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Agilent 16344A 1 MHz Phase Standard

Operating Note

Second Edition



Agilent Technologies

Agilent Part No. 16344-90000
June 2000

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Agilent Technologies Japan, Ltd.

Component Test PGU-Kobe

1-3-2, Murotani, Nishi-Ku, Kobe-shi, Hyogo, 651-2241 Japan

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Manual Printing History

The manual's printing date and part number indicate its current edition. The printing date changes when a new edition is printed. (Minor corrections and updates that are incorporated at reprint do not cause the date to change.) The manual part number changes when extensive technical changes are incorporated.

1983	First Edition (part number : 16344-90000)
June 2000	Second Edition (part number : 16344-90000)

Safety Summary

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific WARNINGS elsewhere in this manual may impair the protection provided by the equipment. In addition it violates safety standards of design, manufacture, and intended use of the instrument.

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- Ground The Instrument

  To avoid electric shock hazard, the instrument chassis and cabinet must be connected to a safety earth ground by the supplied power cable with earth blade.

- DO NOT Operate In An Explosive Atmosphere

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

- Keep Away From Live Circuits

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

- DO NOT Service Or Adjust Alone

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

- DO NOT Substitute Parts Or Modify Instrument

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

- Dangerous Procedure Warnings

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

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

Certification

Agilent Technologies certifies that this product met its published specifications at the time of shipment from the factory. Agilent Technologies further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology, to the extent allowed by the Institution's calibration facility, or to the calibration facilities of other International Standards Organization members.

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1. INTRODUCTION

This operating note provides information required to operate, test, and repair the Hewlett-Packard Model 16344A 1MHz Phase Standard. To order additional copies of this operating note, use the part number listed on the rear-cover and contact the nearest Hewlett-Packard Sales/Service Office.

2. DESCRIPTION

The Hewlett-Packard Model 16344A 1MHz Phase Standard, pictorially shown on the front cover, is specially designed for calibration of instruments capable of phase difference measurements. It outputs, from the front-panel, two precise, stable 1MHz sine waves of equal amplitude. The phase difference between these two signals can be shifted from 0° to 360° in -22.5° steps, thus providing a known phase difference for the test instrument to measure. For a test instrument requiring phase-locking between its internal signal source and the test input signals, the 16344A outputs, from the rear-panel, a 1MHz square wave. This signal is applied to the test instrument's external reference input connector.

3. SPECIFICATIONS

Table 1 lists the specifications of Model 16344A 1MHz Phase Standard. Test procedures for verification of the specifications are covered in 7, Performance Tests.

4. INSTALLATION

The 16344A requires a power source of 100, 120, 220 Volts ac ±10%, or 240 Volts ac +5% -10%, 48 to 66Hz single phase.

CAUTION

BEFORE CONNECTING THE INSTRUMENT TO THE POWER SOURCE, make sure that the correct fuse has been installed and that the line voltage selection switch is set to the correct voltage.

5. PANEL FEATURES

Front- and rear-panel features for the 16344A are described in Figure 1. Reference numbers in the figure match description numbers.

Table 1. Specifications

Output Characteristics: REFERENCE CHANNEL and TEST CHANNEL

- Frequency: 1MHz Sine Wave
- Frequency Accuracy: ±50ppm (23° C±5° C)
- Phase Difference Range: ±180.00°
- Incremental Phase: 22.50°
- Incremental Phase Accuracy: 0°±0.05°
- Output Amplitude: ≥10dBm (with 50Ω Load Switch ON)
- Harmonic Distortion: Less than -50dBm
- Source Impedance (with 50Ω Load Switch OFF): 140Ω±20%

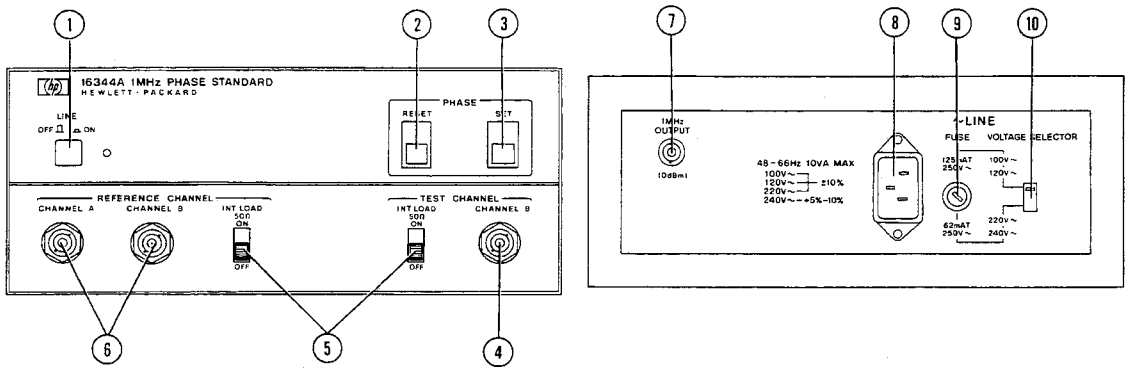
1MHz Output (Rear-Panel):

- Amplitude: ≥6dBm (@50Ω Load)

General

- Operating Temperature: 23° C±5° C
- Relative Humidity: <70%
- Power Consumption: 10VA max.
- Dimensions: 212.3mm (W) x 88.1mm (H) x 360mm (D)
- Weight: Approximately 3.5kg

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FRONT VIEW REAR VIEW

(1) LINE ON/OFF Switch: Line power is applied to the 16344A when this switch is pushed and locked in. Line power is removed when this switch is out.

(2) RESET Key: Resets the phase difference between the TEST CHANNEL (4) and the REFERENCE CHANNEL (6) to 0°.

(3) SET Key: Each time this key is pressed, the phase difference between the TEST CHANNEL (4) and the REFERENCE CHANNEL (6) is shifted -22.5°.

(4) TEST CHANNEL Output Connector: The 1MHz signal to be shifted by the RESET (2) and SET (3) keys is output from this connector. This connector is normally connected to the test input of the test instrument.

(5) INT LOAD 50Ω ON/OFF Switches: When either of these switches is set to the ON position, the corresponding channel is terminated by a 50Ω resistor, and the amplitude of the signal is ≥10dBm. When an attenuator or termination is connected to either channel (Reference or Test), the corresponding INT LOAD switch should be set to the OFF position (see Figure 2).

(6) REFERENCE CHANNEL (CHANNEL A and CHANNEL B) Output Connectors: These two BNC connectors are internally interconnected and, thus, output identical 1MHz signals. Either connector can be used to provide the phase reference signal. Normally, one of these connectors is connected to the reference input of the test instrument, while the TEST CHANNEL (4) is connected to the test instrument's test input. However, when an exact 0° phase difference is desired, the connector labelled CHANNEL A functions as the reference signal source, and the other, labelled CHANNEL B, functions as the test signal source. The TEST CHANNEL is not used in this application.

(7) 1MHz OUTPUT Connector: The signal from this connector (1MHz, 0dBm, square wave) is connected to the test instrument's external reference connector to make a phase-locked loop between the 16344A's signal source and the test instrument's signal source.

(8) LINE Input Receptacle: AC power cable is connected to this receptacle.

(9) LINE FUSE Holder: Instrument power line fuse is installed in this holder:

100/120V operation:	125mA (P/N 2110-0318)
220/240V operation:	62mA (P/N 2110-0311)

(10) LINE VOLTAGE SELECTOR Switch: Appropriate ac operating power voltage is selected by this switch.

Figure 1. Front- and Rear-Panel Features

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6. SETUP AND OPERATION

The procedure given below is for general application of the 16344A. For more specifics, refer to the Operating and Service manual of the instrument to be calibrated.

Note

An application using an attenuator is given in the Figure 2.

a. Using two BNC-to-BNC cables of equal length, connect one of the REFERENCE CHANNEL connectors (6) and the TEST CHANNEL connector (4) of the 16344A to the reference signal input and test signal input, respectively, of the instrument to be calibrated.

Note

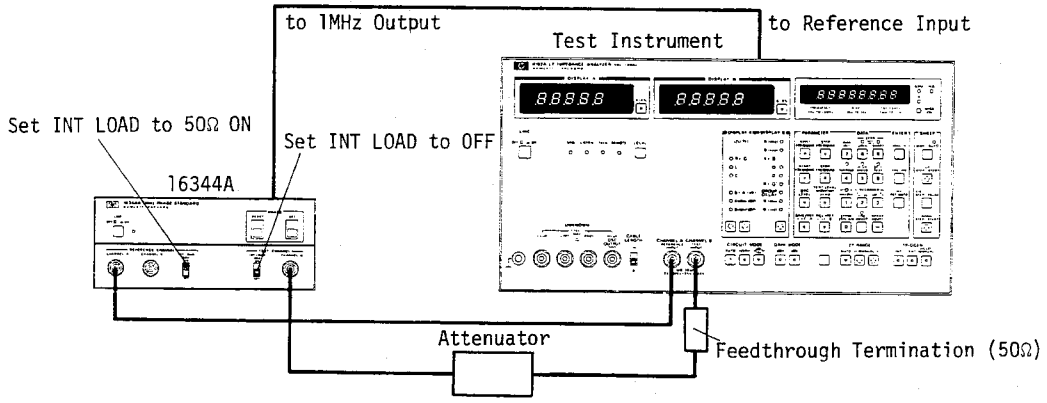
The cables used in step a. must be of equal length to prevent phase shift error.

Table 2. Phase Shifting Identification

SET Key Depressions	Phase Difference	SET Key Depressions	Phase Difference
1	22.5° (+337.5°)	9	-202.5° (+157.5°)
2	45.0° (+315.0°)	10	-225.0° (+135.0°)
3	-67.5° (+292.5°)	11	-247.5° (+112.5°)
4	-90.0° (+270.0°)	12	-270.5° (+112.5°)
5	-112.5° (+247.5°)	13	-292.5° (+67.5°)
6	-135.0° (+225.0°)	14	-315.0° (+45.0°)
7	-157.5° (+225.0°)	15	-337.5° (+22.5°)
8	±180°	16*	±0°

* Pressing the SET key 16 times returns the phase difference to 0°.

An attenuator can be used to obtain signals of various amplitudes from the TEST CHANNEL of the 16344A. Instrument setup for this is shown in the figure below:



Procedure:

a. Connect the REFERENCE CHANNEL of the 16344A to REFERENCE INPUT of the test instrument.

b. Connect the TEST CHANNEL of the 16344A to the TEST INPUT of the test instrument through the attenuator and 50Ω feedthrough termination, as shown in the figure.

c. Set the 16344A's REFERENCE CHANNEL INTO LOAD switch to ON and TEST CHANNEL INT LOAD switch to OFF.

Figure 2. Attenuator Connection

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b. If the instrument to be calibrated requires a phase-locked loop between its signal source and the input signal, connect the 16344A's 1MHz OUTPUT connector (7) to the instrument's external reference connector.

c. Set both INT LOAD switches (5) on the 16344A to the ON position. If an attenuator is used (see Figure 2), these switches should be set to OFF.

d. Press the RESET key (2) to reset the phase difference between the REFERENCE CHANNEL (6) and TEST CHANNEL (4) to 0°.

e. Press the SET key (3) to shift the phase difference between the reference and test signals. Each time the key is pressed, the phase between the two signals shifts -22.5°. Refer to the Table 2 for the correspondence between the number of times the key is pressed and the resultant phase shift.

7. PERFORMANCE TESTS

This section describes the tests and procedures used to verify the instrument specifications listed in Table 1. All tests can be performed without access to the interior of the instrument. The performance tests described here can also be used to perform incoming inspection of the instrument.

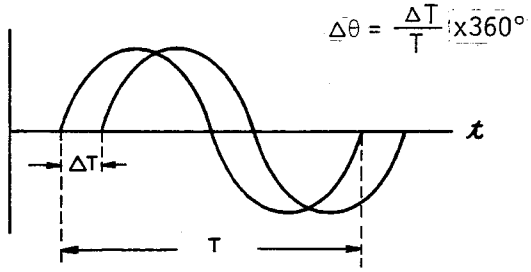
8. Equipment required

Equipment required to perform all of the performance tests is listed in Table 3. Any equipment that satisfies or exceeds the critical specifications listed in the table may be used as a substitute for the recommended models.

9. Incremental Phase Accuracy Test

This test checks that the incremental phase of the TEST CHANNEL signal is 22.5°±0.05°. The check is made by measuring the time interval of the phase increment.

As shown below, phase difference can be calculated from the time interval:



where Δθ is the phase difference between the two signals, ΔT is the time interval of the phase difference, and T is the period of the reference signal. This assumes, of course, that both signals have the same period.

Note

The 5345A, the cables used, and the 16344A itself cause a slight phase offset error. Consequently, before actual measurement of the time interval, the offset error is measured and recorded, and is then subtracted from the measured time intervals.

Table 3. Recommended Test Equipment

Equipment	Critical Specifications	Recommended Model
Universal Counter	Maximum frequency: ≥1MHz Resolution: 10Hz at 1MHz 10psec (TI) Accuracy: 0.001%	HP5345A
RF Voltmeter	Voltage range: ≤100mV Useable frequency: 1MHz Input impedance: 1MΩ	HP3403C

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Equipment:

Universal Counter	....	HP5345A
BNC-to-BNC Cables	....	HP11170B, 2 ea.

Procedure:

a. Using the two BNC-to-BNC cables, connect CHANNEL A and CHANNEL B of the 5345A to the REFERENCE CHANNEL and TEST CHANNEL, respectively, of the 16344A.

Note

The cables used in step a must be of equal length.

b. Set the 5345A's controls as follows:

FUNCTION .....TIME INT. A to B

GATE TIME 10msec

DISPLAY POSITION ..AUTO

CHANNEL A and B:

SLOPE ..... +
ATTEN xl
INPUT
IMPEDANCE 1MΩ
COUPLING ..... DC
MODE ..... SEP

c. Set the 16344A's INT LOAD switches to ON.

d. Press the 16344A's RESET key. Adjust the 5345A's two level controls until the value displayed is less than 10nsec. Note this value as the time interval offset value, TI.

e. Set the 5345A's GATE TIME to 100msec. All zeros will be displayed for about 15 seconds. The display will then return to the value displayed in step d.

f. Press the 16344A's SET key and verify that the time interval reading is 62.50nsec.-TI± 0.14nsec.

g. Press SET key and check that the readings, minus TI, are within the limits listed in the Table 4.

Note

For stable readings, when the reading is over 500nsec, set the 5345A's GATE TIME to 1 sec.

Table 4. Phase Accuracy Test Limits

SET KEY Depressions	Phase Difference	Test Limits (Reading - TI)
(Reset)	±0.0°	0.00 nsec
1	-22.5°	62.50 nsec±0.14nsec
2	-45.0°	125.00 nsec±0.14nsec
3	-67.5°	187.50 nsec±0.14nsec
4	-90.0°	250.00 nsec±0.14nsec
5	-112.5°	312.50 nsec±0.14nsec
6	-135.0°	375.00 nsec±0.14nsec
7	-157.5°	437.50 nsec±0.14nsec
8	±180.0°	500.00 nsec±0.14nsec
9	+157.5°	562.50 nsec±0.14nsec
10	+135.0°	625.00 nsec±0.14nsec
11	+112.5°	687.50 nsec±0.14nsec
12	+90.0°	750.00 nsec±0.14nsec
13	+67.5°	812.50 nsec±0.14nsec
14	+45.0°	875.00 nsec±0.14nsec
15	+22.5°	937.50 nsec±0.14nsec

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10. Output Frequency Accuracy Test

This test checks the accuracy of 16344A's output frequency.

Equipment:

Universal Counter	.....	HP5345A
BNC-to-BNC Cable	.....	HP11170B

Procedure:

a. Connect CHANNEL A of the 5345A to either REFERENCE CHANNEL connector of the 16344A.

b. Set the 5345A's controls as follows:

FUNCTION	.....	FREQ. A
GATE TIME	.....	1msec
DISPLAY POSITION	....	AUTO
MODE	.....	COM A
Other Controls	.....	Any Setting

c. Check that the reading on the 5345A is 1MHz±50Hz.

11. Amplitude Accuracy Test

This test checks that the accuracy of output signals is greater than 10dBm.

Equipment:

Digital Voltmeter	.....	HP3403C
BNC-to-BNC Cable	.....	HP11170B

Procedure:

a. Set the 16344A's INT LOAD switches to ON.

b. Set the 3403C's controls as follows:

FUNCTION	.....	AC
RANGE	.....	AUTO
RESPONSE TIME	.....	FAST

c. Connect the 3403C's input to the 16344A's REFERENCE CHANNEL and TEST CHANNEL, and verify that both readings are over 707mV (10dBm).

12. REPLACEABLE PARTS LIST

Table 5 is the list of replaceable parts and is organized as follows:

a. Electrical assemblies and their components in alphanumerical order by reference designation.

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

c. Miscellaneous parts

The information given for each part consists of the following:

a. The Hewlett-Packard part number

b. The total quantity (Qty) used in the instrument

c. The description of the part

d. A typical manufacturer of the part, listed as a five-digit code

e. The manufacturer's part number

The total quantity for each part is given only once—at the first appearance of the part number in the list.

13. Ordering Information

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.

To order a part not listed, 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.

14. SERVICE

This section provides the information and instructions required to service the HP Model 16344A 1MHz Phase Standard. Included are a Timing Diagram, Component Locations, and a Schematic Diagram, shown in Figure 3, Figure 4, and Figure 5, respectively.

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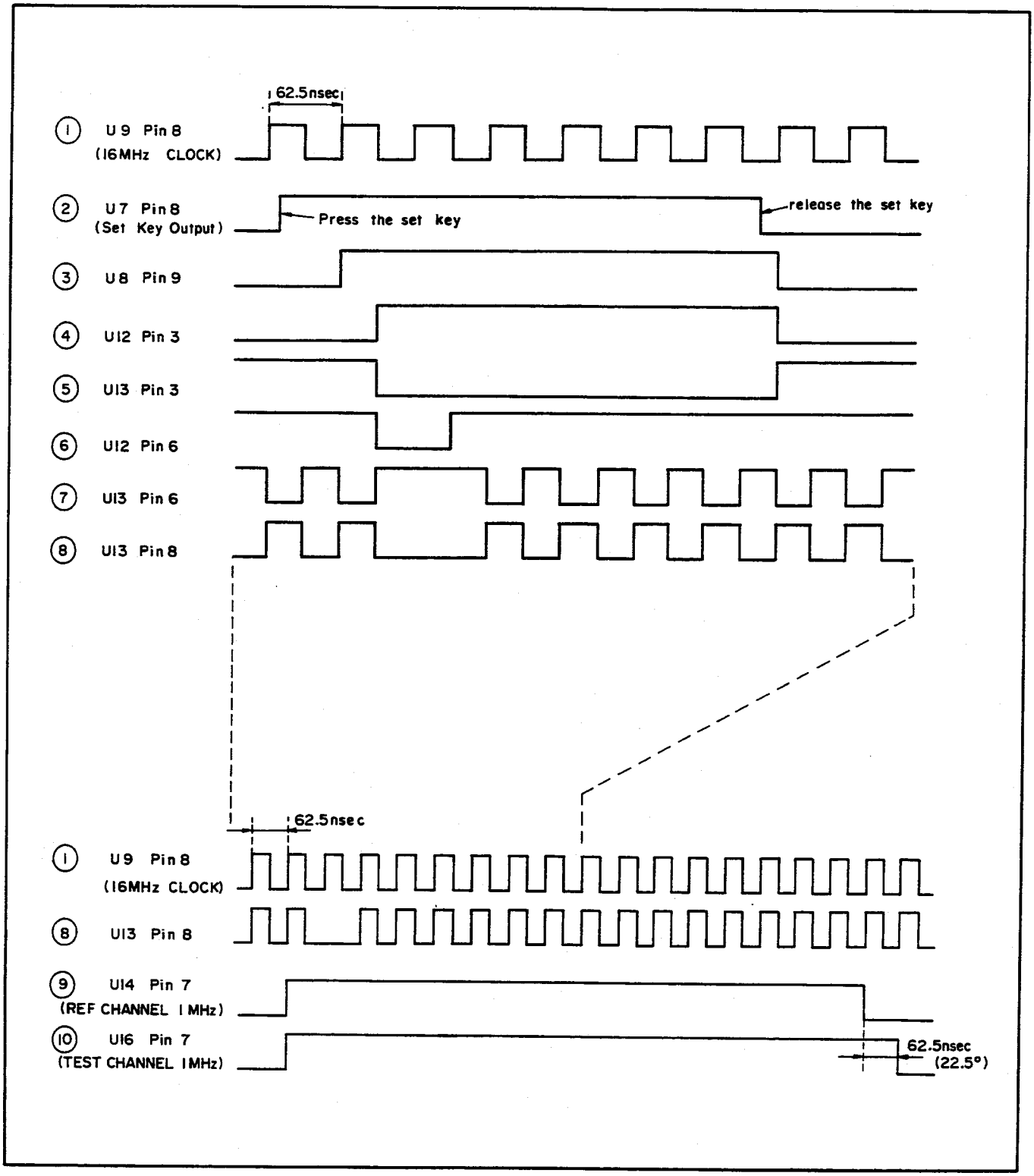


Figure 3. Timing Diagram

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Table 5. Replaceable Parts List

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1	16344-66501	8	1	MAIN GENERATOR ASSEMBLY	28480	16344-66501
A1C1	0160-4835	8	4	CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0160-4571
A1C2	0160-2230	2	4	CAPACITOR-FXD 3300PF +-5% 300VDC MICA	28480	0160-2230
A1C3	0140-0170	3	4	CAPACITOR-FXD 5600PF +-5% 300VDC MICA	72136	DM20F562J0300WV1CR
A1C4	0160-2940	1	4	CAPACITOR-FXD 470PF +-5% 300VDC MICA	28480	0160-2940
A1C5	0160-2940	1		CAPACITOR-FXD 470PF +-5% 300VDC MICA	28480	0160-2940
A1C6	0140-0170	3		CAPACITOR-FXD 5600PF +-5% 300VDC MICA	72136	DM20F562J0300WV1CR
A1C7	0160-2230	2		CAPACITOR-FXD 3300PF +-5% 300VDC MICA	28480	0160-2230
A1C8	0160-3847	9	12	CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C9	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C10	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C11	0180-0229	7	4	CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A1C12	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C13	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C14	0160-4835	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0160-4571
A1C15	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C16	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C17	0180-0229	7		CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A1C18	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C19	0180-0229	7		CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A1C20	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C21	0160-4835	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0160-4571
A1C22	0180-2205	3	1	CAPACITOR-FXD .33UF+-10% 35VDC TA	56289	150D334X9035A2
A1C23	0180-1057	1	1	CAPACITOR:FXD 2200 UF 16VDCW AL ELECT	28480	0180-1057
A1C24	0160-4835	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0160-4571
A1C25	0160-2230	2		CAPACITOR-FXD 3300PF +-5% 300VDC MICA	28480	0160-2230
A1C26	0140-0170	3		CAPACITOR-FXD 5600PF +-5% 300VDC MICA	72136	DM20F562J0300WV1CR
A1C27	0160-2940	1		CAPACITOR-FXD 470PF +-5% 300VDC MICA	28480	0160-2940
A1C28	0160-2940	1		CAPACITOR-FXD 470PF +-5% 300VDC MICA	28480	0160-2940
A1C29	0140-0170	3		CAPACITOR-FXD 5600PF +-5% 300VDC MICA	72136	DM20F562J0300WV1CR
A1C30	0160-2230	2		CAPACITOR-FXD 3300PF +-5% 300VDC MICA	28480	0160-2230
A1C31	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C32	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C33	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C34	0180-0229	7		CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A1CR1	1906-0073	0	1	DIODE S1QB10	28480	1906-0073
A1J1	1250-0257	1	8	CONNECTOR-RF SMB M PC 50-OHM	28480	1250-0257
A1J2	1250-0257	1		CONNECTOR-RF SMB M PC 50-OHM	28480	1250-0257
A1J3	1200-0607	0	2	SOCKET-IC 16-CONT DIP DIP-SLDR	28480	1200-0607
A1J4	1250-0257	1		CONNECTOR-RF SMB M PC 50-OHM	28480	1250-0257
A1J5	1251-4246	8	1	CONNECTOR 3-PIN M POST TYPE	28480	1251-4246
A1L1	9140-0114	4	6	INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG	28480	9140-0114
A1L2	9140-0114	4		INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG	28480	9140-0114
A1L3	9140-0114	4		INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG	28480	9140-0114
A1L4	9100-1788	6	4	CHOKE-WIDE BAND ZMAX=680 OHMS 180 MHZ	02114	VK200 20/4B
A1L5	9100-1788	6		CHOKE-WIDE BAND ZMAX=680 OHMS 180 MHZ	02114	VK200 20/4B
A1L6	9100-1788	6		CHOKE-WIDE BAND ZMAX=680 OHMS 180 MHZ	02114	VK200 20/4B
A1L7	9140-0114	4		INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG	28480	9140-0114
A1L8	9140-0114	4		INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG	28480	9140-0114
A1L9	9140-0114	4		INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG	28480	9140-0114
A1L10	9100-1788	6		CHOKE-WIDE BAND ZMAX=680 OHMS 180 MHZ	02114	VK200 20/4B
A1R1	0698-0082	7	2	RESISTOR 464 1% .125W F TC=0+-100	24546	C4-1/8-T0-4640-F
A1R2	0683-1035	1	9	RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R3	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R4	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R5	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R6	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R7	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R8	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R9	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R10	0698-0082	7		RESISTOR 464 1% .125W F TC=0+-100	24546	C4-1/8-T0-4640-F
A1R11	0757-0984	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R12	0757-0984	3	2	RESISTOR 17.8 1% .5W F TC=0+-100	28480	0698-3389
A1R13	0757-0984	3		RESISTOR 17.8 1% .5W F TC=0+-100	28480	0698-3389
A1U1	1820-1197	9	6	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A1U2	1820-1194	6	3	IC CNTR TTL LS BIN UP/DOWN SYNCHRO	01295	SN74LS193N
A1U3	1820-1074	1	3	IC DRVR TTL NOR QUAD 2-INP	01295	SN74128N
A1U4	1820-1194	6		IC CNTR TTL LS BIN UP/DOWN SYNCHRO	01295	SN74LS193N
A1U5	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A1U6	1820-1074	1		IC DRVR TTL NOR QUAD 2-INP	01295	SN74128N
A1U7	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A1U8	1820-1112	8	1	IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A1U9	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A1U10	1813-0222	4	1	CRYSTAL	28480	1813-0222

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

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Table 5. Replaceable Parts List (cont'd)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1U11	1826-0122	0	1	IC 7805 V RGLTR TO-220	07263	7805UC
A1U12	1820-1469	8	1	IC FF TTL LS J-K NEG-EDGE-TRIG CLEAR	01295	SN74LS107AN
A1U13	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A1U14	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A1U15	1820-1074	1		IC DRVR TTL NOR QUAD 2-INP	01295	SN74128N
A1U16	1820-1194	6		IC CNTR TTL LS BIN UP/DOWN SYNCHRO	01295	SN74LS193N
A2	16344-66502	9	1	SWITCHING BOARD ASSEMBLY	28480	16344-66502
A2DS1	1990-0487	7	1	LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A2J1	1200-0607	0		SOCKET-IC 16-CONT DIP DIP-SLDR	28480	1200-0607
A2J2	1250-0257	1		CONNECTOR-RF SMB M PC 50-OHM	28480	1250-0257
A2J3	1250-0257	1		CONNECTOR-RF SMB M PC 50-OHM	28480	1250-0257
A2J4	1250-0257	1		CONNECTOR-RF SMB M PC 50-OHM	28480	1250-0257
A2J5	1250-0257	1		CONNECTOR-RF SMB M PC 50-OHM	28480	1250-0257
A2J6	1250-0257	1		CONNECTOR-RF SMB M PC 50-OHM	28480	1250-0257
A2J7	1200-0638	7	2	SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0638
A2J8	1200-0638	7		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0638
A2R1	0683-5615	1	1	RESISTOR 560 5% .25W FC TC=-400/+600	01121	CR5615
A2R2	0757-0277	8	2	RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A2R3	0757-0277	8		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A2S1	3101-2460	2	2	SWITCH	28480	PPNR7284702
A2S2	PPNR7284702	2		SWITCH	28480	PPNR7284702
A2S3	3101-2046	7	2	SWITCH-SL DPDT STD 1.5A 250VAC PC	28480	3101-2046
A2S4	3101-2046	7		SWITCH-SL DPDT STD 1.5A 250VAC PC	28480	3101-2046

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

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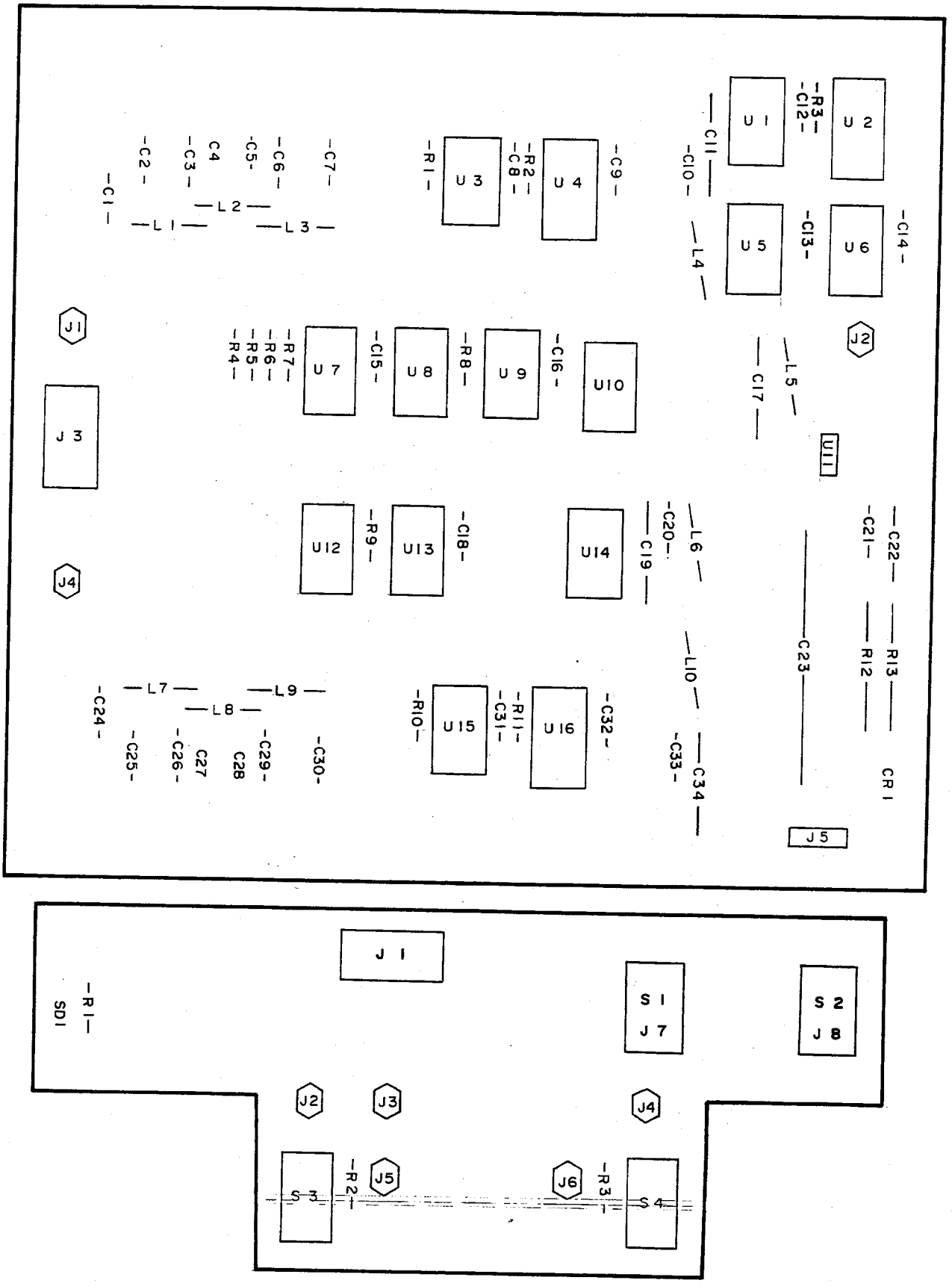


Figure 4. A1 Main Board Assembly/A2 Switching Board Assembly Component Locations

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