W
R43	0757-0925	4	R: fxd metflm 1100 ohms 2% 1/4 W
R44	0757-0948		R: fxd metflm 10 k ohms 2% 1/4 W
R45	0757-0940		R: fxd metflm 4700 ohms 2% 1/4 W
R46	0757-0924		R: fxd metflm 1000 ohms 2% 1/4 W
R47	0757-0934		R: fxd metflm 2700 ohms 2% 1/4 W
R48	0757-0960		R: fxd metflm 33 k ohms 2% 1/4 W
R49	0757-0960		R: fxd metflm 33 k ohms 2% 1/4 W
R50	0757-0965		R: fxd metflm 51 k ohms 2% 1/4 W
R51	0757-0965		R: fxd metflm 51 k ohms 2% 1/4 W
R52	0757-0911		R: fxd metflm 300 ohms 2% 1/4 W
R53	0757-0934		R: fxd metflm 2700 ohms 2% 1/4 W
R54	0757-0924		R: fxd metflm 1000 ohms 2% 1/4 W
R55	0757-0940		R: fxd metflm 4700 ohms 2% 1/4 W
R56	0757-0955		R: fxd metflm 20 k ohms 2% 1/4 W
R57	2100-1772	1	R: var ww 500 ohms 10% 1/2 W
R58	0757-0925		R: fxd metflm 1100 ohms 2% 1/4 W
R59	0757-0281	1	R: fxd metflm 2740 ohms 1% 1/8 W
R60	0757-0444	1	R: fxd metflm 12.1 k ohms 1% 1/8 W
R61	0757-0925		R: fxd metflm 1100 ohms 2% 1/4 W
R62	2100-1986		R: var cer 1000 ohms 30% 1/2 W
R63	0757-0940		R: fxd metflm 4700 ohms 2% 1/4 W
R64	0757-0923		R: fxd metflm 910 ohms 2% 1/4 W
R65	0757-0917		R: fxd metflm 510 ohms 2% 1/4 W
R66	0758-0054		R: fxd metflm 330 ohms 5% 1/2 W
S1	3101-0973		S: slide
VR1	1902-3235	1	VR: Breakdown 19.6 V 2% .4 W
VR2	1902-0026	1	VR: breakdown 36.5 V 10% .4 W
VR3	1902-3155	1	VR: breakdown 9.53 V 2% .4 W

Table 6-2. Model 1815A/B Replaceable Parts (Con't)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			A5 MISCELLANEOUS
	0340-0060		Teflon standoff
XQ14	1200-0777		XQ: socket
XQ18	1200-0777		XQ: socket
			A6
	01815-61901		Switch assy: Horizontal sensitivity
C1	0140-0145	2	C: fxd mica 22 pF 5% 500 wVdc
C2	0130-0009	2	C: var cer 6-25 pF
C3	0140-0064	2	C: fxd mica 62 pF 5% 500 wVdc
C4	0130-0015	4	C: var cer 9-50 pF
C5	0160-2284	2	C: fxd mica 1100 pF 1% 500 wVdc
C6	0130-0015		C: var cer 9-50 pF
C7	0160-2351	2	C: fxd poly .012 uF 1% 50 wVdc
C8	0140-0145		C: fxd mica 22 pF 5% 500 wVdc
C9	0130-0009		C: var cer 6-25 pF
C10	0140-0064		C: fxd mica 62 pF 5% 500 wVdc
C11	0130-0015		C: var cer 9-50 pF
C12	0160-2284		C: fxd mica 1150 pF 1% 500 wVdc
C13	0130-0015		C: var cer 9-50 pF
C14	0160-2351		C: fxd poly .012 uF 1% 50 wVdc
R1	0757-0394	8	R: fxd metflm 51.1 ohms 1% 1/8 W
R2	0684-1001	6	R: fxd carbon comp 10 ohms 10% 1/4 W
R3	0757-0394		R: fxd metflm 51.1 ohms 1% 1/8 W
R4	0684-1001		R: fxd comp 10 ohms 10% 1/4 W
R5	0757-0394		R: fxd metflm 51.1 ohms 1% 1/8 W
R6	0684-1001		R: fxd comp 10 ohms 10% 1/4 W
R7	0757-0394		R: fxd metflm 51.1 ohms 1% 1/8 W
R8	0757-0394		R: fxd metflm 51.1 ohms 1% 1/8 W
R9	0684-1001		R: fxd comp 10 ohms 10% 1/4 W
R10	0757-0394		R: fxd metflm 51.1 ohms 1% 1/8 W
R11	0684-1001		R: fxd comp 10 ohms 10% 1/4 W
R12	0757-0394		R: fxd metflm 51.1 ohms 1% 1/8 W
R13	0684-1001		R: fxd comp 10 ohms 10% 1/4 W
R14	0757-0394		R: fxd metflm 51.1 ohms 1% 1/8 W
R15	0698-3358	1	R: fxd metflm 1000 ohms .5% 1/8 W
R16	0698-4015	1	R: fxd metflm 600 ohms .5% 1/8 W
R17	0698-3318	2	R: fxd metflm 200 ohms .5% 1/8 W
R18	0698-4016	1	R: fxd metflm 2000 ohms .5% 1/8 W
R19	0698-4017	1	R: fxd metflm 6000 ohms .5% 1/8 W
R20	0698-3329	1	R: fxd metflm 10 k ohms .5% 1/8 W
R21	0698-3318		R: fxd metflm 200 ohms .5% 1/8 W
R22	0698-5581	1	R: fxd metflm 250 k ohms .5% 1/8 W
R23	0698-5574	1	R: fxd metflm 62.5 k ohms .5% 1/8 W

Table 6-2. Model 1815A/B Replaceable Parts (Con't)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			A6 (con't)
R24	0698-5573	1	R: fxd metflm 50 k ohms .5% 1/8 W
S1	3100-2511	1	S: rotary, 7 sections, 2 detents
W1	01815-61602	1	W: blu
W2	01815-61621	2	W: blu
			A6 MISCELLANEOUS
	0340-0038	2	Post term
	0340-0039	2	Bushing insulator
			A7
A7	01815-61902		Switch assy: scan
CR1	1901-0040		CR: Si
R1	0757-0965		R: fxd metflm 51 k ohms 2% 1/4 W
R2	2100-2801	1	R: var dual 5000-400 k ohms
R3	0757-0929		R: fxd metflm 1600 ohms 2% 1/4 W
R4	0757-0915	1	R: fxd metflm 430 ohms 2% 1/4 W
S1	3100-2510	1	S; switch rotary
			A7 MISCELLANEOUS
	3130-0038	1	Coupler shaft
	01410-04103	2	Mounting plate (R2)
			A8
A8	01815-61903		Switch assy: Vertical sensitivity
C1	0160-0163	1	C: fxd mylar .033 uF 10% 200 wVdc
R1	0757-1107	4	R: fxd metflm 30 ohms 1% 1/8 W
R2	0698-4380	2	R: fxd metflm 45.3 ohms 1% 1/8 W
R3	0757-0398	2	R: fxd metflm 75 ohms 1% 1/8 W
R4	0757-0284	2	R: fxd metflm 150 ohms 1% 1/8 W
R5	0757-1097	1	R: fxd metflm 1200 ohms 1% 1/8 W
R6	0698-4380		R: fxd metflm 45.3 ohms 1% 1/8 W
R7	0757-1107		R: fxd metflm 30 ohms 1% 1/8 W
R8	0757-0398		R: fxd metflm 75 ohms 1% 1/8 W
R9	0757-0284		R: fxd metflm 150 ohms 1% 1/8 W
R10	0698-3510	1	R: fxd metflm 453 ohms 1% 1/8 W

Table 6-2. Model 1815A/B Replaceable Parts (Con't)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			A8 (con't)
R11	0757-0420	1	R: fxd metflm 750 ohms 1% 1/8 W
R12	0757-0970	1	R: fxd metflm 82 k ohms 2% 1/4 W
R13	0757-0427	1	R: fxd metflm 1500 ohms 1% 1/8 W
R14	0698-3324	1	R: fxd metflm 1800 ohms .5% 1/8 W
R15	0698-4460	1	R: fxd metflm 649 ohms 1% 1/8 W
R16	0757-1100	1	R: fxd metflm 600 ohms 1% 1/8 W
R17	0757-0280	1	R: fxd metflm 1000 ohms 1% 1/8 W
R18	0757-1108	1	R: fxd metflm 300 ohms 1% 1/8 W
R19	0757-0274		R: fxd metflm 1210 ohms 1% 1/8 W
R20	0757-1102	1	R: fxd metflm 180 ohms 1% 1/8 W
R21	0698-4423	1	R: fxd metflm 1370 ohms 1% 1/8 W
R22	0757-1104	1	R: fxd metflm 60 ohms 1% 1/8 W
R23	0757-1095	1	R: fxd metflm 1440 ohms 1% 1/8 W
R24	0757-1107		R: fxd metflm 30 ohms 1% 1/8 W
R25	0757-1094	1	R: fxd metflm 1470 ohms 1% 1/8 W
R26	0757-1107		R: fxd metflm 30 ohms 1% 1/8 W
R27	2100-2821	1	R: var ccl w/S1 50 k ohms
S1	3100-2509	1	S: rotary
			A8 MISCELLANEOUS
	01410-04103		Mounting plate R27
			A9
A9	01815-61904		Switch assy: Function (1815A)
	01815-61905		Switch assy: Function (1815B)
R1	0757-0925		R: fxd metflm 1100 ohms 2% 1/4 W
R2	0757-0959		R: fxd metflm 30 k ohms 2% 1/4 W (1815A)
	0757-0475	1	R: fxd metflm 274 k ohms 1% 1/8 W (1815B)
R3,4	0698-7183	2	R: fxd metflm 3120 ohms 1/2% 1/2 W (1815A)
	0698-5648	2	R: fxd metflm 10.5 k ohms 1/2% 1/4 W (1815B)
R5	0757-0927		R: fxd metflm 1300 ohms 2% 1/4 W
S1	3100-2508	1	S: rotary

Table 6-3. Model 1817A Replaceable Parts

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			CHASSIS PARTS
A1	01817-66501	1	A: board assy: pulse generator
A2	01817-66502	1	A: Stripline assembly
A3	01817-66503	1	A: Pre-amplifier assembly
A4	01817-62901	1	A: Step Generator Module assembly
A5	01817-66505	1	A: Power Source assembly
A6	01817-21301	1	A: Board assy: resistor
A7	1901-1010	1	A: assy block, sampling w/J2, J3
C1	0160-2357	4	C: fxd cer fdth 1000 pF -20 +80%
C2	0160-2357		C: fxd cer fdth 1000 pF -20% +80%
J1	1251-1990	1	J: conn, special purpose
R1	0757-0465	3	R: fxd metflm 100 k ohms 1% 1/8 W
W1	01817-61601	1	W: cable assy, feedback
W2	01817-61602	1	W: cable assy, step stab and reset
W3	01817-61603	1	W: cable assy, TD mount
W4	01817-61604	1	W: cable assy, coaxial delay
W5	01817-61605	1	W: cable assy, output
W6	01817-61607	1	W: cable assy, trigger
W7	01817-61608	1	W: cable assy, strobe/stripline
W8	5060-0441	1	W: cable assy
W9	5060-0473	1	W: cable assy, sampler
			CHASSIS MISCELLANEOUS
	1250-0819	2	Nut, coupling rf conn, w/J2, J3
	1250-0820	2	Retainer, rf conn w/J2, J3
	1400-0024	1	Clamp, cable
	1401-0047	2	Cap, plastic
	00180-09104	2	Clip, grd
	01430-24701	2	Disc, block cover
	01430-48301	1	Pellet, molded
	01432-24702	1	Disc, cable cover
	01817-00601	1	Shield, stobe generator
	01817-14101	1	Cover, top
	01817-04102	1	Cover, bottom
	01817-24101	1	Plate, stobe generator, bottom
	01817-24102	2	Plate, stobe generator, side
	01817-24701	1	Disc, TD cover
	01817-25201	1	Housing, machined
	08411-4003	4	Foot
	909A	1	Load, 50-ohm

Table 6-3. Model 1817A Replaceable Parts (Con't)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			A1
A1	01817-66501		A: board assy: pulse generator
C1	0140-0178	1	C: fxd mica 560 pF 2% 300 wVdc
C2	0160-0161	6	C: fxd my .01 uF 10% 200 wVdc
C3	0160-0161		C: fxd my .01 uF 10% 200 wVdc
C4	0140-0225	1	C: fxd mica 300 pF 1% 300 wVdc
C5	0140-0190	1	C: fxd mica 39 pF 5% 300 wVdc
C6	0160-2198	1	C: fxd mica 20 pF 5% 300 wVdc
C7	0160-0161		C: fxd my .01 uF 10% 200 wVdc
C8	0160-0161		C: fxd my .01 uF 10% 200 wVdc
CR1	1901-0040	3	CR: Si
CR2	1901-0040		CR: Si
CR3	1901-0040		CR: Si
L1	9140-0094	1	L: fxd .68 uH 10%
Q1	1854-0344	2	Q: Si npn
Q2	1853-0034	4	Q: Si pnp
Q3	1853-0201	1	Q: Si pnp
Q4	1854-0344		Q: Si npn
R1	0757-0900	5	R: fxd metox 100 ohms 2% 1/4 W
R2	0757-0760	2	R: fxd metox 20 k ohms 1% 1/4 W
R3	0757-0924	7	R: fxd metox 1000 ohms 2% 1/4 W
R4	0757-0900		R: fxd metox 100 ohms 2% 1/4 W
R5	0757-0924		R: fxd metox 1000 ohms 2% 1/4 W
R6	0757-0900		R: fxd metox 100 ohms 2% 1/4 W
R7	0757-0760		R: fxd metox 20 k ohms 1% 1/4 W
R8	0757-0924		R: fxd metox 1000 ohms 2% 1/4 W
VR1	1902-0578	2	VR: breakdown 27.4 V 5% 1 W
VR2	1902-0578		VR: breakdown 27.4 V 5% 1 W
			A2
A2	01817-66502		A: board assy: stripline
C1	0160-2325	1	C: fxd cer 3000 pF 200 wVdc
CR1	1901-1009	1	CR: Si selected
CR2	1901-0556	1	CR: Si
R1	2100-1770	1	R: var, 100 ohms 10% 1/2 W

Table 6-3. Model 1817A Replaceable Parts (Con't)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			A2 MISCELLANEOUS
	4320-0044	3	Button, rubber
	00188-21304	1	Jumper, disc
	01430-07201	1	Insert, capacitor
	01430-27202	2	Insert, diode
	01817-04701	1	Support, bottom
	01817-21301	1	Jumper, resistor
	01817-26502	1	Board, stripline
			A3
A3			A: board assy: preamplifier
C1	0150-0093	4	C: fxd cer .01 uF -20% +80% 100 wVdc
C2	0180-0155	5	C: fxd Ta 2.2 uF 20% 20 wVdc
C3	0180-0155		C: fxd Ta 2.2 uF 20% 20 wVdc
C4	0180-0155		C: fxd Ta 2.2 uF 20% 20 wVdc
C5	0180-0155		C: fxd Ta 2.2 uF 20% 20 wVdc
C6	0121-0403	1	C: var 8-8.5 pF 750 wVdc
C7	0160-0161		C: fxd cer .01 uF -20% +80% 100 wVdc
C8	0160-0161		C: fxd cer .01 uF -20% +80% 100 wVdc
C9	0140-0222	2	C: fxd mica 240 pF 1% 300 wVdc
C10	0140-0222		C: fxd mica 240 pF 1% 300 wVdc
C11	0180-0155		C: fxd Ta 2.2 uF 20% 20 wVdc
L1	9170-0029	17	L: Bead, ferrite
L2	9100-2276	1	L: fxd 100 uH
L3	9170-0029		L: Bead, ferrite
L4	9170-0029		L: Bead, ferrite
L5	9170-0029		L: Bead, ferrite
L6	9170-0029		L: Bead, ferrite
L7	9170-0029		L: Bead, ferrite
L8	9140-0142	1	L: fxd 2.2 uH 10%
MC1	1820-0046	1	MC1: Amplifier, RF, integrated circuit
Q1	1854-0397	1	Q: Si npn
Q2	1854-0221	1	Q: Si dual npn
Q3	1854-0019	1	Q: Si npn
R1	0757-0924		R: fxd metox 1000 ohms 2% 1/4 W
R2	0698-3444	1	R: fxd metflm 316 ohms 1% 1/8 W
R3	0757-0920	1	R: fxd metox 680 ohms 2% 1/4 W
R4	0757-0914	1	R: fxd metflm 390 ohms 2% 1/4 W
R5	0757-0280	1	R: fxd metflm 1000 ohms 1% 1/8 W

Table 6-3. Model 1817A Replaceable Parts (Con't)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			A3 (con't)
R6	0698-3551	4	R: fxd metflm 280 k ohms 1% 1/8 W
R7	0757-0936	2	R: fxd metox 3300 ohms 2% 1/4 W
R8	0757-0962	1	R: fxd metox 39 k ohms 2% 1/4 W
R9	0698-3551		R: fxd metflm 280 k ohms 1% 1/8 W
R10	0757-0449	6	R: fxd metflm 20 k ohms 1% 1/8 W
R11	0757-0449		R: fxd metflm 20 k ohms 1% 1/8 W
R12	0698-3551		R: fxd metflm 280 k ohms 1% 1/8 W
R13	0757-0959	1	R: fxd metox 30 k ohms 2% 1/4 W
R14	2100-1777	1	R: var 20 k ohms 10% 1/2 W
R15	0757-0936		R: fxd metox 3300 ohms 2% 1/4 W
R16	2100-1948	1	R: var 50 k ohms 5% 1 W
R17	0698-3551		R: fxd metflm 280 k ohms 1% 1/8 W
R18	0757-0442	1	R: fxd metflm 10 k ohms 1% 1/8 W
R19	0757-0465		R: fxd metflm 100 k ohms 1% 1/8 W
R20	0757-0465		R: fxd metflm 100 k ohms 1% 1/8 W
R21	0757-0449		R: fxd metflm 20 k ohms 1% 1/8 W
R22	0757-0449		R: fxd metflm 20 k ohms 1% 1/8 W
R23	0757-0449		R: fxd metflm 20 k ohms 1% 1/8 W
R24	0757-0449		R: fxd metflm 20 k ohms 1% 1/8 W
R25	0757-0434	1	R: fxd metflm 3650 ohms 1% 1/8 W
R26	0757-0924		R: fxd metox 1000 ohms 2% 1/4 W
R27	0757-0900		R: fxd metflm 100 ohms 2% 1/4 W
VR1	1902-3070	1	VR: breakdown 4.22 V 400 mW
VR2	1902-0022	1	VR: breakdown 2.67 V 400 mW
VR3	1902-0049	1	VR: breakdown 6.19 V 400 mW
			A3 MISCELLANEOUS
	0340-0060	5	Insulator
	0360-0124	2	Terminal, test point
	0360-1244	1	Insulator
			A4
A4	01817-62901		A: module assy: step generator
C1	0160-2357		C: fxd cer fdth 1000 pF -20% +80%
C2	0150-0093		C: fxd cer .01 uF -20% +80% 100 wVdc
C3	0160-2142	1	C: fxd cer .0015 uF -20% +80% 100 wVdc
C4	0160-3391	1	C: fxd tubular 10 pF 10% 100 wVdc
C5	0150-0093		C: fxd cer .01 uF -20% +80% 100 wVdc
C6	0160-0157	1	C: fxd cer 4700 pF 10% 200 wVdc
C7	0160-2357		C: fxd cer fdth 1000 pF -20% +80%
CR1	1901-0347	1	CR: Si
CR2	1912-0012	1	CR: Ge

Table 6-3. Model 1817A Replaceable Parts (Con't)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			A4 (con't)
J4	1250-0922	1	J: jack
L1	9170-0029		L: bead, ferrite
L2	9170-0029		L: bead, ferrite
L3	9170-0029		L: bead, ferrite
L4	9170-0029		L: bead, ferrite
L5	9170-0029		L: bead, ferrite
L6	9170-0029		L: bead, ferrite
L7	9100-2256	1	L: fxd .56 uH
L8	9170-0029		L: bead, ferrite
L9	9170-0029		L: bead, ferrite
Q1	1853-0034		Q: Si pnp
Q2	1853-0034		Q: Si pnp
Q3	1853-0034		Q: Si pnp
R1	0757-0895	1	R: fxd metox 62 ohms 2% 1/4 W
R2	0757-0951	1	R: fxd metox 13 k ohms 2% 1/4 W
R3	0757-0940	1	R: fxd metox 4700 ohms 2% 1/4 W
R4	0757-0904	1	R: fxd metox 150 ohms 2% 1/4 W
R5	0757-0917	2	R: fxd metox 10 ohms 2% 1/4 W
R6	0757-0900		R: fxd metox 100 ohms 2% 1/4 W
R7	0757-0941	2	R: fxd metox 5100 ohms 2% 1/4 W
R8	0757-0941		R: fxd metox 5100 ohms 2% 1/4 W
R9	0757-0935	1	R: fxd metflm 3000 ohms 2% 1/4 W
R10	0698-7341	2	R: fxd metox 27 ohms 2% 1/4 W
R11	0757-0931	2	R: fxd metox 2000 ohms 2% 1/4 W
R12	0698-7341		R: fxd metox 27 ohms 2% 1/4 W
R13	0730-0161	1	R: fxd car 50 ohms 1% 1 W
W1	01817-61606	1	W: cable assy, step trigger
VR1	1902-3024	1	VR: breakdown 2.87 V 400 mW
			A4 MISCELLANEOUS
	1460-1037	2	Spring, diode mount for A4CR2
	9170-0029	2	L: bead, ferrite
	9170-0952	1	L: bead, ferrite
	9170-0954	1	L: bead, ferrite
	01817-00602	1	Shield, step generator
	01817-22301	1	Holder
	01817-26507	1	Board, resistor holder

Table 6-3. Model 1817A Replaceable Parts (Con't)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			A5
A5	01817-66505		A: board assy: power source
C1	0160-0174	1	C: fxd cer .47 uF -20% +80% 25 wVdc
C2	0160-0153	1	C: fxd my .001 uF
C3	0150-0093		C: fxd cer .01 uF -20% +80% 100 wVdc
CR1	1901-0025	1	CR: Si
L1	9170-0029	1	L: bead, ferrite
Q1	1854-0071	1	Q: Si npn
Q2	1853-0001	1	Q: Si pnp
R1	0757-0924		R: fxd metox 1000 ohms 2% 1/4 W
R2	0757-0917		R: fxd metox 510 ohms 2% 1/4 W
R3	0757-0931		R: fxd metox 2000 ohms 2% 1/4 W
R4	0757-0897	1	R: fxd metox 62 ohms 2% 1/4 W
R5	0757-0799	1	R: fxd metflm 121 ohms 1% 1/2 W
R6	0757-0924		R: fxd metox 1000 ohms 2% 1/4 W
			A6
A6	01817-21301		A: Board assy: resistor
R1	0698-7342	1	R: fxd cer 15 ohms 1% 1/10 W

BACK DATING

MANUAL CHANGES

SECTION VII

MANUAL CHANGES AND OPTIONS

7-1. MANUAL CHANGES.

7-2. This manual applies directly to the standard Model 1815A or 1815B TDR/Sampler and Model 1817A Remote Sampler having serial prefixes as listed on the title page of this manual. Refer to the separate MANUAL CHANGES sheet supplied with this manual for new instruments and errata.

7-3. OPTIONS.

7-4. Options for an HP instrument are standard modifications installed at the factory. At the present time, no options are offered for the TDR/Sampler Group.

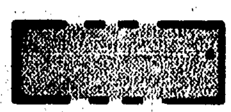
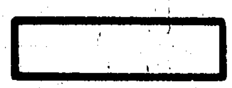
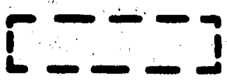
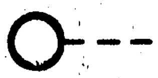
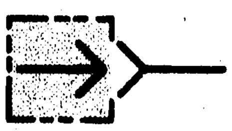
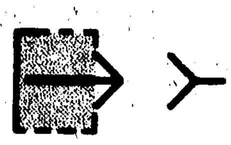
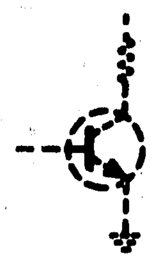
7-5. SPECIAL INSTRUMENT.

7-6. Modified versions (per customer's specifications) of any HP instrument are available on special order. The manual for these special instruments (having electrical modifications) will include a separate insert sheet that describes the modification and any special manual changes in addition to the MANUAL CHANGES sheet (if applicable). Contact the nearest HP Sales/Service Office if either of these sheets is missing from the manual of a special instrument. Be sure to refer to the instrument by its full specification name and number.

SCHEMATIC DIAGRAMS

Table 8-1. Symbols and Conventions

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

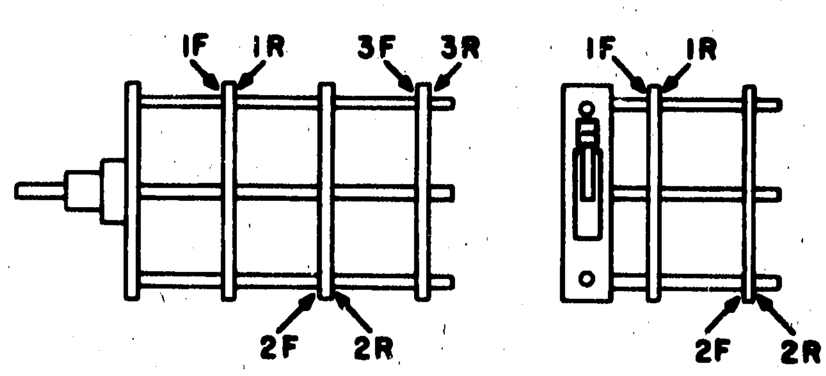
	=	Etched circuit board
	=	Front panel marking
	=	Rear panel marking
	=	Front panel control
	=	Screwdriver adjustment
P/O	=	Part of
CW	=	Clockwise end of variable resistor
N C	=	No connection
	=	Waveform test point (with number)
	=	Common electrical point (with letter) not necessarily ground
	=	Single pin connector on board
	=	Pin of a plug-in board (with letter or number)
	=	Main signal path
	=	Primary feedback path
	=	Secondary feedback path
*	=	Optimum value selected at factory, average value shown; part may have been omitted.
	=	Field effect transistor (N-channel)
	=	Breakdown diode
	=	Tunnel diode
	=	Step recovery diode
	=	Circuits or components drawn with dashed lines (phantom) show function only and are not intended to be complete. The circuit or component is shown in detail on another schematic.

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

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

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

Switch wafers are identified as follows:



SECTION VIII

SCHEMATICS AND TROUBLESHOOTING

8-1. INTRODUCTION.

8-2. This section contains schematics, repair and replacement information, component identification illustrations and troubleshooting tips. Table 8-1 defines symbols and conventions used on the schematics. Tables 8-2 and 8-3 and Figure 8-7 provide guides to locating common problems.

8-3. REFERENCE DESIGNATIONS.

8-4. The unit system of reference designations used in this manual is in accordance with the provisions of the American Standard Electrical and Electronics Reference Designations, dated August, 1965. Minor variations due to design and manufacturing practices not specifically covered by the standard may be noted.

8-5. Each electrical component is identified by a class letter and number. This letter-number combination is the basic designation for each component. Components which are separately replaceable and are part of an assembly have, in addition to the basic designation, a prefix designation indicating the assembly on which the component is physically located. Components not located on an assembly will have only the basic designation and are listed in the replaceable parts list (Section VI) under Chassis Parts.

8-6. All components within the shaded areas on the schematics are physically located on etched circuit boards and should be prefixed with the assembly number assigned to the particular board (e.g., resistor R23 on assembly A2 is referred to as A2R23). There may also be an R23 on several other assemblies but the assembly designation will always be different (A3R23, A9R23, etc).

8-7. CIRCUIT BOARDS.

8-8. The following paragraphs provide information regarding component identification, pin numbering systems, use of heat sinks and special soldering considerations.

8-9. BOARD CONNECTIONS.

8-10. Connections to the circuit boards are of three general types: direct wire, coaxial cables to snap-on jacks and coaxial cables soldered directly to the board. Figure 8-1 shows the types of board connections used. The pins on the circuit board are coded with the wire color coding number.

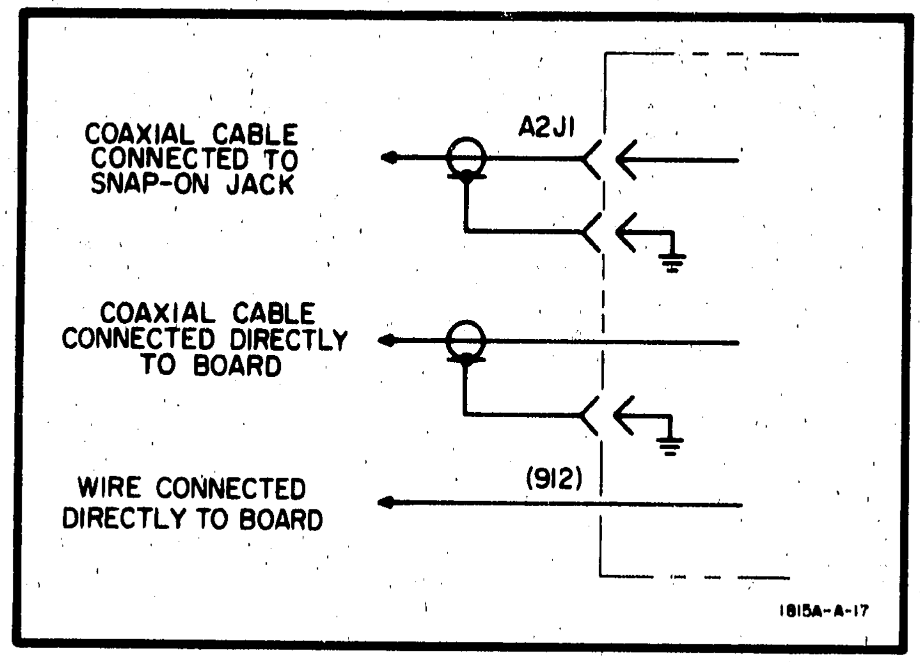


Figure 8-1. Circuit Board Connections

8-11. COMPONENT IDENTIFICATION.

8-12. Locations of components on etched circuit boards are illustrated in photos adjacent to the schematics. Since the schematics are drawn to show function, a particular etched circuit board assembly may be shown on several schematics. The component-identification photo is located next to the schematic that shows most of the circuitry on the board. Components located on the chassis are identified in illustrations preceeding the assembly breakdowns.

8-13. REPAIR AND REPLACEMENT.

8-14. Most electrical components are accessible from the component side of the etched circuit board. Section VI provides a detailed parts list for use in ordering replacement parts. If satisfactory repair cannot be made, contact the nearest Hewlett-Packard Sales/Service Office (address at rear of manual). If shipment for repair is recommended, refer to Section II for repackaging and shipping instructions.

8-15. SERVICING ETCHED CIRCUIT BOARDS.

8-16. The units of the TDR/sampler group use plated-through type etched circuit boards. When servicing this type of board, components may be removed or replaced by unsoldering 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-20D contains additional information on the repair of etched circuit boards. The important considerations are as follows:

a. Do not apply excessive heat.

b. Apply heat to component lead and remove lead with a straight pull away from the board.

c. Use a toothpick or wooden splinter to clean hole.

d. Do not force leads of replacement components into holes.

8-17. If the plated metal surface (conductor) lifts from the board, it may be cemented back with a quick-drying acetate-base cement (used sparingly) having good insulating properties. An alternate method of repair is to solder a good conducting wire along the damaged area.

8-18. SWITCH MAINTENANCE.

8-19. The slide switch on the front panel is lubricated with a silicon-type grease and normally requires no maintenance. If the switch contacts become dirty, causing faulty operation, clean contacts with a mild solvent and re-lubricate with a silicon-type grease.

8-20. REMOTE SAMPLER.

8-21. SAMPLER BLOCK.

8-22. The sampler block is to be repaired at the factory only. The diodes and pick-off resistor may be replaced as described in the following paragraphs. Make no attempt to further disassemble the block. Do not tighten any screws or the 5/8-inch nuts on the ends of the sampler. Torque may twist the sampler center conductor, resulting in an open circuit.

8-23. REMOVING SAMPLING DIODES. Remove the sampling diode(s) only after definitely establishing that they are faulty (refer to Paragraph 8-37 for test procedure). The diodes are extremely fragile and must be handled with caution. The following steps provide instructions for diode removal and replacement.

Note

The upper and lower diodes look alike but they are different electrically.

a. Loosen the screw and slide the diode retainer away from the insulator as shown in Figure 8-2.

b. Carefully withdraw the diode insulator assembly from the sampler. If the glass bead is broken, it may remain in the sampler. It must be removed before the new diode assembly is inserted. To remove the broken bead, turn the sampler upside down and gently tap the side of the block. Do not strike the connectors.

c. Grasp the new diode by the post. Do not handle the glass bead. The bead is quite fragile and continued handling will weaken the device.

d. Insert the assembly straight into the sampler. (A lateral blow will break the glass bead.) The glass bead will center itself in the bottom of the hole.

e. Replace the diode retainer and carefully tighten the screw until it is snug.

f. Recalibrate the instrument as outlined in Section V.

g. The diodes may be damaged by the following:

1. Rough handling.
2. Static discharge of approximately .2 ergs.
3. Soldering irons that induce 60-cycle pickup and leakage currents.

CAUTION

Do not solder anything in the diode circuits without great care.

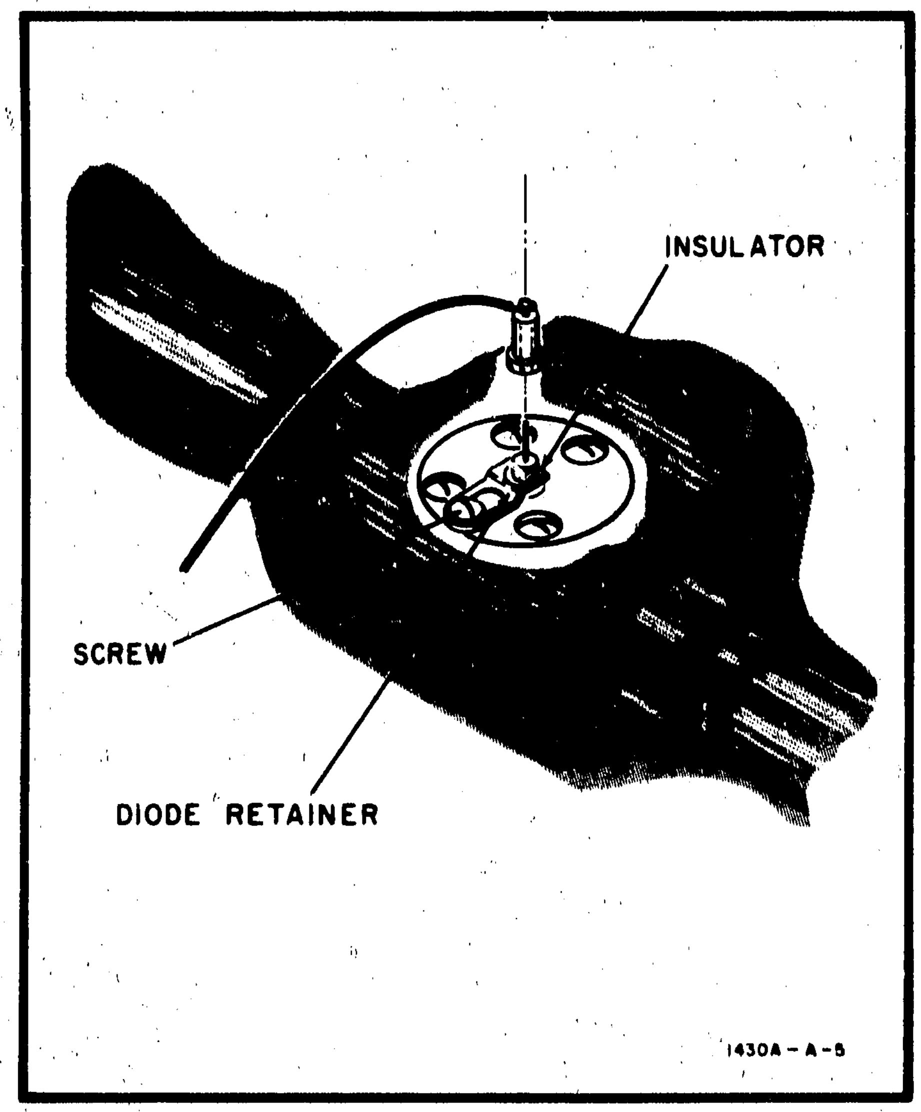


Figure 8-2. Diode Removal

8-24. PICK-OFF RESISTOR. The pick-off resistor (HP Part No. 0811-2641) can be changed by placing the sampler upside down and gently removing the star-tabe connector. Unscrew the 3/16-inch nut and black plastic retainer. Remove the resistor with tweezers. When inserting a new resistor, be sure that it fits properly into the small hole in the center conductor.

CAUTION

The Model 1106A Tunnel-Diode Pulse Generator normally used with the system for TDR purposes is a factory-repair item. Make no attempt to disassemble this unit.

8-25. STRIPLINE AND/OR STEP-RECOVERY DIODES.

8-26. Replace the sampler stripline if it is damaged or its capacitor becomes defective. This capacitor is part of the stripline assembly and individual replacement is not recommended. To remove the stripline, proceed as follows:

a. Remove the mark and sampler diodes from the sampler block.

b. Remove the A6 board. Be extremely careful not to loose or mix the two step-recovery diodes (A2CR1 and A2CR2). These diodes look alike but are electrically different and are extremely small.

c. Unsolder all leads from the stripline.

d. Remove the screw holding the round clear plastic disc. Very carefully bend the fine wire from across the stripline to a vertical position (so that when stripline is lifted, the fine wire will not catch on the board). Bend as little as necessary.

e. Remove the five screws holding the board to the chassis. Be careful not to pull the fine wire out of the sampler.

8-27. If the stripline is ordered as an assembly, (HP Part No. 01817-66502) it will come as a completed assembly with the step-recovery diodes and resistor board A6. If board A2 or capacitor A2C1 is defective, order HP Part No. 01817-26502. This will be considerably less expensive than ordering the entire assembly. If only disc resistor A6R1 is faulty, order HP Part No. 01817-66506. There is a piece of conductive rubber under the step-recovery diodes (A2CR1 and A2CR2). This is made from a sheet of RFI gasket material (HP Part No. 8160-0070).

8-28. TROUBLESHOOTING.

8-29. The most important prerequisite for successful troubleshooting is understanding how the instrument is designed to operate and correct usage of front-panel controls. Often suspected malfunctions are caused by improper control settings or circuit connections such as low intensity, maladjusted trigger level, exceeding dynamic range, etc. Operation Section III which provides an explaination of controls and connectors and general operating considerations, and Principles of Operation Section IV which explains circuit theory are intended to satisfy this information requirement.

8-30. The following paragraphs outline procedures for locating and clearing problems in the TDR/sampler group.

8-31. DC VOLTAGES. DC voltages are indicated on some of the schematics for active components (transistors, etc). Control setup conditions for making the voltage measurements are listed adjacent to each schematic. Since the conditions for making these measurements may differ from one circuit to another, always check the specific conditions listed adjacent to the schematic.

8-32. WAVEFORMS. Typical waveform measurements are made at test points on the schematics. The waveforms are keyed to corresponding test points on each schematic. Test points correspond to pins protruding from the etched circuit board.

8-33. Conditions for making the waveform measurements are also listed adjacent to each schematic and like the dc voltage measurement conditions, may vary slightly from one circuit to another.

8-34. Voltage and waveform measurements provide an invaluable aid when troubleshooting an instrument. Applications include: checking gain of a particular stage, locating a differential amplifier unbalance, or pinpointing a faulty transistor. Also shown on the schematics are primary and secondary signal paths. Primary paths are shown as solid, heavy lines, and secondary or feedback paths are represented by heavy dashed lines.

8-35. 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 board connections are good and are not shorting to any adjacent circuit. If no obvious trouble is found, check the power supply voltages in the unit. Prior to any extensive troubleshooting, check the external power sources also.

8-36. The following paragraphs outline procedures for locating and clearing problems in units of the

TDR/Sampler Group. Two charts and a troubleshooting tree have been provided listing common problems and the most likely areas of trouble. Once a problem has been defined, troubleshoot the suspected area using the dc voltages and waveforms shown adjacent to each schematic.

8-37. CHECKING SAMPLER DIODES. To check the sampling diodes, proceed as follows:

CAUTION

Never use an ohmmeter to check the sampling diodes. The voltage and current outputs of the ohmmeter may exceed the maximum safe input of the diodes.

a. Connect a signal generator set for 400 to 500 kHz at 140 millivolts to the remote sampler input.

b. Ground test point A3TP1 and connect a monitor oscilloscope to A3TP2 in the remote sampler.

c. Externally trigger the monitor oscilloscope from the stretcher gate signal at test point A1TP5 in the Model 1815A.

d. Set the FUNCTION switch on the Model 1815A to TRIG+, and set the TRIGGER LEVEL control between 2 and 3 o'clock (trace free-runs). The presentation on the system under test will be incoherent.

e. Make a mental note of positions or mark the potentiometers with a pencil so that the potentiometers can be reset to their calibrated positions if the diodes prove good.

f. Adjust the Model 1817A BIAS CEN (A3R14) and RESPONSE (A3R16) and observe the monitor oscilloscope. All three waveforms shown in Figure 8-3 should be seen. If not, one or both of the sampling diodes is faulty. This test does not check for noisy diodes. The easiest way to check for excessive noise is to substitute other diodes.

CAUTION

If both diodes are faulty, this indicates that much more than the maximum safe input has been applied. Check the application of the system to assure that excessive inputs are not being used and that cables are being discharged before connection. Costs for replacement of both sampling diodes will be assessed to the customer even though the system may be within the 12-month warranty period.

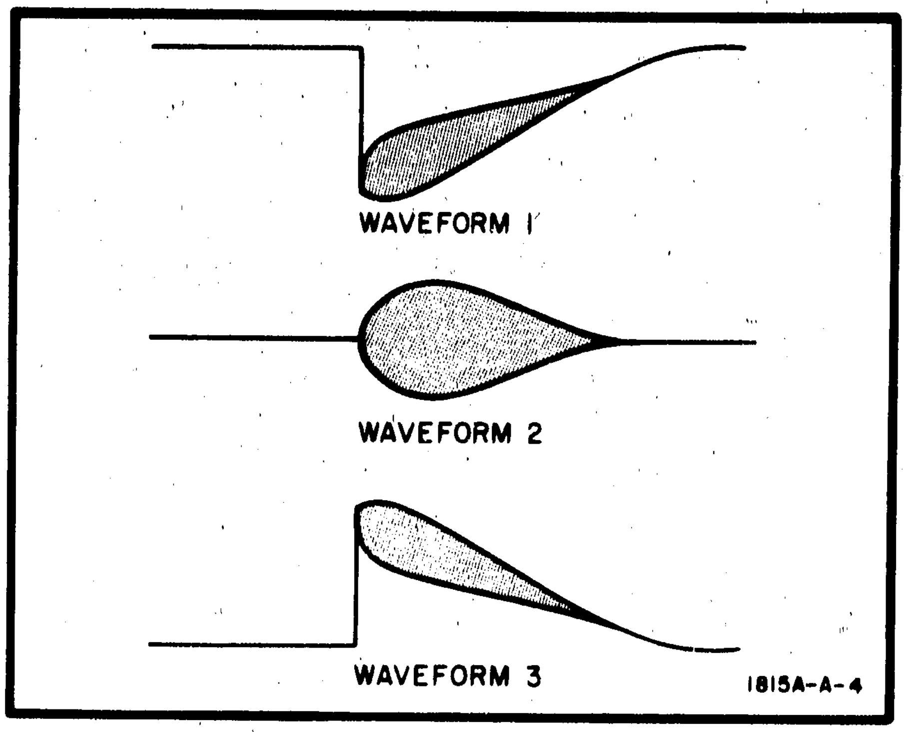


Figure 8-3. Diode Check Waveforms

8-38. LEAKY STRETCHER CIRCUIT. A leaky FET in the stretcher circuitry can be easily checked by adjusting TRIGGER LEVEL so that the time base does not run. Set the SCAN switch to MANUAL and observe the vertical dot drift. With VOLTS/DIV set to .05, drift should not exceed 1 division per second.

8-39. STEP TRIGGER AND RESET CIRCUIT. If the step output can not be obtained (even after adjusting TUNNEL DIODE BIAS), check, by substitution, that the Model 1106A external tunnel-diode pulse generator is operating properly. If another tunnel diode is not available, proceed as follows:

a. Connect a 50-ohm termination to the remote sampler OUTPUT or set the slide switch on the Model 1815A, board A1, to OFF.

b. Set the FUNCTION switch to TIME and observe a baseline.

c. Appearance of a baseline confirms that the strobe comparator and scanner circuits are good. If the baseline is absent, troubleshoot the system as outlined in the troubleshooting tree (Figure 8-7).

d. Set the ρ/DIV switch to .02. A small positive bump should appear at approximately the second division (where the step would normally start). This bump represents the trigger originating in the step comparator and coupled through pin L of the sampler cable to the Model 1817A.

e. If the bump is absent, set the Model 1815A NSEC/DIV switch to 1 and disconnect the interconnecting cable from the remote sampler. Observe the signals at pin L and pin B. The signals should be similar to those shown in Figures 8-4 and 8-5.

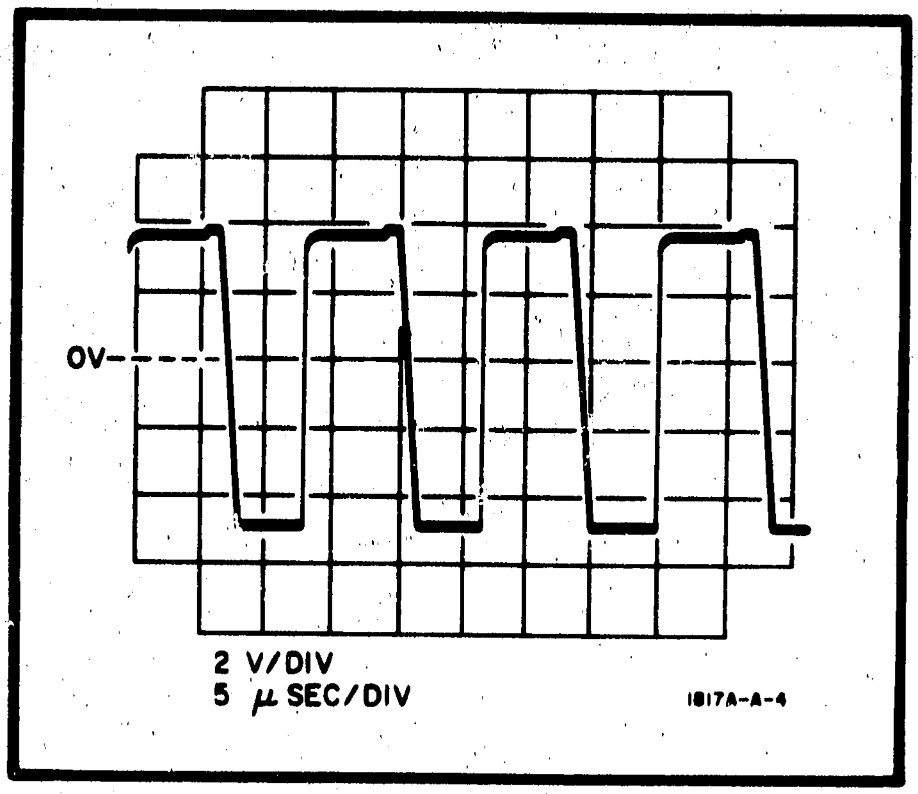


Figure 8-4. Waveform at Pin L, Step Trigger

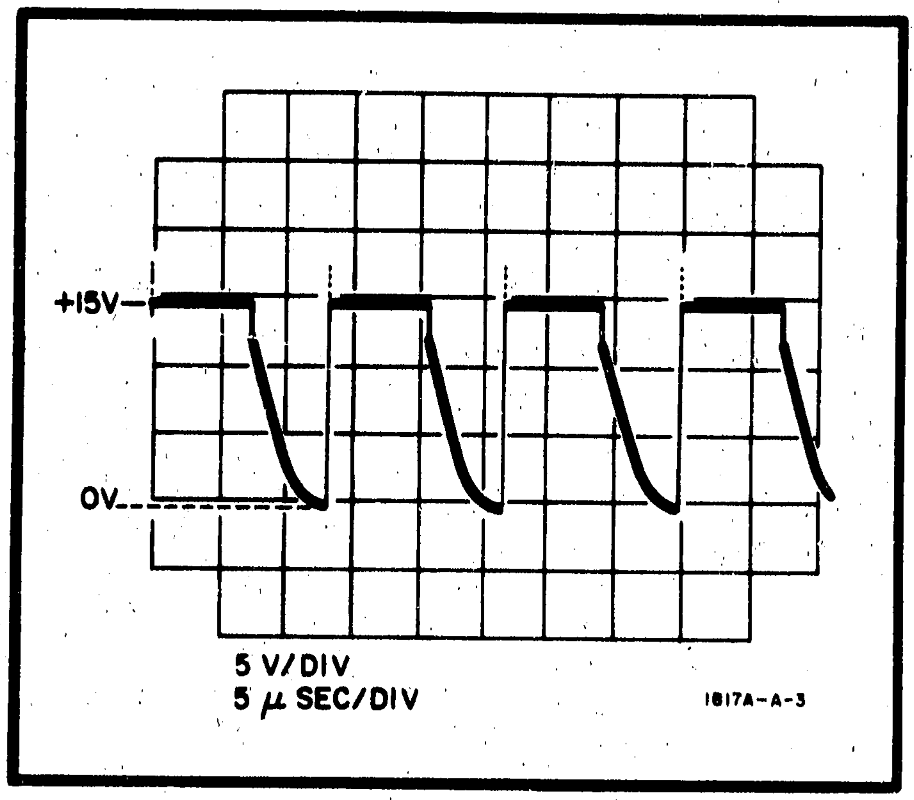


Figure 8-5. Waveform at Pin B, Step Reset

f. If the signal at pin L is absent or incorrect, check the step comparator circuitry on board A2 of the Model 1815A.

g. If the signal at pin B is absent or incorrect, check step reset amplifier A2Q9 in the Model 1815A.

Note

Do not overlook the possibility of a faulty interconnecting cable.

h. If both signals are good, the trouble is in either the A4 or A5 assemblies of the remote sampler. Turn the power off and measure the output impedance at the Model 1817A Type N connector. The impedance should be 50±1/2 ohms.

i. If the resistance is not within the tolerances of step h, the RL assembly (part of A4 in the remote sampler) is defective. Order HP Part No. 01817-66507. This assembly includes the small board with the resistor already installed.

j. If the resistance checks ok, apply power again. Set the Model 1815A FUNCTION switch to TIME. Set the NSEC/DIV switch to 1. Connect the Model 1817A Type N output directly to a monitor oscilloscope and observe the output.

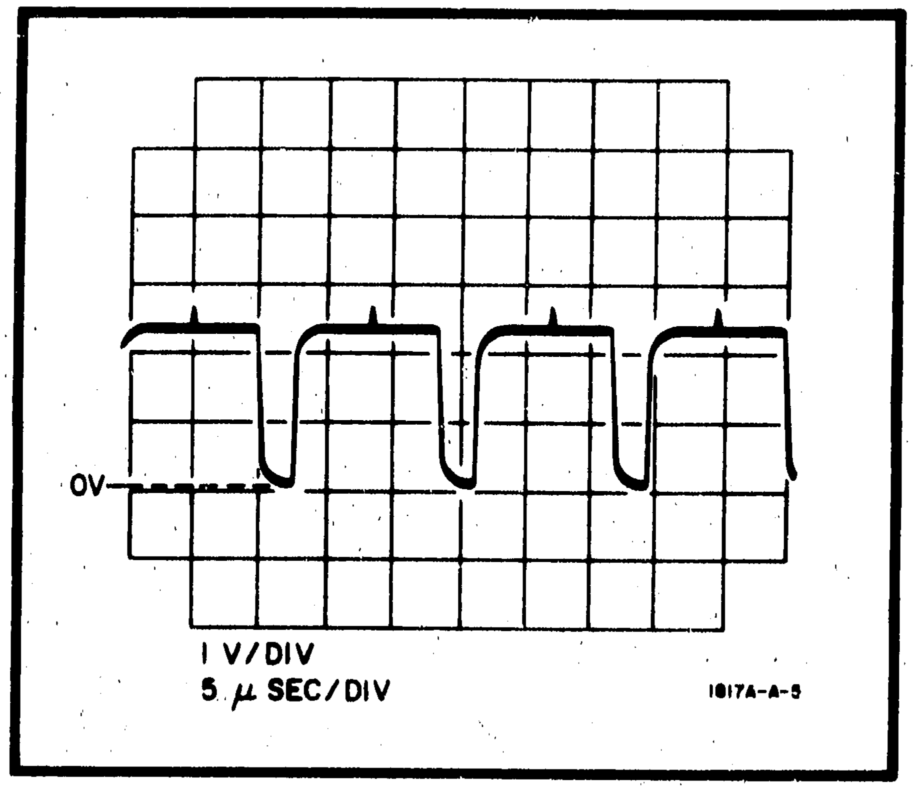


Figure 8-6. Model 1817A Output Waveform

Note

Adjustment of TUNNEL DIODE BIAS should vary the positive amplitude between 1.75 and 2.25 volts approximately. The small positive spike will not be visible on a real-time oscilloscope but the presence of the positive bump mentioned in step d assures that this spike will be present.

k. If the 2-volt pulse is not observed, and/or the voltage does not vary correctly with adjustment of TUNNEL DIODE BIAS, either board A4 or A5 is defective in the Model 1817A. Check the dc levels as shown on the schematic. A most likely source of trouble is tunnel diode A5CR1. Occasionally the Model 1106A will still fire when this diode is faulty but risetime or jitter will be out of specifications.

Table 8-2. Troubleshooting Vertical Circuits

Symptom	Check
Slow Risetime	Model 1106A. Readjust RESPONSE A3R16 in Model 1817A. Readjust BIAS ADJ A2R1 in Model 1817A. Loose connection on stripline A2 in Model 1817A. Step-recovery diodes A2CR1 and A2CR2. Sweep speed calibration.
Excessive overshoot.	Model 1106A. Readjust RESPONSE A3R16 in Model 1817A. Sampling diodes A7CR1 and A7CR2.
Distortion	Readjust capacitor A3C6 in Model 1817A. Readjust machine screw C1 in Model 1817A. Sampling diodes (Para 8-22). Leaky stretcher circuit (Para 8-38). Pick-off resistor (Para 8-24).
Excessive noise.	Readjust RESPONSE A3R16 in Model 1817A. Readjust STRCH GATE A1R30 and SMOOTH A1R11 in Model 1815 Sampling diodes (Para 8-22).
No step display.	Refer to Para 8-39.

Table 8-3. Troubleshooting Horizontal Circuits

Symptom	Check
Poor triggering, excessive jitter.	Readjust TD BIAS A2R24 and LEVEL RANGE A2R8 in Model 1815A. A2Q2, A2CR3 and A2CR4 in trigger circuits of Model 1815A.
No baseline for sampling, baseline ok in TDR.	A2Q2 and associated circuits in Model 1815A.
Short sweep.	Readjust RAMP ADJ A2R81 in Model 1815A. A5VR3, A5CR11, and A5Q11 in reset circuit of Model 1815A. Horizontal amplifier in mainframe.
No bright dot.	Set A5S1 to ON in Model 1815A. A5Q18 (comparator) in Model 1815A. A5Q21 and A5Q22 (multivibrator) in Model 1815A.
Faulty MARKER UNCAL lamp operation.	A5Q26 and A5Q27 (over-range comparator) in Model 1815A. A5Q28 (over-range detector) in Model 1815A.

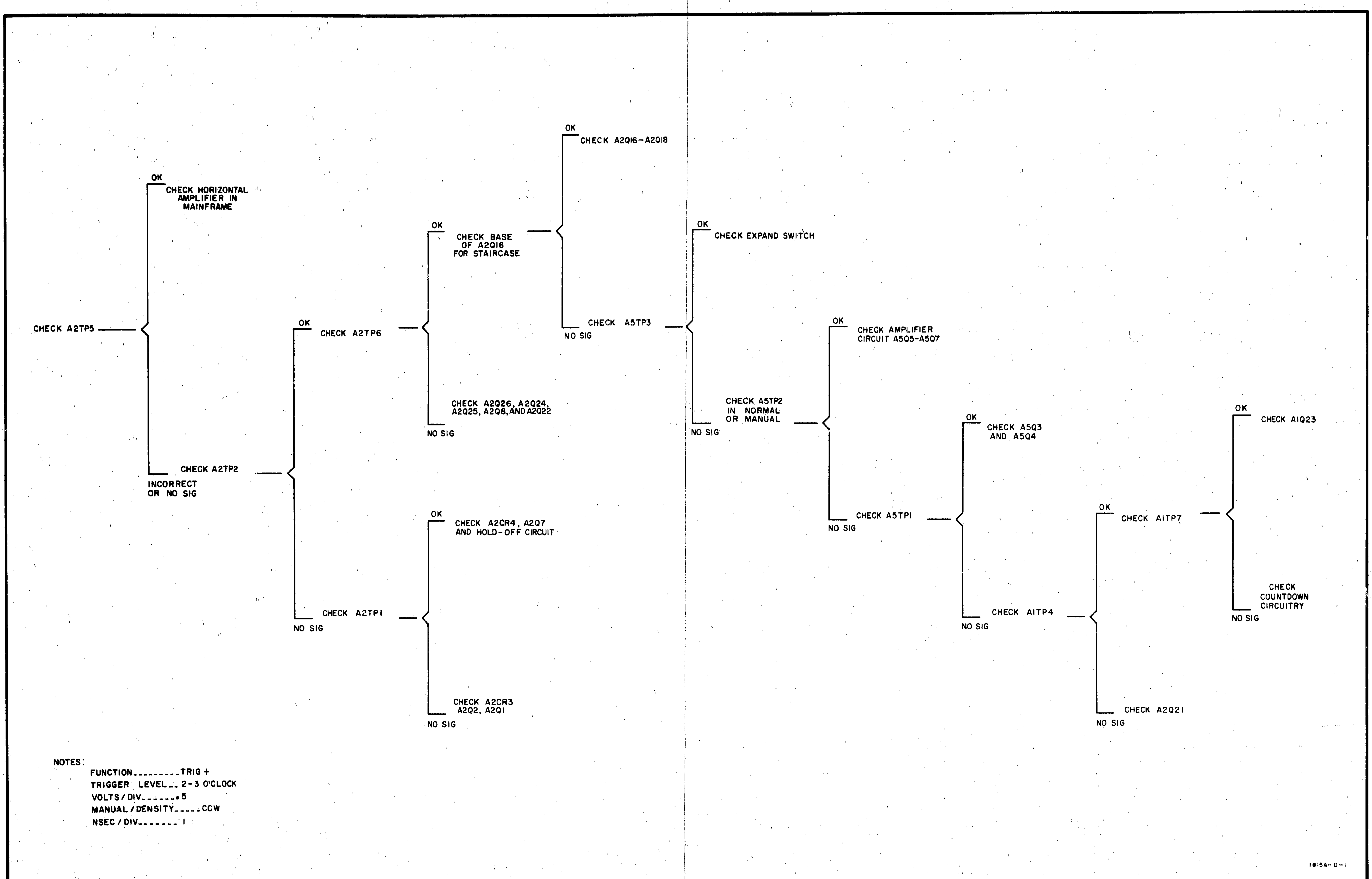


Figure 8-7. Troubleshooting Tree, No Sweep Any Mode

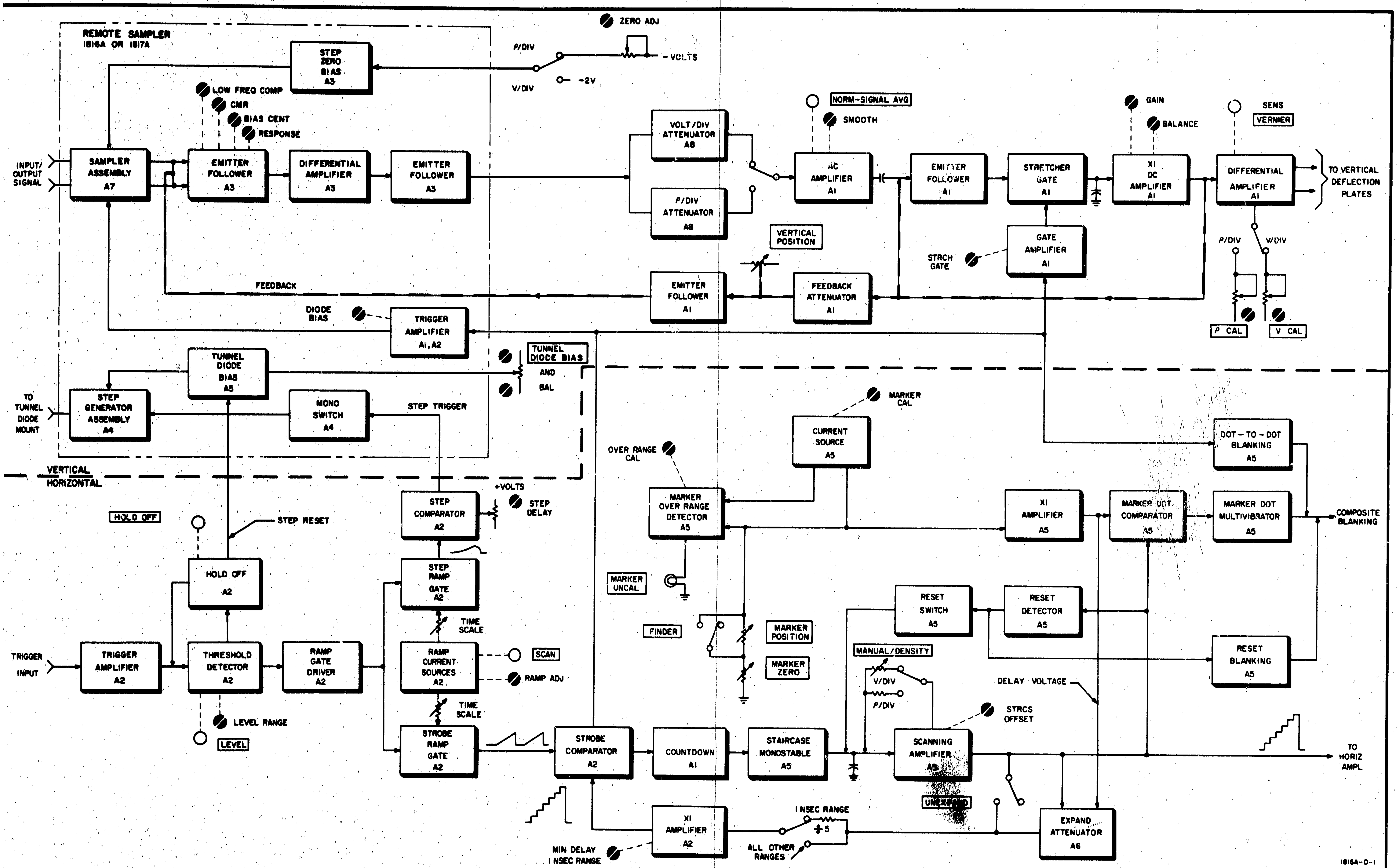


Figure 8-8. TDR/Sampler Group Block Diagram

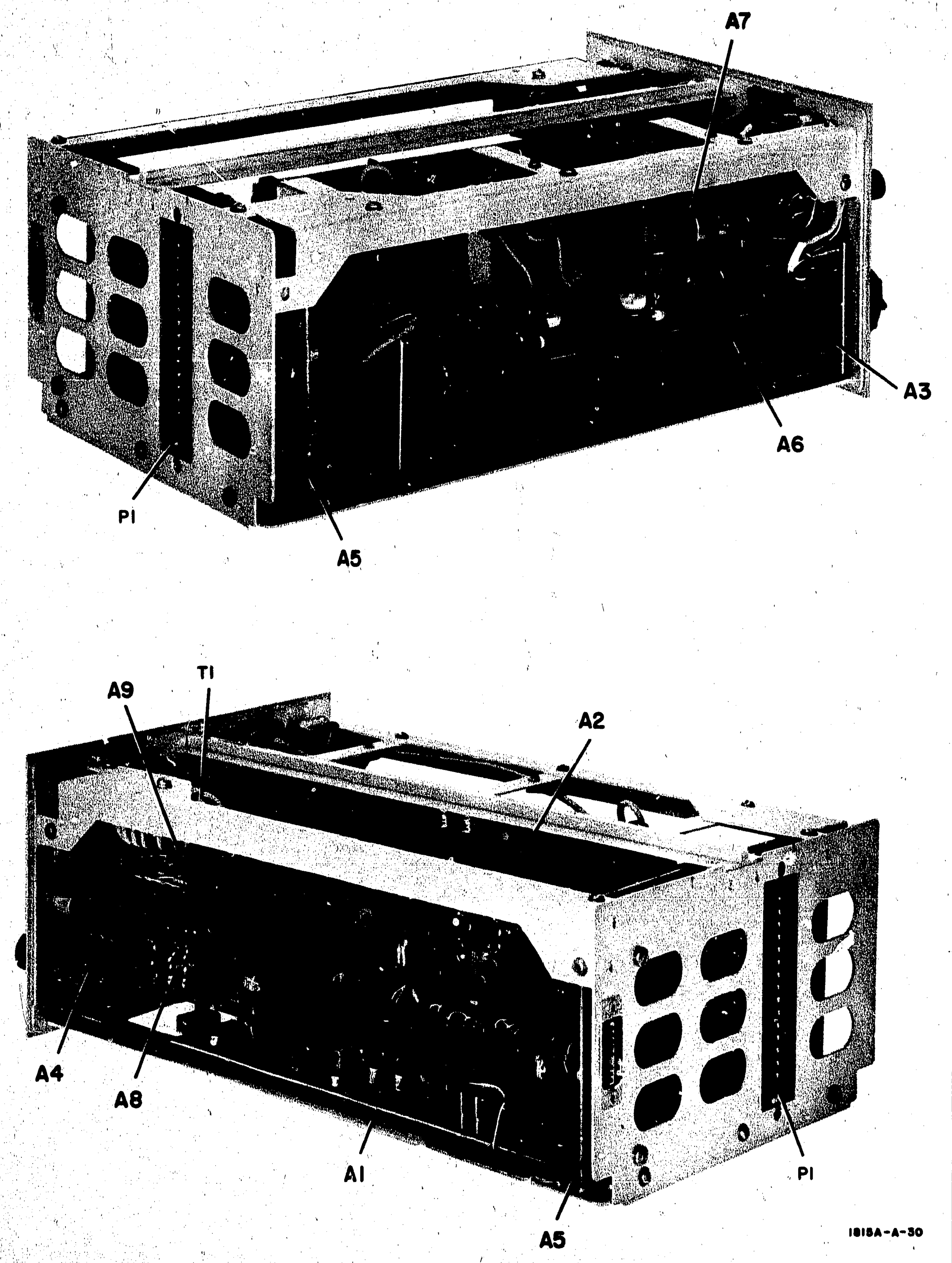
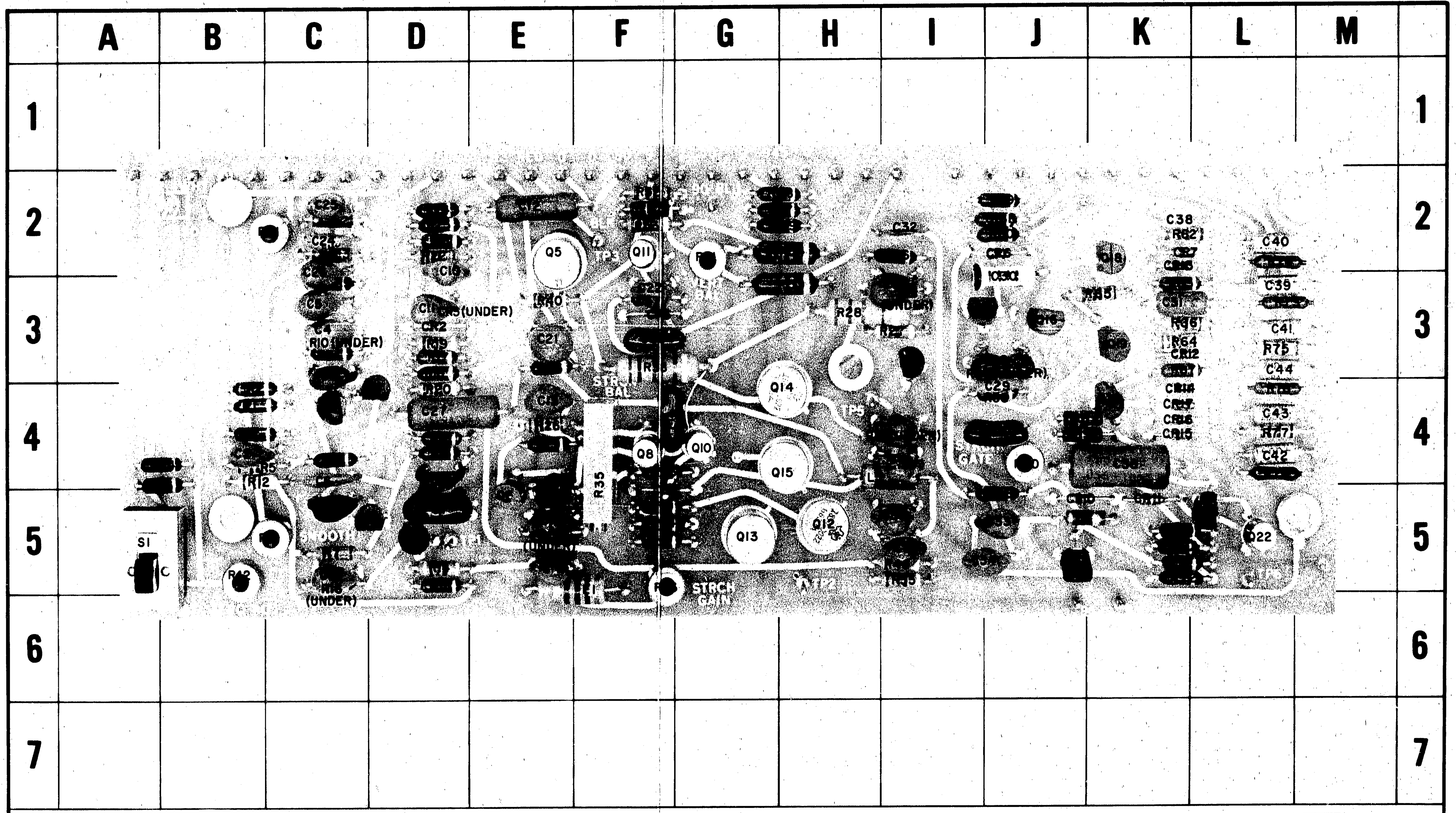


Figure 8-9. Model 1815A or B Assembly Locations



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	C-3	C12	E-2	C23	F-3	C34	I-5	CR2	D-3	CR13	K-2	Q2	C-4	Q13	G-5
C2	B-4	C13	E-4	C24	C-2	C35	I-5	CR3	D-3	CR14	K-4	Q3	C-5	Q14	H-4
C3	C-5	C14	E-5	C25	C-2	C36	K-4	CR4	F-5	CR15	K-4	Q4	D-5	Q15	H-4
C4	C-3	C15	E-5	C26	C-2	C37	I-5	CR5	F-3	CR16	K-4	Q5	E-2	Q16	J-3
C5	C-3	C16	J-4	C27	D-4	C38	K-2	CR6	J-2	CR17	K-4	Q6	E-5	Q17	I-3
C6	C-4	C17	I-4	C28	J-3	C39	L-3	CR7	K-2	L1	F-5	Q7	E-5	Q18	K-2
C7	D-5	C18	I-4	C29	J-4	C40	L-2	CR8	J-4	L2	C-2	Q8	F-4	Q19	K-3
C8	C-5	C19	F-4	C30	J-3	C41	L-3	CR9	J-4	L3	C-2	Q9	I-3	Q20	K-4
C9	D-4	C20	I-3	C31	K-3	C42	L-4	CR10	J-5	L4	J-5	Q10	G-4	Q21	L-5
C10	D-2	C21	E-3	C32	I-2	C43	L-4	CR11	K-5	L5	H-4	Q11	F-2	Q22	L-5
C11	D-3	C22	F-3	C33	J-5	C44	L-3	CR12	K-3	Q1	D-4	Q12	H-5	Q23	J-5

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
R1	B-4	R12	B-4	R22	D-2	R32	H-4	R42	B-5	R52	F-2	R62	K-2	R72	K-5
R2	B-4	R13	D-4	R23	D-2	R33	F-5	R43	A-4	R53	F-2	R63	K-3	R73	L-3
R3	B-4	R14	D-5	R24	D-2	R34	F-5	R44	A-4	R54	H-2	R64	K-3	R74	L-2
R4	C-4	R15	D-5	R25	E-5	R35	F-4	R45	E-3	R55	I-5	R65	K-3	R75	L-3
R5	C-4	R16	C-5	R26	E-4	R36	F-4	R46	I-5	R56	I-2	R66	K-3	R76	L-4
R6	D-4	R17	D-3	R27	I-3	R37	F-3	R47	G-2	R57	I-3	R67	K-3	R77	L-4
R7	C-5	R18	D-3	R28	H-3	R38	F-3	R48	G-2	R58	J-4	R68	J-5	R78	L-4
R8	C-3	R19	D-3	R29	E-4	R39	F-5	R49	H-2	R59	J-2	R69	K-5	S1	A-5
R9	C-3	R20	D-4	R30	J-4	R40	E-3	R50	H-3	R60	J-2	R70	K-5	VR1	I-3
R10	C-3	R21	D-2	R31	F-5	R41	C-2	R51	G-2	R61	J-2	R71	K-5	VR2	F-2
R11	C-5														

1816A-B-9

Figure 8-10. Stretcher, Vertical Amplifier and Countdown Assembly A1 Parts Locations

DC VOLTAGE MEASUREMENT CONDITIONS

FUNCTION .... TRIG+
NORM,SIGNAL AVG .... NORM
NSEC/DIV 1
VOLTS/DIV 5
SCAN .... NORMAL
MANUAL/DENSITY .... Full ccw

HOLD OFF .... Full cw
TRIGGER LEVEL .... free-run trace
VERTICAL POSITION .... Trace mid-screen

No input signal.

Terminate remote sampler OUTPUT in 50 ohms.

WAVEFORM MEASUREMENT CONDITIONS

Square-wave Generator .... 0.5 V at 500 MHz square wave to remote sampler INPUT. Terminate remote sampler OUTPUT into 50 ohms. Trigger output to 1815A trigger input connector using 20-dB pad.

1815A

FUNCTION .... -TRIG
NORM, SIGNAL AVG .... NORM
VOLTS/DIV 1
NSEC/DIV 100
SCAN .... NORMAL

MANUAL/DENSITY .... Full cw
TRIGGER LEVEL .... stable display
MARKER ZERO .... Full ccw
MARKER POSITION .... Full ccw

Exceptions to these settings are noted by each applicable waveform.

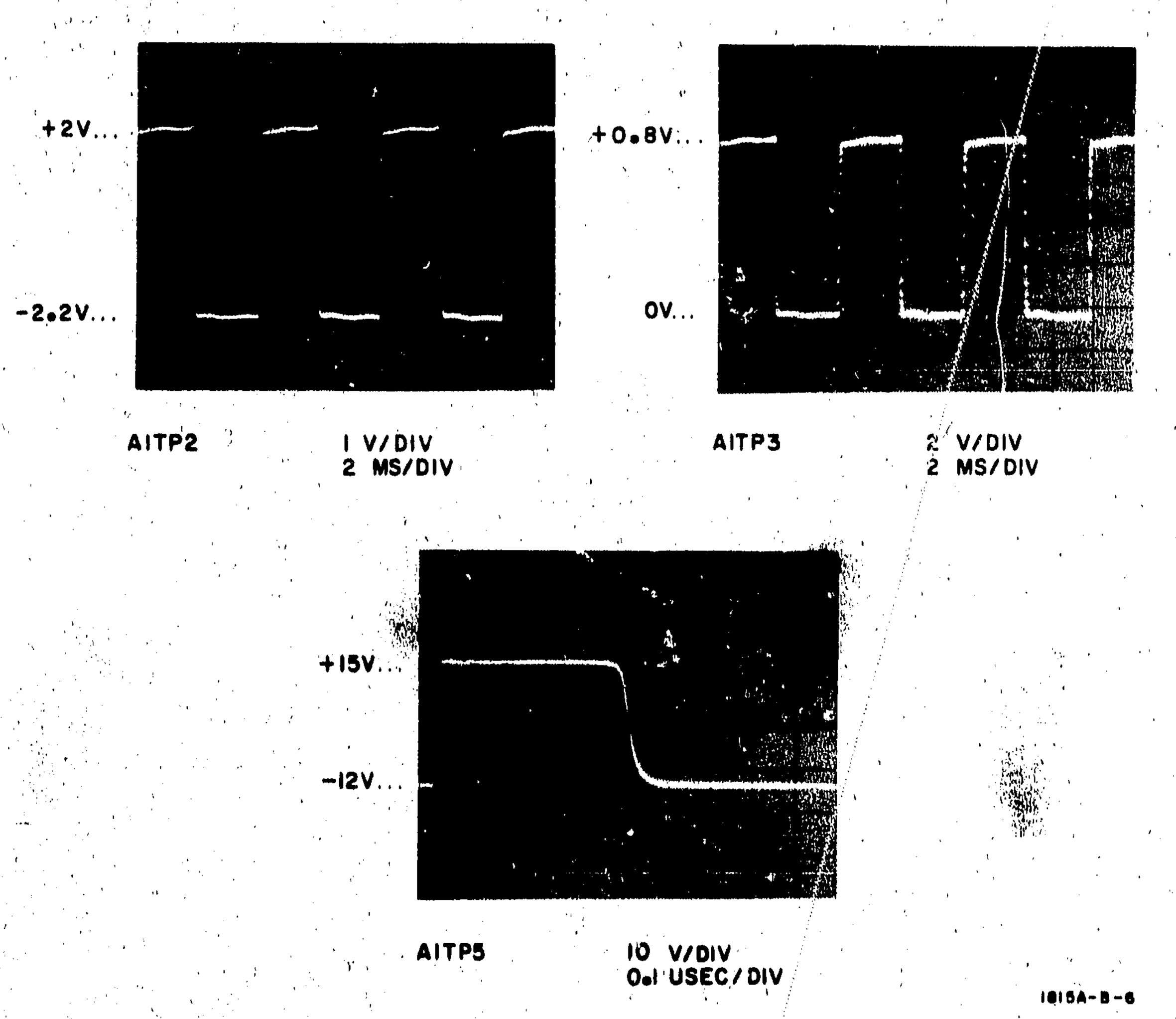
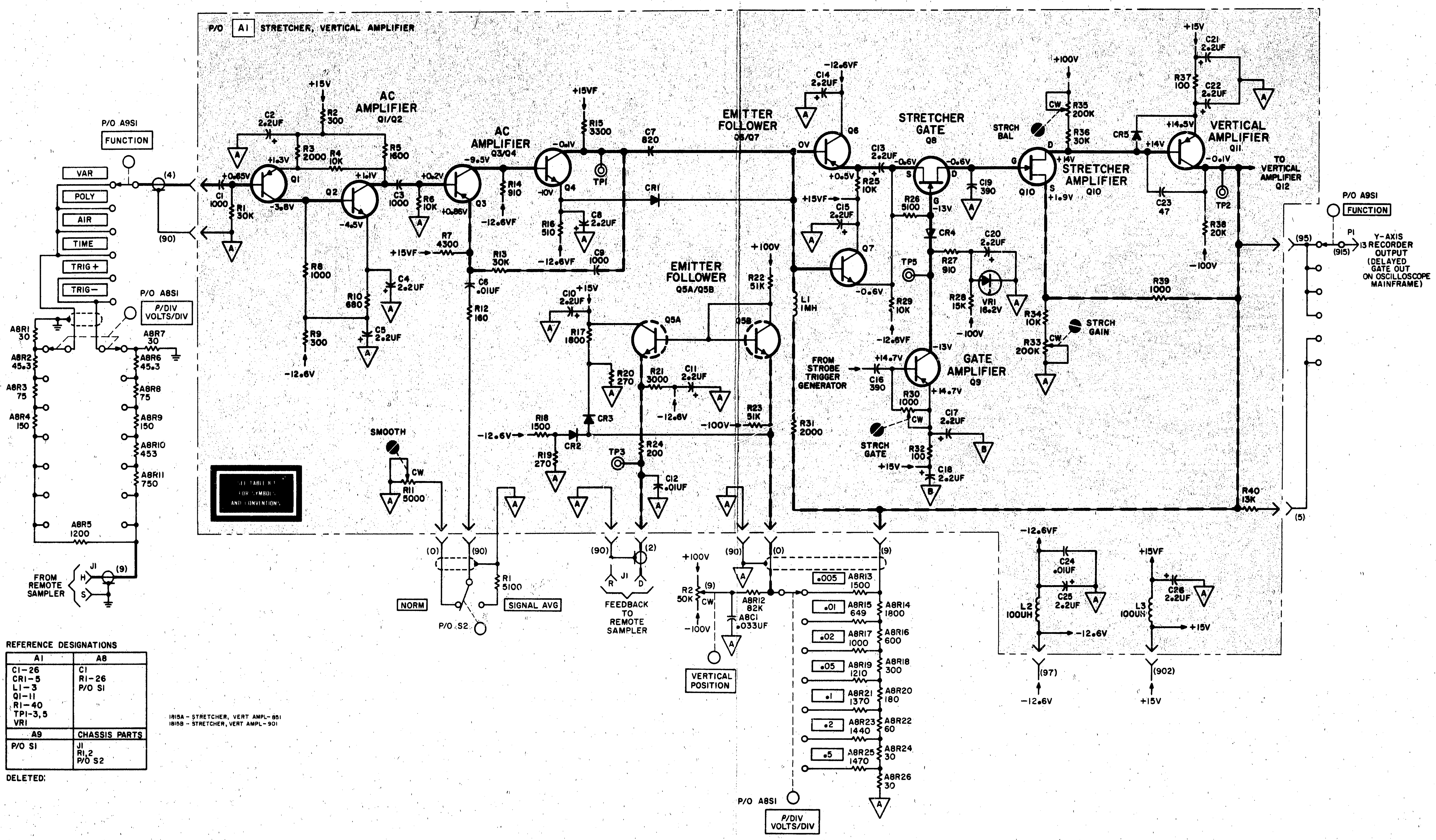


Figure 8-11. Stretcher, Vertical Amplifier Measurements



REFERENCE DESIGNATIONS

A1	A8
C1-26 CR1-5 L1-3 Q1-11 R1-40 TP1-3,5 VR1	C1 R1-26 P/O S1
A9	**CHASSIS PARTS**
P/O S1	J1 R1,2 P/O S2

DELETED:

Figure 8-12. Stretcher, Vertical Amplifier Schematic

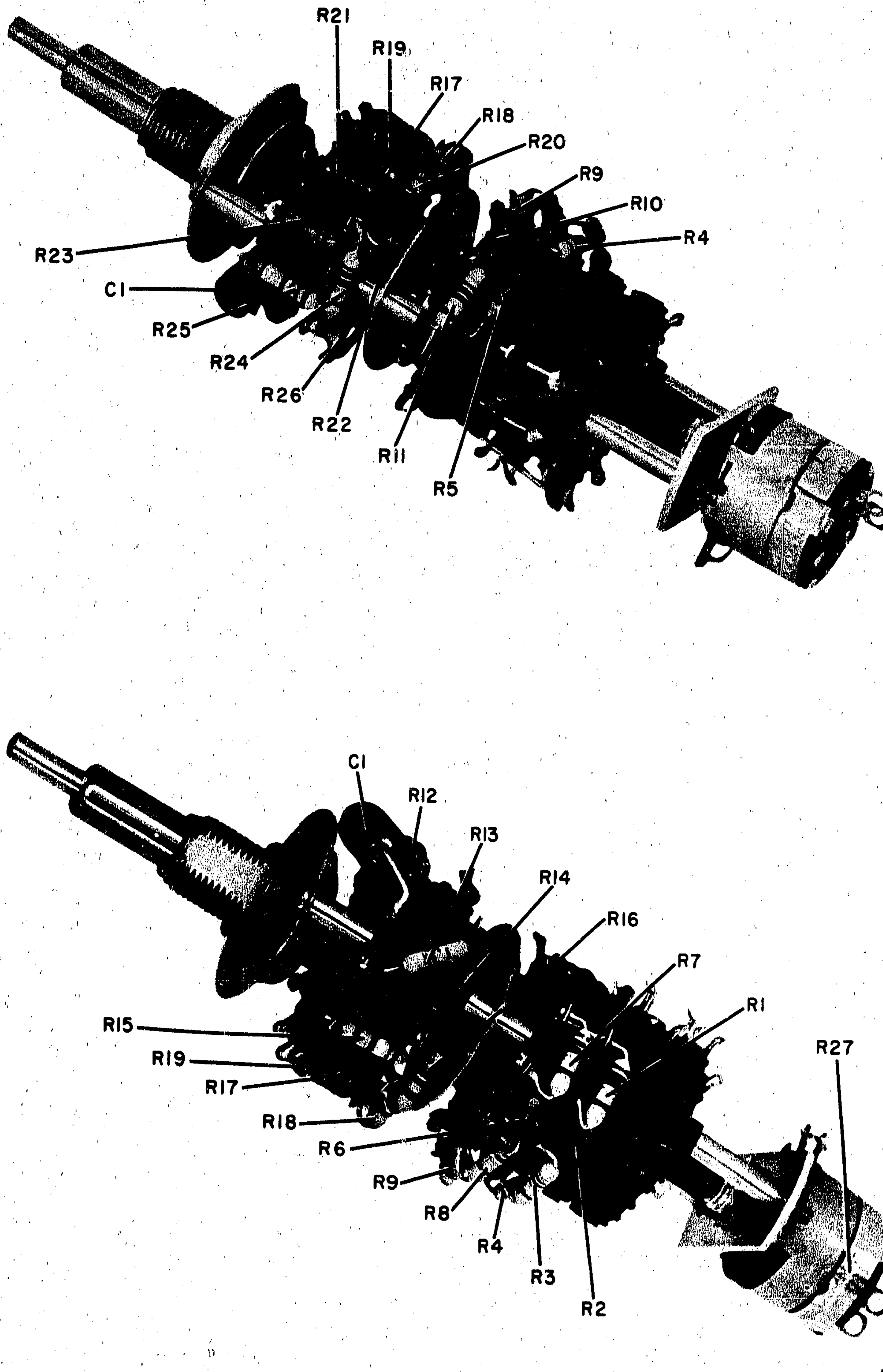
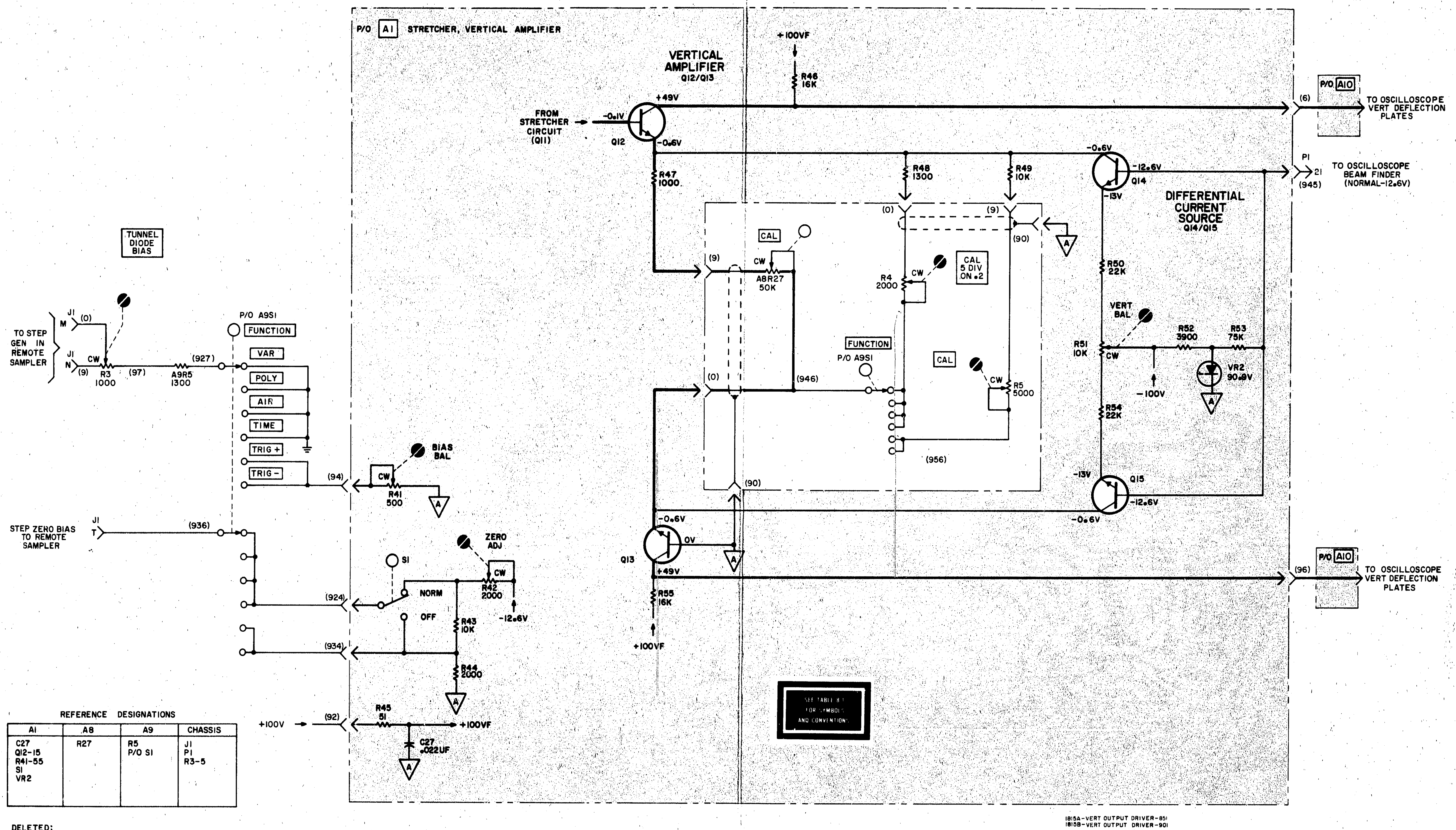


Figure 8-13. ρ/DIV, VOLTS/DIV Switch Assembly A8 Parts Locations

DC VOLTAGE MEASUREMENT CONDITIONS

FUNCTION .... TRIG+	HOLD OFF .... Full cw
NORM, SIGNAL AVG .... NORM	TRIGGER LEVEL .... Free-run trace
NSEC/DIV 1	VERTICAL POSITION .... Trace mid-screen
VOLTS/DIV 5	
SCAN .... NORMAL	No input signal
MANUAL/DENSITY .... Full ccw	Terminate remote sampler OUTPUT in 50 ohms.

Figure 8-14. Vertical Output Driver Measurements



REFERENCE DESIGNATIONS

A1	A8	A9	CHASSIS
C27 Q12-15 R41-55 S1 VR2	R27	R5 P/O S1	J1 P1 R3-5

DELETED:

Figure 8-15. Vertical Output Driver Schematic

DC VOLTAGE MEASUREMENT CONDITIONS

FUNCTION .... TRIG+

NORM, SIGNAL AVG .... NORM

VOLTS/DIV 5

NSEC/DIV 1

TRIGGER LEVEL .... Full ccw

WAVEFORM MEASUREMENT CONDITIONS

Square-wave Generator .... 0.5 V at 500 MHz square wave to remote sampler INPUT. Terminate remote sampler OUTPUT into 50 ohms. Trigger output to 1815A trigger input connector using 20-dB pad.

1815A

FUNCTION .... TRIG

NORM, SIGNAL AVG .... NORM

VOLTS/DIV 1

NSEC/DIV 100

SCAN .... NORMAL

MANUAL/DENSITY .... Full cw

TRIGGER LEVEL .... stable display

MARKER ZERO .... Full ccw

MARKER POSITION .... Full ccw

Exceptions to these settings are noted by each applicable waveform.

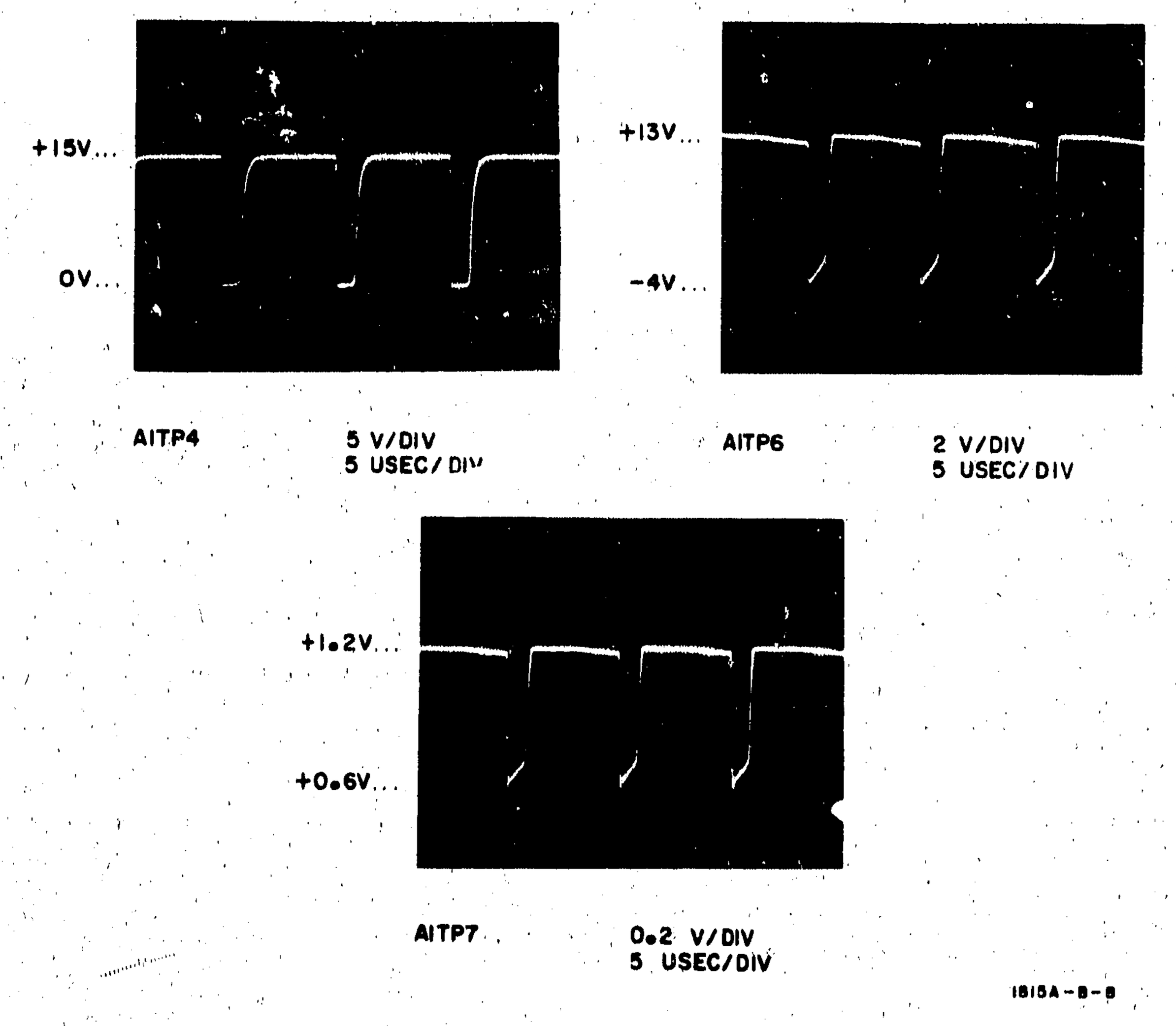


Figure 8-16. Countdown Circuit Measurements

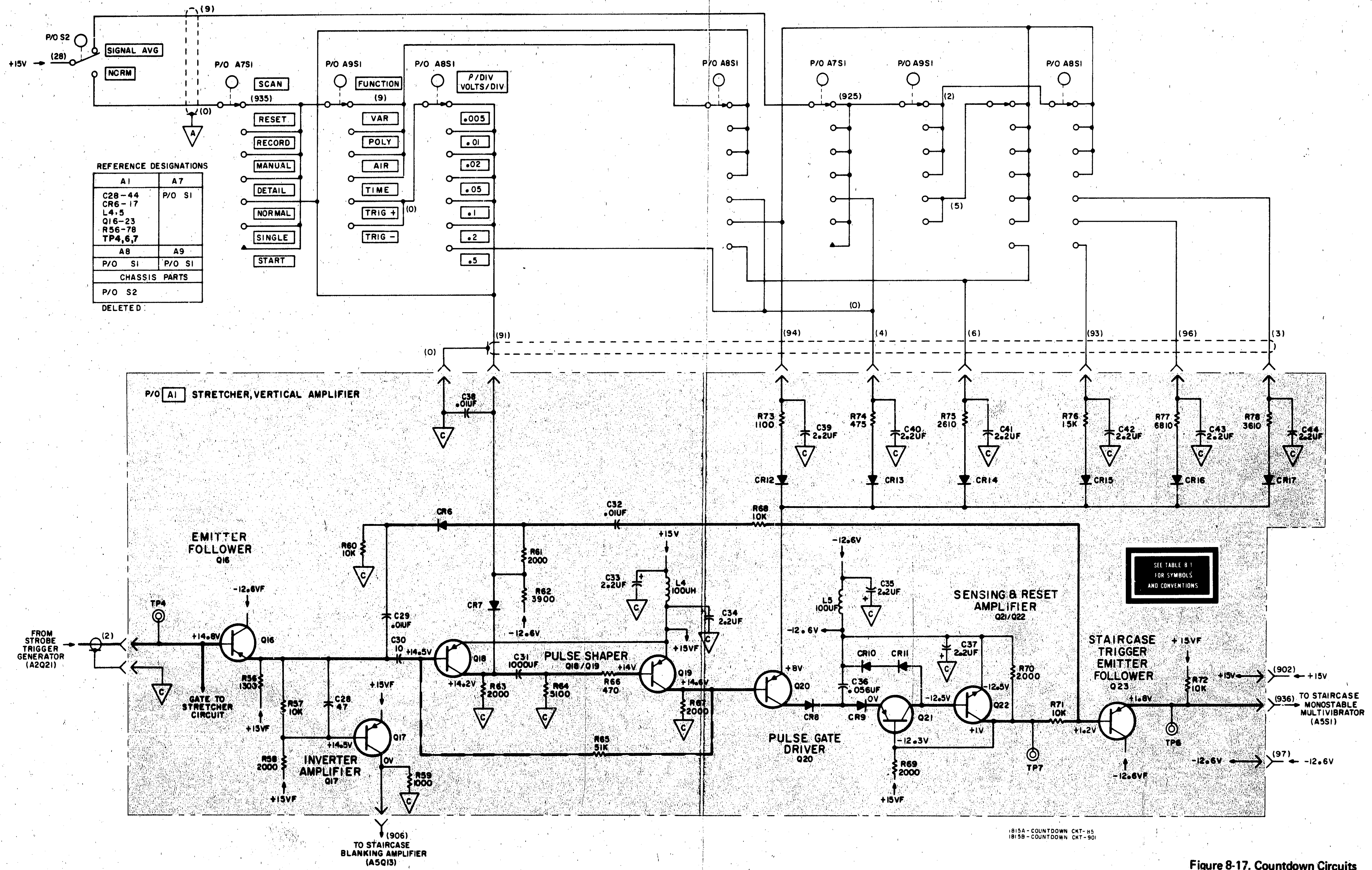
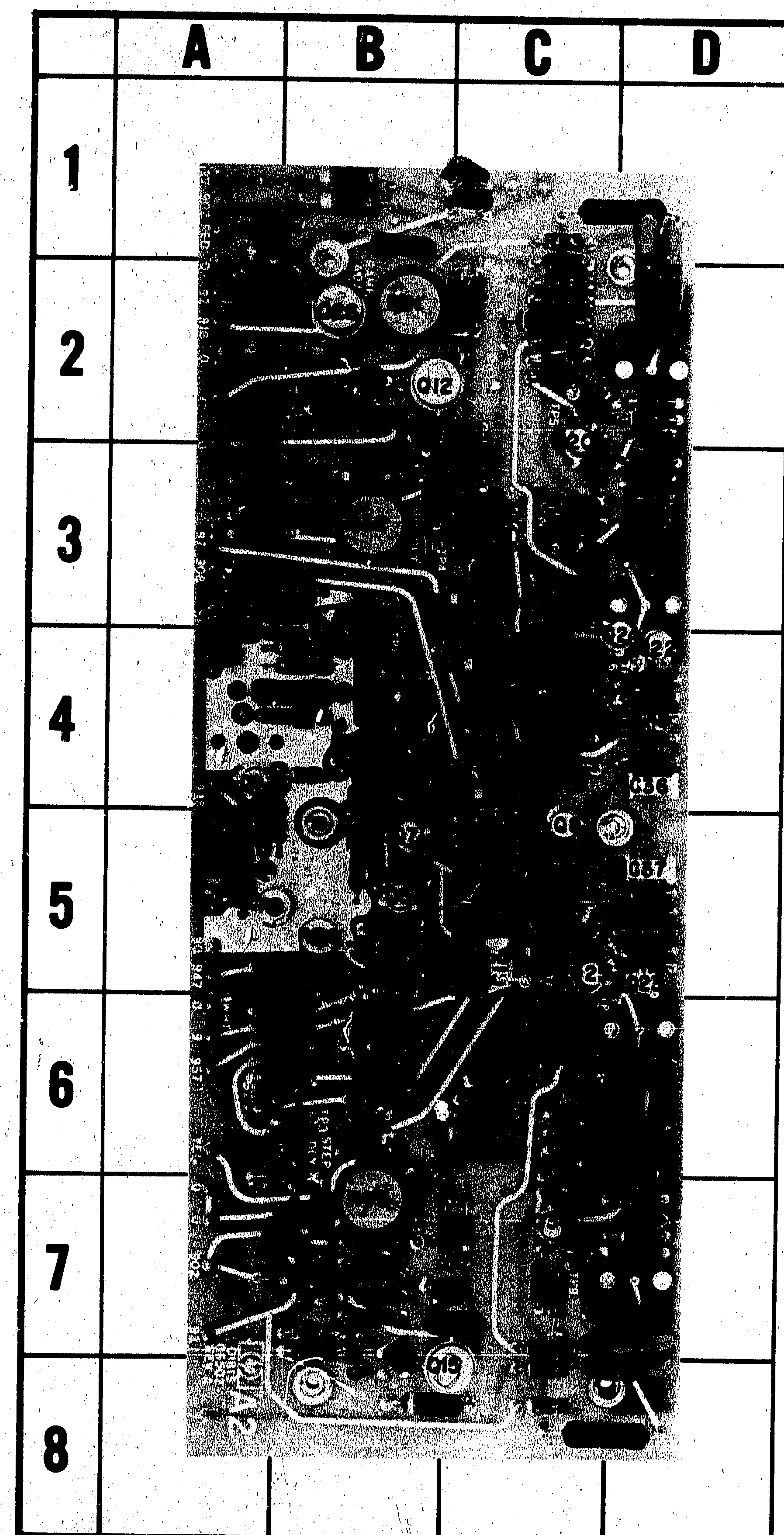


Figure 8-17. Countdown Circuits Schematic



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	A-5	L8	B-3	R31	B-6
C2	B-4	L9	C-3	R32	D-3
C3	A-4	L10	B-7	R33	A-3
C4	A-3	L11	C-7	R34	A-3
C5	B-4	L12	B-1	R35	B-3
C6	B-4	L14	C-4	R36	C-3
C7	B-4	L15	C-4	R37	C-2
C8	B-6	L16	C-3	R38	C-2
C9	B-6	L21	C-4	R39	B-2
C10	A-5	L22	C-5	R40	B-7
C11	C-5	L25	C-6	R41	B-2
C12	C-4	Q1	A-4	R42	B-7
C13	C-5	Q2	B-3	R43	A-2
C14	B-3	Q3	A-6	R44	B-7
C15	A-2	Q4	A-6	R45	C-6
C16	A-3	Q5	B-5	R46	B-8
C17	C-3	Q6	B-6	R47	C-7
C18	B-2	Q7	B-5	R48	B-7
C19	B-8	Q8	C-5	R49	B-7
C20	C-7	Q9	B-6	R50	B-7
C21	A-7	Q10	B-2	R51	B-7
C22	C-1	Q11	B-2	R52	B-7
C23	C-1	Q12	B-2	R53	C-2
C24	C-4	Q13	B-7	R54	C-2
C25	C-4	Q14	C-7	R55	C-2
C26	D-2	Q15	C-8	R56	C-3
C27	D-3	Q16	C-3	R57	C-3
C28	D-3	Q17	D-3	R58	C-3
C29	C-3	Q18	C-3	R59	C-2
C30	C-4	Q19	C-2	R60	C-2
C31	D-2	Q20	C-2	R61	C-3
C32	D-3	Q21	A-1	R62	C-3
C33	D-2	Q22	D-4	R63	C-1
C34	B-1	Q23	D-5	R64	C-1
C35	D-2	Q24	D-4	R65	C-2
C36	D-4	Q25	C-5	R66	D-2
C37	D-5	Q26	B-2	R67	C-1
C38	C-4	Q27	C-6	R68	A-1
C39	C-6	Q28	D-6	R69	A-2
C40	D-6	Q29	C-6	R70	C-2
C41	D-6	Q30	C-7	R71	D-4
C42	C-6	Q31	C-7	R72	D-4
C43	C-6	R1	A-4	R73	D-4
C44	D-7	R2	B-4	R74	C-4
C45	D-8	R3	B-4	R75	C-4
C46	D-6	R4	B-3	R76	C-5
C47	D-7	R5	A-4	R77	D-5
C48	D-7	R6	B-4	R78	D-5
CR1	B-5	R7	A-5	R79	D-5
CR2	B-4	R8	A-5	R80	C-5
CR3	B-4	R9	A-5	R81	B-2
CR4	B-4	R10	B-5	R82	A-2
CR5	B-5	R11	B-5	R83	C-6
CR6	B-7	R12	B-4	R84	C-6
CR7	B-6	R13	B-5	R85	C-6
CR8	B-5	R14	C-5	R86	C-6
CR9	B-6	R15	C-5	R87	C-6
CR10	A-3	R16	C-5	R88	C-7
CR11	C-3	R17	B-7	R89	C-6
CR12	C-3	R18	B-7	R90	C-7
CR13	D-2	R19	B-6	R91	C-7
CR14	D-4	R20	B-6	R92	C-8
CR15	D-4	R21	B-6	R93	C-8
CR16	D-5	R22	B-6	R94	C-8
CR17	D-5	R23	B-5	R95	D-7
CR18	C-6	R24	B-5	R96	C-7
CR19	C-6	R25	B-5	R97	C-7
CR20	D-7	R26	B-5	RT1	B-5
L2	B-4	R27	B-6	VR1	A-3
L3	B-1	R28	C-5	VR2	C-5
L5	B-4	R29	C-5	VR3	D-3
L7	C-5	R30	B-6	VR4	D-7

1818A-A-31

Figure 8-18. Trigger, Strobe and Step Assembly A2 Parts Locations

DC VOLTAGE MEASUREMENT CONDITIONS

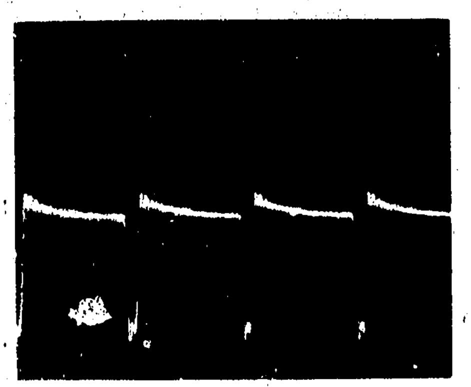
FUNCTION .... TRIG+	HOLD OFF .... Full cw
NORM, SIGNAL AVG .... NORM	TRIGGER LEVEL .... Full ccw
NSEC/DIV 1	*TRIGGER LEVEL .... Full cw
VOLTS/DIV 5	
SCAN .... NORMAL	No signal input.
MANUAL/DENSITY .... Full ccw	Terminate remote sampler OUTPUT in 50 ohms.

WAVEFORM MEASUREMENT CONDITIONS

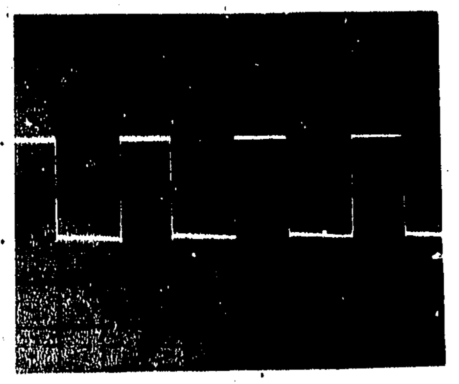
Square-wave Generator .... 0.5 V at 500 MHz square wave to remote sampler INPUT. Terminate remote sampler OUTPUT into 50 ohms. Trigger output to 1815A trigger input connector using 20-dB pad.

1815A

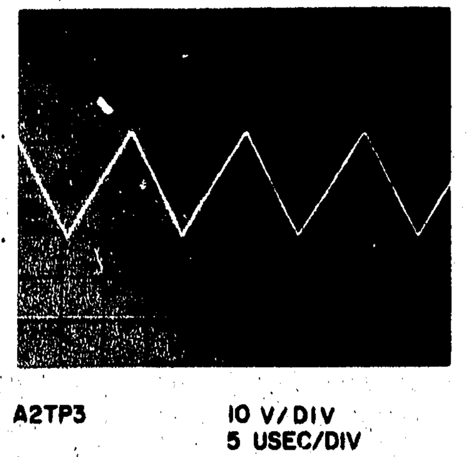
FUNCTION .... -TRIG	MANUAL/DENSITY .... Full cw
NORM, SIGNAL AVG .... NORM	TRIGGER LEVEL .... stable display
VOLTS/DIV 1	MARKER ZERO .... Full ccw
NSEC/DIV 100	MARKER POSITION .... Full ccw
SCAN .... NORMAL	Exceptions to these settings are noted by each applicable waveform.



A2TP1 — 0.2 V/DIV, 0.1 USEC/DIV (EXACT REP RATE DETERMINED BY SETTING OF TRIGGER LEVEL)



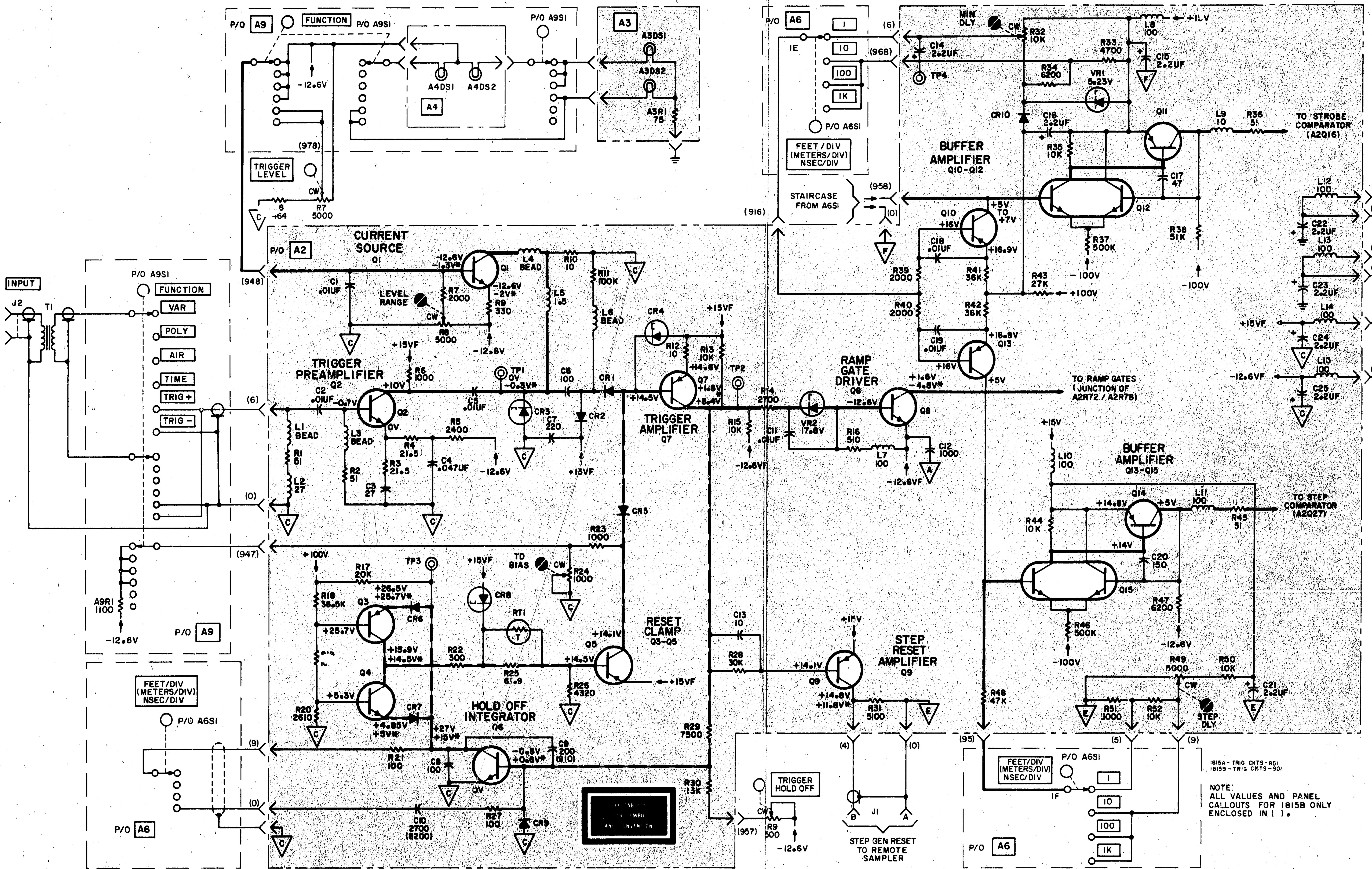
A2TP2 — 5 V/DIV, 5 USEC/DIV



A2TP3 — 10 V/DIV, 5 USEC/DIV

1815A-B-7

Figure 8-19. Trigger Circuits Measurements



REFERENCE DESIGNATIONS

A3	DS1,2 R1
A9	R1 S1
A2	C1-25 CR1-10 L1-15 Q1-15 R1-52 RT1 TP1-4 VR1,2
A4	DS1,2
A6	S1
CHASSIS PARTS	J1,2 R7-9 T1

DELETED:

Figure 8-20. Trigger Circuits Schematic

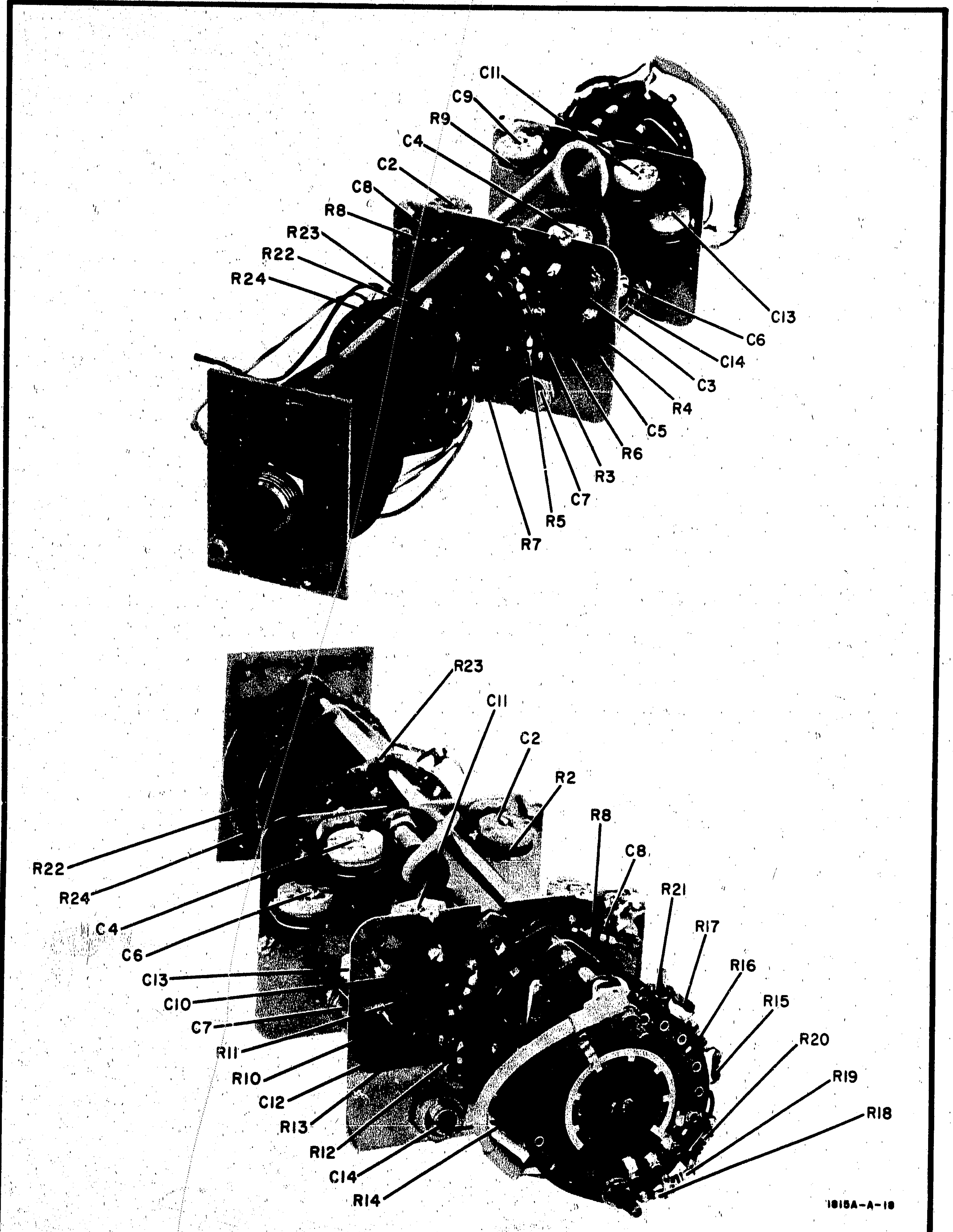


Figure 8-21. FEET/DIV, NSEC/DIV Switch Assembly A6 Parts Locations

DC VOLTAGE MEASUREMENT CONDITIONS

FUNCTION	TRIG+	HOLD OFF	Full cw
SCAN	NORMAL	TRIGGER LEVEL	Full ccw
NSEC/DIV	1	*TRIGGER LEVEL	Full cw
VOLTS/DIV	.5		
NORM, SIGNAL AVG	NORM	No signal input.	
MANUAL DENSITY	Full ccw	Terminate remote sampler in 50 ohms.	

WAVEFORM MEASUREMENT CONDITIONS

Square-wave Generator .... 0.5V at 500 MHz square wave to remote sampler INPUT. Terminate remote sampler OUTPUT into 50 ohms. Trigger output to 1815A trigger input connector using 20-dB pad.

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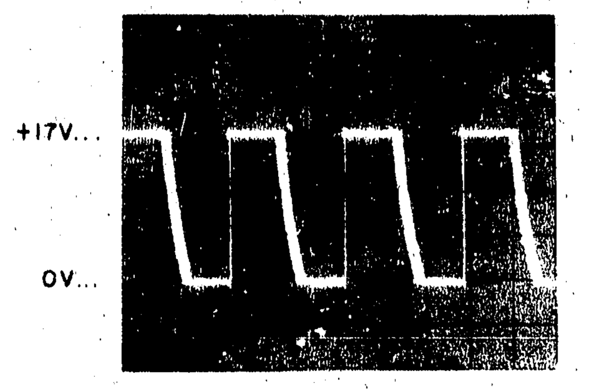
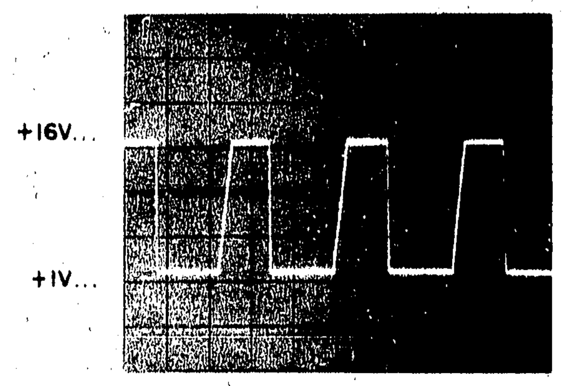
FUNCTION	TRIG	MANUAL/DENSITY	Full cw
NORM, SIGNAL AVG	NORM	TRIGGER LEVEL	stable display
VOLTS/DIV	.1	MARKER ZERO	Full ccw
NSEC/DIV	100	MARKER POSITION	Full ccw
SCAN	NORMAL		

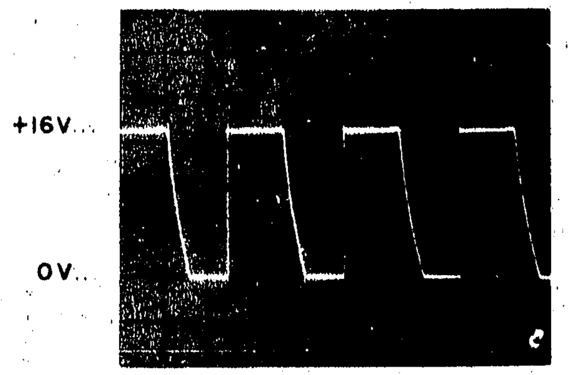
Exceptions to these settings are noted by each applicable waveform.



A2TP5 5 V/DIV 5 USEC/DIV



A2TP6 A2TP7 5 V/DIV 5 USEC/DIV



A2TP8 5 V/DIV 5 USEC/DIV

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Figure 8-22. Strobe and Step Measurements

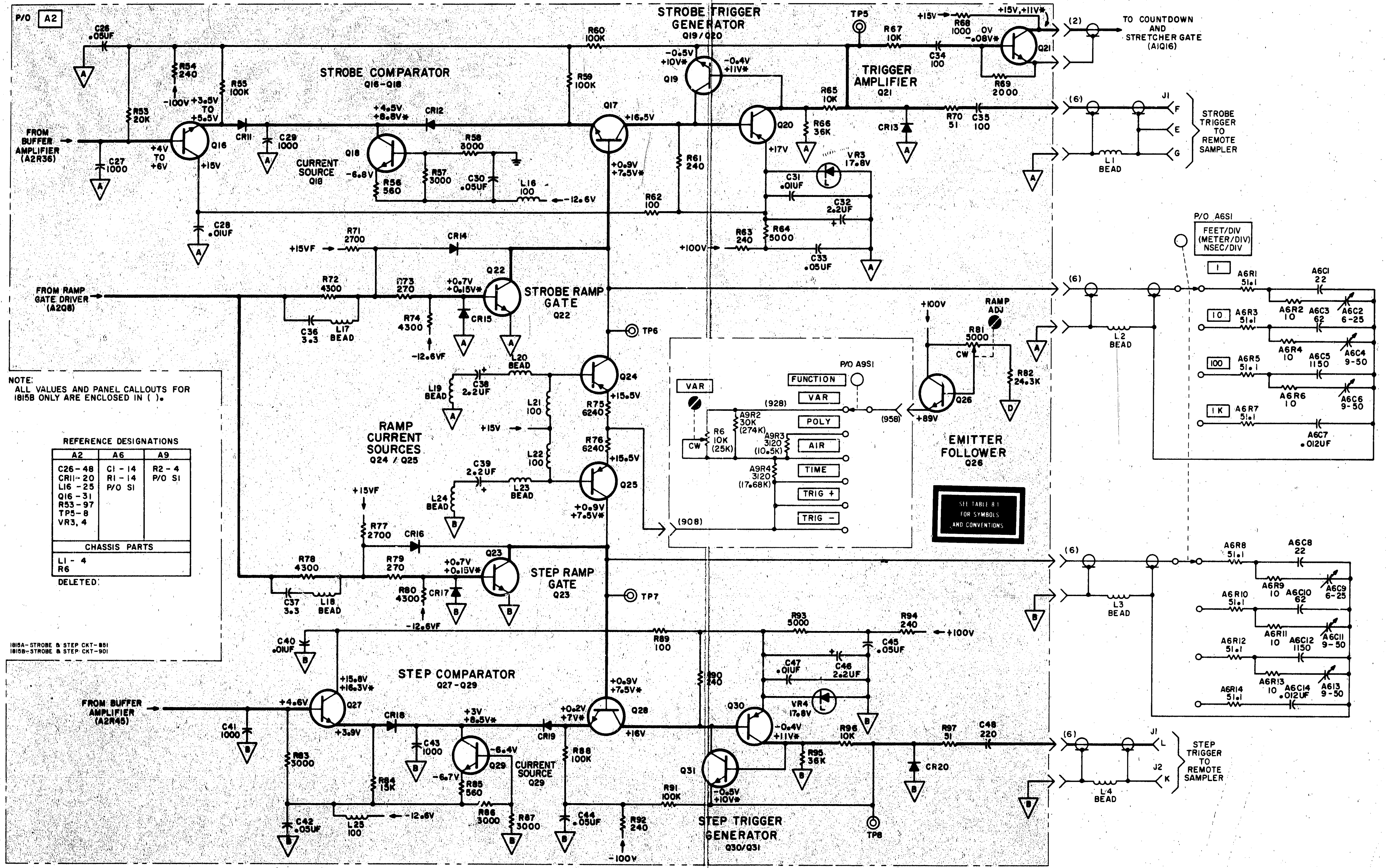
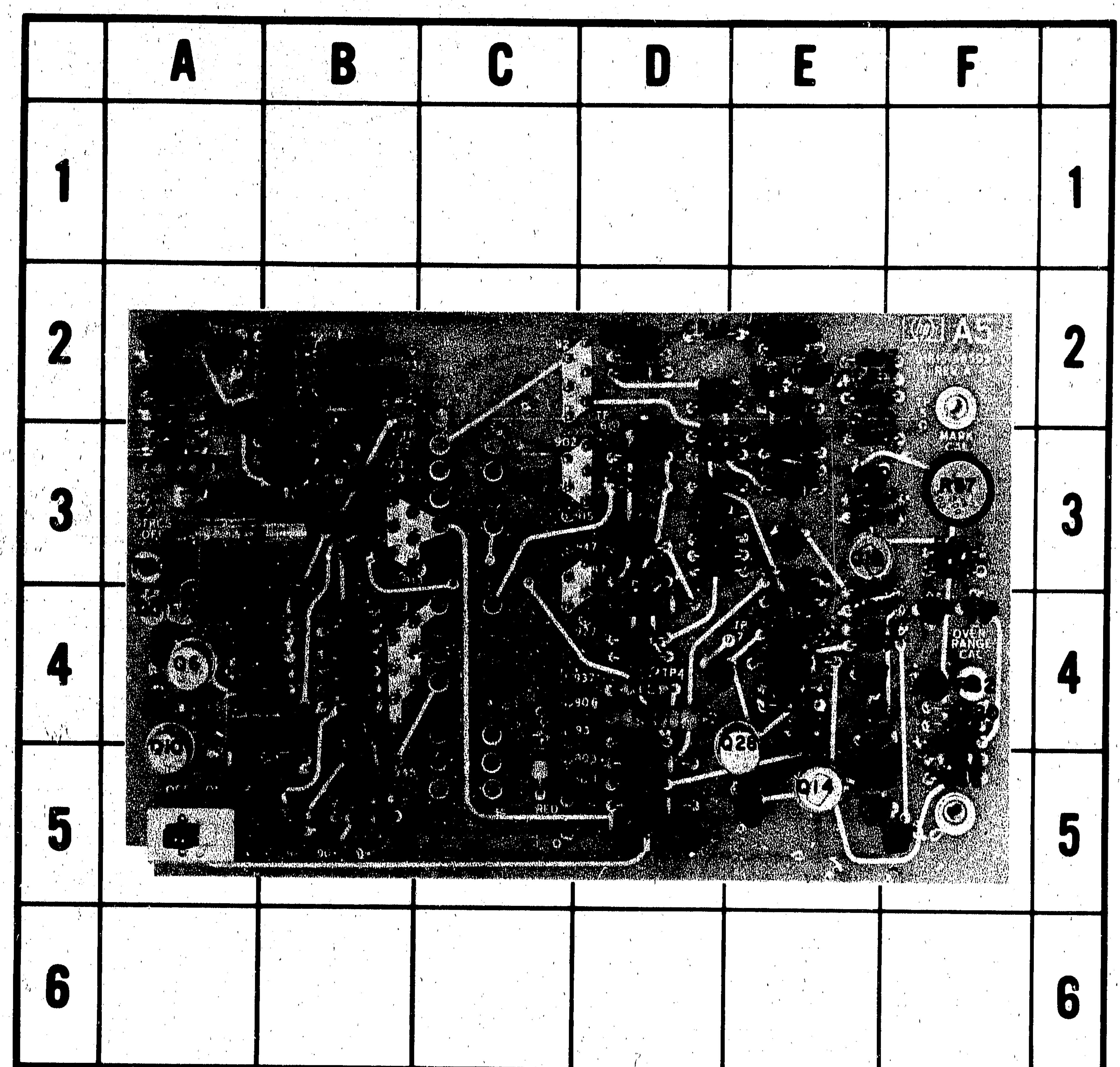


Figure 8-23. Strobe and Step Circuits Schematic



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	B-2	C20	E-4	CR14	E-3	Q9	A-4	Q27	E-4	R17	A-4	R35	D-5	R53	D-2
C2	A-2	C21	E-2	CR15	E-3	Q10	A-5	Q28	E-4	R18	B-4	R36	E-4	R54	D-2
C3	A-2	C22	E-3	CR16	E-3	Q11	B-5	R1	A-3	R19	B-4	R37	D-5	R55	B-3
C4	B-3	C23	E-2	CR17	E-2	Q12	D-3	R2	A-3	R20	A-3	R38	D-5	R56	D-3
C5	B-2	C24	D-2	CR18	D-2	Q13	D-4	R3	B-2	R21	A-3	R39	E-4	R57	F-3
C6	B-2	C25	D-2	CR19	E-4	Q14	E-5	R4	B-2	R22	B-5	R40	E-3	R58	F-3
C7	B-3	CR1	B-2	CR20	F-4	Q15	E-5	R5	A-3	R23	D-4	R41	E-3	R59	E-4
C8	A-3	CR2	A-2	CR21	F-4	Q16	E-5	R6	A-2	R24	D-3	R42	D-3	R60	F-4
C9	A-3	CR3	A-2	CR22	E-4	Q17	F-5	R7	B-2	R25	B-5	R43	D-3	R61	F-3
C10	A-4	CR4	B-2	L1	B-3	Q18	E-3	R8	B-3	R26	B-4	R44	E-4	R62	F-4
C11	B-4	CR5	B-4	Q1	A-2	Q19	E-3	R9	B-3	R27	D-4	R45	E-3	R63	F-5
C12	B-4	CR6	B-4	Q2	A-2	Q20	E-3	R10	B-2	R28	D-3	R46	E-2	R64	F-5
C13	D-3	CR7	A-4	Q3	B-3	Q21	E-2	R11	D-4	R29	B-5	R47	E-2	R65	E-4
C14	B-4	CR8	A-3	Q4	B-3	Q22	E-2	R12	D-4	R30	D-3	R48	E-2	R66	D-5
C15	B-5	CR9	A-4	Q5	A-4	Q23	D-3	R13	D-4	R31	D-3	R49	E-2	S1	A-5
C16	E-4	CR10	A-4	Q6	A-4	Q24	F-4	R14	B-4	R32	C-5	R50	E-3	VR1	B-4
C17	E-5	CR11	B-4	Q7	A-5	Q25	F-4	R15	B-4	R33	D-6	R51	E-3	VR2	B-4
C18	E-4	CR12	D-3	Q8	B-5	Q26	F-4	R16	A-4	R34	D-3	R52	D-2	VR3	B-5
C19	E-4	CR13	E-4												

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Figure 8-24. Staircase and Marker Dot Assembly A5 Parts Locations

DC VOLTAGE MEASUREMENT CONDITIONS

SCAN .... MANUAL	VOLTS/DIV 5
MANUAL/DENSITY .... Full ccw	FUNCTION .... TRIG+
TRIGGER LEVEL .... 2 o'clock	
NSEC/DIV 1	NORM, SIGNAL AVG .... NORM

WAVEFORM MEASUREMENT CONDITIONS

Square-wave Generator .... 0.5 V at 500 MHz square wave to remote sampler INPUT. Terminate remote sampler OUTPUT into 50 ohms. Trigger output to 1815A trigger input connector using 20-dB pad.

1815A	
FUNCTION .... -TRIG	MANUAL/DENSITY .... Full cw
NORM, SIGNAL AVG .... NORM	TRIGGER LEVEL .... stable display
VOLTS/DIV 1	MARKER ZERO .... Full ccw
NSEC/DIV 100	MARKER POSITION .... Full ccw
SCAN .... NORMAL	Exceptions to these settings are noted by each applicable waveform.

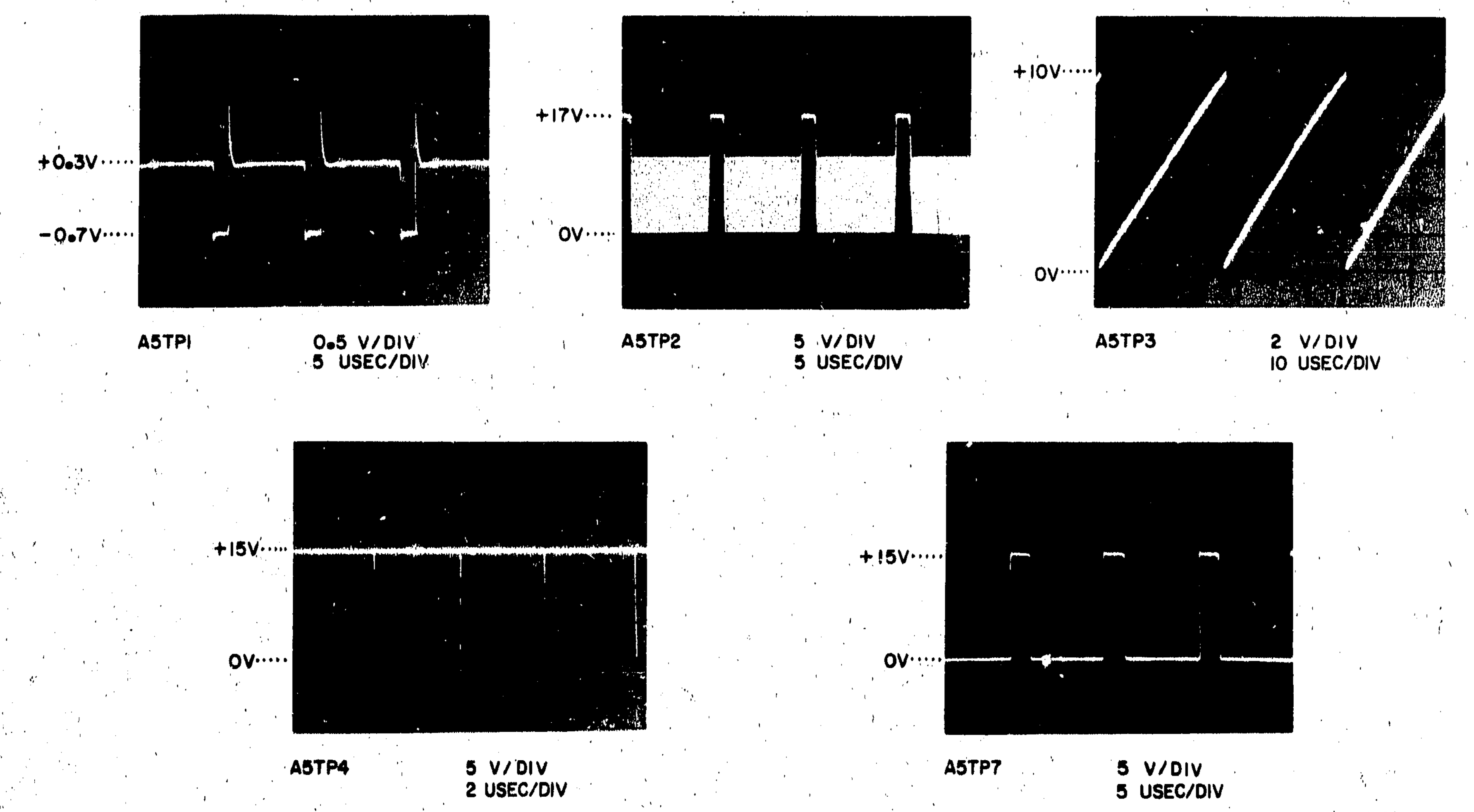

Figure 8-25. Staircase and Blanking Measurements

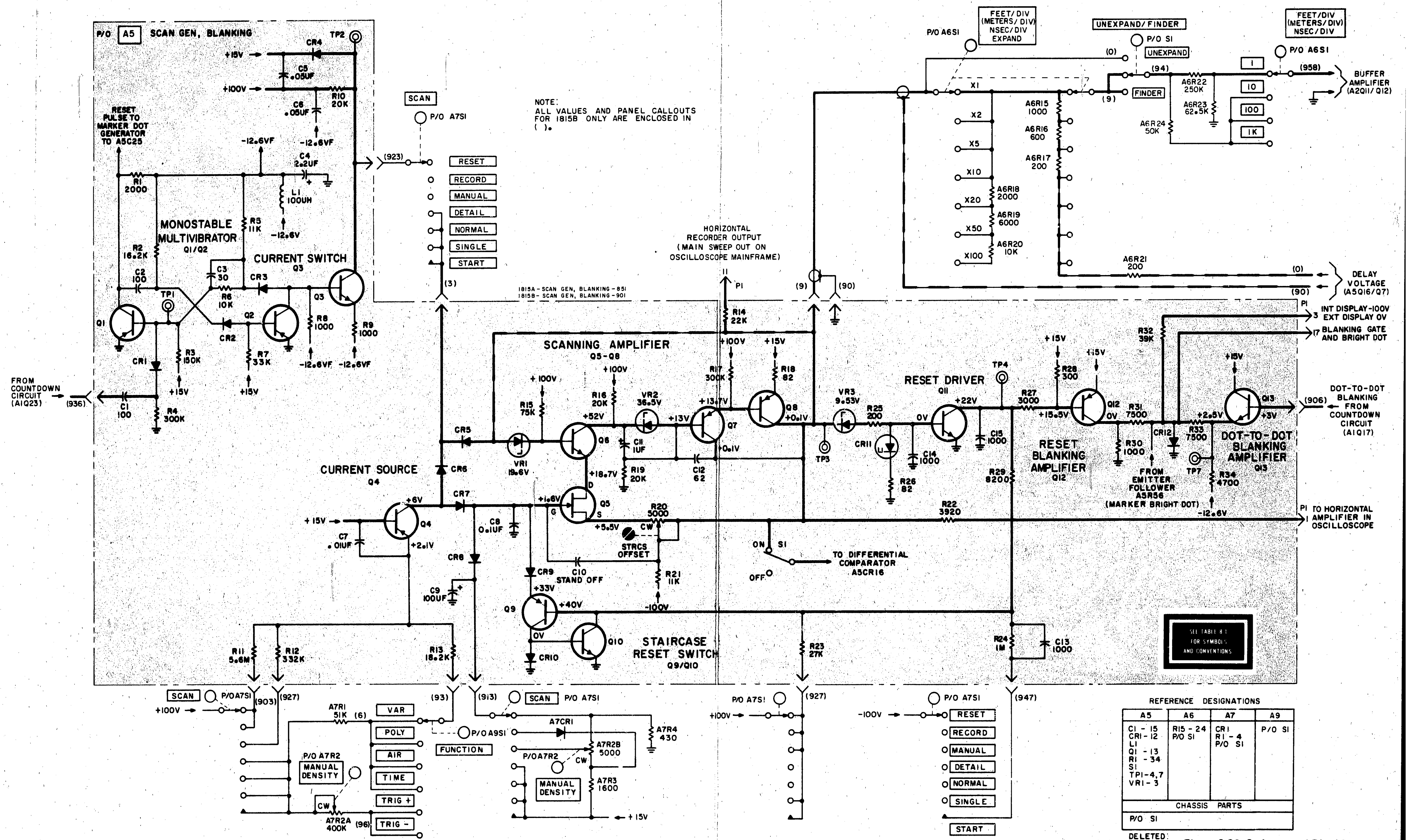

Figure 8-26. Staircase and Blanking Circuits Schematic

DC VOLTAGE MEASUREMENT CONDITIONS

SCAN	NORMAL	NORM, SIGNAL AVG	NORM
MARKER ZERO	Full ccw	NSEC/DIV	1
MARKER POSITION	Full ccw	VOLTS/DIV	.5
FUNCTION	TRIG+	MANUAL/DENSITY	Full ccw

WAVEFORM MEASUREMENT CONDITIONS

Square-wave Generator .... 0.5 V at 500 MHz square wave to remote sampler INPUT. Terminate remote sampler OUTPUT into 50 ohms. Trigger output to 1815A trigger input connector using 20-dB pad.

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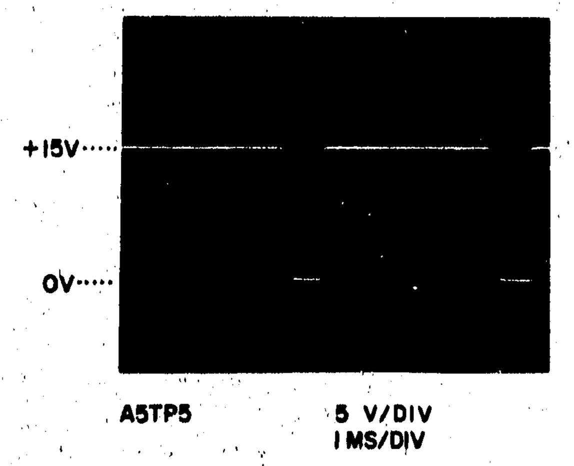
FUNCTION	TRIG	MANUAL/DENSITY	Full cw
NORM, SIGNAL AVG	NORM	TRIGGER LEVEL	stable display
VOLTS/DIV	.1	MARKER ZERO	Full ccw
NSEC/DIV	100	MARKER POSITION	Full ccw
SCAN	NORMAL		

Exceptions to these settings are noted by each applicable waveform.



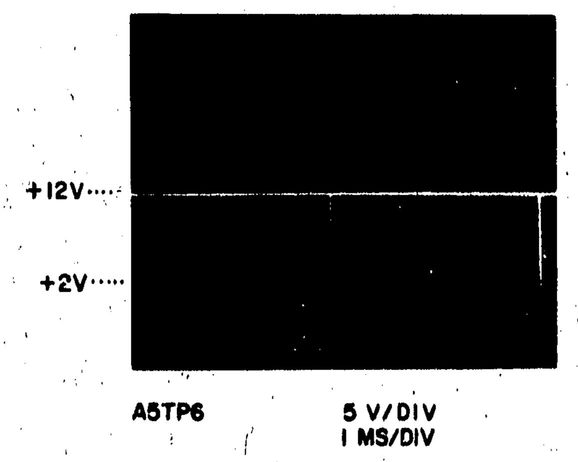


Figure 8-27. Marker Dot Measurements

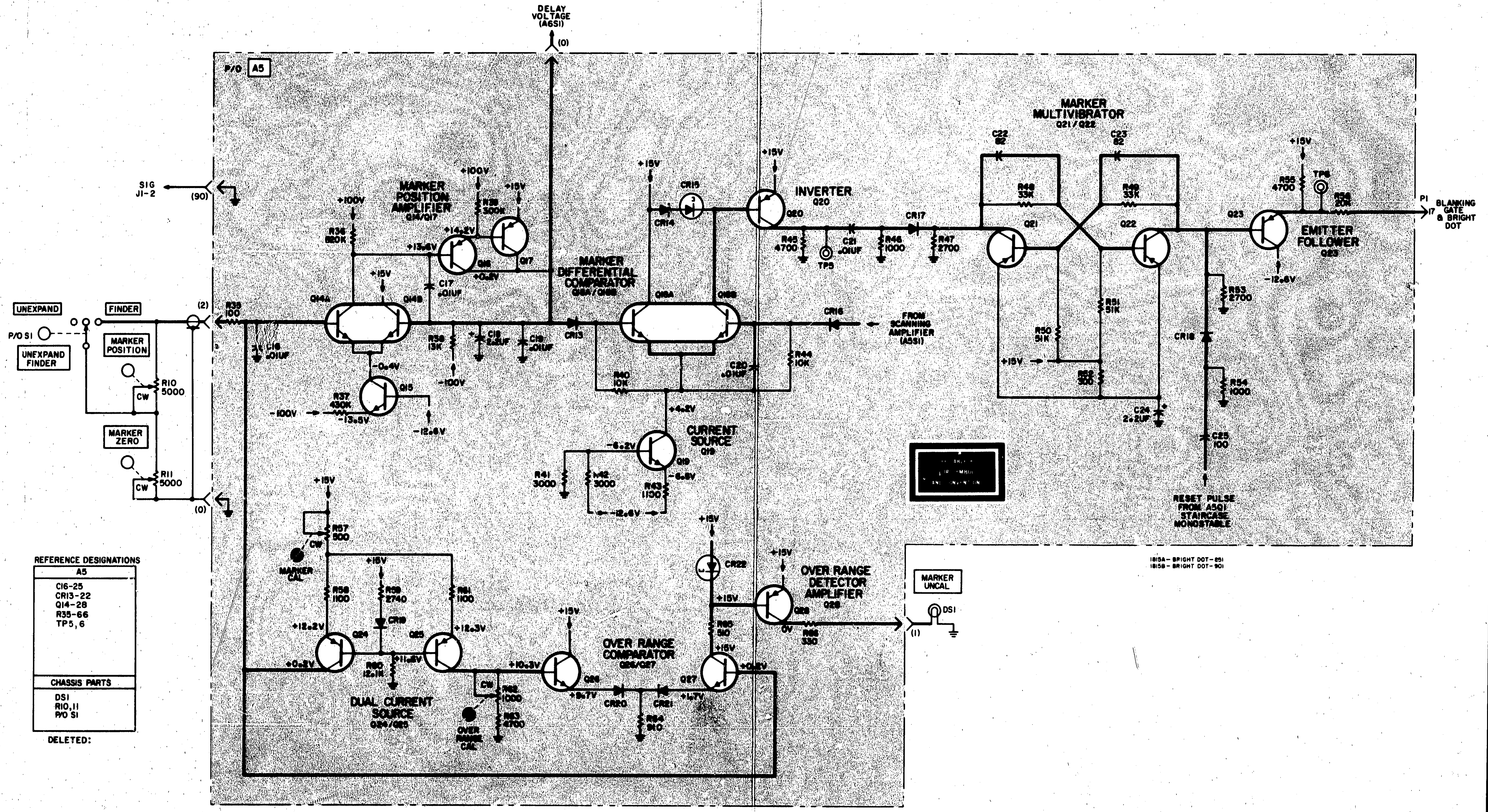
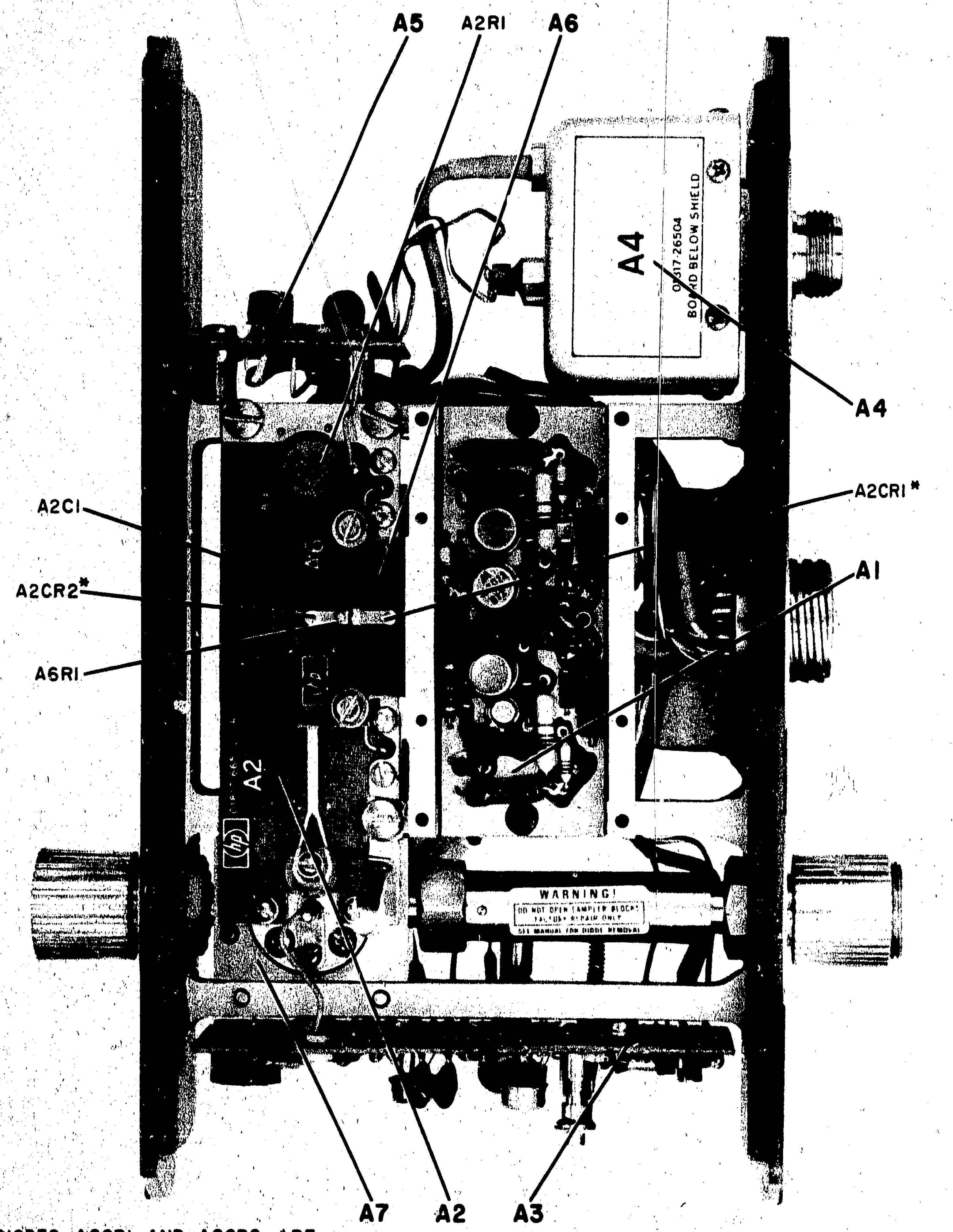


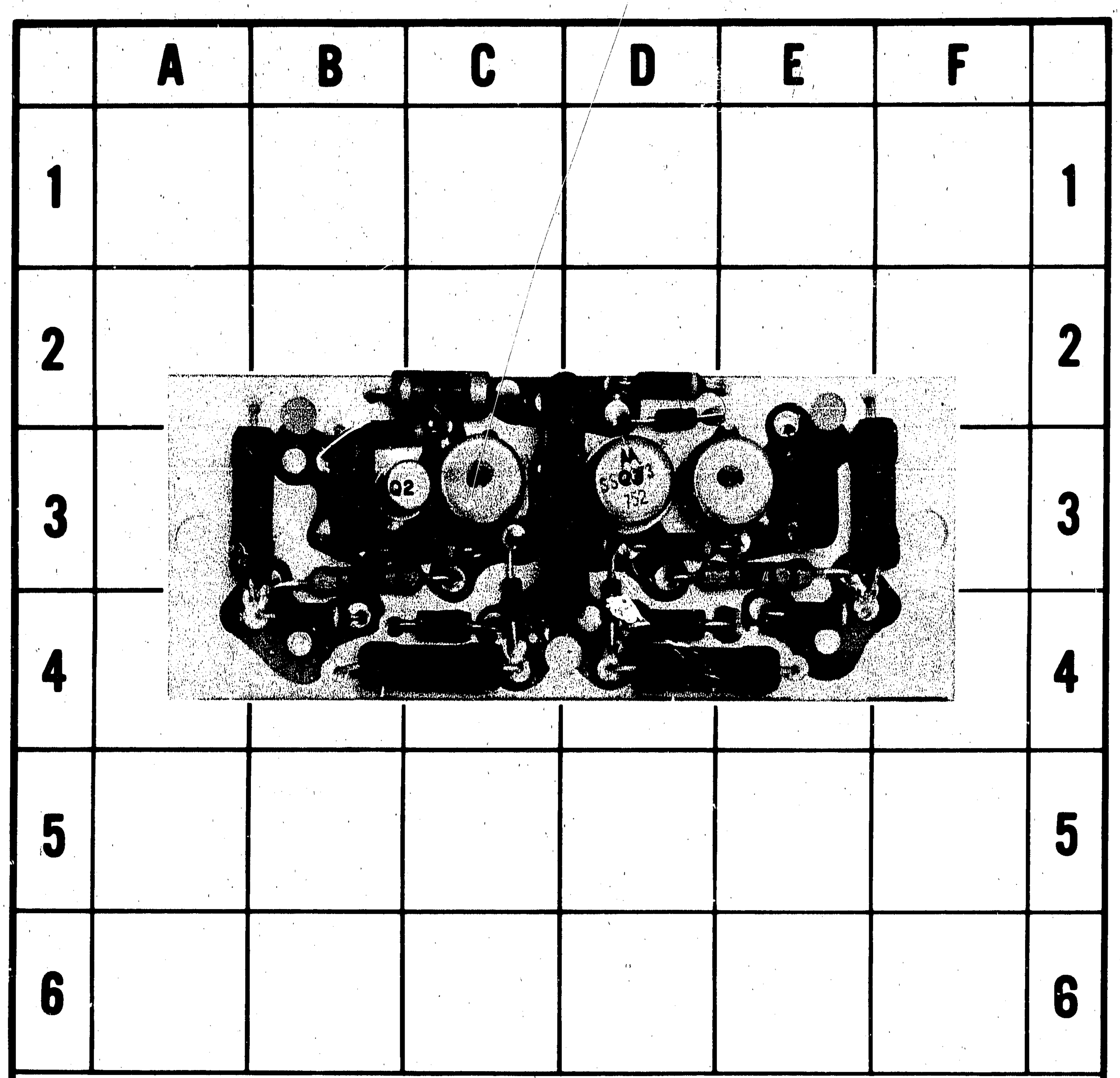
Figure 8-28. Marker Dot Circuits Schematic



*DIODES A2CRI AND A2CR2 ARE SANDWICHED BETWEEN BOARDS A2 AND A6.

1817A-A-1

Figure 8-29. Model 1817A Assembly Locations



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	C-3	C8	D-4	Q3	D-3	R5	D-2
C2	C-4	CR1	D-4	Q4	E-3	R6	D-3
C3	A-3	CR2	D-2	R1	B-3	R7	E-3
C4	B-3	CR3	D-4	R2	B-3	R8	E-4
C5	C-3	L1	C-2	R3	B-4	VR1	C-4
C6	E-3	Q1	C-3	R4	C-3	VR2	D-4
C7	F-3	Q2	B-3				

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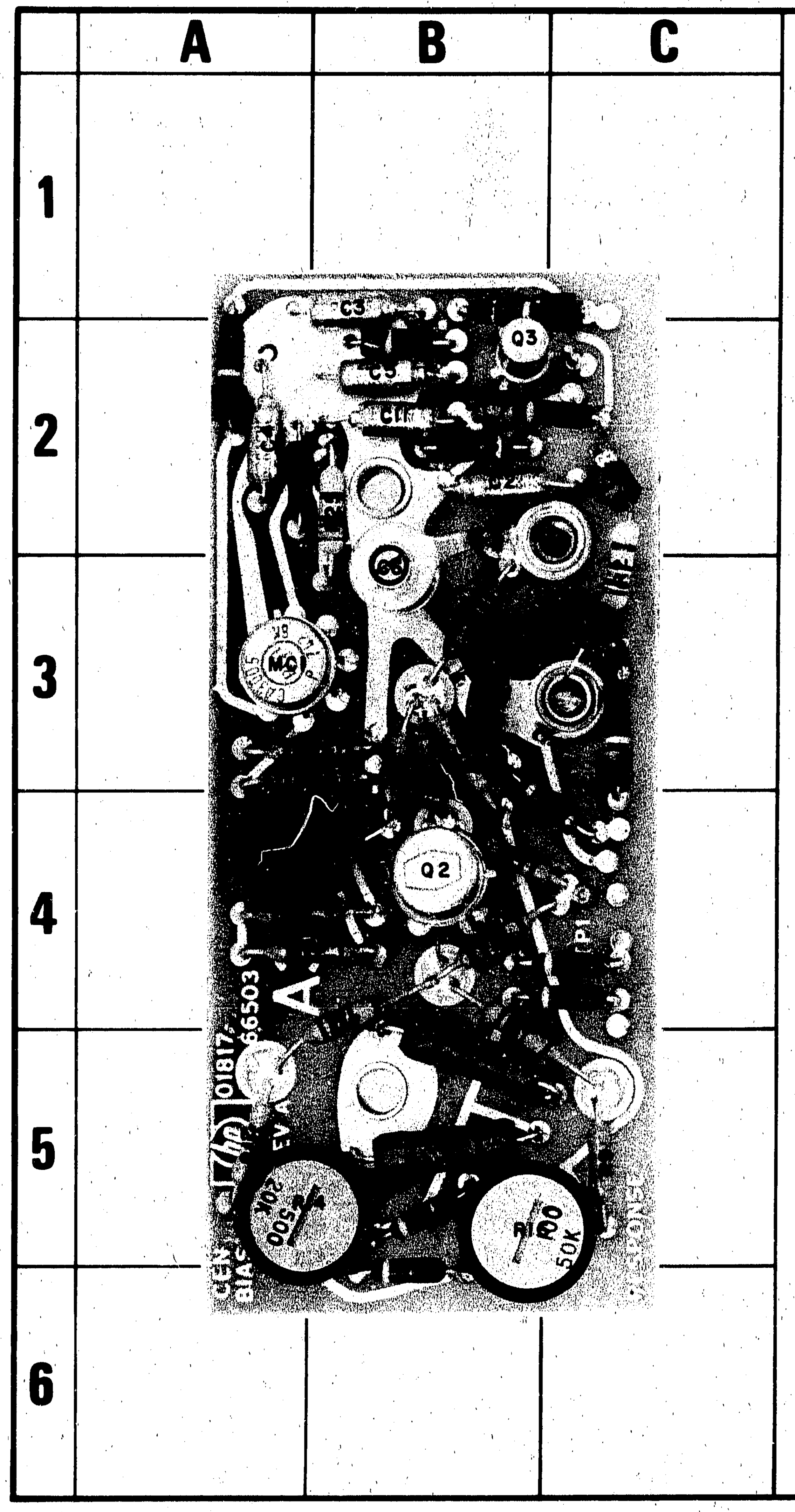
Figure 8-30. Pulse Generator Assembly A1 Parts Locations



REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	B-3	R5	B-3
C2	B-2	R6	B-3
C3	B-1	R7	C-4
C4	A-2	R8	B-5
C5	B-2	R9	C-5
C6	B-3	R10	B-4
C7	B-5	R11	B-4
C8	B-5	R12	A-5
C9	A-4	R13	B-5
C10	A-4	R14	A-5
C11	B-2	R15	C-4
L1	C-3	R16	B-5
L2	B-4	R17	B-3
L3	B-3	R18	B-3
L4	C-2	R19	B-4
L5	A-2	R20	B-4
L6	C-1	R21	A-4
L7	B-2	R22	A-4
MC1	A-3	R23	A-3
Q1	C-3	R24	A-3
Q2	B-4	R25	B-2
Q3	B-2	R26	B-2
R1	C-3	R27	C-2
R2	C-3	VR1	B-3
R3	A-2	VR2	A-2
R4	B-1	VR3	B-2

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Figure 8-31. Preamplifier Assembly A3 Parts Locations

DC VOLTAGE MEASUREMENT CONDITIONS

FUNCTION .... TRIG+
NORM, SIGNAL AVG .... NORM
NSEC/DIV 1
VOLTS/DIV 5

VERTICAL POSITION . . Trace midscreen when baseline free-runs (TRIGGER LEVEL cw).
TRIGGER LEVEL .... Full ccw

WAVEFORM MEASUREMENT CONDITIONS

Square-wave Generator .... 0.5 V at 500 MHz square wave remote sampler INPUT. Terminate remote sampler OUTPUT into 50 ohms. Trigger output to 1815A trigger input connector using 20-dB pad.

1815A

FUNCTION .... TRIG
NORM, SIGNAL AVG .... NORM
VOLTS/DIV 1
NSEC/DIV 100
SCAN .... NORMAL

MANUAL/DENSITY .... Full cw
TRIGGER LEVEL .... stable display
MARKER ZERO .... Full ccw
MARKER POSITION .... Full ccw

Exceptions to these settings are noted by each applicable waveform.

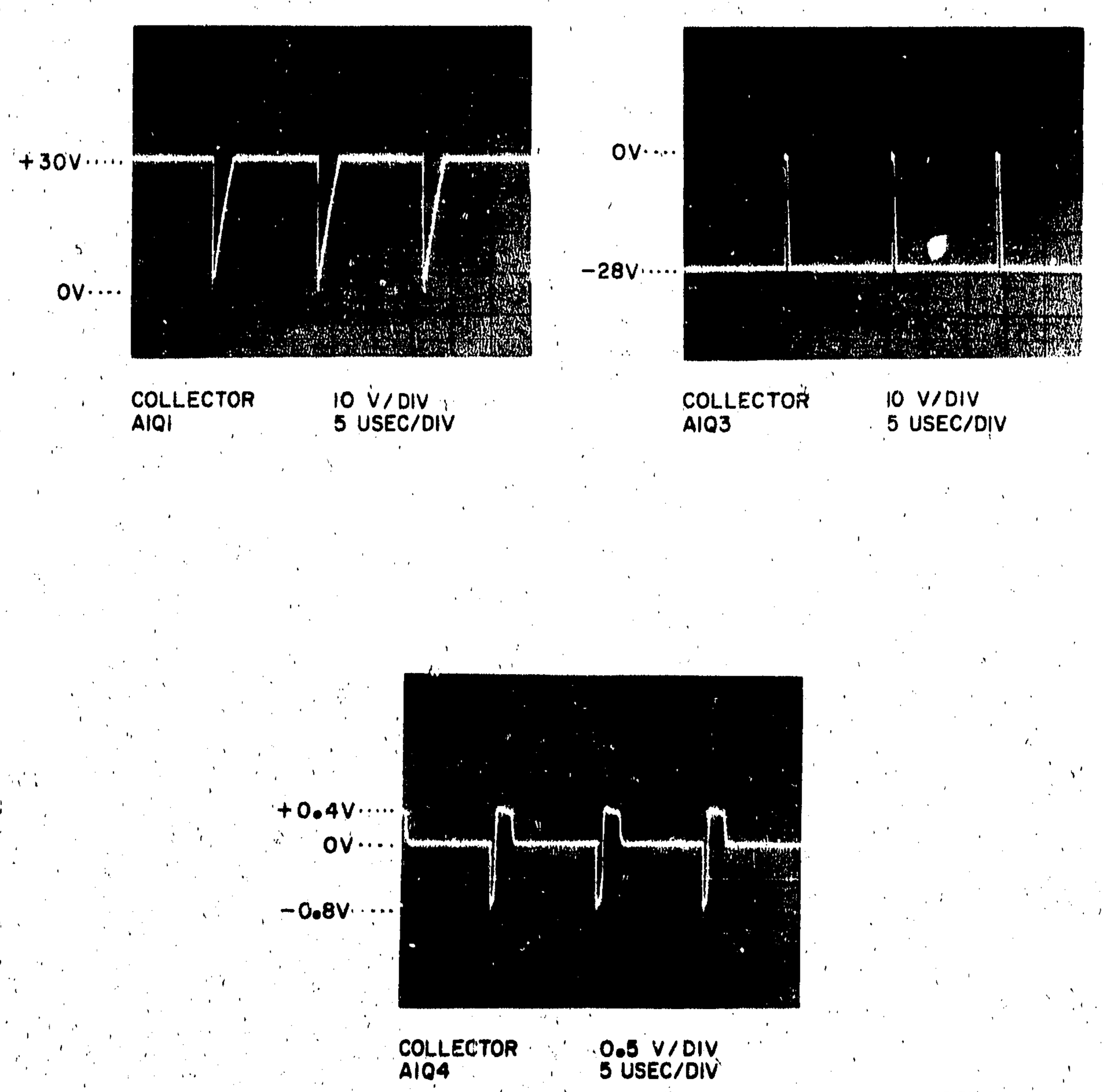
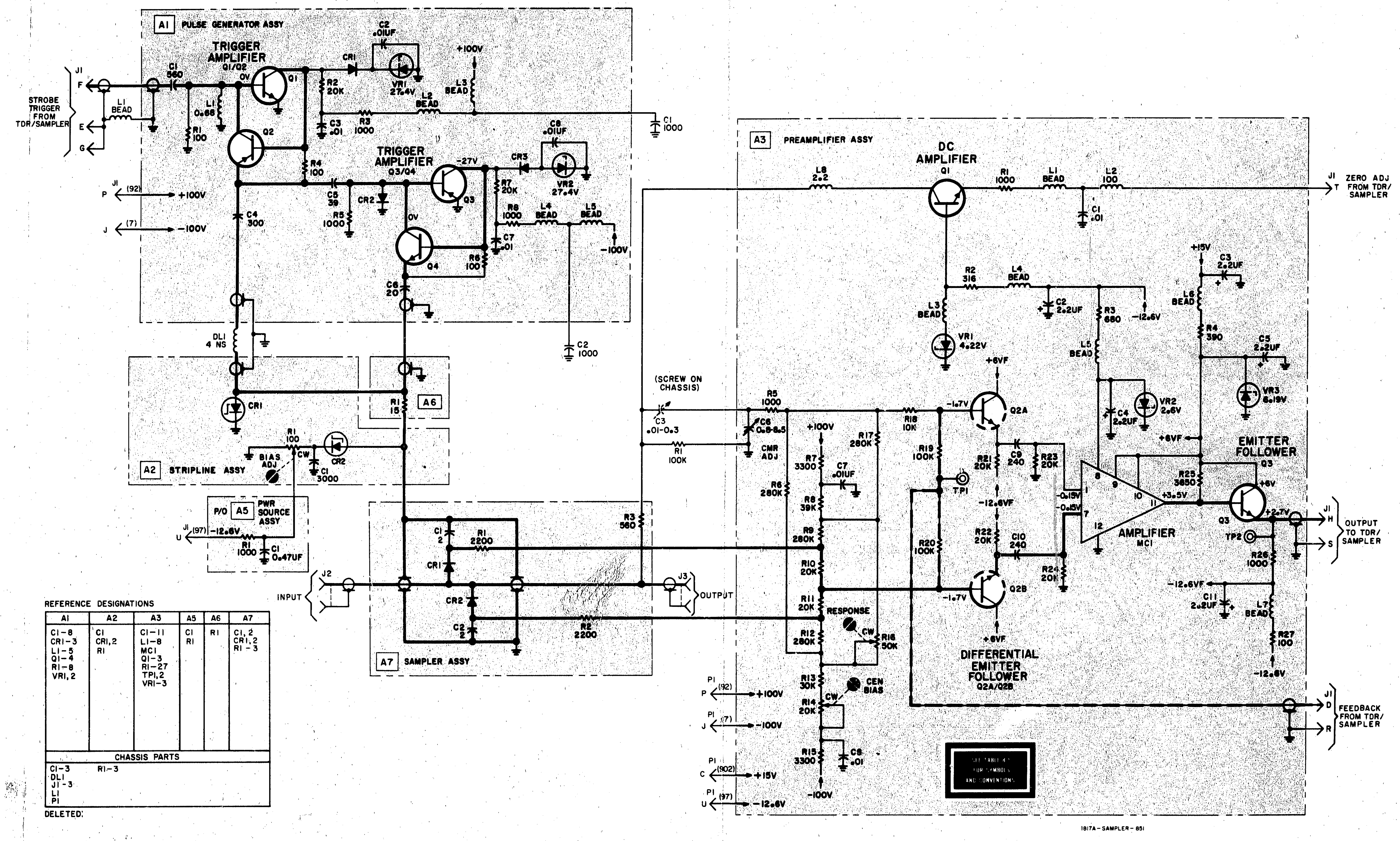


Figure 8-32. Sampler Measurements



REFERENCE DESIGNATIONS

A1	A2	A3	A5	A6	A7
C1-8 CR1-3 L1-5 Q1-4 R1-8 VR1, 2	C1 CR1, 2 R1	C1-11 L1-8 MC1 Q1-3 R1-27 TP1, 2 VR1-3	C1 R1	R1	C1, 2 CR1, 2 R1 - 3

CHASSIS PARTS	
C1-3 DL1 J1-3 L1 P1	R1-3

DELETED:

Figure 8-33. Sampler Circuits Schematic

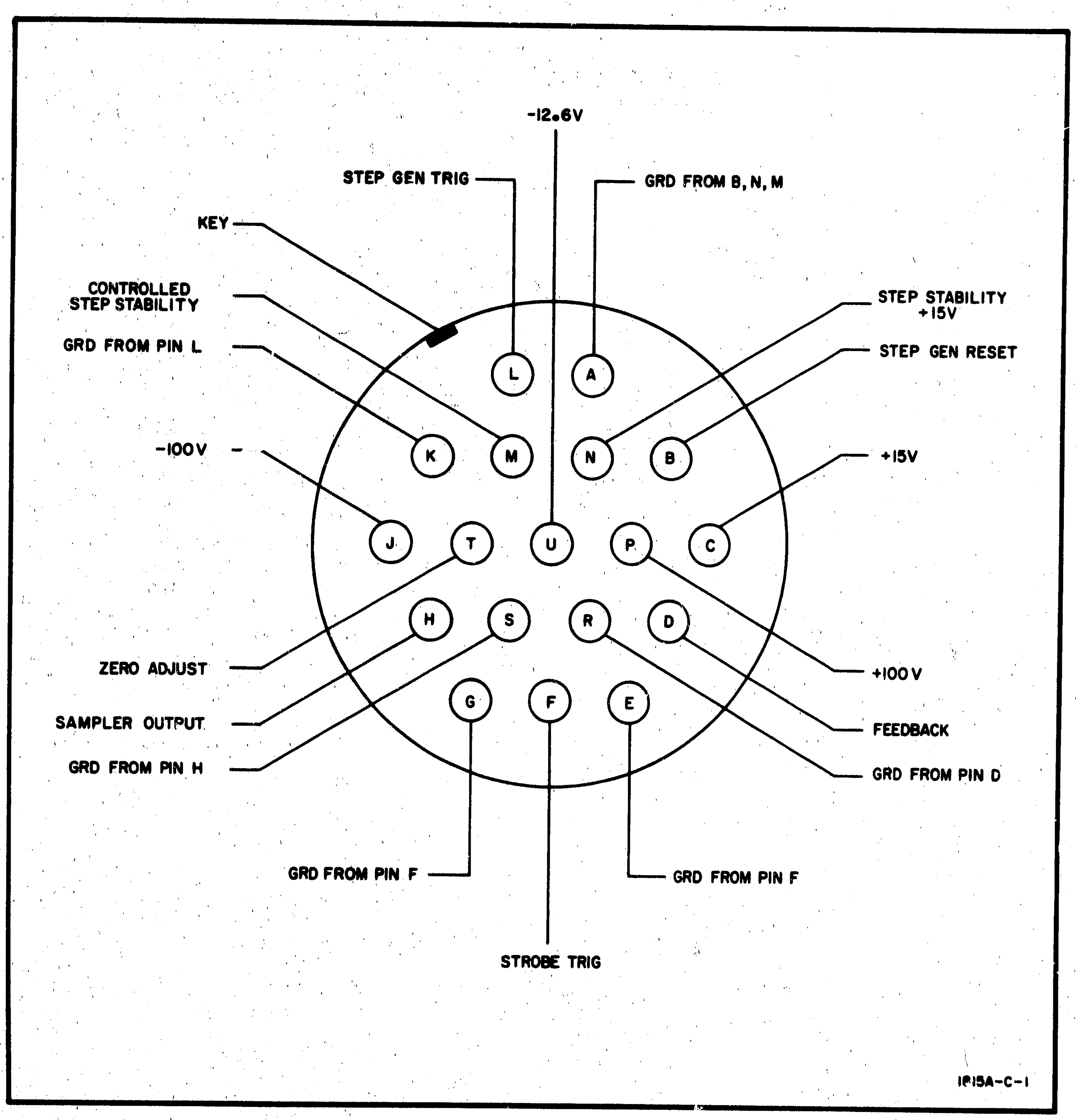
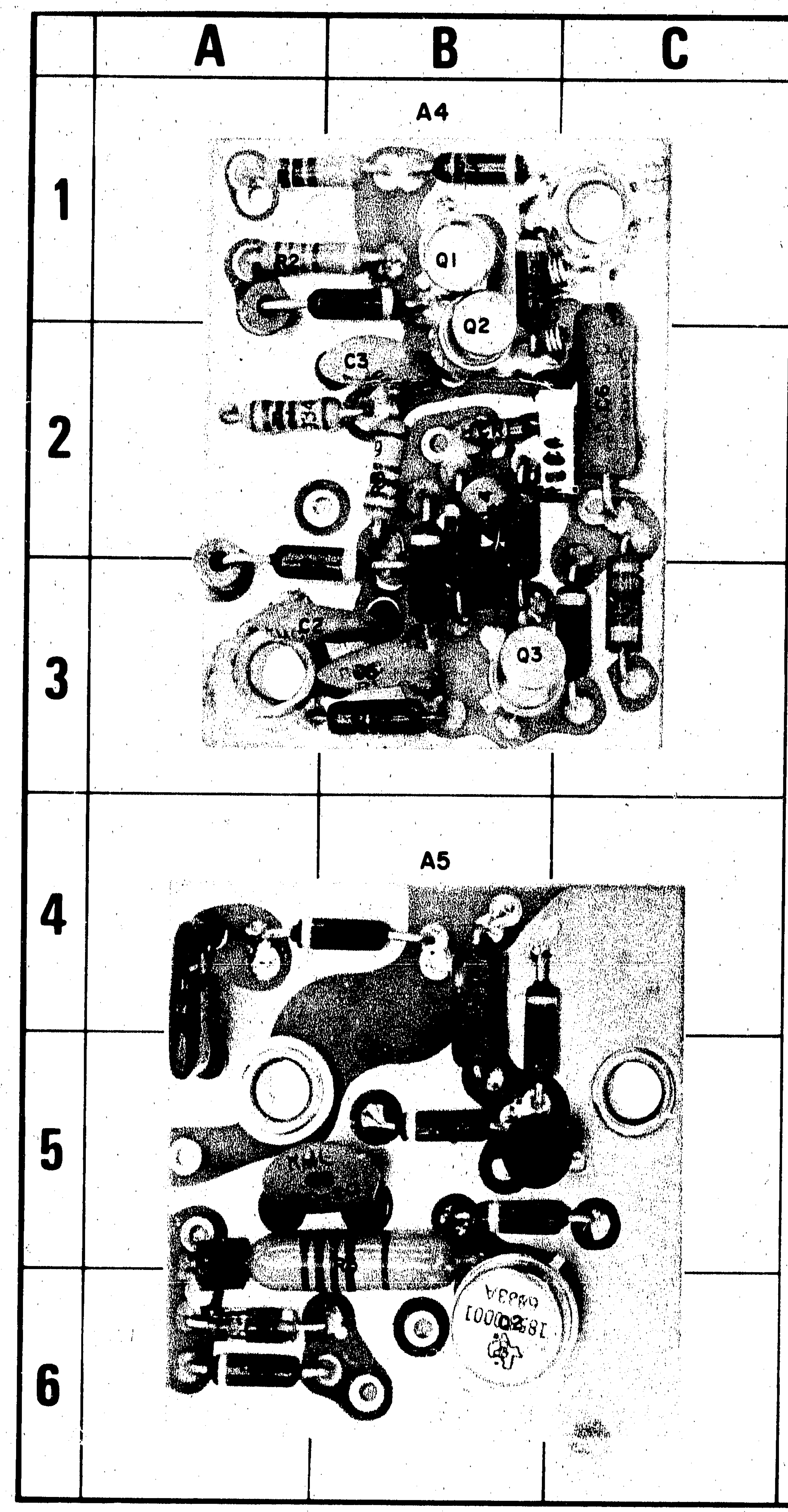


Figure 8-34. Sampler Cable Schematic



REF DESIG	GRID LOC	REF DESIG	GRID LOC
C2	A-3	R1	A-1
C3	B-2	R2	A-1
C4	B-2	R3	B-1
C5	B-2	R4	A-3
C6	C-2	R5	B-1
CR1	B-2	R6	B-1
CR2	B-1	R7	A-2
L4	B-2	R8	B-2
L5	B-3	R9	B-2
L7	C-3	R10	B-2
Q1	B-1	R11	B-3
Q2	B-2	R12	C-3
Q3	B-3	VR1	B-3

REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	A-4	R1	B-4
C2	B-4	R2	B-5
C3	A-5	R3	B-4
CR1	A-6	R4	B-5
L1	A-5	R5	B-5
Q1	B-5	R6	A-6
Q2	B-6		

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Figure 8-35. Step Generator and Power Source Assemblies A4 and A5 Parts Locations

DC VOLTAGE MEASUREMENT CONDITIONS

FUNCTION .... TRIG+	MANUAL/DENSITY .... Full ccw
NSEC/DIV 1	TRIGGER LEVEL .... 2 o'clock
VOLTS/DIV 5	
NORM, SIGNAL AVG .... NORM	SCAN .... NORMAL

WAVEFORM MEASUREMENT CONDITIONS

Square-wave Generator .... 0.5 V at 500 MHz square wave to remote sampler INPUT. Terminate remote sampler OUTPUT into 50 ohms. Trigger output to 1815A trigger input connector using 20-dB pad.

1815A

FUNCTION .... -TRIG	MANUAL/DENSITY .... Full cw
NORM, SIGNAL AVG .... NORM	TRIGGER LEVEL .... stable display
VOLTS/DIV 1	MARKER ZERO .... Full ccw
NSEC/DIV 100	MARKER POSITION .... Full ccw
SCAN .... NORMAL	

Exceptions to these settings are noted by each applicable waveform.

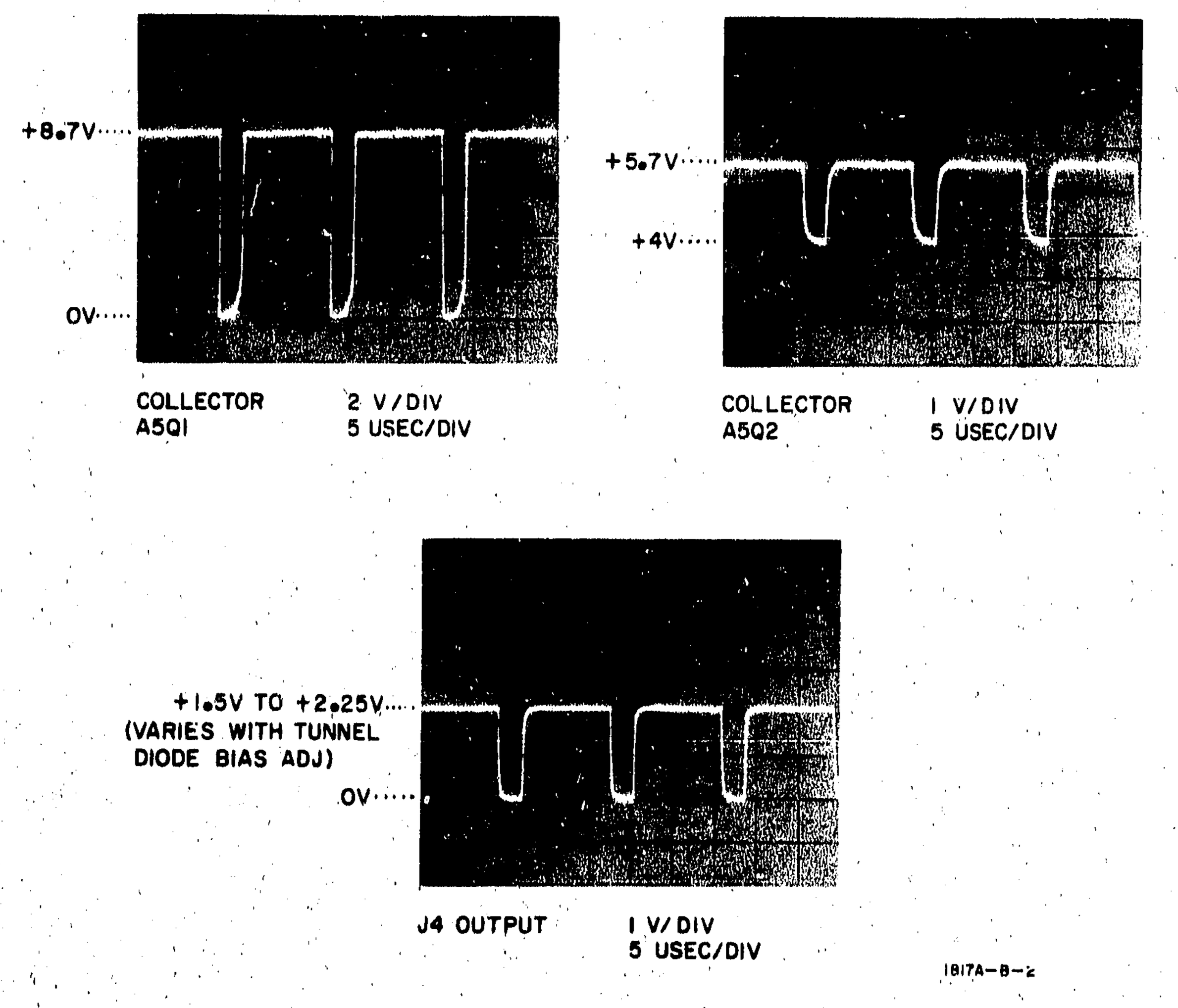
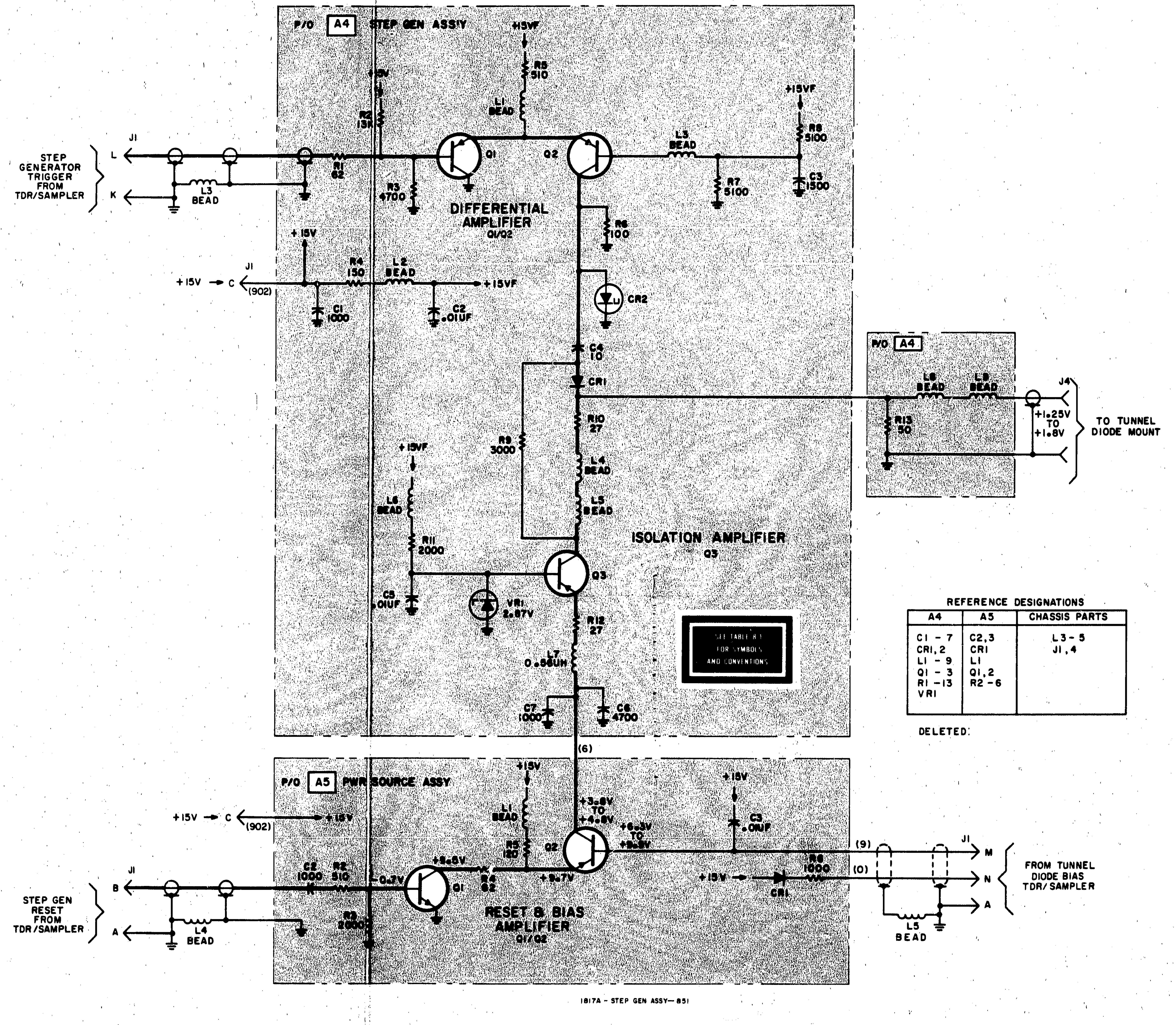


Figure 8-36. Step Generator Measurements



REFERENCE DESIGNATIONS

A4	A5	CHASSIS PARTS
C1 - 7 CR1,2 L1 - 9 Q1 - 3 R1 -13 VR1	C2,3 CR1 L1 Q1,2 R2 -6	L3 - 5 J1,4

DELETED:

Figure 8-37. Step Generator Schematic

CRT

OVERLAY

IMPEDANCE OVERLAYS

50-OHM SYSTEM
75-OHM SYSTEM

IMPEDANCE CONVERSION OVERLAYS

FOR

TDR (TIME-DOMAIN REFLECTOMETER/SAMPLER)

The enclosed set of CRT overlays may be used with the HP TDR to obtain direct impedance indications in 50-ohm or 75-ohm devices or systems. Proceed as follows:

1. Calibrate TDR.

   a. For TDR of 50-ohm system, calibrate according to procedure in Section III of operating and service manual.

   b. For TDR of 75-ohm system calibrate according to procedure in operating note for 75-ohm adapter.

2. Make required connections and instrument settings. Note selected ρ/division and select corresponding impedance overlay (value of ρ, reflection coefficient, appears at top of overlay).

3. Place selected overlay on face of CRT. Use index marks to position overlay at center and along horizontal and vertical axes of graticule. (Cut overlay to fit CRT face.)

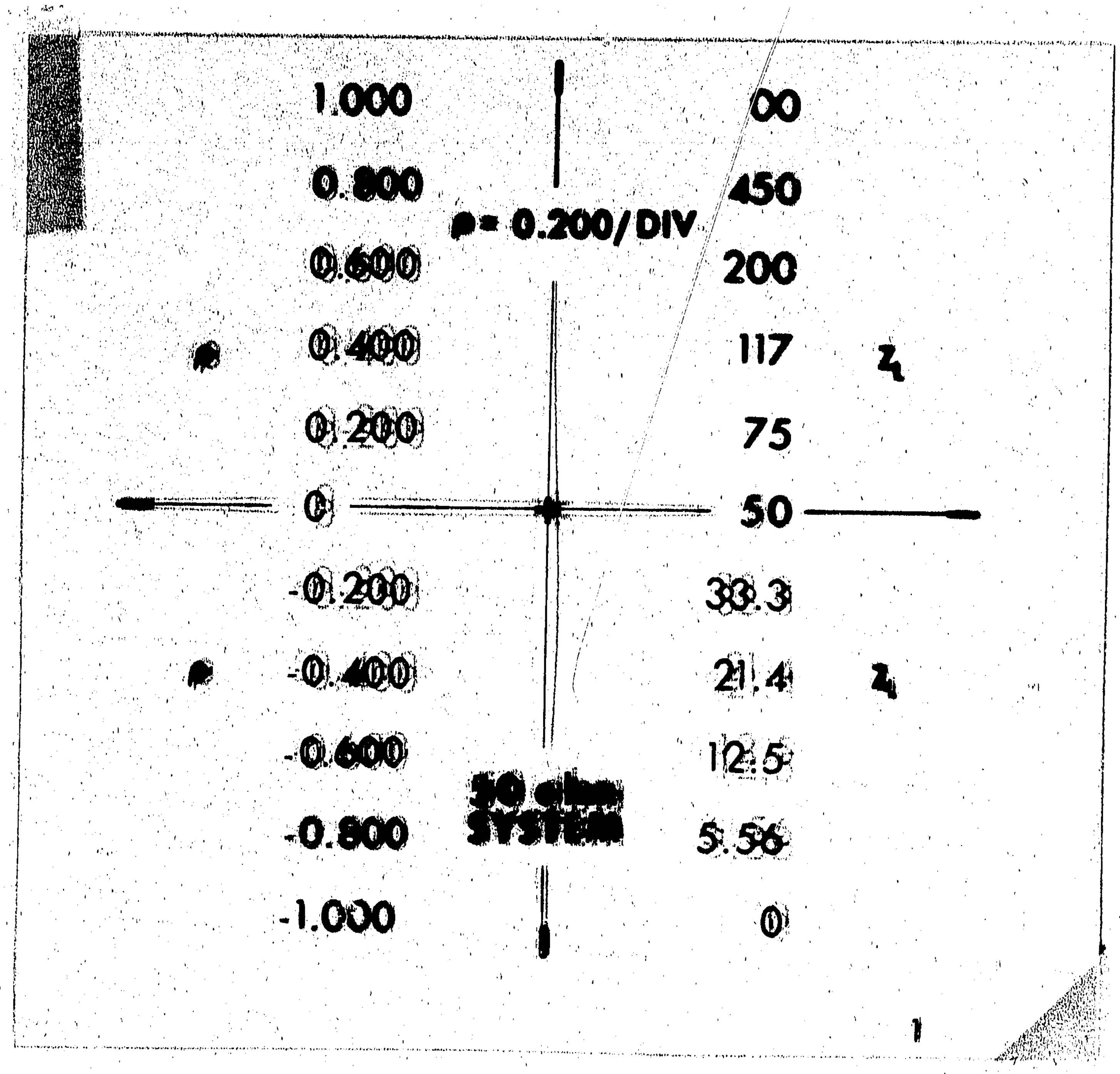
   Note

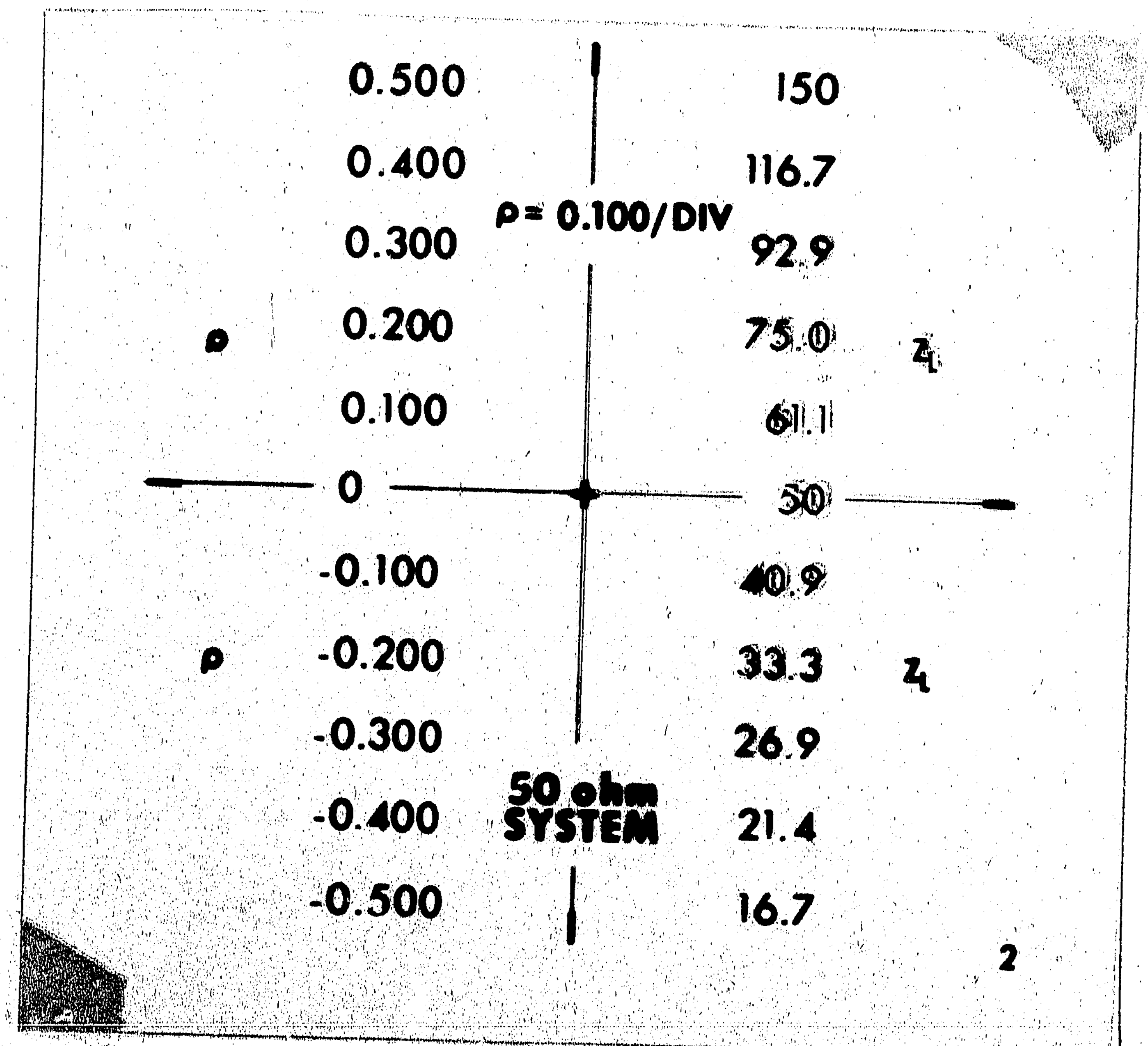
   Values indicated for ρ and Z_L have been located on the overlay to compensate for parallax when taking pictures.

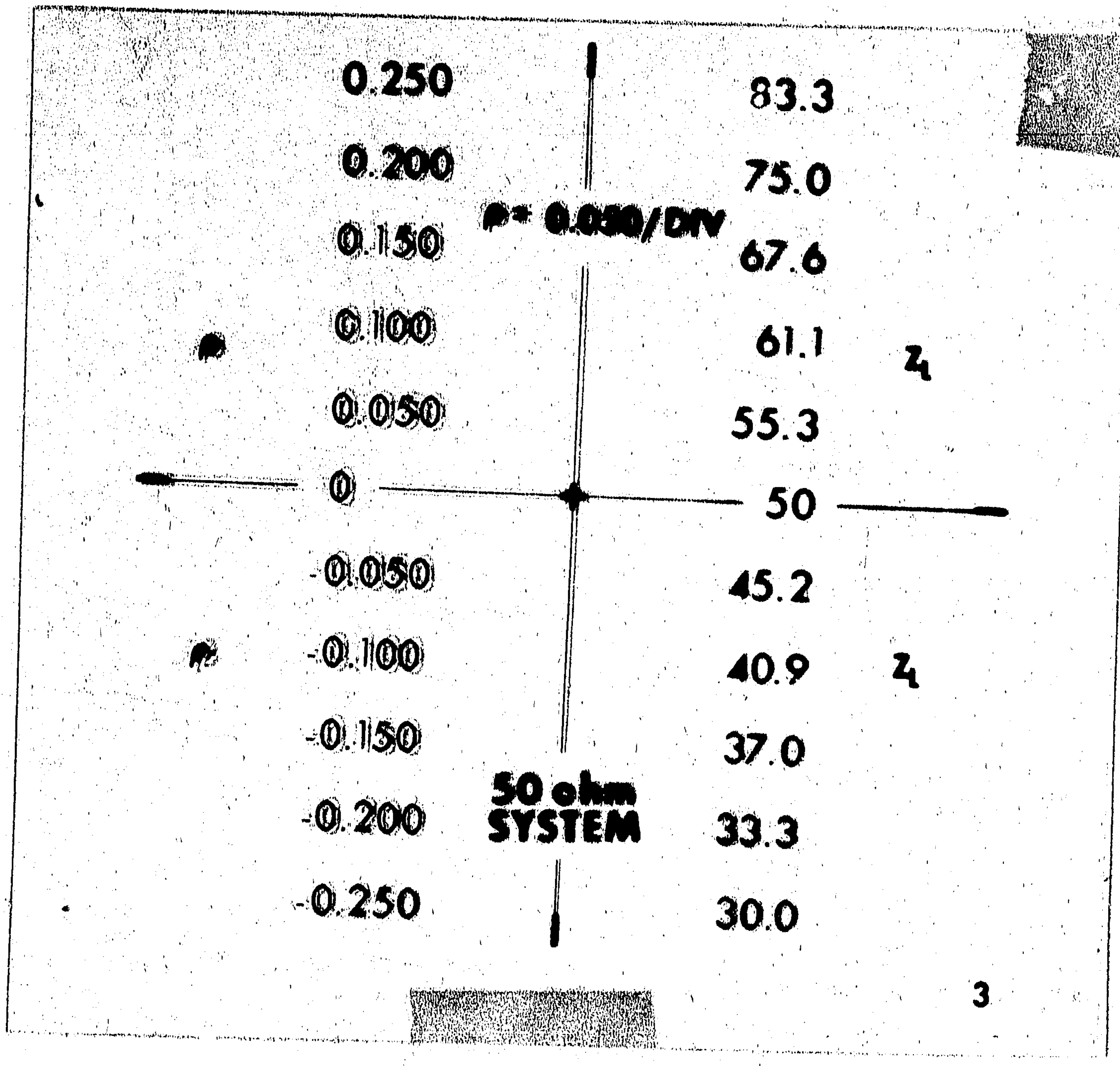
4. Position display with 50-ohm or 75-ohm reference line at center of overlay.

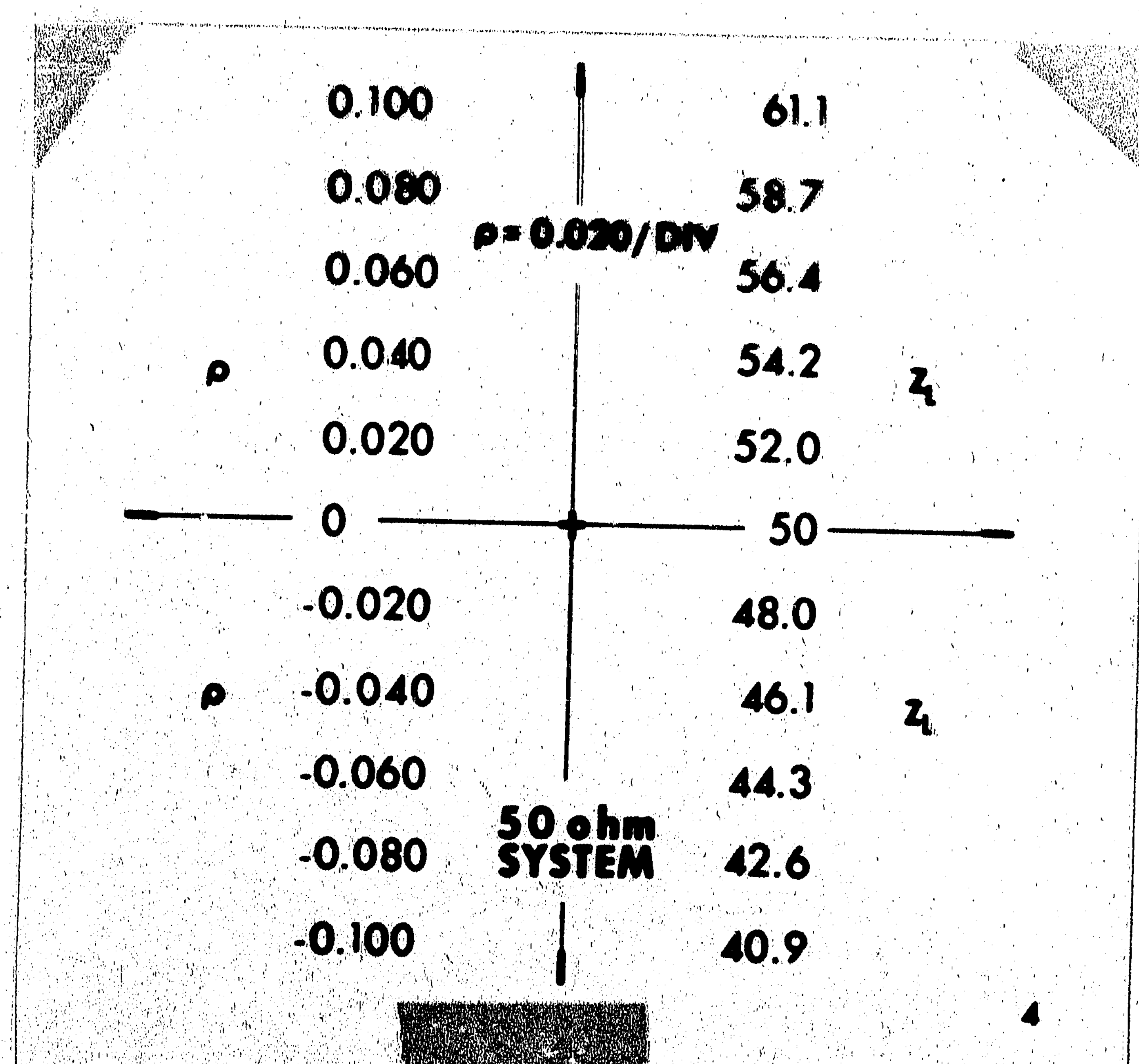
5. Note magnitude of disturbance on display and read impedance value, Z_L, from right-hand column on overlay. Corresponding value of reflection coefficient appears in left-hand column.

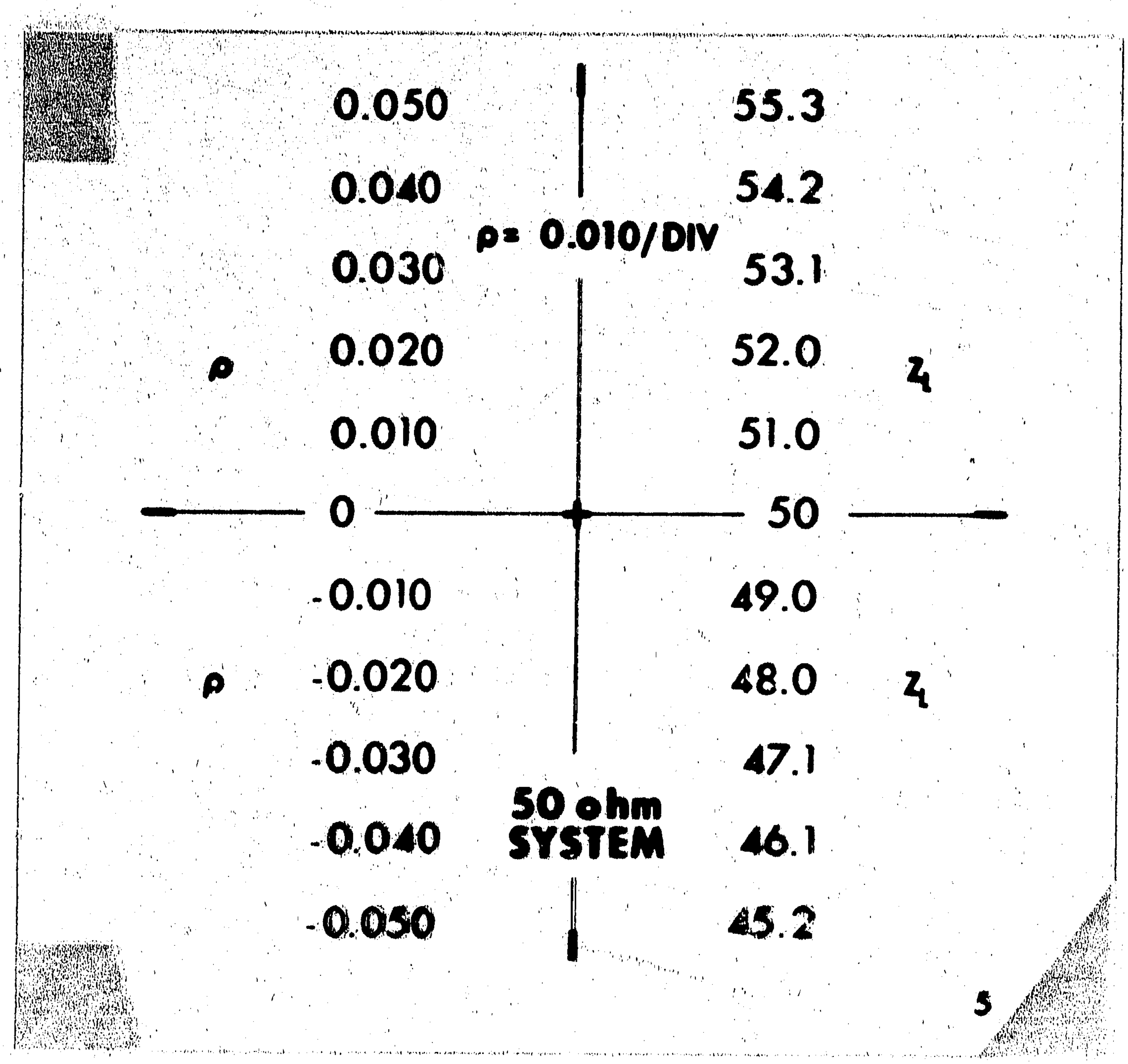
HP Part Number: 01815-90007

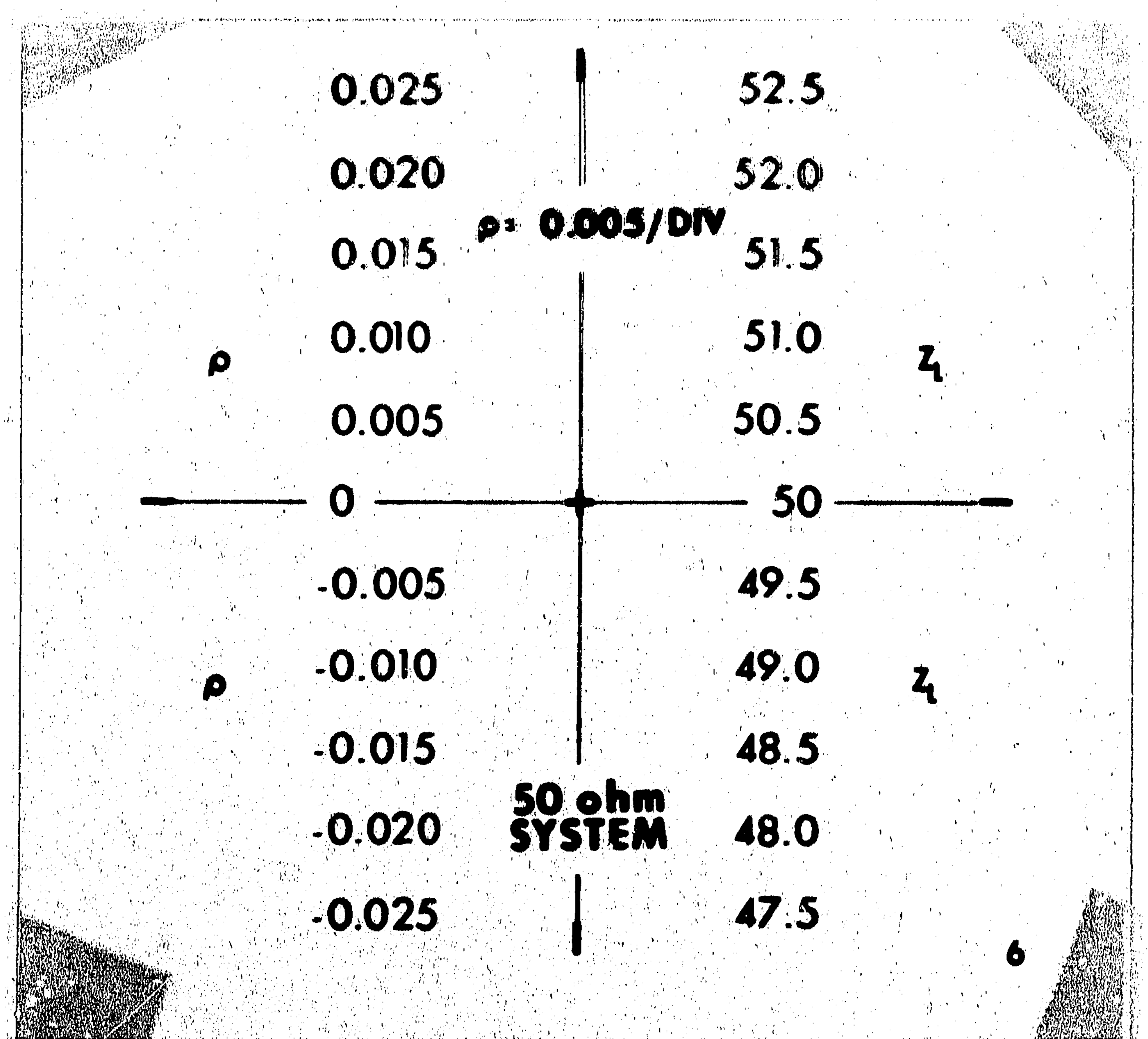

1.000
0.800
0.600
0.400
0.200
0
-0.200
-0.400
-0.600
-0.800
-1.000
ρ = 0.200/DIV
ρ
ρ
00
450
200
117
75
50
33.3
21.4
12.5
5.56
0
Z_L
Z_L
50 ohm SYSTEM
1

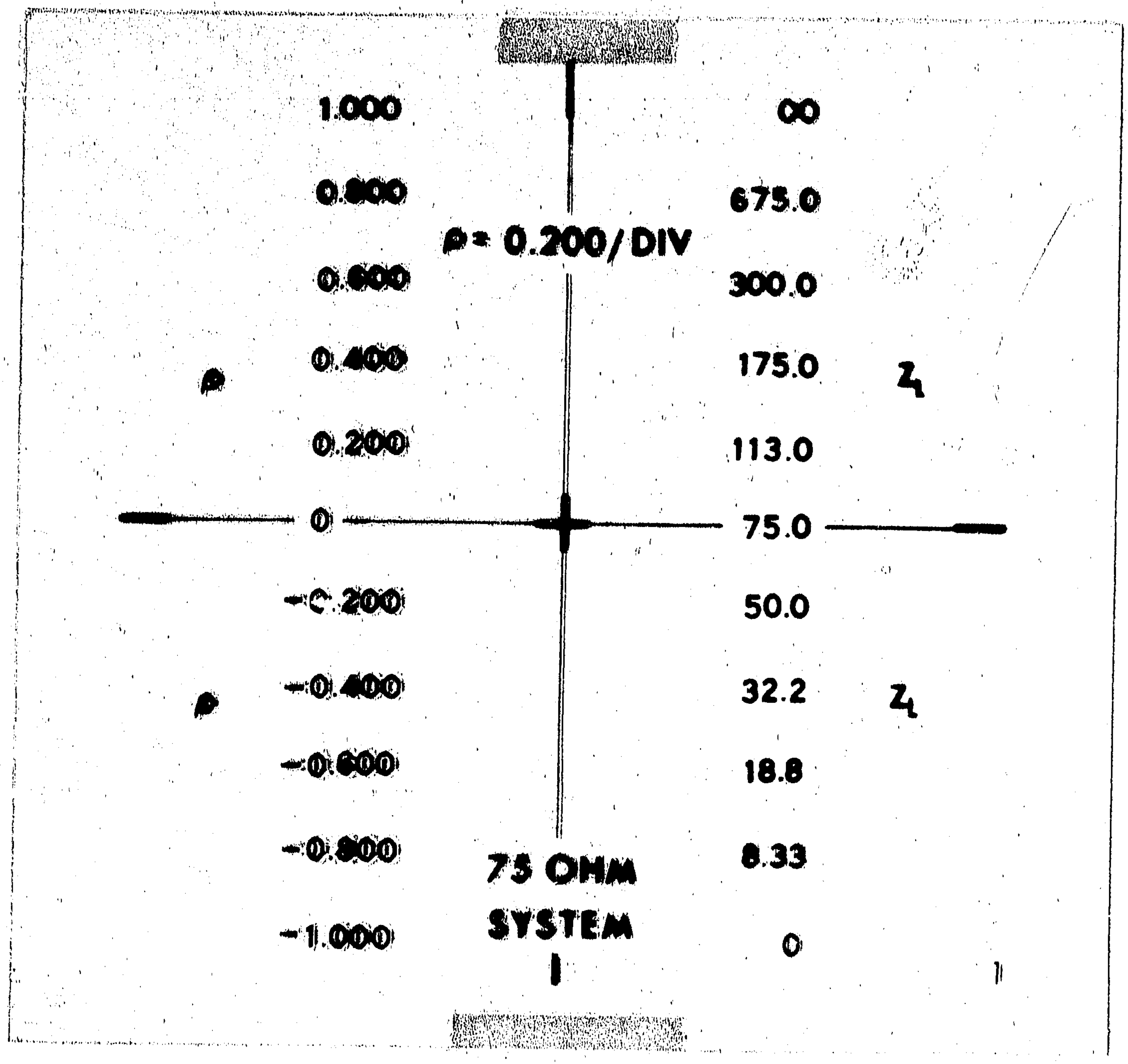

0.500
0.400
0.300
0.200
0.100
0
-0.100
-0.200
-0.300
-0.400
-0.500
ρ = 0.100/DIV
ρ
ρ
150
116.7
92.9
75.0
61.1
50
40.9
33.3
26.9
21.4
16.7
Z_L
Z_L
50 ohm SYSTEM
2


0.250
0.200
0.150
0.100
0.050
0
-0.050
-0.100
-0.150
-0.200
-0.250
ρ
ρ
ρ = 0.050/DIV
50 ohm SYSTEM
83.3
75.0
67.6
61.1
55.3
50
45.2
40.9
37.0
33.3
30.0
Z_L
Z_L
3

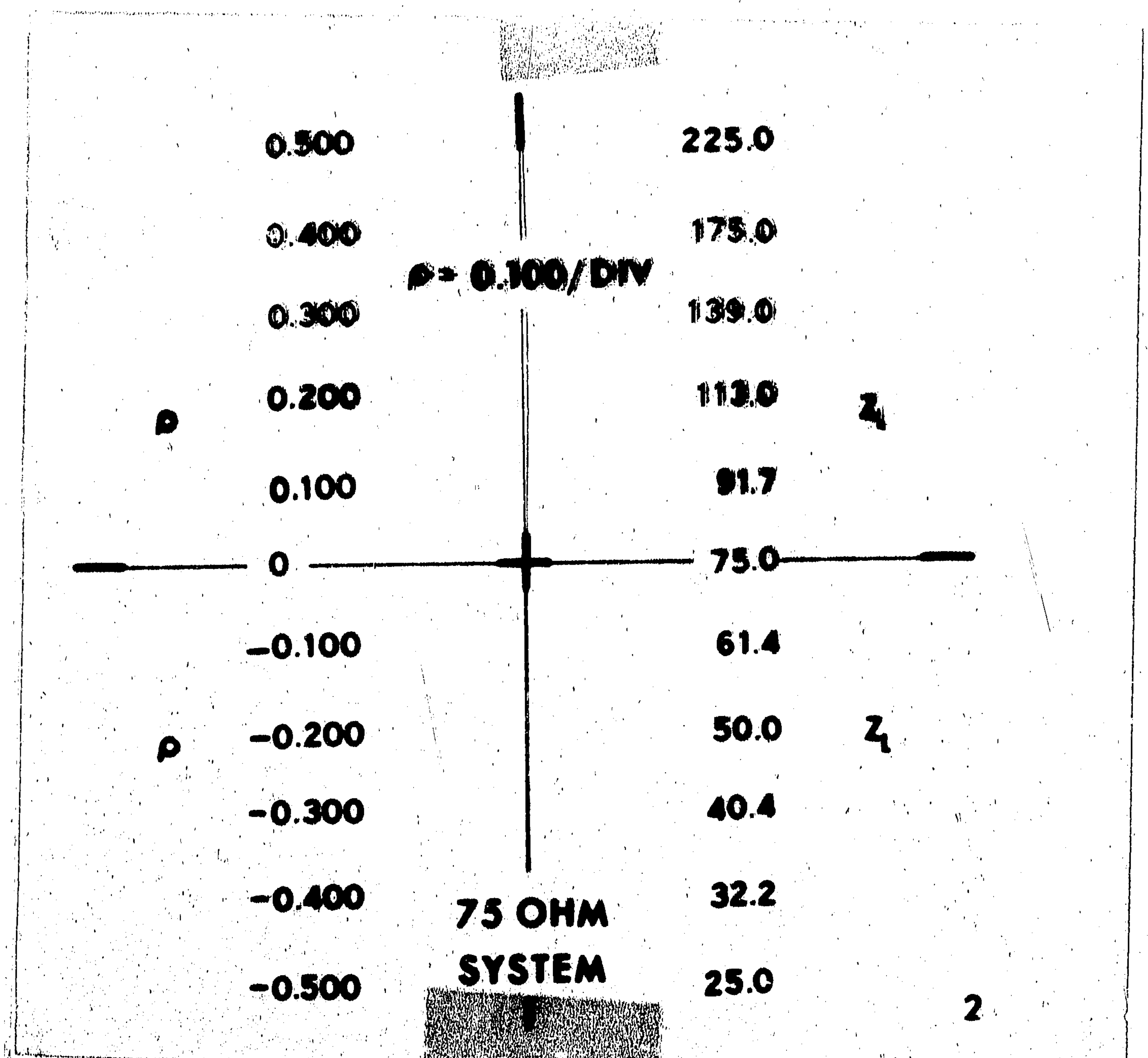

0.100
0.080
0.060
0.040
0.020
0
-0.020
-0.040
-0.060
-0.080
-0.100
ρ
ρ
ρ = 0.020/DIV
50 ohm SYSTEM
61.1
58.7
56.4
54.2
52.0
50
48.0
46.1
44.3
42.6
40.9
Z_L
Z_L
4


0.050
0.040
0.030
0.020
0.010
0
-0.010
-0.020
-0.030
-0.040
-0.050
ρ
ρ
ρ= 0.010/DIV
50 ohm
SYSTEM
55.3
54.2
53.1
52.0
51.0
50
49.0
48.0
47.1
46.1
45.2
Z_L
Z_L
5

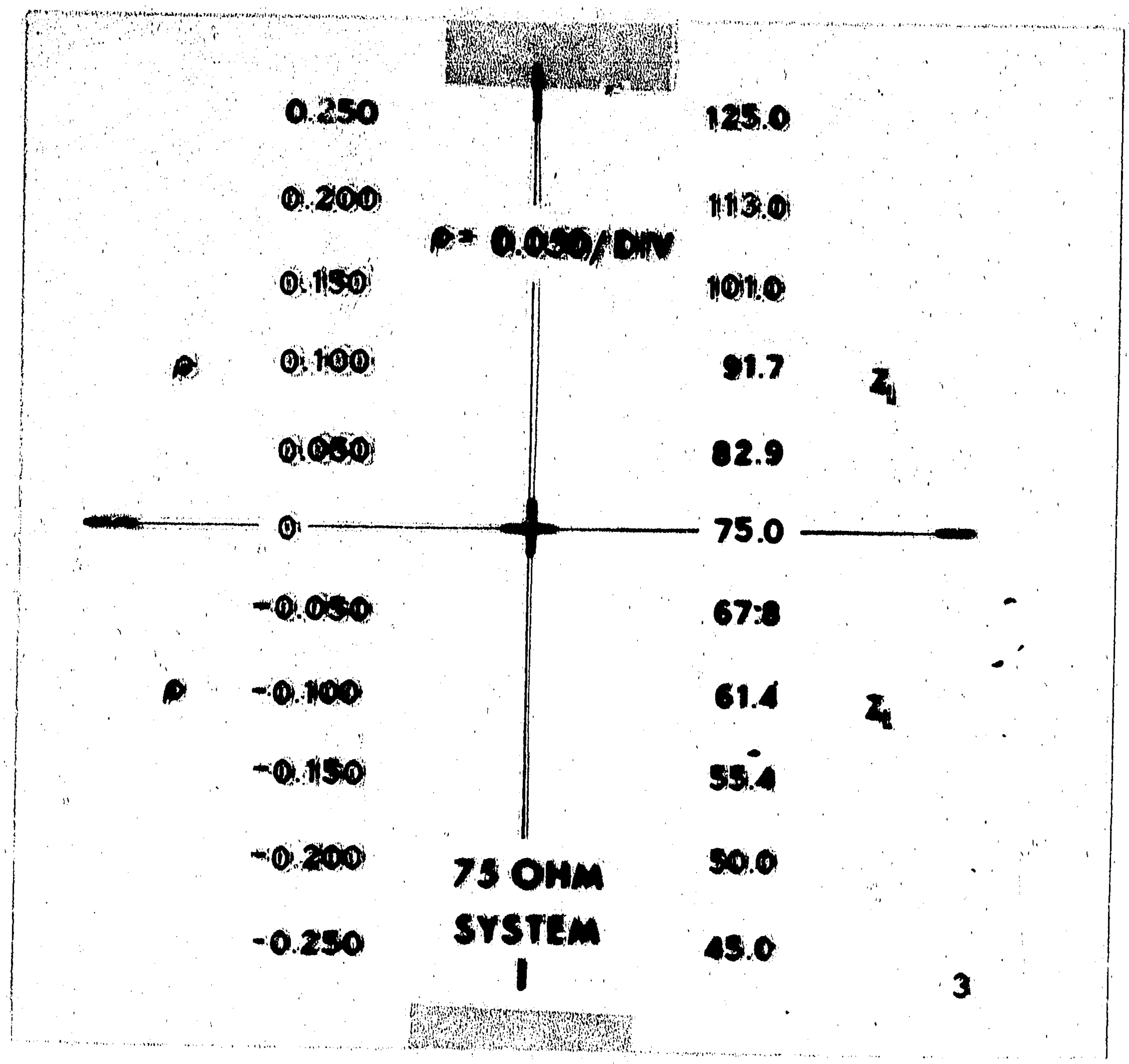

0.025
0.020
0.015
0.010
0.005
0
-0.005
-0.010
-0.015
-0.020
-0.025
ρ
ρ
ρ= 0.005/DIV
50 ohm
SYSTEM
52.5
52.0
51.5
51.0
50.5
50
49.5
49.0
48.5
48.0
47.5
Z_L
Z_L
6

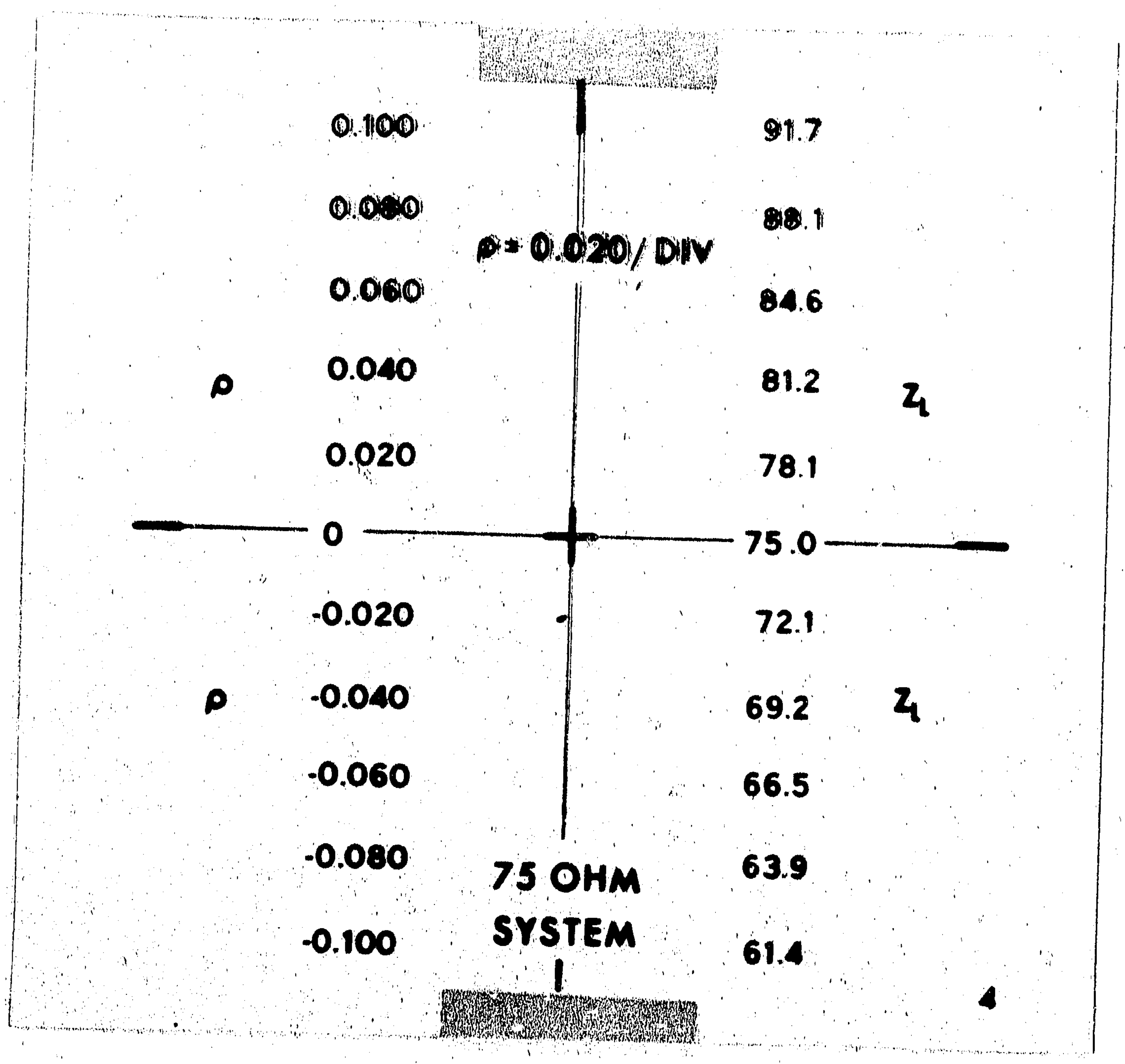


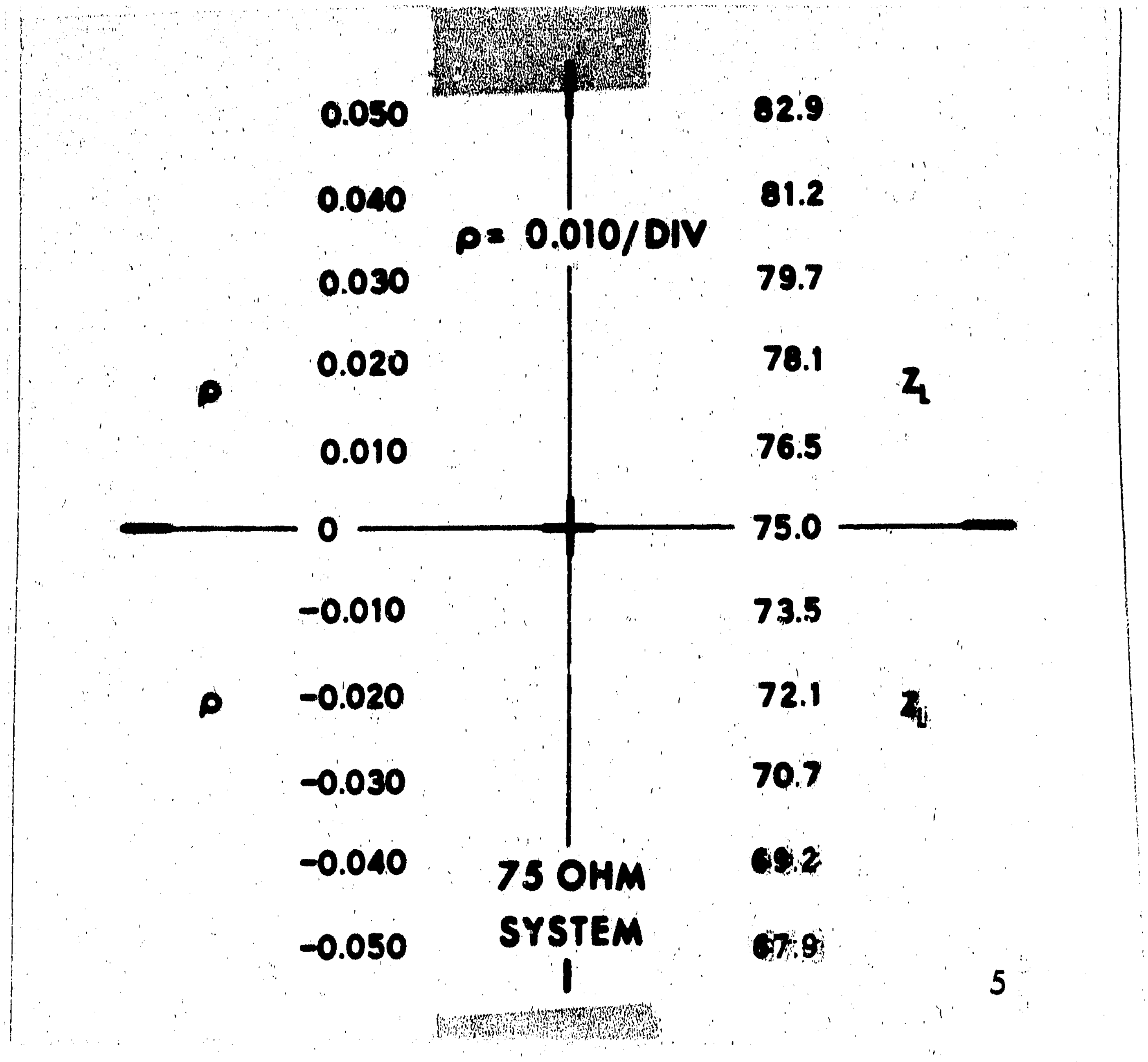
1.000
0.800
0.600
0.400
0.200
0
-0.200
-0.400
-0.600
-0.800
-1.000
ρ
ρ
ρ= 0.200/DIV
75 OHM
SYSTEM
∞
675.0
300.0
175.0
113.0
75.0
50.0
32.2
18.8
8.33
0
Z_L
Z_L

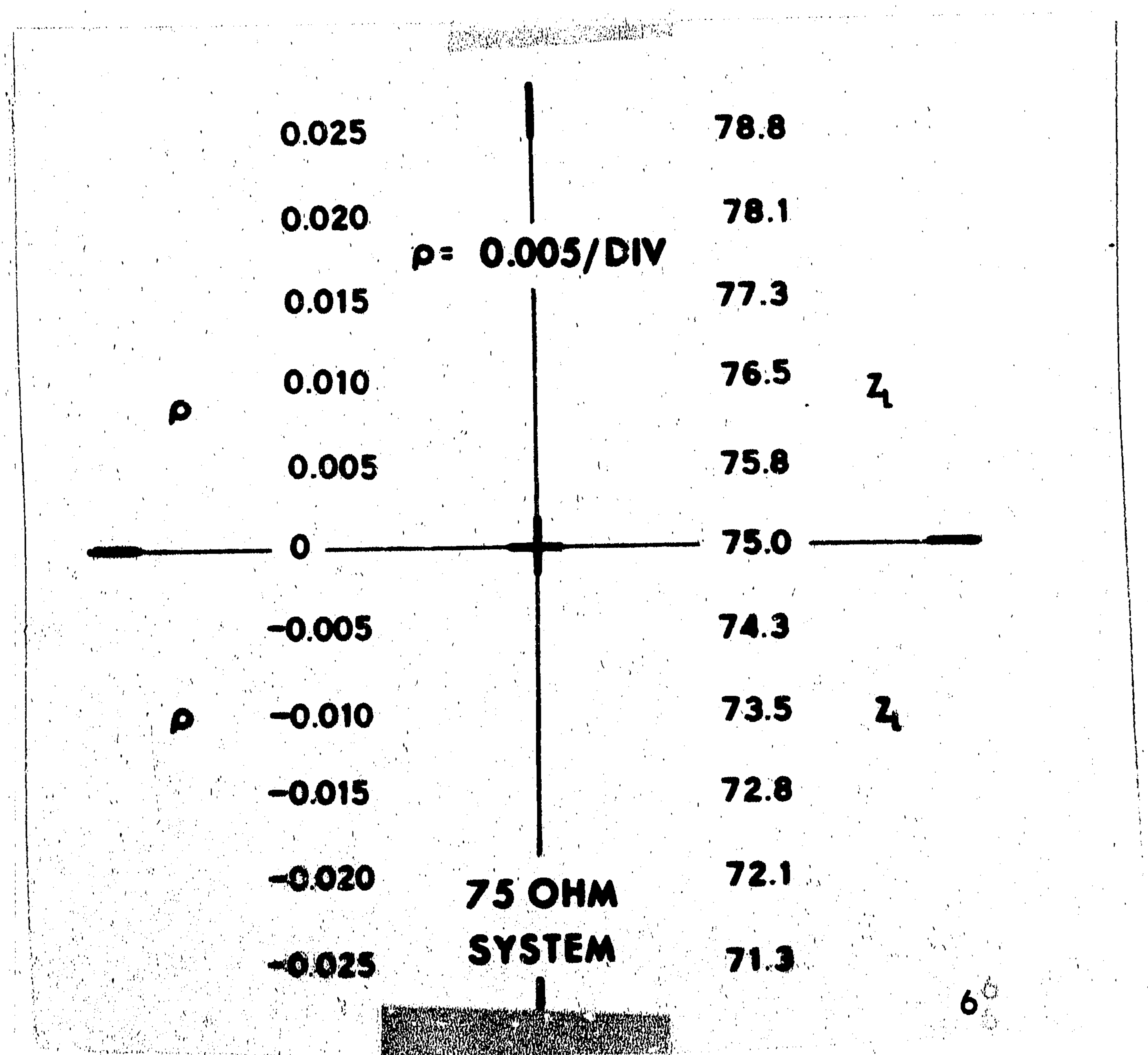


0.500
0.400
0.300
0.200
0.100
0
-0.100
-0.200
-0.300
-0.400
-0.500
ρ
ρ
ρ= 0.100/DIV
75 OHM
SYSTEM
225.0
175.0
139.0
113.0
91.7
75.0
61.4
50.0
40.4
32.2
25.0
Z_L
Z_L


ρ = 0.050/DIV
ρ
0.250
0.200
0.150
0.100
0.050
0
-0.050
-0.100
-0.150
-0.200
-0.250
Z_L
125.0
113.0
101.0
91.7
82.9
75.0
67.8
61.4
55.4
50.0
45.0
75 OHM
SYSTEM
3


ρ = 0.020/ DIV
ρ
0.100
0.080
0.060
0.040
0.020
0
-0.020
-0.040
-0.060
-0.080
-0.100
Z_L
91.7
88.1
84.6
81.2
78.1
75.0
72.1
69.2
66.5
63.9
61.4
75 OHM
SYSTEM
4


ρ= 0.010/DIV
ρ
0.050
0.040
0.030
0.020
0.010
0
-0.010
-0.020
-0.030
-0.040
-0.050
Z_L
82.9
81.2
79.7
78.1
76.5
75.0
73.5
72.1
70.7
69.2
67.9
75 OHM SYSTEM
5


ρ= 0.005/DIV
ρ
0.025
0.020
0.015
0.010
0.005
0
-0.005
-0.010
-0.015
-0.020
-0.025
Z_L
78.8
78.1
77.3
76.5
75.8
75.0
74.3
73.5
72.8
72.1
71.3
75 OHM SYSTEM
6

MANUAL CHANGES

MANUAL CHANGES

MANUAL IDENTIFICATION

Model Number:	1815A/1815B/1817A
Date Printed:	Jan 1969
Part Number:	01817-90901

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

To use this supplement:

Make all ERRATA corrections.

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

Serial Prefix or Number	Make Manual Changes
939– (1815B) 941– (1815A)	1
978–, 979– (1815A)	1, 2, 3
1114A (1815A)	1 thru 4
1114A00366-90 (1815A) 1130A (1815A)	1 thru 5
1241A (1815B)	1, 2, 4, 5, 7
1318A (1815B)	1, 2, 4, 5, 7, 8

Serial Prefix or Number	Make Manual Changes
975–, 976– (1815B)	1, 2
1117A (1815B)	1, 2, 4
1139A (1815B)	1, 2, 4, 5
1241A (1815A)	1 thru 6
1313A (1815A)	1 thru 6, 8
1501A (1815A)	1 thru 6, 8, 9

▲ NEW ITEM

ERRATA

Page 3-3,

Add following paragraph immediately after paragraph 3-19:

3-19A. INSTRUMENT COMPATIBILITY.

3-19B. Model 1815A marker dot may have excessive display intensity and burn the CRT when installed in 181-series or 183-series oscilloscope mainframes. To avoid burning the CRT in these mainframes, turn the marker dot off by removing Model 1815A from the oscilloscope and setting the NORM/OFF switch (S1 on board assembly A1) to OFF. When Model 1815A is used in other mainframes, reset NORM/OFF to NORM for use of the marker dot.

Insert the following between paragraph 3-20 and paragraph 3-21:

CAUTION

The HP warranty is void for any Model 1106A Tunnel-diode Pulse Generator damaged by mistreatment. When using the Model 1815/1817 Sampler Group with the Model 1106A for TDR applications, perform the following procedures exactly. Prior to connecting the Model 1106A, set the Model 1815A front-panel TUNNEL DIODE BIAS control fully counterclockwise. Connect the Model 1106A.

NOTE

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

23 November 1976
17 Pages

HEWLETT PACKARD

Printed in U.S.A.

ERRATA (Cont'd)

CAUTION (Cont'd)

With the horizontal scale unexpanded, slowly adjust TUNNEL DIODE BIAS clockwise until a step just appears. Stop adjustment of TUNNEL DIODE BIAS. Continued clockwise adjustment of TUNNEL DIODE BIAS will cause the Model 1106A to remain in the high voltage state. Operation of the diode in the high voltage state for more than a brief period will destroy the diode.

▲ **Page 3-3,**
In figure 3-2, delete "50 OHM LOAD".

Page 3-3, paragraph 3-25,
Replace Note with following:

NOTE

Two sets of overlays are included in an envelope inside the rear cover of this manual. These overlays allow direct interpretation of displays from 50-ohm and 75-ohm systems. The overlays are prepared for use on all 180-series mainframes except Model 182C. If impedance overlays are desired for the larger CRT of Model 182C, order HP Part No. 01815-90902.

Page 3-4,
Replace paragraph 3-30 with the following:

3-30. Due to Internal circuit delays, the oscilloscope must be triggered before application of the pulse to be observed. The actual delay required varies with the setting of the NSEC/DIV switch. Refer to table 3-1 for the approximate delay required for each switch setting. When triggering on a sine-wave input, the delay may not be necessary because the signal is repetitive.

Table 3-1. Trigger Delay

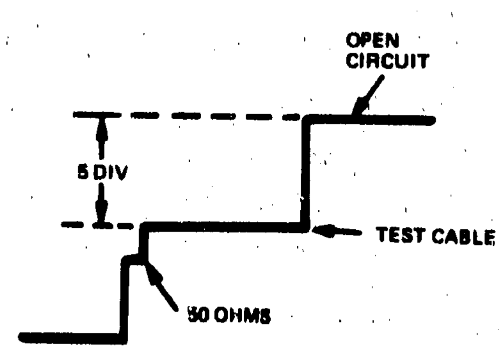
NSEC/DIV Range	Delay in ns approx.
1	60
10	70
100	250
1K	2000

▲ **Page 3-6, figure 3-4,**
Add the following note after step 5:

NOTE

Use steps 1 through 5 for vertical axis calibration when the transition from the different impedance to 50 ohms is through an active probe (such as the HP Model 1120A).

In step 9, change figure as shown below:



ERRATA (Cont'd)

▲ Page 3-6, figure 3-4 (Cont'd),
Insert before step 10:
To make VOLTS/DIV calibration of the vertical axis, proceed as follows:
In step 10 add following:
Set FUNCTION to TRIG+.

▲ Page 4-13, paragraph 4-123,
Change A7CR1 to A7C1 and A7CR2 to A7C2.

▲ Page 4-13, paragraph 4-126,
Change last sentence to:
Capacitor C3 (screw on chassis) is adjusted for minimum low-frequency distortion.

▲ Page 5-0, table 5-1,
Tunnel-diode Pulse Generator: Add HP 1105A.
Square-wave Generator: Delete HP 222A, Add HP 8011A.
Monitor Oscilloscope: Delete 140A, 1421A, 1402A, 180A, 1820A, and 1801A. Add 1740A.
DC VTVM HP412A: Change to HP 3465A.
Signal Generator: Change HP 608D to HP 608E.
Time-mark Generator: Change to HP 226A.
Power Divider: Add HP 11549A.

Page 5-2, table 5-3,
Change the deflection requirements to 8 div ±5% for the .01 and .005 VOLTS/DIV settings.

▲ Page 5-3, table 5-4,
For 1K NSEC/DIV, 200 EXPAND, Change time-mark Generator setting to .2 μSEC, deflection to 1 mark.

Page 5-4, paragraph 5-12,
Change steps n and p to read as follows:
n. Set the FUNCTION switch to AIR. The horizontal length of the line should be 50% for 1815A and 15% for 1815B of the length obtained in the TIME position.
p. Set the FUNCTION switch to POLY. The horizontal length of the line should be 33% for 1815A and 10% for 1815B of the length obtained in the TIME position.

▲ Page 5-5, figure 5-5,
Change square-wave generator to signal generator.

▲ Page 5-5, paragraph 5-19a,
Delete: TUNNEL DIODE BIAS . . . . mid-range; ρ/DIV and VOLTS/DIV CAL pots . . . mid-range.

Page 5-5 and 5-6,
Delete: Paragraph 5-19d and 5-19e.
▲ Paragraph 5-19g: Change 400 ns to 320 ns.
▲ Paragraph 5-20,
Add following NOTE:

NOTE

This step is not required if it is possible to get a pulse on screen when a tunnel diode mount and a 50-ohm load are connected to the sampler input and output respectively.

▲ Paragraph 5-20a,
Add: Set the signal generator to provide a sine wave of approximately 140 mV at a frequency between 100 MHz and 450 MHz.

Page 5-6, figure 5-7,
C1: Change to C3.
A3C5: Change to A3C6.

▲ Figures 5-9, 5-11, 5-12, and 5-19,
Replace with figures supplied with this supplement.

▲ Page 5-7, paragraph 5-22,
Add following after 5-22i:
ia. Adjust BIAS ADJ potentiometer A2R1 in remote sampler for maximum sampling efficiency (maximum dot separation). If the trace breaks up or saturates and the trace goes off screen, readjust SMOOTH potentiometer to maintain slightly greater than 100% sampling efficiency as shown in top waveform of figure 5-11.

ERRATA (Cont'd)

▲ Page 5-8,
Change paragraph 5-24a to read:
a. Connect TUNNEL DIODE MOUNT to the remote sampler INPUT.
Delete paragraph 5-24b.
Change paragraph 5-24c to read:
c. Set FUNCTION switch to TRIG+.
Change paragraph 5-24g to read:
g. Adjust capacitor C3 (machine screw) in the remote sampler for a display of pulse shape most like point B in figure 5-12. Do not run the screw in to where it breaks the pickoff assembly. Adjust A3C6 for a display of pulse shape most like point A in figure 5-12. Repeat these adjustments to minimize interaction and achieve <3% rounding of pulse top.

▲ Page 5-9, paragraph 5-26d,
Add "approximately" before −0.3 volt.

▲ Page 5-10, paragraph 5-29,
Change 5-29j. as follows:
j. Set the time-mark generator for 10-ns output.
Delete 5-29n.
Change 5-29p. as follows:
p. Set the time-mark generator for 2-ns output.

▲ Page 5-10, paragraph 5-30,
Delete step b.

▲ Page 5-12,
Paragraph 5-34m: Perform this step after disconnecting the test power supply (Paragraph 5-34u).

▲ Page 5-12a, Performance Check Record,
Under Para. Ref.:
Change 5-8 to 5-7, 5-13 to 5-12, 5-14 to 5-13, 5-17 to 5-16, 5-18 to 5-17.

Page 6-2, table 6-2,
A2: add to description (1815A only).
ADD: A2, HP Part No. 01815-66506, A: board assy, horizontal (1815B only).
Add: J2, HP Part No. 1250-0102, 1, J: BNC (input).
R5: Change to HP Part No. 2100-2488, R: var comp 10 k ohms 20% 1/2W.
Add: R12; HP Part No. 0757-0834; 1; R: fxd metflm 5620 ohms 1% 1/2W.

Page 6-3, table 6-2,
Change HP Part No. 01815-67408 to 00180-67402, A: Knob assy: trig level, hold off.

Page 6-4, table 6-2,
Add: CR18, HP Part No. 1901-0040, CR: Si.
Add: CR19, HP Part No. 1901-0040, CR: Si.

Page 6-5, table 6-2,
Q12, Q13, Q14, Q15: Change to HP Part No. 1854-0234, Q: Si npn.

▲ Page 6-6, table 6-2,
A1R35: Change to HP Part No. 2100-3162, R: var trmr 200K 10% C SIDE-ADJ.
A1R49: Change to HP Part No. 0757-0946, R: fxd metflm 8.2K ohms 2% 1/8W.

Page 6-7, table 6-2,
A2C3: Change to HP Part No. 0160-2306, C: fxd mica 27 pF 5% 300 wVdc.

Page 6-8, table 6-2,
C34: Change to HP Part No. 0140-0196, C: fxd mica 150 pF 5% 300 wVdc.
CR1: Change HP Part No. to 1901-0535.
CR2: Change HP Part No. to 1901-0535.

Page 6-9,
L9: Change to HP Part No. 9100-2265, L: fxd 10 μH.
L11: Change to HP Part No. 9100-2265, L: fxd 10 μH.

Page 6-14, table 6-2,
CR14: Change to CR: Ge.
Q4: In description, change 2N3904 to 2N3906.

Page 6-19, table 6-2,
R3, 4 for (1815B): Change to R3 (1815B) total quantity 1.
Change: R4 (1815A) to HP Part No. 0698-3410, R: fxd metflm 3160 ohms 1% 1/2W (1815A).
Add: R4, HP Part No. 0698-4174, 1, R: fxd metflm 17.88k ohms 1/2% 1/4W (1815B).
A9R5: Change to HP Part No. 0757-0421; R: fxd metflm 825 ohms 1% 1/8W.

ERRATA (Cont'd)

Page 6-20, table 6-3,
Change W8 description to read:
W: interconnecting cable assy (1817A to 1815A or 1815B).
1400-0024: Change to HP Part No. 1400-0053, Clamp, cable.
Delete: Load, 50-ohm, HP Part No. 909A.

▲ Page 6-22, table 6-3,
A3: Add HP Part No. 01817-66503.
MC1: Change to U1.

Page 6-23, table 6-3,
A3VR2: Change to HP Part No. 1902-0126, VR:breakdown 2.61 V 5%.
A4C3: Change to HP Part No. 0160-2257, C: fxd cer 0.0015 μF 10% 500 wVdc.
A4C4: Change to HP Part No. 0160-2257, C: fxd cer 10 pF 5% 500 wVdc.
A4CR1: Change to HP Part No. 1901-0535, CR: hot carrier.
Delete: Load, 50-ohm, HP Part No. 909A.

Page 6-24, table 6-3,
R5: Change to 510 ohms.

Page 6-25/6-26, table 6-3,
Add the following:
A7, 1901-1010, –, A:Assy block, sampling w/J2, J3
CR1, 1901-0559, 2, CR: sampling (black, top)
CR2, 1901-0558, 1, CR: sampling (clear, bottom)
R3, 0811-2842, –, R: fxd 560 ohms (pick off)

Page 8-3, paragraph 8-24,
Change pick-off resistor to HP Part No. 0811-2842.

▲ Figures 8-4, 8-5, 8-6, 8-11, 8-16, 8-19, 8-22, 8-25, 8-27, 8-32, 8-36:
Replace with figure supplied with this supplement.

▲ Page 8-4, figure 8-3,
Replace with figure 5-9 in this supplement.

Page 8-5,
▲ Paragraph 8-39j: In NOTE, change 2.25 volts to 2.40 volts.
Paragraph 8-39k: Change A5CR1 to A4CR2.
▲ Add the following paragraph to 8-39. STEP TRIGGER AND RESET CIRCUIT.

l. If the 2-volt pulse was observed and it is suspected that the TUNNEL DIODE MOUNT is defective, connect the tunnel diode mount cable (HP Part No. 01817-61603) to J4 of the 1817A and connect the TUNNEL DIODE MOUNT to the other end of the cable. Add the necessary adapters and a 50-ohm feedthrough termination to the output of the TUNNEL DIODE MOUNT. Connect TUNNEL DIODE MOUNT to a 50-MHz oscilloscope. Observe the output waveform shown in figure 8-6A. When the TUNNEL DIODE BIAS on the front panel of the 1815A is set fully CCW, the most positive excursion of the waveform will normally be approximately +60 mV. As the TUNNEL DIODE BIAS is adjusted in a CW direction, you should be able to obtain the waveform in figure 8-6A when the TUNNEL DIODE MOUNT fires. If you can not obtain the waveform in figure 8-6A, the TUNNEL DIODE MOUNT is probably defective.

Page 8-10, figure 8-10,
R1: Change reference designator to R2.
R2: Change reference designator to R1.
▲ Add: CR1 between Q4 and R14 on reverse side of board.

Figures 8-11, 8-16, 8-19, 8-22, 8-25, 8-27, 8-32, 8-36,
Change 500 MHz to read 500 kHz under WAVEFORM MEASUREMENT CONDITIONS.

Page 8-11, figure 8-12,
A8S1: Change VOLTS/DIV settings as follows:
A8R13: .005 to .5
A8R15: .01 to .2
A8R17: .02 to .1
A8R21: .1 to .02
A8R23: .2 to .01
A8R25: .5 to .005
▲ A9S1: Add color code (9) on wire between A8R1 and A9S1.
▲ A9S1: Add color code (0) on wire between A8S1 and TRIG– contact on A9S1.

Page 8-13/8-14, figure 8-15,
Add: CR18 between emitter of Q12 and junction of R47/R48. Connect anode to emitter lead.

ERRATA (Cont'd)

Page 8-13/8-14, figure 8-15 (Cont'd),

Add: CR19 between emitter of Q13 and junction of Q15/A8R27. Connect anode to emitter lead.

A9R5: Change value to 825.

CAL potentiometer R5: Change value to 10k ohms.

Make the change as shown in figure 1 in this supplement.

▲ A1R49: Change value to 8.2K.

▲ Delete (927) color code between A9R5 and A9S1.

▲ Change (97) color code between R3 and A9R5 to (98).

Page 8-13/8-14, figure 8-15,

▲ Add (904) color code between R4 and A9S1.

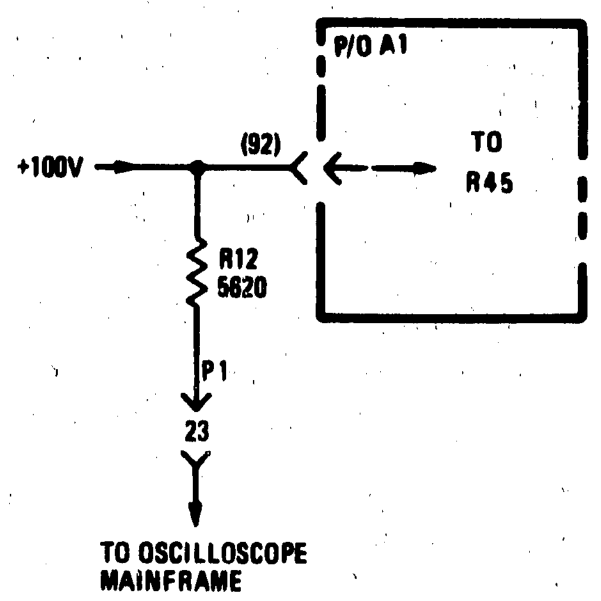


Figure 1

▲ Figures 8-17, 8-20, 8-23, 8-26, 8-33, and 8-37,

Make changes indicated in table 2 of this supplement.

▲ Page 8-15, figure 8-17,

S2: Change (28) color code to (902).

Add (4) color code between A8S1 .5 contact and junction to third contact from bottom on next stage of A8S1. Delete (0) color code from same junction to (4) wire. Add (0) color code between junction with (4) wire and contact on A7S1.

A8S1: Reverse labeling of switch A8S1. For example, .005 changes to .5 and .5 changes to .005.

▲ Page 8-16, figure 8-18,

Change L3 to L13.

▲ Page 8-17, figure 8-20,

Modify schematic as shown below:

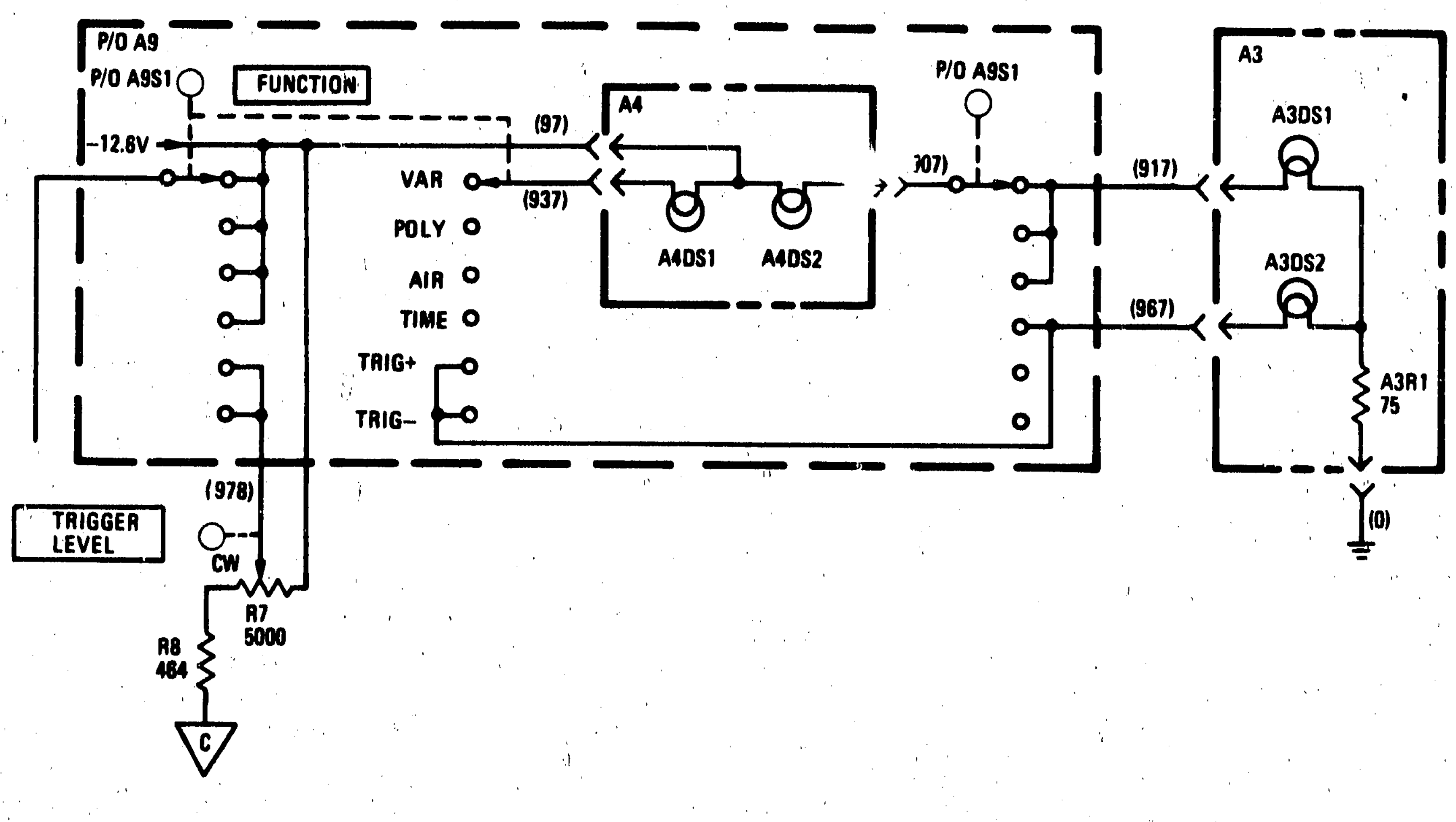


Table 2. Changes to Dc Voltage Measurements

Figure	Component	Dc Voltage	Dc Voltage*
8-17	A1Q21	B: delete −12.3 V	
8-20	A2Q2	B: 0V	
		E: −0.7 V	
	A2Q7		C: +5.6 V
	A2Q8		C: −1.5 V
	A2Q9		C: +13.5 V
	A2Q10	B: +17.5 V	
		C: +3.5 V	
		E: +19 V	
	A2Q13	B: +17.5 V	
		C: +3 V	
		E: +19 V	
	A2Q14	C: +3 V	
8-23	A2Q16	B: +2.4 V to +4.5 V	
		C: +16.5 V	
		E: +1.7 V to +3.9 V	
	A2Q17		B: +4.1 V
	A2Q18		C: +1 V to +4.8 V
	A2Q19	E: −0.5 V	E: +4.2 V
		B: −0.45 V	B: +4.6 V
	A2Q21	C: +15 V	C: +13 V
	A2Q22	B: +0.7 V	B: +0.45 V
	A2Q23	B: +0.7 V	B: +0.45 V
	A2Q25	C: +0.9 V	C: +4.1 V
	A2Q27	B: +2.8 V	
		E: +2.1 V	
		C: +16.5 V	
	A2Q28	C: +17 V	B: +4.1 V
		B: +0.9 V	
		E: +0.2 V	E: +3.4 V
	A2Q29	C: +1.4 V	C: +4.5 V
	A2Q30	C: −0.45 V	C: +4.5 V
	A2Q31	E: −0.6 V	E: +4.2 V
8-26	A5Q4	C: +2.5 V	
	A5Q5	S: +3.5 V	
	A5Q7	B: +14.2 V	
		E: +14.4 V	
	A5Q13	E: +1.5 V	
		B: +2.2 V	
8-37	A2Q8	B: 0 V	
		C: +10 V	
	A2Q9	B: +5.2 V to +9.4 V	
		E: +10.5 V	

ERRATA (Cont'd)

Page 8-17, figure 8-20,
Change wiring of A9S1 to conform to figure 2 of this supplement.

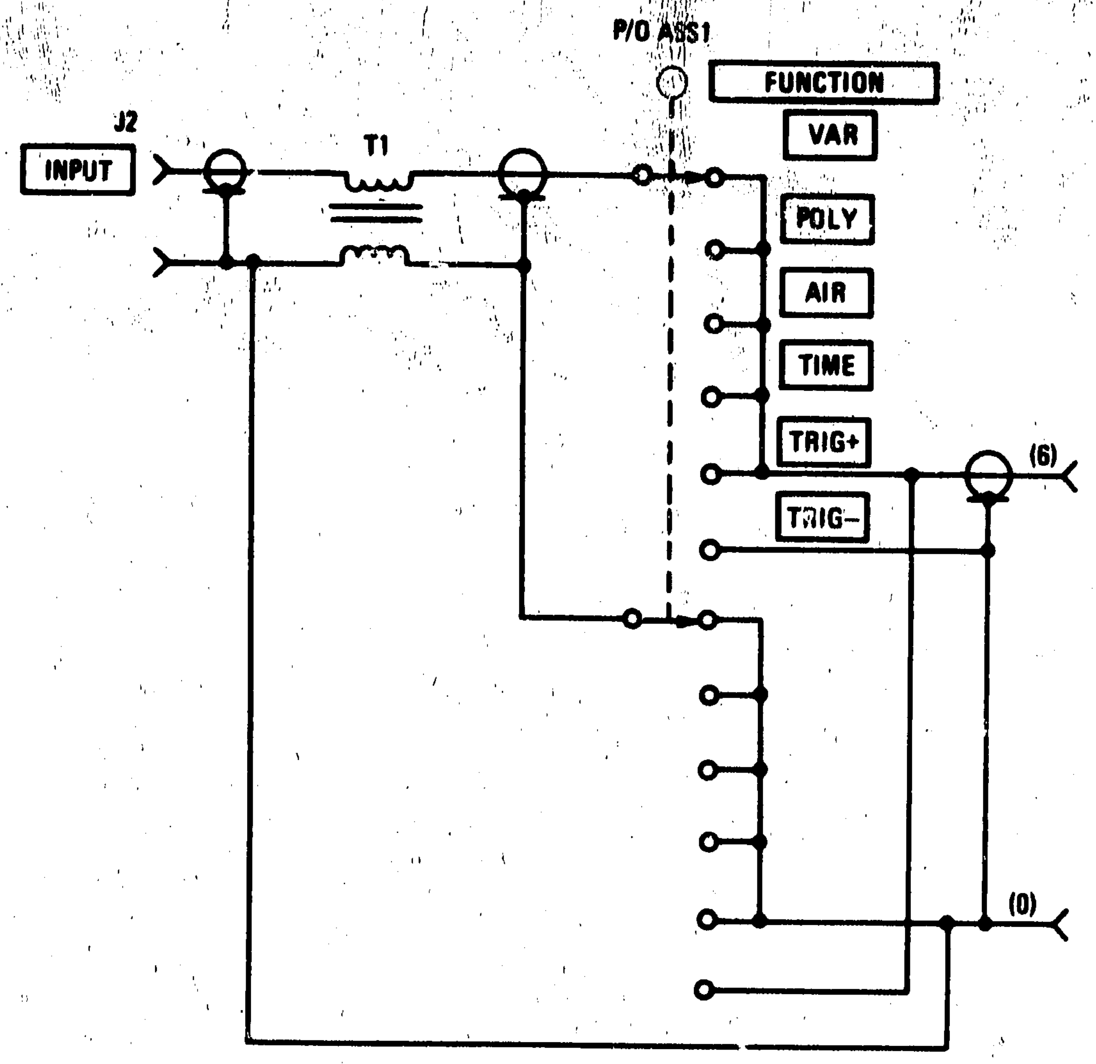


Figure 2. A9S1 Wiring

Page 8-19, figure 8-23,
C34: Change value to 150 pF.
▲ Add: W2 to cable at J1 pins F, E, G.
▲ Add: A6W2 to cable at L2.
▲ Add: A6W2 to cable at L3.
▲ Add: W3 to cable at J1 and J2.
▲ R6: move wiper arm to opposite side.
▲ Add: (938) color code between R6 and A9R2 (A9R4 side).
▲ A9S1: Change (958) to (918) between A9S1 and A2Q26.
▲ Page 8-21, figure 8-26,
A7S1: Change (927) to (937) between A7S1 and A5R12. Delete dashed line on (90) wire to A6S1.
▲ Page 8-23, figure 8-28,
R10: Add (9) color code between R10 and cable (2).
R11: Add (6) color code between R10 and R11.
Page 8-25, figure 8-33,
A3VR2: Change value to 2.61 V.
▲ Page 8-27, figure 8-37,
J1: Change (9) color code to (0) and (0) to (9).

CHANGE 1

Page 6-2, table 6-2,
R10: Change to HP Part No. 2100-2915, R: var ww lin 10 turn 5k ohms 5% 2W.
R11: Change to HP Part No. 2100-2915, R: var ww lin 10 turn 5k ohms 5% 2W.
Panel, sub alum: Change to HP Part No. 01815-00206.
Panel, front alum: Change to HP Part No. 01815-00207 (1815A).
Panel, front alum: Change to HP Part No. 01815-00208 (1815B).

CHANGE I (Cont'd)

Page 6-3, table 6-2,
 Delete: 01815-21201, Bracket, mounting alum.
 Add: 1140-0052, Dial, turns counting.
Page 6-13, table 6-2,
 A4: Change to HP Part No. 01815-66507; A: Board assy: Vertical Sensitivity indicator.
 Add: A4VR1: HP Part No. 1901-0041; VR: Si breakdown 5.11 V 5% 400 mW.
 Add: A4VR2: HP Part No. 1902-0041; VR: Si breakdown 5.11 V 5% 400 mW.
Page 8-17, figure 8-20,
 Change the A4 Schematic to correspond to figure 3.

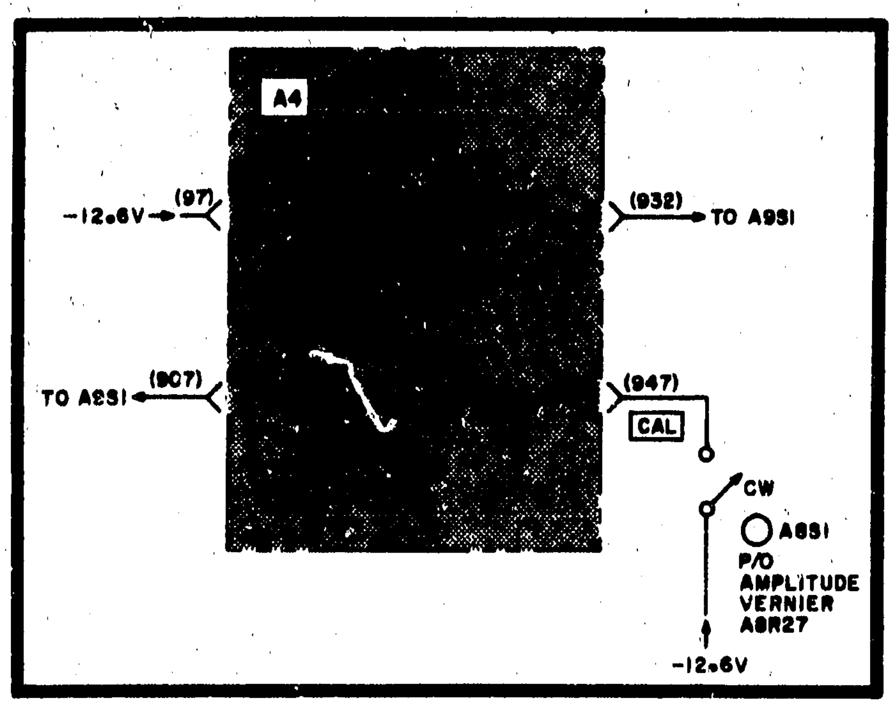


Figure 3.

CHANGE 2

Page 6-9, table 6-2,
 A2L12: Change to HP Part No. 9140-0114; L: fxd 10 μH.
 A2L13: Change to HP Part No. 9140-0114; L: fxd 10 μH.
Page 6-13, table 6-2,
 A5: Change to HP Part No. 01815-66508.
Page 6-14, table 6-2,
 A5CR9: Change to HP Part No. 5080-9624.
Page 6-16, table 6-2,
 Add: A5R67; HP Part No. 0757-0472; R: fxd metflm 200k ohms 1% 1/8W.
Page 6-18, table 6-2,
 Add: A6R25; HP Part No. 0757-0953; R: fxd metflm 16k ohms 2% 1/8W.
Page 8-17, figure 8-20,
 A2L12: Change value to 10 μH.
 A2L13: Change value to 10 μH.
Page 8-21/8-22, figure 8-23,
 Change A5 schematic to correspond to figure 4.

CHANGE 2 (Cont'd)

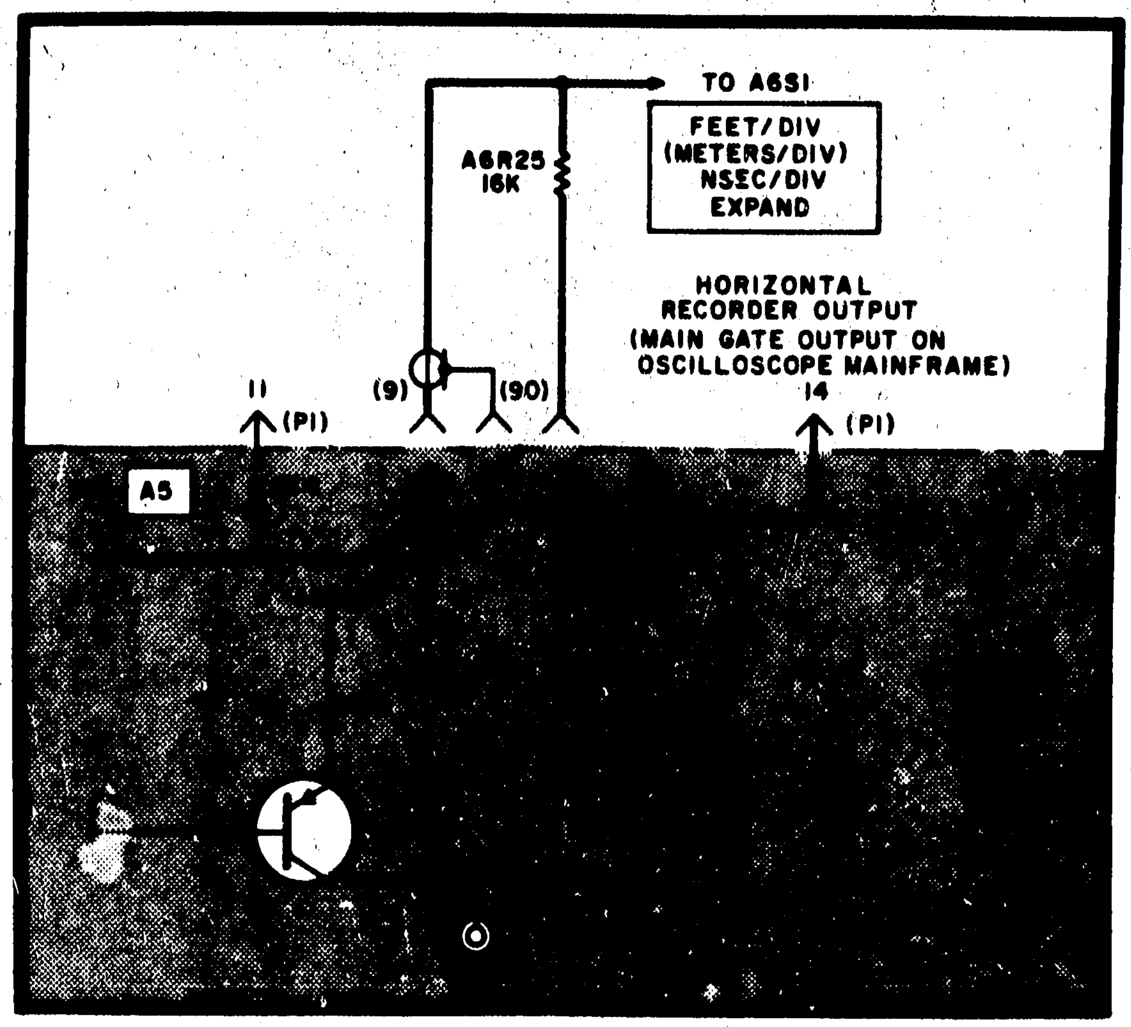


Figure 4

CHANGE 3

Page 6-2, table 6-2,
R6: Change 2100-2488 to 2100-2146; R: var comp lin 10k ohms 10% 3/4W (1815A).
Page 6-7, table 6-2,
A2C9: Change 0140-0198 to 0140-0206; C: fxd mica 270 pF 5% 500 wVdc (1815A).
Page 6-11, table 6-2,
A2R30: Change to HP Part No. 0757-0953; R: fxd metflm 16k ohms 2% 1/8W.
Page 6-19, table 6-2,
A9R2: Change 0757-0959 to 0757-0955; R: fxd metflm 20k ohms 2% 1/8W (1815A).
Page 8-17, figure 8-20,
A2C9: Change value to 270 pF.
A2R30: Change value to 16K.
Page 8-19, figure 8-23,
A9R2: Change value to 20K.

CHANGE 4

Page 6-2, table 6-2,
Panel, sub alum: Change to HP Part No. 01815-00210.
Panel, front alum: Change to HP Part No. 01815-00211 (1815A).
Panel, front alum: Change to HP Part No. 01815-00212 (1815B).
Page 6-3, table 6-2,
DIAL, turns counting: Change to HP Part No. 1140-0055.

CHANGE 5

Page 2-1, paragraph 2-5,
Add step a below and change existing steps a through c to read b through d.
a. Make the marker brightness adjustment described in Section V.
Page 5-12,
Add paragraphs 5-37 and 5-38 as follows:
5-37. MARKER BRIGHTNESS ADJ.
5-38. When Model 1815A is installed in a 181-series or 183-series mainframe, adjust A5R68 so that no blooming occurs on screen with maximum intensity or scan density. When installed in any other oscilloscope mainframe, set A5R68 for maximum market dot brightness.
Page 6-2, table 6-2,
A5: Change to HP Part No. 01815-66509.
Page 6-13, table 6-2,
A5: Change to HP Part No. 01815-66509.
Page 6-16, table 6-2,
Add: R68, 2100-2031, R: var cermet lin 50k 10% 1/2W.
Page 8-23, figure 8-8,
Add A5R68 as shown in figure 5 below.

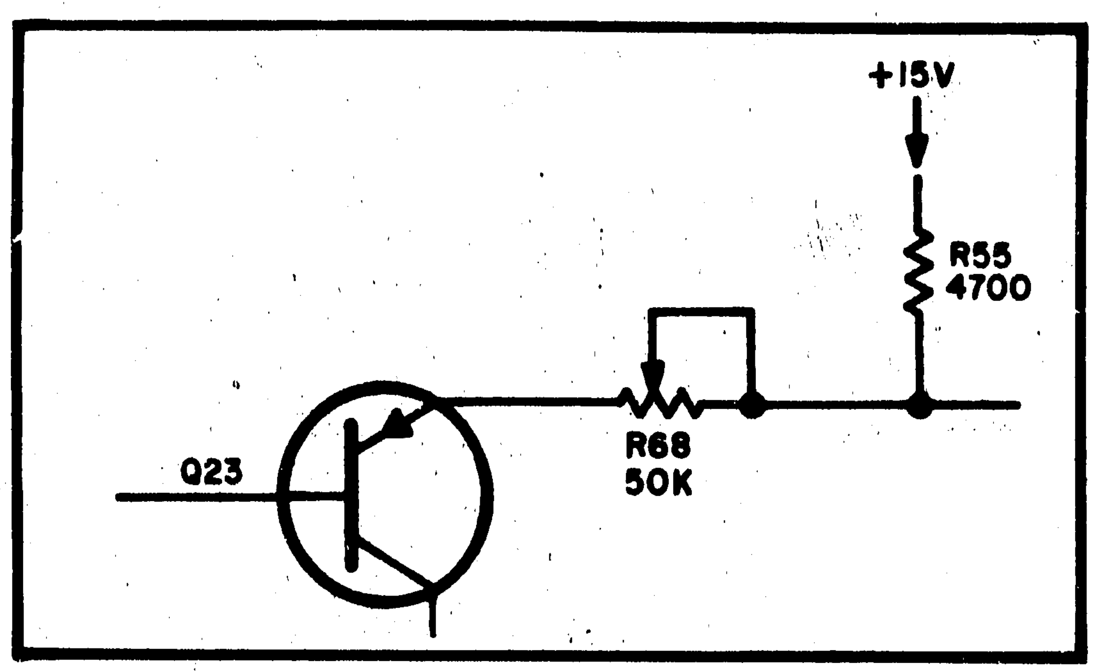


Figure 5

CHANGE 6

Page 6-7, table 6-2,
A2C9: Change to HP Part No. 0140-0198; C: fxd mica 200 pF 5% 300 wVdc (1815A).
Page 6-11, table 6-2,
A2R30: Change to HP Part No. 0757-0450; R: fxd metflm 22.1k ohms 1% 1/8W.
Page 8-17, figure 8-20,
A2C9: Change value to 200 pF.
A2R30: Change value to 22.1k.

CHANGE 7

Page 6-11, table 6-2,
A2R30: Change to HP Part No. 0757-0450; R: fxd metflm 22.1k ohms 1% 1/8W.
Page 8-17, figure 8-20,
A2R30: Change value to 22.1k.

CHANGE 8

Page 6-11, table 6-2,
A2R29: Change to HP Part No. 0757-0443; R: fxd metflm 11.0k ohm 1% 1/8W. (1815A only).
A2R29: Change to HP Part No. 0757-0442; R: fxd metflm 10k ohm 1% 1/8W. (1815B only).
A2R30: Change to HP Part No. 0757-0453; R: fxd metflm 30.1k ohm 1% 1/8W.
Page 8-17, figure 8-20,
A2R29: Change value to 11K (1815A only).
A2R29: Change value to 10K (1815B only).
A2R30: Change value to 30.1K.

CHANGE 9

Page 6-19, table 6-2,
A9R4: Change to HP Part No. 0698-3410, R: fxd metflm 3160 ohms 1% 1/2W (1815A).
Page 8-19, figure 8-23,
A9R4: Change value to 3160 ohms (1815A only).

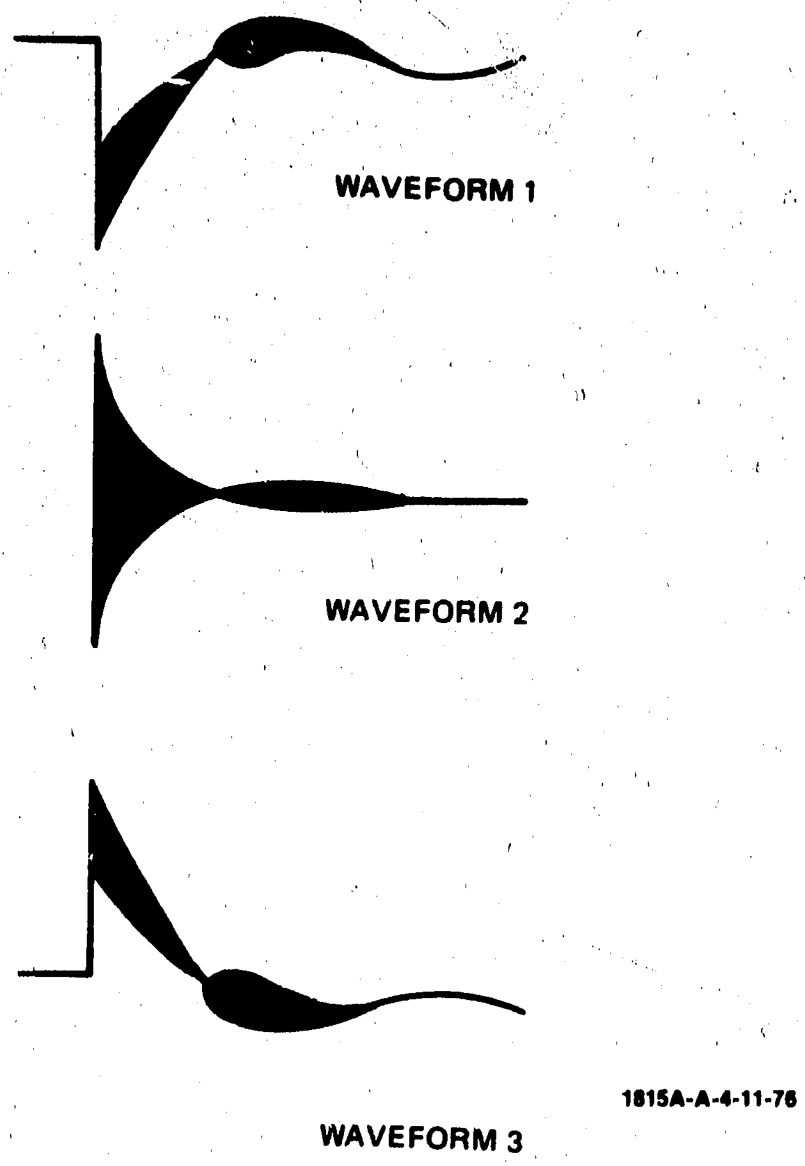


Figure 5-9. Diode Bias Waveforms

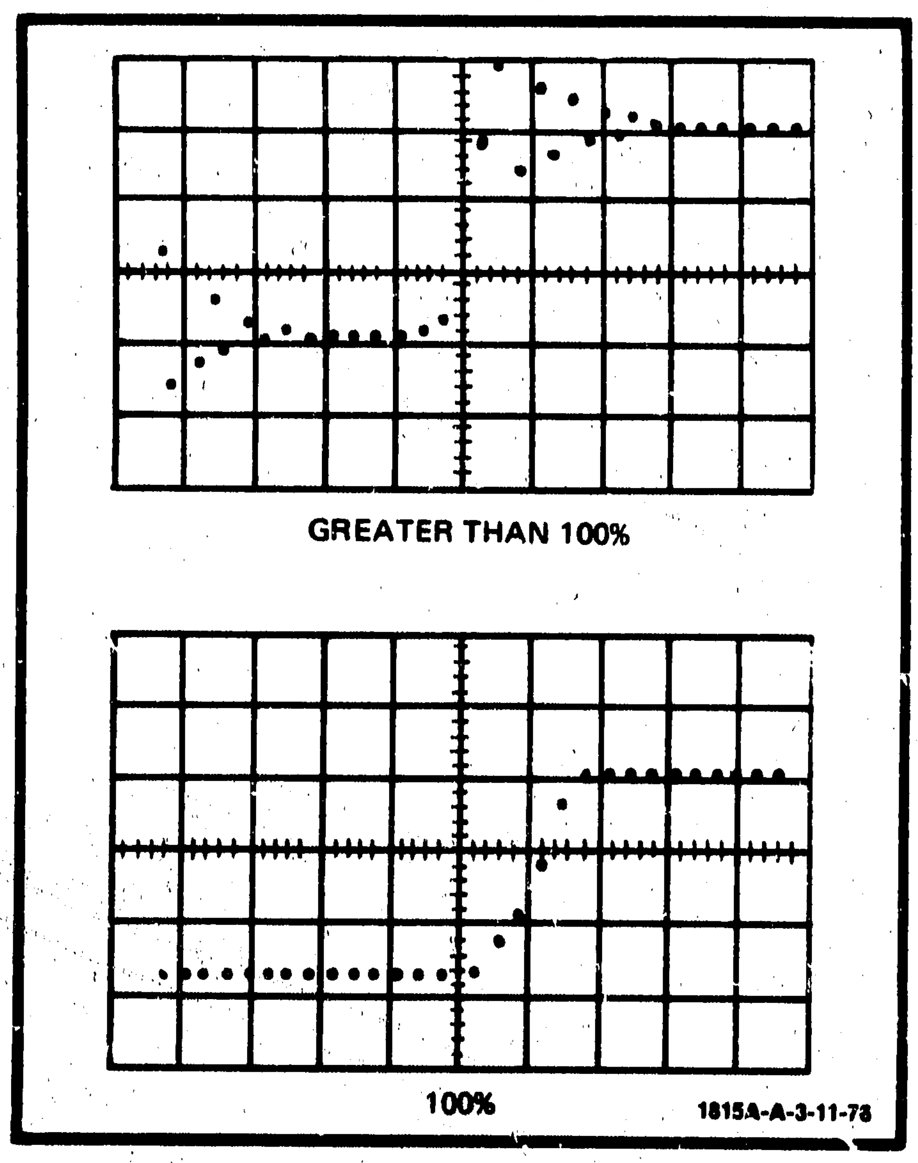


Figure 5-11. Sampling Efficiency Displays

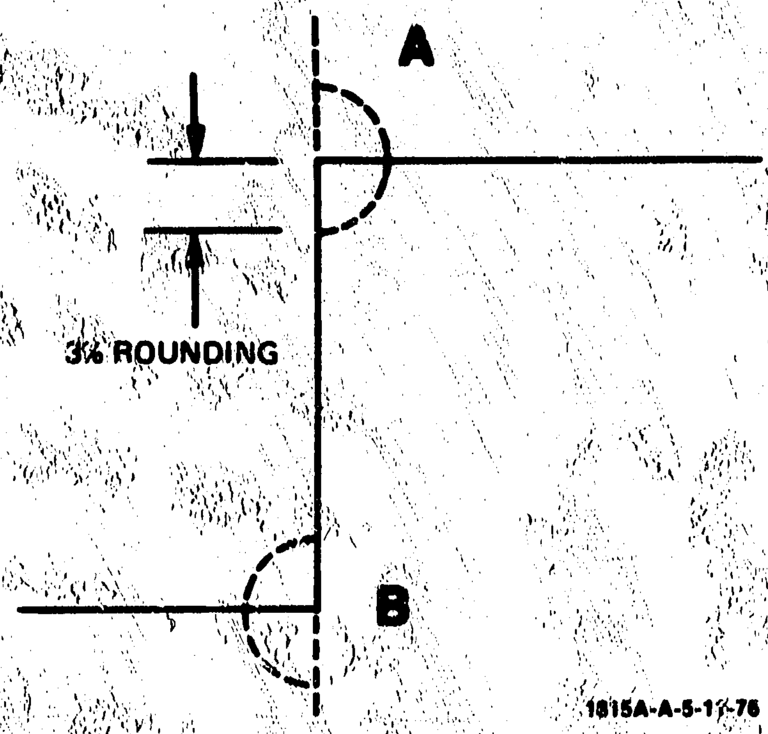


Figure 5-12. Low-frequency Distortion Waveform

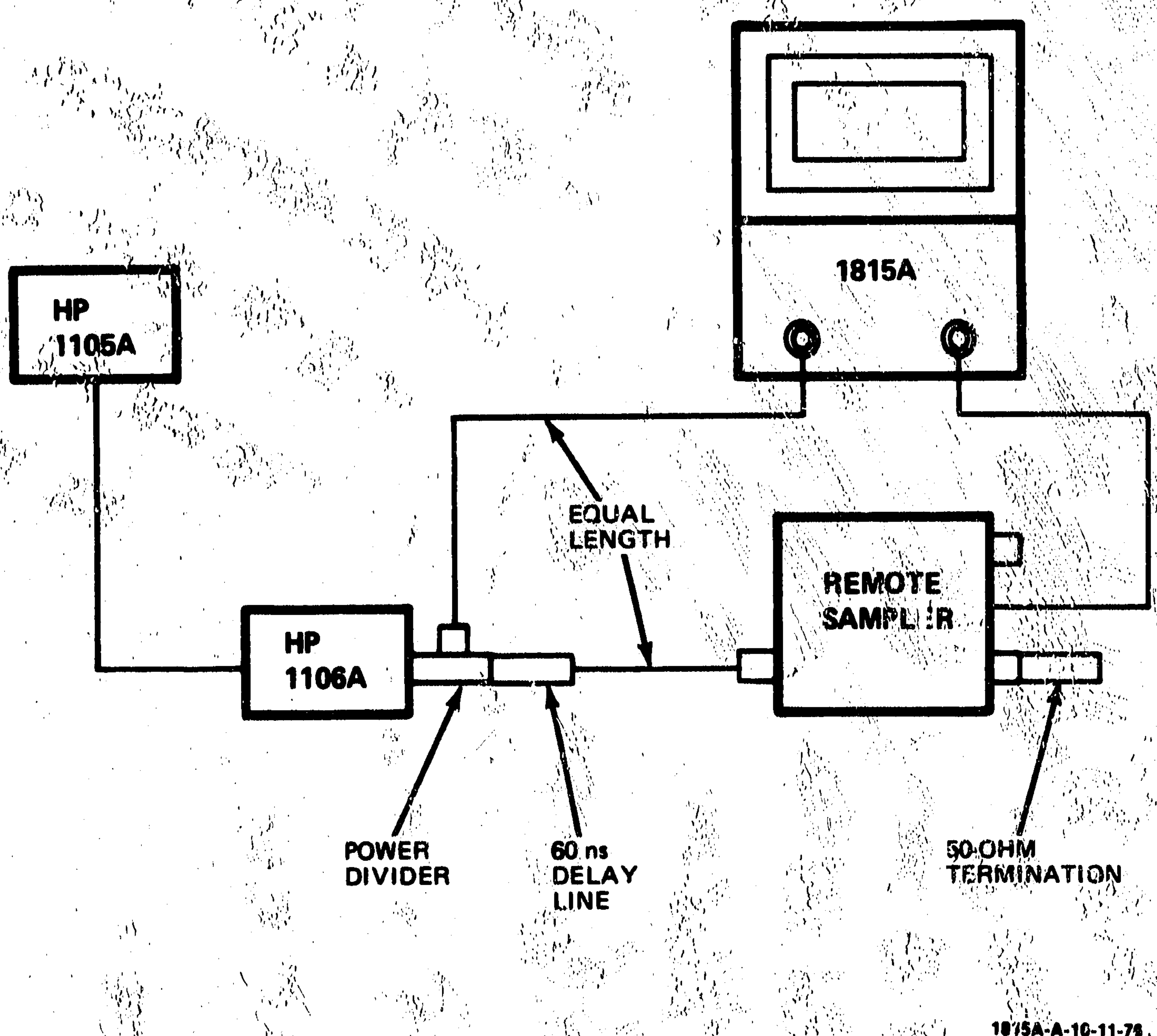


Figure 5-19. Minimum Delay Test Setup

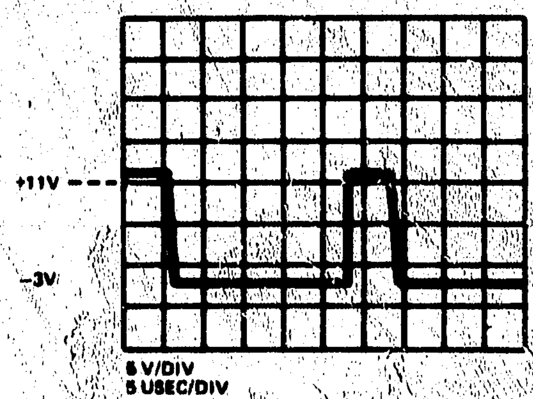


FIGURE 8-4. WAVEFORM AT PIN L, STEP TRIGGER

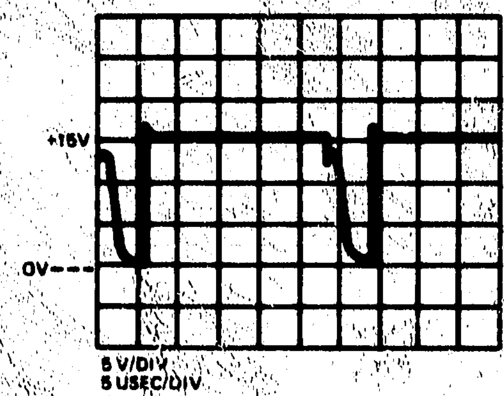


FIGURE 8-5. WAVEFORM AT PIN B, STEP RESET

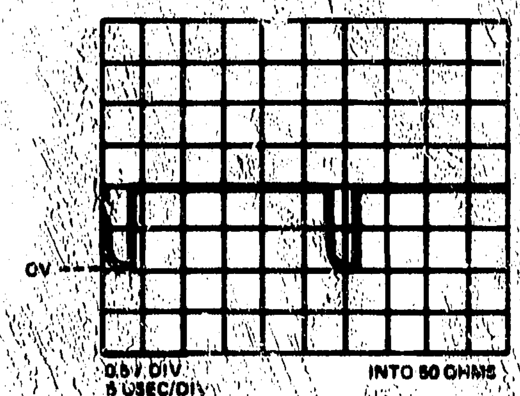


FIGURE 8-6. MODEL 1817A OUTPUT WAVEFORM

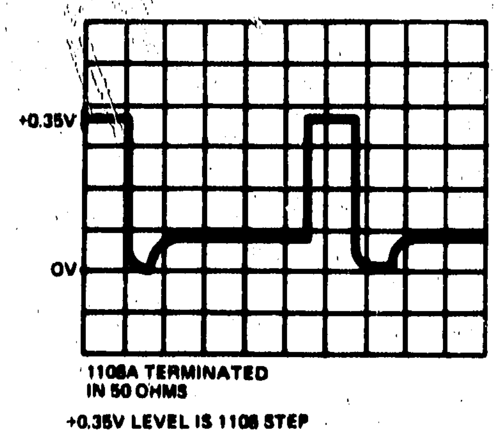


FIGURE 8-6A. WAVEFORM AT OUTPUT OF TUNNEL DIODE MOUNT

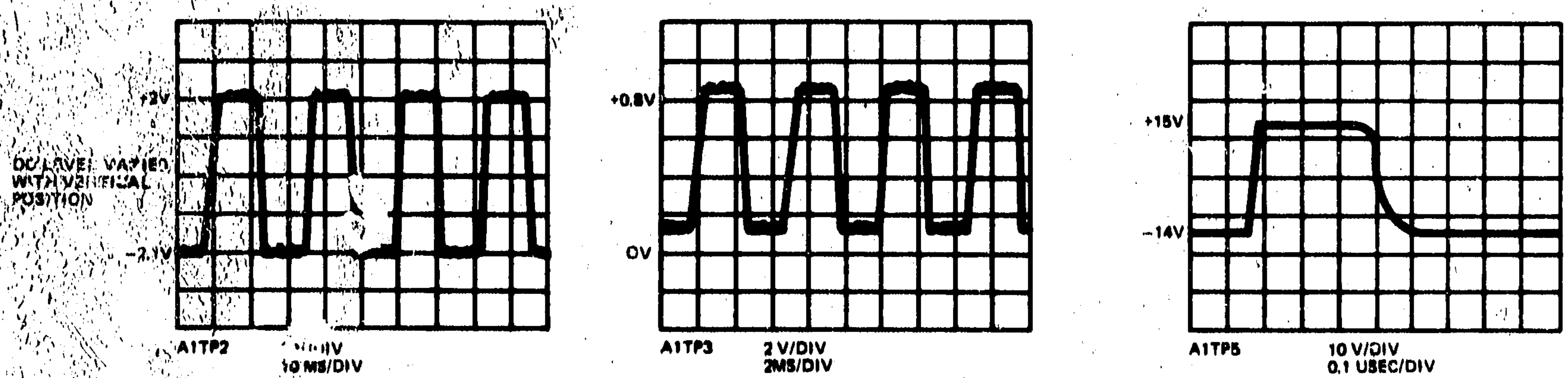


FIGURE 8-11. STRETCHER, VERTICAL AMPLIFIER MEASUREMENTS

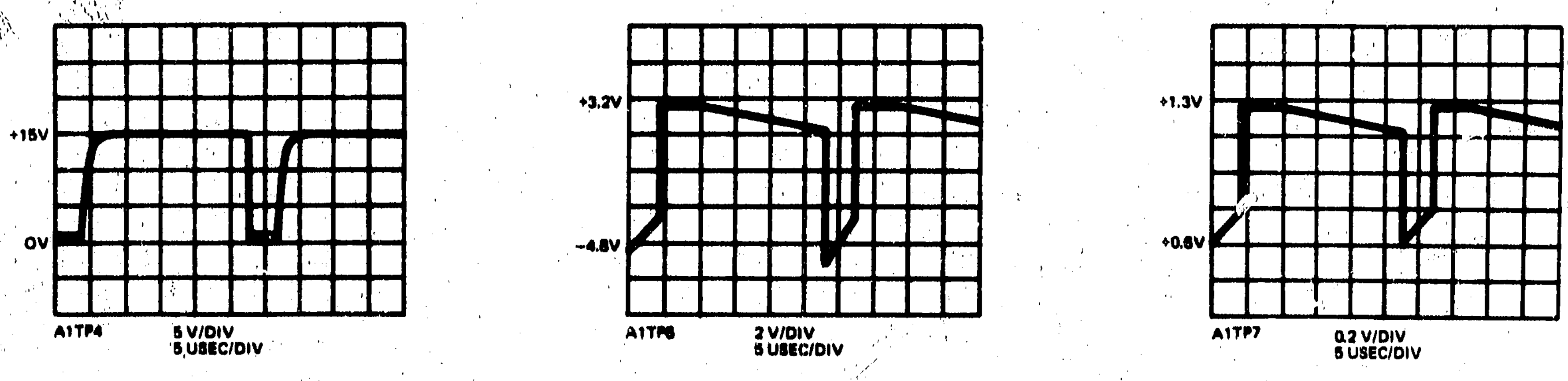


FIGURE 8-16. COUNTDOWN CIRCUIT MEASUREMENTS

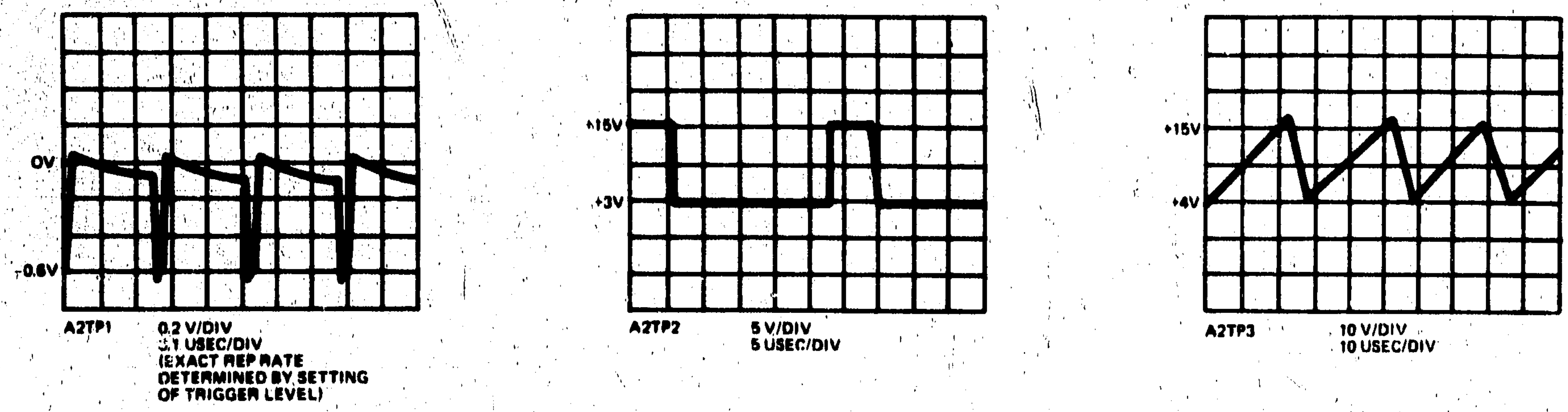


FIGURE 8-19. TRIGGER CIRCUITS MEASUREMENTS

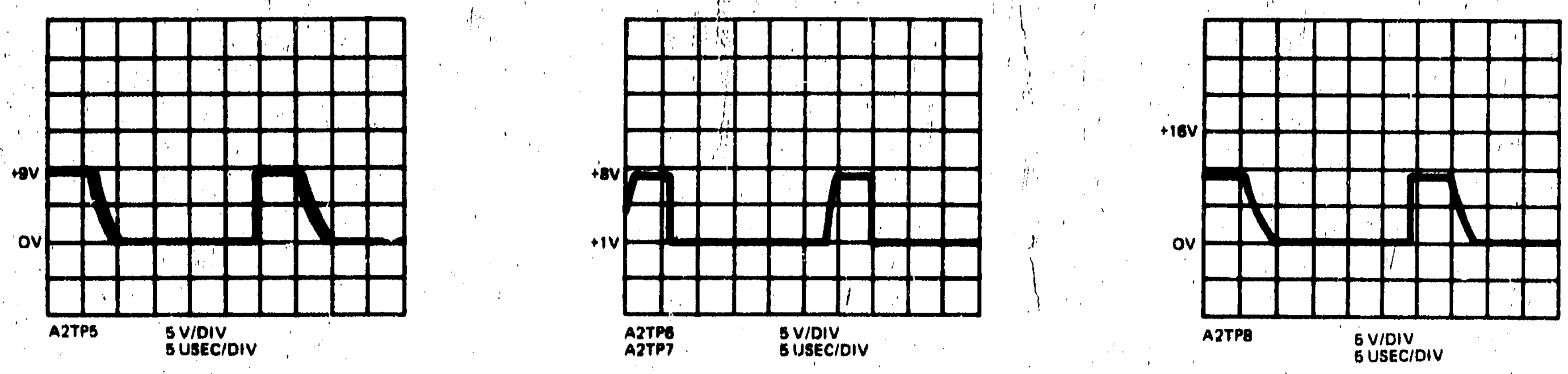


FIGURE 8-22. STROBE AND STEP MEASUREMENTS

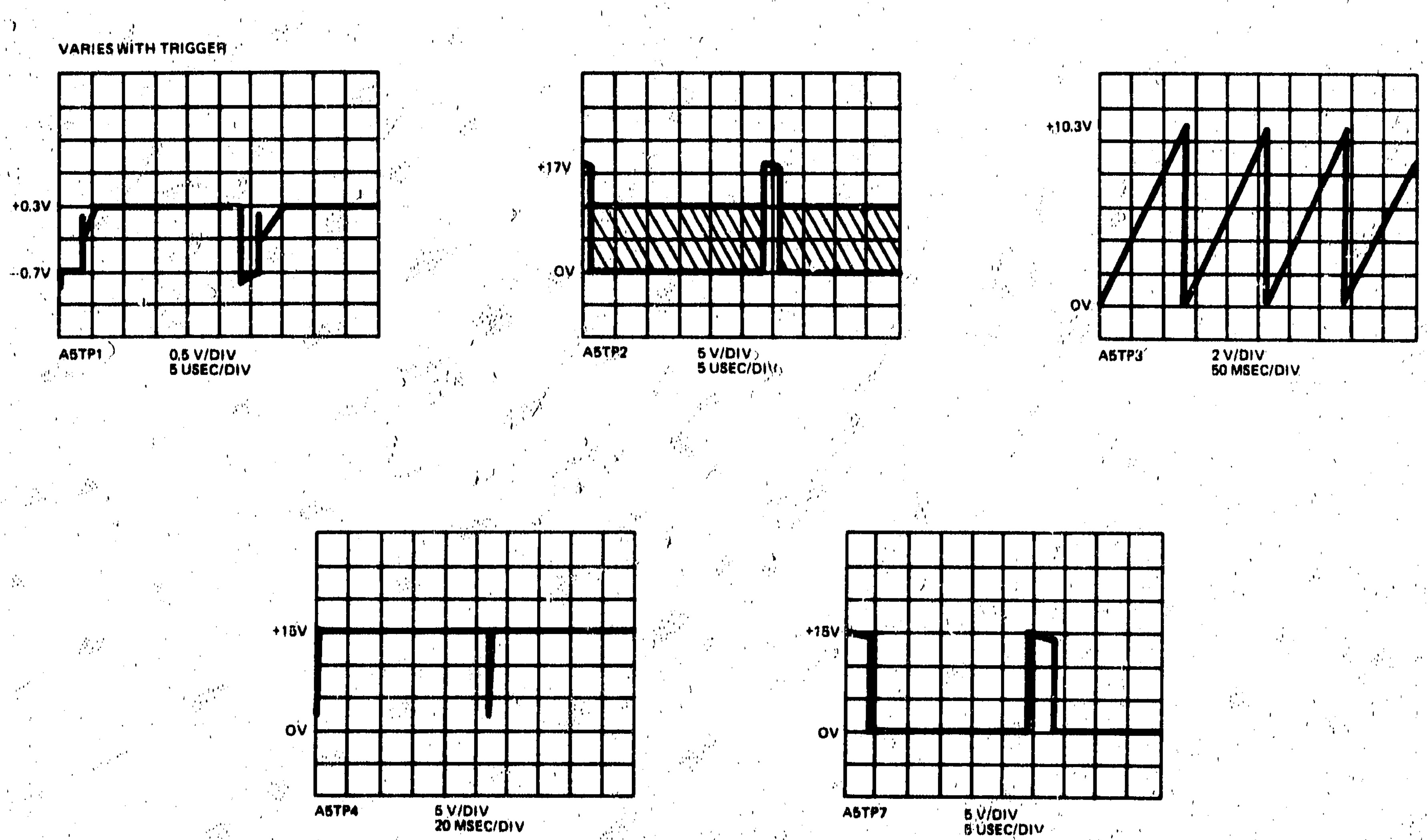


FIGURE 8-25. STAIRCASE AND BLANKING MEASUREMENTS

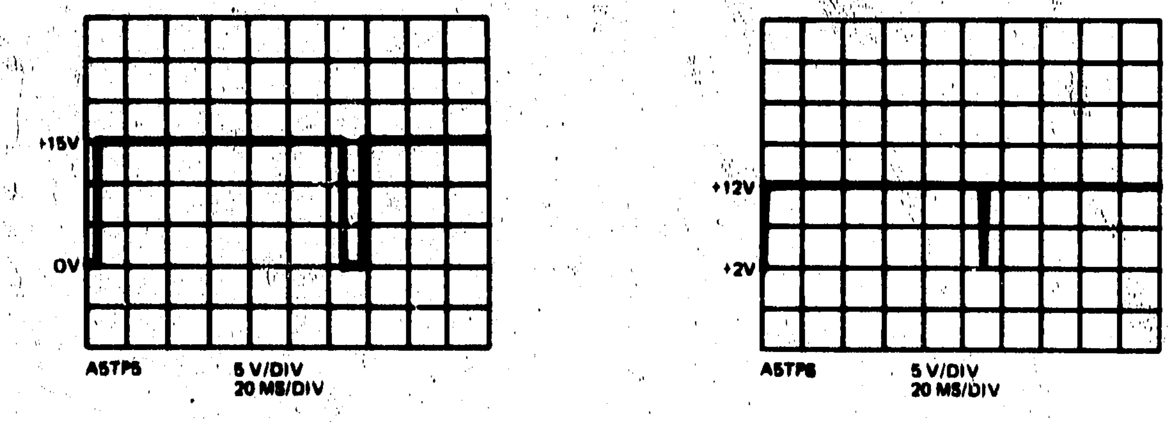


FIGURE 8-27. MARKER DOT MEASUREMENTS

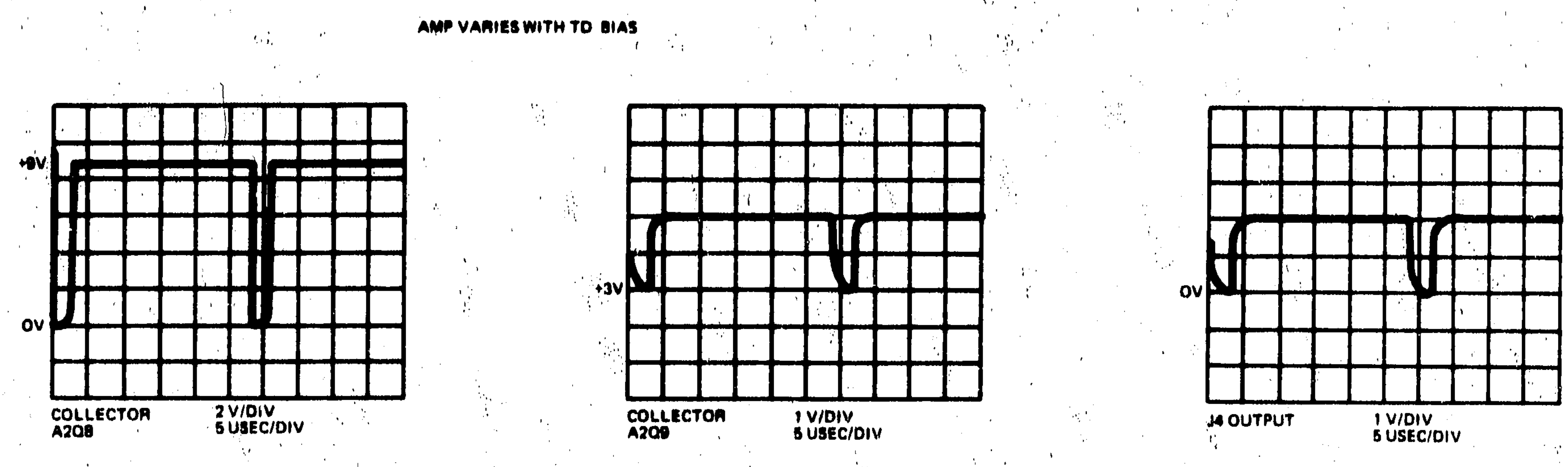


FIGURE 8-32. SAMPLER MEASUREMENTS

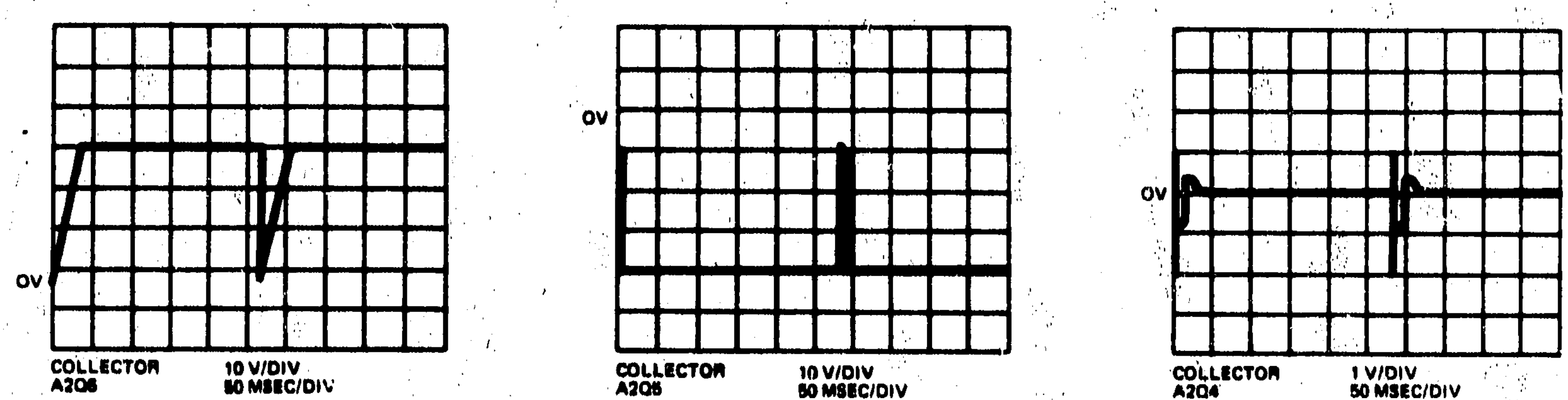


FIGURE 8-36. STEP GENERATOR MEASUREMENTS