Errata

Title & Document Type: **8600A Digital Marker Operating and Service Manual**

Manual Part Number: **08600-90001**

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About this Manual

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

HP References in this Manual

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

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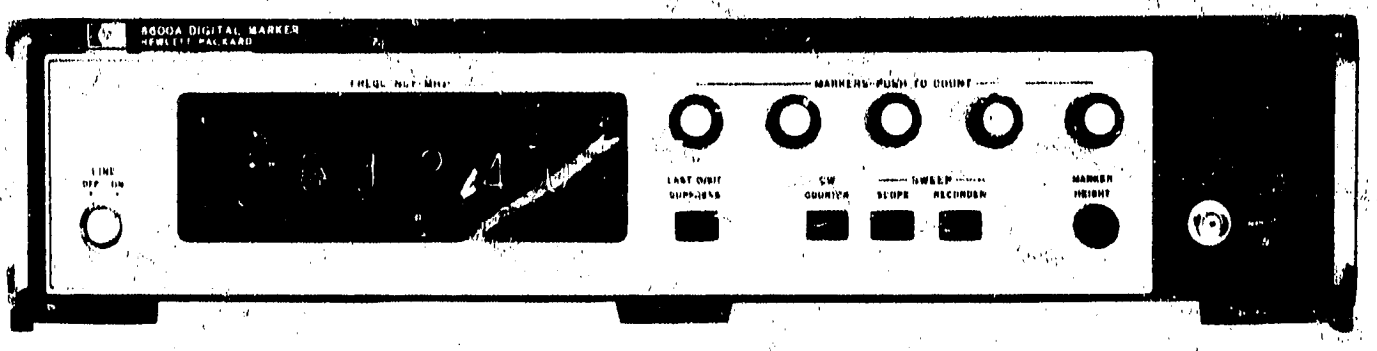
Search for the model number of this product, and the resulting product page will guide you to any available information. Our service centers may be able to perform calibration if no repair parts are needed, but no other support from Agilent is available.

Agilent Technologies

OPERATING AND SERVICE MANUAL

DIGITAL MARKER
8600A



HEWLETT PACKARD

CERTIFICATION

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

WARRANTY

This Hewlett-Packard instrument product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by HP. Buyer shall prepay shipping charges to HP and HP shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to HP from another country.

HP warrants that its software and firmware designated by HP for use with an instrument will execute its programming instructions when properly installed on that instrument. HP does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HP SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HP SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

ASSISTANCE

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.

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

SAFETY CONSIDERATIONS

GENERAL

This product and related documentation must be reviewed for familiarization with safety markings and instructions before operation. This product has been designed and tested in accordance with international standards.

SAFETY SYMBOLS

Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual (refer to Table of Contents).

Indicates hazardous voltages.

Indicates earth (ground) terminal.

WARNING

The WARNING sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

CAUTION

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.

SAFETY EARTH GROUND

This is a Safety Class I product (provided with a protective earthing terminal). An uninterruptible safety earth ground must be provided from the main power source to the product input wiring terminals, power cord, or supplied power cord set. Whenever it is likely that the protection has been impaired, the product must be made inoperative and be secured against any unintended operation.

BEFORE APPLYING POWER

Verify that the product is configured to match the available main power source per the input power configuration instructions provided in this manual.

If this product is to be energized via an autotransformer make sure the common terminal is connected to the neutral (grounded side of mains supply).

SERVICING

WARNING

Any servicing, adjustment, maintenance, or repair of this product must be performed only by qualified personnel.

Adjustments described in this manual may be performed with power supplied to the product while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.

Capacitors inside this product may still be charged even when disconnected from its power source.

To avoid a fire hazard, only fuses with the required current rating and of the specified type (normal blow, time delay, etc.) are to be used for replacement.

DIGITAL MARKER
8600A

Serial Numbers Prefixed: 1030-

This manual applies directly to HP Model 8600A Digitial Marker having serial prefix number 1030-.

Other Prefixes

See Section VII, MANUAL CHANGES.

HP Part No. 08600-90001

Printed: SEPTEMBER 1970

HEWLETT PACKARD

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POWER CABLE

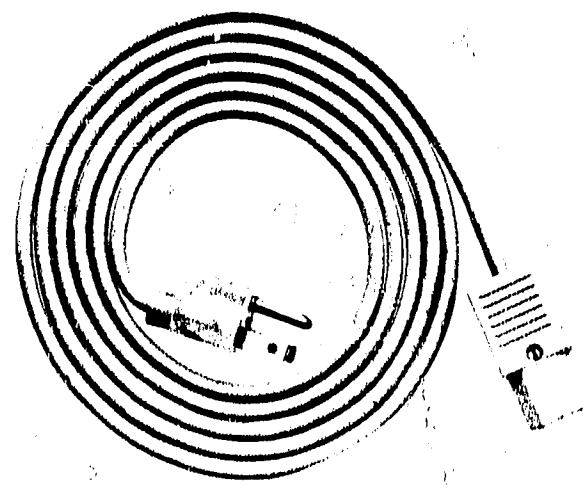


Figure 1-1 Model 8600A Digital Marker and Accessories

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION

1-2. This manual contains all information required to install, operate, test, adjust and service the Hewlett-Packard Model 8600A Digital Marker. This section covers instrument identification, description, specifications and other basic information.

1-3. Figure 1-1 shows a front view of the instrument and accessories supplied.

1-4. The various sections in this manual provide information as follows:

a. SECTION II, INSTALLATION, provides information relative to incoming inspection, power requirements, mounting, packing and shipping, etc.

b. SECTION III, OPERATION, provides information relative to operating the instrument.

c. SECTION IV, PERFORMANCE TESTS, provides information required to ascertain that the instrument is performing in accordance with published specifications.

d. SECTION V, ADJUSTMENTS, provides information required to properly adjust and align the instrument after repairs are made.

e. SECTION VI, REPLACEABLE PARTS, provides ordering information for all parts and assemblies.

f. SECTION VII, MANUAL CHANGES, normally will contain no relevant information in the original issue of a manual. This section is reserved to provide back-dated and up-dated information in manual revisions or reprints.

g. SECTION VIII, SERVICE, inciudes all information required to service the instrument.

1-5. INSTRUMENTS COVERED BY MANUAL

1-6. Hewlett-Packard instruments carry a ten digit serial number (see Figure 1-2) on the back panel. The first four digits are the serial number prefix. When the serial number prefix of your instrument matches one of the prefix numbers on the inside title page of this manual, the manual applies directly to the instrument. When the instrument serial number prefix is not listed on the inside title page of the initial manual issue, manual change sheets and manual up-dating information is provided. Later editions or revisions to the manual will contain the required change information in Section VII.

1-7. DESCRIPTION

1-8. The Model 8600A Digital Marker was designed as a complement to the Model 8601A Generator/Sweeper.

Note

Model 8601A Generator/Sweepers with serial numbers lower than 945-1130 will require a minor modification before being used with the Model 8600A. The modification kit part number is 08601-60093.

1-9. The required modification does not affect sweeper functions; sweep modes, sweep rates, and sweep linearity are all preserved. The 8600/8601 combination may be used with any display having an external horizontal input, such as an oscilloscope, the HP Model 8407A/8412A Network Analyzer, or a graphical recorder.

1-10. The Model 8600A provides five independent markers which may be placed at any point on a display while making swept measurements. The markers appear either as bright spots on the trace or as vertical markers. In addition, the frequency of any selected marker is continually displayed on a numerical read-out while sweeping.

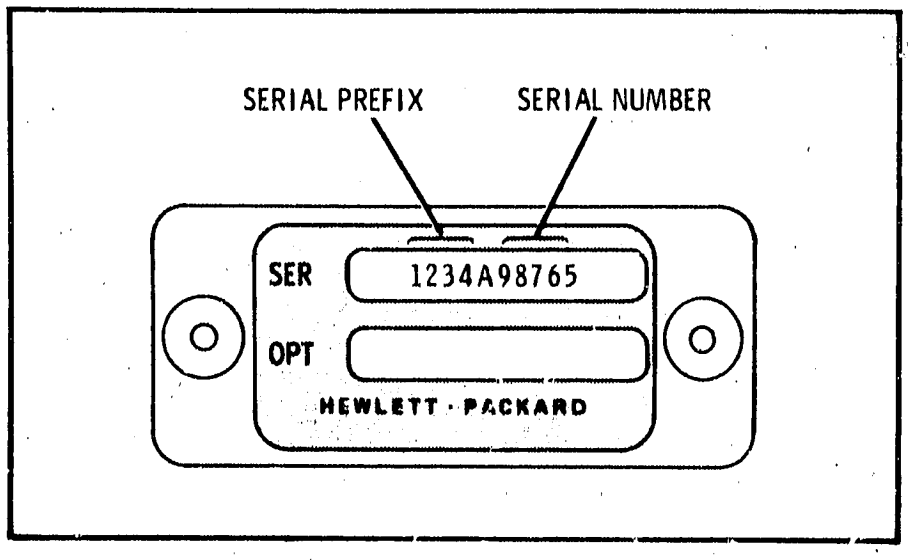


Figure 1-2. Instrument Identification

Table 1-1. Specifications

SPECIFICATIONS

MARKER

When providing markers, the 8600A must be used with the 8601A Generator/Sweeper. Hence, all marker specifications apply only for the 8600A/8601A combination. Markers may be generated on an oscilloscope (SCOPE mode) or recorder (Recorder mode):

Marker Accuracy: Any marker may be placed at a desired frequency ± (0.05% of sweep width + sweeper stability*).

Drift:
- ±0.1%/° temperature change.
- ±0.001%/V line voltage change.
- ± sweeper drift.
- ± counter stability (refer to COUNTER section).

Typical Marker Drift: When the 8601A is in SYMMETRICAL mode and SWEEP speed <1 sweep/second is:
- <5 kHz/10 min high range.
- <0.5 kHz/10 min low range.

Minimum Marker Separation: Approximately 1% of display width.

COUNTER

Display: 6-digit readout, least significant digit may be suppressed.

Frequency Measurement:
- Range: 0.1 kHz to 15 MHz.
- Gate Time: 10 msec (100 Hz resolution).
- Input Sensitivity: 100 mV rms to 10 Vrms.
- Overload: Input should be less than 10 Vrms.
- Damage Level: 15 Vrms. ±50 Vdc.
- Impedance: 0.5 MΩ shunted by 30 pF.

Accuracy: ±1 count ± time base accuracy.

Time Base:
- Frequency: 1 MHz
- Stability:
  - Temperature: ±30 ppm (0° − 50°C); ±5 ppm (10° − 40°C).
  - Line Voltage: <1 ppm for ±10% line voltage variation.
- Sample Rate: 5/sec.
- Reset: Automatic.

GENERAL

Front Panel Connector:
- Input: Accepts AUX OUT from sweeper to count marker frequency; also is the signal input for normal COUNTER operation. (Refer to COUNTER section above.)

Line Voltage: 115 − 230 Vac ±10%; 50 − 400 Hz; 35 watts.

Weight: Model 8600A; Net, 12 lbs 12 oz (5,78 kg). Shipping, 18 lb (8,16 kg).

Dimensions: 3-7/8 in. high x 16-3/4 in. wide x 13-1/4 in. long (99 x 413 x 337 mm).

*Typically < 2 kHz high band, < 0.2 kHz low band.

The scan ramp of the Generator/Sweeper is stopped for 15 milliseconds at the frequency of the marker to be counted. Other markers stop the scan ramp for 1.5 milliseconds.

1-11. At slow sweep rates the ratio of stop time to scan time becomes quite small and marker intensity may be inadequate. Under these conditions, vertical markers may be added which are clearly visible on the slowest sweeps. A positive pulse on the CRT identifies the marker at which the frequency is being counted. Negative pulses identify remaining markers to avoid ambiguity. Marker height is controlled by a front panel MARKER HEIGHT control.

1-12. In the RECORDER mode the Model 8600A operates as it does in the SCOPE mode except that the sweep is stopped for 100 milliseconds at all markers to allow time for the Y-axis of the recorder to respond to the fast marker spikes.

1-13. In the COUNTER mode the Model 8600A operates as a standard 10 millisecond gate time counter with a sample rate of 5/second. The input signal may be from any source within the amplitude and frequency range of the counter.

1-14. Complete specifications for the Model 8600A are provided in Table 1-1.

1-15. ACCESSORIES SUPPLIED

1-16. The following accessories are supplied with the Model 8600A:

a. A power cord.

b. A rack mounting kit.

c. Modification Kit. A simple modification is required on model 8601A's with Serial Number 945-01130 and below. One kit is supplied with each Model 8600A. Additional kits may be ordered through your local HP Sales Office by specifying HP Part Number 08601-60093.

1-17. ACCESSORIES NOT SUPPLIED

1-18. A Service Kit, HP Part Number 08600-60018 is recommended for maintenance purposes.

1-19. WARRANTY

1-20. Certification and Warranty information for the Model 8600A appears on the inside front cover of this manual.

1-21. TEST EQUIPMENT AND ACCESSORIES REQUIRED

1-22. Table 1-2 lists test equipment and accessories recommended to service the Model 8600A.

Table 1-2. Test Equipment and Accessories List

Item	Critical Specifications	Model Number	Use*
Variable Voltage Transformer	Range: 103 – 127 Vac Voltmeter Range: 103 – 127 Vac ±1 Volt	General Radio W5MT3A or Superior Electr. UC1M	P, A
Ohmmeter	Resistance Ranges: 1 ohm to 100 megohms Accuracy: ±10% of reading	HP 410C Volt-ohm-ammeter	S
10:1 probes	10:1 divider attenuation; input 10 megohms, 10 picofarard	HP 10004 (2)	A, S
Oscilloscope	Frequency Range: dc to 50 MHz Time Base: 1 μs/Div to 10 ms/Div Time Base Accuracy: ±3% Dual Channel, Alternate Operation: ac or dc coupling External Sweep Mode Voltage Accuracy Sensitivity: 0.005V/Div	HP 180A with HP 1801 Vertical Amplifier, and HP 1821A Horizontal Amplifier	P, A, S
Digital Voltmeter	Voltage Accuracy: ±02.% Range Selection: Manual or Automatic Voltage Range: 1 – 1000 Vdc full scale Input Impedance: 10 megohms Polarity: Automatic indication	HP 3440A Digital Voltmeter with HP 3443A Plug-in	P, A, S
Frequency Counter	Frequency Range: 10 kHz – 15 MHz Accuracy: ±0.001% Sensitivity: 100 mVrms Readout Digits: ≥7 digits	HP 5245L Frequency Counter	P, A
Power Supply	Output Voltage: Variable, 0 – 32 Vdc Output Current: 0 – 40 mA Meter Resolution: ≥5 mV	HP 6215A Power Supply	S
Generator/Sweeper	.1 to 110 MHz	HP 3601A (no substitute)	P, A, S
Test Oscillator	10 Hz to 10 MHz 3.16V maximum into 50 ohms	HP 651B	P, S
Temperature controlled oven	Adjustable from 0° to 55°C.		P
Logic Probe	Clips on integrated circuits and gives visible indication of state (high or low) of all pins.	HP 10528A	S
RF Detector	.1 MHz to 1.2 GHz 50 ohm input	HP 8471A	S

Table 1-2. Test Equipment and Accessories List (Cont.)

Item	Critical Specifications	Model Number	Use*
Cable Assembly (3)	BNC Male to Dual Banana Plug, 45 inches long.	HP 11001A	P, A, S
Cable Assembly (7)	Male BNC Connectors 48 inches long	HP 10503A	P, A, S
Service Kit	Consisting of: 60 pin extender board 08600-60020 30 pin extender board 08600-60021	08600-60018	S
*P = Performance Tests, A = Adjustments, S = Service			

SECTION II
INSTALLATION

2-1. INITIAL INSPECTION

2-2. Mechanical Check

2-3. Check the shipping carton for evidence of damage immediately after receipt. If there is any visible damage to the carton, request the carrier's agent to be present when the instrument is unpacked. Inspect the model 8600A for physical damage such as bent or broken parts and dents or scratches. If damage is found refer to paragraph 2-6 for recommended claim procedures. If the model 8600A appears undamaged, perform the electrical check (see paragraph 2-4). The packaging material should be retained for possible future use.

2-4. Electrical Check

2-5. The electrical performance check consists of following the procedures listed in paragraphs 4-10 to 4-15. These procedures allow the operator to determine that the instrument is, or is not, operating within the specifications listed in Table 1-1. The initial performance and accuracy of the instrument are certified as stated on the inside front cover of this manual. If the model 8600A does not operate as specified, refer to paragraph 2-6 for the recommended claim procedure.

2-6. CLAIMS FOR DAMAGE

2-7. If physical damage is found when the instrument is unpacked notify the carrier and the nearest Hewlett-Packard Sales/Service Office immediately. The Sales/Service Office will arrange for repair or replacement without waiting for a claim to be settled with the carrier.

2-8. The warranty statement for the model 8600A is on the inside front cover of this manual. Contact the nearest Sales/Service Office for information about warranty claims.

2-9. PREPARATION FOR USE

CAUTION

Before applying power check the rear panel slide switch for proper position (115 or 230 volts).

2-10. Power Requirements

2-11. The model 8600A Digital Marker may be operated on 115 or 230 volts ac ±10% at 50 to 400 cycles, single phase. Power required is about 35 watts. The 115/230 volt slide switch on the rear of the instrument must be in the correct position to avoid damage to the instrument. When shipped, the instrument is set for 115 volt ac operation.

2-12. Power Cable

2-13. To protect operating personnel, the National Electrical Manufacturers Association (NEMA) recommends that the instrument panel and cabinet be grounded. This instrument is equipped with a detachable three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cable three-prong connector is the ground connection. When using a three-prong to two-prong adapter the ground lead on the adapter should be grounded to retain the safety feature.

2-14. Operating Environment

2-15. The model 8600A does not require forced air cooling when operating at temperatures from 0 to 55°C (32 to 131°F). Normal air circulation will maintain a reasonable temperature within the instrument.

2-16. Bench Operation

2-17. The model 8600A has plastic feet and a foldaway tilt stand for convenience in bench operation. The tilt stand permits inclining the instrument for ease in viewing the front panel indicators. The plastic feet are shaped to provide clearance for air circulation and to make modular cabinet width instruments self-aligning when stacked. The instrument may also be rack mounted.

2-18. STORAGE AND SHIPMENT

2-19. Original Packaging

2-20. The same containers and materials used in factory packaging can be obtained through the

Hewlett-Packard Sales/Service Offices listed at the end of this manual.

2-21. If the model 8600A is being returned to Hewlett-Packard for servicing, attach a tag indicating the type of service required, return address, model number and full serial number. Also mark the container FRAGILE to assure careful handling.

2-22. In any correspondence refer to the instrument by model number and full serial number.

2-23. Other Packaging Materials

2-24. The following general instructions should be used for repackaging with commercially available materials.

a. Wrap the instrument in heavy paper or plastic. (If shipping to a Hewlett-Packard Service Office or center, attach a tag indicating the type of service required, return address, model number and full serial number.)

b. Use a strong shipping container. A double-wall carton made of 350 pound test material is adequate.

c. Use enough shock-absorbing material (three to four inch layer) around all sides of the instrument to provide firm cushion and prevent movement inside the container. Protect the control panel with cardboard.

d. Seal the shipping container securely.

e. Mark the shipping container FRAGILE to assure careful handling.

OPERATION

SECTION III
OPERATION

3-1. INTRODUCTION

3-2. This section provides operating instructions for the HP Model 8600A Digital Marker.

3-3. Operating instructions for the Generator/Sweeper, which must be interconnected with the model 8600A, are not included in this manual except as required in initial setup and operation. The operator should be thoroughly familiar with the Generator/Sweeper or have the approriate manual on hand.

3-4. PANEL FEATURES

3-5. Front and rear panel controls, indicators and connectors of the model 8600A are identified in Figure 3-1.

3-6. OPERATING INSTRUCTIONS

3-7. In view of the simplicity of operation of the model 8600A, the Operator's Checks provide adequate information to assure proper operation of the instrument. However, the operator should experiment with the instrument in order to become more familiar with its operation.

3-8. The model 8600A/8601A may be used with any display which can be swept by an external device. The operator's checks include instructions for using the model 8600A/8601A with the HP Model 180A Oscilloscope, the HP Model 8407A Network Analyzer, and the HP Model 7005 X-Y Recorder.

3-9. OPERATOR'S CHECKS

3-10. During checkout at the factory, the model 8600A is adjusted for proper operation. No adjustment should be required prior to use. The following procedures verify proper operation of the instrument.

a. Interconnect the equipment as shown in Figures 3-2, 3-3 or 3-4.

b. Set the slide switch on the rear panel to be compatible with the available line voltage and apply power.

3-11. OSCILLOSCOPE INSTRUCTIONS

3-12. Connect the equipment as shown in Figure 3-2. The output response of any device within the frequency range of the Generator/Sweeper may be displayed on the oscilloscope CRT. The response curve shown in Figure 3-2 is that of a 50 MHz bandpass filter; the model 8601A Generator/Sweeper is in symmetrical mode and is being swept from 45 to 55 MHz.

3-13. With the model 8600A operating in the scope mode, position the markers on the response curve at the points to be counted. If vertical markers are desired the Y-Axis output of the model 8600A must be connected to the oscilloscope vertical input (use BNC Tee).

3-14. Depress the PUSH TO COUNT switches one at a time and note that the counter counts the frequency at the brightest marker dot on the response curve.

3-15. NETWORK ANALYZER INSTRUCTIONS

3-16. Connect equipment as shown in Figure 3-3.

3-17. The output response of any device within the frequency range of the Generator/Sweeper may be displayed on the model 8412A CRT. The display may be amplitude or phase, or both. The response shown in Figure 3-3 is the amplitude display of a 50 MHz bandpass filter being swept from 45 MHz to 55 MHz. The model 8600A is being operated in the SCOPE mode.

3-18. With the model 8600A operating in the SCOPE mode, position the markers on the response curve at the points to be counted.

3-19. At slow sweep rates the markers may not appear because the scan ramp is stopped only a short time compared to the length of the sweep. When this occurs vertical markers may be made to appear on the response curve by adjusting the MARKER HEIGHT control. The positive-going marker is for the frequency being counted. The negative markers identify the markers not selected for counting to avoid ambiguity.

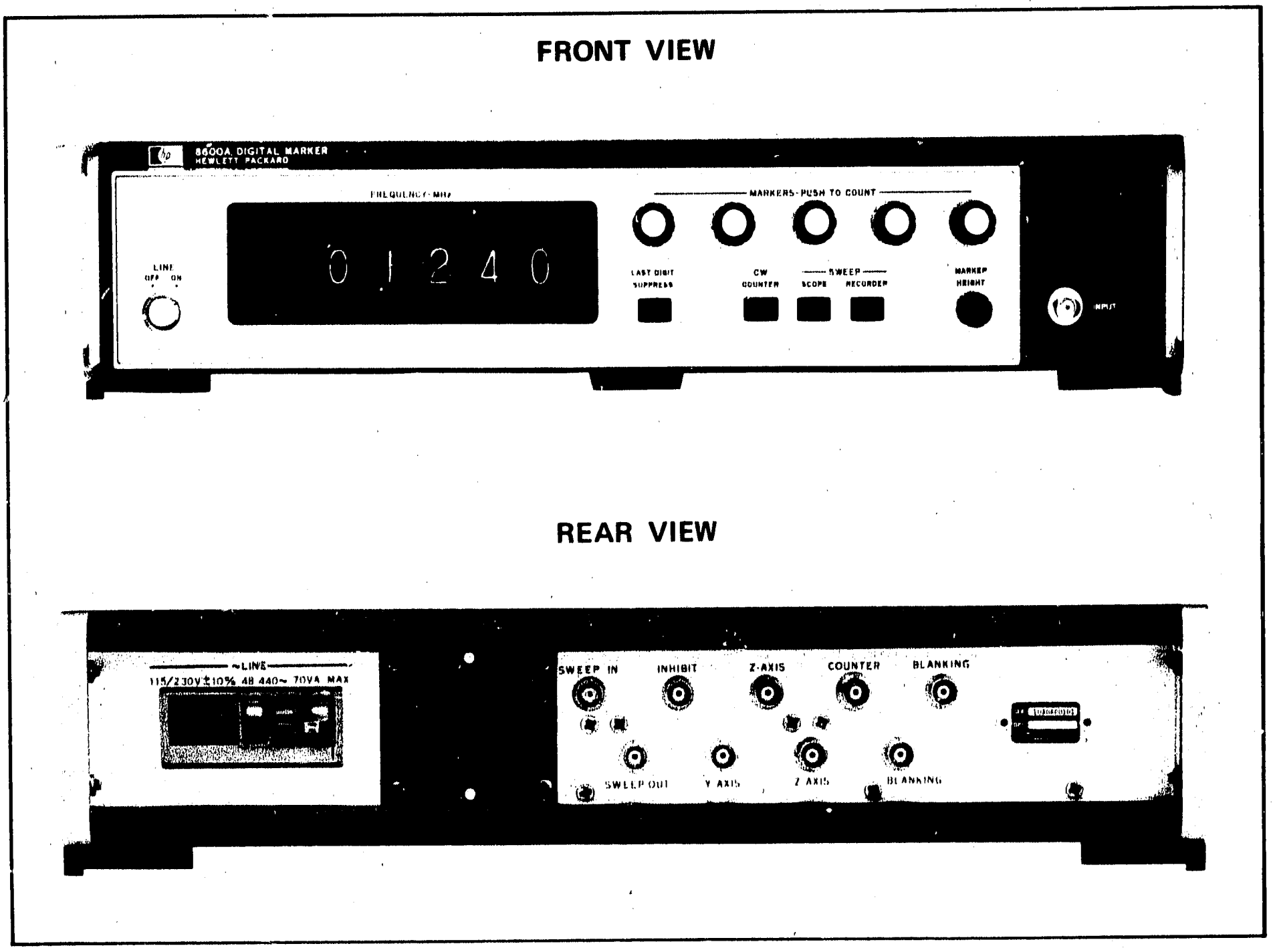


Figure 3-1. Digital Marker Controls, Connectors and Indicators

3-20. Depress the PUSH TO COUNT switches one at a time and note that the counter counts the frequency at the brightest marker dot (or the positive marker) on the response curve.

3-21. X-Y RECORDER INSTRUCTIONS

3-22. Connect equipment as shown in Figure 3-4.

Note

Before placing the model 8600A in the RECORDER mode set the marker position controls to the frequency points of interest in the SCOPE mode.

3-23. The output response of any device within the frequency range of the Generator/Sweeper may be displayed on an X-Y recorder. The display will be that of the response curve with positive and negative markers to identify the markers. As with the Network Analyzer mode, the positive marker identifies the marker being counted and the negative markers identify the markers not counted. The response shown in Figure 3-4 is that of a 50 MHz bandpass filter being swept from 45 MHz to 55 MHz.

3-24. Because the response of X-Y recorders is slow, the SLOW sweep mode (and slow sweep rate) of the Generator/Sweeper must be used.

3-25. Depress the PUSH TO COUNT switches one at a time and note that the counter counts the frequency at the positive marker.

3-26. Last Digit Suppress

3-27. The last digit suppress pushbutton switch on the front panel allows the operator to blank the least significant digit in the numerical readout.

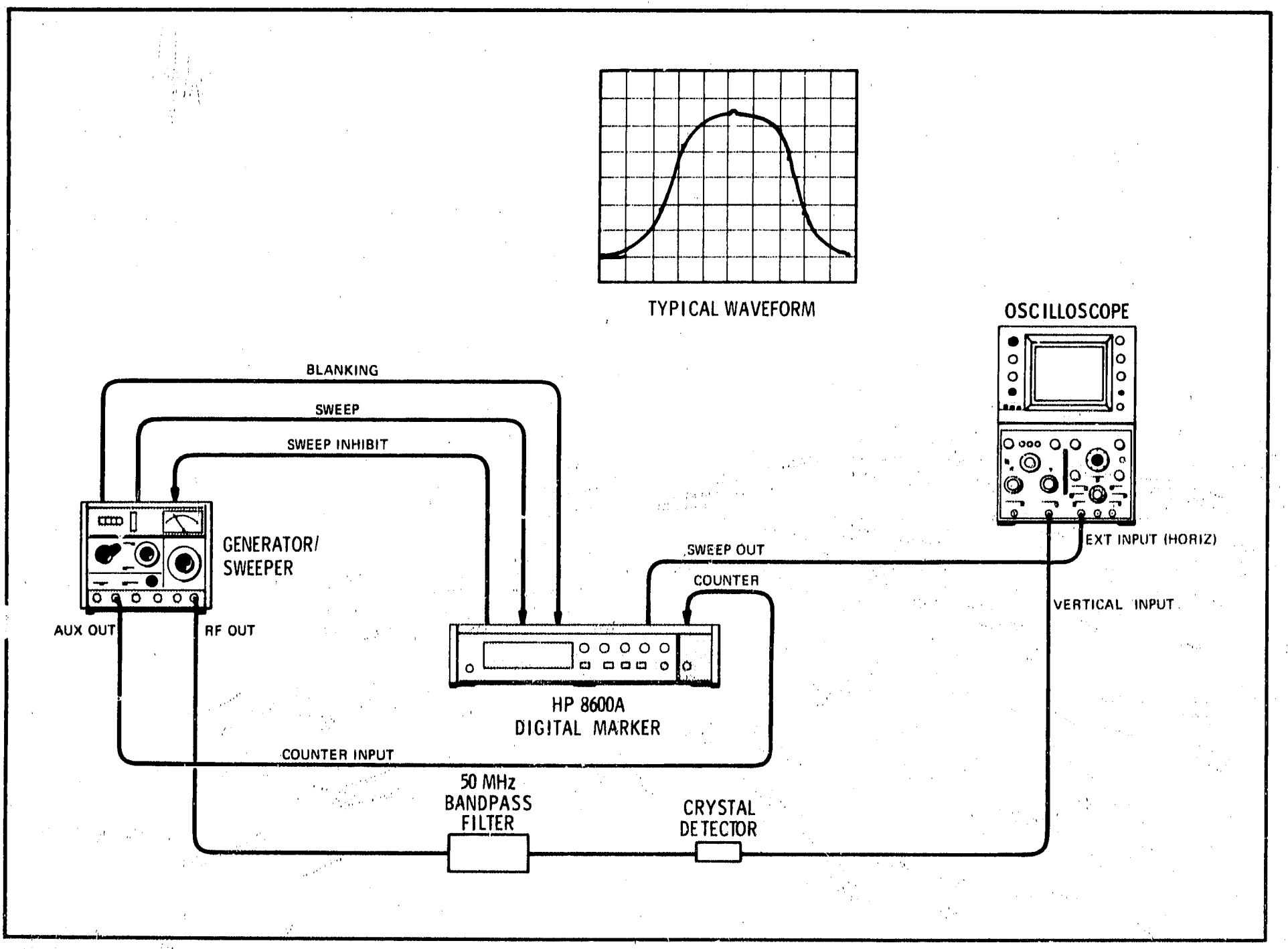


Figure 3-2. Oscilloscope Interconnections and Typical Waveform

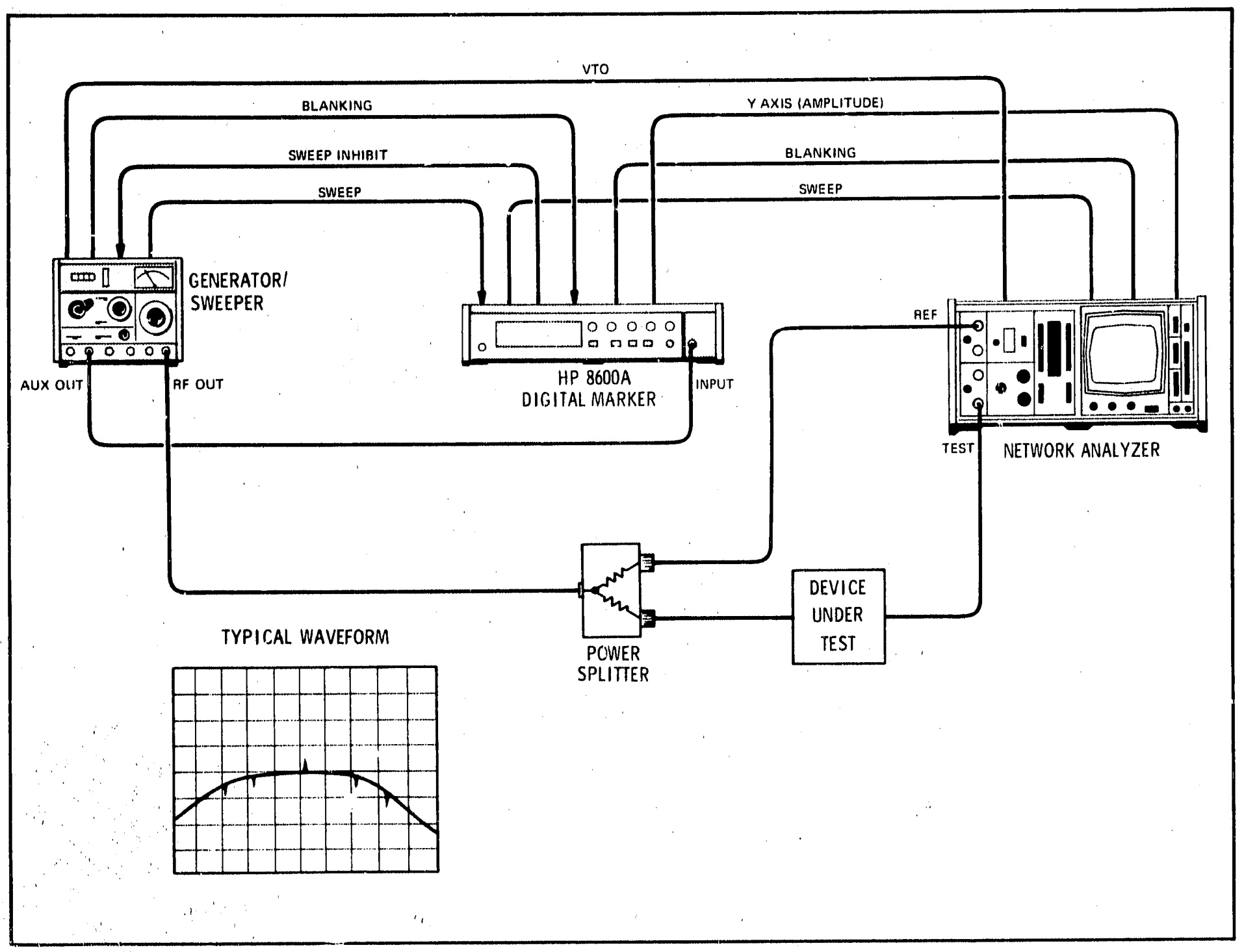


Figure 3-3. Network Analyzer Interconnections and Typical Waveform

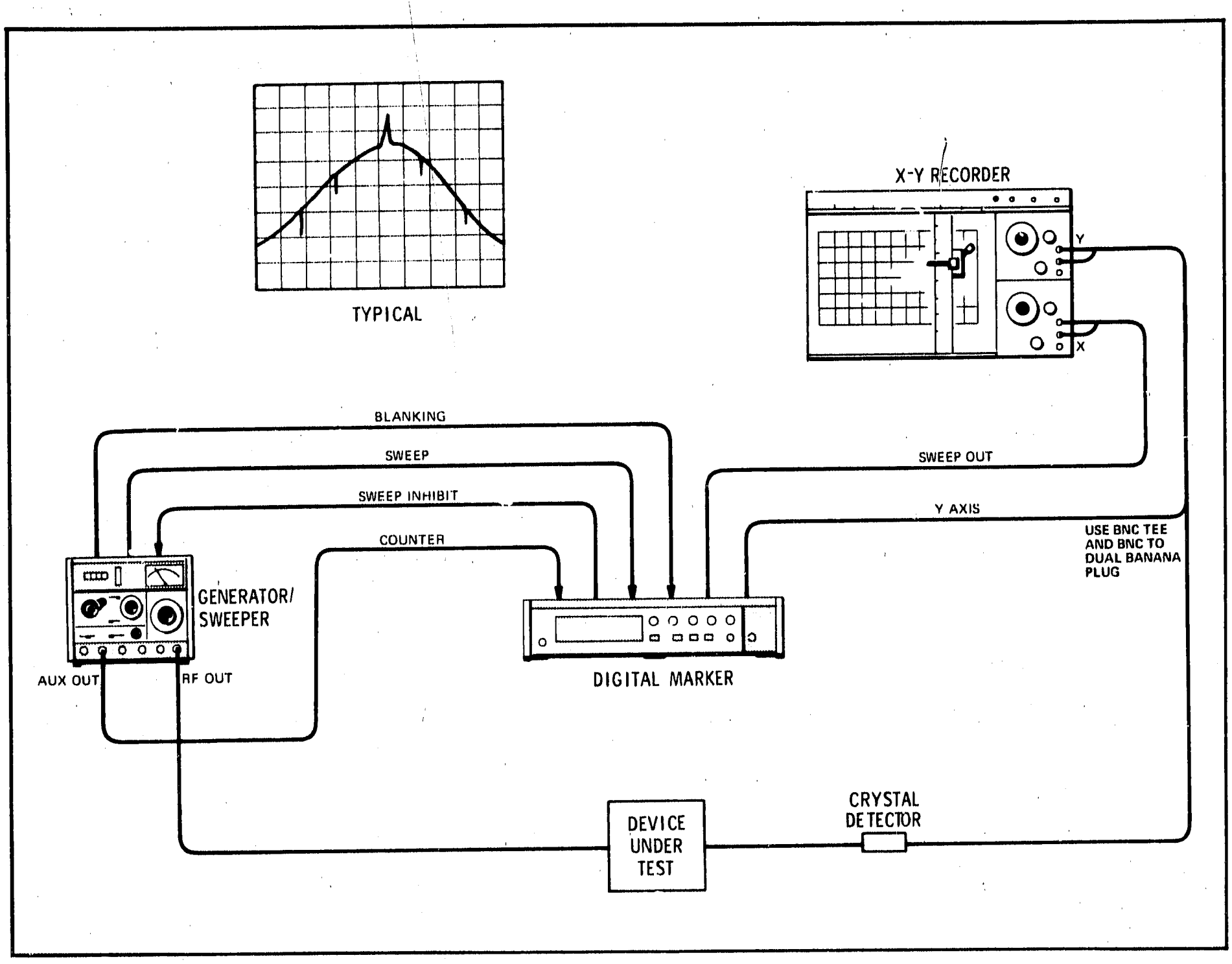


Figure 3-4. X-Y Recorder Interconnections and Typical Display

PERFORMANCE CHECK

SECTION IV
PERFORMANCE TESTS

4-1. INTRODUCTION

4-2. This section provides instructions for performance testing the Model 8600A Digital Marker.

4-3. Performance Tests

4-4. Purpose. The performance test procedures are used to check instrument performance for incoming inspection and periodic evaluation. The tests are designed to verify published specifications for the instrument. Each test applies directly to a listed specification (see Table 1-1).

4-5. Each performance test procedure begins by repeating the specification which it verifies. Next, a description of the test and any special instructions are listed.

4-6. All tests must be made with the model 8600A interconnected with a HP Model 8601A Generator/Sweeper which is known to be functioning properly.

4-7. Test Equipment Required. The test equipment required for performance testing are listed in Table 1-2 and in the individual tests. Test instruments other than those listed may be used providing their performance equals or exceeds the critical specifications listed in Table 1-2.

4-8. Front Panel Checks and Adjustments. Refer to paragraph 3-9, Operator's Checks.

4-9. PERFORMANCE TESTS

PERFORMANCE TESTS

4-10. Marker Accuracy

Specification:

Any marker may be placed at a desired frequency ± (0.05% of sweep width + sweeper stability).

Description:

Marker accuracy is verified by comparing a count made in the COUNTER mode (CW input) with a selected marker count made with a swept input in SCOPE mode.

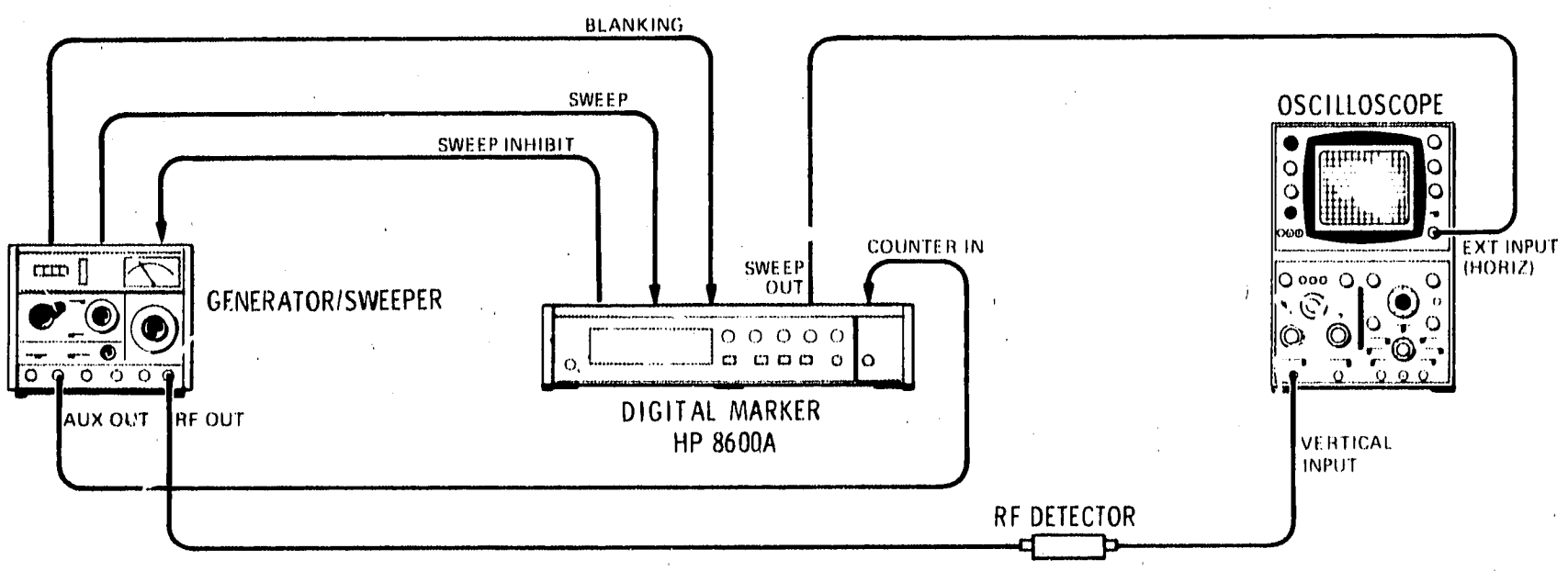


Figure 4-1. Marker Accuracy Test Setup

Equipment:

Generator Sweeper	HP 8601A
RF Detector	HP 8471A
Oscilloscope	HP 180A

Procedure:

1. Connect the equipment as shown in Figure 4-1 and set the controls as follows:

Generator/Sweeper:

SWEEP MODE	FAST	OUTPUT LEVEL	+10 dBm
FREQUENCY	any	MODE	CW
		RANGE	110

PERFORMANCE TESTS

4-10. Marker Accuracy (Cont.)

Digital Marker
MODE . . . . . COUNTER

Oscilloscope
VOLTS/DIV 1

2. Connect a passive device having a known response curve between the Generator/Sweeper RF OUT and the crystal detector. Connect the crystal detector output to the oscilloscope input.

3. Tune the Generator/Sweeper (in CW mode) to a known frequency on the response curve and record the frequency displayed on the model 8600A.

4. Place the Generator/Sweeper in the symmetrical, video, or full sweep mode (depending on the characteristics of the device under test). Place the Digital Marker in the SCOPE mode and adjust the oscilloscope to display the response curve of the device under test.

5. Select a marker to be counted by pushing the grey pushbutton in the center of the desired marker knob. Note that the marker selected provides a brighter marker than other markers. Position the marker to the spot on the response curve at which the frequency is known. The Digital Marker numerical readout (within the limits of the specification) reads the frequency recorded in step 3.

4-11. Marker Separation

Specification:
Minimum marker separation: Approximately one percent of display width.

Description:
This test verifies that any two markers may be positioned adjacent to each other within a minimum separation of one percent of the display width.

Equipment:
Generator Sweeper . . . . . HP 8601A
Oscilloscope . . . . . HP 180A

Procedure:
1. Connect the equipment as shown in Figure 4-2 and set the controls as follows:

Generator/Sweeper:
SWEEP . . . . . FULL
SWEEP MODE . . . . . FAST
RANGE 110

Oscilloscope
MAGNIFIER X10
DISPLAY . . . . . EXT CAL

PERFORMANCE TESTS

4-11. Marker Separation (Cont.)

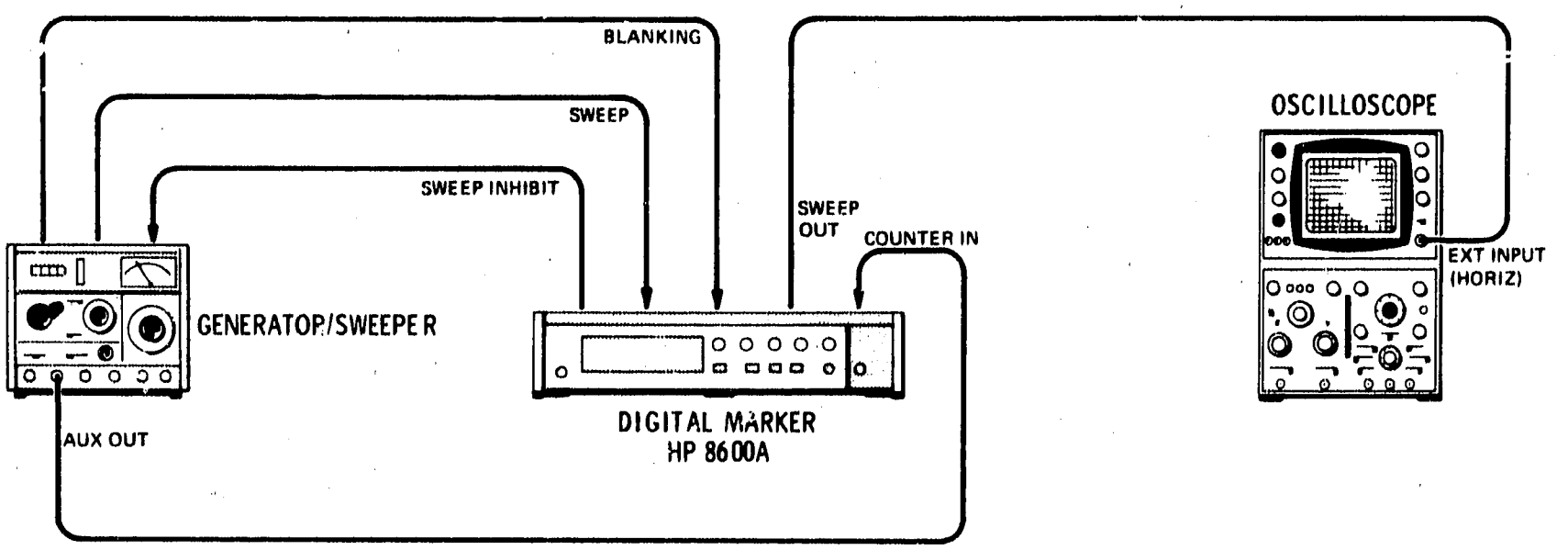


Figure 4-2. Marker Separation Test Setup

2. Place any two markers as close together on the oscilloscope CRT as they can be placed without interaction. (Frequency is unimportant in this test.)

3. Alternately depress the selected markers. Note that the counter readout indicates that the markers are within one percent or less of the display width of each other.

4-12. Frequency Measurement Range and Gate Time

Specification:

Range: 0.1 kHz to 15 MHz,
Gate Time: 10 milliseconds
Input Sensitivity: 100 millivolts rms to 10 volts rms.

Description:

This test verifies the ability of the model 8600A counter section to count frequencies between 100 Hz and 15 MHz at signal levels as low as 100 millivolts rms.

PERFORMANCE TESTS

4-12. Frequency Measurement Range and Gate Time (Cont.)

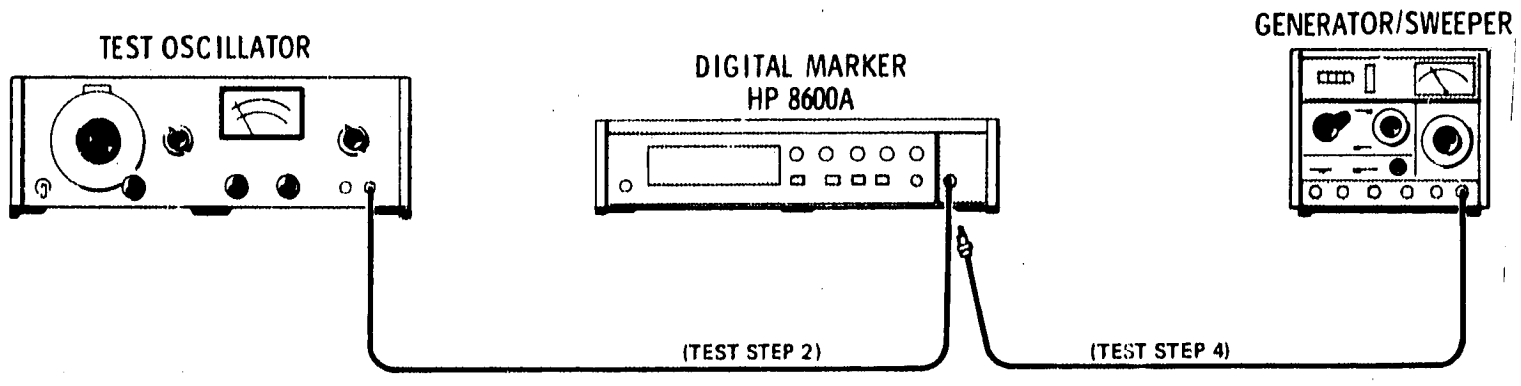


Figure 4-3. Frequency Range Test Setup

Equipment

Test Oscillator . . . . . HP 651B
Generator/Sweeper . . . . . HP 8601A

Procedure:

1. Connect equipment as shown in Figure 4-3.

2. Connect the test oscillator output (100 Hz, 100 millivolts) to the counter INPUT. Set the model 8600A to the CW COUNTER mode. Note that the counter readout is 0.0001 MHz.

3. Increase the test oscillator output to 1 volt and note that the count remains the same.

4. Connect the HF Generator (15 MHz, 100 millivolts) to the model 8600A counter INPUT. Note that the counter readout is 15 MHz.

5. Repeat the test at various frequencies between 100 Hz and 15 MHz.

PERFORMANCE TESTS

4-13. Time Base Temperature Stability

Specification:

Time Base Temperature Stability ±30 ppm (0° to +50°C); ±5 ppm (+10° to +40°C).

Description:

These tests verify time base stability over specificed operating temperature ranges.

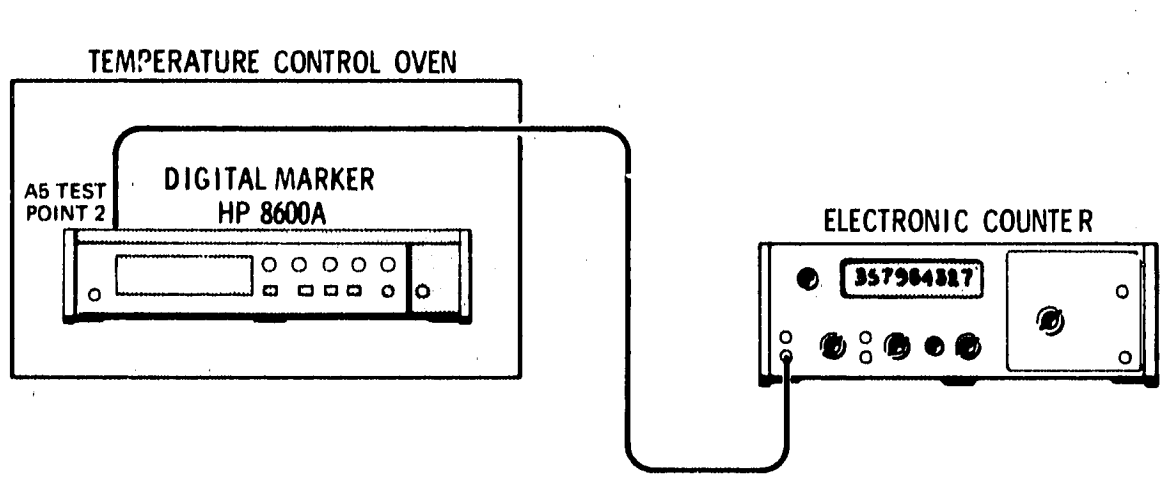


Figure 4-4. Time Base Temperature Stability Test Setup

Equipment:

Electronic Counter	HP 5245L	Temperature Controlled Oven

Procedure:

1. Remove the top cover of the model 8600A and connect the reference oscillator output (A5 Test Point 2) to the Electronic Counter.

2. Place the model 8600A in a temperature controllable oven. Set the oven temperature to +10°C and allow three hours for temperature to stabilize.

3. Measure the frequency of the model 8600A reference oscillator and record.

4. Set the oven temperature to +40°C and allow three hours for temperature to stabilize.

5. Measure the frequency of the model 8600A reference oscillator and record. The variation should not be more than 5 Hz.

6. Repeat above tests at 0°C and at +50°C. The variation should not be more than 30 Hz.

PERFORMANCE TESTS

4-14. Time Base Stability with Line Voltage Variation

Specification:

Time Base Line Voltage: <1 ppm ±10% line voltage variation.

Description:

This test verifies that the time base reference oscillator will not change frequency more than ±1 Hz when the line voltage changes ±10%.

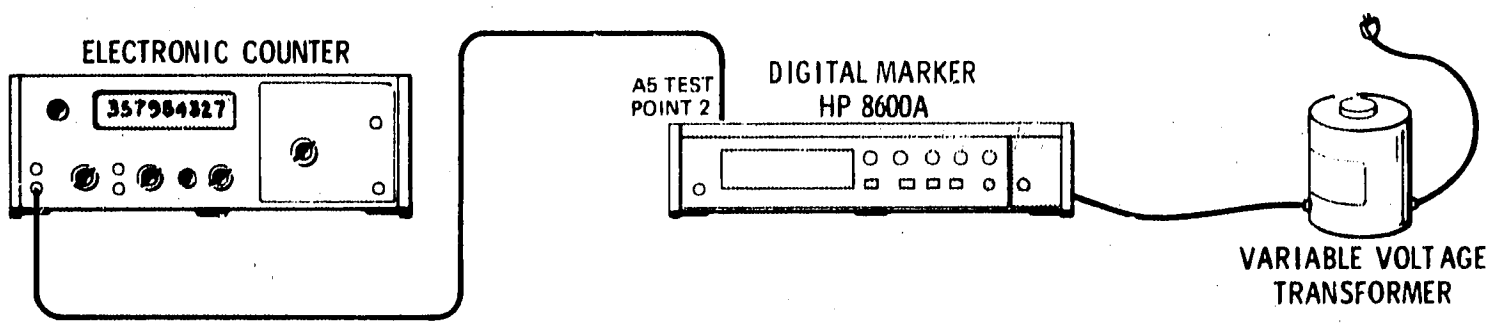


Figure 4-5. Time Base Line Voltage Stability Test Setup

Equipment:

Electronic Counter	HP 5245L
Variable Voltage Transformer	General Radio W5MT3A

Procedure:

1. Connect equipment as shown in Figure 4-6 and set line voltage to 103.5 volts.

2. Measure the 1 MHz signal from the reference oscillator (A5 Test Point 2) with the Electronic Counter and record.

3. Change the line voltage to 126.5 volts and again read and record the reference oscillator frequency.

4. The total variation should not exceed ±1 Hz.

ADJUSTMENTS

SECTION V
ADJUSTMENTS

5-1. INTRODUCTION

5-2. This section describes adjustments and checks required to return the model 8600A to peak operation capability when repairs have been made to the instrument. Included in this section are test setups and procedures. Adjustment location illustrations are provided on the first foldout in this manual.

5-3. TEST EQUIPMENT

5-4. Each test procedure in this section contains a list of test equipment to be used. Required specifications for test equipment are detailed in Table 1-2. Also, each test setup identifies all test equipment and accessories by callouts. Any equipment substituted for the instruments or accessories listed in Table 1-2 must meet the minimum specifications in order to adjust the model 8600A effectively.

5-5. HP 08600-60018 SERVICE KIT

5-6. The HP 08600-60018 Service Kit is an accessory item available from Hewlett-Packard for use in maintaining the Model 8600A Digital Marker.

5-7. Table 1-2 contains a detailed description of the contents of the service kit. Any item in the kit may be ordered separately if desired.

5-8. CHECKS AND ADJUSTMENTS

ADJUSTMENTS

5-9. Power Supplies Checks and Adjustments

Reference:
Service Sheet 8.

Description:
The power supplies in the model 8600A provide regulated outputs of -15 volts, +15 volts and +5 volts. An unregulated 200 volt supply is provided for the numerical readout devices. These checks verify proper operation of the power supplies.

Equipment:

Digital Voltmeter	HP 3440A/3443A
Variable Voltage Transformer	General Radio W5MT3A
Oscilloscope	HP 180A

Procedure:

1. Connect the model 8600A to the ac source through the variable voltage transformer and apply 115 volts ac to the model 8600A. Operate the model 8600A in the CW COUNTER mode with no rf input.

2. Connect the digital voltmeter (in turn) to A7 Test Points 1, 2, and 3. Adjust A7R17 for +15 volts at Test Point 1, A7R21 for -15 volts at Test Point 2 and A7R2 for +5 volts at Test Point 3.

Note

If any of the voltages cannot be adjusted to the right level, refer to the troubleshooting tree to localize the problem to a circuit board or assembly and to the appropriate service sheet to make needed repairs.

3. Adjust the variable voltage transformer to 103.5 volts and recheck the voltage levels at the A7 Test Points. Repeat the test at 126.5 volts. Maximum allowable change is ±20 millivolts. Record levels in the chart.

4. Check the ac ripple at A7 Test Points 1, 2 and 3. Maximum allowable ripple is 5 millivolts peak to peak. Use a 400 Hz (see Figure 5-1) low pass filter to make this measurement.

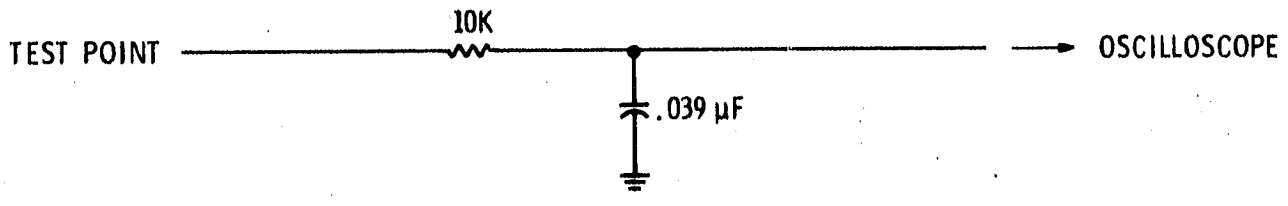


Figure 5-1. 400 Hz Low Pass Filter, Schematic

ADJUSTMENTS

5-9. Power Supplies Checks and Adjustments (Cont.)

5. Check the voltage at XA9 pin 11. Voltage should be +200 volts ±10%.

+180_____+220

	115 Volts	103.5 volts	126.5 volts	Ripple
A7TP1	+15V	_____	_____	_____
A7TP2	-15V	_____	_____	_____
A7TP3	+5V	_____	_____	_____

5-10. Reference Oscillator Checks and Adjustments

Reference:

Service Sheet 6.

Description:

The reference oscillator provides a stable 1 MHz signal which controls the timing functions of the model 8600A counter circuits. This test verifies proper operation of the reference oscillator.

Equipment:

Electronic Counter . . . . . HP 5245L

Procedure:

1. Connect the electronic counter to Test Point 2 on the time base board (A5).

2. Adjust A5C6 for a reading of 1.00000 MHz on the electronic counter.

ADJUSTMENTS

5-11. Y-Axis ZERO OUTPUT Checks and Adjustments

Reference:
Service Sheet 4.

Description:
The Y-axis circuit provides positive and negative markers for signal identification purposes. This procedure verifies proper operation of the circuit.

Equipment:

Generator/Sweeper	HP 8601A
Oscilloscope	HP 180A

Procedure:
Terminate the Y-Axis output with a 1K resistor and observe the waveform across the load. Turn the front panel MARKER HEIGHT control fully clockwise and adjust A8R16 for positive and negative markers which are equal in amplitude.

PARTS LIST

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION

6-2. This section contains information for ordering replaceable parts. Table 6-1 gives the meanings of the abbreviations and reference designations used in the table of replaceable parts.

6-3. Table 6-2 is the table of replaceable parts and is organized as follows:

a. Electrical assemblies and their component parts in alpha-numerical order by reference designation.

b. Chassis parts in alpha-numerical order by reference designation.

c. Miscellaneous parts.

d. Illustrated parts breakdowns, if appropriate.

6-4. The information given for each part consists of:

a. The Hewlett-Packard part number.

b. Total quantity (TQ) in the instrument. Total quantity for each part is given only once — at the first appearance of the part number.

c. Description of the part.

d. Typical manufacturer of the part, in a five-digit code.

e. The manufacturer's number for the part.

6-5. Table 6-3 contains the names and addresses that correspond to the manufacturer's code numbers.

6-6. ORDERING INFORMATION

6-7. To order a part listed in the replaceable parts table, quote the Hewlett-Packard part number, indicate the quantity required, and address the order to the nearest Hewlett-Packard office.

6-8. To order a part that is not listed in the replaceable parts table, include the instrument model number, instrument serial number, the description and function of the part, and the number of parts required. Address the order to the nearest Hewlett-Packard office.

Table 6-1. Reference Designators and Abbreviations

REFERENCE DESIGNATORS

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

ABBREVIATIONS

A	= amperes	H	= henries	N/O	= normally open	RMO	= rack mount only
AFC	= automatic frequency control	HDW	= hardware	NOM	= nominal	RMS	= root-mean square
		HEX	= hexagonal	NPO	= negative positive zero (zero temperature coefficient)	RWV	= reverse working voltage
AMPL	= amplifier	HG	= mercury			S-B	= slow-blow
		HR	= hour(s)			SCR	= screw
BFO	= beat frequency oscillator	Hz	= Hertz			SE	= selenium
				NPN	= negative-positive-negative	SECT	= section(s)
BE CU	= beryllium copper	IF	= intermediate freq			SEMICON	= semiconductor
BH	= binder head	IMPG	= impregnated	NRFR	= not recommended for field replacement	SI	= silicon
BP	= bandpass	INCD	= incandescent			SIL	= silver
BRS	= brass	INCL	= include(s)			SL	= slide
BWO	= backward wave oscillator	INS	= insulation(ed)	NSR	= not separately replaceable	SPG	= spring
		INT	= internal			SPL	= special
				OBD	= order by description	SST	= Stainless steel
CCW	= counterclockwise	K	= kilo = 1000			SR	= split ring
CER	= ceramic			OH	= oval head	STL	= steel
CMO	= cabinet mount only			OX	= oxide		
COEF	= coefficient	LH	= left hand				
COM	= common	LIN	= linear taper	P	= peak	TA	= tantalum
COMP	= composition	LK WASH	= lock washer	PC	= printed circuit	TD	= time delay
COMPL	= complete	LOG	= logarithmic taper	PF	= picofarads = 10^{-12} farads	TGL	= toggle
CONN	= connector	LPF	= low pass filter			THD	= thread
CP	= cadmium plate			PH BRZ	= phosphor bronze	TI	= titanium
CRT	= cathode-ray tube			PHL	= Phillips	TOL	= tolerance
CW	= clockwise	M	= milli = 10^{-3}	PIV	= peak inverse voltage	TRIM	= trimmer
		MEG	= meg = 10^{6}			TWT	= traveling wave tube
DEPC	= deposited carbon	MET FLM	= metal film	PNP	= positive-negative-positive		
DR	= drive	MET OX	= metallic oxide				
		MFR	= manufacturer	P/O	= part of		
ELECT	= electrolytic	MHz	= mega Hertz	POLY	= polystrene	μ	= micro = 10^{-6}
ENCAP	= encapsulated	MINAT	= miniature	PORC	= porcelain		
EXT	= external	MOM	= momentary	POS	= position(s)	VAR	= variable
		MOS	= metalized substrate	POT	= potentiometer	VDCW	= dc working volts
F	= farads			PP	= peak-to-peak		
FH	= flat head	MTG	= mounting	PT	= point		
FIL H	= Fillister head	MY	= "mylar"	PWV	= peak working voltage	W/	= with
FXD	= fixed					W	= watts
		N	= nano (10^{-9})	RECT	= rectifier	WIV	= working inverse voltage
G	= giga (10^{9})	N/C	= normally closed	RF	= radio frequency	WW	= wirewound
GE	= germanium	NE	= neon	RH	= round head or right hand	W/O	= without
GL	= glass	NI PL	= nickel plate				
GRD	= ground(ed)						

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1	08600-60008	1	BOARD ASSY:COUNTER	28480	08600-60008
A1C1	0180-0229	8	C:FXD ELECT 33 UF 10% 10VDCW	28480	0180-0229
A1Q1	1854-0232	4	TSTR:SI NPN(SELECTED FROM 2N3440)	28480	1854-0232
A1Q2	1854-0071	23	TSTR:SI NPN(SELECTED FROM 2N3706)	28480	1854-0071
A1R1	0757-0442	36	R:FXD MET FLM 10.0K 1% 1/8W	14674	C4
A1R2	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	C4
A1R3	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	C4
A1R4	0757-0438	30	R:FXD MET FLM 5.11K 1% 1/8W	14674	C4
A1U1	1820-0055	9	IC:TTL DECADE COUNTER	01295	SN4356
A1U2	1820-0304	1	IC:TTL J-K MASTER-SLAVE	01295	SN4464
A1U3	1820-0301	5	IC:TTL QUAD LATCH BUFF STORAGE	01295	SN4463
A1U4	1820-0077	1	IC:TTL DUAL D FF (LATCH)	01295	SN4354
A1U5	1820-0055		IC:TTL DECADE COUNTER	01295	SN4356
A1U6	1820-0301		IC:TTL QUAD LATCH BUFF STORAGE	01295	SN4463
A1U7	1820-0100	5	IC:TTL NIXIE DRIVER, DECODER	01295	SN4462
A1U8	1820-0055		IC:TTL DECADE COUNTER	01295	SN4356
A1U9	1820-0100		IC:TTL NIXIE DRIVER, DECODER	01295	SN4462
A1U10	1820-0301		IC:TTL QUAD LATCH BUFF STORAGE	01295	SN4463
A1U11	1820-0100		IC:TTL NIXIE DRIVER, DECODER	01295	SN4462
A1U12	1820-0301		IC:TTL QUAD LATCH BUFF STORAGE	01295	SN4463
A1U13	1820-0100		IC:TTL NIXIE DRIVER, DECODER	01295	SN4462
A1U14	1820-0055		IC:TTL DECADE COUNTER	01295	SN4356
A1U15	1820-0100		IC:TTL NIXIE DRIVER, DECODER	01295	SN4462
A1U16	1820-0301		IC:TTL QUAD LATCH BUFF STORAGE	01295	SN4463
A1U17	1820-0055		IC:TTL DECADE COUNTER	01295	SN4356
A2	08600-60009	1	BOARD ASSY:CONTROL	28480	08600-60009
A2CR1	1902-3404	2	DIODE BREAKDOWN:82.5V 5%	28480	1902-3404
A2CR2	1902-3404		DIODE BREAKDOWN:82.5V 5%	28480	1902-3404
A2CR3	1901-0025	31	DIODE:SILICON 100MA/1V	07263	FD 2387
A2CR4	1901-0025		DIODE:SILICON 100MA/1V	07263	FD 2387
A2CR5	1901-0025		DIODE:SILICON 100MA/1V	07263	FD 2387
A2CR6	1901-0025		DIODE:SILICON 100MA/1V	07263	FD 2387
A2CR7	1901-0025		DIODE:SILICON 100MA/1V	07263	FD 2387
A2CR8	1901-0025		DIODE:SILICON 100MA/1V	07263	FD 2387
A2Q1	1854-0232		TSTR:SI NPN(SELECTED FROM 2N3440)	28480	1854-0232
A2Q2	1854-0232		TSTR:SI NPN(SELECTED FROM 2N3440)	28480	1854-0232
A2Q3	1854-0232		TSTR:SI NPN(SELECTED FROM 2N3440)	28480	1854-0232
A2R1	0698-3157	5	R:FXD MET FLM 19.6K 1% 1/8W	14674	C4
A2R2	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	C4
A2R3	0698-3157		R:FXD MET FLM 19.6K 1% 1/8W	14674	C4
A2R4	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	C4
A2R5	0698-3157		R:FXD MET FLM 19.6K 1% 1/8W	14674	C4
A2R6	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	C4
A2R7	0757-0199	7	R:FXD MET FLM 21.5K OHM 1% 1/8W	14674	C4
A2R8	0757-0199		R:FXD MET FLM 21.5K OHM 1% 1/8W	14674	C4
A2R9	0757-0199		R:FXD MET FLM 21.5K OHM 1% 1/8W	14674	C4
A2R10	0757-0199		R:FXD MET FLM 21.5K OHM 1% 1/8W	14674	C4
A2R11	0757-0199		R:FXD MET FLM 21.5K OHM 1% 1/8W	14674	C4
A2R12	0757-0199		R:FXD MET FLM 21.5K OHM 1% 1/8W	14674	C4
A2S1	3101-1388	1	SWITCH:PUSHBUTTON DPDT 5 STATIONS	71590	PB-15
A3	08600-60003	1	BOARD ASSY:INPUT AMPLIFIER	28480	08600-60003
A3C1	0180-0197	9	C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A3C2	0180-0197		C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A3C3	0180-0197		C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A3C4	0150-0121	2	C:FXD CER 0.1 UF +80-20% 50VDCW	56289	5C50B1S-CML
A3C5	0170-0040	1	C:FXD MY 0.047 UF 10% 200VDCW	56289	192P47392-PTS
A3C6	0180-0229		C:FXD ELECT 33 UF 10% 10VDCW	28480	0180-0229
A3C7	0150-0121		C:FXD CER 0.1 UF +80-20% 50VDCW	56289	5C50B1S-CML
A3C8	0160-3459	1	C:FXD CER 0.02 UF 20% 100VDCW	56289	C023F101N203MS22CDH
A3C9	0160-2257	3	C:FXD CER 10 PF 5% 500VDCW	72982	301-000-C0H0-100J
A3C10	0160-2055	16	C:FXD CER 0.01 UF +80-20% 100VDCW	91418	TA
A3C11	0160-2257		C:FXD CER 10 PF 5% 500VDCW	72982	301-000-C0H0-100J
A3C12	0160-2055		C:FXD CER 0.01 UF +80-20% 100VDCW	91418	TA
A3C13	0160-2257		C:FXD CER 10 PF 5% 500VDCW	72982	301-000-C0H0-100J
A3C14	0160-2250	1	C:FXD CER 5.1 PF 500VDCW	72982	301-000-C0H0-519F
A3CR1	1901-0025		DIODE:SILICON 100MA/1V	07263	FD 2387
A3CR2	1901-0025		DIODE:SILICON 100MA/1V	07263	FD 2387
A3Q1	1854-0009	4	TSTR:SI NPN	80131	2N709
A3Q2	1854-0009		TSTR:SI NPN	80131	2N709
A3Q3	1854-0009		TSTR:SI NPN	80131	2N709
A3Q4	1854-0009		TSTR:SI NPN	80131	2N709
A3Q5	1854-0019	4	TSTR:SI NPN	28480	1854-0019
A3Q6	1854-0019		TSTR:SI NPN	28480	1854-0019
A3Q7	1854-0019		TSTR:SI NPN	28480	1854-0019
A3Q8	1854-0019		TSTR:SI NPN	28480	1854-0019

See introduction to this section for ordering information

Table 6-2. Replaceable Parts (Cont.)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A3Q9	1853-0020	15	TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A3Q10	1855-0062	1	TSTR:SI FET 30V	01295	2N1595
A3Q11	1854-0023	1	TSTR:SI NPN(SELECTED FROM 2N2484)	28480	1854-0023
A3Q12	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A3Q13	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A3Q14	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A3Q15	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A3R1	0683-1055	3	R:FXD COMP 1 MEGOHM 5% 1/4W	01121	CB 1055
A3R2	0683-1055		R:FXD COMP 1 MEGOHM 5% 1/4W	01121	CB 1055
A3R3	0683-1055		R:FXD COMP 1 MEGOHM 5% 1/4W	01121	CB 1055
A3R4	0698-0085	2	R:FXD MET FLM 2.61K OHM 1% 1/8W	14674	C4
A3R5	0757-0420	3	R:FXD MET FLM 750 OHM 1% 1/8W	14674	C4
A3R6	0698-3153	1	R:FXD MET FLM 3.83K 1% 1/8W	91637	MFF-1/10-32
A3R7	0757-0438		R:FXD MET FLM 5.11K 1% 1/8W	14674	C4
A3R8	0698-3459	1	R:FXD MET FLM 383K OHM 1% 1/8W	28480	0698-3459
A3R9	0757-0438		R:FXD MET FLM 5.11K 1% 1/8W	14674	C4
A3R10	0698-3158	3	R:FXD MET FLM 23.7K OHM 1% 1/8W	28480	0698-3158
A3R11	0698-3446	2	R:FXD MET FLM 383 OHM 1% 1/8W	14674	C4
A3R12	0698-3156	1	R:FXD MET FLM 14.7K OHM 1% 1/8W	14674	C4
A3R13	0757-0278	1	R:FXD MET FLM 1.78K OHM 1% 1/8W	28480	0757-0278
A3R14	0757-0438		R:FXD MET FLM 5.11K 1% 1/8W	14674	C4
A3R15	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	C4
A3R16	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	C4
A3R17	0757-0416	23	R:FXD MET FLM 511 OHM 1% 1/8W	14674	C4
A3R18	0757-0438		R:FXD MET FLM 5.11K 1% 1/8W	14674	C4
A3R19	0698-3446		R:FXD MET FLM 383 OHM 1% 1/8W	14674	C4
A3R20	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	C4
A3R21	0757-0438		R:FXD MET FLM 5.11K 1% 1/8W	14674	C4
A3R22	0757-0417	4	R:FXD MET FLM 562 OHM 1% 1/8W	14674	C4
A3R23	0757-0274	2	R:FXD MET FLM 1.21K OHM 1% 1/8W	28480	0757-0274
A3R24	0757-0417		R:FXD MET FLM 562 OHM 1% 1/8W	14674	C4
A3R25	0757-0280	24	R:FXD MET FLM 1K OHM 1% 1/8W	14674	C4
A3R26	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	14674	C4
A3R27	0757-0438		R:FXD MET FLM 5.11K 1% 1/8W	14674	C4
A3R28	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	14674	C4
A3R29	0698-0085		R:FXD MET FLM 2.61K OHM 1% 1/8W	14674	C4
A3R30	0757-0438		R:FXD MET FLM 5.11K 1% 1/8W	14674	C4
A3R31	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	14674	C4
A3R32	0757-0438		R:FXD MET FLM 5.11K 1% 1/8W	14674	C4
A3R33	0757-0438		R:FXD MET FLM 5.11K 1% 1/8W	14674	C4
A3R34	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	14674	C4
A3U1	1820-0328	2	IC:TTL QUAD 2-INPT NOR GATE	01295	SN4467
A4	08600-60005	1	BOARD ASSY:COMPARATOR	28480	08500-60005
A4C1	0160-3456	5	C:FXD CER .001 UF 10% 250VDCW	56289	C067F251F102KE12-CDH
A4C2	0160-2055		C:FXD CER 0.01 UF +80-20% 100VDCW	91418	TA
A4C3	0160-0154	2	C:FXD MICA MY 0.0022 UF 10% 200VDCW	56289	192P22292-PTS
A4C4	0140-0208	5	C:FXD MICA 680 PF 5%	72136	RDM15F681J3C
A4C5	0140-0208		C:FXD MICA 680 PF 5%	72136	RDM15F681J3C
A4C6	0140-0208		C:FXD MICA 680 PF 5%	72136	RDM15F681J3C
A4C7	0180-0197		C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A4C8	0180-0197		C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A4C9	0160-2055		C:FXD CER 0.01 UF +80-20% 100VDCW	91418	TA
A4C10	0160-2055		C:FXD CER 0.01 UF +80-20% 100VDCW	91418	TA
A4C11	0180-0373	5	C:FXD ELECT 0.68 UF 10% 35VDCW	56289	150D684X9035A2-DYS
A4C12	0180-0373		C:FXD ELECT 0.68 UF 10% 35VDCW	56289	150D684X9035A2-DYS
A4C13	0180-0373		C:FXD ELECT 0.68 UF 10% 35VDCW	56289	150D684X9035A2-DYS
A4C14	0140-0208		C:FXD MICA 680 PF 5%	72136	RDM15F681J3C
A4C15	0180-0373		C:FXD ELECT 0.68 UF 10% 35VDCW	56289	150D684X9035A2-DYS
A4C16	0140-0208		C:FXD MICA 680 PF 5%	72136	RDM15F681J3C
A4C17	0160-2055		C:FXD CER 0.01 UF +80-20% 100VDCW	91418	TA
A4C18	0180-0373		C:FXD ELECT 0.68 UF 10% 35VDCW	56289	150D684X9035A2-DYS
A4R1	0757-0288	2	R:FXD MET FLM 9.09K OHM 1% 1/8W	14674	C4
A4R2	0757-1458	6	R:FXD MET FLM 51.1K OHM 1% 1/8W	91637	MF-1/10-32
A4R3	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	14674	C4
A4R4	0757-0458		R:FXD MET FLM 51.1K OHM 1% 1/8W	91637	MF-1/10-32
A4R5	0757-0438		R:FXD MET FLM 5.11K 1% 1/8W	14674	C4
A4R6	0698-3155	6	R:FXD MET FLM 4.64K 1% 1/8W	91637	MFF-1/10-32
A4R7	0698-3155		R:FXD MET FLM 4.64K 1% 1/8W	91637	MFF-1/10-32
A4R8	0698-3155		R:FXD MET FLM 4.64K 1% 1/8W	91637	MFF-1/10-32
A4R9	0698-0083	9	R:FXD MET FLM 1.96K OHM 1% 1/8W	14674	C4

Table 6-2. Replaceable Parts (Cont.)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A4R10	0757-0279	11	R:FXD MET FLM 3.16K OHM 1% 1/8W	14674	C4
A4R11	0757-0441	15	R:FXD MET FLM 8.25K OHM 1% 1/8W	14674	C4
A4R12	0698-0083		R:FXD MET FLM 1.96K OHM 1% 1/8W	14674	C4
A4R13	0757-0279		R:FXD MET FLM 3.16K OHM 1% 1/8W	14674	C4
A4R14	0757-0441		R:FXD MET FLM 8.25K OHM 1% 1/8W	14674	C4
A4R15	0698-0083		R:FXD MET FLM 1.96K OHM 1% 1/8W	14674	C4
A4R16	0757-0279		R:FXD MET FLM 3.16K OHM 1% 1/8W	14674	C4
A4R17	0757-0441		R:FXD MET FLM 8.25K OHM 1% 1/8W	14674	C4
A4R18	0757-0438		R:FXD MET FLM 5.11K 1% 1/8W	14674	C4
A4R19	0757-0438		R:FXD MET FLM 5.11K 1% 1/8W	14674	C4
A4R20	0757-0438		R:FXD MET FLM 5.11K 1% 1/8W	14674	C4
A4R21	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	14674	C4
A4R22	0757-0441		R:FXD MET FLM 8.25K 1% 1/8W	14674	C4
A4R23	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	14674	C4
A4R24	0757-0441		R:FXD MET FLM 8.25K 1% 1/8W	14674	C4
A4R25	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	14674	C4
A4R26	0757-0441		R:FXD MET FLM 8.25K 1% 1/8W	14674	C4
A4R27	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	14674	C4
A4R28	0757-0441		R:FXD MET FLM 8.25K OHM 1% 1/8W	14674	C4
A4R29	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	14674	C4
A4R30	0757-0441		R:FXD MET FLM 8.25K OHM 1% 1/8W	14674	C4
A4R31	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	14674	C4
A4R32	0757-0441		R:FXD MET FLM 8.25K OHM 1% 1/8W	14674	C4
A4R33	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	14674	C4
A4R34	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	14674	C4
A4R35	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	14674	C4
A4R36	0757-0438		R:FXD MET FLM 5.11K 1% 1/8W	14674	C4
A4R37	0757-0438		R:FXD MET FLM 5.11K 1% 1/8W	14674	C4
A4R38	0757-0438		R:FXD MET FLM 5.11K 1% 1/8W	14674	C4
A4R39	0698-3442	6	R:FXD MET FLM 237 OHM 1% 1/8W	28480	0698-3442
A4R40	0698-3442		R:FXD MET FLM 237 OHM 1% 1/8W	28480	0698-3442
A4R41	0698-3442		R:FXD MET FLM 237 OHM 1% 1/8W	28480	0698-3442
A4R42	0698-3155		R:FXD MET FLM 4.64K 1% 1/8W	91637	MFF-1/10-32
A4R43	0698-0083		R:FXD MET FLM 1.96K OHM 1% 1/8W	14674	C4
A4R44	0757-0279		R:FXD MET FLM 3.16K OHM 1% 1/8W	14674	C4
A4R45	0757-0441		R:FXD MET FLM 8.25K OHM 1% 1/8W	14674	C4
A4R46	0757-0438		R:FXD MET FLM 5.11K 1% 1/8W	14674	C4
A4R47	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	14674	C4
A4R48	0757-0441		R:FXD MET FLM 8.25K 1% 1/8W	14674	C4
A4R49	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	14674	C4
A4R50	0757-0441		R:FXD MET FLM 8.25K OHM 1% 1/8W	14674	C4
A4R51	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	14674	C4
A4R52	0757-0438		R:FXD MET FLM 5.11K 1% 1/8W	14674	C4
A4R53	0698-3442		R:FXD MET FLM 237 OHM 1% 1/8W	28480	0698-3442
A4R54	0698-3155		R:FXD MET FLM 4.64K 1% 1/8W	91637	MFF-1/10-32
A4R55	0698-0083		R:FXD MET FLM 1.96K OHM 1% 1/8W	14674	C4
A4R56	0757-0279		R:FXD MET FLM 3.16K OHM 1% 1/8W	14674	C4
A4R57	0757-0441		R:FXD MET FLM 8.25K OHM 1% 1/8W	14674	C4
A4R58	0757-0438		R:FXD MET FLM 5.11K 1% 1/8W	14674	C4
A4R59	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	14674	C4
A4R60	0757-0441		R:FXD MET FLM 8.25K 1% 1/8W	14674	C4
A4R61	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	14674	C4
A4R62	0757-0441		R:FXD MET FLM 8.25K OHM 1% 1/8W	14674	C4
A4R63	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	14674	C4
A4R64	0757-0438		R:FXD MET FLM 5.11K 1% 1/8W	14674	C4
A4R65	0698-3442		R:FXD MET FLM 237 OHM 1% 1/8W	28480	0698-3442
A4R66 THRU R70	0698-3154	5	R:FXD MET FLM 4.22K OHM 1% 1/8W	28480	0698-3154
A4U1	1820-0201	2	INTEGRATED CIRCUIT:OPERATIONAL AMPL	04713	MC1439G
A4U2	1821-0001	5	TRANSISTOR ARRAY:SI NPN	02735	CA3046
A4U3	1821-0001		TRANSISTOR ARRAY:SI NPN	02735	CA3046
A4U4	1821-0001		TRANSISTOR ARRAY:SI NPN	02735	CA3046
A4U5	1821-0001		TRANSISTOR ARRAY:SI NPN	02735	CA3046
A4U6	1821-0001		TRANSISTOR ARRAY:SI NPN	02735	CA3046
A4U7	1820-0805	2	IC:TTL QUAD 2-INPT OR GATE	28480	1820-0205
A5	08600-60004	1	BOARD ASSY:TIME BASE	28480	08600-60004
A5C1	0180-0197		C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A5C2	0180-0197		C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A5C3	0180-0229		C:FXD ELECT 33 UF 10% 10VDCW	28480	0180-0229
A5C4	0180-0228	1	C:FXD ELECT 22 UF 10% 15VDCW	56289	150D226X9015B2-DYS
A5C5	0160-2259	1	C:FXD CER 12 PF 5% 500VDCW	72982	301-000-C0GD-120J
A5C6	0121-0036	4	C:VAR CER 5.5-18 PF	28480	0121-0036
A5C7	0160-3456		C:FXD CER .001 UF 10% 250VDCW	56289	C067F251F102KE12-CDH
A5C8	0160-2204	2	C:FXD MICA 100PF 5%	72136	RDM15F101J3C
A5C9	0160-2222	1	C:FXD MICA 1500 PF 5% 300VDCW	28480	0160-2222
A5C10	0160-3533	1	C:FXD MICA 470 PF 5% 100VDCW	00853	RDM15F471J1C
A5C11	0160-2204		C:FXD MICA 100PF 5%	72136	RDM15F101J3C

Table 6-2. Replaceable Parts (Cont.)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A5C12	0160-0157	1	C:FXD MY 0.0047 UF 10% 200VDCW	56289	192P47292-PTS
A5CR1	1901-0025		DIODE:SILICON 100MA/1V	07263	FD 2387
A5CR2	1901-0025		DIODE:SILICON 100MA/1V	07263	FD 2387
A5CR3	1901-0025		DIODE:SILICON 100MA/1V	07263	FD 2387
A5CR4	1901-0025		DIODE:SILICON 100MA/1V	07263	FD 2387
A5CR5	1901-0025		DIODE:SILICON 100MA/1V	07263	FD 2387
A5CR6	1901-0025		DIODE:SILICON 100MA/1V	07263	FD 2387
A5Q1	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A5Q2	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A5Q3	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A5Q4	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A5Q5	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A5R1	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	C4
A5R2	0757-0199		R:FXD MET FLM 21.5K OHM 1% 1/8W	14674	C4
A5R3	0757-0438		R:FXD MET FLM 5.11K 1% 1/8W	14674	C4
A5R4	0757-0438		R:FXD MET FLM 5.11K 1% 1/8W	14674	C4
A5R5	0698-3151	1	R:FXD MET FLM 2.87K OHM 1% 1/8W	28480	0698-3151
A5R6	0698-3150	2	R:FXD MET FLM 2.37K OHM 1% 1/8W	28480	0698-3150
A5R7	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	C4
A5R8	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	14674	C4
A5R9	0757-0420		R:FXD MET FLM 750 OHM 1% 1/8W	14674	C4
A5R10	0698-3150		R:FXD MET FLM 2.37K OHM 1% 1/8W	28480	0698-3150
A5R11	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	14674	C4
A5R12	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	C4
A5R13	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	C4
A5R14	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	C4
A5R15	0757-0459	4	R:FXD MET FLM 56.2K OHM 1% 1/8W	91637	MF-1/10-32
A5R16	0757-0459		R:FXD MET FLM 56.2K OHM 1% 1/8W	91637	MF-1/10-32
A5R17	0757-0438		R:FXD MET FLM 5.11K 1% 1/8W	14674	C4
A5R18	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	C4
A5R19	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	C4
A5R20	0757-0459		R:FXD MET FLM 56.2K OHM 1% 1/8W	91637	MF-1/10-32
A5R21	0757-0459		R:FXD MET FLM 56.2K OHM 1% 1/8W	91637	MF-1/10-32
A5R22	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	C4
A5R23	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	C4
A5R24	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	C4
A5U1	1820-0055		IC:TTL DECADE COUNTER	01295	SN4356
A5U2	1820-0068	1	IC:TTL TRIPLE 3-INPUT POS NAND GATE	12040	SN7410N
A5U3	1820-0076	1	IC:TTL DUAL MASTER/SLAVE FF	01295	SN4355
A5U4	1820-0054	1	IC:TTL QUAD 2-INPUT NAND GATE	01295	SN4342
A5U5	1820-0055		IC:TTL DECADE COUNTER	01295	SN4356
A5U6	1820-0055		IC:TTL DECADE COUNTER	01295	SN4356
A5U7	1820-0055		IC:TTL DECADE COUNTER	01295	SN4356
A5Y1	0410-0142	1	CRYSTAL:QUARTZ 1.0 MHZ	28480	0410-0142
A6	08600-60006	1	BOARD ASSY:INHIBIT	28480	08600-60006
A6C1	0160-2055		C:FXD CER 0.01 UF +80-20% 100VDCW	91418	TA
A6C2	0160-3456		C:FXD CER .001 UF 10% 250VDCW	56289	C067F251F102KE12-CDH
A6C3	0160-3456		C:FXD CER .001 UF 10% 250VDCW	56289	C067F251F102KE12-CDH
A6C4	0160-2055		C:FXD CER 0.01 UF +80-20% 100VDCW	91418	TA
A6C5	0160-2055		C:FXD CER 0.01 UF +80-20% 100VDCW	91418	TA
A6C6	0160-2055		C:FXD CER 0.01 UF +80-20% 100VDCW	91418	TA
A6C7	0160-2055		C:FXD CER 0.01 UF +80-20% 100VDCW	91418	TA
A6C8	0160-2055		C:FXD CER 0.01 UF +80-20% 100VDCW	91418	TA
A6C9	0180-0218	1	C:FXD ELECT 0.15 UF 10% 35VDCW	28480	0180-0218
A6C10	0180-0376	1	C:FXD ELECT 0.47 UF 10% 35VDCW	56289	150D474X9035A2-DYS
A6C11	0160-2672	2	C:FXD MY 0.047 UF 5% 80VDCW	28480	0160-2672
A6C12	0160-2672		C:FXD MY 0.047 UF 5% 80VDCW	28480	0160-2672
A6CR1	1901-0025		DIODE:SILICON 100MA/1V	07263	FD 2387
A6CR2	1901-0025		DIODE:SILICON 100MA/1V	07263	FD 2387
A6CR3	1901-0025		DIODE:SILICON 100MA/1V	07263	FD 2387
A6CR4	1901-0025		DIODE:SILICON 100MA/1V	07263	FD 2387
A6CR5	1901-0025		DIODE:SILICON 100MA/1V	07263	FD 2387
A6CR6	1901-0025		DIODE:SILICON 100MA/1V	07263	FD 2387
A6CR7	1901-0025		DIODE:SILICON 100MA/1V	07263	FD 2387
A6CR8	1901-0025		DIODE:SILICON 100MA/1V	07263	FD 2387
A6CR9	1901-0025		DIODE:SILICON 100MA/1V	07263	FD 2387
A6CR10	1902-0041	1	DIODE:BREAKDOWN 5.11V 5%	04713	SZ10939-98
A6Q1	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A6Q2	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A6Q3	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A6Q4	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A6Q5	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A6Q6	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A6Q7	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A6Q8	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071

See introduction to this section for ordering information

Table 6-2. Replaceable Parts (Cont.)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A6Q9	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A6Q10	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A6Q11	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A6Q12	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A6Q13	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A6Q14	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A6Q15	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A6Q16	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A6Q17	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A6R1	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	C4
A6R2	0698-3160	3	R:FXD MET FLM 31.6K 1% 1/8W	14674	C4
A6R3	0757-0465	4	R:FXD MET FLM 100K 1% 1/8W	14674	C4
A6R4	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	14674	C4
A6R5	0757-0440	3	R:FXD MET FLM 7.50K 1% 1/8W	14674	C4
A6R6	0757-0465		R:FXD MET FLM 100K 1% 1/8W	14674	C4
A6R7	0698-3450	2	R:FXD MET FLM 42.2K OHM 1% 1/8W	28480	0698-3450
A6R8	0757-0462	2	R:FXD MET FLM 75.0K OHM 1% 1/8W	28480	0757-0462
A6R9	0757-0438		R:FXD MET FLM 5.11K 1% 1/8W	14674	C4
A6R10	0698-3450		R:FXD MET FLM 42.2K OHM 1% 1/8W	28480	0698-3450
A6R11	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	C4
A6R12	0757-0440		R:FXD MET FLM 7.50K 1% 1/8W	14674	C4
A6R13	0757-0279		R:FXD MET FLM 3.16K OHM 1% 1/8W	14674	C4
A6R14	0757-0279		R:FXD MET FLM 3.16K OHM 1% 1/8W	14674	C4
A6R15	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	14674	C4
A6R16	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	C4
A6R17	0698-3160		R:FXD MET FLM 31.6K 1% 1/8W	14674	C4
A6R18	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	C4
A6R19	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	C4
A6R20	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	C4
A6R21	0698-3454	1	R:FXD MET FLM 215K OHM 1% 1/8W	28480	0698-3454
A6R22	0757-0438		R:FXD MET FLM 5.11K 1% 1/8W	14674	C4
A6R23	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	14674	C4
A6R24	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	14674	C4
A6R25	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	14674	C4
A6R26	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	14674	C4
A6R27	0698-3160		R:FXD MET FLM 31.6K 1% 1/8W	14674	C4
A6R28	0757-0460	1	R:FXD MET FLM 61.9K OHM 1% 1/8W	28480	0757-0460
A6R29	0757-0458		R:FXD MET FLM 51.1K OHM 1% 1/8W	91637	MF-1/10-32
A6R30	0757-0458		R:FXD MET FLM 51.1K OHM 1% 1/8W	91637	MF-1/10-32
A6R31	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	14674	C4
A6R32	0757-1094	2	R:FXD MET FLM 1.47K OHM 1% 1/8W	14674	C4 T-0
A6R33	0757-0428	2	R:FXD MET FLM 1.62K 1% 1/8W	14674	C4
A6R34	0757-0279		R:FXD MET FLM 3.16K OHM 1% 1/8W	14674	C4
A6R35	0757-0428		R:FXD MET FLM 1.62K 1% 1/8W	14674	C4
A6R36	0757-0279		R:FXD MET FLM 3.16K OHM 1% 1/8W	14674	C4
A6R37	0698-0083		R:FXD MET FLM 1.96K OHM 1% 1/8W	14674	C4
A6R38	0757-0279		R:FXD MET FLM 3.16K OHM 1% 1/8W	14674	C4
A6R39	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	14674	C4
A6R40	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	C4
A6R41	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	14674	C4
A6R42	0698-3157		R:FXD MET FLM 19.6K 1% 1/8W	14674	C4
A6R43	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	C4
A6R44	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	C4
A6R45	0698-3157		R:FXD MET FLM 19.6K 1% 1/8W	14674	C4
A6R46	0757-0462		R:FXD MET FLM 75.0K OHM 1% 1/8W	28480	0757-0462
A6R47	0698-3444	1	R:FXD MET FLM 316 OHM 1% 1/8W	28480	0698-3444
A6R48	0757-0438		R:FXD MET FLM 5.11K 1% 1/8W	14674	C4
A6R49	0698-0083		R:FXD MET FLM 1.96K OHM 1% 1/8W	14674	C4
A6R50	0698-3159	1	R:FXD MET FLM 26.1K OHM 1% 1/8W	75042	CEA
A6R51	0757-0438		R:FXD MET FLM 5.11K 1% 1/8W	14674	C4
A6U1	1820-0205		IC:TTL QUAD 2-INPT OR GATE	28480	1820-0205
A7	08600-60002	1	BOARD ASSY:REGULATOR	28480	08600-60002
A7C1	0180-0229		C:FXD ELECT 33 UF 10% 10VDCW	28480	0180-0229
A7C2	0180-0229		C:FXD ELECT 33 UF 10% 10VDCW	28480	0180-0229
A7C3	0180-0229		C:FXD ELECT 33 UF 10% 10VDCW	28480	0180-0229
A7C4	0160-3455	2	C:FXD CER 470 PF 10% 1000VDCW	56289	C067F102F471KS22
A7C5	0160-3455		C:FXD CER 470 PF 10% 1000VDCW	56289	C067F102F471KS22
A7C6	0160-3456		C:FXD CER .001 UF 10% 250VDCW	56289	C067F251F102KE12-CDH
A7C7	0180-0229		C:FXD ELECT 33 UF 10% 10VDCW	28480	180-0229
A7C8	0180-0116	2	C:FXD ELECT 6.8 UF 10% 35VDCW	56289	150D685X9035B2-DYS
A7C9	0180-0116		C:FXD ELECT 6.8 UF 10% 35VDCW	56289	150D685X9035B2-DYS
A7CR1	1901-0025		DIODE:SILICON 100MA/1V	07263	FD 2387
A7CR2	1901-0025		DIODE:SILICON 100MA/1V	07263	FD 2387
A7CR3	1901-0025		DIODE:SILICON 100MA/1V	07263	FD 2387
A7CR4	1902-0048	1	DIODE:BREAKDOWN 6.81V 5%	04713	SZ10939-134

See introduction to this section for ordering information

Table 6-2. Replaceable Parts (Cont.)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A7MP1	1205-0085	2	HEAT SINK:SEMICONDUCTOR	28480	1205-0085
A7MP2	1205-0085		HEAT SINK:SEMICONDUCTOR	28480	1205-0085
A7Q1	1854-0072	1	TSTR:SI NPN	80131	2N3054
A7Q2	1853-0001	1	TSTR:SI PNP(SELECTED FROM 2N1132)	28480	1853-0001
A7Q3	1853-0052	1	TSTR:SI PNP	80131	2N3740
A7Q4	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A7R1	0757-0420		R:FXD MET FLM 750 OHM 1% 1/8W	14674	C4
A7R2	2100-1757	3	R:VAR WW 500 OHM 5% TYPE V 1W	28480	2100-1757
A7R3	0698-0083		R:FXD MET FLM 1.96K OHM 1% 1/8W	14674	C4
A7R4	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	14674	C4
A7R5	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	14674	C4
A7R6	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	14674	C4
A7R7	0698-0082	2	R:FXD MET FLM 464 OHM 1% 1/8W	14674	C4
A7R8	0698-3155		R:FXD MET FLM 4.64K 1% 1/8W	91637	MFF-1/10-32
A7R9	0698-0082		R:FXD MET FLM 464 OHM 1% 1/8W	14674	C4
A7R10	0757-0288		R:FXD MET FLM 9.09K OHM 1% 1/8W	14674	C4
A7R11	0757-0317	1	R:FXD MET FLM 1.33K OHM 1% 1/8W	14674	C4 T-D
A7R12	0811-1552	1	R:FXD WW 0.56 OHM 5% 2W	28480	0811-1552
A7R13	0683-0565	2	R:FXD COMP 5.6 OHM 5% 1/4W	01121	CB 0565
A7R14	0757-0417		R:FXD MET FLM 562 OHM 1% 1/8W	14674	C4
A7R15	0757-0289	1	R:FXD MET FLM 13.3K OHM 1% 1/8W	28480	0757-0289
A7R16	0698-0084	2	R:FXD MET FLM 2.15K 1% 1/8W	14674	C4
A7R17	2100-1757		R:VAR WW 500 OHM 5% TYPE V 1W	28480	2100-1757
A7R18	0698-0083		R:FXD MET FLM 1.96K OHM 1% 1/8W	14674	C4
A7R19	0683-0565		R:FXD COMP 5.6 OHM 5% 1/4W	01121	CB 0565
A7R20	0698-0084		R:FXD MET FLM 2.15K 1% 1/8W	14674	C4
A7R21	2100-1757		R:VAR WW 500 OHM 5% TYPE V 1W	28480	2100-1757
A7R22	0757-0440		R:FXD MET FLM 7.50K 1% 1/8W	14674	C4
A7U1	1820-0196	3	IC:VOLTAGE REGULATOR	07263	SL8995
A7U2	1820-0196		IC:VOLTAGE REGULATOR	07263	SL8995
A7U3	1820-0196		IC:VOLTAGE REGULATOR	07263	SL8995
A8	08600-60007	1	BOARD ASSY:Y-AXIS	28480	08600-60007
A8C1	0180-1735	1	C:FXD ELECT 0.22 UF 10% 35VDCW	28480	0180-1735
A8C2	0180-0229		C:FXD ELECT 33 UF 10% 10VDCW	28480	0180-0229
A8C3	0180-0197		C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A8C4	0180-0197		C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A8C5	0160-2055		C:FXD CER 0.01 UF +80-20% 100VDCW	91418	TA
A8C6	0160-2055		C:FXD CER 0.01 UF +80-20% 100VDCW	91418	TA
A8C7	0180-2141	2	C:FXD ELECT 3.3 UF 10% 50VDCW	37942	TAS
A8C8	0180-2141		C:FXD ELECT 3.3 UF 10% 50VDCW	37942	TAS
A8C9	0180-2205	1	C:FXD ELECT 0.33 UF 10% 35VDCW	56289	150D334X9035A2-DYS
A8C10	0180-1743	1	C:FXD ELECT 0.1 UF 10% 35VDCW	56289	150D104X9035A2-DYS
A8C11	0160-0154		C:FXD MICA MY 0.0022 UF 10% 200VDCW	56289	192P22292-PTS
A8C12	0160-2055		C:FXD CER 0.01 UF +80-20% 100VDCW	91418	TA
A8C13	0160-2055		C:FXD CER 0.01 UF +80-20% 100VDCW	91418	TA
A8CR1	1901-0025		DIODE:SILICON 100MA/1V	07263	FD 2387
A8CR2	1901-0025		DIODE:SILICON 100MA/1V	07263	FD 2387
A8CR3	1901-0025		DIODE:SILICON 100MA/1V	07263	FD 2387
A8CR4	1902-3094	5	DIODE BREAKDOWN:5.11V 2%	28480	1902-3094
A8CR5	1901-0025		DIODE:SILICON 100MA/1V	07263	FD 2387
A8CR6	1901-0025		DIODE:SILICON 100MA/1V	07263	FD 2387
A8CR7	1902-3094		DIODE BREAKDOWN:5.11V 2%	28480	1902-3094
A8CR8	1902-3094		DIODE BREAKDOWN:5.11V 2%	28480	1902-3094
A8CR9	1902-3094		DIODE BREAKDOWN:5.11V 2%	28480	1902-3094
A8CR10	1902-3094		DIODE BREAKDOWN:5.11V 2%	28480	1902-3094
A8CR11	1902-3110	2	DIODE BREAKDOWN:5.90V 2%	28480	1902-3110
A8CR12	1902-3110		DIODE BREAKDOWN:5.90V 2%	28480	1902-3110
A8Q1	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A8Q2	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A8Q3	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A8Q4	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A8Q5	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A8Q6	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A8Q7	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A8Q8	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A8Q9	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A8R1	0698-3442		R:FXD MET FLM 237 OHM 1% 1/8W	28480	0698-3442
A8R2	0757-1094		R:FXD MET FLM 1.47K OHM 1% 1/8W	14674	C4 T-D
A8R3	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	C4
A8R4	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	14674	C4
A8R5	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	14674	C4
A8R6	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	C4
A8R7	0757-0458		R:FXD MET FLM 51.1K OHM 1% 1/8W	91637	MF-1/10-32
A8R8	0757-0417		R:FXD MET FLM 562 OHM 1% 1/8W	14674	C4
A8R9	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	14674	C4

See introduction to this section for ordering information

Table 6-? Replaceable Parts (Cont.)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A8R10	0757-0279		R:FXD MET FLM 3.16K OHM 1% 1/8W	14674	C4
A8R11	0757-0458		R:FXD MET FLM 51.1K OHM 1% 1/8W	91637	MF-1/10-32
A8R12	0757-0419	1	R:FXD MET FLM 681 OHM 1% 1/8W	14674	C4
A8R13	0757-0274		R:FXD MET FLM 1.21K OHM 1% 1/8W	28480	0757-0274
A8R14	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	C4
A8R15	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	C4
A8R16	2100-2517	1	R:VAR FLM 50K OHM 10% LIN 1/2W	28480	2100-2517
A8R17	0698-3158		R:FXD MET FLM 23.7K OHM 1% 1/8W	28480	0698-3158
A8R18	0757-0438		R:FXD MET FLM 5.11K 1% 1/8W	14674	C4
A8R19	0757-0465		R:FXD MET FLM 100K 1% 1/8W	14674	C4
A8R20	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	C4
A8R21	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	C4
A8R22	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	14674	C4
A8R23	0698-3158		R:FXD MET FLM 23.7K OHM 1% 1/8W	28480	0698-3158
A8R24	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	14674	C4
A8R25	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	14674	C4
A8R26	0698-3152	1	R:FXD MET FLM 3.48K 1% 1/8W	14674	C4
A8R27	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	C4
A8R28	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	C4
A8R29	0757-0438		R:FXD MET FLM 5.11K 1% 1/8W	14674	C4
A8R30	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	14674	C4
A8R31	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	14674	C4
A8R32	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	14674	C4
A8R33	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	14674	C4
A8R34	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	14674	C4
A8R35	0757-0465		R:FXD MET FLM 100K 1% 1/8W	14674	C4
A8U1	1820-0201		INTEGRATED CIRCUIT:OPERATIONAL AMPL	04713	MC1439G
A8U2	1820-0328		IC:TTL QUAD 2-INPT NOR GATE	01295	SN4467
A9	08600-60001	1	BOARD ASSY:RECTIFIER	28480	08600-60001
A9C1	0180-2102	2	C:FXD ELECT 700 UF +75-10% 25VDCW	28480	0180-2102
A9C2	0180-2102		C:FXD ELECT 700 UF +75-10% 25VDCW	28480	0180-2102
A9C3	0180-1962	1	C:FXD ELECT 15 UF +50-20% 250VDCW	56289	39D156F250EJ4-DSB
A9CR1	1901-0028	12	DIODE:SILICON 0.75A 400PIV	04713	SR1358-9
A9CR2	1901-0028		DIODE:SILICON 0.75A 400PIV	04713	SR1358-9
A9CR3	1901-0028		DIODE:SILICON 0.75A 400PIV	04713	SR1358-9
A9CR4	1901-0028		DIODE:SILICON 0.75A 400PIV	04713	SR1358-9
A9CR5	1901-0028		DIODE:SILICON 0.75A 400PIV	04713	SR1358-9
A9CR6	1901-0028		DIODE:SILICON 0.75A 400PIV	04713	SR1358-9
A9CR7	1901-0028		DIODE:SILICON 0.75A 400PIV	04713	SR1358-9
A9CR8	1901-0028		DIODE:SILICON 0.75A 400PIV	04713	SR1358-9
A9CR9	1901-0028		DIODE:SILICON 0.75A 400PIV	04713	SR1358-9
A9CR10	1901-0028		DIODE:SILICON 0.75A 400PIV	04713	SR1358-9
A9CR11	1901-0028		DIODE:SILICON 0.75A 400PIV	04713	SR1358-9
A9CR12	1901-0028		DIODE:SILICON 0.75A 400PIV	04713	SR1358-9
A9R1	0687-2241	1	R:FXD COMP 220K OHM 10% 1/2W	01121	EB 2241

Table 6-2. Replaceable Parts (Cont.)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A10	08600-60016	1	PANEL:REAR ASSY	28480	08600-60016
A10C1	0150-0119	1	C:FXD CER 2 X 0.01 UF 20% 250WVAC	56289	36C219A2-CDH
A10DS1	2140-0244	1	LAMP:GLOW MINIATURE 95V	87034	A1H
A10F1	2110-0202	1	FUSE:0.50A 250V	28480	2110-0202
A10J2	1250-0083	8	CONNECTOR:BNC	02660	31-221-1020
A10J3	1250-0083		CONNECTOR:BNC	02660	31-221-1020
A10J4	1250-0083		CONNECTOR:BNC	02660	31-221-1020
A10J5	1250-0102	2	CONNECTOR:BNC	28480	1250-0102
A10J6	1250-0083		CONNECTOR:BNC	02660	31-221-1020
A10J7	1250-0083		CONNECTOR:BNC	02660	31-221-1020
A10J8	1250-0083		CONNECTOR:BNC	02660	31-221-1020
A10J9	1250-0083		CONNECTOR:BNC	02660	31-221-1020
A10J10	1250-0083		CONNECTOR:BNC	02660	31-221-1020
A10MP1	7124-1765	1	LABEL"LINE MOD"	28480	7124-1765
A10MP2	08600-00002	1	PANEL:REAR	28480	08600-00002
A10S1	3101-1395	1	SWITCH:PUSHBUTTON DPDT-DB	76854	53-67280-121/A1H
A10T1	9100-3132	1	TRANSFORMER:POWER	28480	9100-3132
A10W1	08600-60012	1	CABLE ASSY:PRIMARY	28480	08600-60012
A10A1	08600-60011	1	BOARD ASSY:WIRING	28480	08600-60011
A10A2	5060-1189	1	POWER LINE MODULE, NON-FILTERED	28480	5060-1189
A11	08600-60010	1	BOARD ASSY:MOTHER	28480	08600-60010
A11	08600-40004	4			
A11C1	0180-2181	2	C:FXD ELECT 1300 UF +75-10% 50VDCW	56289	36D132G050AA2A-DQB
A11C2	0180-2181		C:FXD ELECT 1300 UF +75-10% 50VDCW	56289	36D132G050AA2A-DQB
A11DS1	1970-0042	6	TUBE:NUMERICAL INDICATOR	83594	B-5750-S
A11DS1	1200-0405	6	SOCKET:TUBE FOR 5700 SERIES	83594	SK 207
A11DS2	1970-0042		TUBE:NUMERICAL INDICATOR	83594	B-5750-S
A11DS2	1200-0405		SOCKET:TUBE FOR 5700 SERIES	83594	SK 207
A11DS3	1970-0042		TUBE:NUMERICAL INDICATOR	83594	B-5750-S
A11DS3	1200-0405		SOCKET:TUBE FOR 5700 SERIES	83594	SK 207
A11DS4	1970-0042		TUBE:NUMERICAL INDICATOR	83594	B-5750-S
A11DS4	1200-0405		SOCKET:TUBE FOR 5700 SERIES	83594	SK 207
A11DS5	1970-0042		TUBE:NUMERICAL INDICATOR	83594	B-5750-S
A11DS5	1200-0405		SOCKET:TUBE FOR 5700 SERIES	83594	SK 207
A11DS6	1970-0042		TUBE:NUMERICAL INDICATOR	83594	B-5750-S
A11DS6	1200-0405		SOCKET:TUBE FOR 5700 SERIES	83594	SK 207
A11J1	1250-0836	2	CONNECTOR:RF SUB-MINIATURE	98291	50-053-0000
A11J2	1250-0836		CONNECTOR:RF SUB-MINIATURE	98291	50-053-0000
A11S1	3101-1299	1	SWITCH:PUSHBUTTON DPDT	71590	PB-1
A11S2	3101-1300	1	SWITCH:PUSHBUTTON DPDT 3 STATIONS	71590	PB-20
A11XA1	1251-2316	1	CONNECTOR:PC(2 X 30) 60 CONTACT	05574	2VH30/1JV5(079)
A11XA2	1251-1636	3	CONNECTOR:JACK	28480	1251-1636
A11XA3	1251-1886	3	CONN:PC 30-CONTACT (2X15)	71785	252-15-30-340
A11XA3	1251-1558	6	CONNECTOR:PC 15 CONTACTS	28480	1251-1558
A11XA4	1251-1636		CONNECTOR:JACK	28480	1251-1636
A11XA5	1251-1558		CONNECTOR:PC 15 CONTACTS	28480	1251-1558
A11XA5	1251-1886		CONN:PC 30-CONTACT (2X15)	71785	252-15-30-340
A11XA6	1251-1636		CONNECTOR:JACK	28480	1251-1636
A11XA7	1251-1558		CONNECTOR:PC 15 CONTACTS	28480	1251-1558
A11XA7	1251-1886		CONN:PC 30-CONTACT (2X15)	71785	252-15-30-340
A11XA8	1251-1558		CONNECTOR:PC 15 CONTACTS	28480	1251-1558
A11XA9	1251-1558		CONNECTOR:PC 15 CONTACTS	28480	1251-1558
A11XA10	1251-1558		CONNECTOR:PC 15 CONTACTS	28480	1251-1558

Table 6-2. Replaceable Parts (Cont.)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
F1	2110-0201	1	FUSE:0.25A 250V SLO-BLO	71400	MDL-1/4
J1	1250-0102		CONNECTOR:BNC	28480	1250-0102
Q1	1854-0063	1	TSTR:SI NPN	80131	2N3055
R1	2100-2867	5	R:VAR WW 10K OHM 3% LIN 1.5W	28480	2100-2867
R2	2100-2867		R:VAR WW 10K OHM 3% LIN 1.5W	28480	2100-2867
R3	2100-2867		R:VAR WW 10K OHM 3% LIN 1.5W	28480	2100-2867
R4	2100-2867		R:VAR WW 10K OHM 3% LIN 1.5W	28480	2100-2867
R5	2100-2867		R:VAR WW 10K OHM 3% LIN 1.5W	28480	2100-2867
R6	2100-0968	1	R:VAR COMP 10K OHM 20% 20CCLOG 1/4W	28480	2100-0968
W1	08600-60013	2	CABLE ASSY:INPUT	28480	08600-60013
W2	08600-60013		CABLE ASSY:INPUT	28480	08600-60013
W2	8120-1348	1	CABLE ASSY:POWER, DETACHABLE	70903	KHS-7041
W2	08600-60014	1	CABLE ASSY:COMPARATOR	28480	08600-60014
W2	08600-60015	1	CABLE ASSY:MARKER	28480	08600-60015
			MISCELLANEOUS		
	0370-0125	1	KNOB:ROUND FOR 0.125" DIA SHAFT	28480	0370-0125
	0370-0450	4	KNOB:PUSHBUTTON SWITCH, BLK	71590	J52305
	0370-0451	4	BEZEL:PUSHBUTTON KNOB, BLK NYLON	28480	0370-0451
	1200-0043	1	INSULATOR:TRANSISTOR MOUNTING	71785	293011
	1251-1115	6	KEY:POLARIZING FOR CKT BD SOCKETS	71785	456-99-99-193
	7120-2547	6	PLATE:IDENTIFICATION	28480	7120-2547
	7124-1654	6	PLATE:IDENTIFICATION	28480	7124-1654
	5040-0170	14	GUIDE:PLUG-IN PC BOARD	28480	5040-0170
	08600-00006	5	SPRING	28480	08600-00006
	08600-00009	1	BRACKET	28480	08600-00009
	08600-20018	2	FRAME ALTERED	28480	08600-20018
	08600-20016	5	KNOB:ALTERED	28480	08600-20016
	08600-20019	2	INSULATOR	28480	08600-20019
	08600-40001	1	WINDOW	28480	08600-40001
	08600-40002	1	READOUT HOUSING	28480	08600-40002
	08600-40003	5	CONCENTRIC PUSHBUTTON	28480	08600-40003
	08600-40005	2	SUPPORT	28480	08600-40005
			CABINET PARTS		
	1490-0030	1	STAND:TILT	28480	1490-0030
	5000-0050	2	TRIM:SIDES	28480	5000-0050
	5000-0729	2	COVER:SIDE FM	28480	5000-0729
	5000-8637	1	COVER:TOP	28480	5000-8637
	5000-8640	1	COVER:BOTTOM	28480	5000-8640
	5060-0767	5	FOOT ASSY:FM	28480	5060-0767
	5060-0774	1	KIT:RACK MOUNT	28480	5060-0774
	08600-00001	1	PANEL:FRONT	28480	08600-00001
	08600-00003	1	DECK	28480	08600-00003
	08600-00005	1	PANEL CONNECTOR	28480	08600-00005
	08600-20017	1	PANEL FRAME	28480	08600-20017

Table 6-3. Code List of Manufacturers

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements.

Code No.	Manufacturer	Address
00853	Sangamo Electric Co. Pickens Div.	Pickens, S.C.
01121	Allen Bradley Co.	Milwaukee, Wisc.
01295	Texas Instruments Inc. Transistor Products Div.	Dallas, Texas
02660	Amphenol-Borg Electronics Corp.	Broadview, Ill.
02735	Radio Corp. of America, Semiconductor and Materials Division	Somerville, N.J.
04713	Motorola Inc, Semiconductor Products Division	Phoenix, Ariz.
05574	Viking Ind. Inc.	Canoga Park, Cal.
07263	Fairchild Camera & Inst. Corp, Semiconductor Div.	Mountain View, Cal.
12040	National Semiconductor Corp.	Danbury, Conn.
14674	Corning Glass Works	Corning, N.Y.
28480	Hewlett-Packard Co.	Palo Alto, Cal.
37942	P. R. Mallory & Co. Inc.	Indianapolis, Ind.
56289	Sprague Electric Co.	North Adams, Mass.
70903	Belden Mfg. Co.	Chicago, Ill.
71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71785	Cinch Mfg. Co. Howard B. Jones Div.	Chicago, Ill.
72136	Electro Motive. Mfg. Co., Inc.	Willimantic, Conn.
72982	Erie Technological Products Inc.	Erie, Pa.
75042	International Resistance Co.	Philadelphia, Pa.
80131	Electronic Industries Association. Standard tube or semiconductor device, any manufacturer.	
83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.
87034	Marco Industries	Anaheim, Cal.
91418	Radio Materials Co.	Chicago, Ill.
91637	Dale Electronics Inc.	Columbus, Nebr.
98291	Sealectro Corp.	Mamaroneck, N.Y.

BACK DATING MANUAL CHANGES

SECTION VII
MANUAL CHANGES

7-1. INTRODUCTION

7-2. This section will be used in future issues or revisions of this manual to provide up-dating and back-dating information.

7-3. In the interim, any necessary changes to the information contained in this manual will be documented in Manual Change Sheets shipped with the manual.

SERVICE INFORMATION

SECTION VIII
SERVICE

8-1. INTRODUCTION

8-2. This section provides instructions for testing, troubleshooting and repairing the Hewlett-Packard Model 8600A Digital Marker.

8-3. PRINCIPLES OF OPERATION

8-4. Information relative to the principles of operation appears on the foldout page opposing the Block Diagram, Service Sheet 1. This correlation of data will enable the reader to quickly relate functions to specific circuits — without having to look in different parts of the manual.

8-5. RECOMMENDED TEST EQUIPMENT

8-6. Test equipment and accessories required to maintain the model 8600A are listed in Table 1-2. If the equipment listed is not available, equipment that meets the minimum specifications shown may be substituted.

8-7. TROUBLESHOOTING

8-8. Troubleshooting procedures are divided into two maintenance levels in this manual. The first, a troubleshooting tree, is designed to isolate the cause of a malfunction to a circuit or assembly.

8-9. The second maintenance level provides circuit analysis and test procedures to aid in isolating faults to a defective component. Circuit descriptions and test procedures for the second maintenance level are located on the page facing the schematic diagram of the circuit to be repaired.

8-10. After the cause of a malfunction has been found and remedied in any circuit containing adjustable components, the applicable procedure specified in Section V of this manual should be performed.

8-11. Repair

8-12. Adjustable Components. There are five adjustable components in the model 8600A. These adjustable components are identified in Table 8-1.

8-13. Service Kit. A service kit, HP Part Number 08600-60018, is available as an aid in maintaining the model 8600A. This kit is described in Table 1-2.

8-14. Line Voltage Requirements. During adjustment and testing the model 8600A must be connected to a power source capable of delivering

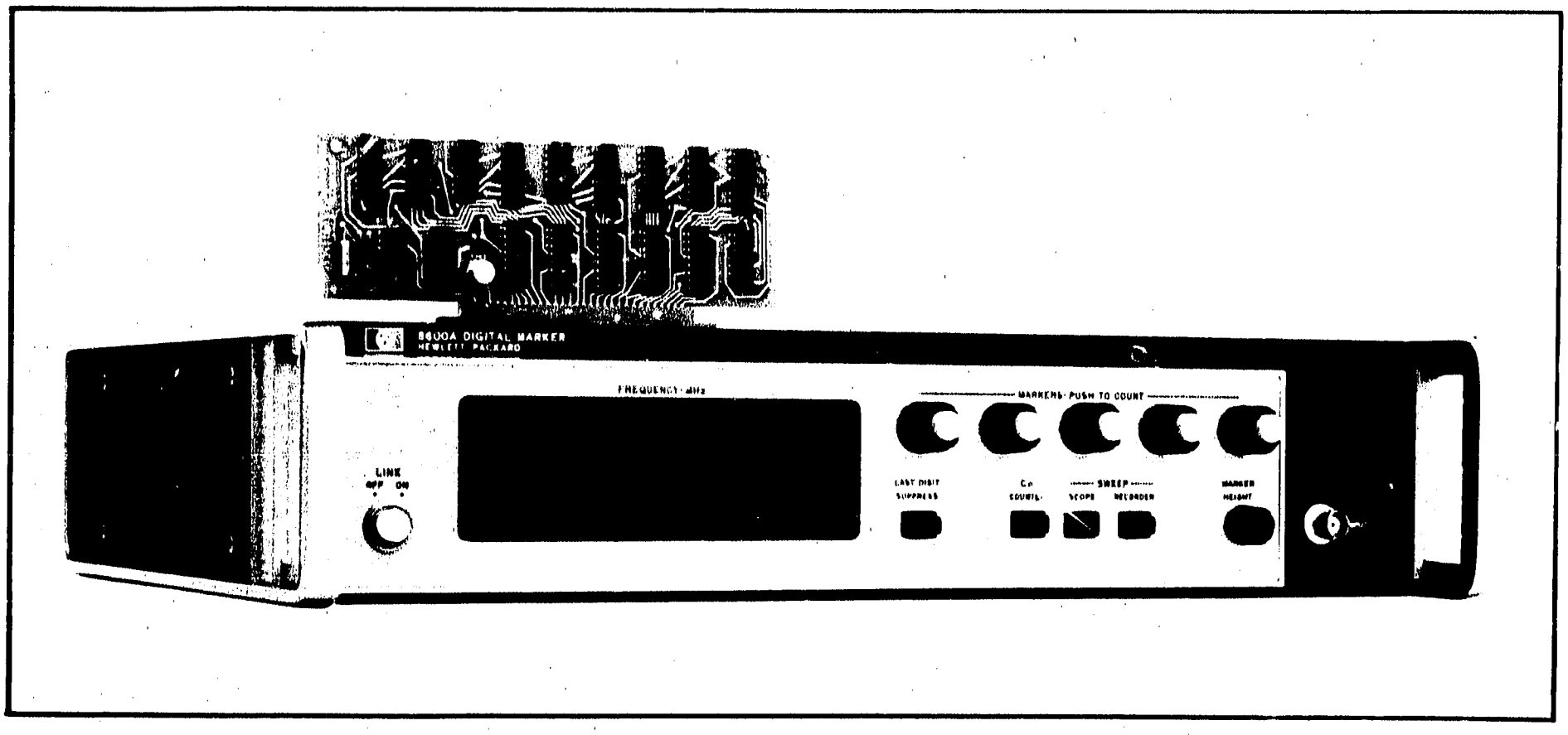


Figure 8-1. Model 8600A with Circuit Board Extended for Maintenance

Table 8-1. Adjustable Components

Designation	Circuit	Purpose
A5C6	Reference Oscillator	Adjust frequency of reference oscillator
A7R2	Voltage Regulator	Adjust +5 volt dc power supply
A7R17	Voltage Regulator	Adjust +15 volt dc power supply
A7R21	Voltage Regulator	Adjust -15 volt power supply
A8R16	Y-Axis Circuit	Adjust for equal positive and negative markers

35 watts of power at 115 or 230 volts ac ±10%, single phase. If adjustment of the dc voltage regulators is required, the model 8600A should be connected to the ac source through an adjustable autotransformer. The line voltage to the model 8600A may then be adjusted to check regulator action when the line voltage is changed ±10%.

8-15. Servicing Aids on Printed Circuit Boards. Servicing aids on printed circuit boards include test points, adjustment callouts, and assembly stock numbers with alpha-numerical revision information.

8-16. Circuit Board Extenders. Circuit board extenders, included in the service kit, may be used to extend the boards clear of the assembly to provide easy access to components and test points. See Figure 8-1 for a typical example of extender board use.

8-17. Part Location Aids. The locations of chassis mounted parts and major assemblies are shown in Figure 8-17.

8-18. The location of individual components mounted on printed circuit boards or assemblies are shown on the appropriate schematic page. The part reference designator is the assembly designation plus the part designation. (Example: A1R1 is R1 on the A1 assembly.) For specific component description and ordering information refer to the parts list in Section VI.

8-19. Diagram Notes. Table 8-2, Schematic Diagram Notes, provides information relative to symbols and values shown on schematic diagrams.

8-20. General Service Hints

8-21. The etched circuit boards used in Hewlett-Packard equipment are the plated-through type consisting of metallic conductors bonded to both sides of an insulating material. The metallic conductors are extended through the component holes by a plating process. Soldering can be performed on either side of the board with equally good results. Table 8-3 lists recommended tools and materials for use in repairing etched circuit boards. Following are recommendations and precautions pertinent to etched circuit repair work.

a. Avoid unnecessary component substitution; it can result in damage to the circuit board and/or adjacent components.

b. Do not use a high power soldering iron on etched circuit boards. Excessive heat may lift a conductor or damage the board.

c. Use a suction device (Table 8-3) or wooden toothpick to remove solder from component mounting holes.

CAUTION

Do not use a sharp metal object such as an awl or twist drill for this purpose. Sharp objects may damage the plated-through conductor.

d. After soldering, remove excess flux from the soldered areas and apply a protective coating to prevent contamination and corrosion.

8-22. Component Replacement. The following procedures are recommended when component replacement is necessary:

a. Remove defective component from board.

b. If component was unsoldered, remove solder from mounting holes with a suction device (Table 8-3) or a wooden toothpick.

Table 8-2. Schematic Diagram Notes

SCHEMATIC DIAGRAM NOTES

Refer to MIL-STD-15B for Symbols not Shown

Resistance is in ohms and capacitance is in microfarads unless otherwise noted.

P/O = part of.

*Asterisk denotes a factory-selected value. Value shown is typical. Capacitors may be omitted or resistors jumpered.

Screwdriver adjustment.

Panel control.

Encloses front panel designations.

Encloses rear panel designation.

Circuit assembly borderline.

Other assembly borderline.

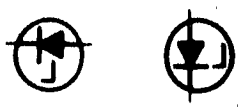
Heavy line with arrows indicates path and direction of main signal.

Heavy dashed line with arrows indicates path and direction of main feedback.

Wiper moves toward CW with clockwise rotation of control as viewed from shaft or knob.

Numbers in stars on circuit assemblies show locations of test points.

Encloses wire color code. Code used (MIL-STD-681) is the same as the resistor color code. First number identifies the base color, second number the wider stripe, and the third number identifies the narrower stripe. E.g., (947) denotes white base, yellow wide stripe, violet narrow stripe.



Voltage regulator (breakdown diode).

Denotes Field Effect transistor (FET) with N-type base.

Denotes FET with P-type base.

Denotes Capacitive diode (Varicap, varactor).

Denotes Silicon Controlled Rectifier.

P-Type Metal Oxide Substrate FET (MOSFET)

N-Type Metal Oxide Substrate FET (MOSFET)

Table 8-3. Etched Circuit Soldering Equipment

Item	Use	Specification	Item Recommended
Soldering tool	Soldering Unsoldering	Wattage rating: 47-1/2 — 56-1/2 Tip Temp: 850 — 900°	Ungar #776 handle with *Ungar #4037 Heating Unit
Soldering* Tip	Soldering Unsoldering	*Shape: pointed	*Ungar #PL111
De-soldering aid	To remove molten solder from connection	Suction device	Soldapullt by Edsyn Co., Arleta, California
Resin (flux) solvent	Remove excess flux from soldered area before application of protective coating	Must not dissolve etched circuit base board material or conductor bonding agent	Freon Aceton Lacquer Thinner Isopropyl Alcohol (100% dry)
Solder	Component replacement Circuit board repair Wiring	Resin (flux) core, high tin content (60/40 tin/lead), 18 gauge (SWG) preferred	
Protective Coating	Contamination, corrosion protection	Good electrical insulation, corrosion-prevention properties	Krylon R ** #1302 Humiseal Protective Coating, Type 1B12 by Columbia Technical Corp., Woodside 77, New York

*For working on etched Boards; for general purpose work, use Ungar #1237 Heating Unit (37.5W, tip temp of 750 — 800°) and Ungar #PL113 1/8 inch chisel tip
**Krylon, Inc., Norristown, Pennsylvania

c. Shape leads of replacement component to match mounting hole spacing.

d. Insert component leads into mounting holes and position component as original was positioned. Do not force leads into mounting holes; sharp lead ends may damage the plated-through conductor.

Note

Although not recommended when both sides of the circuit board are accessible, axial lead components such as resistors and tubular capacitors, can be replaced without unsoldering. Clip leads near body of defective component, remove component and straighten leads left in board. Wrap leads of replacement component one turn around original leads. Solder wrapped connection and clip off excess lead.

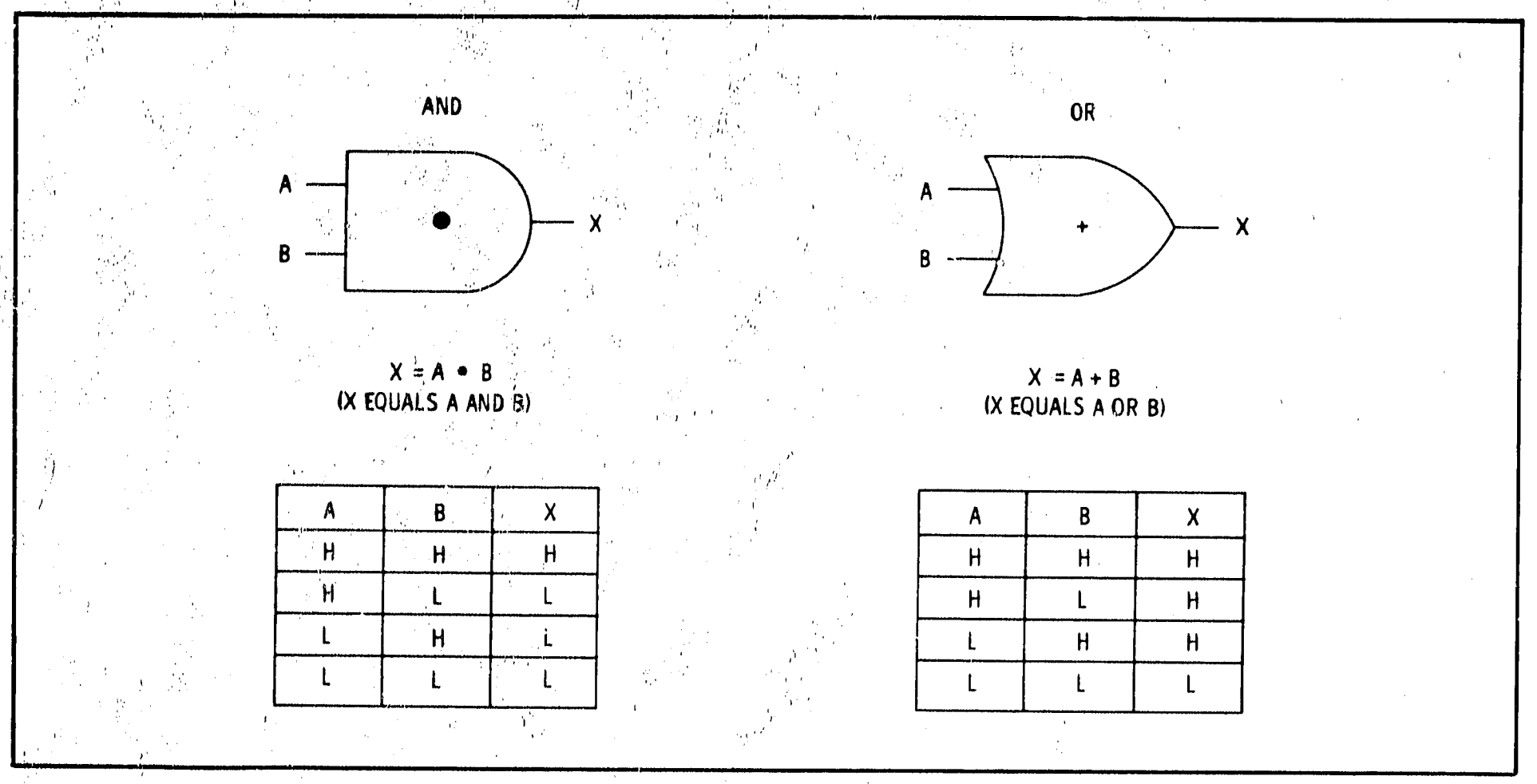
8-23. BASIC SERVICE INFORMATION

8-24. Since basic service information appears in other service manuals, it will not be repeated here.

8-25. Logic Circuits and Symbols

8-26. The following paragraphs and illustrations provide basic information about logic circuits and symbols. While a complete treatment of the subject is not within the scope of this manual, it is believed that this material will help the technician experienced with analog devices, who has had little or no experience with digital circuits.

8-27. The circuits discussed are digital in nature; their outputs are always in one of two possible states, a "1" or "0". These two states are also referred to as being either high (H) or low (L). The high and low states are relative; low must be less positive (more negative) than high, both states may be positive or negative, or high may be positive and low negative. In positive logic the



A	B	X
H	H	H
H	L	L
L	H	L
L	L	L

A	B	X
H	H	H
H	L	H
L	H	H
L	L	L

Figure 8-2. Basic AND and OR Gates

more positive (H) state is a logical "1" and the more negative (L) state is a logical "0". In negative logic the more negative (L) state is a logical "1" and the more positive (H) state is a logical "0".

8-28. Two of the basic "building blocks" of logic circuits are the AND and OR gates. The symbols and truth tables for basic AND and OR gates are shown in Figure 8-2.

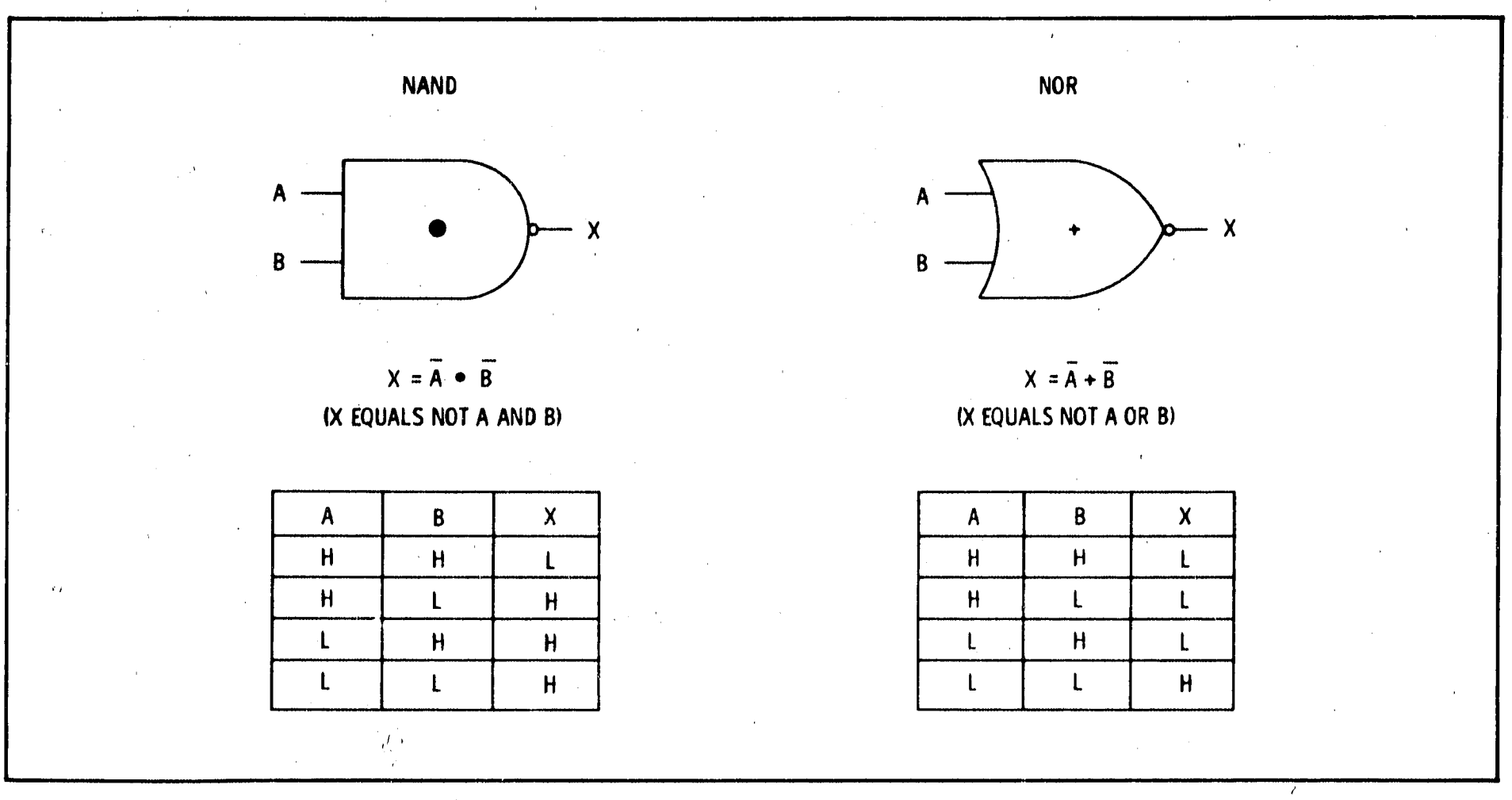
8-29. Basic AND Gate (Positive logic). The basic AND gate is a circuit which produces an output "1" when, and only when, a "1" is applied to all inputs. As shown in Figure 8-2, terminal X will be high only when terminals A and B are both high. The dot (•) shown in the AND gate is the logic term for AND. The term for a simple two input AND gate is X = A • B (X equals A and B). AND gates may be designed to have as many inputs as required to fill a specific requirement.

8-30. Basic OR Gate (Positive Logic). The basic OR gate is a circuit which produces a "1" output when any one, or all of the inputs are in a "1" state. As shown in Figure 8-2, terminal X will be high when either terminal A or terminal B, or both are high. The + shown in the OR gate symbol is the logic term for OR. The term for a simple two input OR gate is X = A + B (X equals A or B). OR gates may be designed to have as many inputs as required for specific needs.

8-31. The symbols for AND and OR gates differ in that AND gate symbols have a flat input side and a rounded output side while OR gate symbols have a concave input side and a pointed output side.

8-32. Truth Tables. Truth tables provide a means of presenting the output state of logic devices for any set of inputs in tabular form. Truth tables contain one column for each of the inputs and a column for the output. In basic truth tables the column notations are usually H or L (for high and low) or, for binary notation, "1" or "0". More complex truth tables use other terms which will be explained where these tables appear in the text.

8-33. Logic Inversion. Adding inversion to AND and OR gates changes their characteristics. Inversion is usually accomplished by adding an inverter stage (common emitter) in front of an input or after an output. A circle added to the input or output leads indicates the portion of the circuit in which the inversion takes place. The simplest of these devices are AND and OR gates in which the output is inverted. These gates are called NAND (for Not AND) and NOR (for Not OR). Basic NAND and NOR gates are shown in Figure 8-3. When all inputs and outputs of an AND gate are inverted, it functions as an OR gate. When all inputs and outputs of an OR gate are inverted, it functions as an AND gate. Figure 8-4 provides information relative to various gate inversion functions.



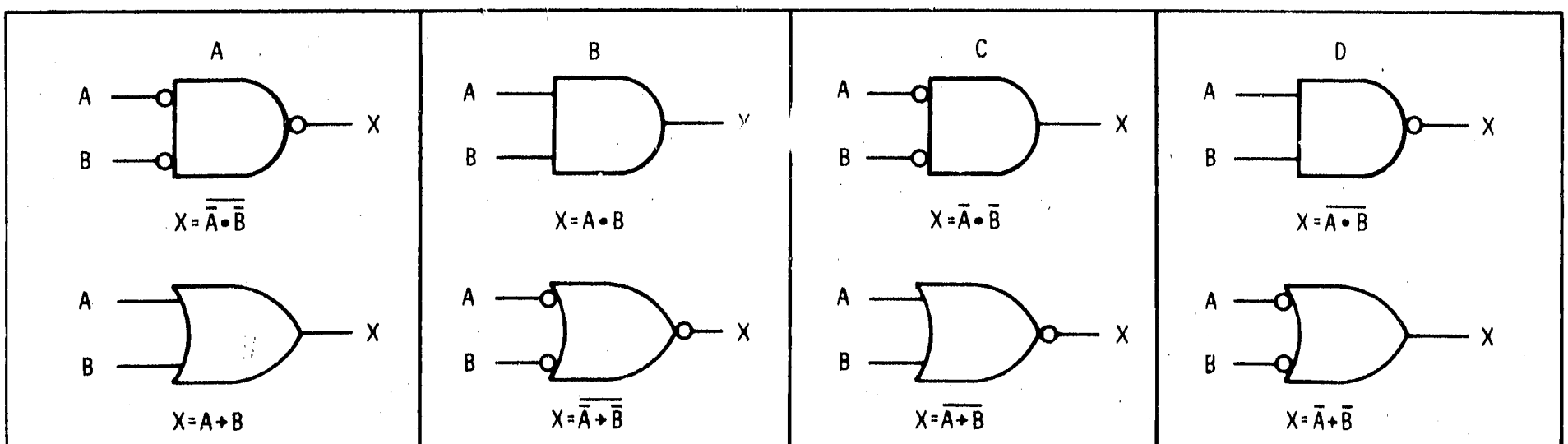
A	B	X
H	H	L
H	L	H
L	H	H
L	L	H

A	B	X
H	H	L
H	L	L
L	H	L
L	L	H

Figure 8-3. Basic NAND and NOR Gates

8-34. When inversion is used the designation at the inverted terminal is frequently termed $\overline{A}$ (not A), $\overline{B}$ (not B), $\overline{X}$ (not X), etc. Table 8-4 shows basic logic, circuits and associated symbology.

8-35. Binary Circuits. Many types of flip-flops are used in binary circuits. Each half of a flip-flop is in one of two states at any given time. The outputs are complementary; when one stage is on, the other is off. The outputs are terms 1 and 0, high and low, or true and false, by the same rules that apply to AND and OR gates. The outputs may be identified in many different ways. This text identifies these outputs as Q and



A	B	X	A	B	X	A	B	X	A	B	X
H	H	H	H	H	H	H	H	L	H	H	L
H	L	H	H	L	L	H	L	L	H	L	H
L	H	H	L	H	L	L	H	L	L	H	H
L	L	L	L	L	L	L	L	H	L	L	H

Figure 8-4. Logic Comparison Diagrams

Table 8-4. Logic Symbology

1 indicates true signal

0 indicates false signal.

o on symbol indicates logical inversion (not necessarily electrical) of the input or output signal(s). The logic indicated within the symbol remains the same.

→ indicates direction of signal flow.

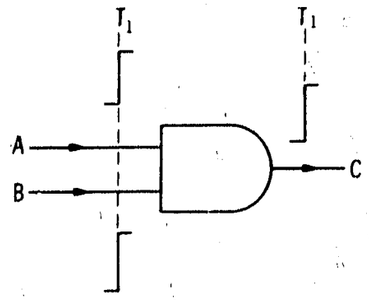
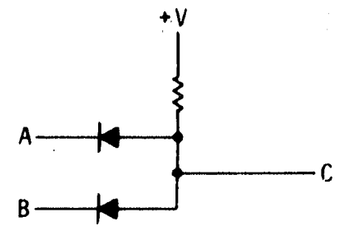
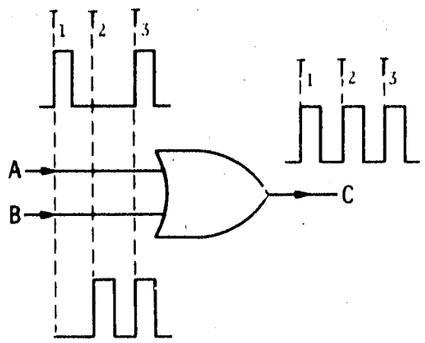
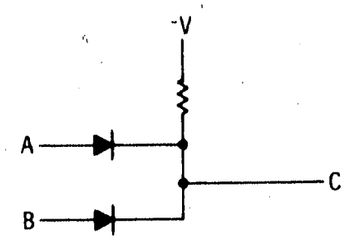
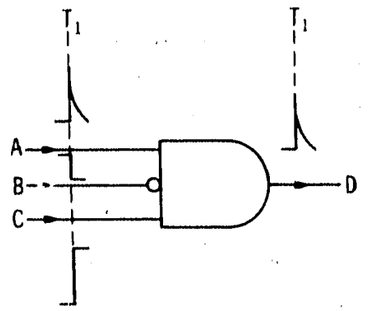
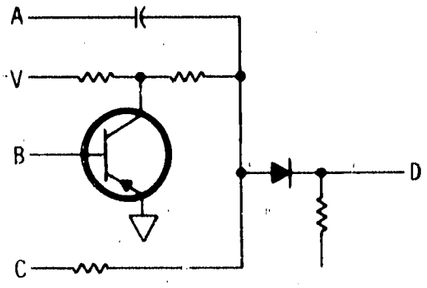
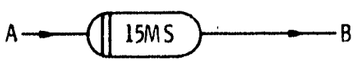
Designation	Logic Symbol	Description	Truth Table	Typical Circuit
AND Gate (Positive True)		Both input signals (A and B) must be true simultaneously to produce a true output at C.	A B C 0 0 0 0 1 0 1 0 0 1 1 1	
OR Gate (Positive True)		If either input signal (A or B) or both is true, the output at C is true.	A B C 0 0 0 0 1 1 1 0 1 1 1 1	
Multiple Input Gate (Positive True)		Any combinations of inputs may be used with an AND or OR Gate to obtain a desired output. In the AND gate shown, input B is inverted and inputs A and C are without inversion. Inputs A and C must both be true and input B must be false simultaneously to produce a true output at D.	A B C D 0 0 0 0 0 0 1 0 0 1 0 0 0 1 1 0 1 0 0 0 1 0 1 1 1 1 0 0 1 1 1 0	
Time Delay		Input signal delayed by the time indicated. True input at A produces a true output at B after a 15 ms delay.		RC and RL Coupling

Table 8-4. Logic Symbology (Cont.)

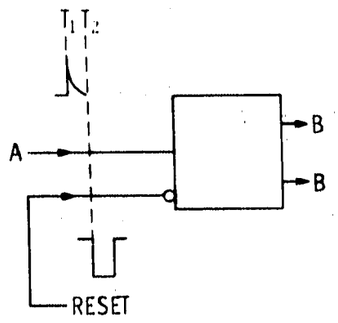
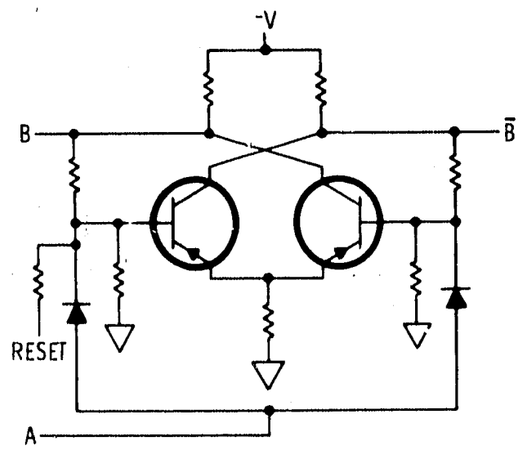
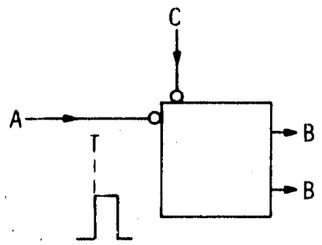
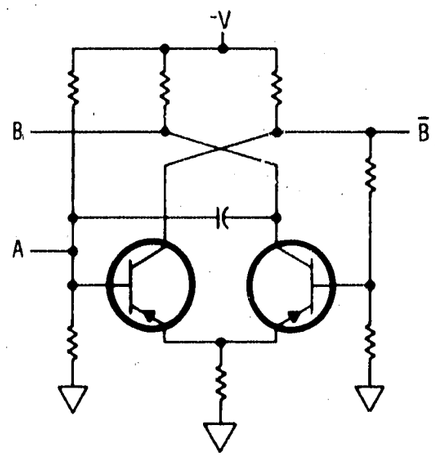
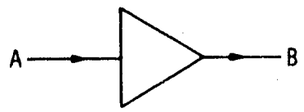
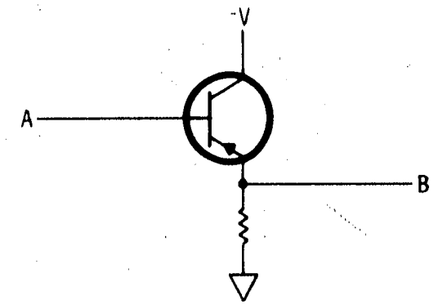
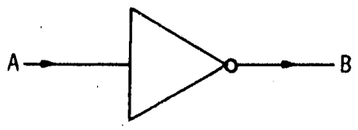
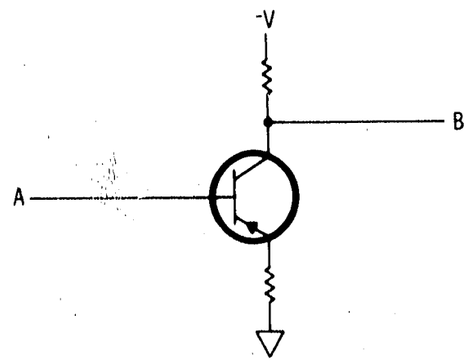
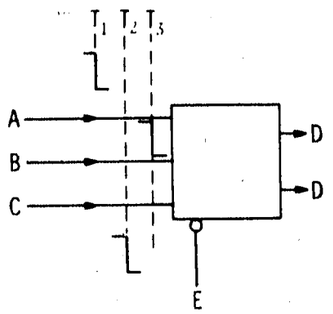
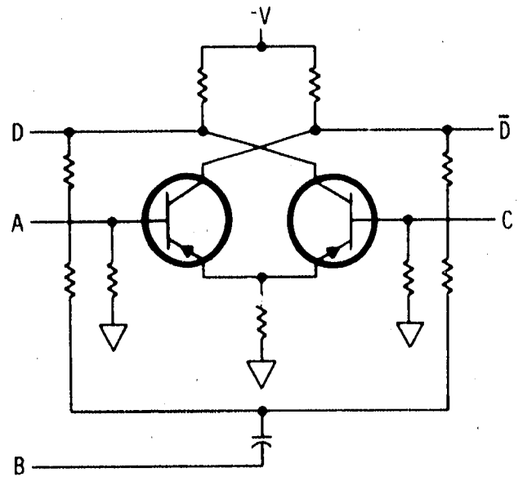
Designation	Logic Symbol	Description	Truth Table	Typical Circuit
Trigger		The binary is a flip-flop which changes state with every true input pulse at A. Since A is applied to the bases of both transistors, it is shown centered in the symbol. The negative pulse produces the same effect as a positive pulse applied to the opposite base. To preserve the positive logic, the reset pulse is shown inverted and applied to the opposite side. A reset pulse sets $\bar{B}$ true.		
One-Shot		True input at A sets the one-shot to unstable state (active) and produces a true output at B. In the symbol shown, the A input must be false (positive) with respect to negative true logic of the one-shot. During the stable state, the $\bar{B}$ output is true. A true input at C (direct set) holds the one-shot in the unstable state.		

Table 8-4. Logic Symbology (Cont.)

Designation	Logic Symbol	Description	Truth Table	Typical Circuit
Amplifier		True input at A produces amplified true output at B. An amplifier will function with either positive true or negative true signals.		
Inverter Amplifier		True input at A produces false output at B and fase input at A produces a true output at B (inverts the input logic level).		
Flip-Flop		Outputs $\overline{D}$ and D are always in opposite states — if D is true, $\overline{D}$ is false. A true input will cause the output directly across to go true — true input at A sets output D true. With no input, the flip-flop remains in the state set by the last input signal. A true input at B will cause the flip-flop to reverse state. A true input at the direct reset input E holds the flip-flop in the $\overline{D}$ true state.		

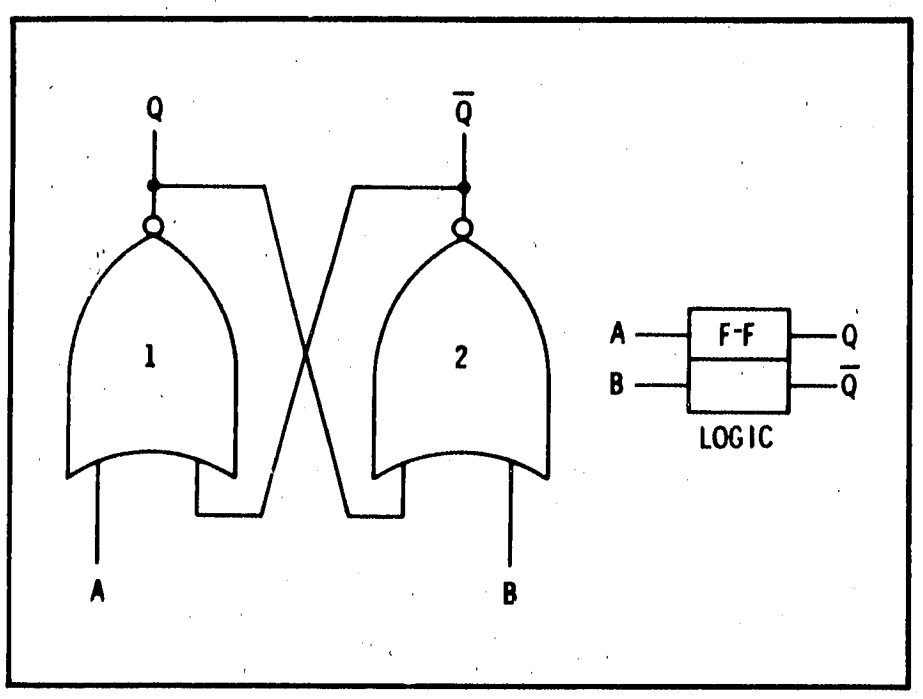


Figure 8-5. Basic NOR Gate Flip-Flop

$\overline{Q}$ for the sake of uniformity. Basic flip-flops which are particularly adaptable to binary circuits and combinations of flip-flops are discussed in the following paragraphs.

8-36. Basic NOR Gate Flip-Flop. Figure 8-5 illustrates a flip-flop constructed with two NOR gates. Operation of the circuit is described below. Assume that initially Q is high and $\overline{Q}$ is low, and A and B are both low. When a high is applied to input A, Q goes low and since there are now two lows applied to NOR gate 2, $\overline{Q}$ will go high. The $\overline{Q}$ high is applied back to NOR gate 1, but since Q is already low, no change in state results. When a high is applied to input B the flip-flop again reverses state. Since the flip-flop will remain in the last state to which it is set, it "remembers" which signal was last received, and can be used as a memory circuit.

8-37. Triggered Flip-Flop. Figure 8-6 illustrates a triggered flip-flop which changes state each time a pulse of a given polarity is applied to the input. The output of a triggered flip-flop is a square wave at one half the frequency of the input triggers. In the circuit shown in Figure 8-6 the input may be negative going triggers or a square wave. If the input is a square wave it will be differentiated by C2 to produce both negative going and positive going pulses. Assume that initially Q is low (Q2 on) and $\overline{Q}$ is high (Q1 off). When a negative going trigger appears at the junction of CR1 and CR2 it has no effect on Q2 through CR2 because output Q is low. However, CR1 is forward biased by the high at $\overline{Q}$ and the trigger is coupled to the collector of Q1. As the collector of Q1 is driven in a negative direction the trigger is also coupled through C1 to the base of Q2. As Q2 begins to cut off, the positive going collector voltage is coupled to the base of Q1 through C3 to drive Q1 into conduction. The process is regenerative; Q2 cuts off quickly and Q1 goes into

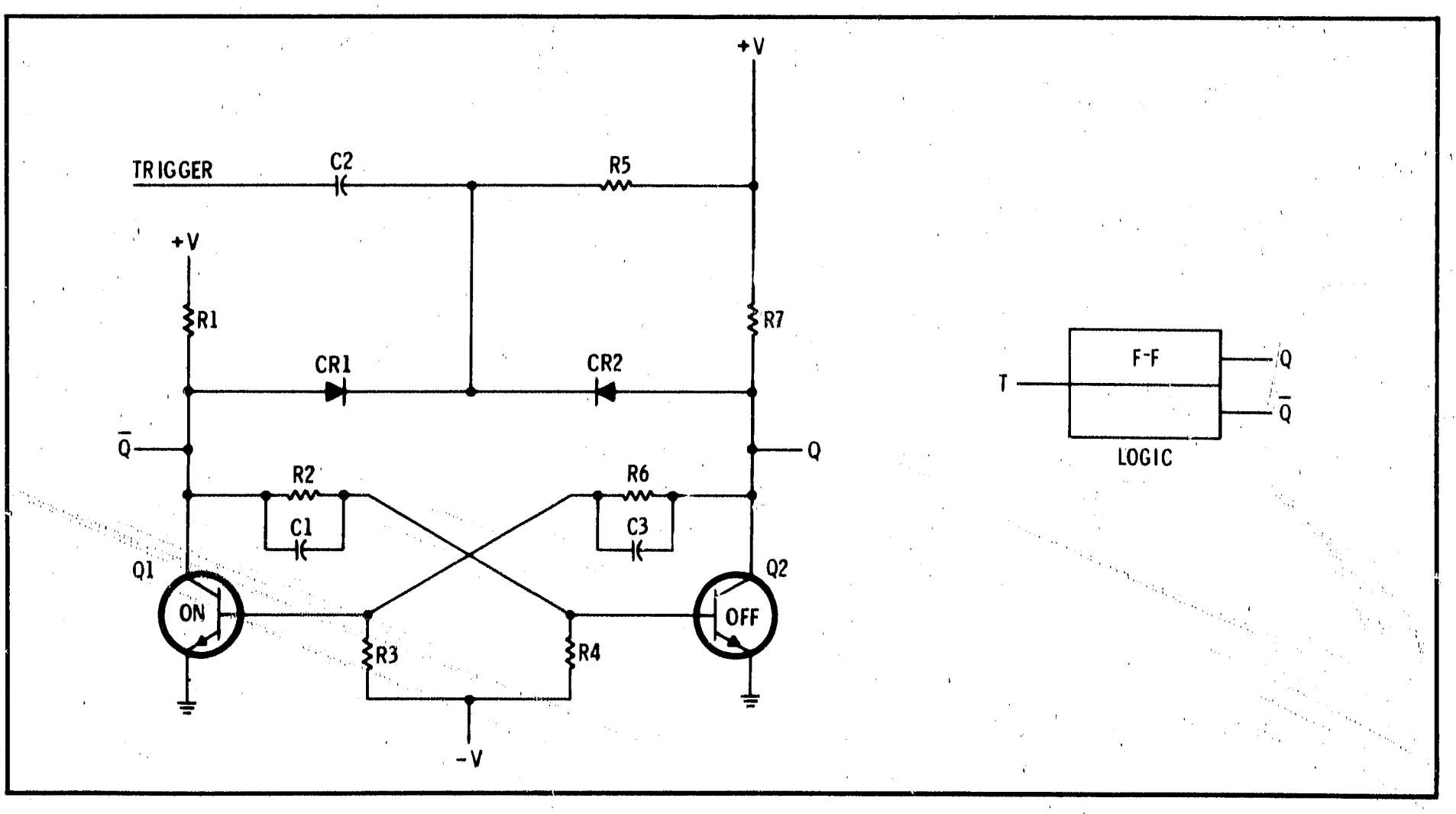


Figure 8-6. Triggered Flip-Flop

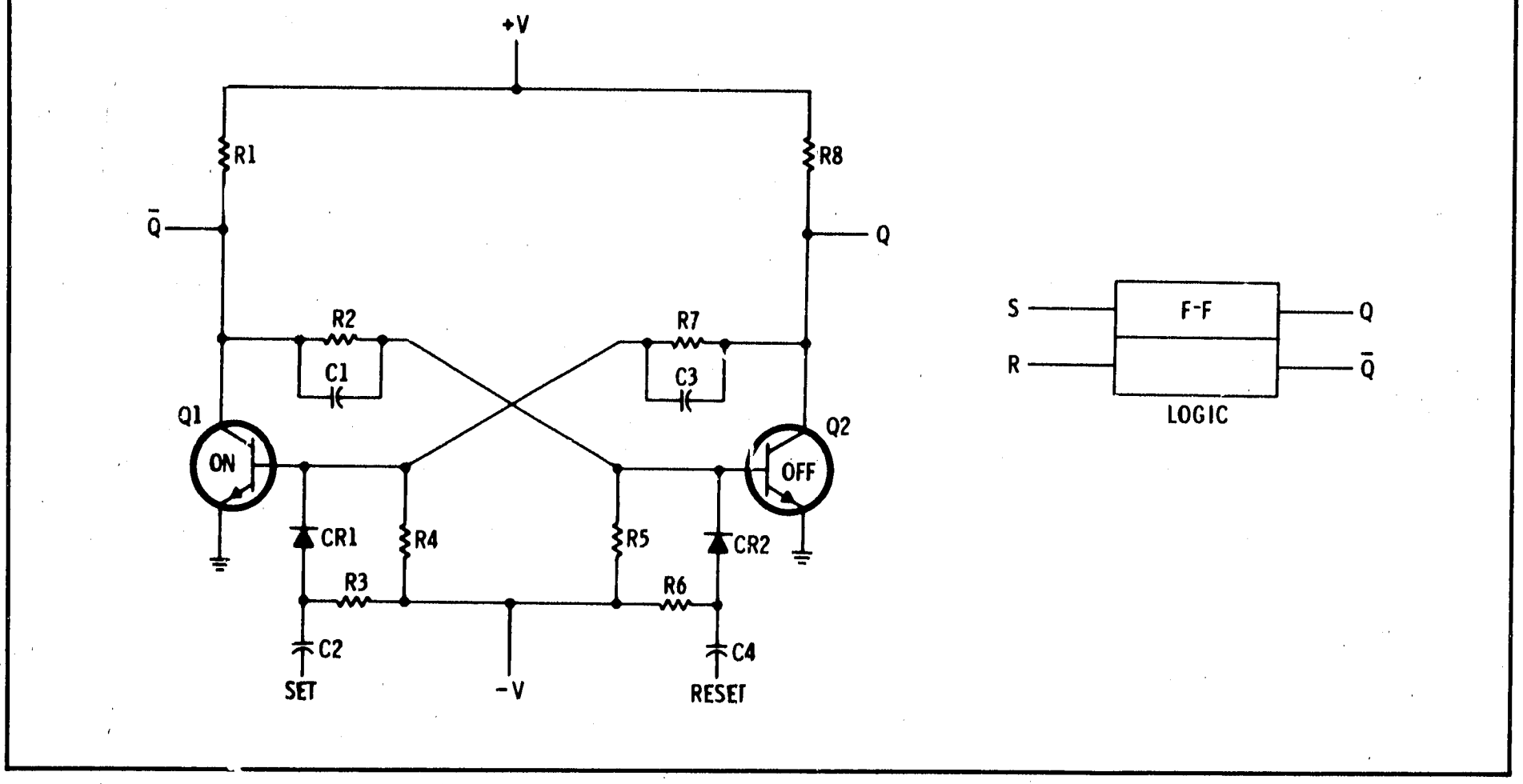


Figure 8-7. RS Flip-Flop

saturation. The next negative going trigger reverses the procedure just described.

8-38. Reset-Set (RS) Flip-Flop. Figure 8-7 shows an RS flip-flop. The RS flip-flop has two inputs, S for Set and R for Reset (sometimes labeled S for set and C for clear). Assume that initially Q is high (Q2 off) and $\overline{Q}$ is low (Q1 on). In this state the flip-flop is set and a positive pulse at the set input will not affect the circuit. When a positive pulse is applied to the reset input it is coupled through C4 and CR2 to the base of Q2. Q2 begins to conduct and the negative going collector voltage is coupled through C3 to the base of Q1 to cut off Q1. The process is regenerative; Q1 is quickly cut off and Q2 saturates. The flip-flop will remain in the reset state until a positive set pulse is applied through C2 and CR1 to the base of Q1. Note that operation of the RS flip-flop is the same as operation of the basic NOR gate flip-flop described in paragraph 8-36.

8-39. RST Flip-Flop. Figure 8-8 illustrates a RST flip-flop which is a combination of reset-set and triggered flip-flops. In the circuit shown, negative trigger pulses will make the flip-flop change states. Positive pulses are required for the set and reset inputs. A positive set input will cause $\overline{Q}$ to go high and a positive reset pulse will cause Q to go high.

8-40. Clocked JK Flip-Flop. A clocked JK flip-flop is triggered by an input clock pulse when certain conditions prevail at the J and K inputs. Figure 8-9 illustrates the logic symbol for a JK flip-flop derived from a RS flip-flop and two three-input AND gates. Figure 8-10 shows a typical JK flip-flop integrated circuit schematic diagram. JK flip-flops have three inputs (J, K and Clock) and complementary outputs. JK flip-flops used as decade counters also have clear or reset inputs, preset and in some cases, a blanking input. When the J and K inputs are both high the flip-flop changes state every time a clock pulse appears; operation is the same as a triggered flip-flop. When the J input is high and the K input is low Q will go high; operation is the same as the reset in RS flip-flops. When the J input is low and the K input is high $\overline{Q}$ will go high; operation is the same as the reset in RS flip-flops. When the J and K inputs are both low clock pulses do not affect the circuit. Frequently JK flip-flops are shown schematically with no connection shown to the J and K inputs; when this occurs, both J and K are actually held high and the circuit functions as a triggered flip-flop.

8-41. Binary Logic. The following paragraphs will explain the basic binary logic required to understand the operation of the dividers and decade counters used in a frequency counter.

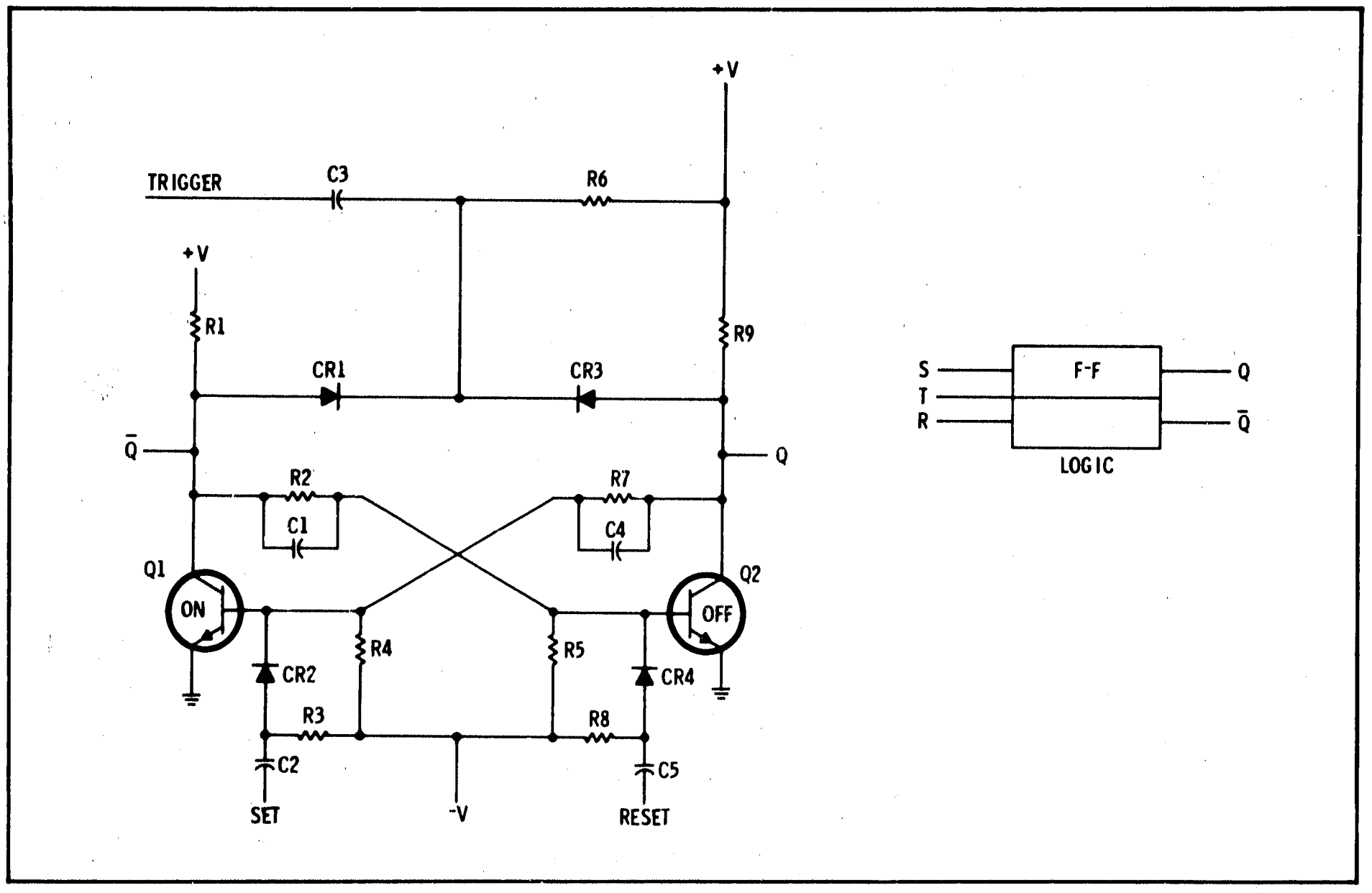


Figure 8-8. RST Flip-Flop

8-42. In frequency counters the decimal numbers 0 through 9 are displayed on each readout device. For this reason, only binary numbers 0000 through 1001, which correspond to decimal numbers 0 through 9 will be discussed in this text. The only exception to this is the discussion of Figure 8-11 which follows.

8-43. Figure 8-11 illustrates four triggered flip-flops in series, with the Q outputs of the first three driving the trigger inputs of the next flip-flop. Since each flip-flop is triggered only by negative going excursions of the input signal, each provides one cycle of output signal for two cycles of input signal. The flip-flops, then, are weighted in ascending powers of two. The first flip-flop has a weighted value of 2^0 (1), the second has a weighted value of 2^1 (2), the third has a weighted value of 2^2 (2 x 2 = 4) and the fourth has a weighted value of 2^3 (2 x 2 x 2 = 8).

8-44. Assume that initially the flip-flops in Figure 8-11 were all set to 0 (Q low). When seven input cycles have been reccived the flip-flops have operated as follows; the first has been turned on (Q high) by inputs 1, 3, 5 and 7, and turned off (Q low) by inputs 2, 4 and 6. The second flip-flop has been turned on by the first and third outputs of the first flip-flop (coincident with initial inputs 2 and 6) and turned off by the second output of the first flip-flop (coincident

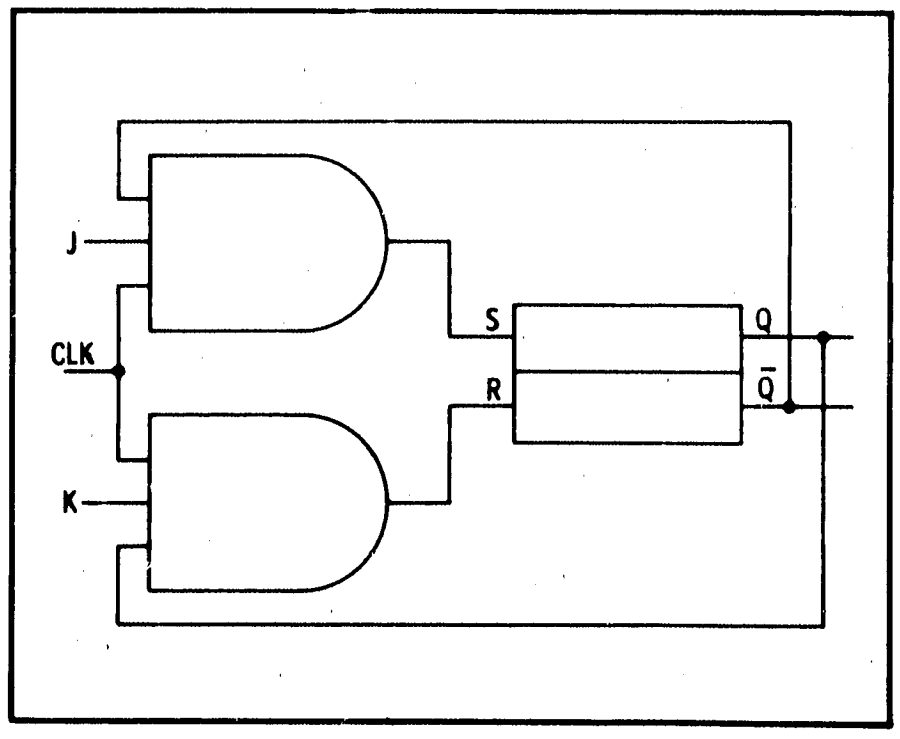


Figure 8-9. Clocked JK Flip-Flop

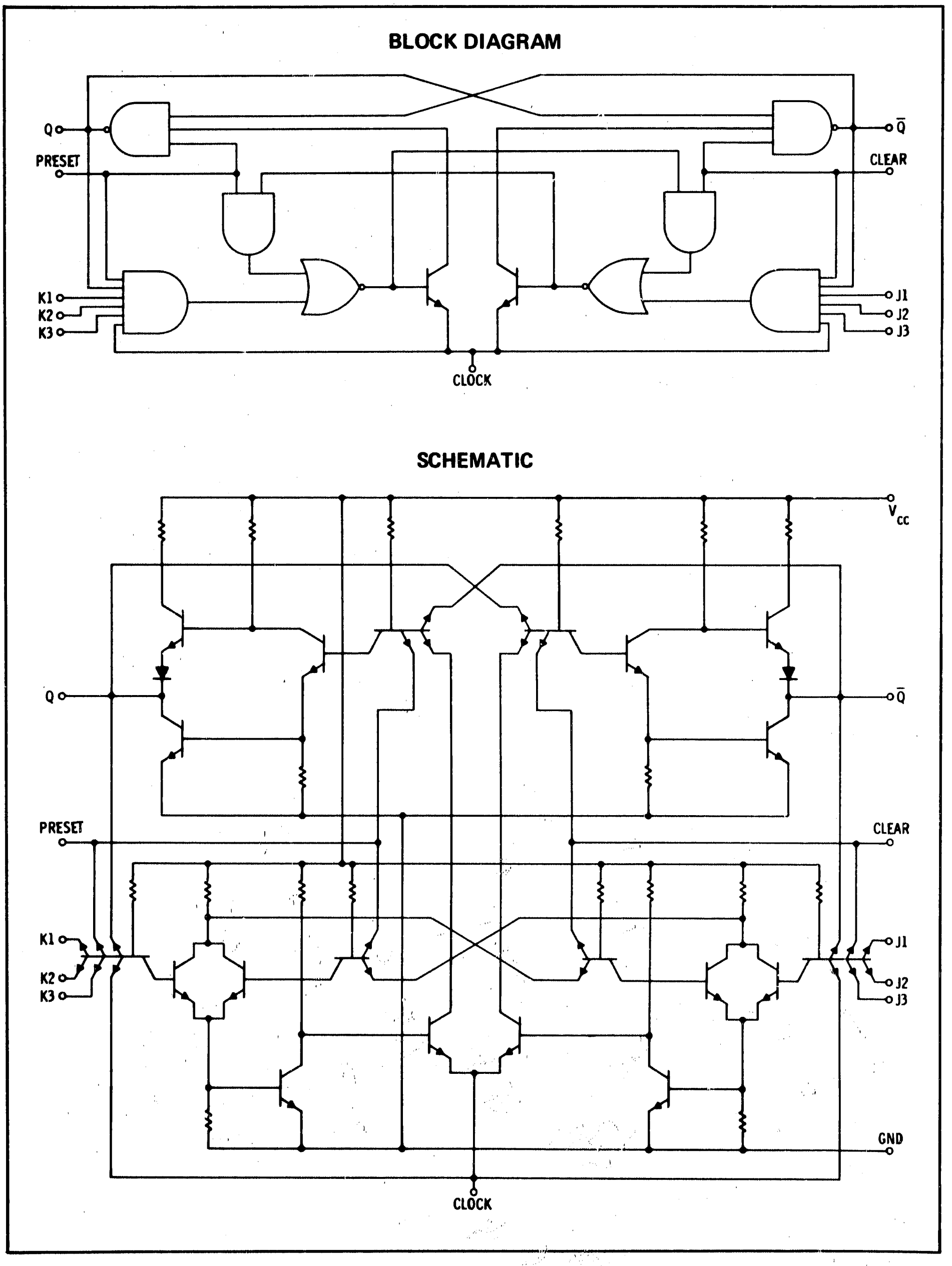


Figure 8-10. JK Master-Slave Flip-Flop

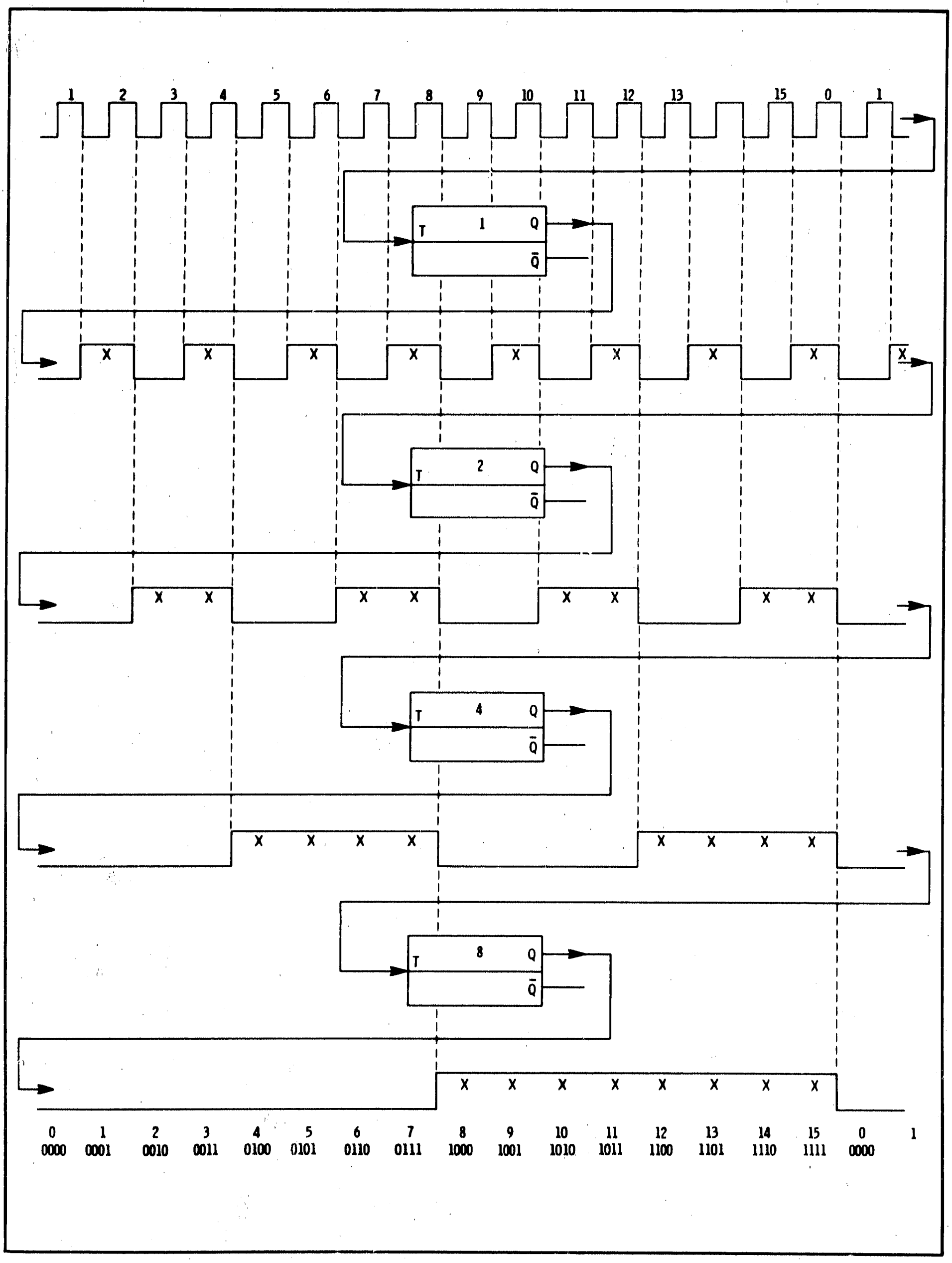


Figure 8-11. 16 Counter Binary Counter Chain

Table 8-5. JK Flip-Flop Truth Table

		Before Trigger		After Trigger	
J	K	Q	$\overline{Q}$	Q	$\overline{Q}$
0	0	1	0	1	0
0	1	1	0	0	1
1	0	0	1	1	0
1	1	0	1	1	0

with initial input 4). The third flip-flop has been turned on by the first negative going output of the second flip-flop (coincident with initial input 4). The fourth flip-flop has not been triggered because there has been no negative going output from flip-flop three. The first three flip-flops are now in the 1 state (Q high) and the binary state is 1110. Their decimal weighted value then is $2^0 + 2^1 + 2^2 = 1 + 2 + 4 = 7$. The next negative input to the chain will cause the first three flip-flops to go off and the fourth to go on. The binary state then is 0001; the decimal weighted value is $0 + 0 + 0 + 2^3 = 0 + 0 + 0 + 8 = 8$.

8-45. As the timing diagram in Figure 8-11 indicates, four flip-flops in this configuration are capable of counting up to 16. Since only the decimal digits 0 through 9 are used in counter circuits, a means must be provided to limit the count to ten. A means must also be provided to reset the flip-flops to zero before beginning a new count. The means by which these facilities are provided are discussed in later paragraphs.

8-46. Since binary numbers, like decimal numbers, are written in ascending order from right to left, the weighted values of the flip-flops are easier to understand in 8, 4, 2, 1 order. Table 8-6 lists the true binary numbers for 8, 4, 2, 1 binary weights and their decimal equivalents.

Table 8-6. 15 Count Binary Truth Table

Binary				
$8 = 2^3$	$4 = 2^2$	$2 = 2^1$	$1 = 2^0$	Decimal
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9
1	0	1	0	10
1	0	1	1	11
1	1	0	0	12
1	1	0	1	13
1	1	1	0	14
1	1	1	1	15
0	0	0	0	0

8-47. A Simple 8421 BCD Code Decade Counter. Figure 8-12 illustrates a simplified decade counter using triggered RS flip-flops. This circuit operates like the circuit shown in Figure 8-11 up through decimal count 9 (binary 1001). When the tenth pulse is received at the input flip-flop point A goes low, flip-flop point B goes high and the flip-flops are temporarily in the 1010 state. Almost immediately the output from B

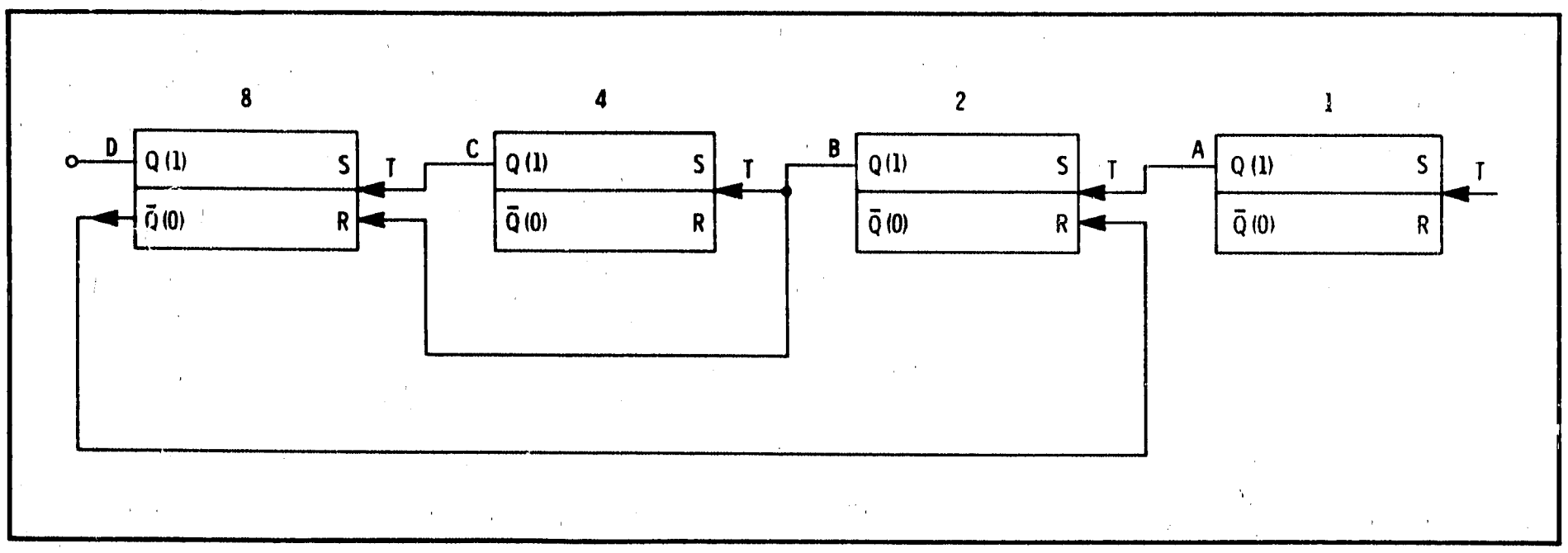


Figure 8-12. 8421 BCD Decade Counter

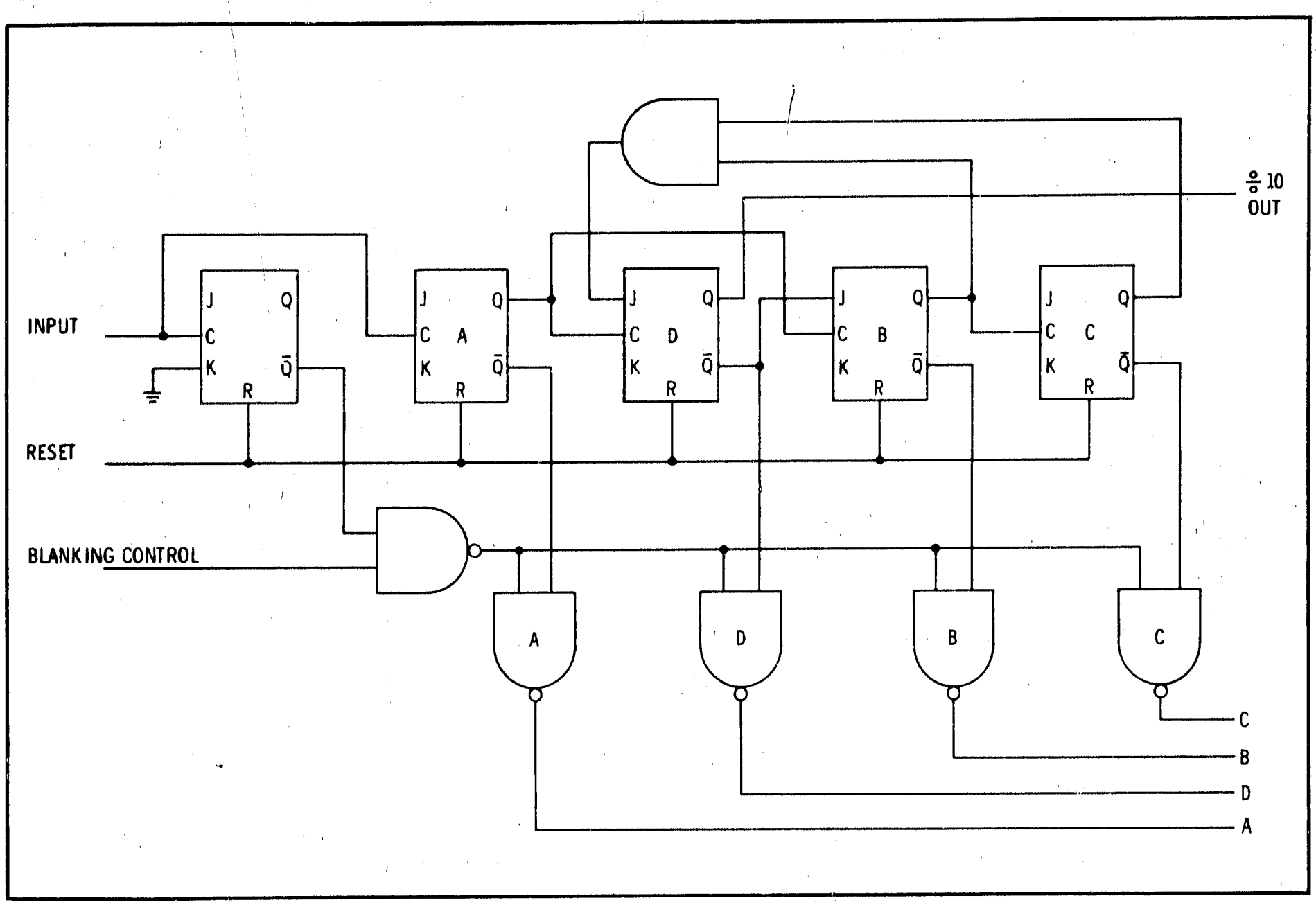


Figure 8-13. Blanking Decade Counter

causes D to reset and the output from D then causes B to reset. The end result is that all flip-flops are rest to 0 by the tenth pulse and are ready to begin the next count. This circuit is useful as a divide by ten decade. To be used as a frequency counter a reset must be provided to reset all flip-flops to zero when the count ends at a number other than ten.

8-48. Blanking Decade Counter. Figure 8-13 illustrates a blanking decade counter. The circuit will divide by ten and provide BCD (binary coded decimal) outputs for decimal numbers 0 through 9. In addition, the A, B, C and D outputs may be set to 1111 (15) to cause the numerical readout device to be blanked.

8-49. The output of the blanking control NAND gate is normally high. When the JK flip-flops are reset their $\overline{Q}$ outputs go high. After reset and before the frequency count begins the outputs of the A, D, B and C NAND gates are normally low because both inputs are high. Now if the blanking control input goes high and $\overline{Q}$ of the first flip-flop is high, the blanking control NAND gate output goes low and the outputs of the A, D, B and C NAND gates go high. In actual use, inverters follow the A, D, B and C NAND gates to provide a negative logic BCD output of 1111 (decimal 15) to the decoders which have no gate to accept 1111, so none of the elements in the numerical readout devices are energized.

8-50. Buffer-Store. In frequency counters it is necessary to transfer the information stored in the decade counters to display decoders prior to starting the next count. Isolation must also be provided to prevent the display from being affected by a count while it is in progress. Figure 8-14 shows a typical buffer-store circuit.

8-51. The terminals labeled $\overline{A}$, $\overline{B}$, $\overline{C}$ and $\overline{D}$ at the bottom of Figure 8-14 are connected to the outputs of the decade counters. Operation of the buffer-store is described below. Normally the input labeled TRANSFER is high, the inverter output is low and all of the AND gates between the BCD inputs and the RS flip-flops are disabled. When the transfer pulse appears one of the two AND gates between the inputs and the RS flip-flops goes high. Assume that when the transfer pulse appears the $\overline{A}$ input is low. The output of

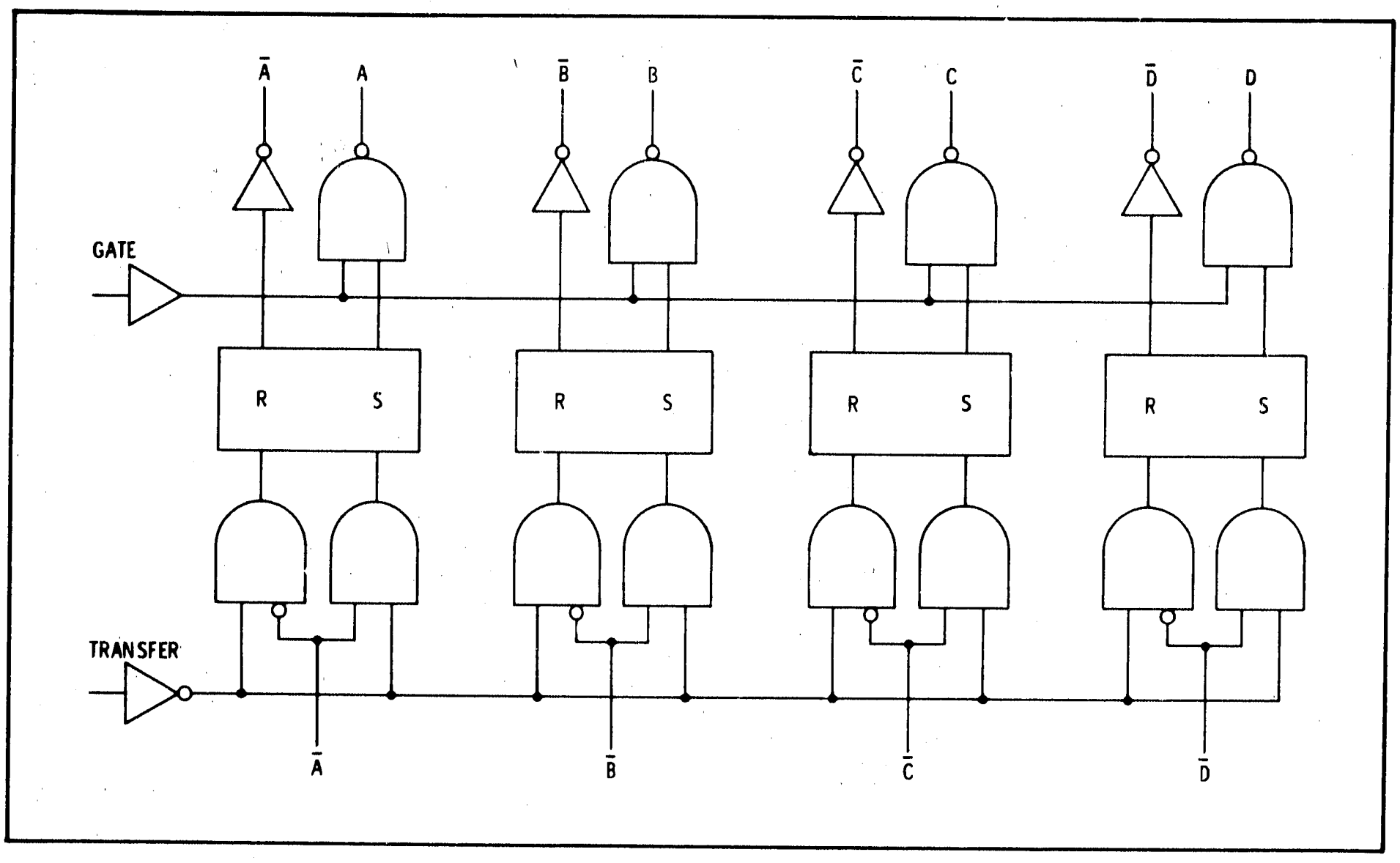


Figure 8-14. Buffer/Store

the reset AND gate of the first RS flip-flop goes high, the input to the $\overline{A}$ inverter goes high and the inverter output goes low. If the A, B, C and D outputs are to be used, the GATE input must be high in order for the output NAND gates to function. With the $\overline{A}$ input low the input to the A NAND gate from the RS flip-flop will be low and the NAND gate output will be high. When the $\overline{A}$ input is high the set AND gate output is high, both inputs to the A NAND gate are high and the A output is low. At the same time the input to the $\overline{A}$ inverter is low, so $\overline{A}$ is high. Operation of the B, C and D circuits is identical to the A circuit. Typically the $\overline{A}$, $\overline{B}$, $\overline{C}$ and $\overline{D}$ outputs are used to drive decoders and the A, B, C and D outputs are used to drive recorders, Digital to Analog converters, etc.

8-52. Decoder-Driver. Decoder-drivers provide a means to "translate" the BCD binary code to a decimal equivalent to drive numerical readout devices. Figure 8-15 shows ten four-input AND gates connected as a decoder. Each AND gate will respond to one, and only one, of the binary equivalents of decimal numbers 0 through 9. Example: the number 1 gate will provide a high output only when $\overline{A}$ is low and $\overline{B}$, $\overline{C}$ and $\overline{D}$ are high.

8-53. Integrated Circuits. Many circuits used in counters and other equipment are available as integrated circuits. The last three circuits discussed are all available as integrated circuits. Figure 8-16 shows some of the packages used for integrated circuits.

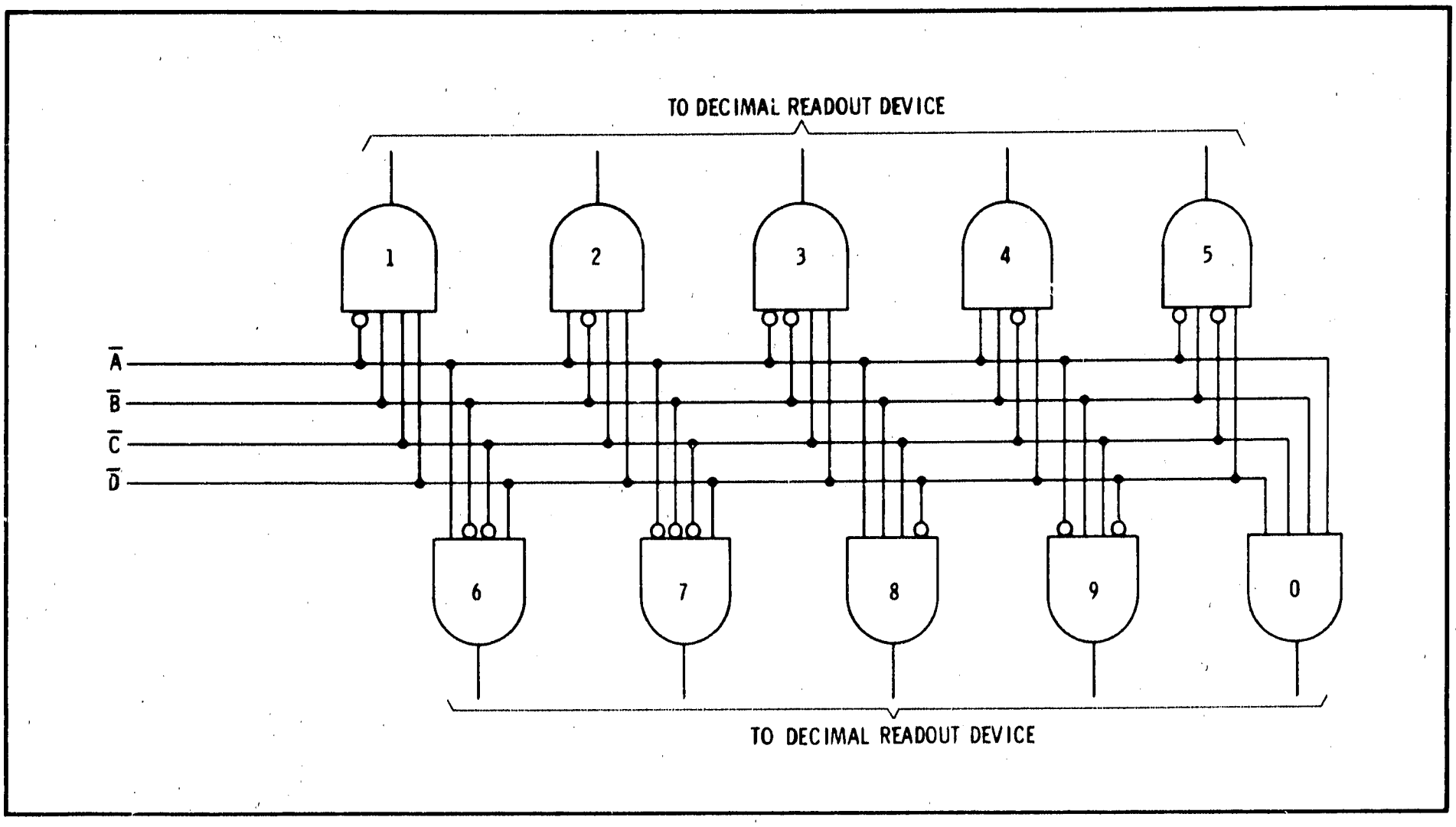


Figure 8-15. Decoder

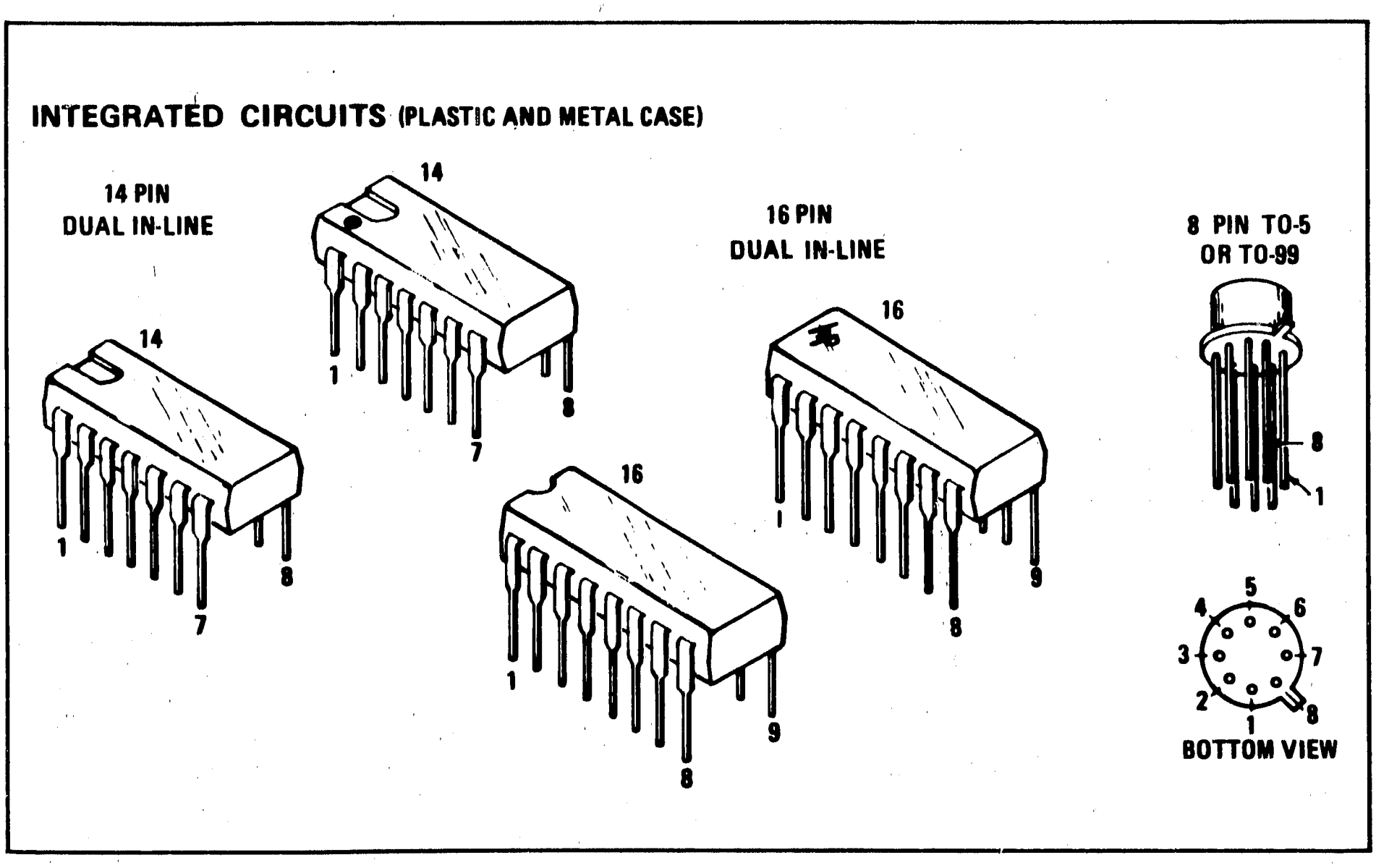


Figure 8-16. Integrated Circuit Packaging

Table 8-7. Assembly and Component Locations

Assembly	Schematic	Photo
A1 Counter Assembly	Service Sheet 7	Service Sheet 7
A2 Control Assembly	Service Sheet 7	Service Sheet 7
A3 Input Amplifier	Service Sheet 5	Service Sheet 5
A4 Comparator Assembly	Service Sheet 2	Service Sheet 2
A5 Time Base Assembly	Service Sheet 6	Service Sheet 6
A6 Sweep Inhibit Assembly	Service Sheet 3	Service Sheet 3
A7 Regulator Assembly	Service Sheet 8	Service Sheet 8
A8 Y-Axis Assembly	Service Sheet 4	Service Sheet 4
A9 Rectifier Assembly	Service Sheet 8	Service Sheet 8
A10 Rear Panel Assembly	Service Sheet 8	Figure 8-17
A11 Mother Board	None	Figure 8-38

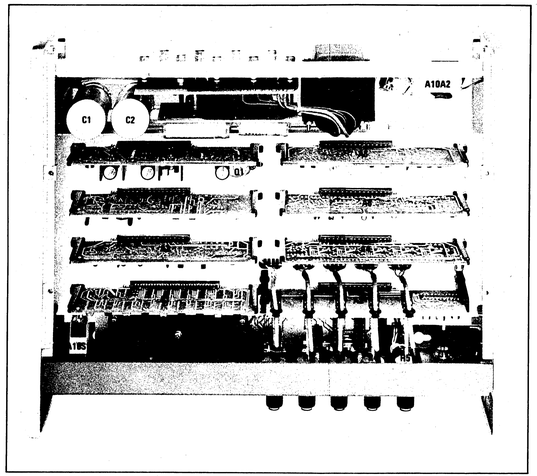
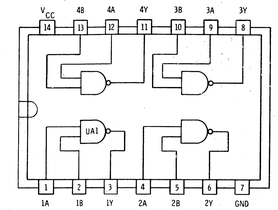
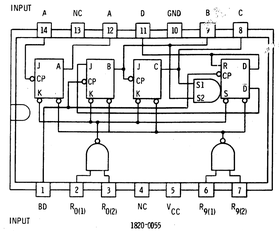
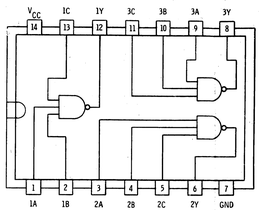
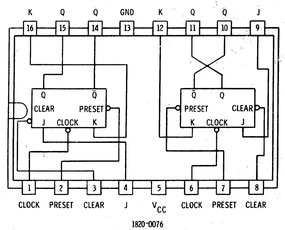


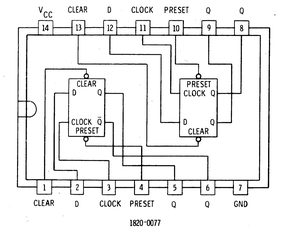
Figure 8-17. Chassis Mounted Parts and Assemblies Locations

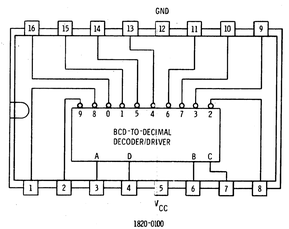


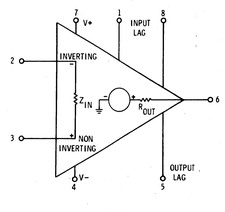


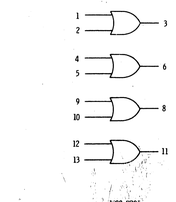


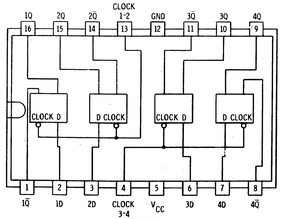


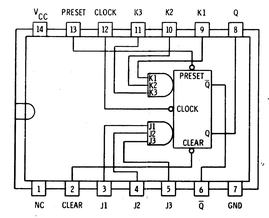


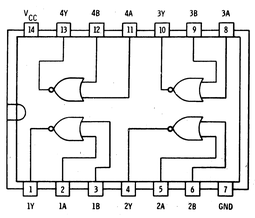












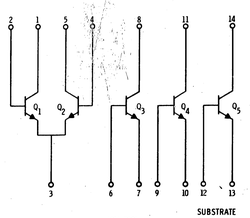
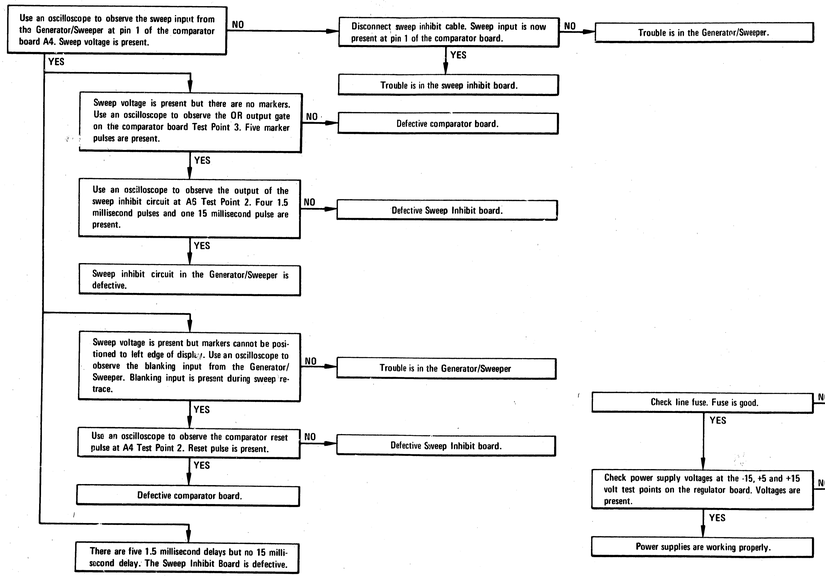


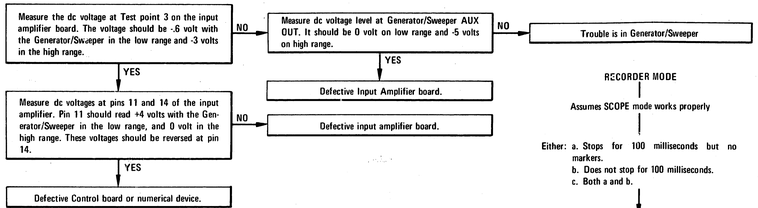
Figure 8-18. Integrated Circuits Used in the Model 8600A Internal Logic

MARKER SECTION TROUBLESHOOTING TREE

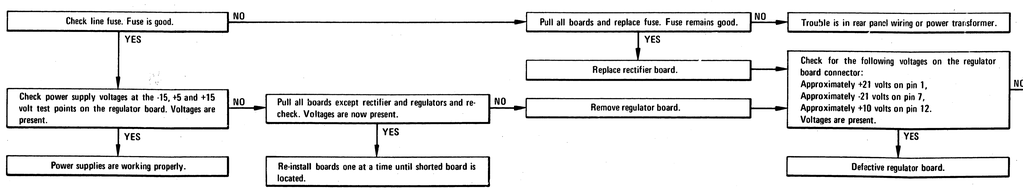
Connect Sweep, Sweep Inhibit, Counter and Blanking to corresponding jacks of the Generator/Sweeper. Operate the Generator/Sweeper in any sweep mode; set sweep rate to maximum in the fast range. Operate the model 8600A in SCOPE mode; markers set close to mid-range.



The counter counts properly but decimal point does not shift when the Generator/Sweeper range is changed.



POWER SUPPLIES AND REGULATORS TROUBLESHOOTING TREE



COUNTER SECTION TROUBLESHOOTING TREE

Set controls as specified in the marker section troubleshooting tree. Numerical readouts do not illuminate and/or indicate counting.

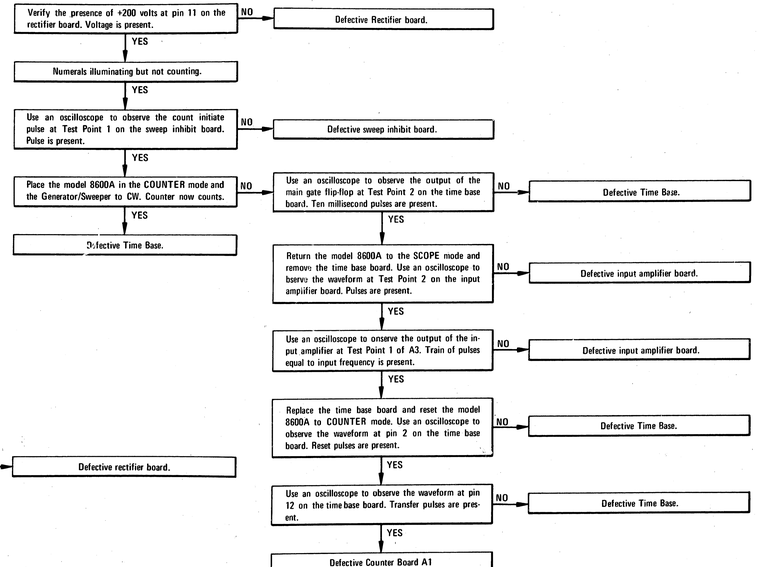


Figure 8-19. Troubleshooting Tree

SERVICE SHEET 1

Block Diagram

The sweep ramp from the Generator/Sweeper is applied to a buffer amplifier which supplies an output ramp of 0 to approximately +7.5 volts.

The output of the buffer amplifier is applied to five Schmitt triggers which function as voltage comparators. The trip points of the Schmitt triggers are set by front panel MARKER position controls. The sweep output from the buffer amplifier is also coupled to a rear panel connector for use with external equipment such as X-Y recorders, oscilloscopes or analyzers.

Because there is about a 2 volt hysterises associated with a Schmitt trigger, a reset must be provided when the sweep ramp is stopped between 0 and +2 volts. The required reset pulses are provided by a pulse shaper which detects the trailing edge of the blanking pulse from the Generator/Sweeper. These reset pulses (approximately -6 volt negative spikes) assure that all comparators are ready to be triggered at the beginning of each sweep.

When the sweep ramp reaches the levels set by the front panel MARKER position controls, the Schmitt triggers are fired. Since the Schmitt triggers' outputs are ac coupled, sharp spikes appear at the OR gate inputs and at the five pushbutton MARKER SELECT switches on the front panel.

Scope Mode

In the scope mode up to five markers may be displayed on the CRT. Any one of the markers may be selected as the point at which the frequency is counted by front panel pushbutton switches.

The output from the selected comparator triggers a 15 millisecond one-shot. The output from the 15 millisecond one-shot is applied through two OR gates to a switching amplifier. The switching amplifier switches a transistor on for 15 milliseconds to sink the current from a constant current source in the Generator/Sweeper sweep circuit. It also causes a diode in the Generator/Sweeper sweep circuit to be reverse-biased to prevent the sweep ramp capacitor charge from leaking off. The sweep ramp is clamped for 15 milliseconds.

The output from the selected comparator also triggers a 3 millisecond one-shot. This 3 millisecond one-shot, together with the mode logic, causes the counter to start counting 3 milliseconds after the Generator/Sweeper sweep ramp is stopped. The 3 millisecond delay ensures that the frequency has stabilized at the time the count has started. The count period is always 10 milliseconds so the count is ended about 2 milliseconds before the sweep ramp is released.

The outputs of the five comparators are also combined in an OR circuit to drive a binary which alternately triggers two 1.5 millisecond one-shot circuits. This circuit is used to allow very close spacing of adjacent markers. The 1.5 millisecond pulses are used to stop the Generator/Sweeper sweep ramp for 1.5 milliseconds. The 1.5 millisecond pulse which coincides with the selected (15 millisecond) output has no effect on the circuit since the 15 millisecond pulse overrides it.

The 1.5 millisecond and 15 millisecond one-shot circuits also drive pulse shapers. The output from the one-shot circuits is a square pulse and if this is applied directly to the Y-axis the dot is shifted above the trace, but not enough electrons impinge on the phosphor to produce a marker. The pulse shapers slow down the leading edge of the one-shot outputs to cause a relatively slower rise of the trace. This results in a visible spike on the CRT trace. The trailing edge of the one-shot outputs is not affected by the pulse shapers. Polarity of the pulse shaper outputs is such as to provide a positive spike for the counted marker and a negative spike for those not counted.

The summing amplifier combines the outputs from the pulse shaper. The MARKER HEIGHT control on the front panel controls the gain of the summing amplifier.

The current amplifier provides a means of signal injection that will not disturb the calibration of the CRT display of the HP 8412A.

Recorder Mode

In the recorder mode the Generator/Sweeper is swept very slowly, near the lower limit of the slow range. In order to get vertical markers on the X-Y graph it is necessary to stop the Generator/Sweeper for a longer period of time to give the Y-axis time to react.

As in the scope mode, there are separate one-shot circuits for the selected marker and those not selected. When the selected marker signal leaves the comparator circuit it is applied directly to a 100 millisecond one-shot, and also to a trigger logic circuit. When the triggering logic has two inputs (at the selected marker), the signal is inhibited and the one-shot which follows the trigger logic is not triggered. The output from the 100 millisecond one-shot for the selected marker is a positive going pulse; the output from the other 100 millisecond one-shot is negative-going. Both outputs are applied to the summing amplifier and the current source to produce positive-going and negative-going vertical peaks on the X-Y recorder Y-axis. As in the scope mode, the vertical peak amplitude is controlled by the MARKER HEIGHT control.

The outputs from the two 100 millisecond one-shot circuits are also coupled through OR gates to the switching amplifier to stop the Generator/Sweeper sweep ramp for 100 milliseconds. The outputs from the unselected markers 100 millisecond one-shot circuit is inverted in order to trigger the switching amplifier.

Counter Mode

In the counter mode only the mode logic and the counter section is used. The count period is 10 milliseconds. The input frequency is counted approximately five times each second.

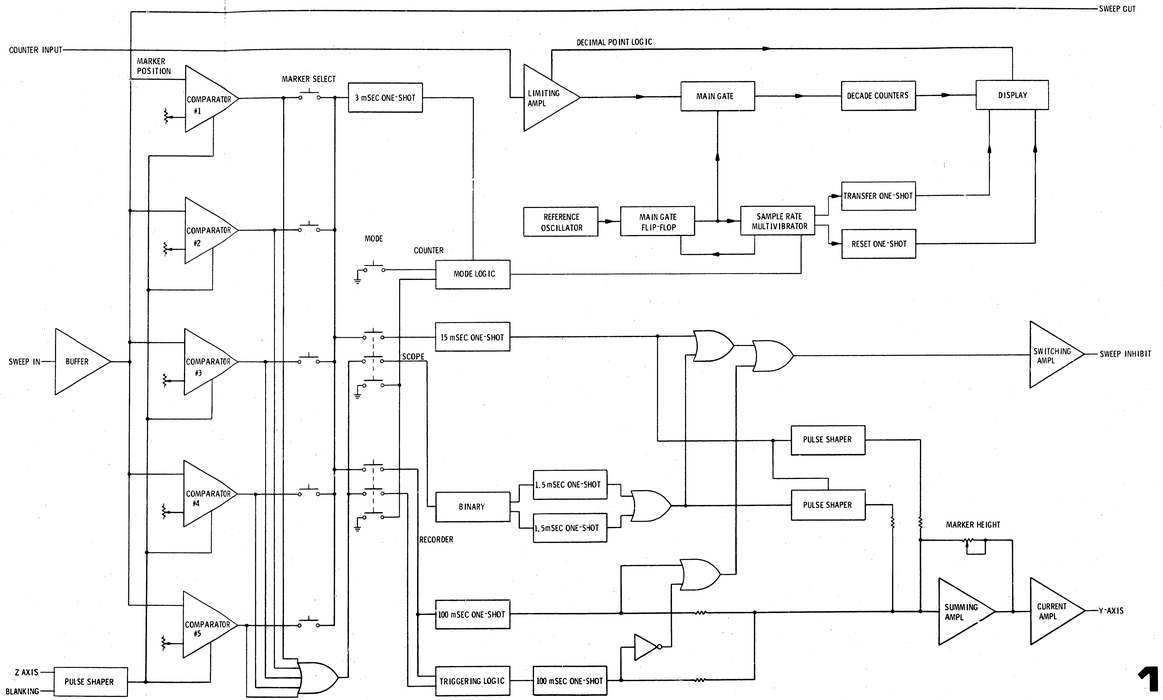


Figure 8-20. Overall Block Diagram

SERVICE SHEET 2

Normally, causes of malfunctions in the model 8600A will be isolated to a circuit board or assembly as a result of performing the tests specified in the trouble-shooting tree.

When trouble has been traced to the comparator board (A4), it should be removed from the chassis and re-installed using an extender board. This will provide easy access to test points and components.

Equipment Required:

Oscilloscope	10:1 Probes (2)
Voltmeter	Service Kit

1 Buffer Amplifier U1

The sweep ramp from the Generator/Sweeper is applied to a buffer amplifier which supplies an output ramp of 0 to approximately +7.5 volts.

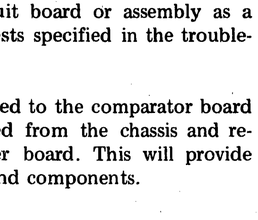
The output of U1 is fed in parallel to five Schmitt trigger circuits which function as voltage comparators. A buffered sweep output is also provided for use with external equipment such as X-Y recorders, oscilloscopes or analyzers.

Note

In all tests using an oscilloscope the Generator/Sweeper sweep ramp should be used to sync the oscilloscope horizontal sweep.

Test Procedure 1

Test 1-a. Use the voltmeter to verify the presence of -15 volts, +5 volts and +15 volts at points shown on the schematic.



Waveform SS2-1

Test 1-b. Use the oscilloscope to observe the signals at XA4 pin 1 and Test Point 1. The oscilloscope CRT display should be similar to those shown in waveform SS2-1. If the sweep ramp is present at XA4 pin 1 (but has no markers on it) and the sweep ramp does not appear at Test Point 1, U1 is probably defective.

If one or more of the markers are missing rotate the marker position controls to ensure that the markers are not positioned off the display. Proceed to test procedure 2.

If markers cannot be made to appear on the lower portion of the sweep ramp, proceed to test procedure 2.

If the sweep ramp is not present at XA4 pin 1, disconnect the sweep inhibit from the Generator/Sweeper. If the waveforms shown in waveform SS2-1 are now present (without markers), trouble is probably in the sweep inhibit circuit (A6). If the sweep ramp does not appear when the sweep inhibit is disconnected, check the cabling and, if necessary, the Generator/Sweeper.

2 Comparators

There are five identical comparators in the assembly. Each comparator has an input from the buffer amplifier and a reset input from the sweep inhibit assembly. A dc threshold level for the Schmitt Trigger circuits is established by front panel marker position controls.

Because there is about a 2 volt hysterises associated with a Schmitt trigger, a reset must be provided when the sweep ramp is stopped between 0 and +2 volts. The required reset pulses are provided by a pulse shaper in the A6 assembly which detects the trailing edge of the blanking pulse from the Generator/Sweeper. These reset pulses (-6 volt negative spikes) assure that all comparators are ready to be triggered at the beginning of each sweep.

Since operation of all of the comparators is identical, only comparator number one will be discussed.

U2D is a constant current source which draws approximately 1 milliampere through its associated marker position control. This results in a linear trip level change with potentiometer rotation.

U2A and U2B comprise a Schmitt trigger circuit. When the sweep ramp from the Generator/Sweeper reaches the level set by the marker position control at U2B base, the Schmitt trigger is fired.

The Schmitt trigger output is emitter coupled to a pulse differentiator. The output from the pulse differentiator has a fast rise time and a decaying time constant on the trailing edge. These pulses are used to trigger one-shot circuits in the sweep inhibit circuit.

The outputs from each of the comparators is applied to marker select switches and also to U7 which functions as a single five-input OR gate.

Test Procedure 2

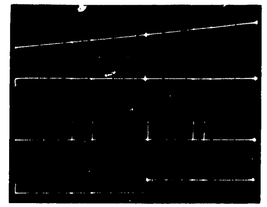
General

Each comparator contains five transistors in a single integrated circuit. These transistors are shown schematically as discrete components to aid in understanding circuit operation. Again, only comparator number one is discussed.

Note

In all tests using an oscilloscope, the Generator/Sweeper sweep ramp should be used to sync the oscilloscope horizontal sweep.

Composite waveform SS2-2 illustrates the correct waveforms for Test Points 1, 2, 3 and pin 7 of U2. The position of the markers on the trace will depend on the setting of the marker position controls.



Waveform SS2-2

If one or more of the markers are missing, connect the oscilloscope to pin 7 of the comparator integrated circuit for that marker. The waveform should be as shown for pin 7 of U2 except for the position of the step. If the signal is not present the integrated circuit is probably defective. If the signal is present, U7 is probably defective.

If markers cannot be made to appear at low sweep ramp levels observe the waveform at Test Point 2. If the negative spike at the beginning of the trace is not present, trouble is probably in the A6 blanking pulse shaper or the blanking input from the Generator/Sweeper.

◀ SERVICE SHEET 1
Block Diagram

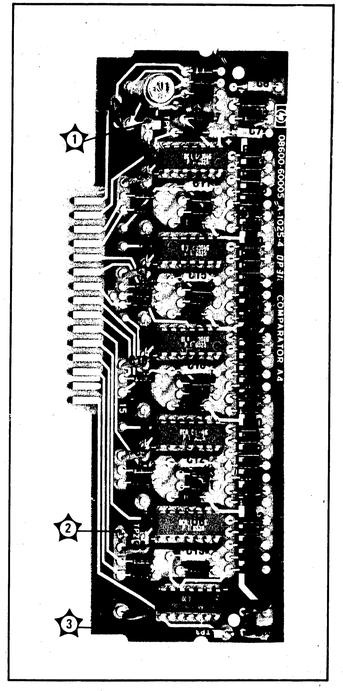


Figure 8-21. Comparator Assembly Component Locations

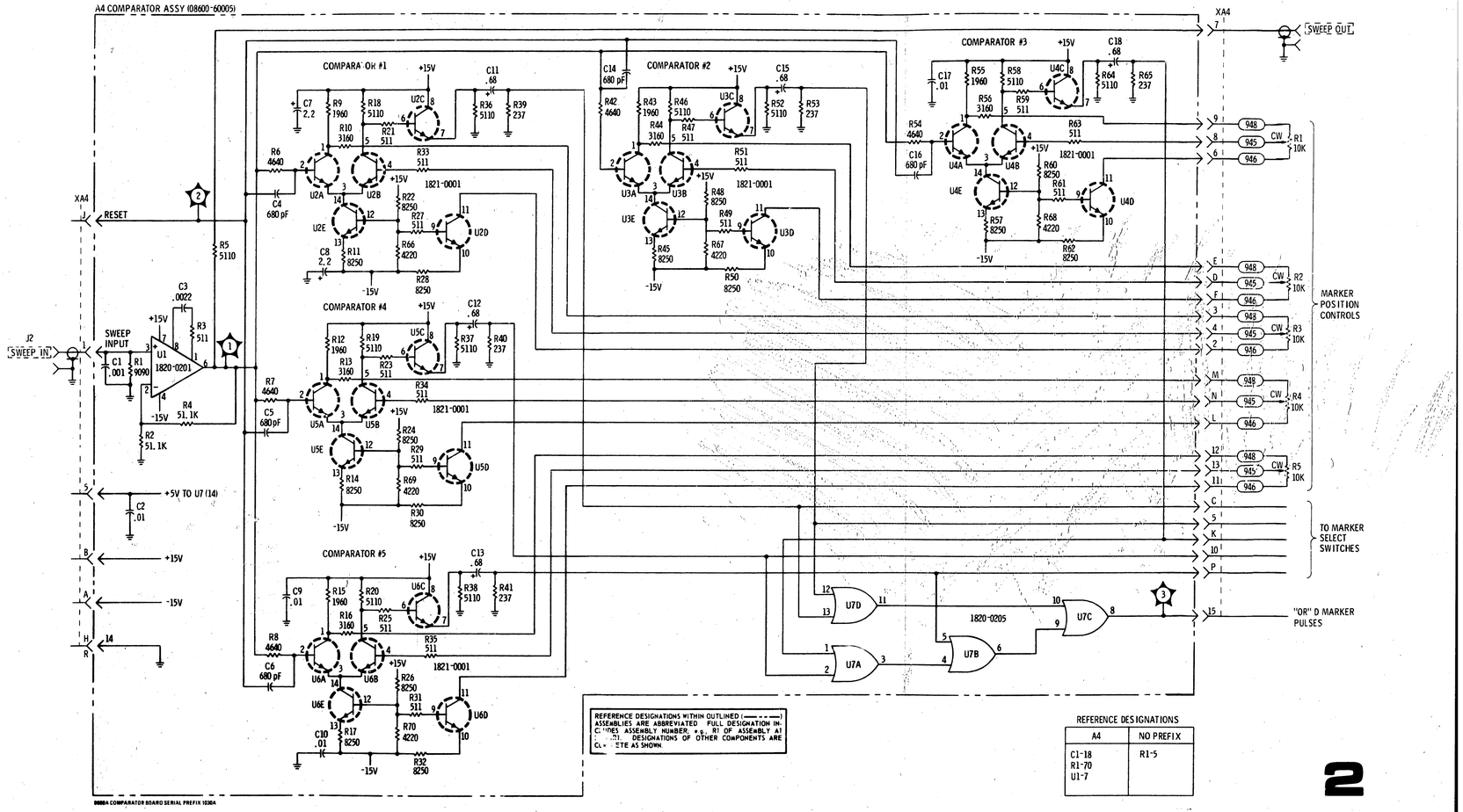


Figure 8-22. Comparator Schematic Diagram

SERVICE SHEET 3

Normally, causes of malfunctions in the model 8600A will be isolated to a circuit board or assembly as a result of performing the tests specified in the troubleshooting tree.

When trouble has been traced to the sweep inhibit board (A6) it should be removed from the chassis and re-installed using an extender board. This will provide easy access to test points and components.

Equipment Required:

Dual Channel Oscilloscope	Voltmeter
10:1 Probes (2)	Generator/Sweeper

General:

The sweep inhibit assembly contains circuitry required to stop the sweep ramp of the Generator/Sweeper. It also contains circuits which generate positive and negative markers, the count initiate pulse and comparator reset pulses.

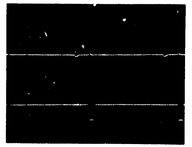
1 Three Millisecond One-Shot

Q6, Q10 and associated components comprise a 3 millisecond one-shot which is triggered by the selected marker. The output of this one-shot is used in the mode logic circuit to initiate the count cycle. The purpose of this one-shot is to delay the start of the count cycle to assure that the output from the Generator/Sweeper is stable at the time it is counted.

Test Procedure 1

Test 1-a. Use the voltmeter to verify the presence of -15, +5 and +15 volts at points shown on the schematic diagram.

Test 1-b. Connect the oscilloscope Channel A input to XA6 pin A and the Channel B input to Test Point 1. Synchronize the oscilloscope sweep with the sweep output from the Generator/Sweeper. Set the oscilloscope for 5 milliseconds/division and .5 volt/division. The oscilloscope CRT display should be as shown in waveform SS3-1.



Waveform SS3-1

If waveform A is as shown, but B is not, check Q6, Q10 and associated components. If neither waveform is present select, in turn, each of the other markers. If the signals are present for some of the marker selections, but not others, trouble is probably in the comparator or switch associated with the inoperative marker. If the signals are not present for any of the selected markers, trouble is probably in the buffer amplifier in the comparator assembly.

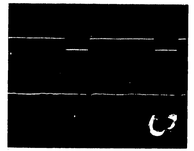
2 Blanking and Z-Axis Pulse Shapers

Depending on the model of Generator/Sweeper used, Z-axis or blanking input signals are used to generate comparator reset pulses. These reset pulses are required when the Generator/Sweeper sweep ramp is stopped at a low voltage level. The reset pulses are required because of the inherent hysterisis associated with the Schmitt trigger circuits used in the comparators.

Q1, Q4, Q5 and associated components provide a sharply defined output pulse when triggered. (Q1 is not used when the blanking input is used.)

Test Procedure 2

Test 2-a. Connect the oscilloscope Channel A input to XA6 pin H and the Channel B input to the junction of CR4 and R21. (Oscilloscope controls set as in test 1-b.) The oscilloscope CRT display should appear as shown in waveform SS3-2.



Waveform SS3-2

If the input waveform is correct, but the output is not, check Q4, Q5 and associated components. (If Z-axis input is used, also check Q1.)

If the input waveform is not correct, check the interconnections with the Generator/Sweeper and if necessary, the Generator/Sweeper circuits.

3 15 Millisecond One-Shot

The 15 millisecond one-shot is triggered by the selected marker. The output is coupled through two OR gates to Q16/Q17. Q17 acts as a switch to sink current from a constant current source in the Generator/Sweeper sweep ramp generator to clamp the sweep ramp.

The 15 millisecond pulse provides the positive marker and also turns on Q14 to prevent the generation of a negative marker for the selected marker.

Test Procedure 3

Test 3-a. Connect the oscilloscope Channel A input to XA6 pin R and the Channel B input to Test Point 3. (Oscilloscope controls set as in test 1-b.) The oscilloscope CRT display should be as shown in waveform SS3-3.

Waveform SS3-3

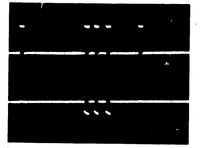
If the CRT Channel A display is incorrect, trouble is in the comparator assembly. If the CRT Channel A display is correct and the Channel B display is incorrect, check Q7, Q11 and associated components.

4 Negative Marker Circuit

Q15 inverts the outputs from U1A to provide negative markers on the CRT display for those markers not selected to be counted.

Test Procedure 4

Test 4-a. Connect the oscilloscope Channel A input to U1 pin 3 and the Channel B input to XA6 pin P. (Oscilloscope set as in test 1-b except that Channel A is .2 volts/Division.) The oscilloscope CRT display should be as shown in waveform SS3-4 (position of pulses will depend on settings of the marker position controls).



Waveform SS3-4

If the Channel A display is correct but the Channel B display is not, check Q14, Q15 and associated components.

If the Channel A display is not correct, proceed to test procedure 5.

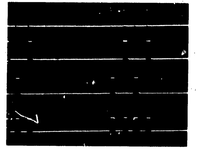
If a negative marker is being generated for the selected marker, Q14 is probably defective.

5 Binary and 1.5 Millisecond One-Shot Circuits

Q2 and Q3 comprise a triggered flip-flop binary. Use of the binary circuit permits alternate operation of the 1.5 millisecond one-shot circuits and allows markers to be placed very close to each other without interaction.

Test Procedure 5

Test 5-a. Waveform SS3-5 represents correct waveforms at the following points (from the top down) XA6 pin D, U1 pin 1, U1 pin 2, and U1 pin 3. One of the markers has been moved off the display to aid in synchronizing the oscilloscope. Oscilloscope settings are the same as in test 1-b except that the top display is taken at .2 volts/division.



Waveform SS3-5

If the display for XA6 pin D is correct but none of the others are, the binary is probably defective. (It is not likely that both of the one-shot circuits would fail at the same time.) If the display is not correct at U1 pin 1 or 2, check the one-shot which is not producing an output.

◆ SERVICE SHEET 2
Comparator

If the display for U1 pin 3 is not correct and the others are, U1 is probably defective.

6 OR Gate and Output Circuit

U1 functions as a single five input OR gate to combine the outputs from the 15 millisecond one-shot, the two 1.5 millisecond one-shot circuits, and two 100 millisecond one-shot circuits located on the Y-axis circuit board. The output circuit acts as a switch to control the sweep ramp generator in the Generator/Sweeper.

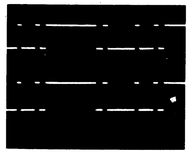
Test Procedure 6

Test 6-a. Connect the oscilloscope Channel A input to U1 pin 8 and the Channel B input to TP2. Oscilloscope settings are the same as in test 1-b. The CRT display should be similar to that shown in waveform SS3-6.

If the Channel A display is correct but the Channel B display is not, check Q16, Q17 and associated components.

If the Channel A display is not correct and the preceeding tests were correct, U1 is defective.

Test 6-b. Place the model 8600A in the recorder mode and adjust the oscilloscope to 20 milliseconds/division. The oscilloscope CRT display should consist of pulses 100 milliseconds in duration.



Waveform SS3-6

If the 100 millisecond pulses are not present, use the oscilloscope to observe pins 13 and 14 of U1.

If the pulses are present at pins 13 and 14 of U1 but were not present at U1 pin 8, U1 is probably defective.

If the pulses are not present at U1 pins 13 and/or 14, trouble is probably in the 100 millisecond one-shot circuits in the Y-axis assembly.

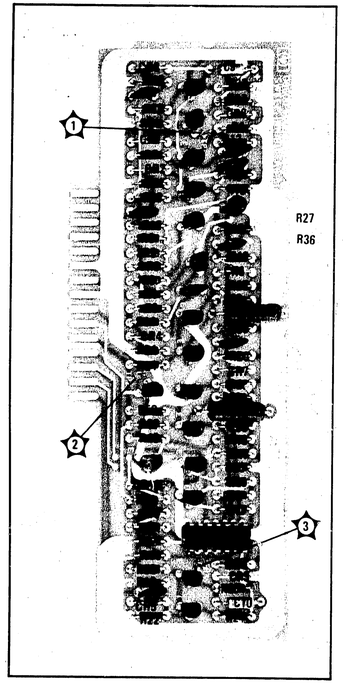


Figure 8-23. Sweep Inhibit Assembly Component Locations

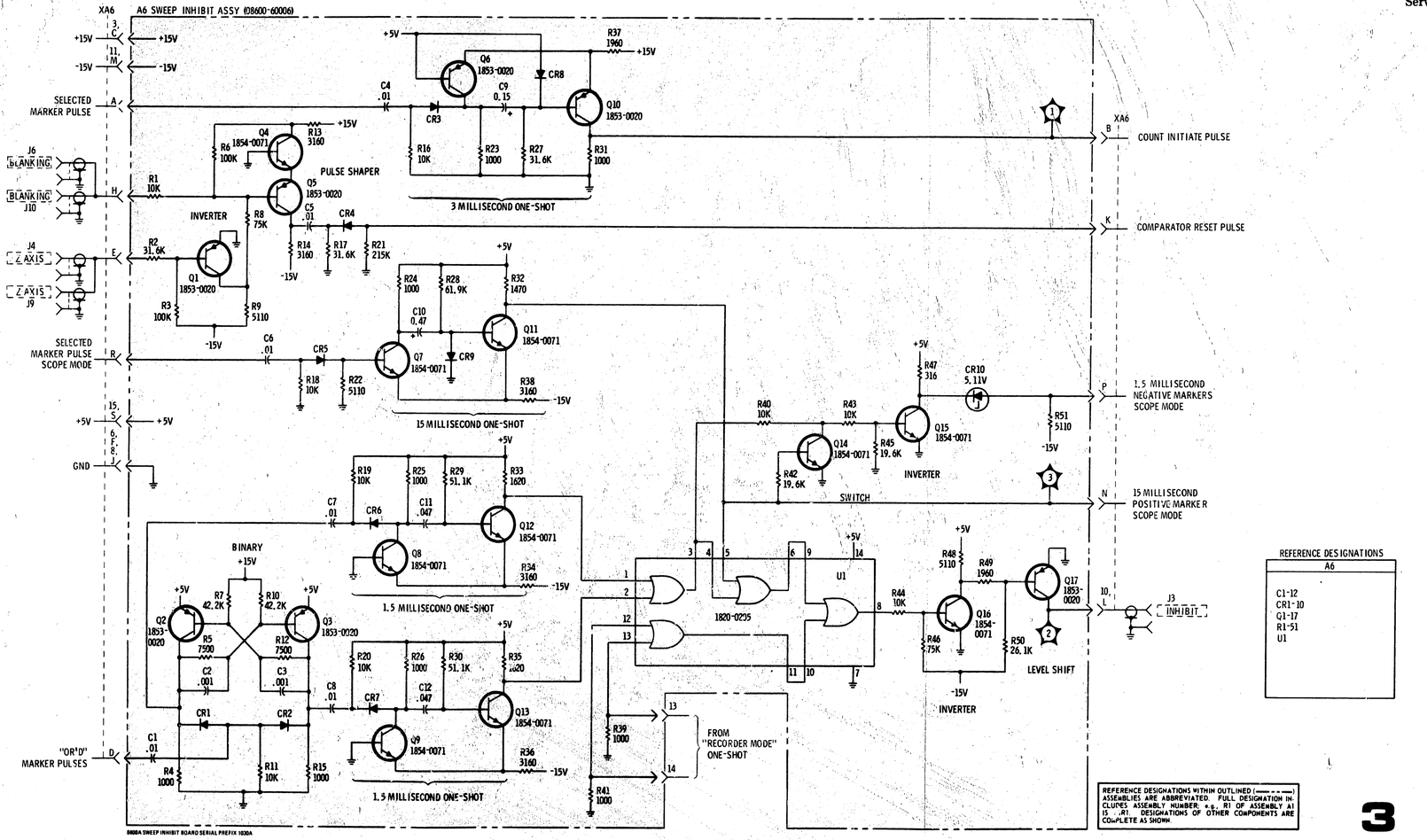


Figure 8-24. Sweep Inhibit Schematic Diagram

SERVICE SHEET 4

Normally, causes of malfunctions in the model 8600A will be isolated to a circuit board or assembly as a result of performing the tests specified in the troubleshooting tree.

When trouble has been traced to the Y-axis assembly it should be removed from the chassis and re-installed using an extender board. This will provide easy access to test points and components.

Equipment Required:

Dual Channel Oscilloscope	10:1 probes (2)
Digital Voltmeter	Generator/Sweeper

General:

The Y-axis assembly contains two circuits. One circuit consists of the two 100 millisecond one-shot circuits which are used in the RECORDER mode. The other contains the Y-axis summing amplifier, two transistor switches and the current amplifier; this circuit is used in all modes where vertical markers are required.

1 100 Millisecond One-Shot Circuits

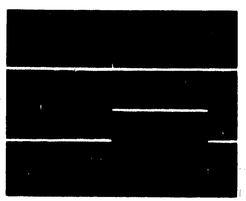
Positive-going pulses from the selected comparator trigger one-shot Q8/Q9. Q7 acts as a buffer amplifier for this 100 millisecond pulse. The positive-going pulses from the selected comparator are also applied to a trigger logic circuit (U2B/U2D) to prevent the second 100 millisecond one-shot from being triggered by the selected marker.

When the combined comparator outputs are applied to U2B pin 5 the positive pulses cause the U2B output to pin 11 of U2D to go low. Four of the five pulses will cause the output of U2D to go high and trigger the Q4/Q6 100 millisecond one-shot. When the selected comparator output is applied to U2B it cannot trigger the Q4/Q6 one-shot because pin 12 of U2D is held high to inhibit U2D. The output of both one-shot circuits is used in the sweep inhibit circuit to stop the Generator/Sweeper sweep ramp.

Test Procedure 1

Test 1-a. Use the voltmeter to verify the presence of -15, +5 and +15 volts at points shown on the schematic.

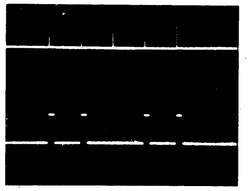
Test 1-b. Connect the oscilloscope Channel A input to XA8 pin 14 and the Channel B input to Test Point 4. Place the model 8600A in the RECORDER mode. Synchronize the oscilloscope to the Generator/Sweeper sweep output. Set the oscilloscope to 20 milliseconds/division, Channel A to .5 volt/division and channel B to .2 volt/division. The CRT display should be similar to that shown in waveform SS4-1.



Waveform SS4-1

If the Channel A waveform is not present trouble is probably in the comparator circuits or marker select switches.

If the Channel A waveform is correct but the Channel B waveform is not, check Q7, Q8, Q9 and associated components.



Waveform SS4-2

Test 1-c. Connect the oscilloscope Channel A input to XA8 pin 10 and the Channel B input to U2C pin 10. Reset the oscilloscope to .2 second/division. The oscilloscope CRT display should be similar to that shown in waveform SS4-2. Note that the selected marker (in this case marker No. 3) does not produce an output from one-shot Q4/Q6.

If the correct waveforms were observed in test 1-b but the Channel A input is missing in waveform SS4-2, A6U1 in the comparator assembly is probably defective.

If the Channel A waveform is correct, but Channel B is not, move the Channel B oscilloscope probe to U2 pin 9. If the signal is now present (opposite polarity), U2 is defective.

If the correct waveform is not observed at U2 pin 9 move the Channel A oscilloscope probe to U2 pin 13. If the input pulses are not present at U2 pin 13, and were present at XA8 pin 10, U2 is defective. If the correct waveform is present at U2 pin 13, check Q4, Q6 and associated components.

2 Y-Axis Summing Amplifier and Current Source

The summing amplifier sums the outputs from five sources. They are: one from each of the two 100 millisecond one-shot circuits, one from the 15 millisecond one-shot in the sweep inhibit circuit, one from the 1.5 millisecond one-shot circuit in the sweep inhibit circuit and one from the wiper of the output zero potentiometer.

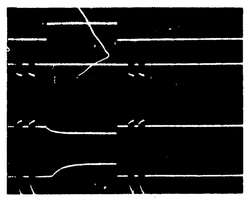
The 15 millisecond inputs to the summing amplifier are shaped by Q3, C9, CR5 and R14 to provide clear vertical markers. When the 15 millisecond input pulse appears, CR5 is forward biased when the signal level reaches approximately .6 volt and C9 begins to charge. The positive-going excursion of the pulse is controlled by the time constant of R14 and C9. This causes a gradual rise in the CRT (or X-Y recorder) signal trace. If the 15 millisecond pulse itself were used an abrupt change in the CRT (or X-Y recorder) signal trace would provide only a dot above the signal display. At the end of the 15 millisecond pulse CR 5 is reverse biased by the charge on C9 until the positive-going output of the summing amplifier turns on Q3 to discharge C9.

◀ SERVICE SHEET 3
Sweep Inhibit

Operation of the 1.5 millisecond shaper circuit is the same as the 15 millisecond shaper except that polarities are reversed.

The marker height control on the front panel is in the summing amplifier feedback path. It controls the gain of the summing amplifier.

The output of the summing amplifier, U1, is a voltage source which drives a voltage to current converter. The output from Q1/Q2 is a current source with a high output impedance.



Waveform SS4-3

Test Procedure 2

Test 2-a. Composite waveform SS4-3, taken in the SCOPE mode, illustrates correct waveforms (from top down) for XA8 pin 3, XA8 pin 8, Test Point 2 and Test Point 1. (Terminate Test Point 1 in 1000 ohms.) Oscilloscope set for 5 milliseconds/division and .5 volt/division, except for Test Point 1 which is shown at .1 volt/division.

If the correct signals are not present at XA8, pins 3 or 8, trouble is in the sweep inhibit assembly (A6).

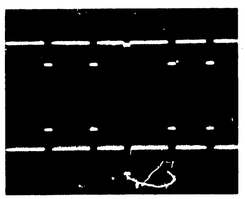
If the negative-going signal at Test Point 2 is not present, Q3 is probably defective.

If the positive-going signal at Test Point 2 is not present, Q5 is probably defective.

If none of the signals are present at Test Point 2 and the input signals are present, U1 is probably defective.

If all signals are present except that shown for Test Point 2, check Q1, Q2 and associated components.

Test 2-b. Connect the oscilloscope Channel A to Test Point 1 and Channel B to Test Point 2. Set the Generator/Sweeper sweep to slow and the model 8600A to RECORDER mode. Set the oscilloscope to .2 second/division, Channel A to 2 volts/division and Channel B to .2 volt/division. The CRT display should be similar to that shown in waveform SS4-4. This test verifies operation of the recorder mode one-shot circuits.



Waveform SS4-4

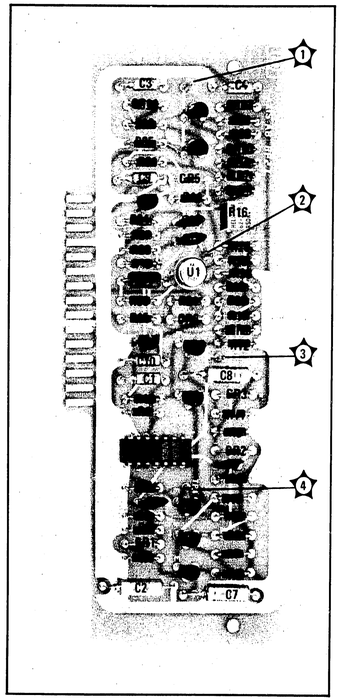


Figure 8-25. Y-Axis Assembly Component Locations

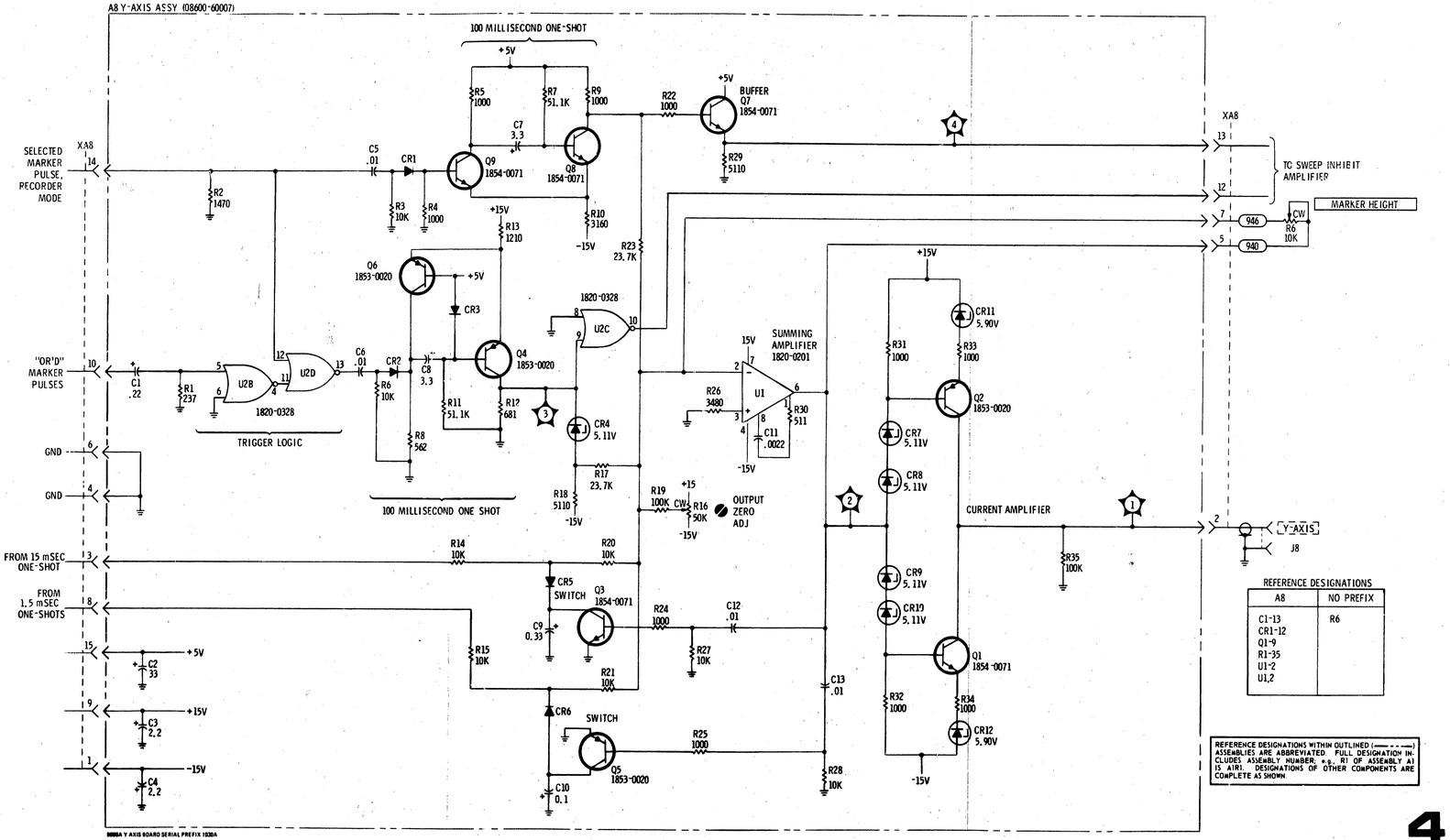


Figure 8-26. Y-Axis Schematic Diagram

SERVICE SHEET 5

Normally, causes of malfunctions in the model 8600A will be isolated to a circuit board or assembly as a result of performing the tests specified in the troubleshooting tree.

When trouble has been traced to the input amplifier assembly (A3), it should be removed from the chassis and re-installed using an extender board. This will provide easy access to test points and components.

Equipment Required:

Dual Channel Oscilloscope	Voltmeter
Variable Power Supply	10:1 probes (2)
Generator/Sweeper	

1 Decimal Point Circuit

The input RF signal from the Generator/Sweeper auxiliary output is a 0.1 to 11 MHz signal which may be superimposed on a dc level. The dc level is detected and used to determine which of three decimal points in the numerical readout (DS2, DS3 or DS4) illuminates.

The input signal goes through a low-pass filter (R1 and C4) and is buffered by Q11 and Q15. Only the dc level (attenuated by a factor of 2) on which the RF signal was superimposed appears at Test Point 3.

When the dc level at Test Point 3 is +2 volts, transistor Q12 is turned on and pin 12 of U1D goes low. U1D pin 13 goes high and turns on a transistor (Q3) in the A2 assembly to provide a ground return for the decimal point in DS2.

When the dc level at Test Point 3 is -3 volts, both Q13 and Q14 are turned on to provide a low to pin 4 of U1B. U1B pin 4 goes high and turns on a transistor (Q2) in the A2 assembly to provide a ground return for the decimal point in DS3.

When the dc level at Test Point 3 is -.6 volt, Q12, Q13 and Q14 are all off and pin 12 of U1D and pin 5 of U1B are both high. The low outputs of U1D and U1B are applied to the inputs of U1A. U1A pin 1 goes high and turns on a transistor (Q1) in the A2 assembly to provide a ground for the decimal point in DS4.

Test Procedure 1

Test 1-a. Use the voltmeter to verify the presence of -15, +5 and +15 volts at points shown on the schematic.

Test 1-b. With no RF input applied to the model 8600A, connect the variable power supply (set for 0 volt) to Test Point 3. The DS4 decimal point should illuminate. If it does not, check for a voltage of approximately +3.8 volts at XA3 pin 11. If the voltage is present, A2Q1 or DS4 may be defective.

If the voltage is not present at XA3 pin 11, check for voltages of approximately +5 volts at U1 pins 5 and 12. If voltages are present, replace U1; if not, proceed to test 1-c.

Test 1-c. Adjust the variable power supply for an output of +3 volts. The DS2 decimal point should illuminate. If DS2 decimal point illuminates, proceed to test 1-d. If not, check the voltage at U1D pin 12; it should be almost 0 volt (saturation voltage of Q12 above ground). If the voltage is the right level, check the voltage at XA3 pin 12 (should be about +3.8 volts). If the correct voltage is present at XA3 pin 12, DS2 or A2Q3 may be defective; if the correct voltage is not present, U1 is probably defective. If the voltage at U1D pin 12 is close to 5 volts, Q12 or CR1 may be defective.

Test 1-d. Adjust the variable power supply for an output of -3 volts. The DS3 decimal point should illuminate. If DS3 does not illuminate, check the voltage at U1B pin 5; it should be almost 0 volt (saturation voltage of Q14 above ground). If the voltage is the right level, check the voltage at XA3 pin 14 (should be about +3.8 volts). If the voltage is present at XA3 pin 14, DS3 or A2Q3 may be defective. If the voltage at U1B pin 5 is close to +5 volts, Q13, Q14 or CR2 may be defective.

2 Signal Processing Circuit

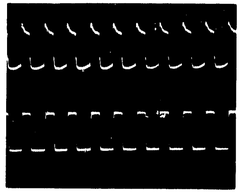
Q9 and Q10 comprise a unity gain buffer amplifier. Q7 and Q8 are connected as a differential pair which operates as a linear amplifier for low level signals and as a limiter for high level signals. The output from Q7 is ac coupled to Q5/Q6 which is a Schmitt trigger. The Schmitt trigger output is coupled to the base of Q4 by C11. Q4 is normally on; the sharp negative-going pulses at the base produce sharp positive-going pulses at the collector.

Q3 acts as a switch. When the main gate in the counter time base is off (A5U3A $\overline{Q}$ high), XA3 pin 3 is high and Q3 is saturated. Under these conditions the positive pulses at Q4 collector are by-passed to ground; they cannot reach one-shot Q1/Q2.

When the main gate flip-flop in the counter time base is "on" (A5U3A $\overline{Q}$ low), Q3 is off and the signal pulses are coupled to Q2. One-shot Q1/Q2 provides short time duration pulses to the decade counters in the counter assembly (A1).

Test Procedure 2

Test 2-a. Connect the oscilloscope Channel A input to XA3 pin 13 and the Channel B input to Q7-c. Set oscilloscope controls to 1 microsecond/division and .2 volt/division. Set the Generator/Sweeper to 10 MHz CW and the model 8600A to the counter mode. The CRT display should be similar to that shown in waveform SS5-1.



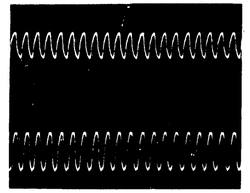
Waveform SS5-1

If both signals are correct, proceed to Test 2-b.

If neither of the signals are present, check the interconnections with the Generator/Sweeper and if necessary the Generator/Sweeper circuits.

If the input signal is present but the signal at Q7-c is not, check Q7, Q8, Q9, Q10 and associated components.

Test 2-b. Connect the oscilloscope Channel A input to Q4-b and the Channel B input to Test Point 2. Set the oscilloscope for .2 microsecond/division and .2 volt/division. Synchronize the oscilloscope to the Generator/Sweeper auxiliary output (connect the model 8600A INPUT jack to the oscilloscope sync input). Set the Generator/Sweeper output to 100 MHz CW and the model 8600A to the counter mode. The oscilloscope CRT display should be similar to that shown in waveform SS5-2.



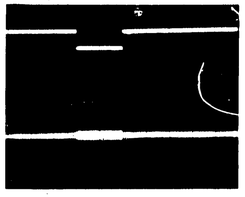
Waveform SS5-2

If both waveforms are present proceed to test 2-c.

If neither waveform is present, check Q5, Q6 and associated components.

If the Channel A waveform is present but the Channel B waveform is not, check C11 and Q4.

Test 2-c. Connect the oscilloscope Channel A input to XA3 pin 3 and the Channel B input to Test Point 1. Set the oscilloscope for 5 milliseconds/division, Channel A to .5 volt/division and Channel B to .2 volt/division. Synchronize the oscilloscope to the Generator/Sweeper sweep ramp. Set the Generator/Sweeper for a 1 MHz symmetrical output and the model 8600A to the scope mode. The CRT display should be similar to that shown in waveform SS5-3.



Waveform SS5-3

If both signals are present the assembly is functioning properly.

If the Channel A signal is incorrect, trouble is in the time base circuit (A5).

If the Channel A signal is correct and the Channel B signal is not, check Q1, Q2, Q3 and associated components.

SERVICE SHEET 4
Y-Axis

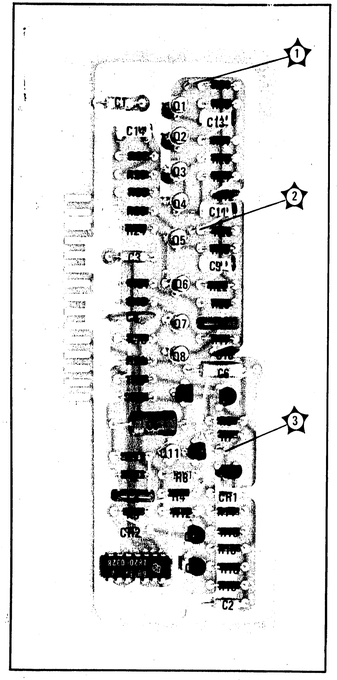


Figure 8-27. Input Amplifier Assembly Component Locations

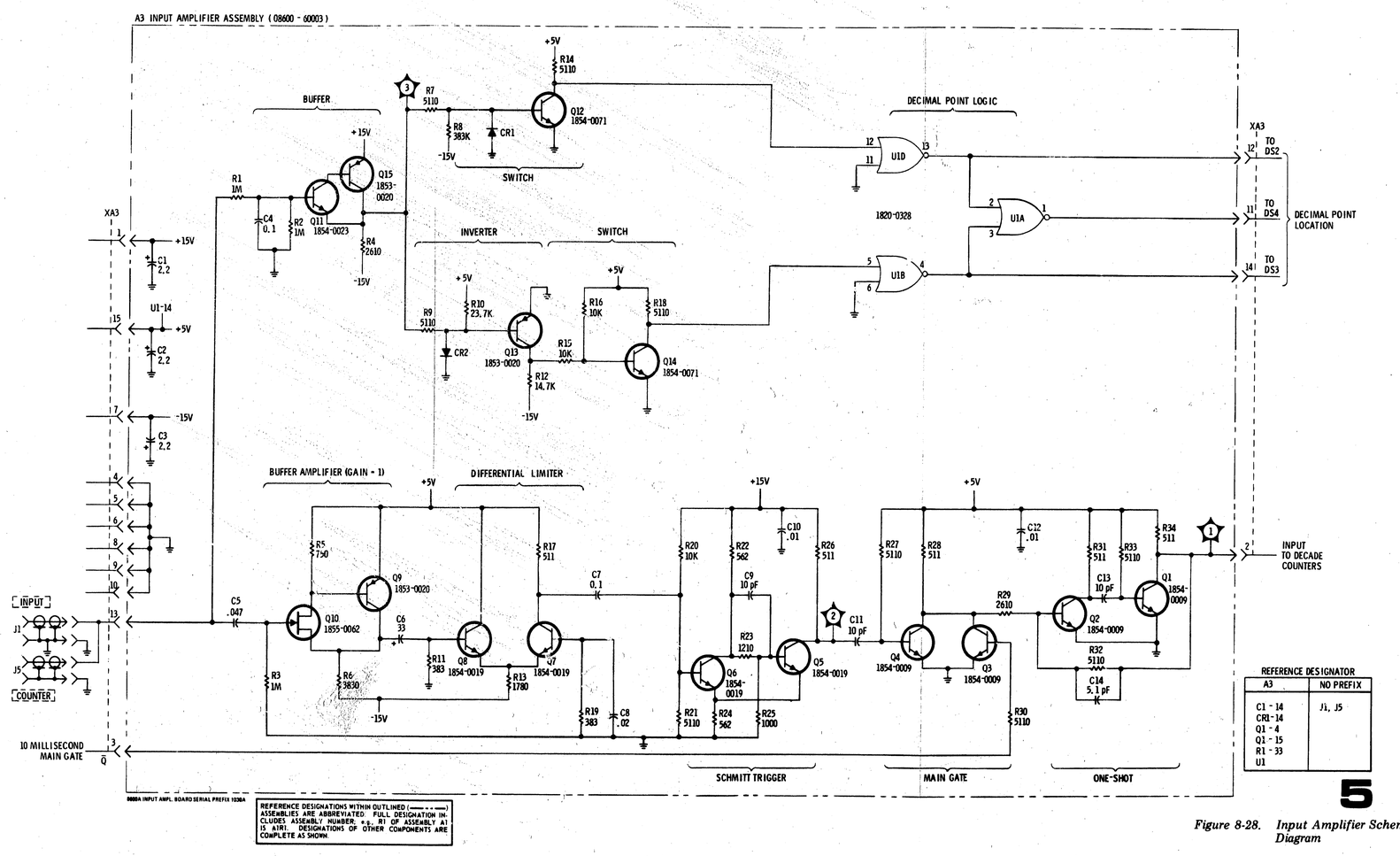


Figure 8-28. Input Amplifier Schematic Diagram

5

SERVICE SHEET 6

Normally causes of malfunctions in the model 8600A will be isolated to a circuit board or assembly as a result of performing the tests specified in the troubleshooting tree.

When trouble has been traced to the counter time base assembly (A5), it should be removed from the chassis and re-installed using an extender board. This will provide easy access to test points and components.

Equipment Required:

Dual Channel Oscilloscope	10:1 probes (2)
Generator/Sweeper	Voltmeter

1 Reference Oscillator and Divide-by-Ten Circuits

The reference oscillator is a stable crystal controlled oscillator which produces a 1 MHz output. The output signal at Test Point 2 is approximately 4 volts peak-to-peak.

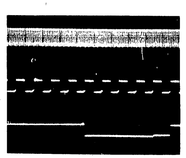
There are four divide-by-ten circuits; two of them, U6 and U7, are free-running. U1 and U5 are reset at the beginning of each count cycle; U1 to 9 and U5 to 0.

U2A, the NAND gate between U5 and U1 is used to delay the beginning of the count cycle slightly to ensure that the reset pulse has ended before the count begins. The negative-going reset pulse from U2C pin 8 is coupled through CR1 to pin 13 of U1A. The positive-going trailing edge of the reset pulse from U2C pin 8 is delayed by R9 and C7.

When pin 13 of U2A goes high, pin 1 is high because the Q output of the sample rate multivibrator (U3B pin 10) is high. The first positive pulse from U5 resets U1 to 0. When U1 is reset to 0 the negative going pulse at pin 12 clocks the main gate flip-flop to start the 10 millisecond count period.

Test Procedure 1

Test 1-a. Use the voltmeter to verify the presence of -15 and +5 volts at points shown on the schematic diagram.



Waveform SS6-1

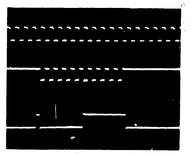
Test 1-b. Composite waveform SS6-1 illustrates (from top down) correct signals at Test Point 2, U7 pin 12, and U6 pin 12. The oscilloscope settings are 10 microseconds/division and .5 volt/division. The model 8600A may be operated in any mode while observing these waveforms. Generator/Sweeper control settings have no effect on the tests. If all signals are as illustrated proceed to test 1-c.

If the signal is not present at Test Point 2 check Q4, Q5 and associated components.

If the signal is present at Test Point 2 but is not present at U7 pin 12, U7 is probably defective.

If the signal is present at U7 pin 12, but is not present at U6 pin 12, U6 is probably defective.

Test 1-c. Composite waveform SS6-2 illustrates (from top down) correct signals at U5 pin 12, U2A pin 12 and U1 pin 12. The oscilloscope settings are 2 milliseconds/division and .5 volt/division. The model 8600A is operating in the scope mode. Generator/Sweeper controls, other than the SWEEP mode, which must be in the fast mode, have no effect on the test. If all signals are as illustrated, proceed to test procedure 2.



Waveform SS6-2

If the signal at U5 pin 12 is incorrect, U5 is probably defective.

If the signal at U2A pin 12 is incorrect and the correct signal was observed at U5 pin 12, U2 may be defective. However, test procedures 2 and 3 should be performed before replacing U2 at this point in the tests.

If the signal at U2A pin 23 is correct and the signal at U1 pin 12 is not, U1 is probably defective.

2 Sample Rate Multivibrator and Main Gate Flip-Flop

The sample rate multivibrator (U3B) provides outputs to trigger the reset and transfer one-shot circuits and an enable to delay gate U2A.

In the scope and recorder modes XA5 pin 8 is grounded and count initiate pulses from the selected comparator are applied to XA5 pin 11. These positive-going pulses cause the output of U4D to go low. The negative-going pulses at U4D pin 11 are coupled through C11 and CR6 to reset U3B. U3B pin 11 (Q) goes low to trigger the reset one-shot.

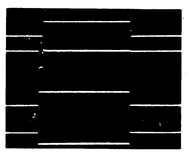
In the counter mode XA5 pin 9 is grounded. Since there are no count initiate signals provided by the sweep inhibit assembly, the count must be initiated in the time base circuit. In this mode when the count cycle ends and U3B is clocked by the negative-going pulses from U3A pin 15 (Q), U3B Q output goes high. C9 begins to charge through R12 and R15. When the charge on C9 reaches a level of about 2 volts U4C pin 8 is coupled through CR5 to reset U3B to initiate the count cycle.

When U3B is clocked by the negative-going Q output of U3A, U3B $\overline{Q}$ output goes low to initiate the transfer pulse.

The main gate flip-flop, U3A is considered to be off when the counter is not counting. $\overline{Q}$ is high and is driving a switch in the A3 assembly to ground the input RF signal.

Test Procedure 2

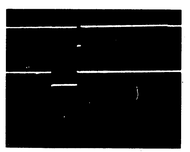
Test 2-a. Composite waveform SS6-3 illustrates (from top down) the correct waveforms for U3 pins 6 (clock), 8 (reset), 10 ($\overline{Q}$) and 11 (Q). The oscilloscope settings are 2 milliseconds/division and .5 volt/division except for U3 pin 8 which was taken at 0.5 volt/division. The model 8600A is in the scope mode and the Generator/Sweeper is in the fast sweep mode. If all the signals are correct, proceed to test 2-b.



Waveform SS6-3

If only the reset pulse (U3 pin 8) is present, U3 may be defective. However, the reset circuit check, test 3-a, should be performed before U3 is replaced.

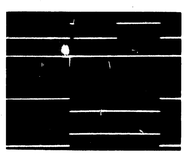
If the reset pulse is not present connect the oscilloscope Channel A input to U3 pin 8 and the Channel B input to U4D pin 13. The oscilloscope settings are 2 milliseconds/division, Channel A .05 volt/division and Channel B .5 volt/division. The CRT display should be as shown in waveform SS6-4.



Waveform SS6-4

If the signal is present at U4D pin 13 and is not present at U3 pin 8, U4 is probably defective. Check C7 and CR4 before replacing U4.

Test 2-b. Composite waveform SS6-5 illustrates (from top down) the correct signals for U3 pins 2 (clock), 3 (reset), 14 ($\overline{Q}$) and 15 (Q). The oscilloscope settings are 2 milliseconds/division and .5 volt/division. The model 8600A is in the scope mode and the Generator/Sweeper is in the fast sweep mode.



Waveform SS6-5

If all of the waveforms are as shown in tests 2-a and 2-b and the counter still does not count, trouble is probably in the counter circuit, the reset inverter or the transfer one-shot.

If none of the waveforms are present U3 may be defective. However, the reset circuit check, test 3-a, should be performed before U3 is replaced.

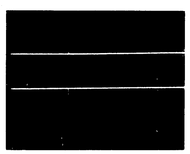
3 Reset and Transfer Circuits

The reset one-shot is triggered by the negative-going Q output (pin 11) of U3B when the count cycle is initiated. All inputs to U2B are normally high and the output is normally low. When the negative-going Q output of U3B is coupled through C8 to U2B pin 2, U2B pin 6 goes high. The high at U2B pin 6 resets U5 and U1 and also causes the output of U2C to go low. The output of U2C (pin 8) is used to reset the main gate flip-flop, delay the start of the count and through an inverter, reset the decade counters in the A1 assembly. The duration of the reset pulse is very short; the one-shot quickly returns to its quiescent state.

The transfer pulse is initiated by the negative-going Q output (pin 10) of U3B when the count cycle is ended. Both inputs to U4B are normally high and the output is low. When the negative-going leading edge of the U3B Q output is coupled through C10 to U4B, pin 6 of U4B goes high to transfer the information from the decade counters to buffer/stores in the A1 assembly. The duration of the transfer pulse is very short; the one-shot quickly returns to its quiescent state.

Test Procedure 3

Test 3-a. Connect the oscilloscope Channel A input to U2 pin 6 and the Channel B input to U2 pin 8. Set the oscilloscope to 2 milliseconds/division and .5 volt/division. Set the model 8600A to the scope mode and the Generator/Sweeper to the fast sweep mode. The CRT display should be similar to waveform SS6-6.

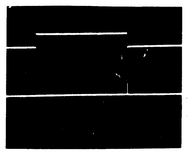


Waveform SS6-6

If the signals are present but the counter still is not working, use one of the oscilloscope channels to check for the reset pulse at XA5 pin 2. With the oscilloscope sensitivity set at .2 volt/division the CRT display should be similar to the display for U2 pin 6 shown in SS6-6. If the signal is not present, Q1 is probably defective. If the signal is present, proceed to test 3-b.

If the signals are not present, momentarily ground pin 3 of U1B while watching the oscilloscope CRT display. If a pulse does not appear, U2 is probably defective. If a pulse does appear, U3 is probably defective.

Test 3-b. Connect the oscilloscope Channel A input to U3 pin 10 and the Channel B input to U4 pin 6. Set the oscilloscope to 2 milliseconds/division and .5 volt/division. Set the model 8600A to scope mode and the Generator/Sweeper to fast sweep mode. The CRT display should be similar to that shown in waveform SS6-7.



Waveform SS6-7

If the signal at U3 pin 10 is present and the signal at U4 pin 6 is not, U4 is probably defective.

If neither signal is present U3 is probably defective.

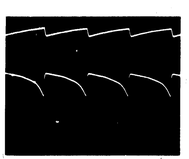
4 Counter Mode Count Initiate Circuit

In the counter mode the count cycle is initiated by Q2, Q3 and C4.

Between counts the sample rate flip-flop Q output (pin 11) is high. This high is coupled through R7 and R11 to charge C4. When the charge on C4 reaches about 2 volts Q2 and Q3 are both turned on. CR2 couples the positive-going pulse from Q2-e to NAND gate U4C. The negative-going output of U4C is coupled through CR3 to reset the sample rate flip-flop and initiate the count cycle. The R/C time constant of the circuit determines the five times per second count rate.

Test Procedure 4

Connect the oscilloscope Channel A input to U4 pin 9 and the Channel B input to U4 pin 8. Set the oscilloscope controls to .1 second/division and .2 volt/division. Place the model 8600A in the counter mode. The CRT display should be similar to that shown in waveform SS6-8.



Waveform SS6-8

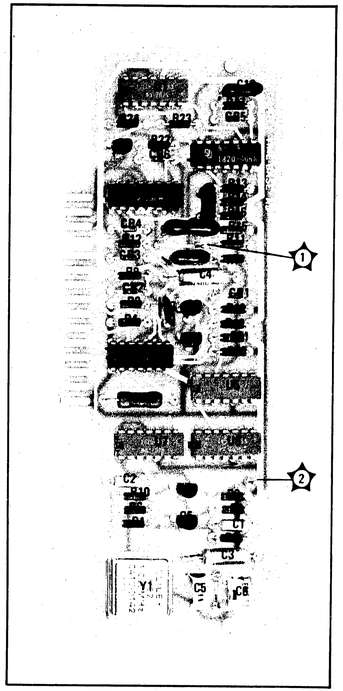


Figure 8-29. Time Base Assembly Component Locations

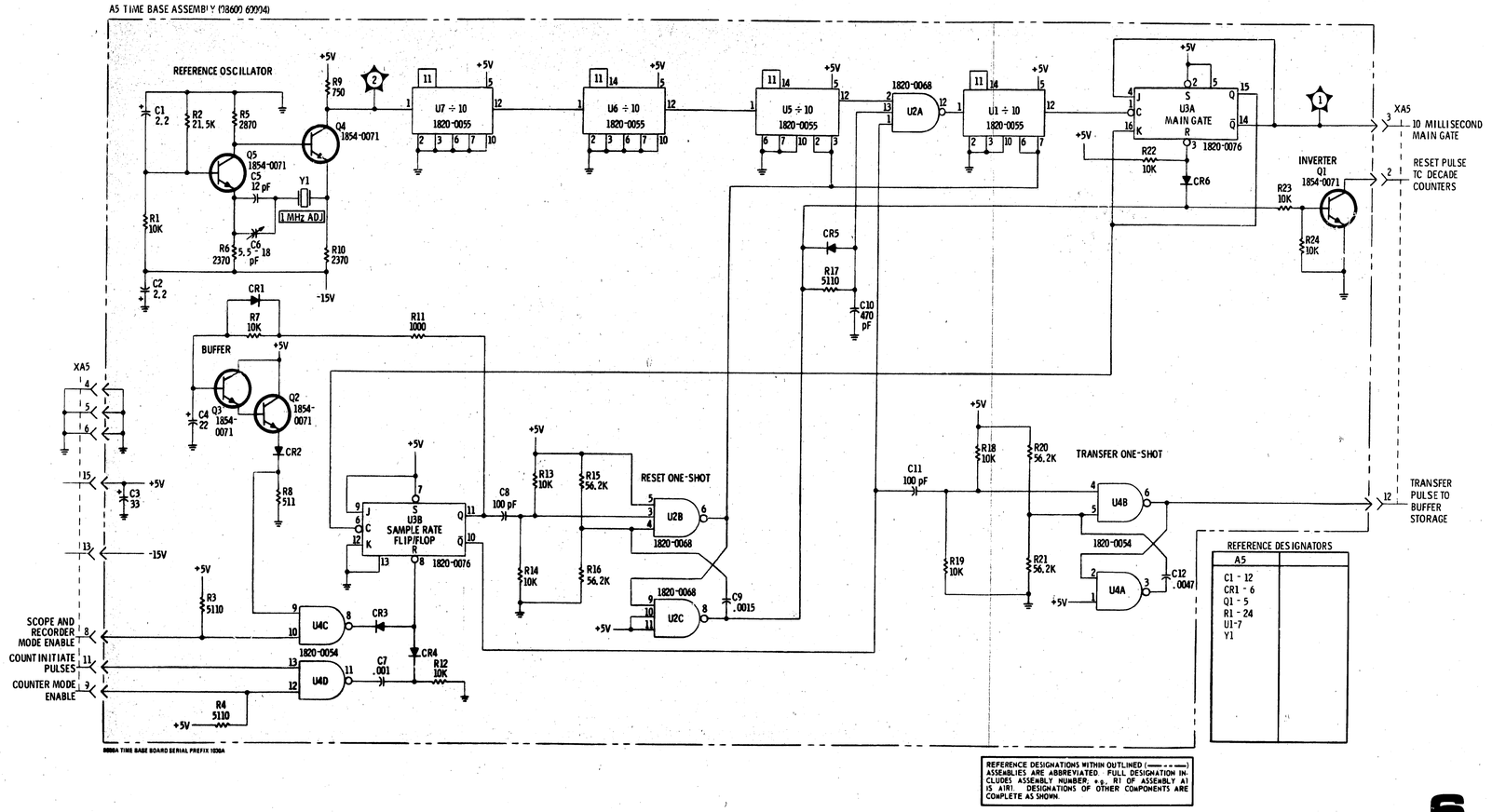


Figure 8-30. Time Base Schematic Diagram

SERVICE SHEET 7

Normally, causes of malfunctions in the model 8600A will be isolated to a circuit board or assembly as a result of performing the tests specified in the troubleshooting tree.

When trouble has been isolated to the counter circuits the counter board (A1) should be removed from the socket and re-installed using an extender board. This will provide easy access to test points and components.

Equipment Required:

Dual Channel Oscilloscope	10:1 probes (2)
Logic Clip	Digital Voltmeter
Test Oscillator	

1 DS1 through DS5 Drive Circuits

When the main gate in the A3 assembly is opened the signal to be counted is applied to pin 14 of U7. For every tenth pulse received the D output of U17 provides an input pulse to pin 14 of U14. Each decade counter provides divide-by-ten outputs to the input of the decade counter which follows it. Each decade counter remains in the state it was in when the count ended until the reset pulse appears.

The transfer pulse from the counter control assembly (A5) is applied to the buffer-stores after the count is completed to transfer the BCD information from the decade counters to the decoder/drivers. The decoder/drivers decode the BCD information to decimal information and provide a ground to the appropriate number in the numerical readout device.

Test Procedure 1

General

The numerical readout indicators, in many instances, will help localize a problem to a specific area within the counter circuits.

If any one of the numerical readouts does not function, but numerical readouts to the left of it do, the trouble is likely to be the readout device itself, the decoder/driver or the buffer/store associated with that readout. It is not likely that the associated decade counter is defective.

If any numerical readout is blank or reads only one number, and the readouts to the left consistently read 0, the decade counter for the first readout affected (from the right) is probably defective.

A fast and efficient means of testing DTL and TTL digital circuits is provided by the Hewlett-Packard Model 10528A Logic Clip. This clip clamps directly on IC pins (either 14 or 16 pin IC's) and light emitting diodes indicate high and low logic levels at each pin.

◀ SERVICE SHEET 6
Time Base

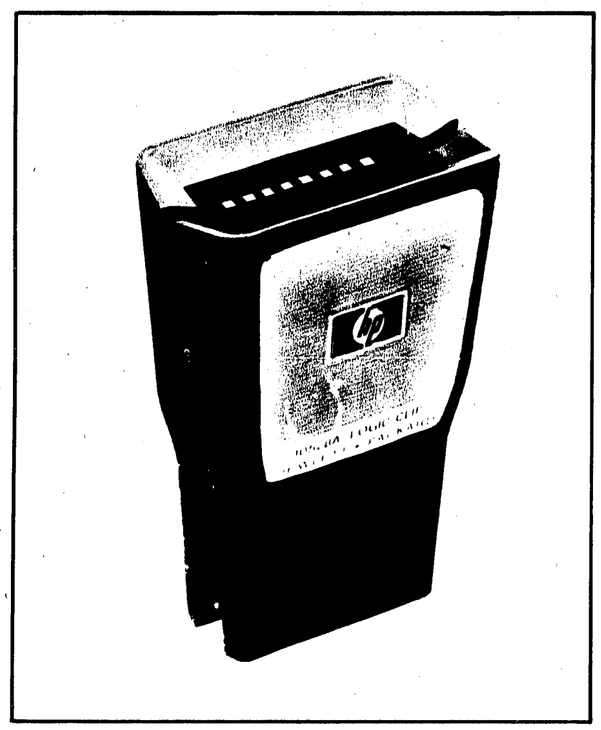


Figure 8-31. HP 10528A Logic Clip

Test 1-a. Apply a signal from the Generator/Sweeper RF OUT to the model 8600A INPUT. (12 MHz, SYM SWEEP, 3 MHz SWEEP WIDTH and FAST SWEEP MODE.)

Place the logic clip on the decade counters beginning with U17, then U14, etc. If the light emitting diodes blink rapidly on all decade counters, the decade counters are probably good. Watch particularly for action at pin 14 of all decade counters; if pin 14 is active but other pins are not, the decade counter being tested is defective. If there is no action at pin 14 the preceeding decade counter is probably defective.

Test 1-b. Place the logic clip on the buffer/stores starting with U16, then U12, etc. If pins 2, 3, 6 and 7 are active but pins 9, 10, 15 and 16 are not, the buffer/store is defective.

Test 1-c. If one or more of the numerical readouts does not illuminate, ground pins 16, 15, 8, 9, 13, 14, 11, 10, 1 and 2 of the decoder/driver associated with the readout one at a time. The appropriate numbers as shown on the schematic should illuminate. If the correct numbers illuminate and tests 1-a and 1-b were successfully concluded, the decoder/driver is defective. If the numbers do not illuminate check the +200 volt supply to the readout anode. If the +200 volt supply is present, the readout device is defective.

2 DS6 Driver Circuit

The most significant digit, displayed by DS6, is used only when the input frequency to the counter is 10 MHz or higher. Below 10 MHz DS6 is blanked because U2 has not been clocked by U1. The output of U1 changes state at the count of 8 (representative of 8 MHz), but since this transition is positive-going, it has no effect on U2. When U1 receives its tenth pulse (representative of 10 MHz), it again changes state and the negative-going transition clocks U2. When U2 is clocked the Q output goes high and toggles U4 which acts as a buffer/store. When U4 is toggled the Q output goes high and turns on Q1. Q1 provides a ground for the numeral 1 in DS6. The transfer pulse is not required in the DS6 drive circuit; both U2 and U4 are reset by the reset pulse.

Test Procedure 2

Test 2-a. Connect the logic clip to U2. Note that when the frequency is under 10 MHz none of the IC pins are active. Over 10 MHz pin 8 goes high and pin 6 flickers.

Test 2-b. Connect the logic clip to U4. Note that pins 2, 3, 5, 7 and 8 are low at frequencies of less than 10 MHz. Over 10 MHz pins 3, 6, 7 and 8 are low.

Test 2-c. Ground Q1-c. The number 1 should illuminate. It it does not, check the 200 volt supply. If +200 volts is present, DS6 is defective.

3 Decimal Points

Three transistor switches are provided in the A2 assembly to cause a decimal point to appear in DS2, DS3 or DS4. These switches are controlled by logic circuitry in the A3 assembly.

Test Procedure 3

With the A3 assembly removed, connect +5 volts to XA1 pins 7, 8 and 9. The appropriate decimal point should illuminate. If it does not, check Q1, Q2 or Q3 as appropriate.

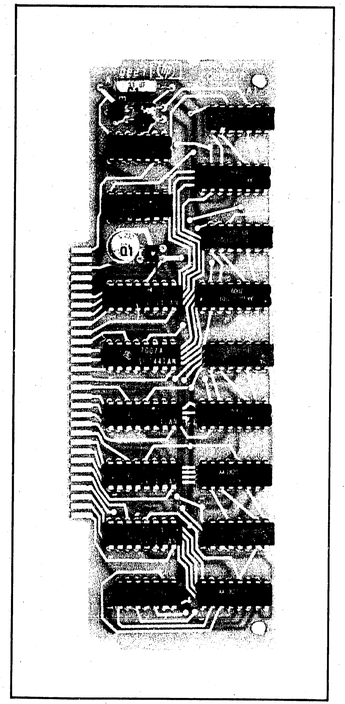


Figure 8-32. Counter Assembly Component Locations

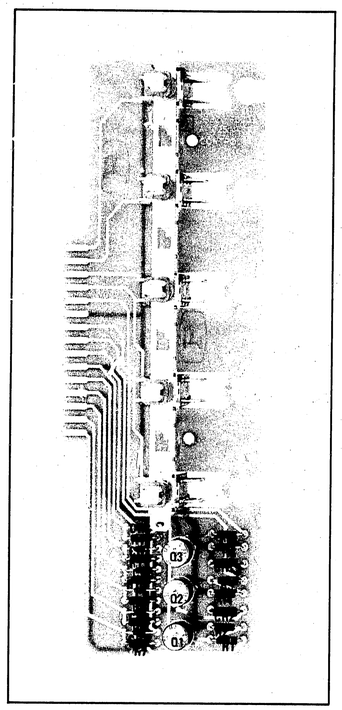


Figure 8-33. Control Assembly Component Locations

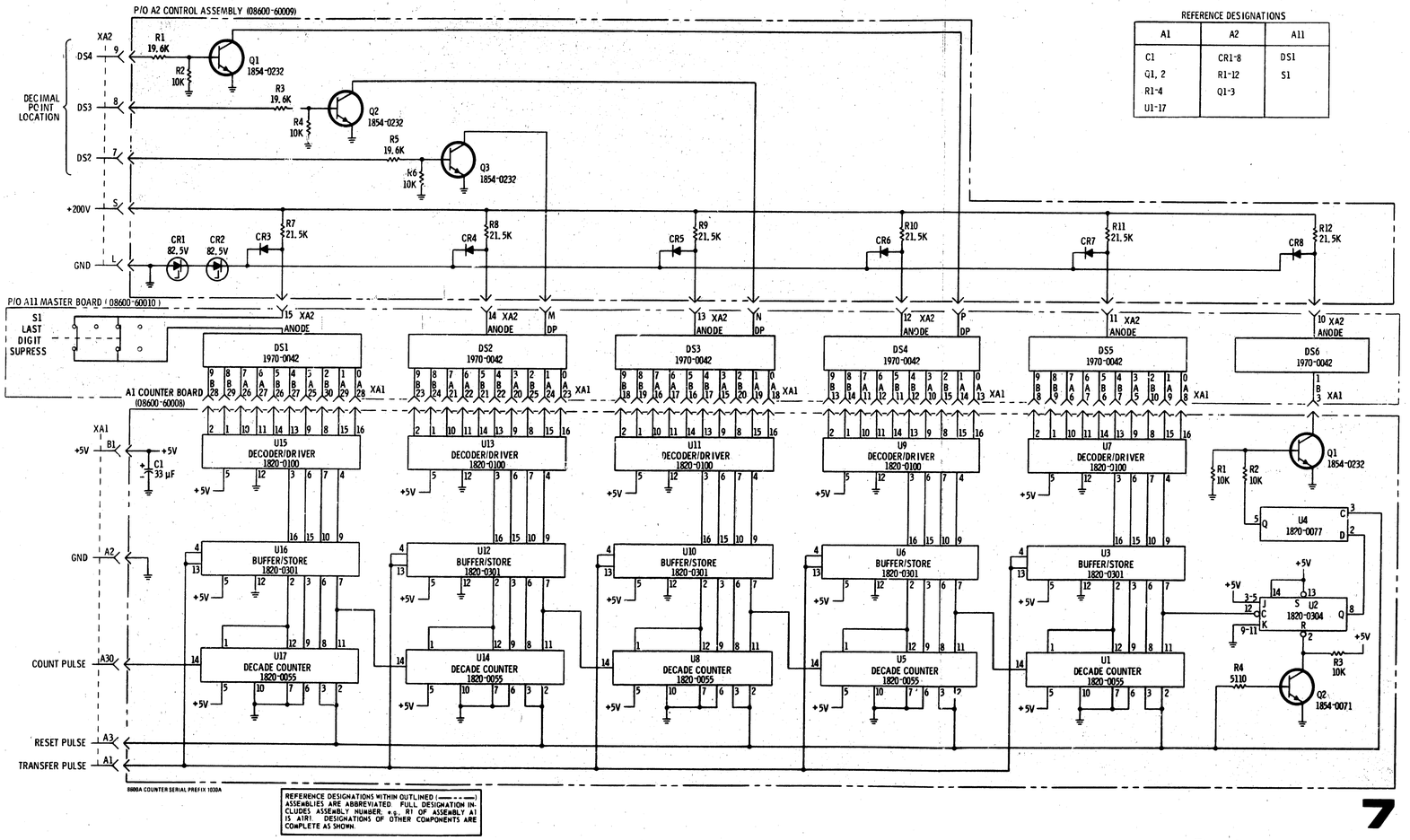


Figure 8-34. Counter and Decimal Control Schematic Diagram

SERVICE SHEET 8

Normally, causes of malfunctions in the model 8600A will be isolated to a circuit board or assembly as a result of performing the tests specified in the troubleshooting tree.

When trouble has been isolated to the Regulator Assembly (A7) or the Rectifier Assembly (A9), the defective assembly should be removed from the chassis and re-installed using an extender board. This will provide easy access to test points and components.

Equipment Required:

Digital Voltmeter

1 Rectifier Assembly A9

AC power for the rectifiers in the model 8600A is supplied by a single power transformer with three secondary windings.

The +5 volt and +200 volt supplies are both full-wave bridge-type rectifiers.

The +15 volts and -15 volts are derived from full-wave rectifiers driven by a common transformer secondary.

Test Procedure 1

If none of the voltages shown on the schematic are present, trouble is probably in the power transformer, line module, power switch or wiring.

Two voltage levels are shown for each of the rectifier outputs. The upper level is taken with the regulator board in place; the lower level is taken with the regulator board removed from the chassis.

If the voltage level is right with the regulator board removed, but is not with it in place, trouble is probably in the regulator board, or a short elsewhere in the instrument.

If the voltage level is not right, first verify the presence of ac at the transformer secondary, then replace the rectifiers.

2 Regulator Assembly A7

The series regulator for the five volt supply is located on the main chassis which serves as a heat sink. The 15 volt regulators, mounted on the regulator assembly, have individual heat sinks.

Series regulators function as a variable resistance in series with the power supply and the load. If the regulated output rises, the series regulators conduct less and cause the output to be lowered. If the regulated output drops, the series regulators conduct more and cause the output voltage to rise.

Test Procedure 2

Since most of the regulators' circuitry is enclosed in an integrated circuit, failed components should be easily located. The voltages shown are specified by the IC manufacturer. Check for the control voltages shown, then check individual components.

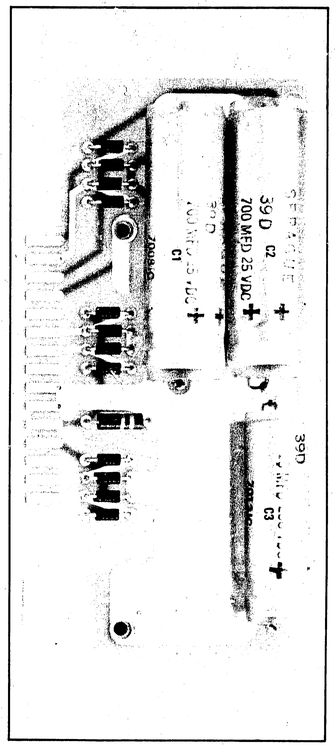


Figure 8-35. Rectifier Assembly Component Locations

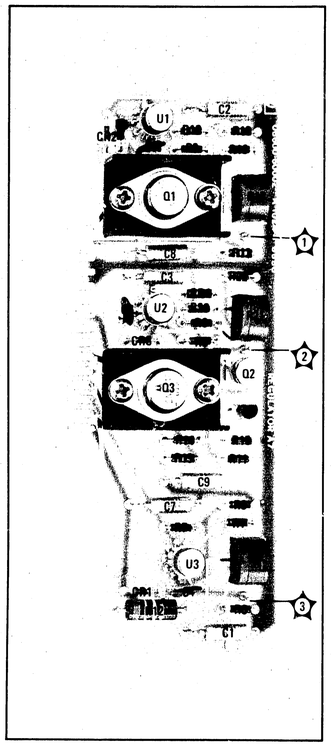


Figure 8-36. Regulator Assembly Component Locations

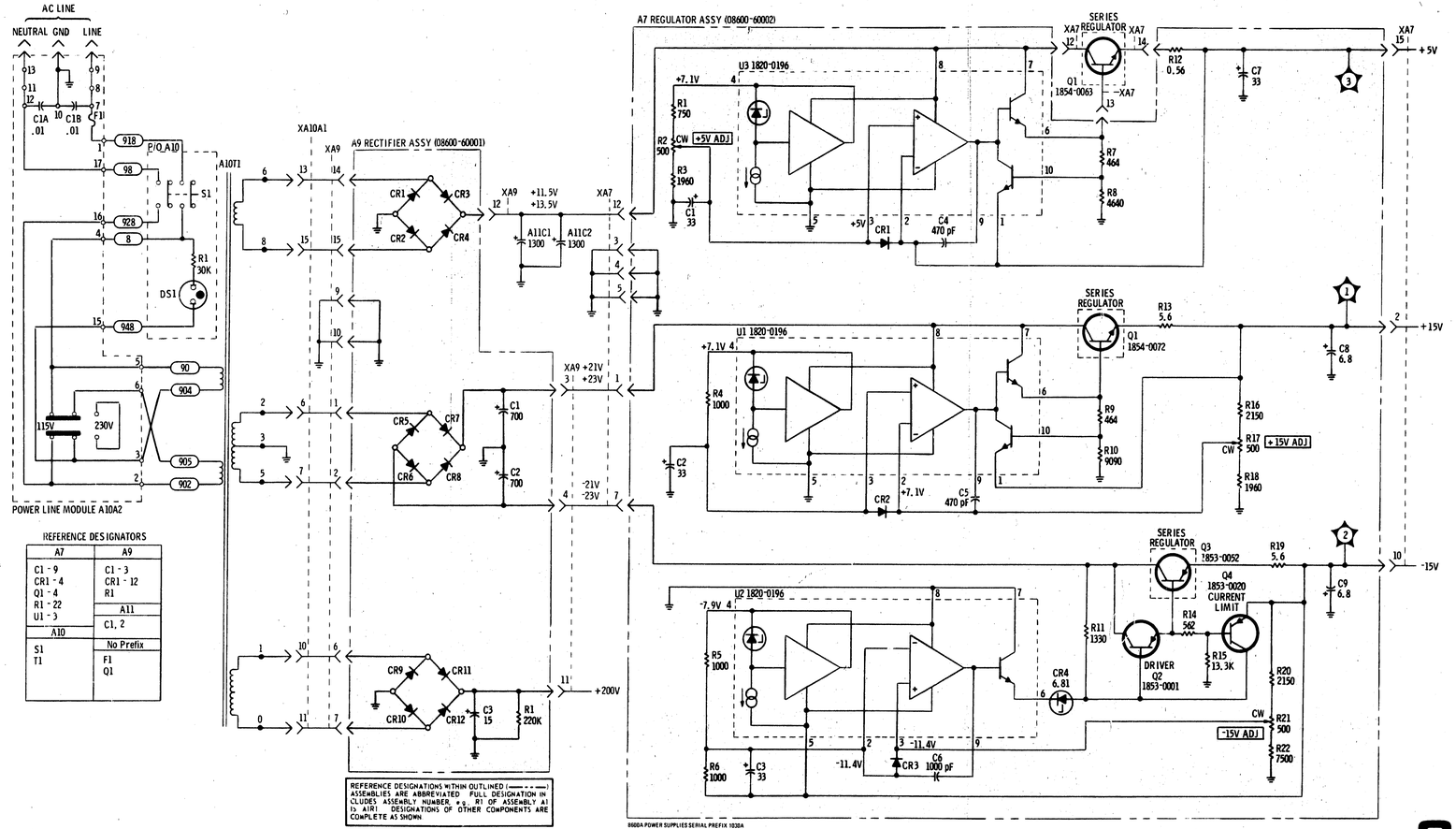


Figure 8-37. Rectifier and Regulator Schematic Diagram

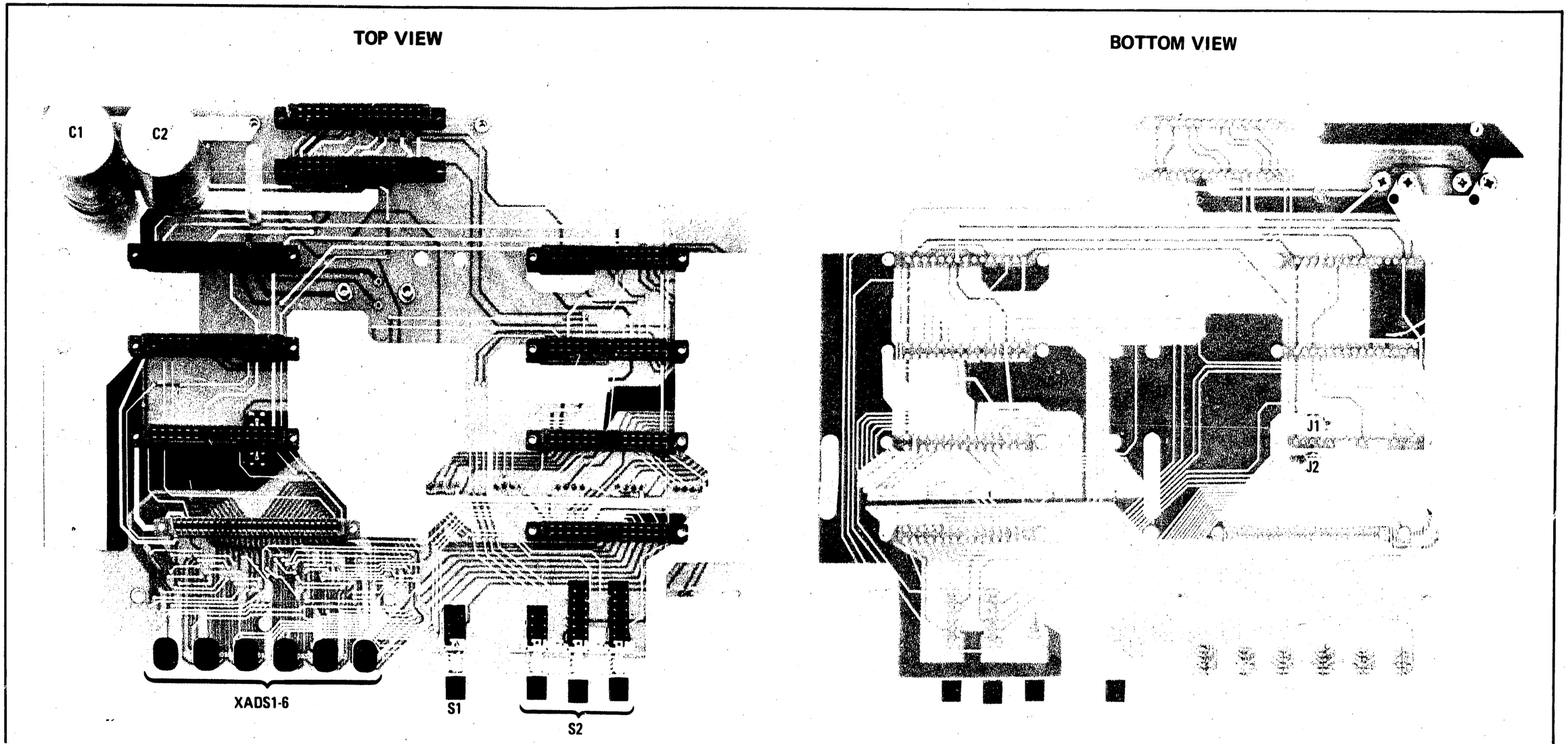


Figure 8-38. Mother Board

MANUAL CHANGES

MANUAL CHANGES

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.

MANUAL IDENTIFICATION

Model Number: 8600A
Date Printed: Sept. 1970
Part Number: 08600-90001

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

▶ = NEW ITEM

Serial Prefix or Number	Make Manual Changes
1044A00111 thru 1044A00130	1
1044A00131 thru 1044A00200	1, 2
1144A00201 thru 1148A00210	1, 2, 3
1148A00211 thru 1148A00310	1, 2, 3, 4
1148A00311 thru 1148A00410	1-5
1148A00411 thru 1148A00740	1-6

Serial Prefix or Number	Make Manual Changes
1601A	1-7
1651A	1-8
1702A	1-9
1901A	1-10
2006A	1-11
2020A	1-12
2048A	1-13
2117A	1-14

The following Service Notes are available from your local HP Sales and Service Office:

Service Note	Serial Number	Description
8600A-1	All Serials	Sweep Inhibit Modification Kit
8600A-2	Prefix 1601A and below	Recommended Replacements for A5Q1 through Q5

30 JULY 1986
18 pages plus 2 foldouts

HEWLETT PACKARD

Printed in U.S.A.

ERRATA

Page 1-2, Table 1-1, Specifications:
Add: OPTION 001: A modification kit (PN 08600-60022) is supplied to make the HP 8690 sweep oscillator/8698B RF unit compatible with the HP 8600A digital marker.

Add:

NOTE

When using 8601A Generator/Sweeper, Serial Numbers 954-01131 and up, in some cases the minimum marker separation specification will not be met due to interaction on the 8601's sweep board. In such cases it is recommended that the modification kit (Part Number 08601-60093 be installed in the 8601A Generator/Sweeper.

Page 1-2, Paragraph 1-16:
Delete all references to Rack Mounting Kit.
Delete all references to Modification Kit.

Page 1-3, Paragraph 1-18:
Add: "A Rack Mounting Kit is available to install the instrument in a 19-inch rack. Rack Mounting Kits may be obtained through your nearest Hewlett-Packard office by ordering HP Part Number 5060-8739."
Add: "A Modification Kit, HP Part Number 08601-60093 is available for the 8601A. This modification is required on Model 8601A's with Serial Number 945-01130 and below."

Page 1-3, Table 1-2:
Change the Model Number of the recommended Frequency Counter to HP 5381A.

Page 4-6, Paragraph 4-13:
Under *Equipment*,change the recommended Electronic Counter model to HP 5381A.

Page 4-7, Paragraph 4-14:
Under *Equipment*, change the recommended Electronic Counter model to HP 5381A.

Page 5-3, Paragraph 5-10:
Under *Equipement*, change the recommended Electronic Counter model to HP 5381A.

Page 6-10, Table 6-2:
Add A10R1, HP Part Number 0683-3035, RESISTOR 30K 5% .25W FC TC = −500/+800, Mfr. Code 28480, Mfr. Part No. 0683-3035.
Change A10A1 to HP Part Number 08600-60035 (Recommended Replacement).

Page 6-11, Table 6-2:
Change the first "W2" description to: "CABLE ASSY: COUNTER."
Change the second "W2" entry (Power Cable) to W3.
Change the third "W2" entry to W4.
Delete the fourth "W2" entry (08600-60015).
Add cables W5, W6, W7, and W8, HP Part No. 08600-60014, CABLE ASSY: COMPARATOR.

Page 8-19, Figure 8-17:
Change T1 to A10T1.

ERRATA (Cont'd)

Page 8-23, Figure 8-22:
Change XA4 pin 5 to pin S.
Add "J7" under "SWEEP OUT" label.
Add a shielded, grounded cable, W4, around the three wires from R1.
Add a shielded, grounded cable, W5, around the three wires from R2.
Add a shielded, grounded cable, W6, around the three wires from R3.
Add a shielded, grounded cable, W7, around the three wires from R4.
Add a shielded, grounded, cable, W8, around the three wires from R5.

Page 8-29, Figure 8-28:
Add to cable attached to J1 the label "W1" and color code "4" (yellow).
Add to cable attached to J5 the label "W2" and color code "4" (yellow).

Page 8-35, Figure 8-37:
In the top left-hand corner, change "AC LINE" to "POWER CABLE W3."

CHANGE 1

Page 6-6, Table 6-2:
Add A5R25 0757-0442 R: FXD MET FLM 10.0K 1% 1/8W.

Page 6-7, Table 6-2:
Change resistor A6R14 to HP Part No. 0698-0083 R; FXD MET FLM 1.96K ohm 1% 1/8W.

Page 8-25, Figure 8-24:
Change resistor A6R14 to 1960 ohms.

Page 8-31, Figure 8-30:
Add 10K resistor (A5R25) between A5Q3 base and junction of A5C4, A5CR1 and A5R7.

CHANGE 2

Page 6-3, Table 6-2:
Change diodes A2CR1 and A2CR2 to HP Part No. 1902-0197. Change resistors A2R7, A2R8, A2R9, A2R10, A2R11 and A2R12 to HP Part No. 0698-3136 R:FXD MET FLM 17.8K OHM 1% 1/8W.
Change capacitor A3C7 to HP Part No. 0160-0174 C: FXD CER .47 UF +80-20% 25 VDCW.

Page 6-10, Table 6-2:
Change power line module A10A2 to HP Part No. 5060-1200.

Page 8-29, Figure 8-28:
Change value of capacitor A3C7 to .47 UF.

Page 8-33, Figure 8-34:
Change value of resistors A2R7, A2R8, A2R9, A2R10, A2R11 and A2R12 ro 17.8K OHMS.

CHANGE 3

Page 6-11, Table 6-2, under MISCELLANEOUS:
Add the following note to define the 8600A color scheme.

NOTE

This change implements a different color scheme for the standard instrument. Colors prior to this change are now available as options. Refer to listing below.

8600A STANDARD. Indicates color scheme for the 8600A beginning with this change. (Includes MINT GRAY front panel and OLIVE BLACK panel connector.)

8600A Option A85. Indicates LIGHT GRAY front panel.

8600A Option X95. Indicates color scheme for 8600A prior to this change. (Includes LIGHT GRAY front panel and BLACK panel connector.)

Add the following 8600A parts or description changes:

08600-40003	CONCENTRIC PUSHBUTTON (LIGHT GRAY)
# 08600-40006	CONCENTRIC PUSHBUTTON (JADE GRAY) (STANDARD)
5000-0729	SIDE COVER 3 X 11 (BLUE GRAY)
# 5000-8591	SIDE COVERS 3 X 11 (OLIVE GRAY) (STANDARD)
5000-8637	TOP COVER (BLUE GRAY)
# 5001-0102	TOP COVER (OLIVE GRAY) (STANDARD)
5000-8640	BOTTOM COVER (BLUE GRAY)
# 5000-0103	BOTTOM COVER (OLIVE GRAY) (STANDARD)
5060-0774	RACK MOUNT KIT (LIGHT GRAY)
# 5060-8739	RACK MOUNT KIT (MINT GRAY) (STANDARD)
08600-0001	FRONT PANEL (LIGHT GRAY)
# 08600-00012	FRONT PANEL (MINT GRAY) (STANDARD)
08600-00005	PANEL CONNECTOR PANEL (BLACK)
# 08600-00011	CONNECTOR PANEL (OLIVE BLACK) (STANDARD)
08600-20017	PANEL FRAME (BLUE GRAY)
# 08600-20022	PANEL FRAME (OLIVE GRAY) (STANDARD)

# Denotes standard color for 8600A part beginning with this change.

CHANGE 4

Page 6-3, Table 6-2:
Add A3CR3, 1901-0050 DIODE; SILICON.
Add A3CR4, 1901-0050 DIODE: SILICON.

Page 6-4, Table 6-2:
Add A3R53, 0757-0416 R: FXD MET FLM 511 OHM 1%.

CHANGE 4 (Cont'd)

Page 8-29, Figure 8-27:
Replace Figure 8-27 with Figure 8-27 in this Change Sheet (CHANGE 4).

Page 8-29, Figure 8-28:
Add a partial schematic, Figure 1 of this change sheet.

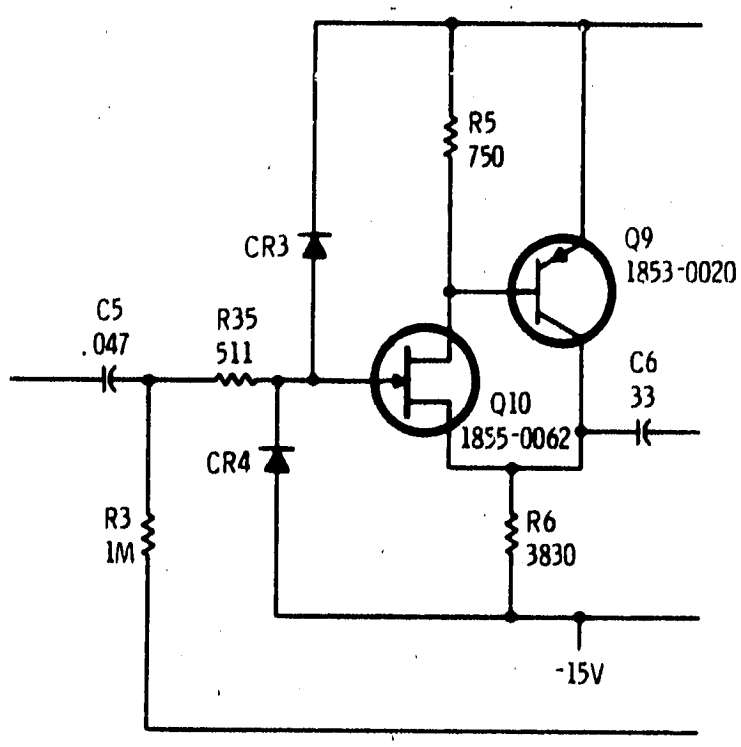


Figure 1

CHANGE 5

Page 6-8, Table 6-2:
Change A7R12 to HP Part No. 0811-1662 R: FXD WW 0.47 OHM 5% 2W.

Page 8-35, Figure 8-37:
Change value of resistor A7R12 to 0.47 OHM.

CHANGE 6

This change adds a grounding lug to the HP 8600A rear panel.

Page 6-11, Table 6-2, MISCELLANEOUS:
Add HP Part Number 0360-0268 LUG: GROUND.
Add HP Part Number 2360-0115 SCREW: PAN HEAD.
Add HP Part Number 2420-0001 NUT: HEX.

CHANGE 7

Page 2-2:
Add Figure 2-1 included in this Manual Change Supplement.

Page 6-10, Table 6-2:
Change A10A2 power line module to HP Part No. 0960-0444.

Page 8-35, Figure 8-37:
Replace A10A2 power line module with Figure 2 in this Manual Changes Supplement.

NOTE

The power line module in Figure 2 is not directly interchangeable. the 8600A Digital Markers with serial number prefix 1148A and below must use power line modules HP Part No. 5060-1200.

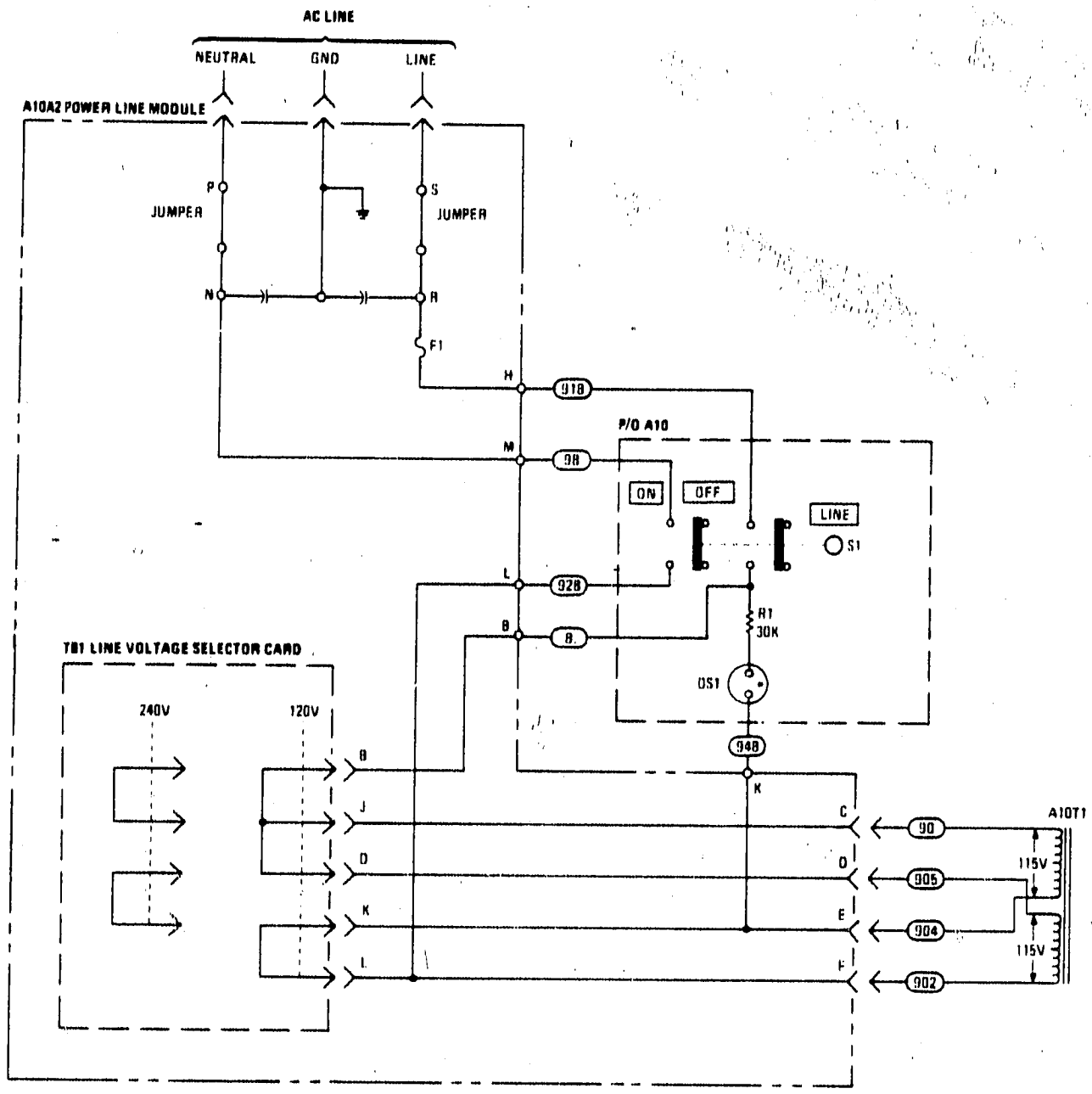


Figure 2. A10A2 Power Line Module (Change 7)

CHANGE 8

Page 6-6, Table 6-2:

Change A5Q1 through A5Q5 to 1854-0019, TRANSISTOR NPN SI TO-18 PD=360MW, 28480, 1854-0019.

Page 8-31, Figure 8-30:

Change HP Part Number of A5Q1 through A5Q5 to 1854-0019.

CHANGE 9

Page 6-10, Table 6-2:

Delete A10C1 (entire line).

Change A10A2 power line module to HP Part No. 0960-0448.

Change A10S1 to 3101-1957, SWITCH: PUSHBUTTON DPST-NO ALTNG 10.5A 250VAC.

Page A10A2 power line module with Figure 3 in this Manual Changes Supplement.

NOTE

The power line module in Figure 3 is directly interchangeable in instruments with serial number prefix 1601A. The 8600A Digital Markers with serial number prefix 1148A and below must use power line modules HP Part No. 5060-1200.

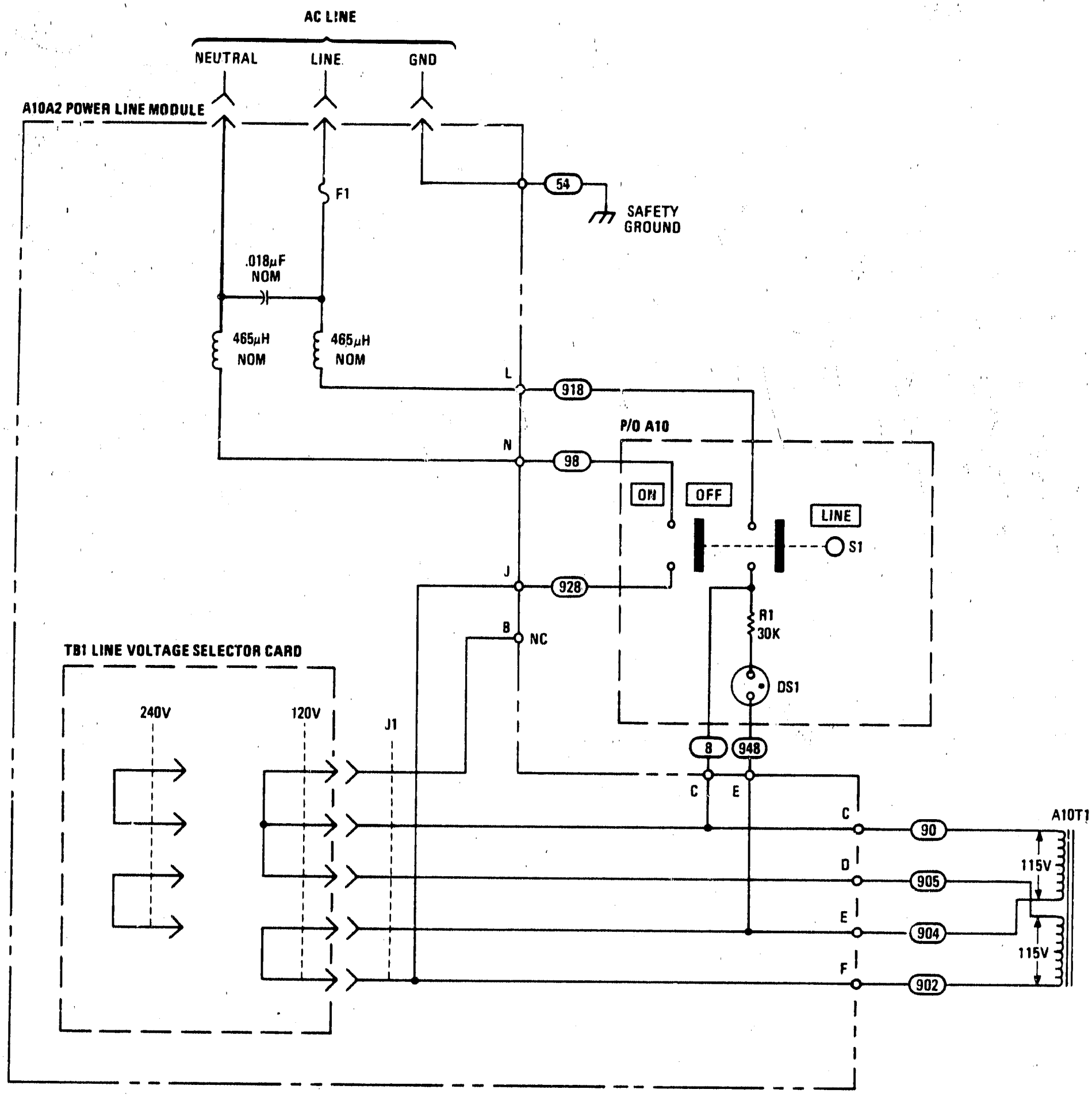


Figure 3. A10A2 Power Line Module (CHANGE 9)

CHANGE 10

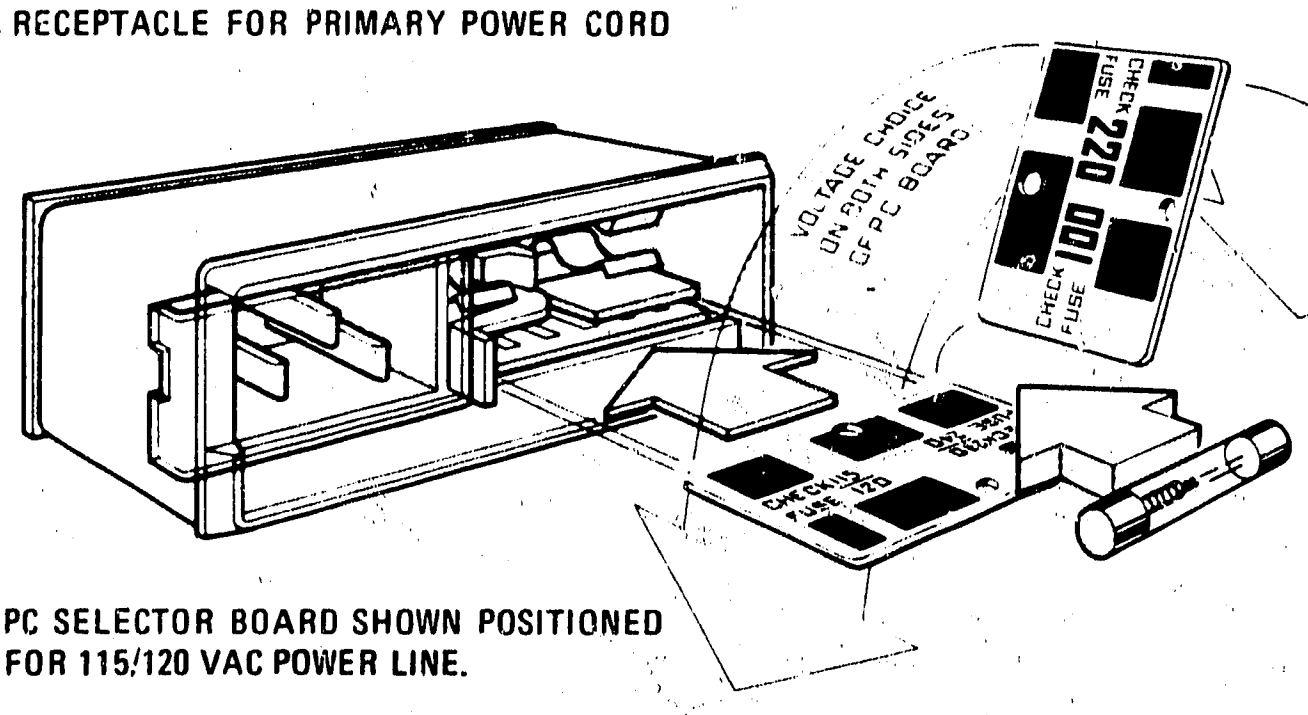
Page 6-10, Table 6-2:

Change A10R1 to HP Part Number 0698-3162, RESISTOR 46.4K 1% .125W F TC=0=−100, Mfr. Code 24546, Mfr. Part No. C4-1/8-TO-4642-F.

Page 8-35, Figure 8-37 (CHANGE 9, Figure 3):

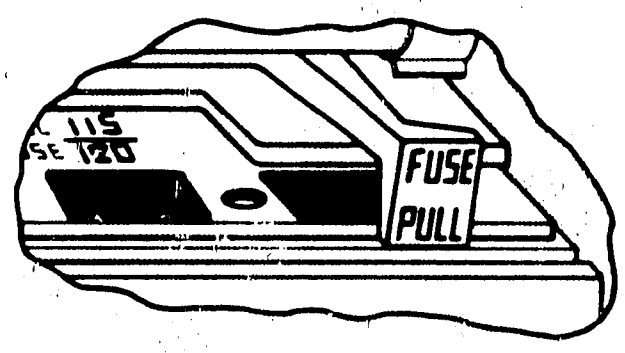
Change value of A10R1 to 46.4K.

RECEPTACLE FOR PRIMARY POWER CORD



PC SELECTOR BOARD SHOWN POSITIONED FOR 115/120 VAC POWER LINE.

OPERATING VOLTAGE APPEARS IN MODULE WINDOW.



SELECTION OF OPERATING VOLTAGE

1. SLIDE OPEN POWER MODULE COVER DOOR AND PUSH FUSE-PULL LEVER TO LEFT TO REMOVE FUSE.
2. PULL OUT VOLTAGE-SELECTOR PC BOARD. POSITION PC BOARD SO THAT VOLTAGE NEAREST ACTUAL LINE VOLTAGE LEVEL WILL APPEAR IN MODULE WINDOW. PUSH BOARD BACK INTO ITS SLOT.
3. PUSH FUSE-PULL LEVER INTO ITS NORMAL RIGHT-HAND POSITION.
4. CHECK FUSE TO MAKE SURE IT IS OF CORRECT RATING AND TYPE FOR INPUT AC LINE VOLTAGE. FUSE RATINGS FOR DIFFERENT LINE VOLTAGES ARE INDICATED BELOW POWER MODULE.
5. INSERT CORRECT FUSE IN FUSEHOLDER.

Figure 2-1. Line Voltage Selection with Power Module PC Board (CHANGE 7)

CHANGE 11

Page 6-3, Table 6-2:
Change A1 Counter Board to HP Part Number 08600-60026 and change the component parts to the list in this change sheet.

Page 6-4, Table 6-2:
Change A3U1 to HP Part No. 1820-1144, CD 6, IC GATE TTL LS NOR QUAD 2-INP.

Page 6-6, Table 6-2:
Change A5U1, A5U5, A5U6, and A5U7 to HP Part No. 1820-1490, CD 5, IC CNTR TTL LS DECD ASYNCHRO.
Change A5U2 to HP Part No. 1820-1202, CD 7, IC GATE TTL LS NAND TPL 3-INP.
Change A5U4 to HP Part No. 1820-1197, CD 9, IC GATE TTL LS NAND QUAD 2-INP.

Page 6-7, Table 6-2:
Change A6R32 to HP Part Number 0757-0280, CD 3, RESISTOR IK 1% .125 W F TC = 0 ± 100.
Change A6R33 and A6R35 to HP Part Number 0757-0424, CD 7, RESISTOR 1.1K 1% .125W F TC = 0 ± 100.
Change A6U1 to HP Part Number 1820-1208, CD 3, IC GATE TTL LS OR QUAD 2-INP.

Page 6-9, Table 6-2:
Change A8U2 to HP Part No. 1820-1144, CD 6, IC GATE TTL LS NOR QUAD 2-INP.

Page 6-10, Table 6-2:
Change A11 Mother Board to HP Part Number 08600-60027 and change the component parts to the list in this change sheet.
Add A12 Display Board, HP Part Number 08600-60028 and the component parts listed in this change sheet.

Page 6-11, Table 6-2:
Under Miscellaneous, change part number for window from 08600-40001 to 08600-40010, check digit 4.
Delete HP Part Number 08600-40002.
Add Display Bracket, HP Part Number 08600-00018, Check Digit 8.

Page 8-19, Figure 8-17:
Add Display Assembly A12 directly in front of A1 (just below A1 on photo).

Page 8-25, Figure 8-24:
Change A6R32 to 1000 Ohms.
Change A6R33 and A6R35 to 1100 Ohms.
Change A6U1 to HP Part Number 1820-1208.

Page 8-27, Figure 8-26:
Change A8U2 to HP Part Number 1820-1144.

Page 8-29, Figure 8-28:
Change A3U1 to HP Part Number 1820-1144,

Page 8-31, Figure 8-30:
Change A5U1, A5U5, A5U6, and A5U7 to HP Part Number 1820-1490.
Change A5U2 to HP Part Number 1820-1202.
Change A5U4 to HP Part Number 1820-1197.

Page 8-32, Service Sheet 7:
Replace the theory of operation and test procedures with the following text:

SERVICE SHEET 7

THEORY OF OPERATION FOR A1 COUNTER/DRIVER BOARD (08600-60026)

A simplified block diagram of A1 is shown in Figure 8-31A. The dual decade counters (U1, U2, and U3) convert a 10ms interval of COUNT IN to six BCD outputs. At the end of the 10ms interval, the latches (U6, U7, and U8) are enabled and store the output of the decade counters. Each of the four 6-to-1 multiplexers (U4, U5, U9, and U10) is responsible for a unique bit of the BCD code. For instance, U9 selects the least significant bit, the BCD "A" bit, of each of the six four-bit latches. U10 selects the BCD "B" bits, U5 the BCD "C" bits, and U4 the BCD "D" bits.

CHANGE 11 (Cont'd)

A clock operating at approximately 3 KHz sequences a four-bit decade counter (U13) through the following count: 0000, 0001, 0010, 0011, 0100, 0101. The leading zero is not used, so we end up with six three-bit control codes which are repeated to give a multiplexed display as follows. Suppose the control code is 000. Then the least significant digit, DS1, will be turned on. At the same time the BCD data for DS1 on pins 4, 5, 6, and 7 of latch U8 is routed by the four 6-to-1 multiplexers to the BCD-to-7 segment decoder/driver. The decoded output arrives on the display board as DS1 is turned on. In this way the BCD selection is synchronized with digit turn-on. The sequencing control code causes the multiplexed display.

Add Figure 8-31A included in this Change Sheet.

Page 8-33, Figure 8-32:

Replace Figure 8-32 with the new Figure 8-32 (Change 11) included in this Change Sheet.
Add Figure 8-32A, A12 Display 08600-60028 Component Location (Change 11) included in this Change Sheet.

Page 8-33, Figure 8-34:

Change the A11 Mother Board as shown in the partial schematic included in this Change Sheet for new mother board 08600-60027.
Replace the A1 Counter Board section of the schematic with new schematic of A1 Counter/Driver Board 08600-60026, Figure 8-34A, and A12 Display Board 08600-60028, Figure 8-34B.

Page 8-36, Figure 8-38:

Replace A11 Mother Board photos with New Mother Board 08600-60027 included in this Change Sheet.

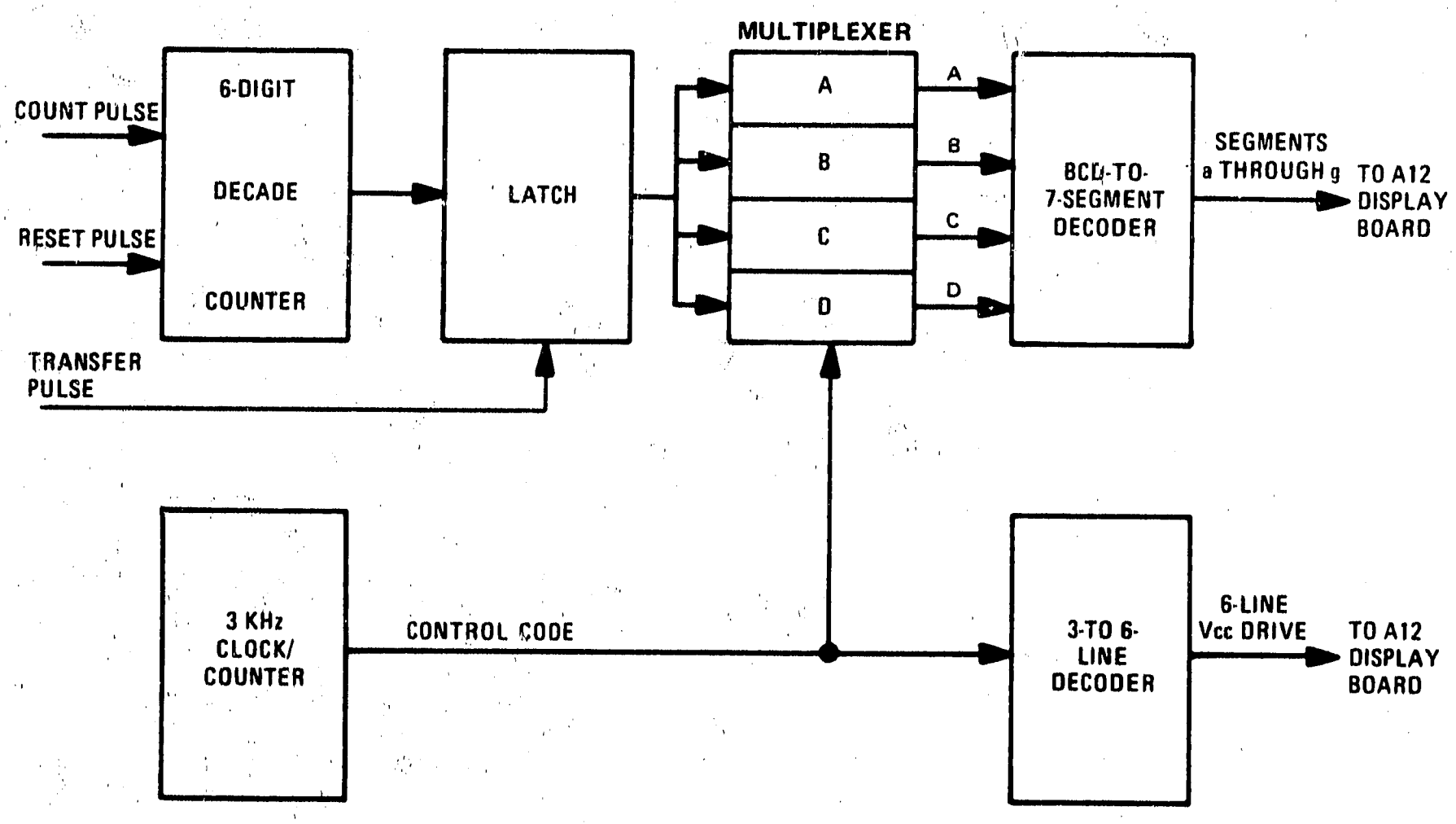


Figure 8-31A. A1 Counter/Driver 08600-60026, Simplified Block Diagram (CHANGE 11)

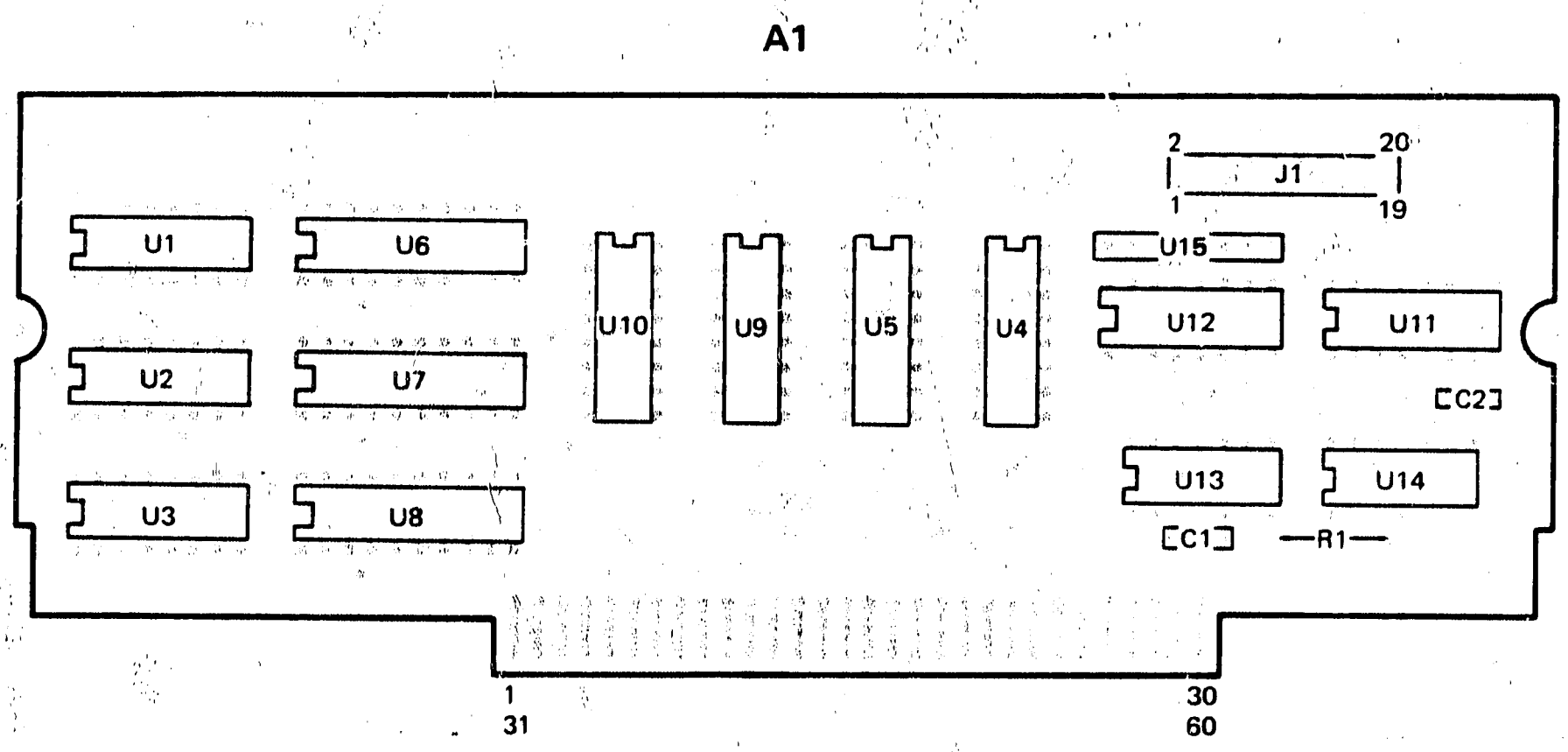


Figure 8-32. A1 Counter/Driver 08600-60026 Component Location (CHANGE 11)

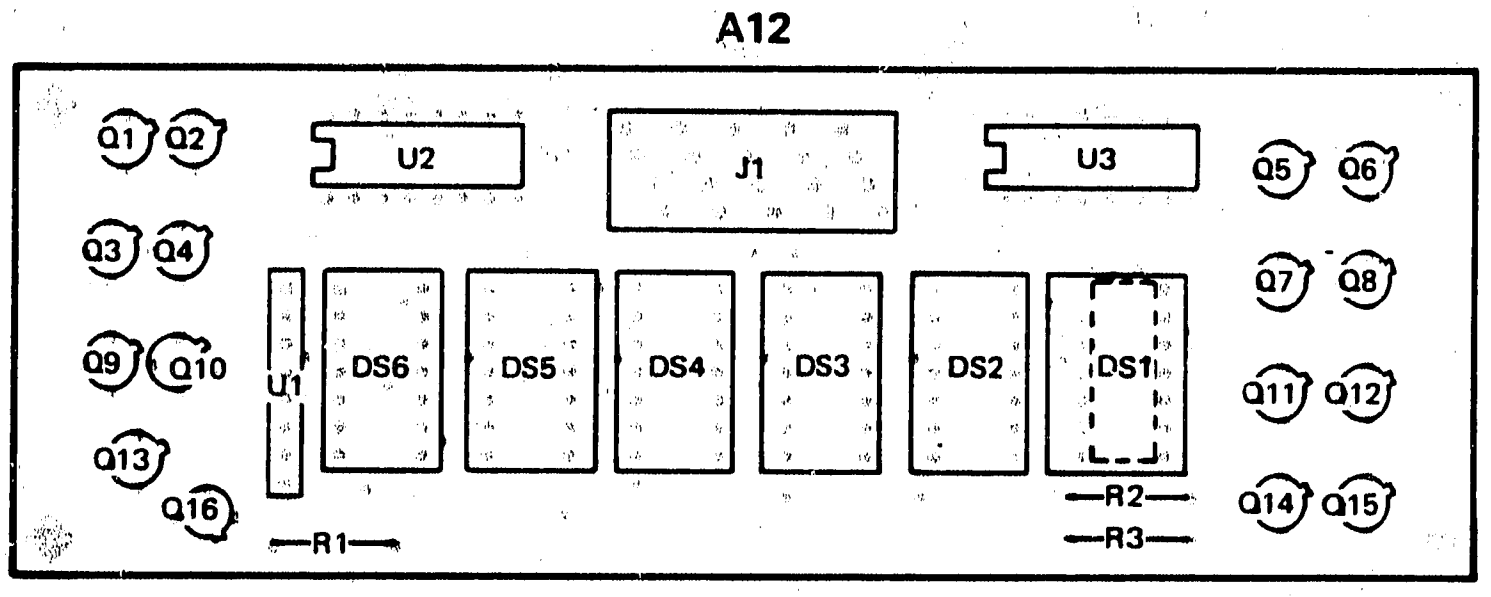
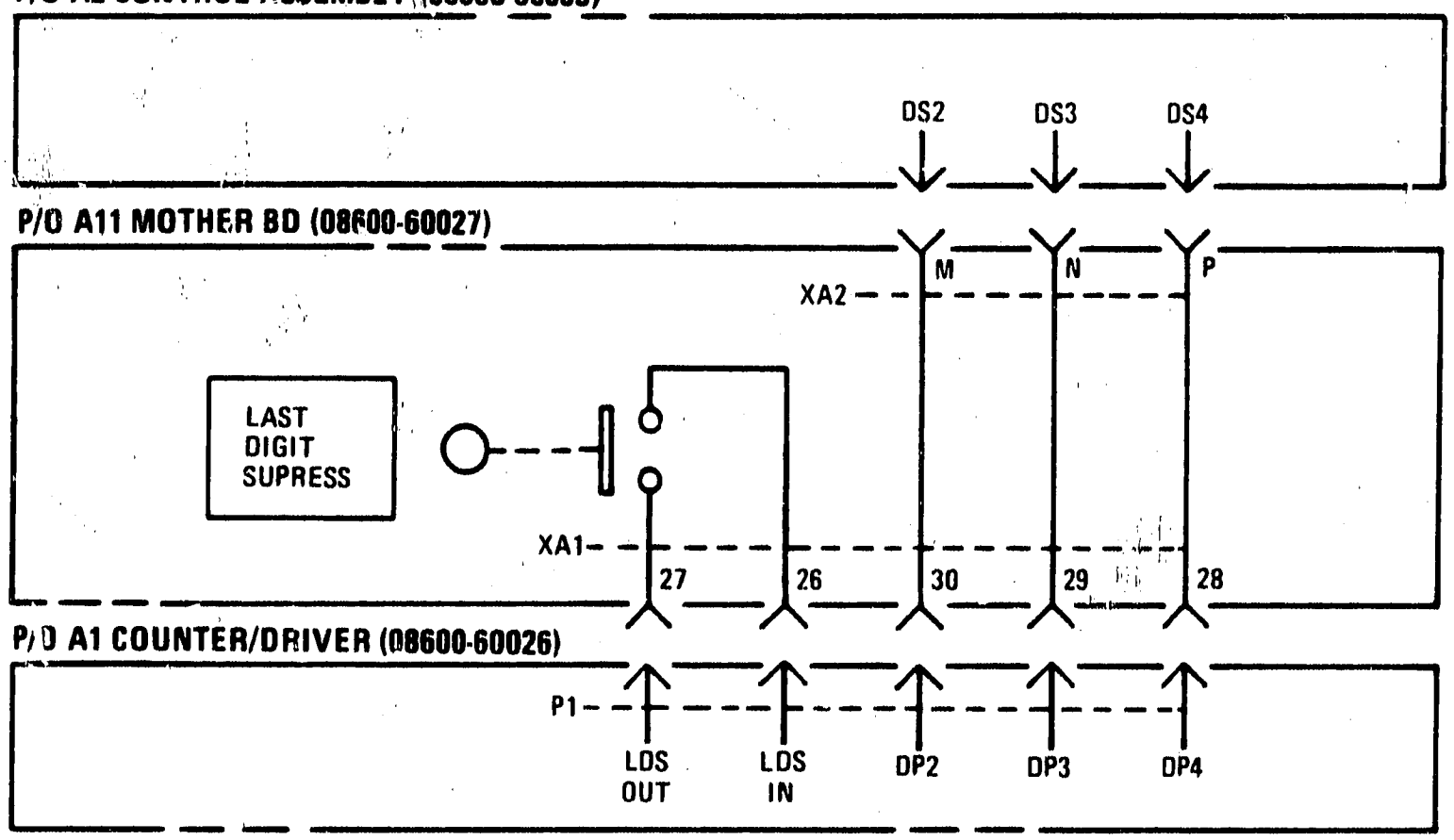


Figure 8-32A. A12 Display 08600-60028 Component Location (CHANGE 11)



NOTE

LDS = LAST DIGIT SUPRESSED.
DP2, DP3, DP4 = DECIMAL POINT SIGNALS TO A12DS2, 3, AND 4.

P/O Figure 8-34. Partial Schematic of A11 Mother Board 08600-60027 (CHANGE 11)

A11

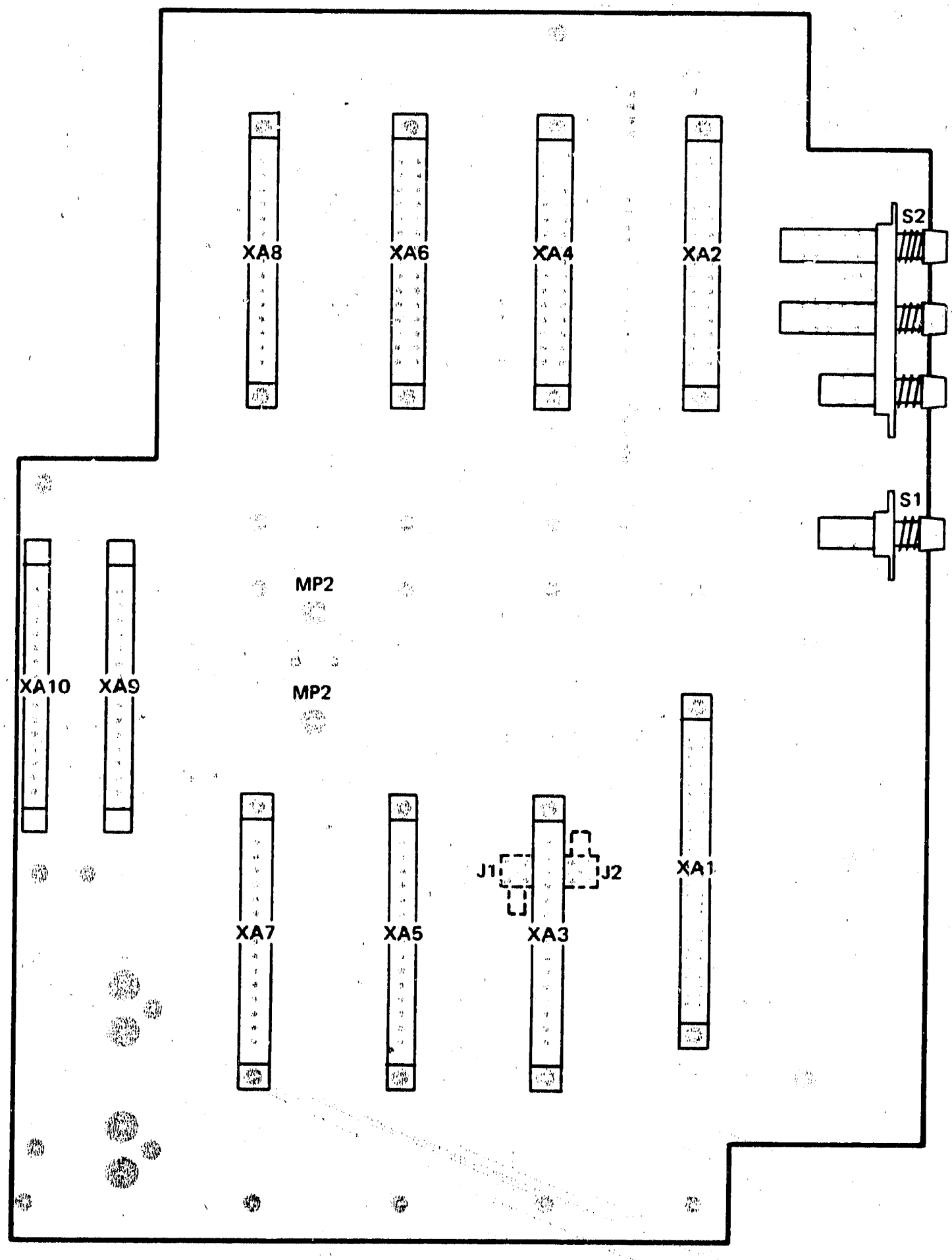


Figure 8-38. Mother Board 08600-60027 (Change 11)

Table 6-3. Replaceable Parts (Change 11)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1	08600-60026	4	1	COUNTER/DRIVER BOARD	28480	08600-60026
A1C1	0160-4084	4	2	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A1C2	0160-4084	4		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A1J1	1251-3905	4	1	CONNECTOR 20-PIN M RECTANGULAR	28480	1251-3905
A1R1	0757-0438	1	1	RESISTOR 1.62K 1% .125W F TC0+-100	24546	C4-1/8-T0-1621-F
A1U1	1820-1991	1	3	IC CNTR TTL LS DECD DUAL 4-BIT	01295	SN74LS390N
A1U2	1820-1991	1		IC CNTR TTL LS DECD DUAL 4-BIT	01295	SN74LS390N
A1U3	1820-1991	1		IC CNTR TTL LS DECD DUAL 4-BIT	01295	SN74LS390N
A1U4	1820-1298	1	4	IC MUXR/DATA-SEL TTL LS 8-TO-1-LINE	01295	SN74LS251N
A1U5	1820-1298	1	4	IC MUXR/DATA-SEL TTL LS 8-TO-1-LINE	01295	SN74LS251N
A1U6	1820-2102	4	3	IC LCH TTL LS D-TYPE OCTL	01295	SN74LS373N
A1U7	1820-2102	4		IC LCH TTL LS D-TYPE OCTL	01295	SN74LS373N
A1U8	1820-2102	1	4	IC LCH TTL LS D-TYPE OCTL	01295	SN74LS373N
A1U9	1820-1298	1		IC MUXR/DATA-SEL TTL LS 8-TO-1-LINE	01295	SN74LS251N
A1U10	1820-1298	1		IC MUXR/DATA-SEL TTL LS 8-TO-1-LINE	01295	SN74LS251N
A1U11	1820-1210	5	1	IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A1U12	1820-1698	5	1	IC DCDR TTL LS BCD-TO-7-SEG	01295	SN74LS247N
A1U13	1820-1442	7	1	IC CNTR TTL LS DECD ASYNCHRO	01295	SN74LS290N
A1U14	1820-1425	6	1	IC SCHMITT-TRIG TTL LS NAND QUAD 2-INP	01295	SN74LS132N
A1U15	1820-0208	8	1	NETWORK-RES 8-SIP08.0K OHM X 7	01121	208A8A3
A11	08600-60027	5	1	MOTHER BOARD ASSEMBLY	28480	08600-60027
A11J1	1250-0836	2	2	CONNECTOR-RF SMC M PC 50-OHM	28480	1250-0836
A11J2	1250-0836	2		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-0836
A11MP1	08600-40004	6	4	SWITCH-SPACER	28480	08600-40004
A11MP2	08600-40004	6		SWITCH-SPACER	28480	08600-40004
A11MP3	08600-40004	6		SWITCH-SPACER	28480	08600-40004
A11MP4	08600-40004	6		SWITCH-SPACER	28480	08600-40004
A11S1	3101-1299	0	1	SWITCH-PB DPDT ALTNG .4VA 115VAC	28480	3101-1299
A11S2	3101-1300	4	1	SWITCH-PB 3-STATION 20MM C-C SPACING	28480	3101-1300
A11XA1	1251-2316	2	1	CONNECTOR-PC EDGE 30-CONT/ROW 2-ROWS	28480	1251-2316
A11XA2	1251-1886	6	3	CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A11XA3	1251-1558	9	6	CONNECTOR-PC EDGE 15-CONT/ROW 1-ROW	28480	1251-1558
A11XA4	1251-1886	6		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A11XA5	1251-1558	9		CONNECTOR-PC EDGE 15-CONT/ROW 1-ROW	28480	1251-1558
A11XA6	1251-1886	6		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A11XA7	1251-1558	9		CONNECTOR-PC EDGE 15-CONT/ROW 1-ROW	28480	1251-1558
A11XA8	1251-1558	9		CONNECTOR-PC EDGE 15-CONT/ROW 1-ROW	28480	1251-1558
A11XA9	1251-1558	9		CONNECTOR-PC EDGE 15-CONT/ROW 1-ROW	28480	1251-1558
A11XA10	1251-1558	9		CONNECTOR-PC EDGE 15-CONT/ROW 1-ROW	28480	1251-1558
A12	08600-60028	6	1	DISPLAY BOARD	28480	08600-60028
A12DS1	1990-0725	6	8	DISPLAY-NUM-SEG 1-CHAR .43-H YEL	28480	HDSP-4130
A12DS2	1990-0725	6		DISPLAY-NUM-SEG 1-CHAR .43-H YEL	28480	HDSP-4130
A12DS3	1990-0725	6		DISPLAY-NUM-SEG 1-CHAR .43-H YEL	28480	HDSP-4130
A12DS4	1990-0725	6		DISPLAY-NUM-SEG 1-CHAR .43-H YEL	28480	HDSP-4130
A12DS5	1990-0725	6		DISPLAY-NUM-SEG 1-CHAR .43-H YEL	28480	HDSP-4130
A12DS6	1990-0725	6		DISPLAY-NUM-SEG 1-CHAR .43-H YEL	28480	HDSP-4130
A12J1	0360-1786	5	1	CABLE TRANSITION 20-TERM DIP SOLDER	28480	0360-1786
A12J2	1251-3881	5	1	CONNECTOR 20-PIN F POST TYPE	28480	1251-3881
A1Q1	1853-0281	9	16	TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A1Q2	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A1Q3	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A1Q4	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A1Q5	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A1Q6	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A1Q7	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A1Q8	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A1Q9	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A1Q10	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A1Q11	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A1Q12	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A1Q13	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A1Q14	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A1Q15	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A1Q16	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A1R1	0698-4037	0	1	RESISTOR 46.4 1% .125W F TC0+-100	24546	C4-1/8-T0-46R4-F
A1R2	0698-4037	0		RESISTOR 46.4 1% .125W F TC0+-100	24546	C4-1/8-T0-46R4-F
A1R3	0698-4037	0		RESISTOR 46.4 1% .125W F TC0+-100	24546	C4-1/8-T0-46R4-F
A1RN1	1810-0391	2	1	NETWORK-RES 8-SIP47.0 OHM X 7	91637	CSPUN8U1-470G/MSPUN8U1-470G
A1RN2	1810-0358	7	12	NETWORK-RES 10-DIP100.0 OHM X 8	11236	761-3-R100
A1RN3	1810-0358	7		NETWORK-RES 10-DIP100.0 OHM X 8	11236	761-3-R100

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-3. Replaceable Parts (Change 11)

Reference Designation	HP Part Number	CD	Qty	Description	Mfr Code	Mfr Part Number
A12W1	8120-2074	6	1	CABLE-RIBBON 20-CONDUCTOR 80.5 FT LG9	28480	8120-2074
A12XDS1	1200-0508	0	6	SOCKET-IC 14-CONT DIP-SLDR	28480	1200-0508
A12XDS2	1200-0508	0		SOCKET-IC 14-CONT DIP-SLDR	28480	1200-0508
A12XDS3	1200-0508	0		SOCKET-IC 14-CONT DIP-SLDR	28480	1200-0508
A12XDS4	1200-0508	0		SOCKET-IC 14-CONT DIP-SLDR	28480	1200-0508
A12XDS5	1200-0508	0		SOCKET-IC 14-CONT DIP-SLDR	28480	1200-0508
A12XDS6	1200-0508	0		SOCKET-IC 14-CONT DIP-SLDR	28480	1200-0508

CHANGE 12

Page 6-10, Table 6-2:
Change A10A1 to HP Part Number 08600-60032, Check Digit 2.
Change A10S1 to HP Part Number 3101-2329, Check Digit 9, SWITCH; DPDT Toggle.
Change A11 to HP Part Number 08600-60030, Check Digit 0.

Page 6-11, Table 6-2, MISCELLANEOUS:
Change Part Number of Identification Plaate from 7120-2547 to 7121-0364, Check Digit 4.
Add HP Part Number 5021-0999, Check Digit 7, COVER-TRIM.
Change Part Number 08600-20018 to 5060-0729, Check Digit 3, FRAME ASSEMBLY 3 ∓11 FM (QUANTITY 2).
Change Part Number of Top Cover from 5001-0102 to 5060-8587, Check Digit 7.
Change Part Number of Bottom Cover from 5001-0103 to 5060-8711, Check Digit 9.
Add HP Part Number 08443-00021, Check Digit 2, Front Panel Bracket (QUANTITY 4).
Change Part Number of Front Panel from 08600-00012 to 08600-00019, Check Digit 9.
Change Part Number of Deck from 08600-00003 to 08600-00020, Check Digit 2.
Delete HP Part Number 08600-20022, Panel Frame.
Add HP Part Number 08600-20029, Check Digit 3, Bottom Panel Trim.
Add HP Part Number 08600-20031, Check Digit 7, Top Panel Trim.

CHANGE 13

Page 6-3, Table 6-2:
Change A2 to HP Part Number 08600-60033, Check Digit 3.

Page 6-3, Table 6-2:
Delete A2CR1 through A2CR8.
Delete A2R7 through A2R12.

Page 8-33, Figure 8-34:
Change A2 to HP Part Number 08600-60033.
Delete A2CR1 through A2CR8.
Delete A2R7 through A2R12.

CHANGE 14

Pages 6-4 and 6-5, Table 6-2:
Change A4 to HP Part Number 08600-60034.
Add A4R71, HP Part Number 0698-0085, RESISTOR-2.61K 1% .125W F TC = 0 ± 100, Mfr. Code 24546, Mfr. Part No. C4-1/8-TO-2611F.
Change A4U7 to HP Part Number 1820-1208, Mfr. Code 01295, Mfr. Part No. SN74LS32N.

Page 8-23, Figure 8-21:
Add R71 to the Component Locations Diagram in the lower left corner of the Figure, between R35 and C2.

Page 8-23, Figure 8-22:
Change the HP Part Number printed in the upper left corner of the schematic to 08600-60034.
Change U7 to HP Part Number 1820-1208.
Add resistor R71, 2.61K, between U7 pin 8 and the +5V supply.

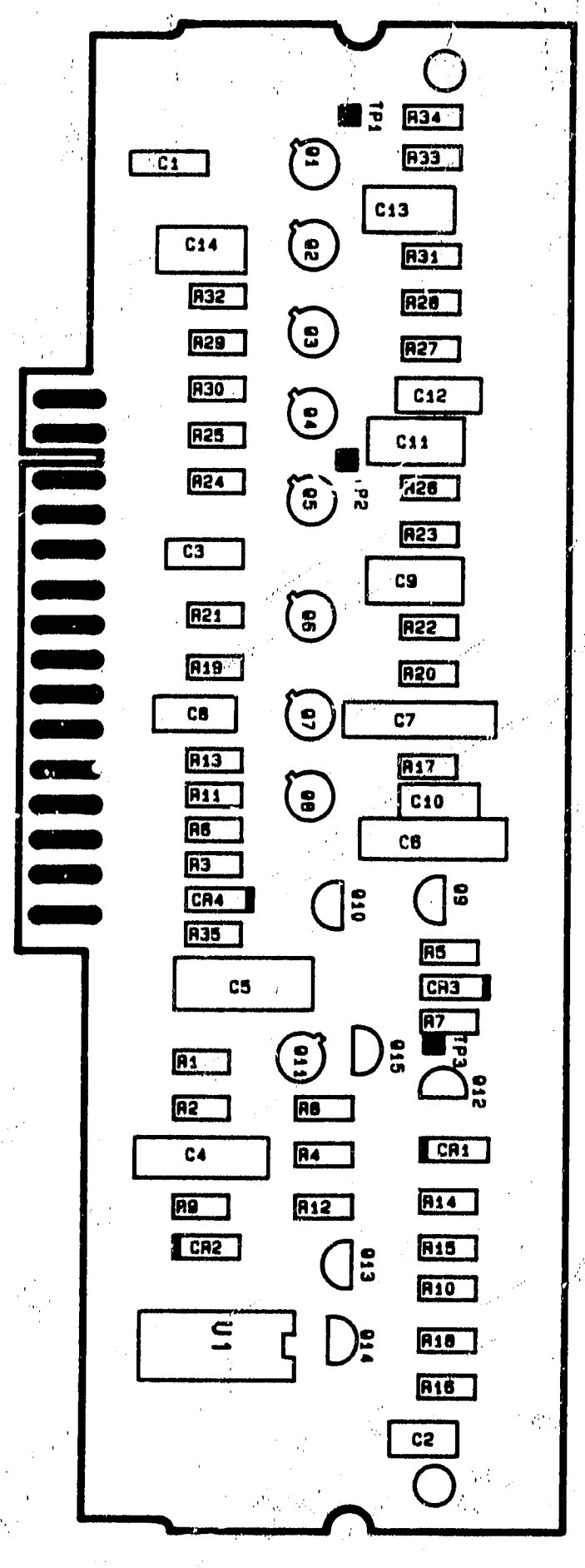


Figure 8-27. Input Amplifier Component Locations (CHANGE 4)

P/O A11 MOTHERBOARD (08600-60027)

A1 COUNTER/DRIVER BD (08600-60026)

A12 DISPLAY BD (08600-60028)

P/O A11 MOTHER BD (08600-60027) A2 CONTROL BD (08600-60009)

Figure 8-34A. A1 Counter/Driver, Schematic (CHANGE 11)

A1 COUNTER DRIVER ASSEMBLY (08600-60026) A12 DISPLAY ASSEMBLY (08600-60028)

DS1 VCC DRIVE
DS2 VCC DRIVE
DS3 VCC DRIVE
DS4 VCC DRIVE
DS5 VCC DRIVE
DS6 VCC DRIVE
DP4 (DECIMAL POINT ON DS4)
DP3 (DECIMAL POINT ON DS3)
DP2 (DECIMAL POINT ON DS2)
SEGMENT g (PIN 11) DRIVE
SEGMENT f (PIN 2) DRIVE
SEGMENT e (PIN 7) DRIVE
SEGMENT d (PIN 8) DRIVE
SEGMENT c (PIN 10) DRIVE
SEGMENT b (PIN 13) DRIVE
SEGMENT a (PIN 1) DRIVE
+5V

J1 W3 J1 U3 U2 U1 +5V

Q6 Q5 Q11 Q12 Q7 Q8 Q15 Q14 Q16 Q1 Q2 Q3 Q4 Q9 Q10 Q13

R3 46.4 R2 46.4 R1 46.4

U1R2 U1R4 U1R3 U1R6 U1R5 U1R7

DS6 DS5 DS4 DS3 DS2 DS1

Figure 8-34B. A12 Display, Schematic (CHANGE 11)