Service Manual

HP 437B Power Meter

SERIAL NUMBERS

Attached to the rear panel of the instrument is a serial number plate. The serial number is in the form: 0000A00000. The first four digits and the letter are the serial number prefix. The last five digits are the suffix. The prefix is the same for identical instruments; it changes only when a configuration change is made to the instrument. The suffix, however, is assigned sequentially and is different for each instrument.

This manual applies to instruments with serial numbers prefixed 3114A and below.

HP Part No. 00437-90016

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NOTICE

The information contained in this document is subject to change without notice.

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WARRANTY

A copy of the specific warranty terms applicable to your Hewlett-Packard product and replacement parts can be obtained from your local Sales and Service Office.

Herstellerbescheinigung

Hiermit wird bescheinigt, daß dieses Gerät/System in Übereinstimmung mit den Bestimmungen von Postverfügung 1046/84 funkentstört ist.

Der Deutschen Bundespost wurde das Inverkehrbringen dieses Gerätes/System angezeigt und die Berechtigung zur Überprüfung der Serie auf Einhaltung der Bestimmungen eingeräumt.

Zusatzinformation für Meß- und Testgeräte:

Werden Meß- und Testgeräte mit ungeschirmten Kabeln und/oder in offenen Meßaufbauten verwendet so ist vom Betreiber sicherzustellen, daßdie Funkentstörbedingungen unter Betriebsbedingungen an seiner Grundstücksgrenze eingehalten werden.

Manufacturer's Declaration

This is to certify that this equipment is in accordance with the Radio Interference Requirements of Directive FTZ 1046/1984. The German Bundespost was notified that this equipment was put into circulation, and has been granted the right to check the equipment type for compliance with these requirements.

Note: If test and measurement equipment is operated with unshielded cables and/or used for measurements in open setups, the user must ensure that under these operating conditions, the radio frequency interference limits are me at the border of his premises.

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LIST OF ILLUSTRATIONS (cont'd)

Safety Considerations

This product and related documentation must be reviewed for familiarization with safety markings and instructions before operation.

This product is a Safety Class I instrument (provided with a protective earth terminal).

Before Applying Power

Verify that the product is set to match the available line voltage and the correct fuse is installed.

Safety Earth Ground

An uninterruptable safety earth ground must be provided from the main power source to the product input wiring terminals, power cord, or supplied power cord set.

Warning 

Any interruption of the protective (grounding) conductor (inside or outside the instrument) or disconnecting the protective earth terminal will cause a potential shock hazard that could result in personal injury. (Grounding one conductor of a two conductor outlet is not sufficient protection.) In addition, verify that a common ground exists between the unit under test and this instrument prior to energizing either unit.

Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation.

If this instrument is to be energized via an autotransformer (for voltage reduction) make sure the common terminal is connected to neutral (that is, the grounded side of the mains supply).

Servicing instructions are for use by service-trained personnel only. To avoid dangerous electric shock, do not perform any servicing unless qualified to do so.

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

Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.

For continued protection against fire hazard. replace the line fuse(s) only with 250V fuse(s) of the same current rating and type (for example, normal blow, time delay, etc.). Do not use repaired fuses or short circuited fuseholders.

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 (see Table of Contents for page references).

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.

5 ADJUSTMENTS

5-1. Introduction

This section contains adjustments and checks that ensure proper performance of the Power Meter. Adjustments are not required on any fixed periodic basis, and normally are performed only after a performance test has indicated that some parameters are out of specification. Performance tests should be completed after any repairs that may have altered the characteristics of the instrument. The test results will make it possible to determine whether or not adjustments are required. Allow 30 minutes for the Power Meter to warm up, and then remove the top and bottom covers, for access to the test and adjustment points.

To determine which performance tests and adjustments to perform after a repair, refer to paragraph 5-5, Post-Repair Adjustments.

5-2. Safety Considerations

This section contains a warning that must be followed for your protection and to avoid damage to the equipment being used.

Warning

Adjustments described in this section are performed with power applied to the instrument and with protective covers removed. Maintenance should be performed only by trained personnel who are aware of the hazards involved. When the maintenance procedure can be performed without power, the power should be removed.

5-3. Equipment Required

Most of the adjustment procedures include a list of recommended test equipment. The test equipment is also identified on the test setup diagrams.

If substitutions must be made, the equipment used must meet the critical specification listed in Table 1-3 in Section 1.

5-4. Factory Selected Components

Factory selected components are identified on the schematics and parts lists by an asterisk(*) which follows the reference designator. The nominal value of the selected component is shown. Table 5-1 lists the reference designator, the service sheet where the component is shown, the value range, and the basis for selecting a particular value.

Note Make adjustments only in the order specified.

5-5. Post-Repair Adjustments

Table 5-2 lists the adjustments related to repairs or replacement of any of the assemblies.

Table 5-1. Factory Selected Components

Reference Designator	Service Sheet	Range of Values	Basis of Selection
A4R73 A4VR3 combination	A4C	825 Ω with 5.11V Zener or 1470 Ω with 8.25V Zener	1. If the reference power is outside the range of 1.000 +/- 0.007 mW between 0C and 55C, and if the A4R73, A4VR3 combination is 825 Ω & 5.11V then change the A4R73, A4VR3 combination to 1470 Ω & 8.25V. However, if the A4R73, A41VR3 combination is already 1470 Ω & 8.25V, then a problem exists elsewhere.

Table 5-2. Post-Repair Adjustments, Tests, and Checks

Assembly Repaired	Related Adjustments or Performance Test	Reference Service Sheet
A1 Display	None	A3B
A2 Keyboard	None	A3B
A3 Central Processing Unit	4-7, 4-8	A3A-A3C
A4 Analog Assembly (Includes Ref Oscillator)	4-8, 4-9, 5-6, 5-7, 5-8, 5-9	A4A-A4C
50 MHz Reference Oscillator (Part of Analog Assembly)	4-10, 5-8, 5-9	A4C

5-6. 220 Hz Frequency Adjustment

Reference

Service Sheet A4C

Description

The 220 Hz is adjusted for maximum Power Meter readout.

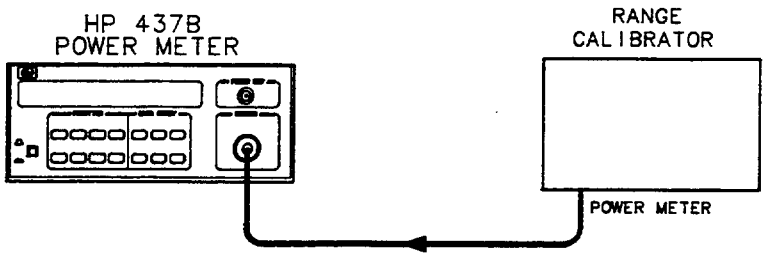


Figure 5-1. 220 Hz Frequency Adjustment Setup

Equipment

Range Calibrator ..... HP 11683A

Procedure

1. Turn on both the Power Meter and the range calibrator. Set the range calibrator controls as follows:

LINE ..... ON
RANGE ..... 1 mW
FUNCTION ..... STANDBY
POLARITY ..... NORMAL

2. Connect the range calibrator to the Power Meter as shown in Figure 5-1.

3. Press the PRESET/LOCAL key, then the ENTER key.

4. Press the ZERO key on the Power Meter, and allow time (5 to 15 seconds) for the Power Meter zeroing routine to finish.

5. Set the range calibrator's FUNCTION switch to CALIBRATE.

6. Press the Power Meter's CAL (SHIFTed ZERO) key.

7. Using ▲, ▼, ◀, or ▶, modify the REF CF to read 100.0%.

8. Press the ENTER key.

9. Adjust A4R87 (FREQ) for the maximum front panel reading.

5-7. Ranges 4 and 5 Shaper Adjustment

Reference

Service Sheet A4A

Description

Ranges 4 and 5 Shaper circuits are adjusted for proper gain.

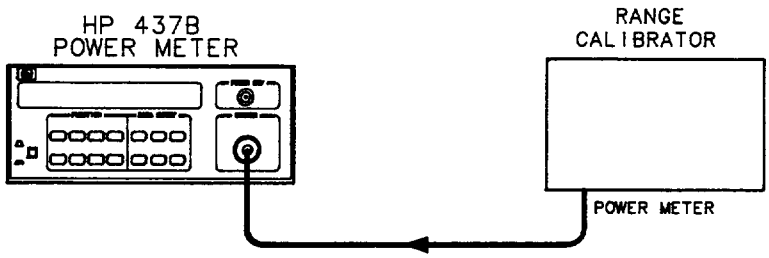


Figure 5-2. Ranges 4 and 5 shaper Adjustment Setup

Equipment

Range Calibrator ..... HP 11683A

Procedure

1. Connect range calibrator to the Power Meter as shown in Figure 5-2.
2. Set the range calibrator controls as follows:

LINE ..... ON
RANGE ..... 1 mW
FUNCTION ..... STANDBY
POLARITY ..... NORMAL

3. Press the Power Meter's LINE switch to ON.

4. Press the PRESET/LOCAL key, then the ENTER key.

5. Press the ZERO key, and allow time (5-15 seconds) for the zeroing routine to finish.

6. Set the range calibrator's FUNCTION switch to CALIBRATE.

7. Press the Power Meter's CAL (SHIFTed ZERO) key.

8. Using ▲, ▼, ▶, or ◀, modify the REF CF to read 100.0%

9. Press the ENTER key.

10. Set the range calibrator's RANGE to 10 mW.

11. Adjust A4R111 (RNG 4 SHP) for a reading of 10.00 ±0.01 mW on the Power Meter display.

12. Set the range calibrator's RANGE to 100 mW.

13. Adjust A4R112 (RNG 5 SHP) for a reading of 100.0 ±0.1 mW on the Power Meter display.

14. Repeat steps 10 through 13 to check that interaction between steps has not caused a shift in settings.

5-8. Power Reference Frequency Oscillator Adjustment

Note

Adjustment of the Power Reference Oscillator frequency may also affect the output level of the oscillator. Thus, after the frequency is adjusted to 50.0 ±0.5 MHz, the output level should be checked as described in Section 4. A procedure for adjusting the output to the specified level is provided in the next paragraph.

Reference

Service Sheet A4C

Description

Variable inductor A4L5 is adjusted to set the power reference oscillator output frequency to 50.0 ±0.5 MHz.

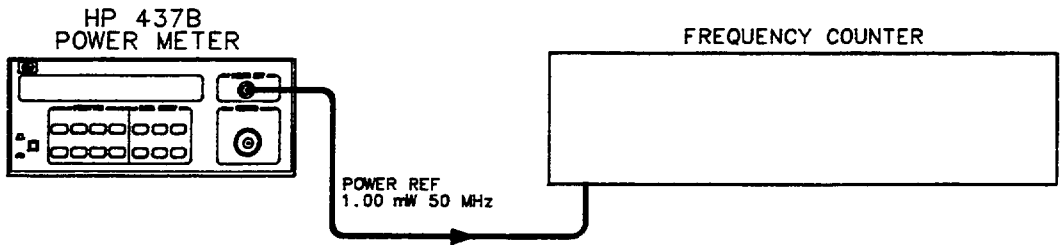


Figure 5-3. Power Reference Oscillator Frequency Adjustment Setup

Equipment

Frequency Counter ..... HP 5328A Option 031

Procedure

1. Connect the equipment as shown in Figure 5-3. Set up the counter to measure frequency.
2. Set the Power Meter LINE switch to ON.
3. Press the PRESET/LOCAL key, then the ENTER key.
4. Press the PWR REF (SHIFTed [▶]) key.
5. Observe the indication on the frequency counter. If it is 50.0 ±0.5 MHz, no adjustment of the power reference oscillator frequency is necessary. If it is not within these limits, adjust the power reference oscillator frequency as described in steps 6 and 7.
6. Remove the Power Meter bottom cover.
7. Adjust A4L5 (FREQ) to obtain a 50.00 ±0.5 MHz indication on the frequency counter.

5-9. Power Reference Oscillator Level Adjustment

Reference

Service Sheet A4C

Description

The power reference oscillator is factory-adjusted to 1.0 mW ±0.7% using a special measurement system accurate to 0.5% traceable to the National Bureau of Standards and allowing for a 0.2% transfer error. To ensure maximum accuracy in readjusting the power reference oscillator, the following procedure provides step-by-step instructions for using specified Hewlett-Packard instruments of known capability. If equivalent instruments are used, signal acquisition criteria may vary and reference should be made to the manufacturer's guidelines for operating the equipment.

Note

The Power Meter may be returned to the nearest HP office to have the power reference oscillator checked and/or adjusted. Refer to Section 2, PACKAGING.

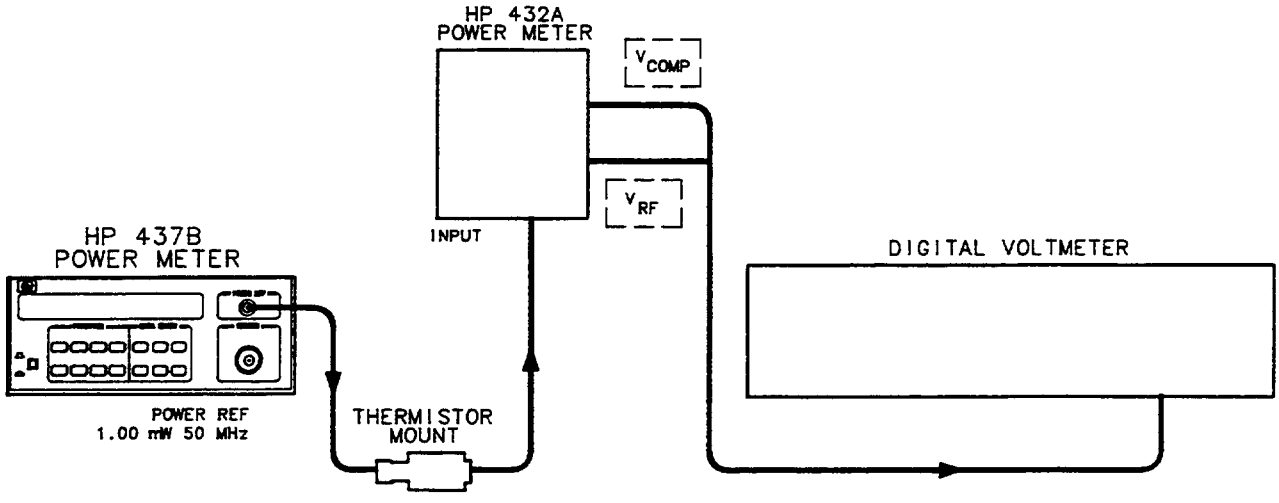


Figure 5-4. Power Reference Oscillator Level Adjustment Setup

Equipment

Test Power Meter	HP 432A
Thermistor Mount	HP 478A-H75
Digital Voltmeter (DVM)	HP 3456A

Procedure

1. Set up the DVM to measure resistance. Connect the DVM between the Vrf connector on the rear panel of the test power meter and pin 1 on the thermistor mount end of the test power meter interconnect cable.

2. Round off the DVM indication to two decimal places and record this value as the internal bridge resistance (R) of the test power meter (approximately 200 ohms).

   R (Internal Bridge Resistance) _____

3. Connect the test power meter to the Power Meter as shown in Figure 5-4.

4. Set the Power Meter LINE switch to ON. Ensure that the PWR REF is off. Wait thirty minutes for the test power meter thermistor mount to stabilize before proceeding to the next step.

5. Set the test power meter range switch to coarse zero and adjust the front panel coarse zero control to obtain a zero meter indication.

6. Fine zero the test power meter on the most sensitive range, then set the power meter range switch to 1 mW.

Note 

Ensure that the DVM input leads are isolated from chassis ground when performing the next step.

7. Set up the DVM to measure microvolts.

8. Connect the positive and negative input leads, respectively, to the Vcomp and Vrf connectors on the rear panel of the test power meter.

9. Observe the indication on the DVM. If less than 400 microvolts, proceed with the next step. If 400 microvolts or greater, press and hold the test power meter fine zero switch and adjust the coarse zero control so that the DVM indicates 200 microvolts or less. Then release the fine zero switch and proceed to the next step.

10. Round off the DVM indication to the nearest microvolt and record this value as V0.

    V0 _____

11. Disconnect the DVM negative input lead from the Vrf connector on the test power meter and reconnect it to chassis ground.

12. Press the PWR REF (SHIFTed ▶) key to turn the reference oscillator on.

13. Record the indication observed on the DVM as Vcomp.

Vcomp _____

14. Disconnect the DVM negative input lead from chassis ground and reconnect it to the Vrf connector on the rear panel of the test power meter. The DVM is now set up to measure V1 which represents the power reference oscillator output level.

15. Calculate the value of V1 equal to 1 mW from the following equation:

$$V_1 - V_0 = V_{COMP} - \sqrt{(V_{COMP})^2 - (10^{-3})(4R)(\text{EFFECTIVE EFFICIENCY})}$$

Where:

V_0 = previously recorded value

V_{COMP} = previously recorded value

10^{-3} = 1 milliwatt

R = previously recorded value

EFFECTIVE EFFICIENCY = value for thermistor mount at 50 MHz (traceable to the National Bureau of Standards).

16. Remove the Power Meter's top cover and adjust A4R114 (LEVEL) until the DVM indicates the calculated value of V1.

Typical Calculations

1. ACCURACY:

DVM Measurements:	(V_{COMP})	±0.018%
	($V_1 - V_0$)	±0.023%
	(R)	±0.03%
Math Assumptions:		±0.01%
EFFECTIVE EFFICIENCY CAL (NBS):		±0.5%
MISMATCH UNCERTAINTY:		±0.1%
(Source and Mount SWR ≤1.05)		≤±0.7%

2. MATH ASSUMPTIONS:

$$P_{RF} = \frac{2V_{COMP}(V_1 - V_0) + V_0^2 - V_1^2}{(4R)(\text{EFFECTIVE EFFICIENCY})}$$

Assume: $V_0^2 - V_1^2 = (V_1 - V_0)^2$

$$-(V_1 - V_0)^2 = -V_1^2 + 2V_1 - V_0^2$$

Want: $V_0^2 - V_1^2$

$$\therefore \text{error} = (V_1^2 + 2V_1 V_0 - V_0^2) - (V_0^2 - V_1^2)$$
$$= -2V_0^2 + 2V_1 V_0 = 2V_0(V_1 - V_0)$$

if $2V_0(V_1 - V_0) \ll 2V_{COMP}(V_1 - V_0)$ i.e., $V_0 \ll V_{COMP}$, error is negligible.

$V_{COMP} \sim 4$ volts. If $V_0 < 400\ \mu V$, error is $< 0.01\%$.
(Typically V_0 can be set to $<50\ \mu V$).

3. Derivation of Formula for $V_1 - V_0$

$$P_{RF} = \frac{2V_{COMP}(V_1 - V_0) + V_0^2 - V_1^2}{(4R)(\text{EFFECTIVE EFFICIENCY})}$$

Desired $P_{RF} = 1\text{ mW} = 10^{-3}$

$$\therefore 10^{-3} = \frac{2V_{COMP}(V_1 - V_0) + V_0^2 - V_1^2}{(4R)(\text{EFFECTIVE EFFICIENCY})}$$

Let (4R) (EFFECTIVE EFFICIENCY) $(10^{-3}) = K$
Substitute $-(V_1 - V_0)^2$ for $V_0^2 - V_1^2$ (see Math Assumptions under Accuracy).
Then $0 = (V_1 - V_0)^2 - 2V_{COMP}(V_1 - V_0) + K$

$$\text{or } V_1 - V_0 = V_{COMP} - \sqrt{(V_{COMP})^2 - K}$$

6 REPLACEABLE PARTS

6-1. General Information

This section contains information for ordering parts. Table 6-1 lists part numbers for restored assemblies. Table 6-2 lists the abbreviations used in the parts list and throughout the manual. Table 6-3 lists all replaceable parts in reference designator order. Table 6-4 contains the names and addresses that correspond to the manufacturer's code numbers.

6-2. Abbreviations

Table 6-2 lists abbreviations used in the parts list, schematics, and throughout the manual. In some cases, two forms of the abbreviations are used, one in all capital letters, and one partial or no capitals. This occurs because the abbreviations in the parts list are always all capitals. However, other abbreviation forms are used with both lower case and upper case letters.

6-3. Replaceable Parts List

Table 6-3 is the list of replaceable parts and is organized as follows:

a. Electrical assemblies and their compon ents in alphanumeric order by reference designation.

b. Chassis-mounted parts in alphanumeric order by reference designation.

c. Mechanical parts.

The information given for each part consists of the following:

a. The Hewlett-Packard part number.

b. Part number check digit (CD).

c. Total quantity (Qty) used in the instrument.

d. Part description.

e. Five-digit code that represents a typical manufacturer.

f. Manufacturer's part number.

Note The total quantity for each part is given only once, that is, at the first occurrence of the part number in the list. The total quantities for optional assemblies are totalled by assembly and not integrated into the standard list.

6-4. Factory Selected Parts

Parts marked with an asterisk (*) are factory selected parts. The value listed in the parts list is the nominal value. Refer to Sections V and VIII of this manual for information on determining what value to use for replacement.

6-5. Parts List Backdating

Parts marked with a (†) are different in Power Meters with serial number prefixes lower than the one that this manual applies to directly.

6-6. Parts List Updating (Change Sheet)

Production changes to Power Meters made after the publication date of this manual are accompanied by a change in the serial number prefix. Changes to the parts list are recorded by serial number prefix on a MANUAL CHANGES supplement. Also, parts list errors are noted in the ERRATA portion of the MANUAL CHANGES supplement.

6-7. Ordering Information

To order a part listed in the replaceble parts table, include the Hewlett-Packard part number (with the check digit), and the quantity required. Address the order to the nearest Hewlett-Packard office. The check digit will ensure accurate and timely processing of your order.

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

Note

Within the USA, it is better to order from the HP parts center in Mountain View, California. Ask your nearest HP office for information and forms for the "Direct Mail Order System".

6-8. Recommended Spares List

Stocking spare parts for an instrument is often done to ensure quick return to service after a malfunction occurs. Hewlett-Packard prepares a "Recommended Spares" list for this instrument. The contents of the list are based on failure reports and repair data. Quantities given are for one year of parts support. A complimentary copy of the "Recommended Spares" list may be requested from your nearest Hewlett- Packard office.

When stocking parts to support more than one Power Meter, or to support a variety of Hewlett-Packard instruments, it may be more economical to work from one consolidated list rather than simply adding together stocking quantities from the individual instrument lists. Hewlett-Packard will prepare consolidated "Recommended Spare" lists for any number or combination of instruments. Contact your nearest HP office for details.

6-9. Restored Assemblies

Table 6-1 lists assemblies within the instrument that may be replaced on an exchange basis, thus affording a considerable cost saving. Exchange, factory-repaired and tested assemblies are available on a trade-in basis; therefore, the defective assemblies must be returned for credit. For this reason, assemblies required for spare parts stock must be ordered by the new assembly part number.

Table 6-1. Part Numbers for Restored Assemblies

Reference Designation	Description	Part Number Restored Assembly	Part Number New Assembly
A3	Digital Assembly	00437-69035	00437-60035*
A4	Analog Assembly	00437-69036	00437-60036*

*The preferred replacement for all HP 437B instruments.

Table 6-2. Reference Designations and Abbreviations (1 of 2)

REFERENCE DESIGNATIONS

A . . . . . assembly
AT . . . attenuator; isolator; termination
B . . . . . fan; motor
BT . . . . . battery
C . . . . . capacitor
CP . . . . . coupler
CR . . . . . diode; diode thyristor; varactor
DC . . . . directional coupler
DL . . . . . delay line
DS . . . . . annunciator; signaling device (audible or visual); lamp; LED
E . . . . . miscellaneous electrical part
F . . . . . fuse
FL . . . . . filter
H . . . . . hardware
HY . . . . . circulator
J . . . . electrical connector (stationary portion); jack
K . . . . . relay
L . . . . . coil; inductor
M . . . . . meter
MP . . . . . miscellaneous mechanical part
P . . . . electrical connector (movable portion); plug
Q . . . . . transistor; SCR; triode thyristor
R . . . . . resistor
RT . . . . . thermistor
S . . . . . switch
T . . . . . transformer
TB . . . . . terminal board
TC . . . . . thermocouple
TP . . . . . test point
U . . . . . integrated circuit; microcircuit
V . . . . . electron tube
VR . . . . voltage regulator; breakdown diode
W . . . . cable; transmission path; wire
X . . . . . socket
Y . . . . . crystal unit (piezo-electric or quartz)
Z . . . . tuned cavity; tuned circuit

ABBREVIATIONS

A . . . . . ampere
ac . . . . . alternating current
ACCESS . . . . . accessory
ADJ . . . . . adjustment
A/D . . . . analog-to-digital
AF . . . . . audio frequency
AFC . . . . . automatic frequency control
AGC . . . . . automatic gain control
AL . . . . . aluminum
ALC . . . . . automatic level control
AM . . . . . amplitude modulation
AMPL . . . . . amplifier
APC . . . . automatic phase control
ASSY . . . . . assembly
AUX . . . . . auxiliary
avg . . . . . average
AWG . . . . . American wire gauge
BAL . . . . . balance
BCD . . . . . binary coded decimal
BD . . . . . board
BE CU . . . . . beryllium copper
BFO . . . . . beat frequency oscillator
BH . . . . . binder head
BKDN . . . . . breakdown
BP . . . . . bandpass
BPF . . . . . bandpass filter
BRS . . . . . brass
BWO . . . . . backward-wave oscillator
CAL . . . . . calibrate
ccw . . . . . counter-clockwise
CER . . . . . ceramic
CHAN . . . . . channel
cm . . . . . centimetre
CMO . . . . . cabinet mount only
COAX . . . . . coaxial
COEF . . . . . coefficient
COM . . . . . common
COMP . . . . . composition
COMPL . . . . . complete
CONN . . . . . connector
CP . . . . . cadmium plate
CRT . . . . cathode-ray tube
CTL . . . . . complementary transistor logic
CW . . . . . continuous wave
cw . . . . . clockwise
D/A . . . . digital-to-analog
dB . . . . . decibel
dBm . . . . . decibel referred to 1 mW
dc . . . . . direct current
deg . . . degree (temperature interval or difference)
...° . . . . . degree (plane angle)
°C . . . . . degree Celsius (centigrade)
°F . . . . . degree Fahrenheit
°K . . . . . degree Kelvin
DEPC . . . deposited carbon
DET . . . . . detector
diam . . . . . diameter
DIA . . . . diameter (used in parts list)
DIFF AMPL . . . differential amplifier
div . . . . . division
DPDT . . . . . double-pole, double-throw
DR . . . . . drive
DSB . . . . . doublesideband
DTL . . . . . diode transistor logic
DVM . . . . digital voltmeter
ECL . . . . . emitter coupled logic
EMF . . . electromotive force
EDP . . . . . electronic data processing
ELECT . . . . . electrolytic
ENCAP . . . . encapsulated
EXT . . . . . external
F . . . . . farad
FET . . . . . field-effect transistor
F/F . . . . . flip-flop
FH . . . . . flat head
FIL H . . . . . fillister head
FM . . . . . frequency modulation
FP . . . . . front panel
FREQ . . . . . frequency
FXD . . . . . fixed
g . . . . . gram
GE . . . . . germanium
GHz . . . . . gigahertz
GL . . . . . glass
GRD . . . . . ground(ed)
H . . . . . henry
h . . . . . hour
HET . . . . . heterodyne
HEX . . . . . hexagonal
HD . . . . . head
HDW . . . . . hardware
HF . . . . . high frequency
HG . . . . . mercury
HI . . . . . high
HP . . . . . Hewlett-Packard
HPF . . . . . high pass filter
HR . . . . . hour (used in parts list)
HV . . . . . high voltage
Hz . . . . . Hertz
IC . . . . . integrated circuit
ID . . . . . inside diameter
IF . . . . . intermediate frequency
IMPG . . . . . impregnated
in . . . . . inch
INCD . . . . . incandescent
INCL . . . . . include(s)
INP . . . . . input
INS . . . . . insulation
INT . . . . . internal
kg . . . . . kilogram
kHz . . . . . kilohertz
kΩ . . . . . kilohm
kV . . . . . kilovolt
lb . . . . . pound
LC . . . . . inductance-capacitance
LED . . light-emitting diode
LF . . . . . low frequency
LG . . . . . long
LH . . . . . left hand
LIM . . . . . limit
LIN . . . . linear taper (used in parts list)
lin . . . . . linear
LK WASH . . . lock washer
LO . . . low; local oscillator
LOG . . . . logarithmic taper (used in parts list)
log . . . . . logarithm(ic)
LPF . . . . . low pass filter
LV . . . . . low voltage
m . . . . . metre (distance)
mA . . . . . milliampere
MAX . . . . . maximum
MΩ . . . . . megohm
MEG . . . . . meg (10^6) (used in parts list)
MET FLM . . . . metal film
MET OX . . . metallic oxide
MF . . . . medium frequency; microfarad (used in parts list)
MFR . . . . . manufacturer
mg . . . . . milligram
MHz . . . . . megahertz
mH . . . . . millihenry
mho . . . . . mho
MIN . . . . . minimum
min . . . . . minute (time)
...' . . . . . minute (plane angle)
MINAT . . . . . miniature
mm . . . . . millimetre

NOTE
All abbreviations in the parts list will be in upper-case.

Table 6-2. Reference Designations and Abbreviations (2 of 2)

MOD . . . . . modulator
MOM . . . . . momentary
MOS . . . . . metal-oxide semiconductor
ms . . . . . millisecond
MTG . . . . . mounting
MTR . . . . meter (indicating device)
mV . . . . . millivolt
mVac . . . . . millivolt, ac
mVdc . . . . . millivolt, dc
mVpk . . . . . millivolt, peak
mVp-p . . . . millivolt, peak-to-peak
mVrms . . . . . millivolt, rms
mW . . . . . milliwatt
MUX . . . . . multiplex
MY . . . . . mylar
μA . . . . . microampere
μF . . . . . microfarad
μH . . . . . microhenry
μmho . . . . . micromho
μs . . . . . microsecond
μV . . . . . microvolt
μVac . . . . . microvolt, ac
μVdc . . . . . microvolt, dc
μVpk . . . . . microvolt, peak
μVp-p . . . . . microvolt, peak-to-peak
μVrms . . . . . microvolt, rms
μW . . . . . microwatt
nA . . . . . nanoampere
NC . . . . . no connection
N/C . . . . . normally closed
NE . . . . . neon
NEG . . . . . negative
nF . . . . . nanofarad
NI PL . . . . . nickel plate
N/O . . . . . normally open
NOM . . . . . nominal
NORM . . . . . normal
NPN . . . negative-positive-negative
NPO . . . . . negative-positive zero (zero temperature coefficient)
NRFR . . . not recommended for field replacement
NSR . . . . . not separately replaceable
ns . . . . . nanosecond
nW . . . . . nanowatt
OBD . . . . . order by description
OD . . . . . outside diameter
OH . . . . . oval head
OP AMPL . . . . . operational amplifier
OPT . . . . . option
OSC . . . . . oscillator
OX . . . . . oxide
oz . . . . . ounce
Ω . . . . . ohm
P . . . . . peak (used in parts list)
PAM . . . . . pulse-amplitude modulation
PC . . . . . printed circuit
PCM . . . pulse-code modulation; pulse-count modulation
PDM . . . . . pulse-duration modulation
pF . . . . . picofarad
PH BRZ . . phosphor bronze
PHL . . . . . Phillips
PIN . . . . . positive-intrinsic-negative
PIV . . . . . peak inverse voltage
pk . . . . . peak
PL . . . . . phase lock
PLO . . . . . phase lock oscillator
PM . . . . . phase modulation
PNP . . . . positive-negative-positive
P/O . . . . . part of
POLY . . . . . polystyrene
PORC . . . . . porcelain
POS . . . positive; position(s) (used in parts list)
POSN . . . . . position
POT . . . . . potentiometer
p-p . . . . . peak-to-peak
PP . . . . . peak-to-peak (used in parts list)
PPM . . . . . pulse-position modulation
PREAMPL . . . preamplifier
PRF . . . . . pulse-repetition frequency
PRR . . . . . pulse repetition rate
ps . . . . . picosecond
PT . . . . . point
PTM . . . . . pulse-time modulation
PWM . . . . . pulse-width modulation
PWV . . . . . peak working voltage
RC . . . . . resistance-capacitance
RECT . . . . . rectifier
REF . . . . . reference
REG . . . . . regulated
REPL . . . . . replaceable
RF . . . . . radio frequency
RFI . . . . . radio frequency interference
RH . . . . . round head; right hand
RLC . . . . . resistance-inductance-capacitance
RMO . . . . rack mount only
rms . . . . . root-mean-square
RND . . . . . round
ROM . . . read-only memory
R&P . . . . . rack and panel
RWV . . . . . reverse working voltage
S . . . . scattering parameter
s . . . . . second (time)
..." . . . second (plane angle)
S-B . . . . . slow-blow (fuse) (used in parts list)
SCR . . . . . silicon controlled rectifier; screw
SE . . . . . selenium
SECT . . . . . sections
SEMICON . . . . . semiconductor
SHF . . . . . superhigh frequency
SI . . . . . silicon
SIL . . . . . silver
SL . . . . . slide
SNR . . . signal-to-noise ratio
SPDT . . . . . single-pole, double-throw
SPG . . . . . spring
SR . . . . . split ring
SPST . . . . . single-pole, single-throw
SSB . . . . . single sideband
SST . . . . . stainless steel
STL . . . . . steel
SQ . . . . . square
SWR . . . standing-wave ratio
SYNC . . . . . synchronize
T . . . timed (slow-blow fuse)
TA . . . . . tantalum
TC . . . . . temperature compensating
TD . . . . . time delay
TERM . . . . . terminal
TFT . . . thin-film transistor
TGL . . . . . toggle
THD . . . . . thread
THRU . . . . . through
TI . . . . . titanium
TOL . . . . . tolerance
TRIM . . . . . trimmer
TSTR . . . . . transistor
TTL . . . transistor-transistor logic
TV . . . . . television
TVI . . . . . television interference
TWT . . . traveling wave tube
U . . . . . micro (10^{-6}) (used in parts list)
UF . . . . microfarad (used in parts list)
UHF . . ultrahigh frequency
UNREG . . . . . unregulated
V . . . . . volt
VA . . . . . voltampere
Vac . . . . . volts, ac
VAR . . . . . variable
VCO . . . . voltage-controlled oscillator
Vdc . . . . . volts, dc
VDCW . . volts, dc, working (used in parts list)
V(F) . . . . . volts, filtered
VFO . . . . variable-frequency oscillator
VHF . . . . . very-high frequency
Vpk . . . . . volts, peak
Vp-p . . . . volts, peak-to-peak
Vrms . . . . . volts, rms
VSWR . . . voltage standing wave ratio
VTO . . . . . voltage-tuned oscillator
VTVM . . . . . vacuum-tube voltmeter
V(X) . . . . . volts, switched
W . . . . . watt
W/ . . . . . with
WIV . . . . . working inverse voltage
WW . . . . . wirewound
W/O . . . . . without
YIG . . . yttrium-iron-garnet
Z_o . . . . . characteristic impedance

NOTE
All abbreviations in the parts list will be in upper-case.

MULTIPLIERS

Abbreviation	Prefix	Multiple
T	tera	10^{12}
G	giga	10^{9}
M	mega	10^{6}
k	kilo	10^{3}
da	deka	10
d	deci	10^{-1}
c	centi	10^{-2}
m	milli	10^{-3}
μ	micro	10^{-6}
n	nano	10^{-9}
p	pico	10^{-12}
f	fento	10^{-15}
a	atto	10^{-18}

Table 6-3 Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Manufacturer Part Number
A1	00437-60030	5	1	LIQUID XTAL DSPL (NOT USER REPAIRABLE)	28480	00437-60030
A2	00437-60016	7	1	KEYPAD ASSY (NOT USER REPAIRABLE)	28480	00437-60016
A3 (2908A & BELOW)	00437-60033	0	1	MICROPROC BD AY	28480	00437-60035
A3 (2912A & ABOVE)	00437-60040	0	1	MICROPROC BD AY	28480	00437-60035
A3BT1	1420-0338	5	1	BATTERY 3V 1.2A-HR LITHIUM POLYCARBON		BR-2/3A
A3C1	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A3C2	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A3C3	0180-4010	2	1	CAP-FXD 470uF 50 V AL-ELCTLT	56289	674D477H050GJ5A
A3C4	0180-4010	2	1	CAP-FXD 470uF 50 V AL-ELCTLT	56289	674D477H050GJ5A
A3C5	0180-3343	2	1	CAP-FXD 10uF 25 V AL-ELCTLT		KMC25T10M
A3C6	0180-3343	2	1	CAP-FXD 10uF 25 V AL-ELCTLT		KMC25T10M
A3C7	0180-4009	9	1	CAP-FXD 4700uF 25 V AL-ELCTLT	56289	674D478H025JJ5A
A3C8	0160-4835	7	1	CAP-FXD 0.1uF 50 V	04222	SA115C104KAAH
A3C9	0160-4835	7	1	CAP-FXD 0.1uF 50 V	04222	SA115C104KAAH
A3C10	0160-4835	7	1	CAP-FXD 0.1uF 50 V	04222	SA115C104KAAH
A3C11	0180-3343	2	1	CAP-FXD 10uF 25 V AL-ELCTLT		KMC25T10M
A3C12	0180-2207	5	1	CAP-FXD 100uF 10 V TA	56289	150D107X9010R2-DYS
A3C13	0180-0197	8	1	CAP-FXD 2.2uF 20 V TA	56289	150D225X9020A2-DYS
A3C14	0160-4835	7	1	CAP-FXD 0.1uF 50 V	04222	SA115C104KAAH
A3C15	0160-4801	7	1	CAP-FXD 100pF 100 V	04222	SA102A101JAAH
A3C16	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A3C17	0160-5901	0	1	CAP-FXD 10pF 200 V		MA12C0G2D100D
A3C18	0180-0197	8	1	CAP-FXD 2.2uF 20 V TA	56289	150D225X9020A2-DYS
A3C19	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A3C20	0160-5901	0	1	CAP-FXD 10pF 200 V		MA12C0G2D100D
A3C21	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A3C22	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A3C23	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A3C24	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A3C25	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A3C26	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A3C27	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A3C28	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A3C29	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A3C30	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A3C31	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A3C32	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A3C33	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A3C34	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A3C35	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A3C36	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A3C37	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A3C38	0180-0197	8	1	CAP-FXD 2.2uF 20 V TA	56289	150D225X9020A2-DYS
A3C39	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A3C40	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A3C41	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A3C42	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A3C43	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A3C44	0160-4835	7	1	CAP-FXD 0.1uF 50 V	04222	SA115C104KAAH
A3C45	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A3C46	0160-4835	7	1	CAP-FXD 0.1uF 50 V	04222	SA115C104KAAH
A3C47 (2908A & BELOW)	0160-4835	7	1	CAP-FXD 0.1uF 50 V	04222	SA115C104KAAH
A3C47 (2912A & ABOVE)				NOT ASSIGNED		
A3CR1	1906-0289	0	1	DIODE-FW BRDG 200V 800MA	71744	RDF02M
A3CR2	1901-0028	5	1	DIODE-PWR RECT 400V 750MA DO-29	04713	SR1358-9BRL
A3CR3	1901-0028	5	1	DIODE-PWR RECT 400V 750MA DO-29	04713	SR1358-9BRL

Table 6-3 Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Manufacturer Part Number
A3CR4	1901-0028	5	1	DIODE-PWR RECT 400V 750MA DO-29	04713	SR1358-9BRL
A3CR5	1901-0028	5	1	DIODE-PWR RECT 400V 750MA DO-29	04713	SR1358-9BRL
A3CR7 (2908A & BELOW)	1826-1589	5	1	IC V RGLTR-OV-V-SEN TO-220 PKG	04713	MPC2004
A3CR7 (2912A & ABOVE)	1884-0310	0	1	THYRISTOR-SCR TO-220AB	04713	MCR69-3
A3CR8	1901-1085	6	1	DIODE-SCHOTTKY SM SIG	28480	5082-2835
A3CR9	1901-0539	3	1	DIODE-SCHOTTKY SM SIG	28480	50825510
A3CR10	1902-0244	9	1	DIODE-ZNR 30V 5% PD=1W IR=5UA	04713	
A3CR11 (2908A & BELOW)	1902-0244	9	1	DIODE-ZNR 30V 5% PD=1W IR=5UA	04713	
A3CR11 (2912A & ABOVE)				NOT ASSIGNED		
A3CR12	1901-1085	6	1	DIODE-SCHOTTKY SM SIG	28480	5082-2835
A3DS1	1990-0652	8	1	LED-LAMP ARRAY LUM-INT=200UCD IF=5MA-MAX	28480	HLMP-6620 SELECTED
A3DS2	1990-0652	8	1	LED-LAMP ARRAY LUM-INT=200UCD IF=5MA-MAX	28480	HLMP-6620 SELECTED
A3DS3	1990-0900	9	1	LED-LAMP LUM-INT=200UCD IF=5MA-MAX BVR=5	28480	HLMP-6620 OPTION QLMP-6626
A3F1	2110-0642	3	1	FUSEHOLDER-XTR-PST 6.3A 250 V BAY CAP	H9027	FAU 031.3577
A3J1	9135-0339	4	1	FILTER-LINE CEE-22-TERMS	01ME1(S)	
A3J2	1252-2161	4	1	CONN-RECT MICRORBN 24-CKT 24-CONT	00779	554923-2
A3J3	1252-2409	3	1	CONN-POST TYPE .200-PIN-SPCG 9-CONT	27264	26-49-7091
A3J4	1251-8281	9	1	CONN-POST TYPE .100-PIN-SPCG 5-CONT	18873	65408-106
A3J5	1252-2409	3	1	CONN-POST TYPE .200-PIN-SPCG 9-CONT	27264	26-49-7091
A3J6	1252-0242	8	1	CONN-POST TYPE .100-PIN-SPCG 34-CONT	76381	3431-6202
A3J7	1251-8304	7	1	CONN-POST TYPE .100-PIN-SPCG 8-CONT	00779	102202-5
A3J8	1252-3492	6		CONN-POST TYPE .100-PIN-SPCG 7-CONT	18873	87800-106
A3MP1	0403-0026	6	1	PLUG-HOLE BDR-HD FOR .19-D-HOLE NYL	02768	207-120241-03-0101
A3MP2	0403-0026	6	1	PLUG-HOLE BDR-HD FOR .19-D-HOLE NYL	02768	207-120241-03-0101
A3MP3	0403-0026	6	1	PLUG-HOLE BDR-HD FOR .19-D-HOLE NYL	02768	207-120241-03-0101
A3MP4	0403-0026	6	1	PLUG-HOLE BDR-HD FOR .19-D-HOLE NYL	02768	207-120241-03-0101
A3MP5	0403-0026	6	1	PLUG-HOLE BDR-HD FOR .19-D-HOLE NYL	02768	207-120241-03-0101
A3MP6	0403-0026	6	1	PLUG-HOLE BDR-HD FOR .19-D-HOLE NYL	02768	207-120241-03-0101
A3MP7	0370-2862	1	1	PUSHBUTTON 0.230 IN SQ 0.425 IN HGT	28480	
A3MP8	0340-0944	3	1	INSULATOR-IC NYLON BLACK	13103	7717-156N
A3MP9	1252-2409	3	2	CONN-POST TYPE .200-PIN-SPCG 9-CONT	27264	26-49-7091
A3MP10	1390-0104	3	4	FASTENER-SNAP-IN GROM PANEL THKNS	83014	HN5P-53-1
A3MP11	1390-0281	7	4	FASTENER-SNAP-IN PLGR PANEL THKNS	83014	HN5P-53-4-1
A3Q1	1854-0832	8	1	TRANSISTOR NPN PD=625MW FT=250MHZ	04713	
A3R1	0698-7260	7	1	RESISTOR 10K +-1% .05W TF TC=0+-100	2M627	CRB20
A3R2	0698-7253	8	1	RESISTOR 5.11K +-1% .05W TF TC=0+-100	2M627	CRB20
A3R4 (2908A & BELOW)	0757-0443	2	1	RESISTOR 11K +-1% .125W TF TC=0+-100	19701	5033R-1/8-TO-1332-F
A3R4 (2912A & ABOVE)	-			NOT ASSIGNED		
A3R5	0757-0199	3	1	RESISTOR 21.5K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A3R6	0757-0280	3	1	RESISTOR 1K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A3R7	0757-0280	3	1	RESISTOR 1K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A3R8	0757-0280	3	1	RESISTOR 1K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A3R9	0698-7212	9	1	RESISTOR 100 +-1% .05W TF TC=0+-100	2M627	CRB20
A3R10	1810-0280	8	1	NETWORK-RES 10-SIP 10.0K OHM X 9	11236	750-101
A3R11	1810-0280	8	1	NETWORK-RES 10-SIP 10.0K OHM X 9	11236	750-101
A3R12	1810-0280	8	1	NETWORK-RES 10-SIP 10.0K OHM X 9	11236	750-101
A3R13	1810-0280	8	1	NETWORK-RES 10-SIP 10.0K OHM X 9	11236	750-101
A3R14	1810-0280	8	1	NETWORK-RES 10-SIP 10.0K OHM X 9	11236	750-101
A3R15	0698-7220	9	1	RESISTOR 215 +-1% .05W TF TC=0+-100	2M627	CRB20
A3R16	0698-7205	0	1	RESISTOR 51.1 +-1% .05W TF TC=0+-100	2M627	CRB20
A3R17	0698-7260	7	1	RESISTOR 10K +-1% .05W TF TC=0+-100	2M627	CRB20
A3R18	0698-7212	9	1	RESISTOR 100 +-1% .05W TF TC=0+-100	2M627	CRB20

Table 6-3 Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Manufacturer Part Number
A3R19	0698-7205	0	1	RESISTOR 51.1 +-1% .05W TF TC=0+-100	2M627	CRB20
A3R20	0698-7220	9	1	RESISTOR 215 +-1% .05W TF TC=0+-100	2M627	CRB20
A3R21	0698-7205	0	1	RESISTOR 51.1 +-1% .05W TF TC=0+-100	2M627	CRB20
A3R22	0698-7212	9	1	RESISTOR 100 +-1% .05W TF TC=0+-100	2M627	CRB20
A3R23	0698-7253	8	1	RESISTOR 5.11K +-1% .05W TF TC=0+-100	2M627	CRB20
A3R24	0757-0317	7	1	RESISTOR 1.33K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A3R25	0698-7260	7	1	RESISTOR 10K +-1% .05W TF TC=0+-100	2M627	CRB20
A3R26	0698-7260	7	1	RESISTOR 10K +-1% .05W TF TC=0+-100	2M627	CRB20
A3R27	0698-7212	9	1	RESISTOR 100 +-1% .05W TF TC=0+-100	2M627	CRB20
A3R28	0698-7260	7	1	RESISTOR 10K +-1% .05W TF TC=0+-100	2M627	CRB20
A3R29	0698-3153	9	1	RESISTOR 3.83K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A3R30	0698-7220	9	1	RESISTOR 215 +-1% .05W TF TC=0+-100	2M627	CRB20
A3R31	0757-0280	3	1	RESISTOR 1K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A3R33	0698-7220	9	1	RESISTOR 215 +-1% .05W TF TC=0+-100	2M627	CRB20
A3R34	0698-7205	0	1	RESISTOR 51.1 +-1% .05W TF TC=0+-100	2M627	CRB20
A3S1	3101-2966	0	1	SWITCH-SL DPDT STD 5A 220VAC PC	D8351	4021.4922
A3S2	3101-2966	0	1	SWITCH-SL DPDT STD 5A 220VAC PC	D8351	4021.4922
A3S4	3101-2761	3	1	SWITCH-DIP SL 7-1A 0.1A 30VDC	00779	436393-7
A3S5	3101-3057	2	1	SWITCH-PB DPDT-NO ALTNG .5A 100 VAC	71468	120049
A3T1	9100-4712	2	1	XFMR-PWR 100/120/220/240V		
A3TP1	0360-0535	0	1	TERMINAL-TEST POINT .330IN ABOVE	4G819	
A3TP2	0360-0124					
A3TP3	0360-0124					
A3U1	1826-1750	2	1	IC V RGLTR-FXD-POS 4.75/5.25V TO-220 PKG	27014	LM2935T05B
A3U2	1826-0457	4	1	IC V RGLTR-DUAL-TRKG 14.5/15.5V TO-100	27014	LM325H
A3U3	1820-3431	8	1	IC-INTERFACE XCVR BCD UP/DOWN INSTRUMENT	27014	DS75160AN
A3U4	1820-2549	7	1	IC-GPIB TALKER/LISTENER	34649	P8291A SELECTED
A3U5	1820-3513	7	1	IC-INTERFACE XCVR BCD UP/DOWN INSTRUMENT	27014	DS75161AN
A3U6	1820-3330	6	1	IC TRANSCEIVER CMOS/74HC BUS OCTL	04713	MC74HC245AN
A3U7	1820-3330	6	1	IC TRANSCEIVER CMOS/74HC BUS OCTL	04713	MC74HC245AN
A3U8	00437-80014	7	1	EPROM PROGRAMMED	28480	00437-80011
A3U9	1818-3760	1	1	IC CMOS 65536 (64K) STAT RAM 150-NS 3-S	S0562	TC5564
A3U10	1820-2922	0	1	IC GATE CMOS/74HC NAND QUAD 2-INP	04713	MC74HC00N
A3U11	1826-1338	2	1	IC MISC 8-DIP-P PKG	01295	TL7705A
A3U12	1820-3079	0	1	IC DCDR CMOS/74HC 3-TO-8-LINE	04713	MC74HC138N
A3U13	1820-3081	4	1	IC FF CMOS/74HC D-TYPE POS-EDGE-TRIG PRE	01295	SN74HC74N
A3U14	1820-2925	3	1	IC CNTR CMOS/74HC BIN SYNCHRO POS-EDGE-T	04713	MC74HC161N
A3U15	1820-3173	5	1	IC FF CMOS/74HC J-K NEG-EDGE-TRIG PRESET	04713	MC74HC112N
A3U16	1820-5049	8	1	IC-8-BIT MPU f=0.5-3MHZ BUS TIME:2MHZ	S4013	HD63B09EP
A3U17	1820-3297	4	1	IC DRVR CMOS/74HC BUS OCTL	04713	MC74HC244N
A3U18	1826-1751	3	1	IC MISC 28-DIP-P PKG	S4013	HD63B40P
A3U19	1820-2921	9	1	IC INV CMOS/74HC HEX	04713	MC74HC04N
A3U20	1820-3297	4	1	IC DRVR CMOS/74HC BUS OCTL	04713	MC74HC244N
A3U21	1820-3173	5	1	IC FF CMOS/74HC J-K NEG-EDGE-TRIG PRESET	04713	MC74HC112N
A3U22	00437-80001	2	1	PAL PROGRAMMED	28480	00437-80001
A3U23	1820-2922	0	1	IC GATE CMOS/74HC NAND QUAD 2-INP	04713	MC74HC00N
A3U24	1820-3827	6	1	IC-PERIPHERAL INTERFACE ADAPTER	S4013	HD63B21P
A3U25	1820-3827	6	1	IC-PERIPHERAL INTERFACE ADAPTER	S4013	HD63B21P
A3U26	1820-6594	0	1	KEYBD CONTROLLER	34694	P80C51BH
A3U27	1820-3082	5	1	IC FF CMOS/74HC D-TYPE POS-EDGE-TRIG OCT	01295	SN74HC374N
A3U28	1820-4608	3	1	IC MUXR/DATA-SEL CMOS/74HC 8-TO-1-LINE	01295	SN74HC356NAPL-15
A3W1	8159-0005	0	1	RESISTOR-ZERO OHMS 22 AWG LEAD DIA	55210	L-2007-1
A3W2	8159-0005	0	1	RESISTOR-ZERO OHMS 22 AWG LEAD DIA	55210	L-2007-1
A3XU8	1200-0567	1	1	SOCKET-IC 28-CONT DIP DIP-SLDR	00779	2-641605-1
A3XU16	1200-0654	7	1	SOCKET-IC 40-CONT DIP DIP-SLDR	00779	641606-1
A3XU22	1200-1107	7	1	SOCKET-IC 24-CONT DIP DIP-SLDR	00779	2-641932-1
A3XU26	1200-0654	7	1	SOCKET-IC 40-CONT DIP DIP-SLDR	00779	641606-1
A3Y1	1813-0130	3	1	CLOCK-OSCILLATOR-XTAL 16.0-MHZ 0.05%	00815	HS-102-16.000MHZ

Table 6-3 Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Manufacturer Part Number
A4 (2932A & BELOW)	00437-60034	1	1	SEQ ANALOG BD AY	28480	00437-60036
A4 (2949A & ABOVE)	00437-60036	1	1	SEQ ANALOG BD AY	28480	00437-60036
	00437-90036	1	1	RESTORED SEQ ANALOG BD AY	28480	00437-60036
A4	00437-60039	1	1	METER ASSEMBLY	28480	00437-60039
A4C1	0180-2206	4	1	CAP-FXD 60uF 6 V TA	56289	150D606X9006B2-DYS
A4C2	0160-4624	2	1	CAP-FXD 8200pF 50 V	04222	SA405A822JAAH
A4C3	0180-0228	6	1	CAP-FXD 22uF 15 V TA	56289	150D226X9015B2-DYS
A4C4	0180-0228	6	1	CAP-FXD 22uF 15 V TA	56289	150D226X9015B2-DYS
A4C5	0160-6399	2	1	CAP-FXD 0.15uF 50 V	04222	SA405C154KAAH
A4C6	0160-4801	7	1	CAP-FXD 100pF 100 V	04222	SA102A101JAAH
A4C7	0180-0373	2	1	CAP-FXD 0.68uF 35 V TA	56289	150D684X9035A2-DYS
A4C8	0180-0373	2	1	CAP-FXD 0.68uF 35 V TA	56289	150D684X9035A2-DYS
A4C9	0160-4624	2	1	CAP-FXD 8200pF 50 V	04222	SA405A822JAAH
A4C10	0160-5467	3	1	CAP-FXD 0.01uF 63 V POLYE-MET		MKS 2
A4C11	0160-6430	2	1	CAP-FXD 0.1uF 63 V POLYC-MET		MKC-2
A4C12	0160-6279	7	1	CAP-FXD 3300pF 50 V		MA14C0G1H332J
A4C13	0160-6059	1	1	CAP-FXD 0.18uF 25 V	04222	MA305C184KAAH
A4C14	0160-4801	7	1	CAP-FXD 100pF 100 V	04222	SA102A101JAAH
A4C15	0160-4801	7	1	CAP-FXD 100pF 100 V	04222	SA102A101JAAH
A4C16	0160-4966	5	1	CAP-FXD 1uF 100 V POLYC-MET		MKC4/1.0/100V/10%
A4C17	0160-5928	1	1	CAP-FXD 0.68uF 100 V POLYC-MET		MKC4.68UF/10%/100VDC
A4C18	0160-4966	5	1	CAP-FXD 1uF 100 V POLYC-MET		MKC4/1.0/100V/10%
A4C19	0160-6430	2	1	CAP-FXD 0.1uF 63 V POLYC-MET		MKC-2
A4C20	0160-6975	0	1	CAP-FXD 0.027uF 63 V POLYC-MET		MKC2/.027/63V/5%
A4C21	0160-6974	9	1	CAP-FXD 0.039uF 63 V POLYC-FL		MKC2/.039/63V/5%
A4C22	0160-3723	0	1	CAP-FXD 0.33uF 40 V POLYC-MET	84411	HEW-428
A4C23	0160-7136	7	1	CAP-FXD 0.1uF 100 V POLYP-FL	84411	HEW860/0.1UF/2%/100V
A4C24	0160-4801	7	1	CAP-FXD 100pF 100 V	04222	SA102A101JAAH
A4C25	0160-6430	2	1	CAP-FXD 0.1uF 63 V POLYC-MET		MKC-2
A4C26	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A4C27	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A4C28	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A4C29	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A4C30	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A4C31	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A4C32	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A4C33	0160-4801	7	1	CAP-FXD 100pF 100 V	04222	SA102A101JAAH
A4C34	0160-4792	5	1	CAP-FXD 8.2pF 100 V	04222	SA102A8R2DAAH
A4C35	0160-3878	6	1	CAP-FXD 1000pF 100 V	04222	SR201C102MAAH
A4C36	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A4C37	0160-4807	3	1	CAP-FXD 33pF 100 V	04222	SA102A330JAAH
A4C38	0160-7088	8	1	CAP-FXD 36pF 300 V GL	04222	TY06-360G
A4C39	0160-7087	7	1	CAP-FXD 200pF 300 V GL	04222	CY06C201G
A4C40	0180-0228	6	1	CAP-FXD 22uF 15 V TA	56289	150D226X9015B2-DYS
A4C41	0160-6974	9	1	CAP-FXD 0.039uF 63 V POLYC-FL		MKC2/.039/63V/5%
A4C42	0160-6974	9	1	CAP-FXD 0.039uF 63 V POLYC-FL		MKC2/.039/63V/5%
A4C43	0180-0197	8	1	CAP-FXD 2.2uF 20 V TA	56289	150D225X9020A2-DYS
A4C44	0180-0197	8	1	CAP-FXD 2.2uF 20 V TA	56289	150D225X9020A2-DYS
A4C45	0180-0197	8	1	CAP-FXD 2.2uF 20 V TA	56289	150D225X9020A2-DYS
A4C46	0180-0197	8	1	CAP-FXD 2.2uF 20 V TA	56289	150D225X9020A2-DYS
A4C47	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A4C48	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A4C49	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A4C50	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A4C51	0180-3831	3	1	CAP-FXD 10uF 35 V TA	56289	299D106X9035DB1
A4C52	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A4C54	0180-3831	3	1	CAP-FXD 10uF 35 V TA	56289	299D106X9035DB1
A4C55	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A4C56	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A4C57	0180-3831	3	1	CAP-FXD 10uF 35 V TA	56289	299D106X9035DB1

Table 6-3 Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Manufacturer Part Number
A4C58	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A4C59	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAHDC
A4C60	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A4C61	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A4C62	0180-0100	3	1	CAP-FXD 4.7uF 35 V TA	56289	150D475X9035B2-DYS
A4C63	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A4C64	0160-4801	7	1	CAP-FXD 100pF 100 V	04222	SA102A101JAAH
A4C65	0160-4801	7	1	CAP-FXD 100pF 100 V	04222	SA102A101JAAH
A4C66	0160-4801	7	1	CAP-FXD 100pF 100 V	04222	SA102A101JAAH
A4C67	0160-4801	7	1	CAP-FXD 100pF 100 V	04222	SA102A101JAAH
A4C68	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A4C69	0160-3334	9	1	CAP-FXD 0.01uF 50 V	04222	SA105C103KAAH
A4CR1	1901-0996	6	1	DIODE-SCHOTTKY SM SIG	28480	QSCH1187
A4CR2	1901-0996	6	1	DIODE-SCHOTTKY SM SIG	28480	QSCH1187
A4CR4	1901-0050	3	1	DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A4CR5	1901-0518	8	1	DIODE-SCHOTTKY SM SIG	28480	5082-5509
A4CR6	1901-0518	8	1	DIODE-SCHOTTKY SM SIG	28480	5082-5509
A4CR7	0122-0299	9	1	DIODE-VVC 82PF 5% C2/C20-MIN=2 BVR=20V	04713	
A4J1	1250-1782	9	1	CONNECTOR-RF BNC FEM PCH-PNL 50-OHM	24931	28JR326-1
A4J2	1250-1425	7	1	CONNECTOR-RF SMC M SGL-HOLE-RR 50-OHM	24931	37JR117-3
A4J3	1251-8919	0	1	CONN-POST TYPE .100-PIN-SPCG 4-CONT	18873	65806-067
A4J4	1252-2275	1	1	CONN-POST TYPE .100-PIN-SPCG 9-CONT	76381	961435-01-05-30
A4J5	1251-8918	9	1	CONN-POST TYPE .100-PIN-SPCG 5-CONT	18873	65806-072
A4J6	1251-8930	5	1	CONN-POST TYPE .100-PIN-SPCG 34-CONT	18873	66429-258
A4J9	1252-1882	4	1	CONN-POST TYPE .100-PIN-SPCG 3-CONT	18873	78208-103
A4L1	9140-0144	0	1	INDUCTOR RF-CH-MLD 4.7UH +-10% .105D-INX	24226	10M471K
A4L2	9140-0210	1	1	INDUCTOR RF-CH-MLD 100UH +-5% .166D-INX.	24226	15M103J
A4L3	9140-0144	0	1	INDUCTOR RF-CH-MLD 4.7UH +-10% .105D-INX	24226	10M471K
A4L4	9140-0144	0	1	INDUCTOR RF-CH-MLD 4.7UH +-10% .105D-INX	24226	10M471K
A4L5	00436-80001	1	1		28480	00436-80001
A4L6	00436-80002	2	1		28480	00436-80002
A4L7	9140-0096	1	1	INDUCTOR RF-CH-MLD 1UH +-10% .166D-INX.3	24226	15M101K
A4L8	9140-0096	1	1	INDUCTOR RF-CH-MLD 1UH +-10% .166D-INX.3	24226	15M101K
A4L9	9140-0096	1	1	INDUCTOR RF-CH-MLD 1UH +-10% .166D-INX.3	24226	15M101K
A4L10	9140-0144	0	1	INDUCTOR RF-CH-MLD 4.7UH +-10% .105D-INX	24226	10M471K
A4MP1	00437-00005	8	2	SHLD RF REF TOP	28480	00437-00005
A4MP2	0380-1238	4	8	STANDOFF-RVT-ON 10-MM-LG M3.0 X 0.5-THD	05791	
A4MP3	0403-0026	6	4	PLUG-HOLE BDR-HD FOR .19-D-HOLE NYL	02768	207-120241-03-0101
A4MP4	0515-0907	9	8	SCREW-MACH M3 X 0.5 8MM-LG 90-DEG-FLH-HD	28480	0515-0907
A4MP5	0515-0924	0	8	SCREW-MACH M3 X 0.6 10MM-LG PAN-HD	28480	0515-0924
A4MP6	0515-0925	1	2	SCREW-MACH M3 X 0.5 10MM-LG PAN-HD	28480	0515-0925
A4MP7	00437-00027	6	2	SHLD RF REF BOTT	28480	00437-00027
A4MP8	08780-00047	0	2	INSULATOR PLATE	28480	08780-00047
A4MP9	1390-0104	3	4	FASTENER-SNAP-IN GROM PANEL THKNS	83014	HN5P-53-1
A4MP10	1390-0281	7	4	FASTENER-SNAP-IN PLGR PANEL THKNS	83014	HN5P-53-4-1
A4Q1	1853-0459	3	1	TRANSISTOR PNP SI PD=625MW FT=200MHZ	04713	
A4Q2	1854-0810	2	1	TRANSISTOR NPN SI PD=625MW FT=200MHZ	04713	
A4Q3	1855-0414	4	1	TRANSISTOR J-FET 2N4393 N-CHAN D-MODE TO	04713	2N4393
A4Q4	1200-0173	5	1	INSULATOR-XSTR DAP-GL	07047	A-10001 DAP
A4Q4	1854-0247	9	1	TRANSISTOR NPN SI TO-39 PD=1W FT=800MHZ	04713	
A4Q5	1854-0810	2	1	TRANSISTOR NPN SI PD=625MW FT=200MHZ	04713	
A4Q6	1854-0810	2	1	TRANSISTOR NPN SI PD=625MW FT=200MHZ	04713	
A4Q7	1853-0459	3	1	TRANSISTOR PNP SI PD=625MW FT=200MHZ	04713	
A4Q8	1854-0810	2	1	TRANSISTOR NPN SI PD=625MW FT=200MHZ	04713	
A4Q9	1854-0810	2	1	TRANSISTOR NPN SI PD=625MW FT=200MHZ	04713	
A4R	0757-0442	9	1	RESISTOR 10K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R1	0698-3450	9	1	RESISTOR 42.2K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R2	0698-6619	8	1	RESISTOR 15K +-0.1% .125W TF TC=0+-25	2M627	CRB14 OR CRB25
A4R3	0757-0459	8	1	RESISTOR 56.2K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R4	0757-0444	1	1	RESISTOR 12.1K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25

Table 6-3 Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Manufacturer Part Number
A4R5	0757-0442	9	1	RESISTOR 10K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R6	0757-0463	4	1	RESISTOR 82.5K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R7	0698-3159	5	1	RESISTOR 26.1K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R8	0698-3450	9	1	RESISTOR 42.2K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R9	0698-3441	8	1	RESISTOR 215 +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R10	0698-3441	8	1	RESISTOR 215 +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R11	0698-3441	8	1	RESISTOR 215 +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R12	0698-3451	0	1	RESISTOR 133K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R13	0698-3160	8	1	RESISTOR 31.6K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R14	0698-0083	8	1	RESISTOR 1.96K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R15	0698-0084	9	1	RESISTOR 2.15K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R16	0811-3351	1	1	RESISTOR 11K +-0.025% .05W PN TC=0+-10	01686	R342
A4R17	0811-3348	6	1	RESISTOR 111.11 +-0.025% .05W PN TC=0+-1	01686	R342
A4R18	0757-0280	3	1	RESISTOR 1K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R19	0757-0465	6	1	RESISTOR 100K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R24	0811-3350	0	1	RESISTOR 10K +-0.025% .05W PN TC=0+-10	01686	R342
A4R25	0811-3349	7	1	RESISTOR 1K +-0.025% .05W PN TC=0+-10	01686	R342
A4R26	0811-3348	6	1	RESISTOR 111.11 +-0.025% .05W PN TC=0+-1	01686	R342
A4R27	0757-0442	9	1	RESISTOR 10K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R28	0757-0123	3	1	RESISTOR 34.8K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R29	0698-3450	9	1	RESISTOR 42.2K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R30	0757-0278	9	1	RESISTOR 1.78K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R31	0698-6619	8	1	RESISTOR 15K +-0.1% .125W TF TC=0+-25	2M627	CRB14 OR CRB25
A4R32	0757-0465	6	1	RESISTOR 100K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R33	0757-0441	8	1	RESISTOR 8.25K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R34	0757-0442	9	1	RESISTOR 10K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R35	0757-0442	9	1	RESISTOR 10K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R36	0757-0442	9	1	RESISTOR 10K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R37	0757-0465	6	1	RESISTOR 100K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R38	0698-3453	2	1	RESISTOR 196K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R39	0757-0444	1	1	RESISTOR 12.1K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R40	0757-0463	4	1	RESISTOR 82.5K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R41	0757-0470	3	1	RESISTOR 162K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R42	0698-3162	0	1	RESISTOR 46.4K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R43	0698-3455	4	1	RESISTOR 261K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R44	0757-0199	3	1	RESISTOR 21.5K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R45	0698-6619	8	1	RESISTOR 15K +-0.1% .125W TF TC=0+-25	2M627	CRB14 OR CRB25
A4R46	0757-0442	9	1	RESISTOR 10K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R47	0698-6360	6	1	RESISTOR 10K +-0.1% .125W TF TC=0+-25	2M627	CRB14 OR CRB25
A4R48	0698-6320	8	1	RESISTOR 5K +-0.1% .125W TF TC=0+-25	2M627	CRB14 OR CRB25
A4R50	0698-8643	2	1	RESISTOR 84.5K +-0.1% .125W TF TC=0+-25	2M627	CRB14 OR CRB25
A4R51	0698-6343	5	1	RESISTOR 9K +-0.1% .125W TF TC=0+-25	2M627	CRB14 OR CRB25
A4R52	0698-7394	8	1	RESISTOR 698 +-0.1% .125W TF TC=0+-25	2M627	CRB14 OR CRB25
A4R53	0757-0280	3	1	RESISTOR 1K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R54	0757-0465	6	1	RESISTOR 100K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R55	0757-0280	3	1	RESISTOR 1K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R56	0757-0465	6	1	RESISTOR 100K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R57	0698-3447	4	1	RESISTOR 422 +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R58	0698-5350	2	1	RESISTOR 2.613K +-0.1% .125W TF TC=0+-25	K8479	H8
A4R59	0698-6631	4	1	RESISTOR 2.5K +-0.1% .125W TF TC=0+-25	2M627	CRB14 OR CRB25
A4R60	0698-3154	0	1	RESISTOR 4.22K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R61	0757-0200	7	1	RESISTOR 5.62K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R62	0757-0460	1	1	RESISTOR 61.9K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R63	0757-0460	1	1	RESISTOR 61.9K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R64	0698-3154	0	1	RESISTOR 4.22K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R65	0757-0200	7	1	RESISTOR 5.62K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R66	0757-0279	0	1	RESISTOR 3.16K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R67	0757-0280	3	1	RESISTOR 1K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R68	0757-0422	5	1	RESISTOR 909 +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R69	0698-3446	3	1	RESISTOR 383 +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25

Table 6-3 Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Manufacturer Part Number
A4R70	0757-0123	3	1	RESISTOR 34.8K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R71	0757-0442	9	1	RESISTOR 10K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R72	0757-0442	9	1	RESISTOR 10K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R73	0757-1094	9	1	RESISTOR 1.47K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R74	0811-3682	1	1	RESISTOR 6.8K +-1% .05W PN TC=0+-10	01686	R342
A4R75	0757-0440	7	1	RESISTOR 7.5K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R76	0757-0465	6	1	RESISTOR 100K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R77	0757-0459	8	1	RESISTOR 56.2K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R78	0757-0280	3	1	RESISTOR 1K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R79	0757-0280	3	1	RESISTOR 1K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R80	0757-0465	6	1	RESISTOR 100K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R81	0757-0442	9	1	RESISTOR 10K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R82	0757-0438	3	1	RESISTOR 5.11K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R83	0757-0398	4	1	RESISTOR 75 +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R84	0757-0317	7	1	RESISTOR 1.33K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R85	0698-6364	0	1	RESISTOR 50 +-0.1% .125W TF TC=0+-25	2M627	CRB14 OR CRB25
A4R86	0757-0280	3	1	RESISTOR 1K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R87	2100-2030	6	1	RESISTOR-TRMR 20K 10% TKF TOP-ADJ 1-TRN	32997	3329H-DM3-203
A4R88	0757-0440	7	1	RESISTOR 7.5K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R90	0757-0346	2	1	RESISTOR 10 +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R91	0757-0346	2	1	RESISTOR 10 +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R92	0698-6619	8	1	RESISTOR 15K +-0.1% .125W TF TC=0+-25	2M627	CRB14 OR CRB25
A4R93	0698-3159	5	1	RESISTOR 26.1K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R94	0698-6619	8	1	RESISTOR 15K +-0.1% .125W TF TC=0+-25	2M627	CRB14 OR CRB25
A4R95	0698-3159	5	1	RESISTOR 26.1K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R96	0698-6320	8	1	RESISTOR 5K +-0.1% .125W TF TC=0+-25	2M627	CRB14 OR CRB25
A4R97	0698-6320	8	1	RESISTOR 5K +-0.1% .125W TF TC=0+-25	2M627	CRB14 OR CRB25
A4R98	0698-6360	6	1	RESISTOR 10K +-0.1% .125W TF TC=0+-25	2M627	CRB14 OR CRB25
A4R99	0811-1557	5	1	RESISTOR 15 +-5% 3W PWI TC=0+-20	01686	T2B-79
A4R100	0757-0438	3	1	RESISTOR 5.11K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R101	0757-0438	3	1	RESISTOR 5.11K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R102	0757-0420	3	1	RESISTOR 750 +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R103	0698-6360	6	1	RESISTOR 10K +-0.1% .125W TF TC=0+-25	2M627	CRB14 OR CRB25
A4R104	0699-0148	8	1	RESISTOR 31.6K +-0.1% .1W TF TC=0+-15	19701	5023Z
A4R105	0699-0148	8	1	RESISTOR 31.6K +-0.1% .1W TF TC=0+-15	19701	5023Z
A4R106	0699-0924	8	1	RESISTOR 11K +-0.1% .125W TF TC=0+-25	2M627	CRB14 OR CRB25
A4R107	0698-0084	9	1	RESISTOR 2.15K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R108	0757-0424	7	1	RESISTOR 1.1K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R109	0698-6619	8	1	RESISTOR 15K +-0.1% .125W TF TC=0+-25	2M627	CRB14 OR CRB25
A4R110	0757-0465	6	1	RESISTOR 100K +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R111	2100-2655	1	1	RESISTOR-TRMR 100K 10% TKF TOP-ADJ 1-TRN	32997	3329H-DM3-104
A4R112	2100-2655	1	1	RESISTOR-TRMR 100K 10% TKF TOP-ADJ 1-TRN	32997	3329H-DM3-104
A4R114	2100-3091	1	1	RESISTOR-TRMR 2K 10% TKF TOP-ADJ 17-TRN	32997	3296W-DM3-202
A4R115	0698-6619	8	1	RESISTOR 15K +-0.1% .125W TF TC=0+-25	2M627	CRB14 OR CRB25
A4R116	0698-6320	8	1	RESISTOR 5K +-0.1% .125W TF TC=0+-25	2M627	CRB14 OR CRB25
A4R118	0698-3441	8	1	RESISTOR 215 +-1% .125W TF TC=0+-100	2M627	CRB14 OR CRB25
A4R121	2100-2216	0	1	RESISTOR-TRMR 5K 10% TKF TOP-ADJ 1-TRN	32997	3329H-DM3-502
A4TP1	1460-2201	4	1	ER DIVISION	28480	1460-2201
A4TP2	1460-2201	4	1	ER DIVISION	28480	1460-2201
A4TP3	1460-2201	4	1	ER DIVISION	28480	1460-2201
A4TP4	1460-2201	4	1	ER DIVISION	28480	1460-2201
A4TP5	1460-2201	4	1	ER DIVISION	28480	1460-2201
A4TP6	1460-2201	4	1	ER DIVISION	28480	1460-2201
A4TP7	1460-2201	4	1	ER DIVISION	28480	1460-2201
A4TP8	1460-2201	4	1	ER DIVISION	28480	1460-2201
A4TP9	1460-2201	4	1	ER DIVISION	28480	1460-2201
A4TP10	1460-2201	4	1	ER DIVISION	28480	1460-2201
A4TP11	1460-2201	4	1	ER DIVISION	28480	1460-2201
A4TP12	1460-2201	4	1	ER DIVISION	28480	1460-2201
A4TP13	1460-2201	4	1	ER DIVISION	28480	1460-2201

Table 6-3 Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Manufacturer Part Number
A4TP14	1460-2201	4	1	ER DIVISION	28480	1460-2201
A4TP15	1460-2201	4	1	ER DIVISION	28480	1460-2201
A4TP16	1460-2201	4	1	ER DIVISION	28480	1460-2201
A4TP17	1460-2201	4	1	ER DIVISION	28480	1460-2201
A4TP18	1460-2201	4	1	ER DIVISION	28480	1460-2201
A4TP19	1460-2201	4	1	ER DIVISION	28480	1460-2201
A4U1	1858-0086	2	1	TRANSISTOR ARRAY 14-PIN PLSTC TO-116	04713	MPQ6700
A4U2	1826-1075	4	1	IC OP AMP GP DUAL 8-DIP-P PKG	27014	LF442CN
A4U3	1826-1076	5	1	IC OP AMP GP QUAD 14-DIP-P PKG	27014	LF444CN
A4U4	1826-1076	5	1	IC OP AMP GP QUAD 14-DIP-P PKG	27014	LF444CN
A4U5	1826-1733	1	1	ANALOG SWITCH 4 SPST 16 -DIP-P	17856	DG221CJ
A4U6	1826-0639	4	1	D/A 8-BIT 16-PLASTIC CMOS	24355	AD7524JN
A4U7	1826-1733	1	1	ANALOG SWITCH 4 SPST 16 -DIP-P	17856	DG221CJ
A4U8	1826-1590	8	1	IC OP AMP PRCN QUAD 14-DIP-P PKG		LT1014CN
A4U9	1826-0065	0	1	IC COMPARATOR PRCN 8-DIP-P PKG	01295	LM311P
A4U10	1826-1075	4	1	IC OP AMP GP DUAL 8-DIP-P PKG	27014	LF442CN
A4U11	1826-1590	8	1	IC OP AMP PRCN QUAD 14-DIP-P PKG		LT1014CN
A4U12	1826-1441	8	1	IC V RGLTR-V-REF-ADJ 9.95/10.05V 8-DIP-C	06665	REF-01HZ
A4U13	1826-1021	0	1	ANALOG MULTIPLEXER CHNL 16 -DIP-P	17856	DG508ACJ
A4U14	1820-1934	2	1	D/A 8-BIT 16-CERDIP BPLR	06665	DAC-08EQ
A4U15	1820-1934	2	1	D/A 8-BIT 16-CERDIP BPLR	06665	DAC-08EQ
A4U16	1820-3082	5	1	IC FF CMOS/74HC D-TYPE POS-EDGE-TRIG OCT	01295	SN74HC374N
A4U17	1826-0639	4	1	D/A 8-BIT 16-PLASTIC CMOS	24355	AD7524JN
A4U18	1820-3079	0	1	IC DCDR CMOS/74HC 3-TO-8-LINE	04713	MC74HC138N
A4U20	1820-3294	1	1	IC FF TTL ALS D-TYPE POS-EDGE-TRIG COM C	01295	SN74ALS374N
A4U21	1820-3294	1	1	IC FF TTL ALS D-TYPE POS-EDGE-TRIG COM C	01295	SN74ALS374N
A4VR1	1902-3002	3	1	DIODE-ZNR 2.37V 5% DO-7 PD=.4W TC=-.074%	04713	
A4VR2	1902-3002	3	1	DIODE-ZNR 2.37V 5% DO-7 PD=.4W TC=-.074%	04713	
A4VR3	1902-0956	0	1	DIODE-ZNR 8.2V 5% DO-35 PD=.4W TC=+.065%	04713	
A4VR4	1902-0680	7	1	DIODE-ZNR 1N827 6.2V 5% DO-7 PD=.4W TC=+	04713	1N827
A4W1	8159-0005	0	1	RESISTOR-ZERO OHMS 22 AWG LEAD DIA	55210	L-2007-1
A4W2	8159-0005	0	1	RESISTOR-ZERO OHMS 22 AWG LEAD DIA	55210	L-2007-1
A4W3	8159-0005	0	1	RESISTOR-ZERO OHMS 22 AWG LEAD DIA	55210	L-2007-1
A4W4	8159-0005	0	1	RESISTOR-ZERO OHMS 22 AWG LEAD DIA	55210	L-2007-1
A4W5	8159-0005	0	1	RESISTOR-ZERO OHMS 22 AWG LEAD DIA	55210	L-2007-1
A4W6	8159-0005	0	1	RESISTOR-ZERO OHMS 22 AWG LEAD DIA	55210	L-2007-1
MP1	00437-00007	4	1	FRONT-PANEL	28480	00437-00001
MP2	00437-00002	5	1	REAR-PANEL	28480	00437-00002
MP3	00437-00003	6	1	MAIN-DECK	28480	00437-00003
MP4	00437-00009	7	1	DISPLAY-SHIELD	28480	00437-00004
MP5	00437-00006	9	1	Z-BRACKET	28480	00437-00006
MP6	00437-40001	8	1	CLAMSHELL TOP	28480	00437-40001
MP7	00437-40002	9	1	CLAMSHELL BOTTOM	28480	00437-40002
MP8	00437-40004	1	1	HOLE PLUG	28480	00437-40004
MP14	0340-0614	4	2	INSULATOR-XSTR POLYHI HD-ANDZ	13103	4778A
MP15	0340-0933	0	2	INSULATOR-FLG-BSHG PPS BLACK	13103	7721-3PPS
MP16	0380-1332	9	2	STANDOFF-HEX .18-IN-LG 6-32-THD	28480	0380-1332
MP17	0515-0169	5	1	SCREW-MACHINE ASSEMBLY M3X 0.5 10MM-LG (OPT 002, 003 ONLY)	00000	ORDER BY DESCRIPTION
MP18	0515-0900	2	1	SCREW-MACHINE M3.5 X 0.6 14MM-LG PAN-HD	28480	0515-0900
MP19	0515-0971	7	2	SCREW-MACHINE M2.5 X 0.45 10MM-LG PAN-HD	28480	0515-0971
MP20	0515-1146	0	5	SCREW-MACHINE ASSEMBLY M3X 0.5 6MM-LG	28480	0515-1146
MP21	0515-1285	8	4	SCREW-MACHINE M3.5 X 0.6 35MM-LG PAN-HD	28480	0515-1285
MP22	0515-1785	3	2	SCREW-MACHINE ASSEMBLY M3.5 X 0.6	28480	0515-1785
MP23	0535-0004	9	1	NUT-HEX DBL-CHAM M3 X 0.5 2.9MM-THK (OPT 002, 003 ONLY)	00000	ORDER BY DESCRIPTION
MP24	0535-0006	1	2	NUT-HEX DBL-CHAM M4 X 0.7 3.8MM-THK	00000	ORDER BY DESCRIPTION
MP25	0535-0007	2	2	NUT-HEX DBL-CHAM M3.5 X 0.6 3.3MM-THK	00000	ORDER BY DESCRIPTION
MP26	0535-0008	3	2	NUT-HEX DBL-CHAM M2.5 X 0.45 2MM-THK	00000	ORDER BY DESCRIPTION

Table 6-3 Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Manufacturer Part Number
MP27	0624-0333	6	2	SCREW-TPG 4-20 .25-IN-LG PAN-HD-POZI-STL	28480	0624-0333
MP28	1205-0698	9	1	HEAT SINK SGL TO-5/TO-39-CS	13103	2262R
MP29	1205-3362	7	1	NUT-AUDIO CONN (STD OPT 002, 003)	05876	91-T-422-6-9
MP30	1400-0510	8	2	CLAMP-CABLE .15-DIA .62-WD NYL	02768	8511-28-00-9909
MP31	1600-1185	9	2	STAMPING -SST RACK MOUNT FASTERNER	28480	1600-1185
MP32	2110-0311	6	1	FUSE (INCH) .062A 250V TD FE UL	D3841	19343
MP33	2110-0318	0	1	FUSE (INCH) .125A 250V TD FE UL	11870	60.00125
MP34	2110-0565	9	1	FUSHEHOLDER CAP 12A MAX FOR UL	H9027	031.1666
MP35	2190-0068	5	3	WASHER-LK INTL T 1/2 IN .505-IN-ID	78189	1924-02
MP36	2190-0104	0	1	WASHER-LK INTL T 7/16 IN .439-IN-ID	78189	1924-04
MP37	2190-0577	1	2	WASHER-LK HLCL NO. 10 .194-IN-ID	28480	2190-0577
MP38	2190-0585	1	5	WASHER-LK HLCL 3.5 MM 3.6-MM-ID	28480	2190-0585
MP39	2190-0643	2	2	WASHER-LK EXT T-B 2.5 MM 2.65-MM-ID	28480	2190-0643
MP40	2190-0645	4	4	WASHER-LK EXT T-B 3.5 MM 3.65-MM-ID	28480	2190-0645
MP41	2190-0646	5	2	WASHER-LK EXT T-B 4.0 MM 4.15-MM-ID	28480	2190-0646
MP42	00436-20014	0	1	WASHER MOUNT CONN (STD OPT 002, 003)	28480	00436-20014
MP43	2200-0164	5	1	SCREW-MACH 4-40 .188-IN-LG UNCT 82 DEG	00000	ORDER BY DESCRIPTION
MP44	2950-0035	8	1	NUT-HEX-DBL-CHAM 15/32-32-THD	00000	ORDER BY DESCRIPTION
MP45	2950-0132	6	2	NUT-HEX-DBL-CHAM 17/16-28-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
MP46	3050-0890	6	2	WASHER-FL MTLC 2.5 MM 2.78-MM-ID	28480	3050-0890
MP47	3050-0892	8	4	WASHER-FL MTLC 3.5 MM 3.8-MM-ID	28480	3050-0892
MP48	3050-0893	9	2	WASHER-FL MTLC 4.0 MM 4.4-MM-ID	28480	3050-0893
MP49	5001-0538					
MP50	5040-5448	1	1	WINDOW	28480	5040-5448
MP51	5041-8801	8	2	FOOT FULL 1/2 MOD	28480	5041-8801
MP52	5041-8822	3	2	REAR FOOT NO SKD	28480	5041-8822
MP53	6960-0024	0	1	PLUG-HOLE FL-HD FOR .688-D-HOLE NYL (STD ONLY)	28520	2673 (BLACK)
MP54	8120-3386	5	1	SHIELDED PWR CD STA 30-AWG 6-COND (STD ONLY)	28480	8120-3386
W2	00438-60038	4	1	CABLE AY SENOR (OPT 002, 003 ONLY)	28480	00438-60038
W3	00437-60025	8	1	SENSOR CABLE AY	28480	00437-60025
W4	00438-60026	0	1	CBL AY REF OSC	28480	00438-60026
W5	00437-60037	2	1	DISPLAY CABLE	28480	00437-60037
W6	00438-60031	7	1	KEYBOARD CABLE	28480	00438-60031

Table 6-4 Code List of Manufacturers

SUP #	SUPPLIER NAME
00779	AMP INC
00815	NEL FREQUENCY CONTROLS INC
01295	TEXAS INSTRUMENTS INC
02768	ITW FASTEX
04222	AVX CORP
04713	MOTOROLA INC
11236	CTS CORP
13103	THERMALLOY INC
18873	DUPONT E I DE NEMOURS & CO
19449	BERK-TEK INC
27014	NATIONAL SEMICONDUCTOR CORP
27264	MOLEX INC
28480	HEWLETT PACKARD COMPANY
28480	HP DIV 01 SAN JOSE COMPONENTS
28480	HP DIV 05 MSD
28480	HP DIV 09 LID COMPONENTS
2M627	ROHM CORP
34649	INTEL CORP
4G819	OVERLAND PRODUCTS CO
55210	GETTIG ENGRG & MFG CO INC
56289	SPRAGUE ELECTRIC CO
71468	ITT CORP
71744	GENERAL INSTRUMENT CORP
76381	3M CO
83014	HARTWELL CORP, THE
91833	KEYSTONE ELECTRONICS CORP
D8351	MARQUARDT GMBH
	DELTA ELECTRONIC INDUSTRIES CO
H9027	SCHURTER AG
	HP DIV 53 SAD
	PANASONIC INDUSTRIAL CO
S0562	TOSHIBA CORP
S4013	HITACHI AMERICA LTD
	TDK CORPORATION OF AMERICA
	UNITED CHEMI-CON INC

8 SERVICE

8-1. General Information

This section contains information required for servicing the Power Meter. It includes block diagrams with theory and troubleshooting, schematic diagrams, and schematic diagram notes.

8-2. Service Sheets

The foldout pages in the last part of this section are called the service sheets (SS). They contain block diagrams, schematic diagrams, supplemental diagrams, and associated information.

8-3. Block Diagrams

The block diagram and related service information is found on Service Sheet BD1. BD1 is an overall block diagram that shows major functional sections of the Power Meter. It serves as an index to the more detailed information on the succeeding service sheets and is the starting point for most trouble shooting procedures.

8-4. Schematic Diagrams

Service Sheet 1 is a detailed block diagram and mechanical assembly drawing of the A1 Display Assembly and the A2 Keyboard Assembly. These assemblies are replaced as assemblies only, and SS1 is provided to show interconnects between these assemblies and the A3 Digital board. The schematic diagrams and their related information are presented in the additional seven Service Sheets A3a, A3b, A3c, A3d, and A4a, A4b, A4c. These diagrams, in functional groupings, are designed to aid in understanding the principles of operation and to aid in troubleshooting the Power Meter.

8-5. Safety Considerations

Before applying power, verify that the instrument is properly set to operate from the available line voltage and that the correct fuse is installed. An uninterrupted safety earth ground must be provided from the main power source to the instrument input wiring terminals, power cord, or supplied power cord set.

8-6. Warnings and Cautions

Pay attention to the WARNINGS and CAUTIONS. They must be followed for your protection and to avoid damage to the equipment.

Warning 

Maintenance described herein must be performed with power supplied to the instrument and with the protective covers removed. Such maintenance should be performed only by service trained personnel who are aware of the hazards involved (for example, fire and electrical shock). Where maintenance can be performed without power applied, the power should be removed.

Any interruption of the protective (grounding) conductor (inside or outside of the instrument), or disconnection of the protective earth terminal will create a potential shock hazard and could result in personal injury. Grounding one conductor of a two-conductor outlet is not sufficient. Whenever it is likely that the protection has been impaired, the instrument must be made inoperative (i.e., secured against unintended operation).

If the instrument is to be energized via an autotransformer (for voltage reduction), make sure the common terminal is connected to neutral (that is, the grounded side of the mains supply).

Make sure that the 250 volt normal-blow fuses with the specified current rating are used for replacement. Do not use repaired fuses or short- circuited fuse holders. To do so could create a shock or fire hazard.

Caution 

Some printed circuit boards contain devices that may be damaged if the board is removed or installed while the power is on. Verify that the LINE switch is OFF or that the power cord is unplugged before you remove or install a printed circuit board.

After removing devices from sockets, store the devices with the pins in conductive foam. This will prevent accidental damage from a static discharge.

8-7. Test Equipment, Tools, Aids, and Information

Test equipment and test accessories required to maintain the Power Meter are listed in Table 1-3, Recommended Test Equipment. Equipment other than that listed may be used if it meets the critical specifications listed.

8-8. Service Tools

Equipment recommended for use when changing components on printed circuit boards is listed in Table 8-1. The following unique service tools will make servicing of this instrument much easier.

Pozidriv Screwdrivers. Many screws in the Power Meter appear to be Phillips type, but they are not. To avoid damage to the screw heads, Pozidriv screwdrivers should be used. The Pozidriv No. 1 size can be ordered as HP part number 8710-0899, and the No. 2 size as HP part number 8710-0900.

Tuning Tools. For adjustments requiring non-metallic tuning tools, use the blade tuning tool HP part number 8710-0033 or hex tuning tool (JFD Model No. 5284) HP part number 8710-1010. For other adjustments, an ordinary screwdriver is sufficient. No matter which tool is used, never force any adjustment control against it stops. This is especially critical when adjusting variable inductors or capacitors.

8-9. Assembly Locations

Printed circuit board assemblies are numbered sequentially from front to back. For example, A1 is part of the front panel assembly.

8-10. Parts and Cable Locations

The locations of individual components on the printed circuit boards and other assemblies are shown adjacent to the schematic diagrams on the appropriate service sheets. The complete reference designator consists of the assembly designator plus the part designator. For example, A3R9 is resistor R9 on the A3 assembly. For specific component descriptions and ordering information, refer to Table 6-3, Replaceable Parts.

Mechanical parts have reference designators that begin with the letters MP. Mechanical parts such as screws, washers, and nuts are listed in the replaceable parts list.

The Power Meter has a mixture of Unified National (inch) and metric screws. The metric screws are defined by Industrial Fasteners publication (IFI 500) and are identified in the replaceable parts list as metric (M). Unified National screws have a dull steel gray appearance and the metric screws have a shiny silver appearance. Do not use a metric screw in a Unified National nut, thread damage will result.

8-11. Test Point and Adjustment Locations

Most test points and adjustments are indicated on individual circuit board assemblies. Test points and adjustments can also be found on the component locator diagrams adjacent to the assembly schematic diagrams.

8-12. Service Aids On Printed Circuit Boards

The service aids on the printed circuit boards include test points, indicator LEDs, reference designators, adjustment names, and assembly part numbers.

8-13. Other Service Documents

Service Notes, Change Pages, Application Notes and other service literature are available from Hewlett-Packard. For further information, contact your nearest Hewlett-Packard office.

Table 8-1. Etched Circuit Soldering Equipment

Item	Use	Specification	Item Recommended	HP P/N
Soldering Tip	Soldering, Unsoldering	*Shape: Chisel	*Ungar PL113	8690-0007
De-Solder Aid	To remove molten solder From connection	Suction Device	Soldapullt by Edson Co., Van Nuys, CA 91406	8690-0060
Rosin (flux) Solvent	To remove excess flux from soldered area before application of protective coating	Must not dissolve etched circuit base board	Freon	8500-0232
Solder	Component replacement; Circuit board repair wiring	Rosin (flux-core, high tin content (63/37 tin/lead) 18-gauge (AWG) 0.040 in. diameter pre-ferred		8090-0607

*For working on circuit boards, for general purpose work, use No. 555 Handle (8690-0261) and No. 4037 heating unit 47.5–53.5 W (HP 8690-0006): temperature of 850 - 900 °F; and Ungar No. PL113 1/8" chisel tip.

Table 8-2. Schematic Diagram Notes (1 of 8)

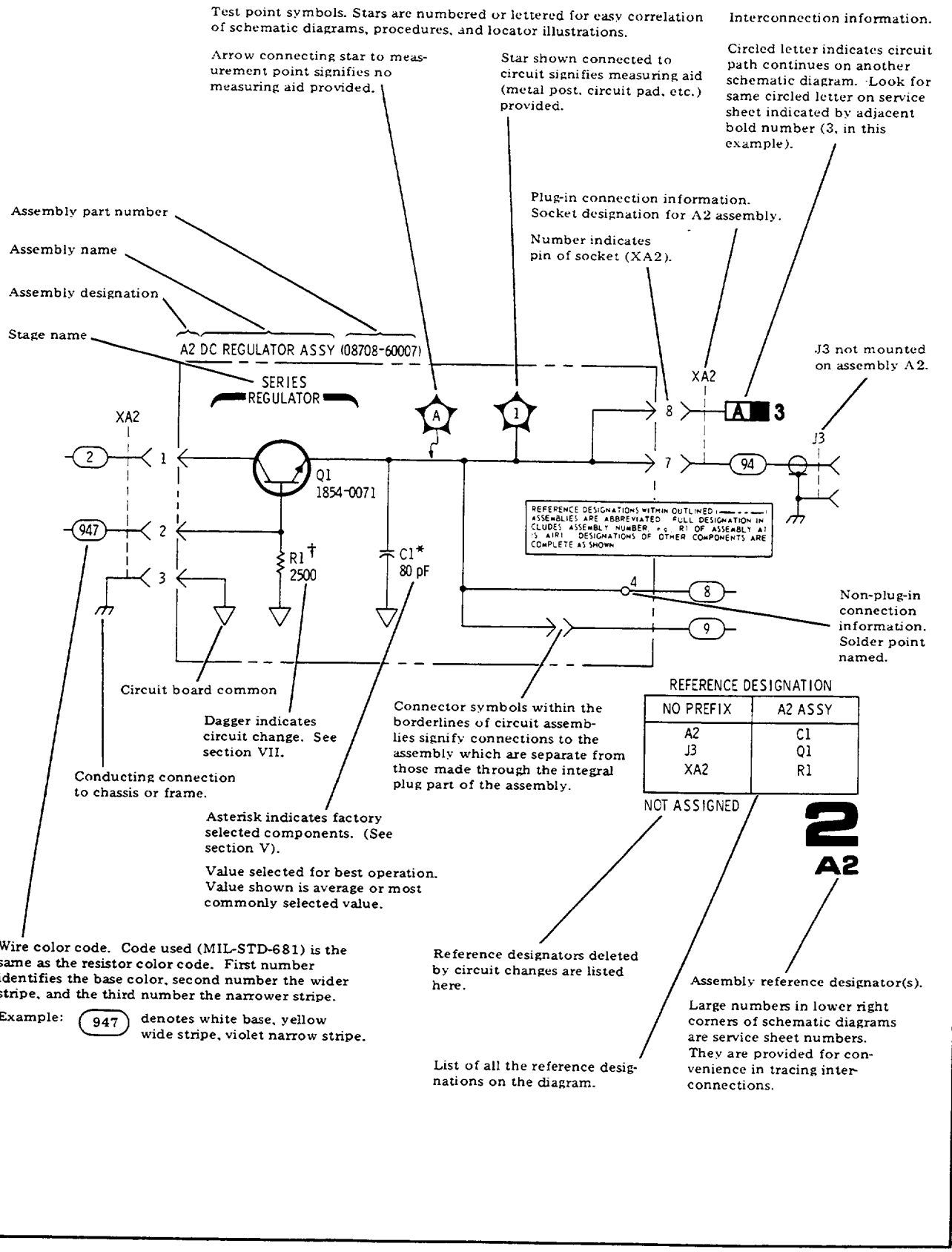


Table 8-2. Schematic Diagram Notes (2 of 8)

SCHEMATIC DIAGRAM NOTES

*	Asterisk denotes a factory-selected value. Value shown is typical.
†	Dagger indicates circuit change. See Section VII.
	Tool-aided adjustment. ○ Manual control.
	Encloses front-panel designation.
	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.
	Indicates stripline (i.e., RF transmission line above ground).
CW	Wiper moves toward cw with clockwise rotation of control (as viewed from shaft or knob).
1	Numbered Test Point measurement aid provided.
	Encloses wire or cable color code. Code used is the same as the resistor color code. First number identifies the base color, second number identifies the wider stripe, and the third number identifies the narrower stripe, e.g., denotes white base, yellow wide stripe, violet narrow stripe.
	A direct conducting connection to earth, or a conducting connection to a structure that has a similar function (e.g., the frame of an air, sea, or land vehicle).
	A conducting connection to a chassis or frame.
	Common connections. All like-designation points are connected.
AK 12	Letters = off-page connection, e.g., AK Number = Service Sheet number for off-page connection, e.g., 12
1 THIS PAGE	Number (only) = on-page connection.

Table 8-2. Schematic Diagram Notes (3 of 8)

SCHEMATIC DIAGRAM NOTES

Indicates multiple paths represented by only one line. Letters or names identify individual paths. Numbers indicate number of paths represented by the line.

Coaxial or shielded cable.

Relay. Contact moves in direction of arrow when energized.

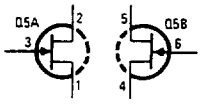
Indicates a pushbutton switch with a momentary (ON) position.

Indicates a PIN diode.

Indicates a current regulation diode.

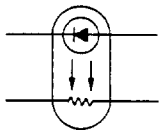
Indicates a voltage regulation diode.

Indicates a Schottky (hot-carrier) diode.



Multiple transistors in a single package—physical location of the pins is shown in package outline on schematic.

Identification of logic families as shown (in this case, ECL).

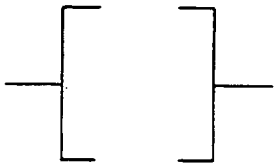


Indicates an opto-isolator of a LED and a photoresistor packaged together. The resistance of the photoresistor is a function of the current flowing through the LED.

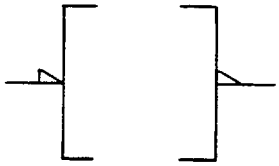
Table 8-2. Schematic Diagram Notes (4 of 8)

DIGITAL SYMBOLOGY REFERENCE INFORMATION

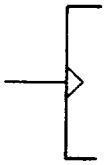
Input and Output Indicators



Implied Indicator—Absence of polarity indicator (see below) implies that the active state is a relative high voltage level. Absence of negation indicator (see below) implies that the active state is a relative high voltage level at the input or output.

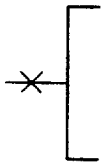


Polarity Indicator—The active state is a relatively low voltage level.

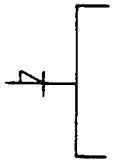


Dynamic Indicator—The active state is a transition from a relative low to a relative high voltage level.

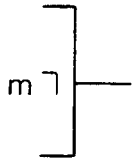
Inhibit Input—Input that, when active, inhibits (blocks) the active state outputs of a digital device.



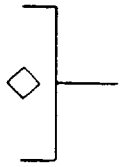
Analog Input—Input that is a continuous signal function (e.g., a sine wave).



Polarity Indicator used with Inhibit Indicator—Indicates that the relatively low level signal inhibits (blocks) the active state outputs of a digital device.



Output Delay—Binary output changes state only after the referenced input (m) returns to its inactive state (m should be replaced by appropriate dependency or function symbols).



Open Collector Output—Output that must form part of a distributed connection.

Table 8-2. Schematic Diagram Notes (5 of 8)

DIGITAL SYMBOLOGY REFERENCE INFORMATION

Input and Output Indicators (Cont'd)

3-STATE	Three-state Output—Indicates outputs that can have a high impedance (disconnect) state in addition to the normal binary logic states.

Combinational Logic Symbols and Functions

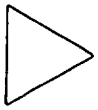
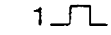
&	AND—All inputs must be active for the output to be active.
≥1	OR—One or more inputs being active will cause the output to be active.
≥m	Logic Threshold—m or more inputs being active will cause the output to be active (replace m with a number).
=1	EXCLUSIVE OR—Output will be active when one (and only one) input is active.
=m	m and only m—Output will be active when m (and only m) inputs are active (replace m with a number).
=	Logic Identity—Output will be active only when all or none of the inputs are active (i.e., when all inputs are identical, output will be active).
	Amplifier—The output will be active only when the input is active (can be used with polarity or logic indicator at input or output to signify inversion).
X/Y	Signal Level Converter—Input level(s) are different than output level(s).
	Bilateral Switch—Binary controlled switch which acts as an on/off switch to analog or binary signals flowing in both directions. Dependency notation should be used to indicate affecting/affected inputs and outputs. Note: amplifier symbol (with dependency notation) should be read to indicate unilateral switching.
X—Y	Coder—Input code (X) is converted to output code (Y) per weighted values or a table.
(Functional Labels)	The following labels are to be used as necessary to ensure rapid identification of device function.
MUX	Multiplexer—The output is dependent only on the selected input.
DEMUX	Demultiplexer—Only the selected output is a function of the input.
CPU	Central Processing Unit
PIO	Peripheral Input/Output
SMI	Static Memory Interface

Table 8-2. Schematic Diagram Notes (6 of 8)

DIGITAL SYMBOLOGY REFERENCE INFORMATION

Sequential Logic Functions

1 	Monostable—Single shot multivibrator. Output becomes active when the input becomes active. Output remains active (even if the input becomes inactive) for a period of time that is characteristic of the device and/or circuit.
G 	Oscillator—The output is a uniform repetitive signal which alternates between the high and low state values. If an input is shown, then the output will be active if and only if the input is in the active state.
FF	Flip-Flop—Binary element with two stable states, set and reset. When the flip-flop is set, its outputs will be in their active states. When the flip-flop is reset, its outputs will be in their inactive states.
T	Toggle Input—When active, causes the flip-flop to change states.
S	Set Input—When active, causes the flip-flop to set.
R	Reset Input—When active, causes the flip-flop to reset.
J	J Input—Analogous to set input.
K	K Input—Analogous to reset input.
D	Data Input—Always enabled by another input (generally a C input—see Dependency Notation). When the D input is dependency-enabled, a high level at D will set the flip-flop; a low level will reset the flip-flop. Note: strictly speaking, D inputs have no active or inactive states—they are just enabled or disabled.
m	Count-Up Input—When active, increments the contents (count) of a counter by "m" counts (m is replaced with a number).
−m	Count-Down Input—When active, decrements the contents (count) of a counter by "m" counts (m is replaced with a number).
→m	Shift Right (Down) Input—When active, causes the contents of a shift register to shift to the right or down "m" places (m is replaced with a number).
← m	Shift Left (Up) Input—When active, causes the contents of a shift register to shift to the left or up "m" places (m is replaced with a number).

NOTE

For the four functions shown above, if m is one, it is omitted.

(Functional Labels)	The following functional labels are to be used as necessary in symbol build-ups to ensure rapid identification of device function.

Table 8-2. Schematic Diagram Notes (7 of 8)

DIGITAL SYMBOLOGY REFERENCE INFORMATION

Sequential Logic Functions (Cont'd)

mCNTR	Counter—Array of flip-flops connected to form a counter with modulus m (m is replaced with a number that indicates the number of states: 5 CNTR, 10 CNTR, etc.).
REG	Register—Array of unconnected flip-flops that form a simple register or latch.
SREG	Shift Register—Array of flip-flops that form a register with internal connections that permit shifting the contents from flip-flop to flip-flop.
ROM	Read Only Memory—Addressable memory with read-out capability only.
RAM	Random Access Memory—Addressable memory with read-in and read-out capability.

Dependency Notation

mAm	Address Dependency—Binary affecting inputs of affected outputs. The m prefix is replaced with a number that differentiates between several address inputs, indicates dependency, or indicates demultiplexing and multiplexing of address inputs and outputs. The m suffix indicates the number of cells that can be addressed.
Gm	Gate (AND) Dependency—Binary affecting input with an AND relationship to those inputs or outputs labeled with the same identifier. The m is replaced with a number or letter (the identifier).
Cm	Control Dependency—Binary affecting input used where more than a simple AND relationship exists between the C input and the affected inputs and outputs (used only with D-type flip-flops).
Vm	OR Dependency—Binary affecting input with an OR relationship to those inputs or outputs labeled with the same identifier. The m is replaced with a number or the letter (the identifier).
Fm	Free Dependency—Binary affecting input acting as a connect switch when active and a disconnect when inactive. Used to control the 3-state behavior of a 3-state device.

NOTE

The identifier (m) is omitted if it is one—that is, when there is only one dependency relationship of that kind in a particular device. When this is done, the dependency indicator itself (G, C, F, or V) is used to prefix or suffix the affected (dependent) input or output.

Table 8-2. Schematic Diagram Notes (8 of 8)

DIGITAL SYMBOLOGY REFERENCE INFORMATION

Miscellaneous

Schmitt Trigger—Input characterized by hysterisis; one threshold for positive going signals and a second threshold for negative going signals.

Active

Active State—A binary physical or logical state that corresponds to the true state of an input, an output, or a function. The opposite of the inactive state.

Enable

Enabled Condition—A logical state that occurs when dependency conditions are satisfied. Although not explicitly stated in the definitions listed above, functions are assumed to be enabled when their behavior is described. A convenient way to think of it is as follows:

A function becomes active when:

- it is enabled (dependency conditions—if any—are satisfied)
- and its external stimuls (e.g., voltage level) enters the active state.

Service Sheet BD1 Overall Trouble-shooting

References

Principles of Operation

The HP 437B Power Meter is a programmable single-channel average responding power meter with a built in 1 mW 50 MHz power reference. For purposes of explanation and troubleshooting the Power Meter is split into three functional sections:

1. The Digital Section and display/keyboard.
2. The Analog Section.
3. The Power Supply.

The keyboard and display are not user repairable, but they can be replaced separately.

The Digital Section executes all functions that are enabled by the user via front panel keystrokes (local operation) or HP-IB commands (remote operation). The overall power range and frequency response of the Power Meter is determined by the power sensor that is connected to the front panel input connector.

The power sensor converts the input power to an analog voltage. This voltage is conditioned and digitized by the Analog Section. The Digital Section calculates and displays the measurement result in the specified units.

Digital Section

The Digital Section provides control over all of the Power Meter's functions. The following text describes the function of each of the components of the Digital Section.

The microprocessor controls the Power Meter by interpreting input instructions and issuing commands. Specific instructions for the microprocessor are stored in ROM. Data is exchanged between the microprocessor and the other blocks of the Digital Section over the data bus (D0-D7). The address bus (A0-A15) is used by the microprocessor to select either specific data from the RAM or instructions from the ROM and to provide address and control information inputs to the address and control decoder.

Note 

The RAM contains the frequency vs. calibration factor (sensor data) tables. This data is protected by a battery (A3BT1). This battery occasionally needs replacement. For replacement indications and procedure, see "Battery Replacement Procedure" in the Digital Board Check further on in this section.

The address and control decoder interprets data from the microprocessor to create control signals that enable other components of the Digital Section to gain access to the data bus.

The system clock generator supplies timing signals to various components in the Digital Section. Two 2.0 MHz timing signals are sent to the microprocessor, and one 2.0 MHz timing signal is sent to the address and control decoder, the analog PIA, the analog timer, the keyboard and display PIA, the LED data latch, and the HP-IB interface. An 8.0 MHz signal from the system clock generator is sent to the analog timer and the display/keyboard controller.

The ROM contains permanent instructions that are interpreted and executed by the microprocessor. The RAM is used by the microprocessor to store various data such as front panel conditions and the Sensor Data tables. A battery supplies power to the RAM when the Power Meter is not connected to the mains power line. This prevents loss of stored data.

When the Power Meter is turned on, the reset circuitry holds the microprocessor in the reset state for 25 milliseconds to allow the power supply to reach a steady +5V. If the +5V power supply drops below +4.5V the reset circuitry will issue a signal to halt the microprocessor.

The analog PIA is an input/output device that allows the microprocessor to control the components in the Analog Section. Data from the data bus is transferred by the analog PIA to the Analog Section. This data is sent to the Analog Section via eleven data lines and two control lines (STRAMP and NADS).

The service test buffer is a digital multiplexer. Data lines AA0-AA2, STRAMP, NADS, and NWR control the multiplexer and select one of 8 data lines AD0-AD7 from the analog PIA. During self-test, the service test buffer verifies the data and control lines from the Digital Section to the Analog Section.

The analog timer measures the width of the pulse at the output of the analog-to-digital converter (in the Analog Section) and converts it to data that can be interpreted by the microprocessor as a measurement. The analog timer also generates a microprocessor interrupt signal. This interrupt signal occurs every 5 milliseconds.

The keyboard and display PIA provides the interface between the microprocessor and the display/keyboard controller. Data from the data bus is read by the PIA and sent to the display/keyboard controller. Keystroke information from the display/keyboard controller is read by the PIA. The PIA places the data on the data bus where it is read by the microprocessor.

The display/keyboard controller is an 8-bit microprocessor. The controller detects keystroke information from the keyboard, converts it to parallel data and transmits it to the microprocessor through the PIA. The microprocessor sends display data through the PIA to the controller. The controller then sends the data to the display.

The service function switch consists of seven single-pole single-throw switches. These switches allow the user to set seven of the eight data lines on the data bus to ground. Certain settings of these switches cause the microprocessor to invoke certain self tests. The service function switch is also used to set a default HP-IB address.

The LED data latch is used to convey operating information of the Power Meter. Data from the data bus causes the LEDs to illuminate or blink in certain patterns. These patterns convey information about errors and operating states. More information about the LED data latch and service function switch can be found in the troubleshooting information in this section.

The HP-IB interface is a bi-directional device that allows the Power Meter to interface with external instruments and controllers. Control signals and data from the data bus are received by the HP-IB interface and transmitted onto the external HP-IB bus through two devices: the HP-IB transmit/receive buffer and the HP-IB data control. Similarly, control signals and data from external instruments and controllers are received by the HP-IB interface and transmitted onto the data bus.

Analog Section

The Analog Section measures the input signal from the power sensor. The signal is amplified, filtered, and then measured. The Analog Section then produces a pulse with a width that is proportional to the power level of the measured signal. This pulse width is counted by the Digital Section. The microprocessor converts this count to a power measurement.

Power levels (from an external source) are converted to a DC voltage. A 220 Hz square wave signal from the power meter amplitude modulates the DC voltage. This creates a 220 Hz signal whose amplitude is proportional to the sensed power level. The 220 Hz amplitude modulated signal from the power sensor is fed into the input amplifier. The input amplifier contains a shaping network to compensate for non-linearities in ranges 4 and 5 of the power sensor.

Range attenuator 1 and range attenuator 2 work together to create five 10 dB power ranges whose values are determined by the power sensor being used. The higher the power at the input, the more it is attenuated. This creates greater sensitivity for low power measurements while providing the needed resolution for each range.

The variable gain amplifier provides between 23 and 39 dB of gain depending on the control signals from the Digital Section. The gain of the variable gain amplifier is digitally adjusted when the power sensor is calibrated to a reference power (the CAL function).

The bandpass amplifier provides filtering and amplification of the signal from range attenuator 2. The passband frequency is 220 Hz ±20 Hz with a gain of approximately 45 dB.

The synchronous phase detector has an alternating gain of +1 and -1 which is synchronized with the 220 Hz multivibrator. This alternating gain provides full-wave rectification of the 220 Hz signal from the 220 Hz bandpass amplifier.

The rectified 220 Hz signal from the synchronous phase detector is fed into the low pass filters. The low pass filters section consists of a fast filter and a slow filter. The fast filter has a response time of 45 milliseconds, while the slow filter has a response time of 800 milliseconds. When the digital filter is set to 1, 2, 4, or 8 averages, the fast filter is selected. When the digital filter is set to 16, 32, 64, 128, 256, or 512 averages, the slow filter is selected.

The internal digital filter is not a hardware component. It is a software routine that averages together readings from the low pass filters. This averaging produces a more stable and accurate power reading. The number of readings averaged together by the digital filter can be selected automatically or manually.

In auto filter mode, the Power Meter automatically sets the number of readings averaged together to satisfy the filtering requirements for most power measurements. The number of readings averaged together depends upon the resolution and the power range in which the Power Meter is currently operating. The following table lists the number of readings averaged for each range and resolution when the Power Meter is in auto filter mode.

Table 8-3. Number of Averages vs. Range and Resolution (Auto Filter Mode)

	Res 1	Res 2	Res 3
	Number of Averages	Number of Averages	Number of Averages
Range 1	8	128	128
Range 2	1	8	256
Range 3	1	2	32
Range 4	1	1	16
Range 5	1	1	8

The output of the low pass filters is a dc voltage that is proportional to the power of the input signal. The output of the low pass filters is fed into the A-to-D input multiplexer.

The A-to-D input multiplexer can select any one of the following signals as the input to the analog-to-digital converter:

1. The low pass filter output.
2. The front or rear sensor resistor.
3. The B-GND (0V).
4. The +2.5V reference voltage (only selected during the CAL routine).
6. The RECORDER output (only selected during the CAL routine).
7. The Offset DAC output (only selected during the ZERO and CAL routines).

During the normal measurement cycle, the A-to-D input multiplexer selects the inputs in the following pattern:

1. B-GND.
2. Front sensor resistor.
3. Rear sensor resistor.
4. Low pass filter output.

The B-GND is selected for a reference for power measurement. The front and rear sensor resistors are checked to determine what sensor is attached and if the sensor has been changed since the last measurement. The low pass filter output is then selected to be sent to the A-to-D converter for measurement.

The analog-to-digital converter consists of three parts: a ramp generator, a comparator, and a counter (the analog timer circuit). The ramp generator produces a voltage that ramps from -.78V to +10.0V. Upon receiving the STRAMP signal from the Digital Section, the ramp voltage begins ramping up. The comparator compares the low pass filter output from the A-to-D input multiplexer to the ramp voltage. When the ramp voltage matches the voltage from the low pass filters, the comparator issues the RAMPEND signal. The analog timer measures the time between the STRAMP and RAMPEND signals. The measured time is used by the Digital Section to determine the power level at the input power sensor.

The recorder output circuitry scales the signal from the output of the low pass filters to a voltage between 0V and +1.0v that is proportional to the power input at the power sensor. This voltage is sent to the RECORDER OUTPUT connector on the back panel of the Power Meter. The RECORDER OUTPUT voltage range is from 0V to +1V for each power range. This voltage is not corrected for the calibration factor. The RECORDER OUTPUT voltage is set to 1.00V during calibration.

The 220 Hz multivibrator provides the 220 Hz square wave drive signals to the power sensor and the synchronous phase detector. These signals are 180° out of phase with each other. This ensures that the output of the synchronous phase detector is a full-wave rectified voltage.

The 50 MHz Reference Oscillator provides a 50.0 ±0.5 MHz output at 1.0 mW ±0.7%. This output is used during operation to calibrate the individual power sensors used with the Power Meter. The output is provided at the POWER REF connector on the front panel or the rear panel (Option 003 only).

Power Supply

The Power Supply provides three regulated voltages plus a fourth regulated standby voltage. The three regulated voltages are +15V, -15V, and +5V. These voltages are used throughout the instrument. When the LINE switch is set to STBY, these voltages are switched off.

The standby voltage is a regulated +5V. This voltage is connected to the RAM components in the digital section. The standby voltage remains on constantly, even when the LINE switch is set to STBY. This prevents data loss when the Power Meter is in STBY mode. The standby voltage will switch off when the line (mains) voltage is disconnected from the Power Meter. A backup battery is installed in the Digital Section to prevent data loss when the line (mains) voltage is disconnected.

Troubleshooting

Test Equipment

Digitizing Oscilloscope	HP 54201A
Probe	HP 10081A
Sensor Cable	HP 11730A
Range Calibrator	HP 11683A
Digital Voltmeter (DVM)	HP 3456A
TTL/CMOS Logic Probe	HP 545A

Introduction

Note

This troubleshooting procedure assumes that the Installation Checklist (Paragraph 2-4 in Section 2, Installation) has been performed and that the proper line voltage and fuse have been selected.

The troubleshooting checks in this section are designed to isolate a malfunction to a schematic diagram as quickly as possible. The tests progress from general "over-all" tests to specific tests of certain areas of the Power Meter.

The HP 437B Power Meter consists of 4 major sections; the digital board, the analog board, the keyboard/display section, and the power supply.

The digital board consists of the digital circuitry of the Power Meter and the power supply. The digital board is located underneath the Power Meter's top cover. The analog board is located underneath the Power Meter's bottom cover.

The troubleshooting procedure is separated into three checks as follows:

1. Power Supply Check
2. Digital Board Check
3. Analog Board Check

Some malfunctions of the Power Meter may cause the display to fail. To aid troubleshooting when this situation occurs, the digital board has a set of service LEDs (D0 to D7). These LEDs blink in certain patterns to indicate various states and conditions of the Power Meter. These LEDs will be referred to in several places in this procedure.

Troubleshooting hints

The following items are general troubleshooting techniques that are useful when troubleshooting the Power Meter.

1. Check all ribbon cables, wires, and coaxial cables to ensure a tight connection.
2. Any cables that look worn or frayed should be checked for repeatable continuity. If continuity is not repeatable, the cable should be replaced.
3. A wrench should always be used when tightening or loosening coaxial connectors.
4. Any connectors that are disconnected should be inspected for damage.
5. Test equipment and personnel should be grounded to avoid static-induced failures. Observe all electrostatic discharge (ESD) precautions.

Cover Removal

1. Remove the four rear panel standoffs.
2. Remove the four feet on the bottom cover.
3. Remove the four screws from the bottom cover.
4. Carefully separate the top and bottom covers.

Power Supply Check

1. Connect the negative lead of the DVM to J3 pin 8 (DGND) on the digital board.
2. Measure the voltage at J3 pin 7. The voltage should read +5.0V, ±.25V.
3. Measure the voltage at J3 pin 6. The voltage should read -15.0V, ±.5V. Record the voltage here.

   -15.0V _____

4. Measure the voltage at J3 pin 5. The voltage should read +15.0V, ±.5V. Record the voltage here.

   +15.0V _____

5. Calculate the difference between the absolute values of the -15.0V and +15.0V power supplies. The difference must be no greater than ±2.00% (-300 mV to +300 mV).

   _____ (Absolute value of -15.0V)

   -_____ (Absolute value of +15.0V)

   _____ (-300mV < calculated value < +300mV)

6. If any of the voltages do not meet the specification, go to Service Sheet A3d to troubleshoot the power supply.

7. Disconnect the DVM from the Power Meter.

8. Set the oscilloscope as follows:

   Vertical Sensitivity ..... 10 mV/div
   Sweep ..... 5 ms/div S/div
   Triggering ..... internal
   Coupling ..... AC

9. Connect the ground lead of the oscilloscope to J3 pin 8 (DGND).

10. Connect the oscilloscope probe to J3 pin 7 (+5 REG) and observe the waveform. Ripple on the power supply should be less than ±5 mV.

11. Repeat steps 9 and 10 for J3 pin 6 (-15 REG) and J3 pin 5 (+15 REG).

12. If the amount of ripple on the power supply is not within the specification, go to Service Sheet A3d to troubleshoot the power supply.

Digital Board Check

When the LINE switch is set to ON, the Digital Board runs a series of self tests to check for possible failures. If the Digital and Analog boards pass the self tests, the display will read "SELF TEST OK". If the Digital or Analog boards do not pass one of the self tests, the front panel will display one or more error codes. In case the display is inoperative, the service LEDs will indicate the error code by (a) blinking LED 1 rapidly, and (b) displaying the error code of the failed test on LEDs 2 through 8.

To invoke the self-tests (and set the meter to display all errors):

1. Set the LINE switch to STBY.
2. Set the switches in A3S4 to the following positions:

   S7 = ON
   S6 = OFF
   S5 = OFF
   S4 = ON
   S3 = OFF
   S2 = OFF
   S1 = OFF

3. Set the LINE switch to ON.

4. Observe the Power Meter's display. Note all of the error codes displayed. If the display is inoperative, note the patterns displayed on the service LEDs on the Digital board while LED 1 is blinking.

5. If the Power Meter displays a single error code, locate the error code in Table 8-5. If the Power Meter displays multiple error codes, locate the pattern of error codes displayed in Table 8-6. After locating the error codes, read the troubleshooting suggestions listed.

6. If using the service LEDs, locate the LED pattern in Table 8-4, "Service LED Error Codes". Read across to the "Error Code" column. Then locate the error code and the troubleshooting suggestions in Tables 8-5 or 8-6.

Note These tables contain the most common causes of the displayed error messages. Other malfunctions that are not listed may cause the error codes as well.

Table 8-4. Service LED Error Codes

LED Number							Error Code
2	3	4	5	6	7	8	
		(1 = on)					
0	1	1	1	1	0	1	61
0	1	1	1	1	1	0	62
1	0	0	0	0	0	0	64
1	0	0	0	0	0	1	65
1	0	0	0	0	1	0	66
1	0	0	0	0	1	1	67
1	0	0	0	1	0	0	68
1	0	0	0	1	0	1	69
1	0	0	0	1	1	0	70
1	0	0	0	1	1	1	71
1	0	0	1	0	0	0	72
1	0	0	1	0	0	1	73
1	0	0	1	0	1	0	74
1	0	0	1	0	1	1	75

Table 8-5. Single Error Codes and Troubleshooting Suggestions

Error Code	Troubleshooting Suggestions
61 only	Stack RAM failure (A3U9). Check for TTL signals at A3U9 pins 20, 22, 27. If TTL signals are present, replace A3U9. If a TTL signal is not present at A3U9 pin 20, connect a logic probe to A3U12 pin 10. Set the Power Meter's LINE switch to STBY, then ON. A high-low-high transition should be detected at A3U12 pin 10. If not, replace A3U12.
62 only	ROM checksum failure (A3U8). Replace A3U8.
64 only	RAM failure (A3U9). Replace A3U9.
65 only	Analog I/O PIA Failure (A3U24). Replace A3U24.
66 only	Keyboard and Display PIA Failure (A3U25). Verify TTL signals at A3U22 pins 21 and 22. If signals are present, replace A3U25.
67 only	Analog-to-Digital converter failure. Verify TTL signals at the following locations on Service Sheet A3b: A3U12 pin 11, 13. A3U14 pins 7, 10, 11. A3U18 pins 13, 26. A3U24 pins 5 - 8, 40. If the TTL signals are present, troubleshoot circuit block Q on Service Sheet A4c and circuit blocks L, M, and N on Service Sheet A4b.
68 only	HP-IB failure (A3U4). Verify a TTL signal at A3U12 pin 12. If present, replace A3U4.
69 only	Timer failure (A3U18). Verify TTL signals at A3U16 pin 3, A3U22 pins 16 , and A3U18 pin 3. If present, replace A3U18 or A3U21. Verify TTL signals at A3U18 pin 3, then check for a TTL low at A3U21B pin 9. If A3U21B pin 9 is not low, replace A3U21. If a TTL signal is present at A3U18 pin 3 and A3U21B pin 9 is at TTL low, check for TTL signals at A3U22 pin 16. If TTL signals are not present at A3U22 pin 16, replace A3U22.

Table 8-5. Single Error Codes and Troubleshooting Suggestions (Cont.)

Error Code	Troubleshooting Suggestions
70 only	Keyboard/Display controller failure (A3U25 or A3U26). Verify TTL signals at A3U25 pins 19 and 39. If not present, replace A3U25. If present, verify a TTL signal at A3U26 pin 15. If not present, replace A3U26.
71 only	Keyboard data failure (A3U25 or A3U26). Check for a pulse at A3U26 pin 8 when pressing a key. If a pulse is not present, press all keys consecutively while checking for a pulse. If none of the keys pressed creates a pulse at A3U26 pin 8, replace A3U26. If error 71 persists, replace A3U25.
72 only	Data line to A3U26 is open. Check data bus from A3U25 to A3U26 (KD0-KD7) or replace the Digital board.
73 only	Keyboard/Display controller self-test failure (A3U26). Replace A3U26.
74 only	Display not responding. Ensure display cable (at A3J8) is connected. Verify TTL signals at A3U26 pins 13, 14. If the display cable is connected and TTL signals are present, replace the display.
75 only	Digital failure at A3J6. Disconnect ribbon cable W6 at A3J6. Set LINE switch to STBY, then ON. If error code 75 persists, replace A3U24 (and A3U28 if necessary). If the error code is not repeated, the problem is on the Analog board. One of the Analog board components connected to the following data lines is preventing normal operation. AD0 - AD7 AA0 - AA2 NADS STRAMP Turn to Service Sheets A4a, b, or c to troubleshoot the Analog board.

Note

The following table lists troubleshooting suggestions for patterns of multiple displayed error codes. To find the right troubleshooting suggestion, locate the error code pattern that is in the exact sequence displayed on the Power Meter's front panel.

Some combinations of error codes may occur which are not in this table. To help identify the cause of the problem, locate common data and control lines among the components indicated by the error codes.

Table 8-6. Multiple Error Codes and Troubleshooting Suggestions

Error Code	Troubleshooting Suggestions
65, 67	Verify TTL signals at A3U24 pins 21, 23, and 36. If TTL signals are present, replace A3U24.
65, 75, 67	Verify TTL signals at A3U24 pin 35. If TTL signals are present, replace A3U24.
65, 71, 68, 75, 67	Verify TTL signals at A3U12 pin 11. If TTL signals are present, replace A3U12.
65, 70, 68, 69, 75, 67	Verify TTL signals at A3U20 pin 5. If TTL signals are present, replace A3U20.
66, 70	Verify TTL signals at A3U25 pin 23. If TTL signals are present, replace A3U25.
66, 68, 69, 75, 67	Verify TTL signals at A3U20 pin 7. If TTL signals are present, replace A3U20.
66, 65, 70, 68, 75, 67	Verify TTL signals at A3U20 pin 3 and A3U12 pin 15. If TTL signals are present, replace A3U12.
66, 65, 70, 75, 67	Verify TTL signals at A3U20 pin 5. If TTL signals are present, replace A3U20.

Table 8-6. Multiple Error Codes and Troubleshooting Suggestions (Cont.)

Error Code	Troubleshooting Suggestions
66, 65, 70, 68, 69	Verify TTL signals at A3U12 pin 13. If TTL signals are present, replace A3U12. See the note following in this table.
66, 65, 70, 69, 67	Verify TTL signals at A3U20 pin 7. If TTL signals are present, replace A3U20. See the note following in this table.
66, 65, 70, 68, 69, 75, 67	Verify TTL signals at A3U6 pin 2. If TTL signals are present, replace A3U6. See the note following in this table. Note - A malfunction in any of the following components will cause the previous three error code combinations: A3U4, A3U6, A3U18, A3U24, A3U25, and A3U27.
67, 65, 73, 69, 75	Verify TTL signals at A3U6 pin 4. If TTL signals are present, replace A3U6.
68, 69, 67	Verify TTL signals at A3U20 pin 9. If TTL signals are present, replace A3U20.
69, 67	Verify TTL signals at A3U18 pin 15. If TTL signals are not present, replace A3U12. If TTL signals are present, replace A3U18.
70, 67	Verify TTL signals at A3U12 pin 12. If TTL signals are not present, replace A3U12. If TTL signals are present, replace A3U4.
70, 68	Verify TTL signals at A3U19 pin 4. If TTL signals are not present, replace A3U19. If TTL signals are present, replace A3U4 and A3U26.
75, 67	Verify TTL signals at A3U24 pin 39. If TTL signals are present replace A3U24.

Battery Replacement Procedure

Note

Battery replacement is necessary when the Power Meter repeatedly displays "RECALL FAIL" when turned on.

1. Set the LINE switch to STBY.
2. Leave the line (Mains) power cord connected.
3. Remove A3BT1 from the Digital Board.
4. Replace A3BT1 with the recommended battery, HP part number 1420-0341.

Analog Board Check

This section contains procedures for troubleshooting the Analog board. Most of the procedures will narrow the cause of a malfunction to a schematic. Some of the procedures will isolate the problem to a circuit or component.

Note

The following procedures must be performed in the sequence presented.

Analog Board Functional Verification

1. Connect the equipment as shown in Figure 8-1.

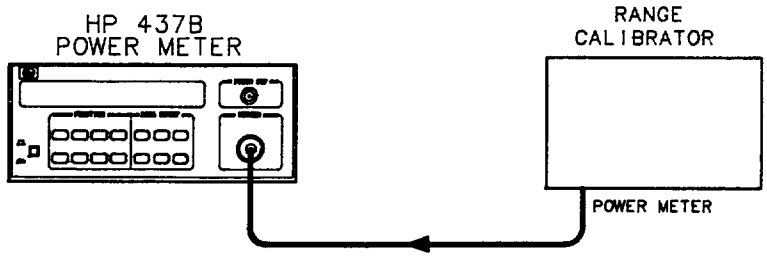


Figure 8-1. Analog Board Troubleshooting Setup

2. Set the range calibrator as follows:

   FUNCTION .....STANDBY
   RANGE ..... 1 mW

3. Press the PRESET/LOCAL key, then the ENTER key.

4. Press the ZERO key on the Power Meter. The Power Meter should perform the zeroing function. If the Power Meter will not zero, proceed to the Analog Board Troubleshooting Procedure.

5. Set the FUNCTION switch on the range calibrator to CALIBRATE.

6. Press the Power Meter's dBm/W key for a reading in watts.

7. Press the CAL key on the Power Meter.

8. Press ▲ or ▼ until the display reads "REF CF 100.0%".

9. Press the Power Meter's ENTER key. The Power Meter should perform the calibration function. Verify that the Power Meter display reads 1.00 ±0.001 mW.

10. If the Power Meter will not calibrate, proceed to the Analog Board Troubleshooting Procedure.

11. Set the range calibrator's RANGE switch to the positions shown in the following table. For each setting, verify that the Power Meter's reading is within the limits shown.

Note

If the readings are not within limits when the range calibrator is set to 10 mW or 100 mW, ranges 4 and 5 may need adjustment. Perform Adjustment 5-4, Ranges 4 and 5 Shaper Adjustment, in Section 5 of this service manual and then retest the Power Meter at 10 mW and 100 mW.

Range Calibrator Setting	Min	Actual Results	Max
10 µW	9.90 µW	_____	10.10 µW
100 µW	99.5 µW	_____	100.5 µW
1 mW	0.995 mW	_____	1.005 mW
10 mW	9.95 mW	_____	10.05 mW
100 mW	99.5 mW	_____	100.5 mW

If the Power Meter does not meet these limits, a problem may exist with A4U5, A4U7, or A4R16, 17, 24, 25, or 26. Replace these components. If

replacing the components doesn't solve the problem, replace the Analog board.

12. Set the range calibrator's RANGE switch to 1 mW.

13. Press the Power Meter's CAL key. Enter a REF CF of 100.0%.

14. Connect the DVM to the RECORDER OUTPUT connector on the rear panel.

15. Verify that the DVM reading is 1.000V ±0.003 Vdc.

16. If the voltage is correct, go to Step 18. If the voltage is incorrect, continue with the next step.

17. Using the logic probe, verify the presence of TTL signals at A4U18 pins 12 and 13 (on Service Sheet A4c). If the signals are present, turn to Service Sheet A4c to troubleshoot the Recorder Output circuit block.

18. Press the Power Meter's PWR REF (SHIFTed ◁) key.

19. Set the oscilloscope as follows:

Vertical Sensitivity	100 mV/div
Sweep	5 ns/div
Triggering	Internal
Coupling	DC, 50Ω

20. Connect the oscilloscope to the POWER REF output connector on the Power Meter's front panel.

21. Verify the 50 MHz signal as shown in Figure 8-2.

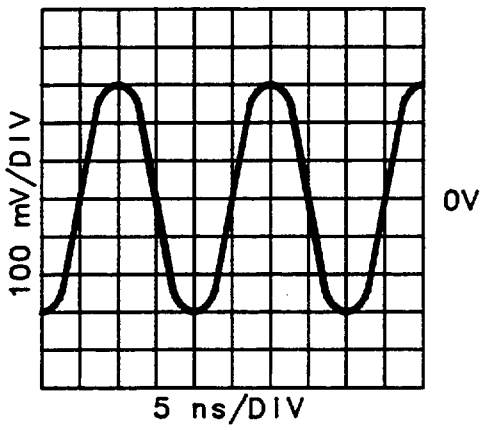


Figure 8-2. 50 MHz POWER REF Waveform

22. If the 50 MHz signal can be verified, the Power Meter is fully operational. No further troubleshooting is necessary. If the 50 MHz signal cannot be verified, proceed to Step 23.

23. Using the logic probe or oscilloscope, check for a logical high (>+2.5V) at A4U16, pin 19 (on Service Sheet A4c).

24. If the signal at A4U16 pin 19 is a logical high, turn to Service Sheet A4c and troubleshoot either the 50 MHz Reference Oscillator or the Power Reference Switch.

25. If the signal at A4U16 pin 19 is not a logical high, turn to Service Sheet A4c and troubleshoot the Microprocessor Control circuit or the ribbon cable assembly W6.

Analog Board Troubleshooting

Microprocessor Control Circuit Verification.

1. Press the Power Meter's PRESET/LOCAL key.

2. Connect the range calibrator to the Power Meter's SENSOR connector.

Note For steps 3 through 12, refer to Figure 8-3.

3. Using a logic probe, verify the presence of TTL signals at A4U16 pins 3, 4, 7, 8, 12-18 and A4U18 pins 7, 9-13.

4. Set the Power Meter's POWER REF to off.

5. Verify a logical low level (<.80V) at U16, pin 19 (CALOSC).

6. Press the Power Meter's SET RANGE key. Select range 3.

7. Verify a logical high level at A4U16 pin 6 (NATTEN).

8. Press the Power Meter's SET RANGE key. Select range 4.

9. Verify a logical low level at A4U16 pin 6.

10. Verify a logical high level at A4U16 pin 2 (NSLOW) and a logical low level at A4U16 pin 5 (NFAST).

11. Press the SET RANGE key. Select range 1.

12. Verify a logical low level at A4U16 pin 2 (NSLOW) and a logical high level at A4U16 pin 5 (NFAST).

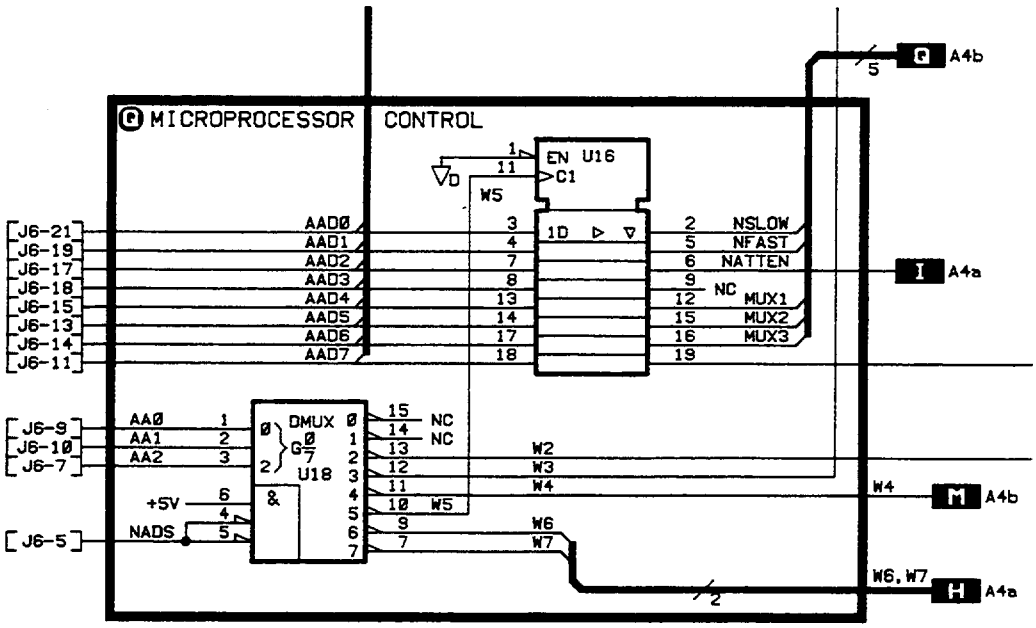


Figure 8-3. A4U16, U18 Pinout Diagram

The digital control signals for the Analog board have now been verified. Continue with the troubleshooting procedure for Service Sheet A4a.

Service Sheet A4a troubleshooting

1. Press the Power Meter's SET RANGE key. Select range 3.
2. Press the dBm/W key for a reading in watts.
3. Set the range calibrator as follows:

   FUNCTION ..... CALIBRATE
   RANGE ..... 1 mW

4. Verify that the level at A4TP10 (C-GND) is equal to A4TP9 (A-GND) ±5.00 mV.
5. Set the oscilloscope as follows:

   Vertical Sensitivity 5V/div
   Sweep ..... 1 ms/div
   Coupling ..... DC
   Triggering ..... Internal

6. Connect the oscilloscope to A4TP3 (220 Hz). Verify the signal shown in Figure 8-4.

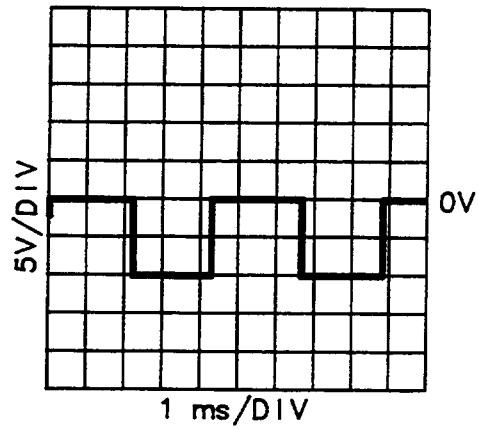


Figure 8-4. A4TP3, 220 Hz Multivibrator Waveform

7. Set the oscilloscope as follows:

Vertical Sensitivity ..... 50 mV/div
Sweep ..... 1 ms/div
Triggering ..... External
Coupling ..... AC

Connect the oscilloscope's external trigger input to A4TP3 (220 Hz).

8. Connect the oscilloscope to A4U7 pin 3. Verify the signal shown in Figure 8-5. The signal level should be 0.12 Vp-p ±0.01V.

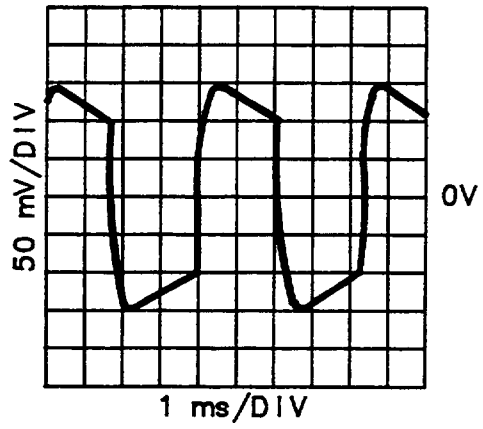


Figure 8-5. A4U7 pin 3 Range Attenuator 1 Waveform

9. Change the oscilloscope's vertical sensitivity setting to 1V/div.

10. Connect the oscilloscope to A4TP17. Verify the signal shown in Figure 8-6. The signal level should be between 2.00 and 11.00 Vp-p.

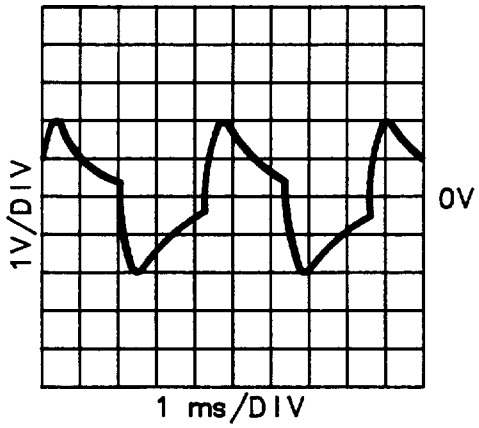


Figure 8-6. A4TP17 Variable Gain Amplifier Waveform

11. Connect the oscilloscope to A4TP4. Verify the signal shown in Figure 8-7. The signal level should be 1.8 times the voltage at A4TP17 p-p, ±0.8V.

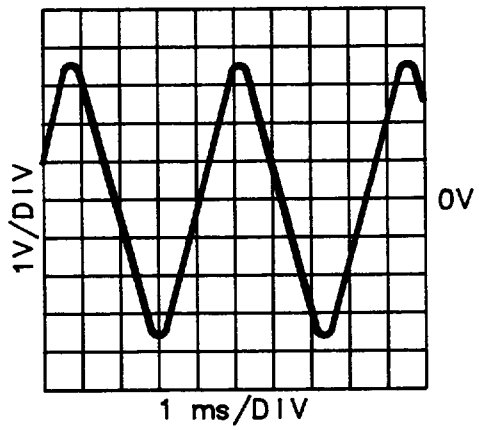


Figure 8-7. A4TP4 Bandpass Amplifier Waveform

12. Connect the oscilloscope to A4TP5. Verify the signal shown in Figure 8-8. The signal level should be .9 times the voltage at A4TP17 p-p, ±0.4V. Retain the peak voltage reading for steps 13 and 15.

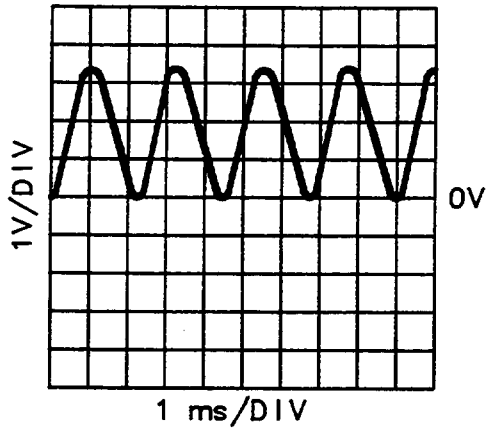


Figure 8-8. A4TP5 Phase Detector Waveform

Service Sheet A4b Troubleshooting

13. Select a digital filter setting of 1 for the Power Meter. This selects the fast low-pass filter.

14. Connect the oscilloscope to A4TP7.

15. Verify that the dc voltage at A4TP7 is approximately equal to the peak voltage at A4TP5 (see Step 9).

16. Select a digital filter setting of 512 for the Power Meter. This selects the slow low-pass filter.

17. Verify that the dc voltage at A4TP7 is approximately equal to the peak voltage at A4TP5 (see Step 10).

18. Verify that the dc voltage from the AUTO-ZERO DAC at the junction of R57 and C26 (see Figure 8-9) is between ±15 mV.

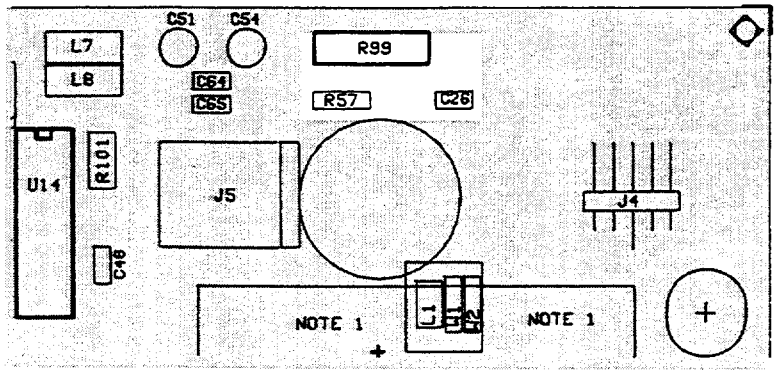


Figure 8-9. R57-C26 Junction Location

19. Set the oscilloscope as follows:

Vertical Sensitivity 1V/div
Sweep ..... 10 ms/div
Coupling ..... DC
Triggering ..... External, ÷1

Connect the oscilloscope's external trigger input to A4U13 pin 16.

20. Connect the oscilloscope to A4TP18. Verify the signal shown in Figure 8-10.

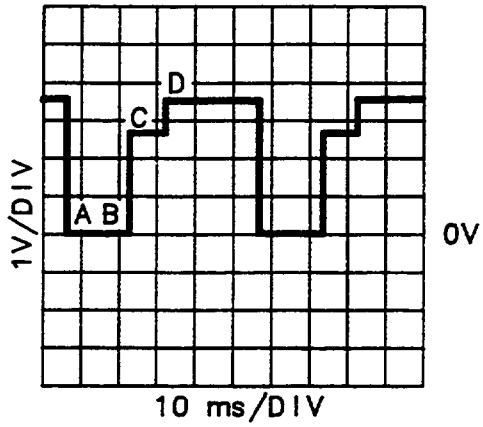


Figure 8-10. A4TP18 ADC Input Waveform

21. Connect the oscilloscope to A4TP13. Verify the signal shown in Figure 8-11.

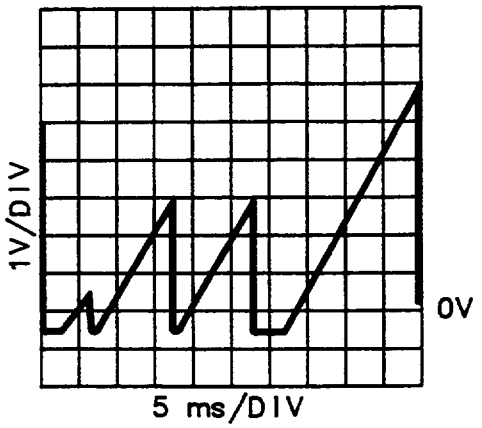


Figure 8-11. A4TP13 ADC Ramp Waveform

22. Connect the oscilloscope to A4TP14. Verify the signal shown in Figure 8-12.

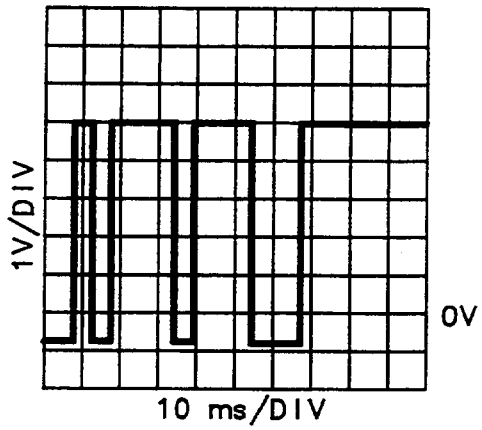


Figure 8-12. A4TP14 Ramp End Waveform

Service Sheet A4c Troubleshooting

23. Set the oscilloscope's vertical sensitivity to 5.0V/div.

24. Repeat Steps 12 through 16 of the Analog Board Functional Verification procedure (checking the RECORDER OUTPUT signal).

25. Repeat Steps 18 through 22 of the Analog Board Functional Verification procedure (checking the POWER REF signal).

Power Sensor Detection Circuitry Troubleshooting

Note

The following steps need to be performed only if the Power Meter indicates sensor problems. For example:

a. The Power Meter displays "NO SENSOR" when a sensor is attached.

b. The Power Meter does not display "NO SENSOR" when a sensor is not attached.

c. The Power Meter displays "2 SENSOR ERR" when only one sensor or no sensor is attached (Option 002 or 003 only).

d. The Power Meter is operating in the wrong power range for the attached sensor.

1. Connect the oscilloscope to A4TP18.

2. Refer to Figure 8-10, A4TP18. Examine the displayed waveform at point B (if the power sensor is connected to the front input port) or at point C (if the power sensor is connected to the rear input port).

The labels on Figure 8-10 indicate measurements by the ADC input multiplexer as follows:

A: Measures the ground connection at B-GND.

B: Measures the voltage level at the front sensor.

C: Measures the voltage level at the rear sensor.

D: Measures the output of the low-pass filters.

3. Using the table below, verify the proper voltage at A4TP18 points B or C for the power sensor you are using.

Table 8-7. Sensor Power Ranges, Resistor Values, and Voltages

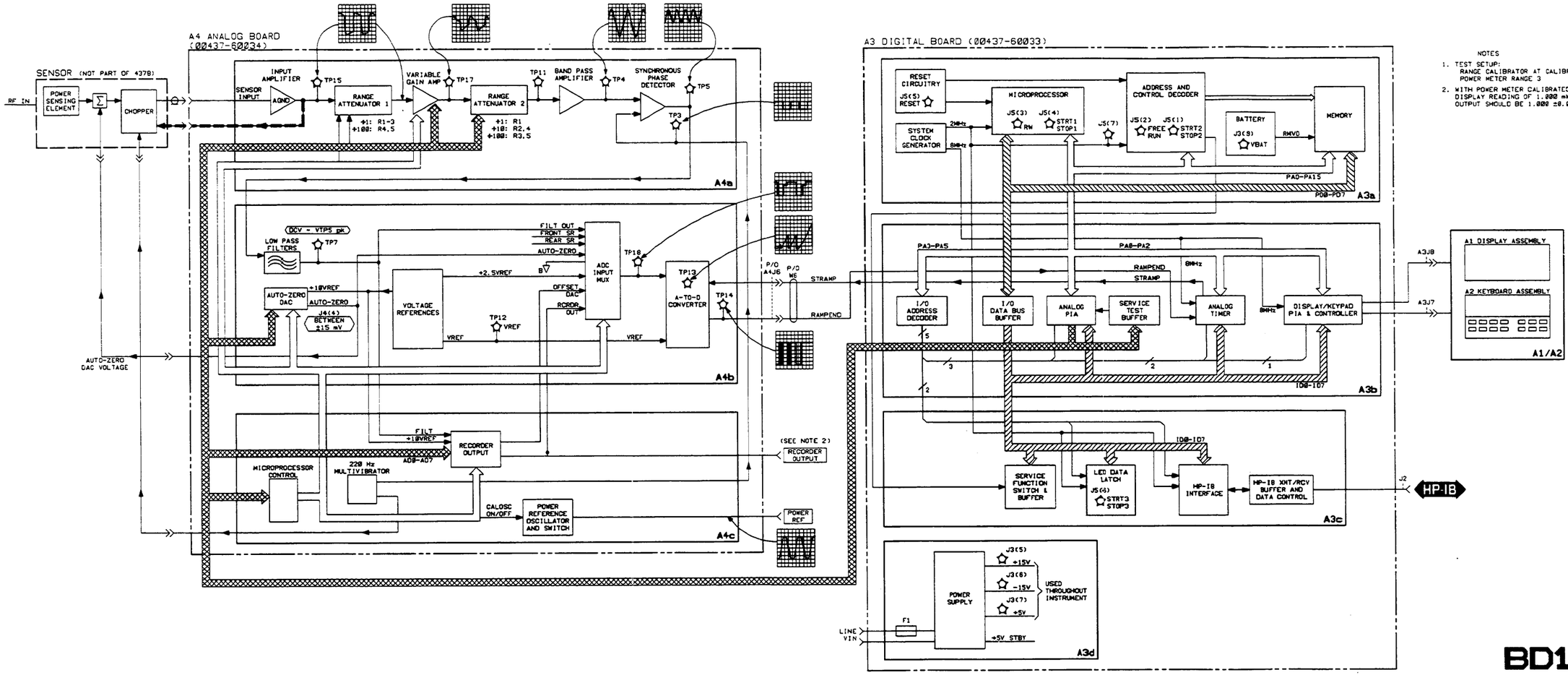
Power Sensor	Power Range	Power Sensor Resistor Value	A4TP18 Voltage
8484A	-70 to -20 dBm (100 pW to 10 μW)	10.0 kΩ	1.00V
8481A, 8482A, 8483A, 8485A, R8486A, Q8486A, Range Calibrator	-30 to +20 dBm 1 μW to 100 mW	0Ω (Gnd)	0.00V
8481H, 8482H	-10 to +35 dBm 100 μW to 3 W	3.46 kΩ	0.47V
8481B, 8482B	0 to +44 dBm 1 mW to 25 W	6.19 kΩ	.073V

Completion of Testing

Upon completion of testing, place all switches in their original positions (see below), remove all test gear, and restore the Power Meter to the normal operating condition. If repairs have been made or adjustments changed, refer to the references listed in the front of this section. Then refer to the applicable sections for post-testing procedures.

The normal operating positions of the switches in A3S4 are:

S1 = 1
S2 = 1
S3 = 0
S4 = 1
S5 = 1
S6 = 1
S7 = 0



BD1

Figure 8-13. Overall Block Diagram

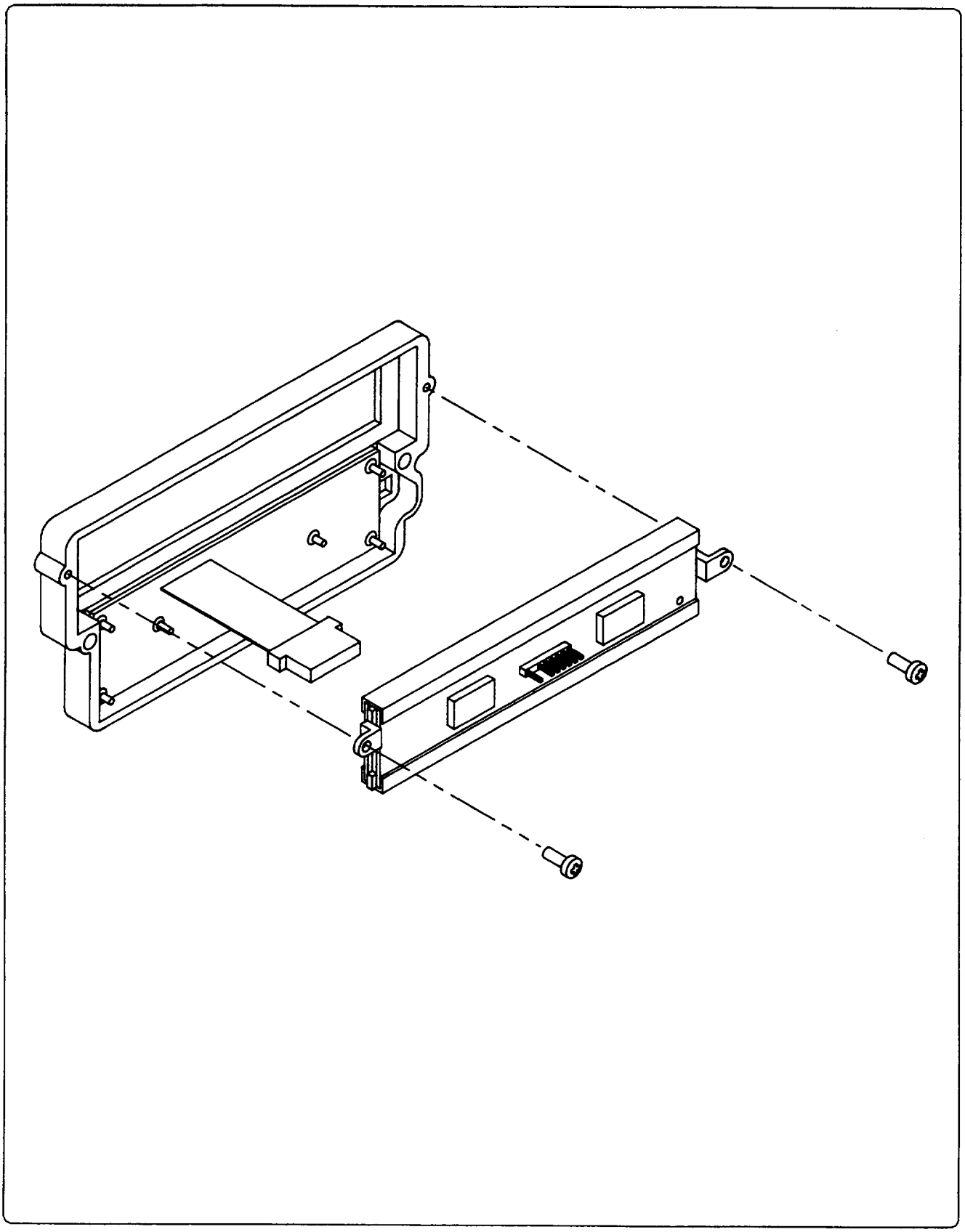
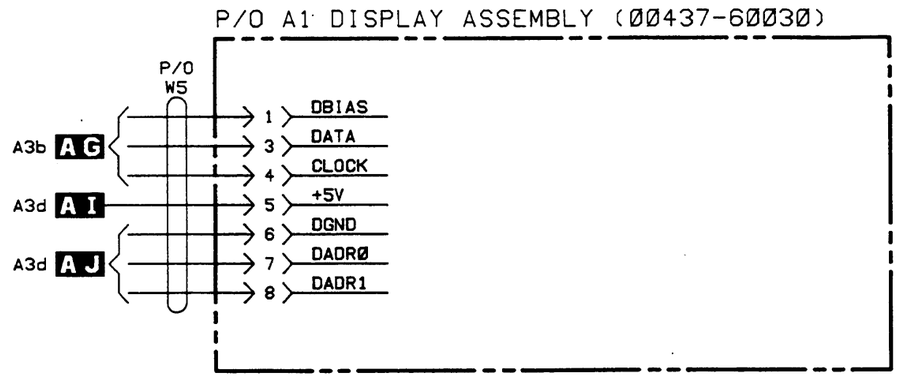


Figure 8-14. Display (A1) and Keyboard (A2) Mechanical Assembly



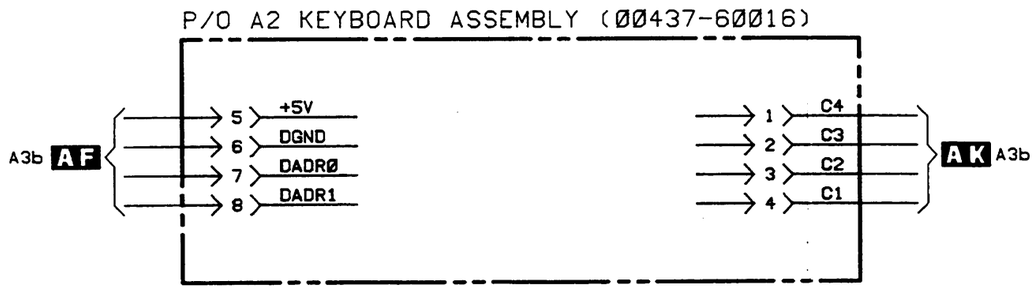


Figure 8-15. A1/A2 Interconnects to Digital Board A3

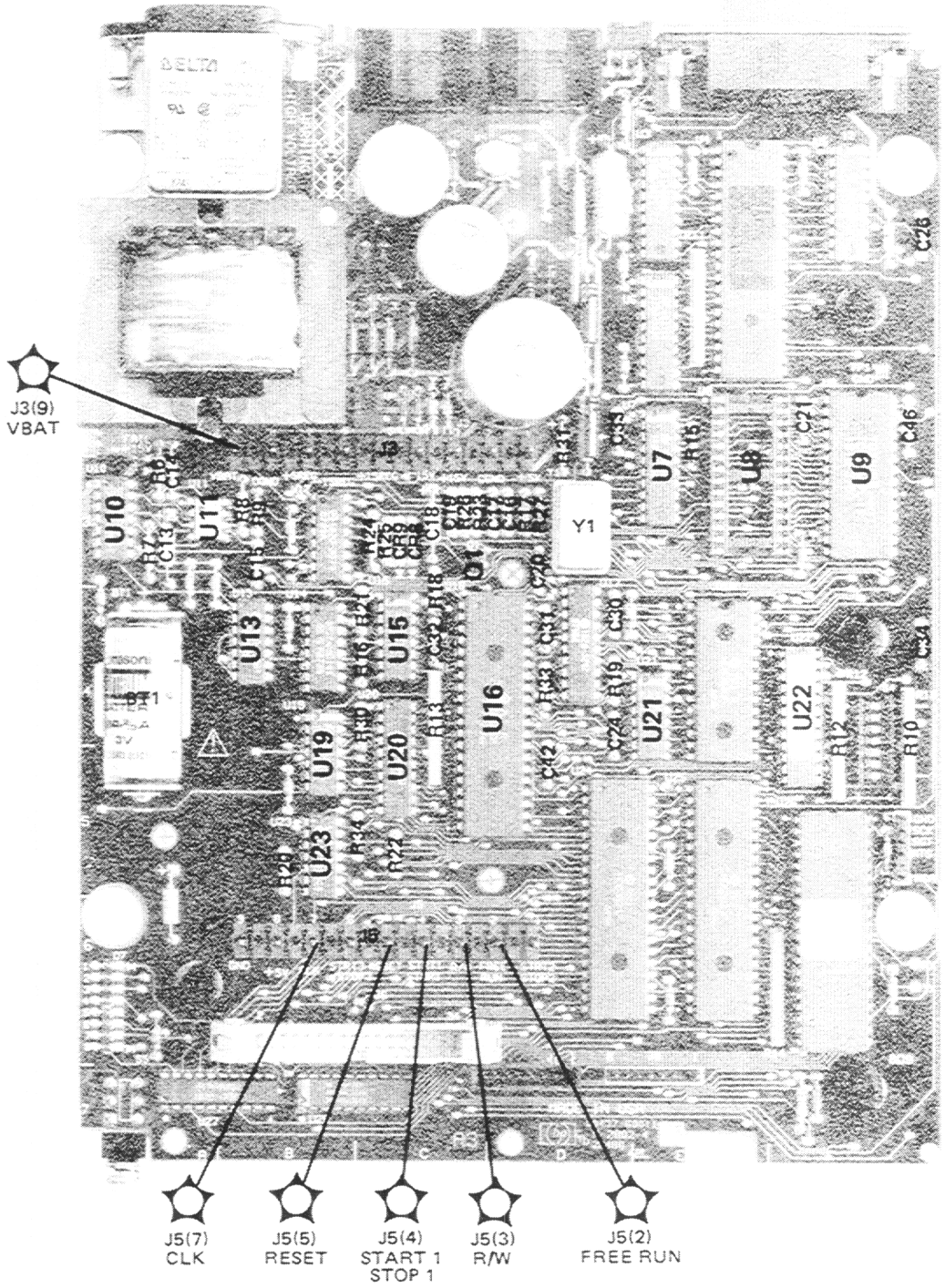
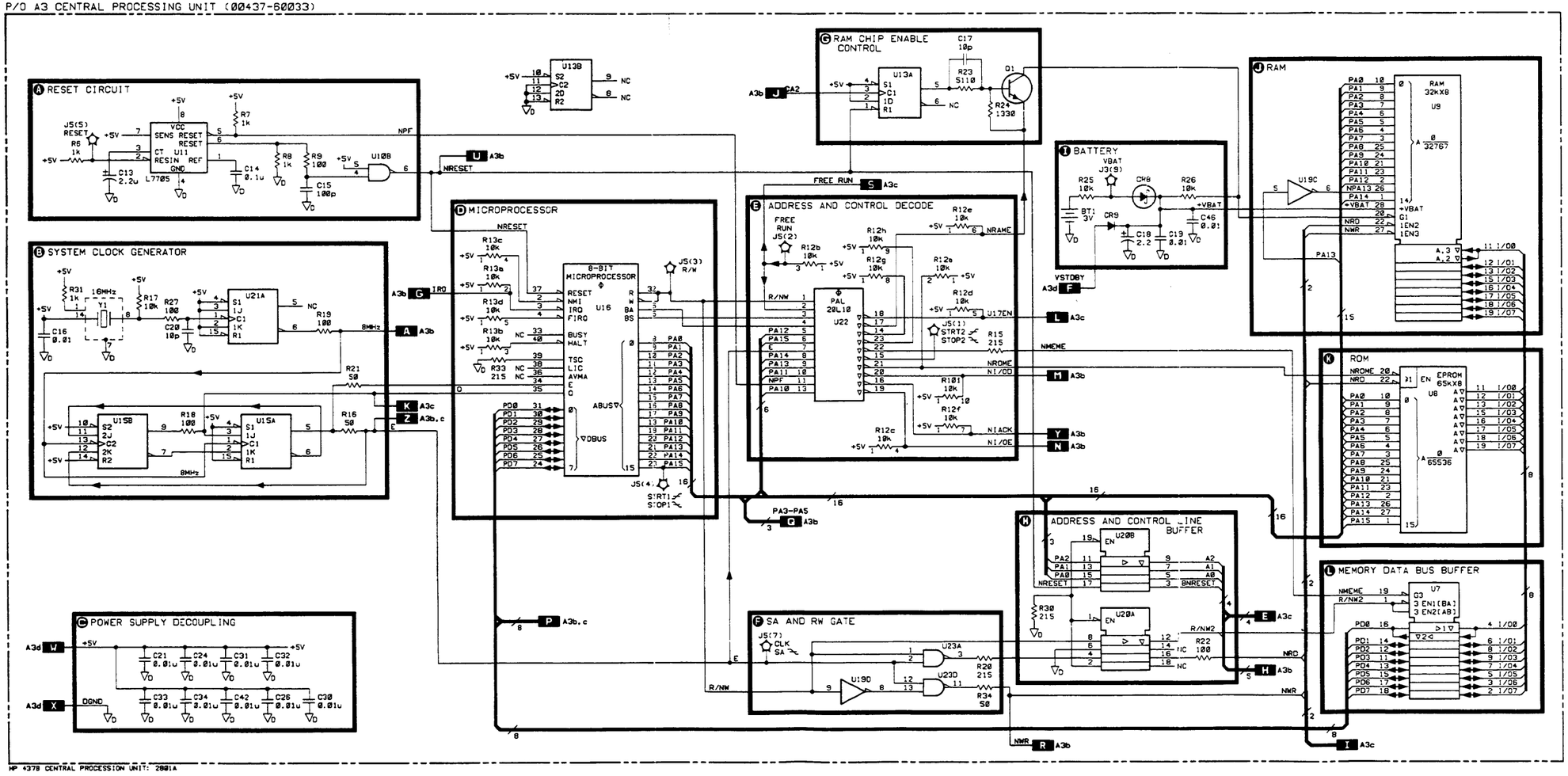


Figure 8-16. A3a Component Locations

P/O A3 CENTRAL PROCESSING UNIT (00437-60033)



NOTES

1. SEE TABLE 8-2 FOR SCHEMATIC DIAGRAM NOTES.
1. ALL RESISTOR VALUES ARE IN OHMS. ALL CAPACITOR VALUES ARE IN FARADS, AND ALL INDUCTOR VALUES ARE IN HENRIES.

REFERENCE DESIGNATIONS

A3
BT1 C13-21, 24, 26, 30-34, 42, 46 CR8, 9 J3, 5 Q1 R6-10, 12, 13, 16-27, 30, 31, 33, 34 U7-11, 13, 15, 16, 19-23 Y1

TRANSISTOR AND INTEGRATED CIRCUIT PART NUMBERS

REFERENCE DESIGNATIONS	PART NUMBER
Q1	1854-0832
U7	1820-3330
U8	00437-80002
U9	1818-3760
U10, 23	1820-2922
U11	1820-1338
U13	1820-3081
U15, 21	1820-3173
U16	1820-5049
U19	1820-2921
U20	1820-3297
U22	1820-1107

LOGIC LEVELS

	TTL	CMOS
HIGH	>2V	>3.5V
LOW	<0.8V	<1.5V
< IS MORE NEG. THAN / > IS MORE POS. THAN		
OPEN	HIGH	UNDEF.
GROUND	LOW	LOW

INTEGRATED CIRCUIT VOLTAGE, GROUND AND BYPASS CAPACITOR CONNECTIONS

REFERENCE DESIGNATION	BYPASS CAP	PIN NUMBER
U7 U20	C33	+5V - 20 ∇_D - 10
U8	C21	+5V - 28 ∇_D - 14
U9	C19	+VBAT-28 ∇_D - 14
U10 U13 U23	C45	+5V - 14 ∇_D - 7
U15 U21	C32 C24	+5V - 16 ∇_D - 8
U16	C31, C42	+5V - 7 ∇_D - 1
U22	C34	+5V - 24 ∇_D - 12

A3a

Figure 8-17. A3a Schematic Diagram

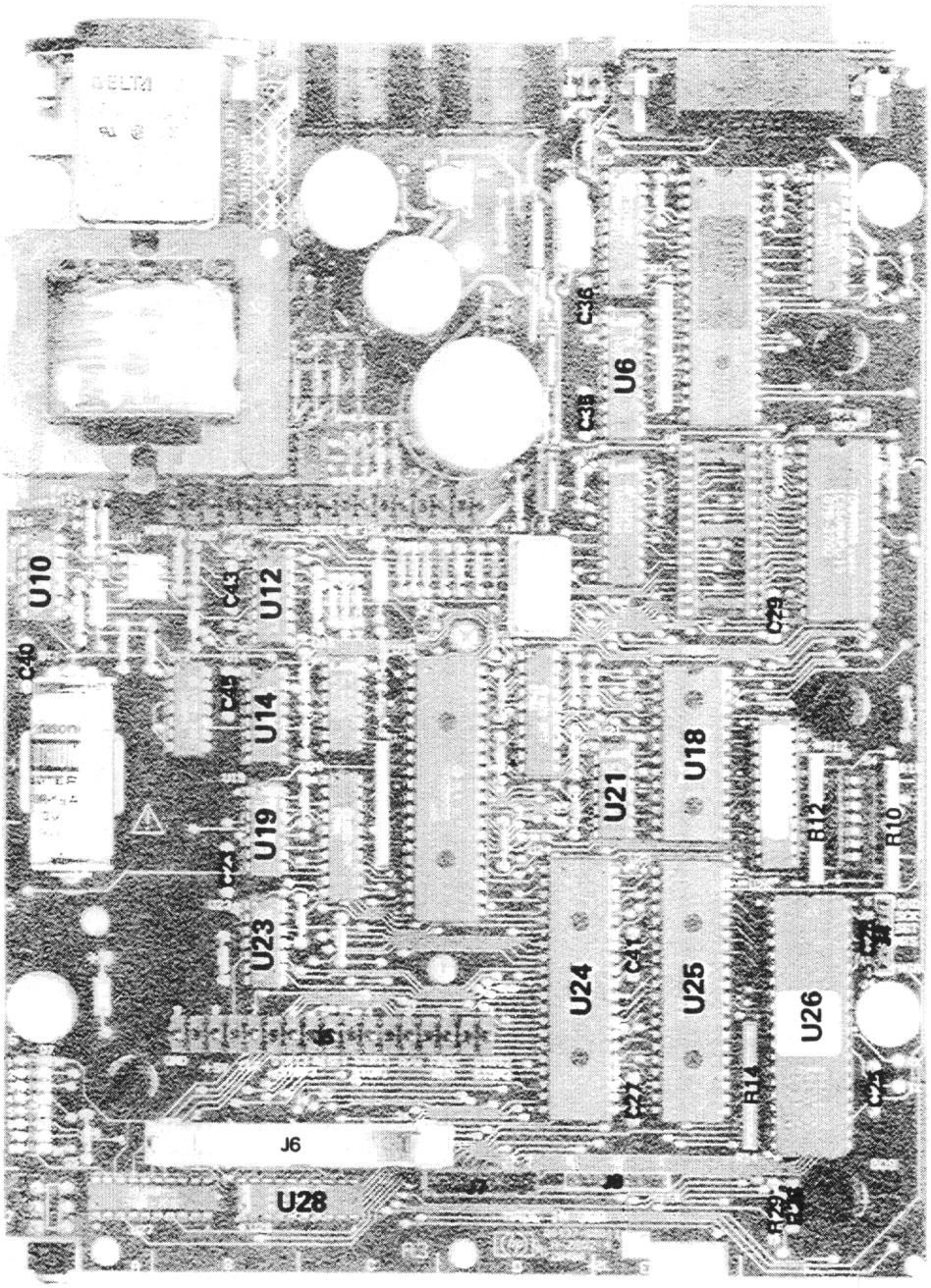
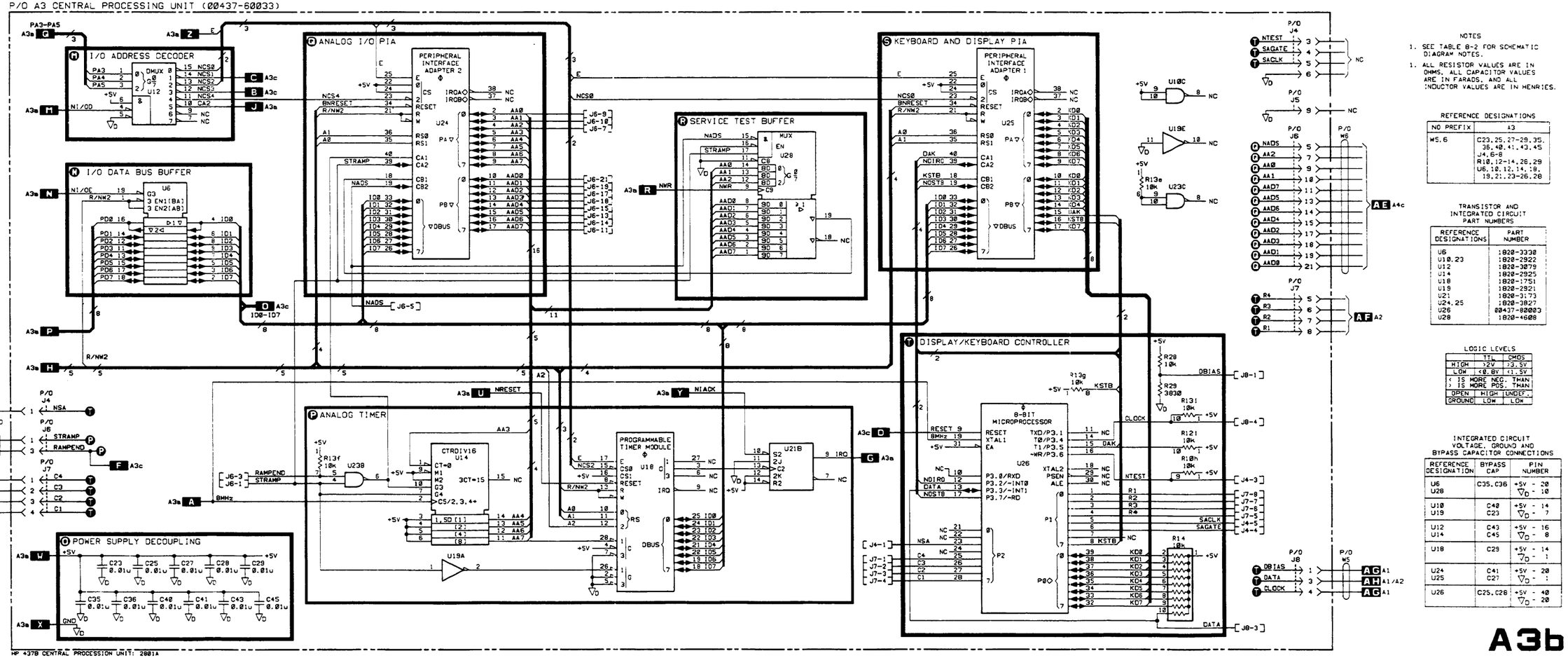


Figure 8-18. A3b Component Locations

P/O A3 CENTRAL PROCESSING UNIT (00437-60033)



A3b

Figure 8-19. A3b Schematic Diagram

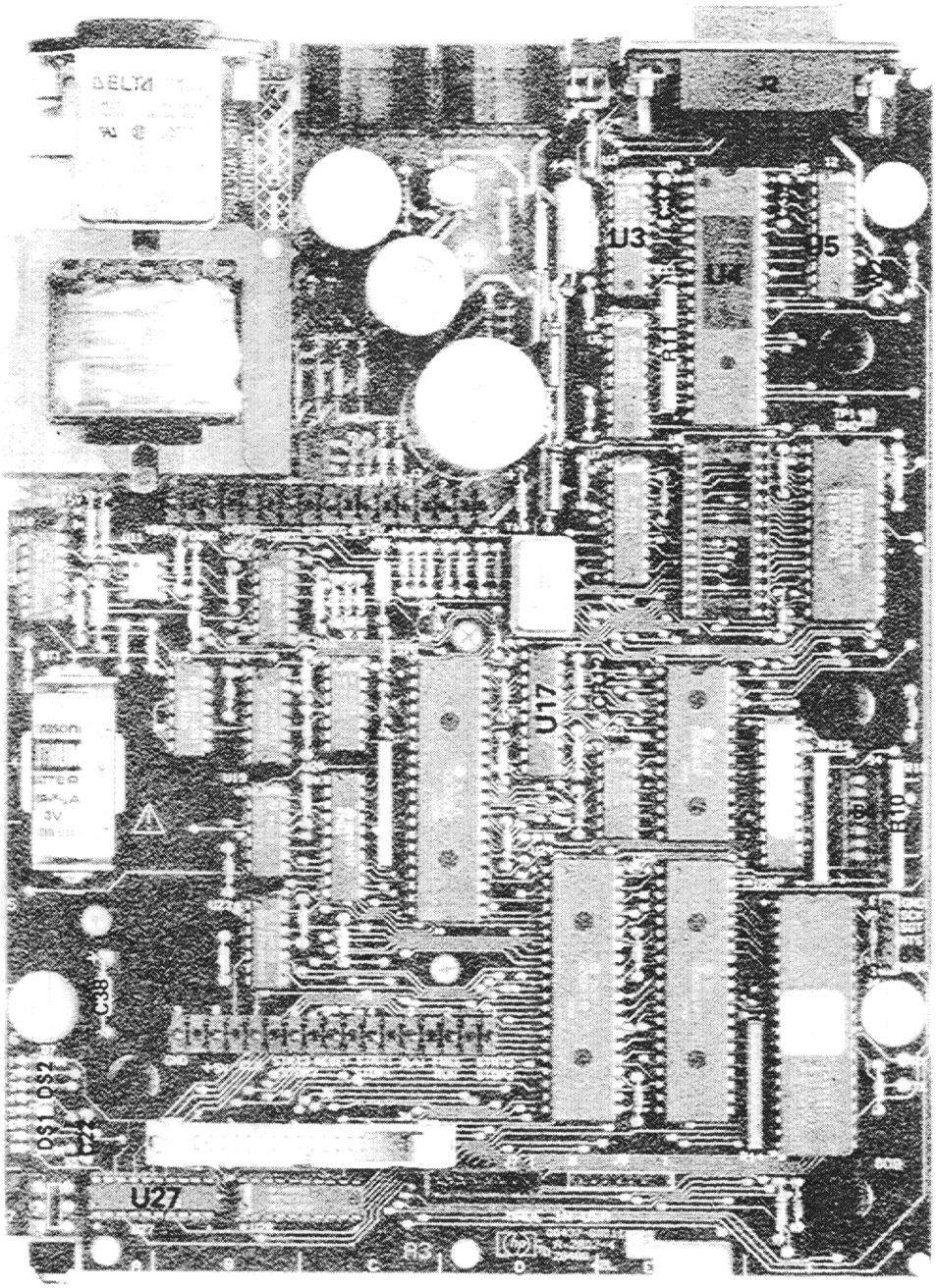
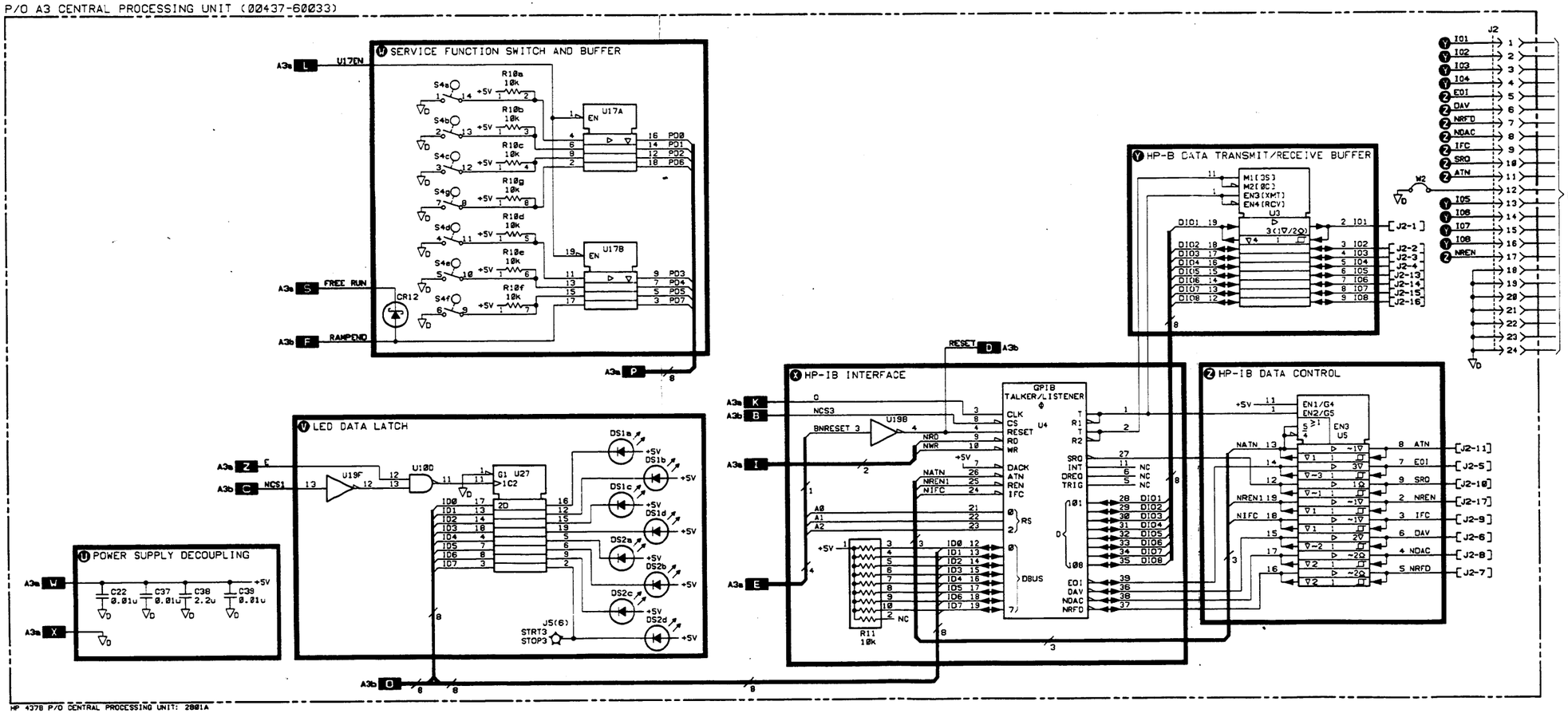


Figure 8-20. A3c Component Locations



NOTES

1. SEE TABLE 8-2 FOR SCHEMATIC DIAGRAM NOTES.
1. ALL RESISTOR VALUES ARE IN OHMS, ALL CAPACITOR VALUES ARE IN FARADS, AND ALL INDUCTOR VALUES ARE IN HENRIES.

REFERENCE DESIGNATIONS

A3
C22,37-39
CR12
DS1,2
J2
R10,11
S4
U3-5,10,17,19,27
W2

TRANSISTOR AND INTEGRATED CIRCUIT PART NUMBERS

REFERENCE DESIGNATIONS	PART NUMBER
U3	1820-3431
U4	1820-2549
U5	1820-3513
U10	1820-2922
U17	1820-3297
U19	1820-2921
U27	1820-3082

LOGIC LEVELS

	TTL	CMOS
HIGH	>2V	>3.5V
LOW	<0.8V	<1.5V
< IS MORE NEG. THAN		
> IS MORE POS. THAN		
OPEN	HIGH	UNDEF.
GROUND	LOW	LOW

INTEGRATED CIRCUIT VOLTAGE, GROUND AND BYPASS CAPACITOR CONNECTIONS

REFERENCE DESIGNATION	BYPASS CAP	PIN NUMBER
U3 U5 U17 U27	C37 C26 C38 C22	+5V - 20 ∇_D - 10
U4	C39	+5V - 40 ∇_D - 20

A3c

Figure 8-21. A3c Schematic Diagram

Service Sheet A3d Power Supply

Operation

The power supply contained in the 437B Power Meter provides regulated ±15V to the analog board assembly (A4) and regulated +5V to both the digital board assembly (A3) and analog board assembly A4. The supply is physically located on the A3 board and service access is gained by removing the instrument top cover. Figure 8-21 (Service Sheet A3d) shows the power supply component locations.

Primary AC power is applied via a three-wire power cable (supplied) to J1 on the instrument rear panel. Mains voltage is then routed through the voltage select switches to the primary side of of transformer T1 (See schematic diagram, Figure 8-22).

±15V Supply

The ±15V supply is coupled via a center tapped secondary winding of T1. The secondary AC voltage is applied to the full wave bridge rectifier CR1. The rectified output from the bridge is applied in turn to filter capacitors C3 and C4, over voltage protection devices CR10 and CR11 and dual voltage regulator U2. The regulated +15V of U2 is applied to capacitor C5 and is routed to the A4 board via cable connector J6 and ribbon cable W6. The regulated -15V output of U2 is applied to capacitor C6 and is also routed to the A4 board via connector J6.

Zener diodes CR10 and CR11 provide over voltage protection for the dual regulator U2 in the ±15V supply. If the unregulated voltage exceeds 30.10V these diodes will conduct holding the voltage constant and thus protecting the regulator until the crowbar circuit CR7 (shown on the +5V supply schematic) can blow the line fuse.

Also shown on the schematic is DS3, the +15V Fail LED circuit. This LED will be normally off and will turn on if the +15V supply drops below ≈12V.

+5V Supply

The +5V supply is coupled via another secondary winding of T1. The secondary AC voltage is applied to the bridge rectifier consisting of CR2, CR3, CR4, and CR5. Rectified output from the bridge is applied to filter capacitor C7, crowbar circuit CR7, and voltage regulator U1. The regulated

+5V output is applied to capacitor C12 and is routed directly to decoupling circuits on the A3 assembly, and via J6-2 (cable W6) to the A4 analog assembly. Jumper W1 and cable W6 provide a means of effectively removing the load from the supply.

CR7 provides over voltage protection for regulator U1. If the unregulated +5V rises above 13.40V, CR7 will conduct causing fuse F1 to blow. The voltage reading at CR7 pin 3 will be the product of 0.18 x voltage at J3(1).

The ON/STANDBY switch (S5) is shown on the schematic. The ON position controls the application of dc power to the digital and analog boards. In both the ON and STDBY positions of line switch S5 (whenever line power cable is plugged in), a +5V standby voltage is provided to maintain the data stored in non-volatile RAM. When mains power is disconnected, battery BT1 provides the voltage required to maintain the data in non-volatile RAM.

Due to the high precision requirements, the Power Meter uses separate grounding points for each type of digital and analog signal. The grounds are defined as follows:

1. Chassis ground is at pin 8 of tranformer T1.
2. The A-GND is defined as the ground at the sensor bulkhead. This ground is buffered on the A4 Input Amplifier Assembly and is the reference for the Variable Gain Amplifiers, the Range Attenuators, and the bandpass filter. A-GND is the actual signal reference, but is not directly connected to instrument ground – it floats.
3. B-GND is the dc analog ground. It is used with the amplifier filters and the analog to digital converter.
4. C-GND is the 220 Hz analog ground.
5. D-GND is the main digital ground and is applied to the A3 Central Processing Unit (CPU) Assembly.
6. R-GND is the ground for the 50 MHz Reference Oscillator.

Troubleshooting

The service procedure contained herein assumes that the unit power cable is plugged into an approriate power source, the voltage select switches are correctly set, and the line fuse is of the correct value.

Test Equipment

Oscilloscope ..... HP 54201A

Digital Voltmeter(DVM) ..... HP 3456A

Procedure

Troubleshooting the power supply consists of making dc voltage checks and measuring AC ripple at prescribed test points. There are no adjustments on the power supply. To perform these checks disconnect the power cable from the AC source and remove the top cover to gain access to power supply test points. Refer to Figure 8-X for location of J3 test points.

Warning 

Maintenance described in this section is performed with power supplied to the instrument and with protective covers removed. Maintenance should be performed only by service trained personnel who are aware of the hazards involved (for example, fire and electrical shock). where maintenance can be performed without power applied, the power should be removed.

Mains voltage is present at the line input to the voltage select switches S1,S2 and on the primary side of transformer T1 whenever the power cord is connected. Be extremely careful when working in proximity to these areas. These hazardous voltages could cause serious personal injury if contacted.

±15V Supply Checks

1. Connect power cord to AC source and turn front panel LINE switch S5 to ON.

2. Make a quick visual check and note particularly that the +15V Fail LED is OFF indicating this supply is working. This does not mean that the supply is within tolerance.

3. Connect the negative lead of the DVM to J3(8).

4. Connect the positive lead to J3(5). The voltage should read +15.00V ±0.5V. If the reading is normal, proceed to Step 8. If abnormal, go to Step 5.

5. Connect the DVM positive lead to J3(3). Voltage at this point should be >+17.50V. If the indication is normal, dual voltage regulator U2 is suspect or there is an excessive load on the supply.

6. Set the front panel LINE switch S5 to STBY, disconnect the ribbon cable W6 at connector J6 to remove the load from the supply. Place LINE switch S5 to ON and repeat Step 4. If the voltage is now normal, the fault is on the A4 analog board.

7. Set LINE switch S5 to STBY and reconnect cable W6 to connector J6. Place LINE switch S5 to ON position.

8. Set the controls on the oscilloscope as follows:

   Vertical sensitivity 10mV/div
   Sweep 5mS/div
   Triggering .....internal
   Coupling .....AC

9. Using the oscilloscope, check the ripple voltage on the +15V output at J3(5). Amplitude of the ripple should not exceed 10.00 mV p-p. An excessive ripple voltage indicates faulty filter capacitors, or excessive load on the supply.

10. Using the DVM, measure the voltage at J3(6). Normal voltage at this point is -15.00V ±0.5V. If indicated voltage at J3(6) is normal, proceed to Step 14. If abnormal, go to Step 11.

11. Check the unregulated -15V at J3(4). Normal indication is a reading of <-17.50V. If normal, dual regulator U2 is suspect, or there is an excessive load on this supply.

12. Set LINE switch S5 to STBY position and disconnect cable W6 from connector J6 to isolate the load. Place LINE switch S5 to ON and repeat Step 10. If the reading is now normal, the fault is on the A4 analog board.

13. Place LINE switch to STBY position, reconnect ribbon cable W6 to connector J6. Set the LINE switch S5 to the ON position.

14. Set the oscilloscope controls as indicated in Step 8.

15. Using the oscilloscope check the ripple voltage on the -15V output at J3(6). Ripple should not exceed 10.00 mV p-p. An excessive ripple component indicates faulty filter capacitors, or an excessive load condition. Try isolating the load and rechecking the ripple component on this output.

16. The absolute values of the +15V measured at J3(5), and the -15V measured at J3(6) should track within 2%. That is, the difference between the two absolute values should not be more than ±300.00 mV as measured at the specified test points.

+5V Supply Checks

1. Using the DVM, measure the voltage at J3(7). Normal indication at this point is +5.00V ±0.25V. If indication is normal go to Step 3. If abnormal, go to Step 2.

2. With the DVM measure the voltage at J3(1). Normal indication is >5.60V. If this unregulated +5V is normal, suspect voltage regulator U1, or an excessive load. Isolate fault by desoldering one side of W1 and disconnecting cable W6 (to remove the load) and remeasure the +5V output at U1 pin 2. Be sure to reconnect W1 and cable W6.

3. Using the oscilloscope measure the ripple component on the +5V output. AC ripple should be <10.00 mV measured at J3(7). Excessive ripple indicates failure in the filter capacitors, or an excessive load condition. (The +5V regulator may oscillate if capacitor C11 or C12 is defective.)

4. Using the DVM, measure the +5V standby voltage at U9 pin 28 (See service sheet A3a). With the power cord plugged in, normal indication is ≈5.00V and with the power cord disconnected the indication is ≈3.00V. Replace battery BT1 if the measured battery voltage is below 2.50V.

Causes of Blown Fuse

Probable causes of a blown fuse F1 are:

- Improper line voltage selection
- Improper fuse
- Excessive load on the supply
- Defective transformer
- Defective filter capacitors C3, C4, C7.
- Defective crowbar circuit CR7.

Overvoltage Protection Changes to the +12V and +5V Power Supplies

In order to provide more overvoltage protection, two changes were made to the power supply circuits. If your Power Meter has a serial number prefix of 2908A and below, the partial schematic labeled 2908A applies to your circuitry. If your Power Meter has a serial number prefix of 2912A and above, the partial schematic labeled 2912A applies to your circuitry. If your instrument intermittently blows fuse F1, contact your nearest Hewlett-Packard service representative.

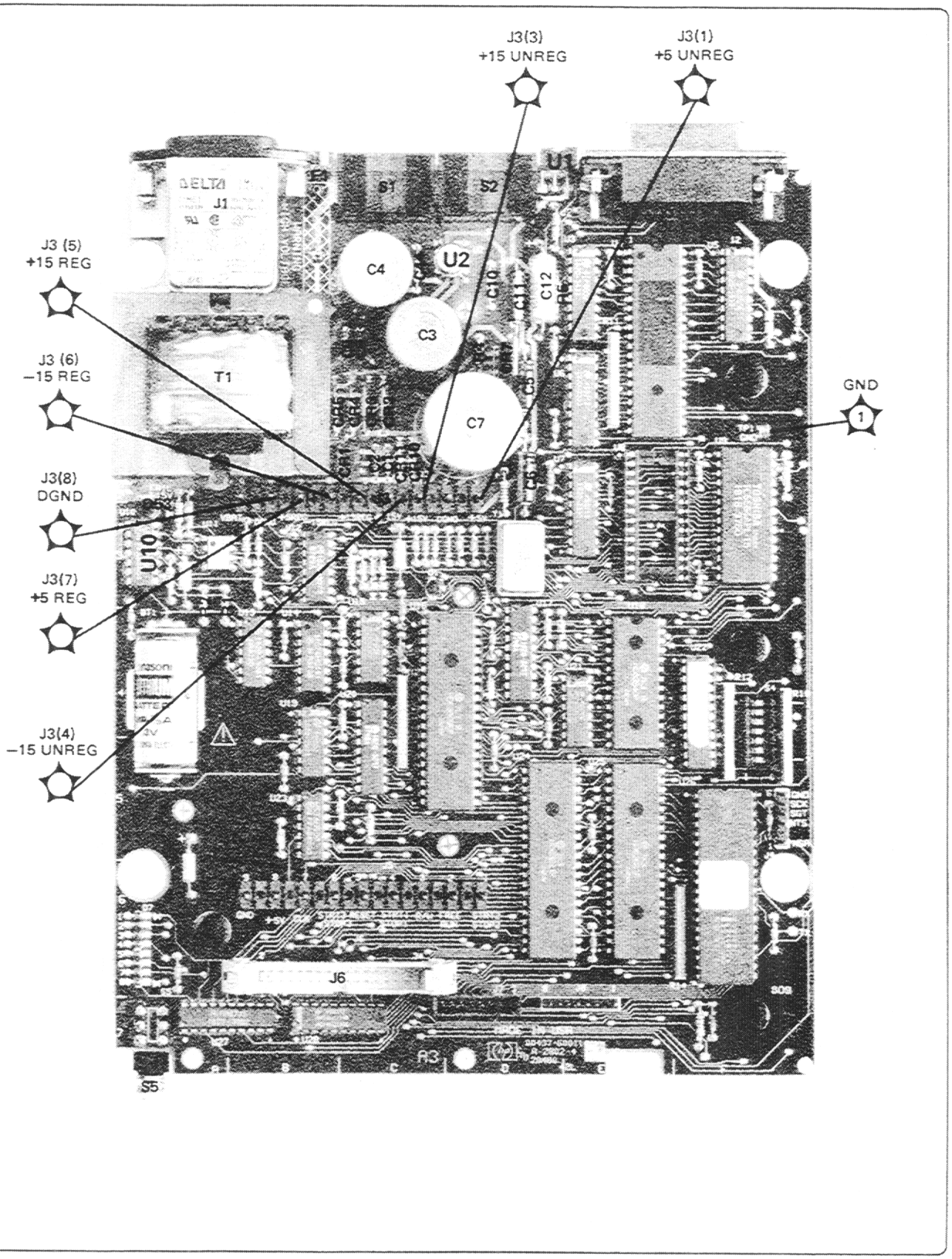
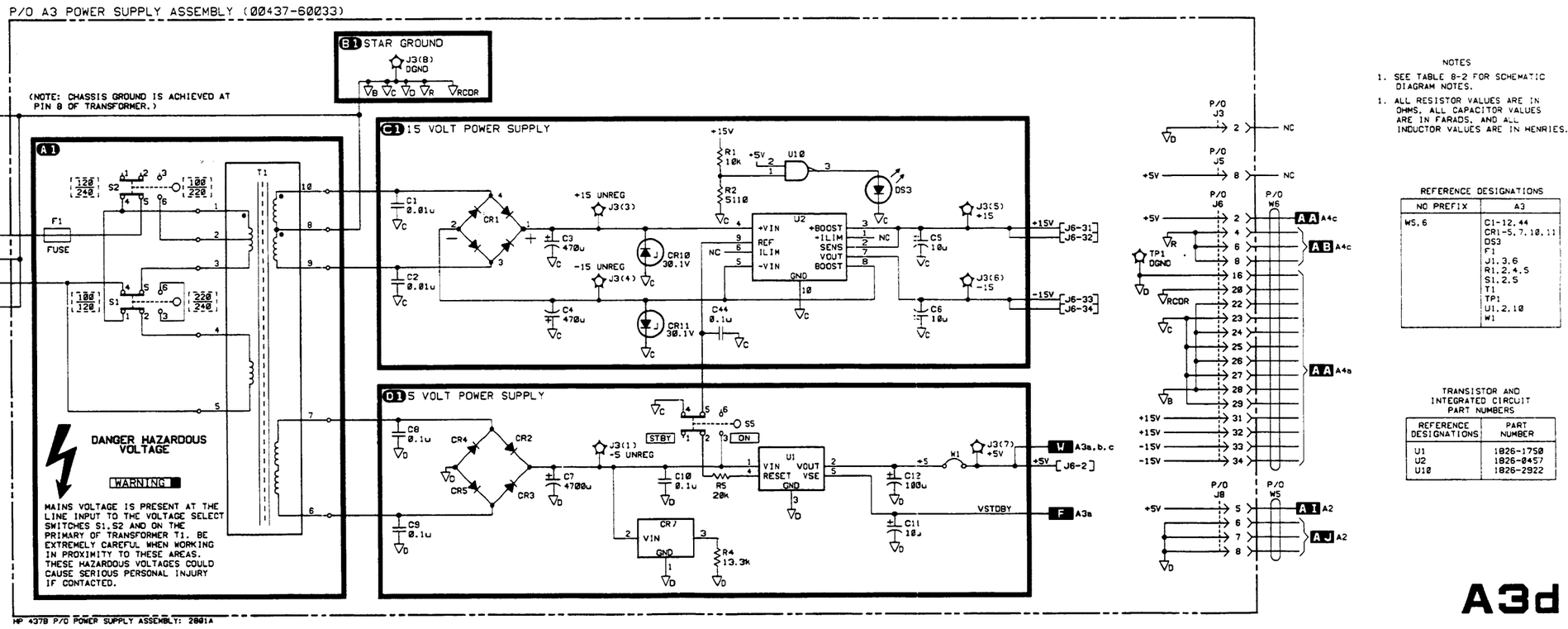


Figure 8-22. A3d Component Locations



NOTES

1. SEE TABLE 8-2 FOR SCHEMATIC DIAGRAM NOTES.
1. ALL RESISTOR VALUES ARE IN OHMS, ALL CAPACITOR VALUES ARE IN FARADS, AND ALL INDUCTOR VALUES ARE IN HENRIES.

REFERENCE DESIGNATIONS

NO PREFIX	A3
W5,6	C1-12,44 CR1-5,7,10,11 DS3 F1 J1,3,6 R1,2,4,5 S1,2,5 T1 TP1 U1,2,10 W1

TRANSISTOR AND INTEGRATED CIRCUIT PART NUMBERS

REFERENCE DESIGNATIONS	PART NUMBER
U1	1826-1750
U2	1826-0457
U10	1826-2922

A3d

Figure 8-23. A3d Schematic Diagram

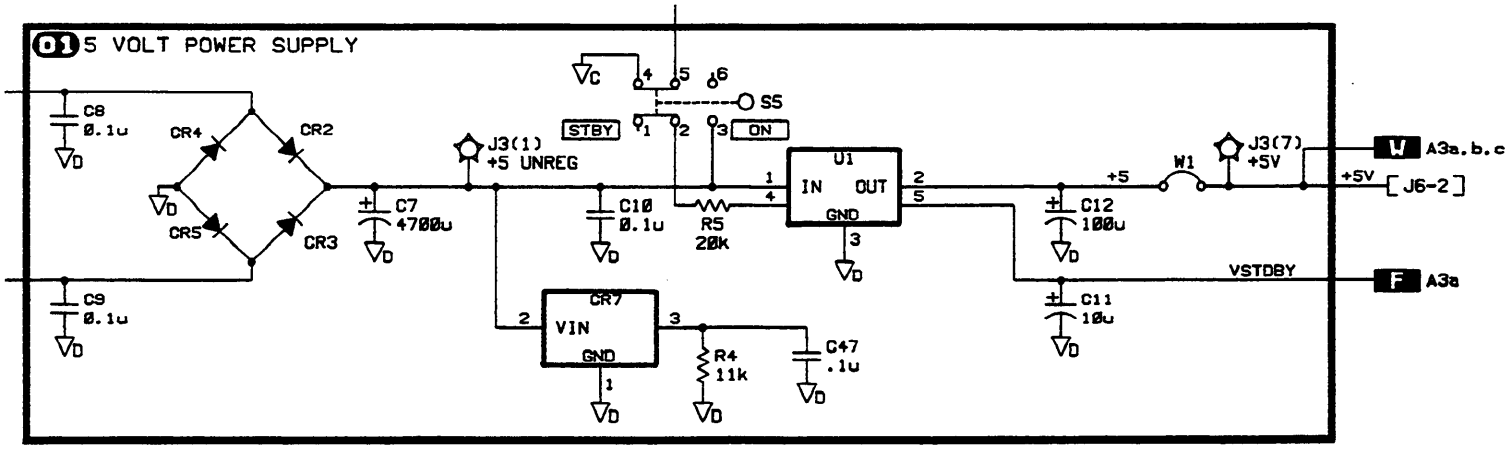


Figure 8-23. A3d Partial Schematic Diagram for 2908A

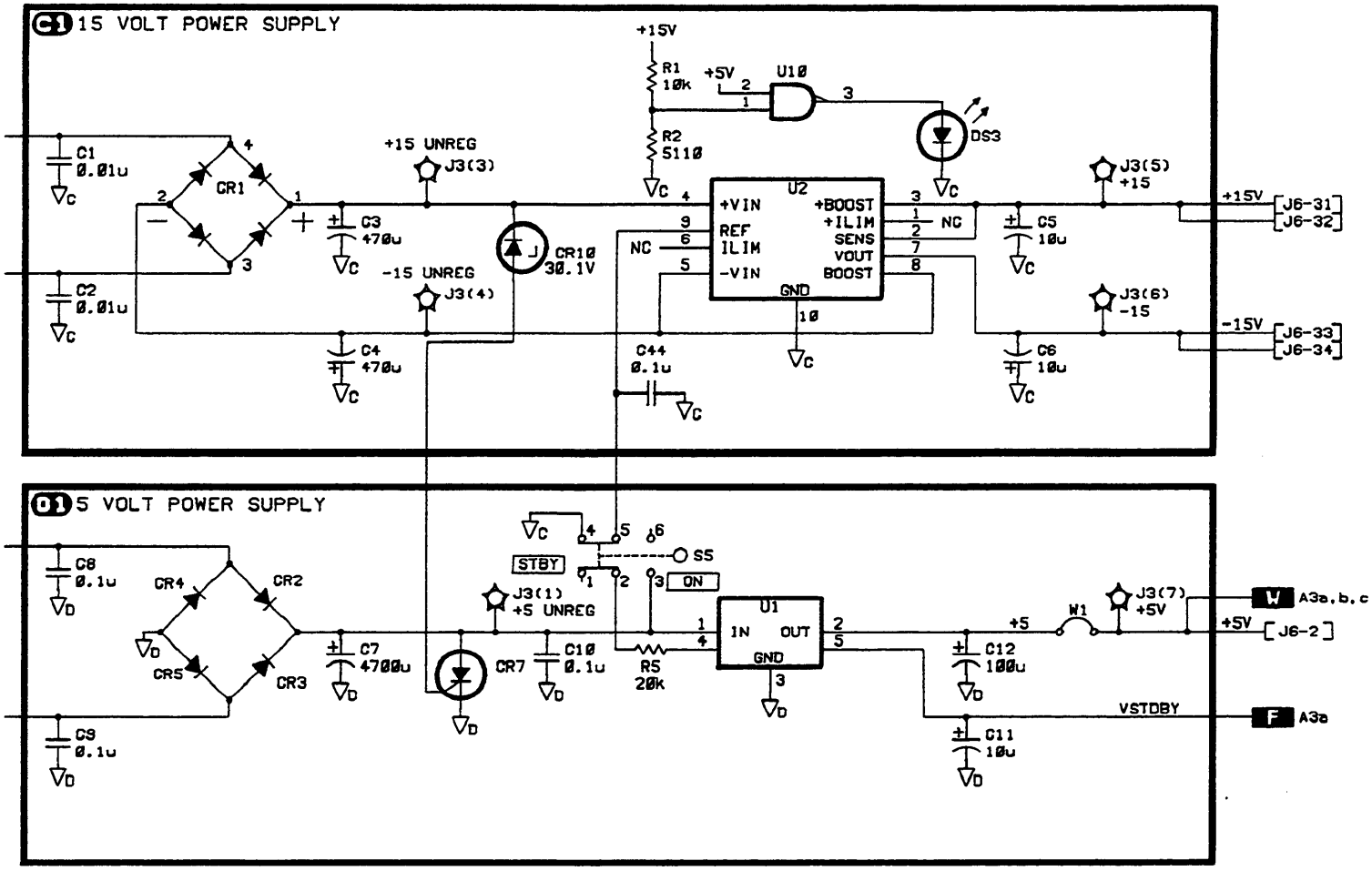


Figure 8-23. A3d Partial Schematic Diagram for 2912A

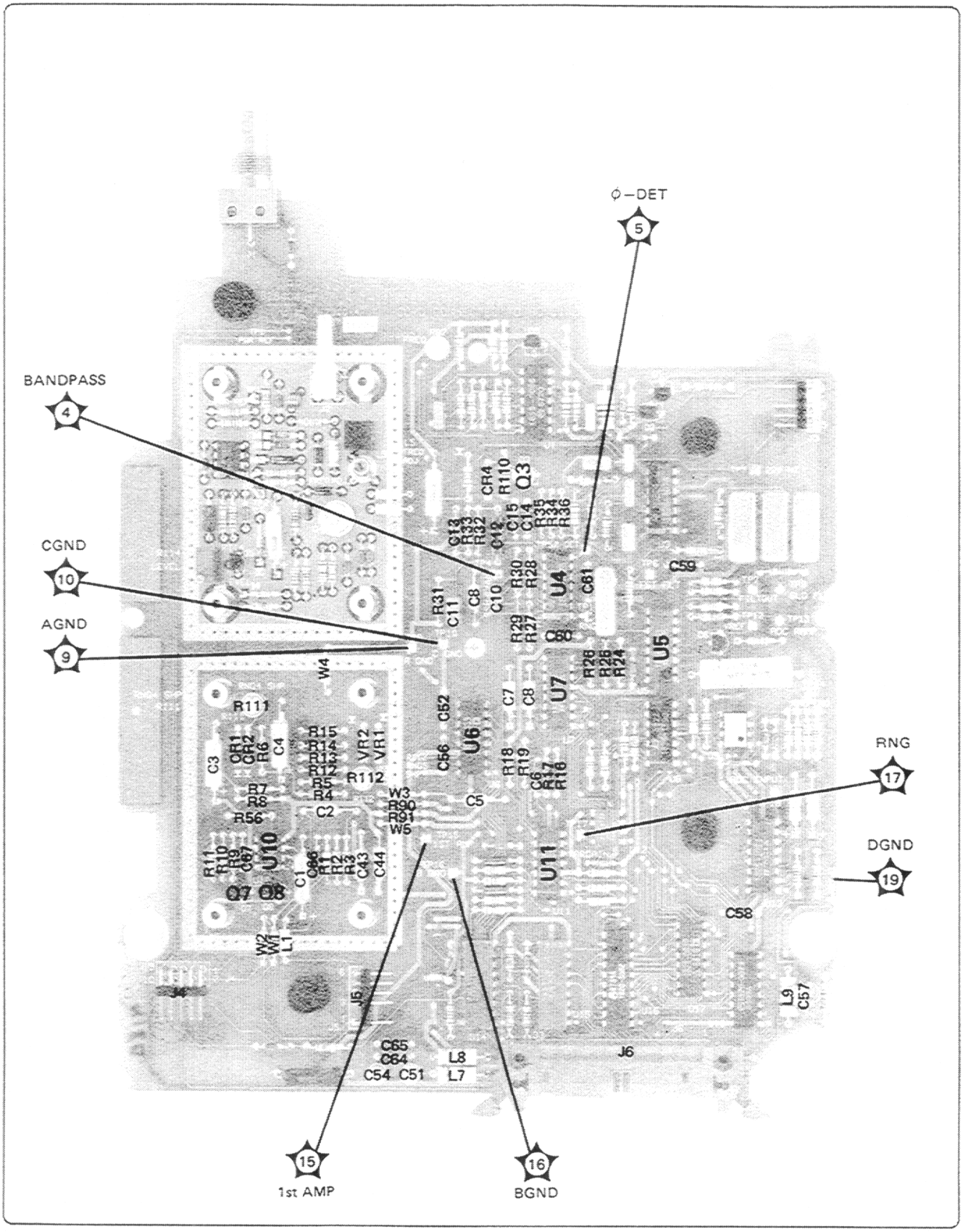
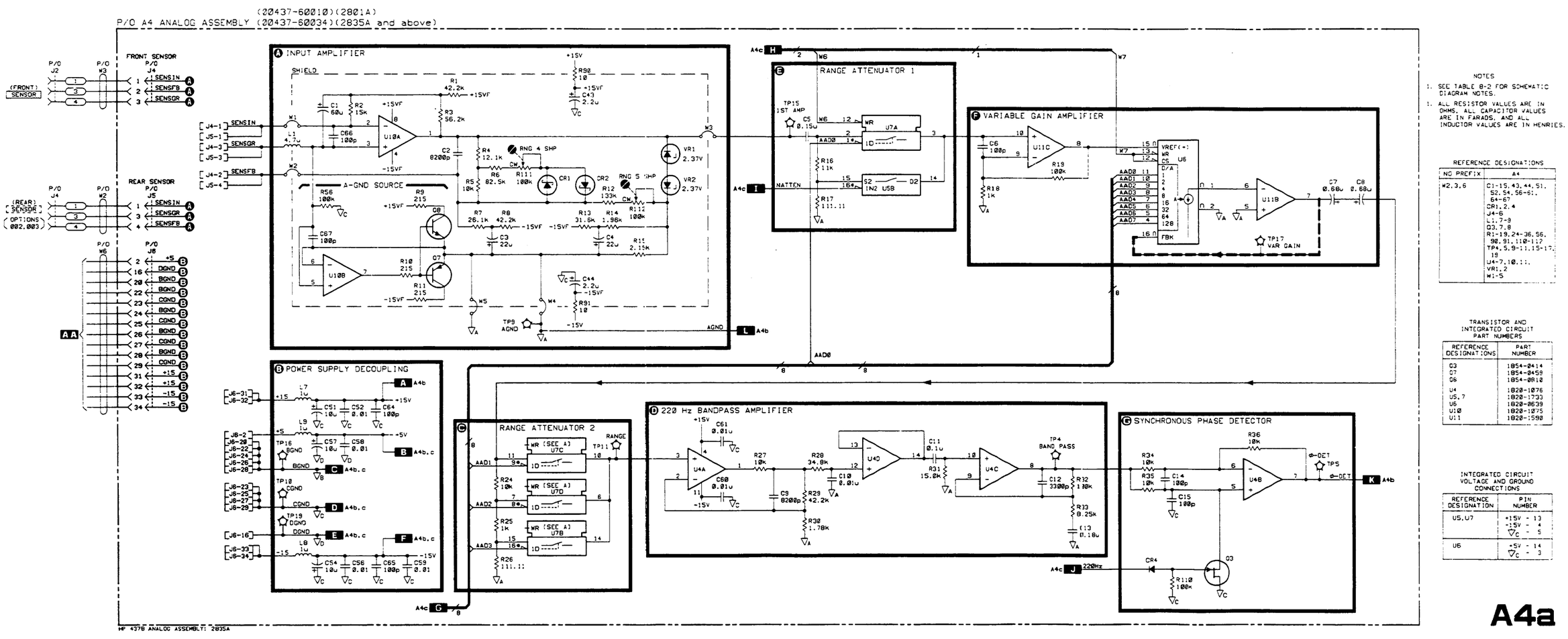


Figure 8-24. A4a Component Locations



NOTES

1. SEE TABLE 8-2 FOR SCHEMATIC DIAGRAM NOTES.
1. ALL RESISTOR VALUES ARE IN OHMS, ALL CAPACITOR VALUES ARE IN FARADS, AND ALL INDUCTOR VALUES ARE IN HENRIES.

REFERENCE DESIGNATIONS

NO PREFIX	A4
W2,3,6	C1-15,43,44,51, 52,54,56-61, 64-67 CR1,2,4 J4-6 L1,7-9 Q3,7,8 R1-19,24-36,56, 90,91,110-112 TP4,5,9-11,15-17, 19 U4-7,10,11, VR1,2 W1-5

TRANSISTOR AND INTEGRATED CIRCUIT PART NUMBERS

REFERENCE DESIGNATIONS	PART NUMBER
Q3	1854-0414
Q7	1854-0459
Q6	1854-0812
U4	1820-1076
U5,7	1820-1733
U6	1820-0639
U10	1820-1075
U11	1820-1598

INTEGRATED CIRCUIT VOLTAGE AND GROUND CONNECTIONS

REFERENCE DESIGNATION	PIN NUMBER
U5,U7	+15V - 13 -15V - 4 ⏚C - 5
U6	+5V - 14 ⏚C - 3

A4a

Figure 8-25. A4a Schematic Diagram

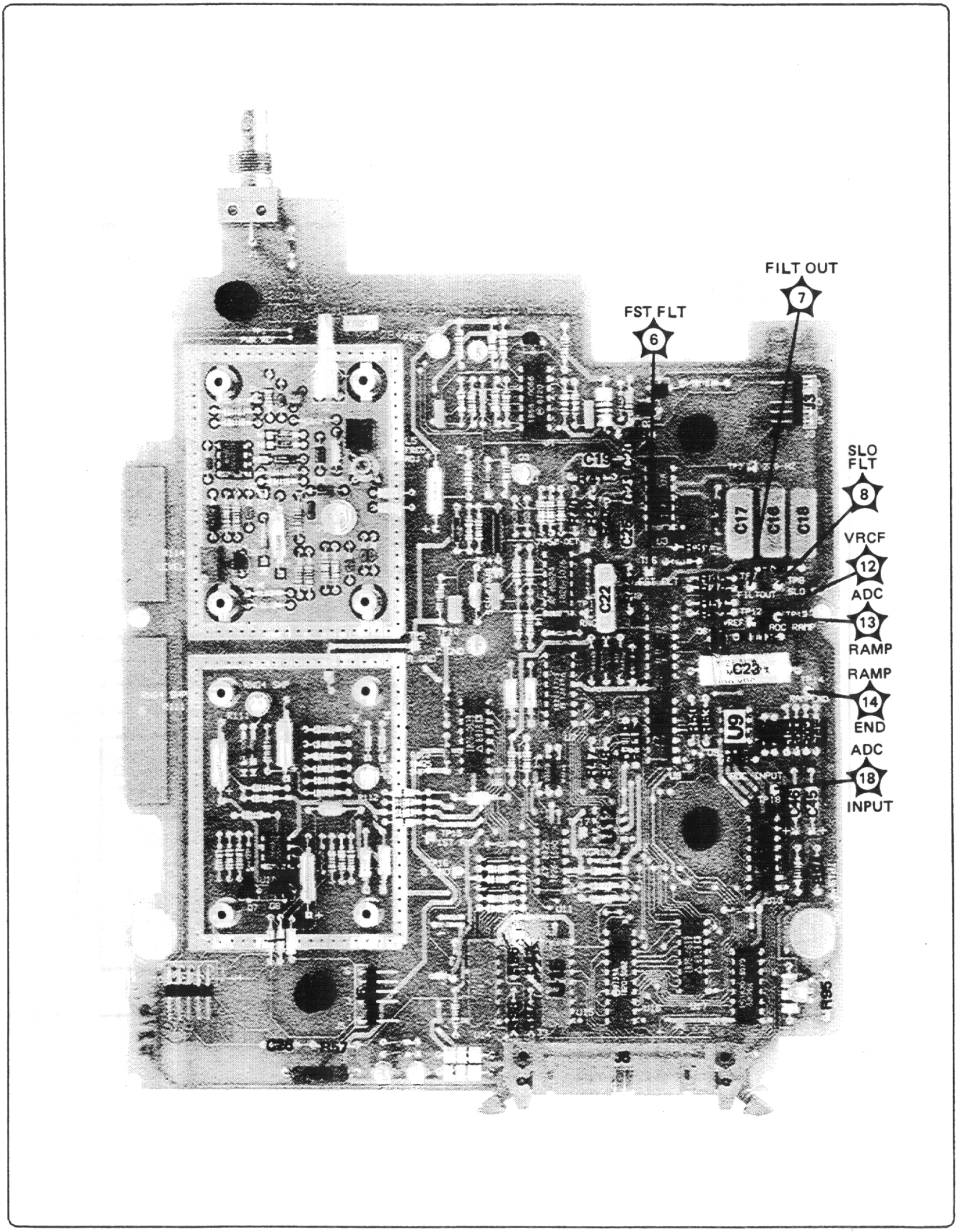
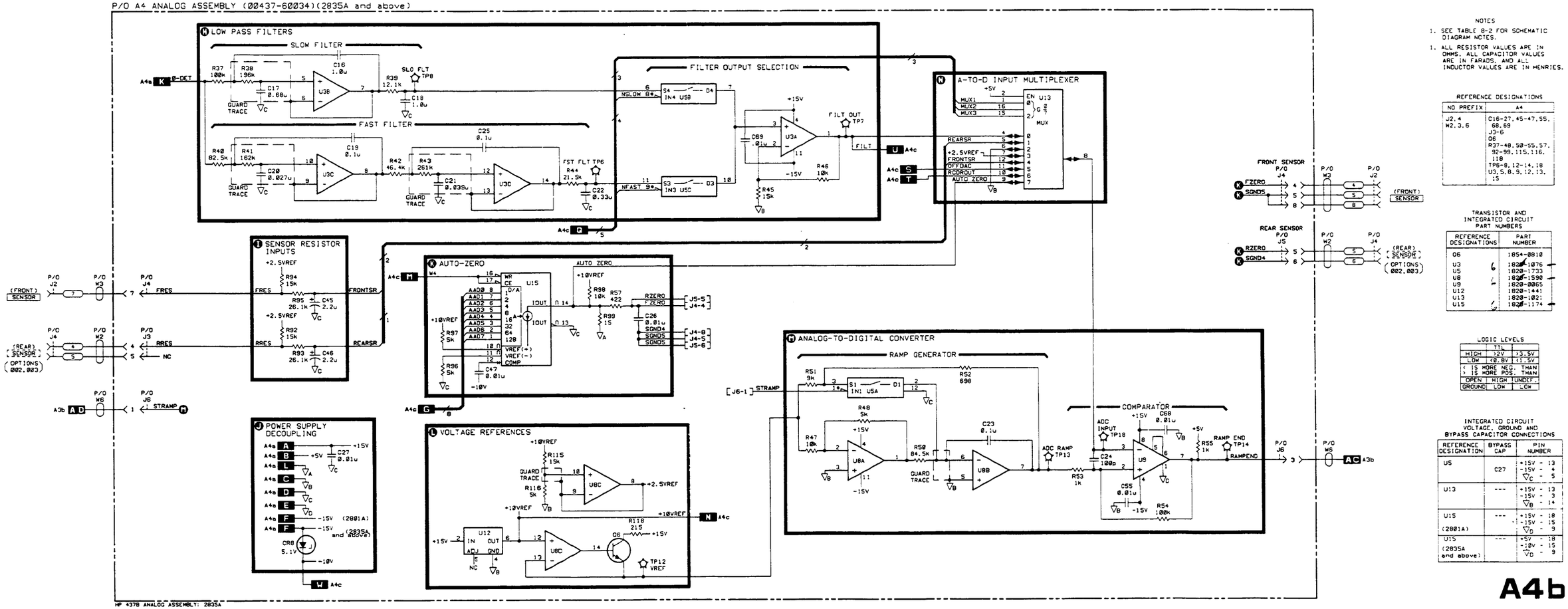


Figure 8-26. A4b Component Locations



NOTES

1. SEE TABLE 8-2 FOR SCHEMATIC DIAGRAM NOTES.
1. ALL RESISTOR VALUES ARE IN OHMS. ALL CAPACITOR VALUES ARE IN FARADS, AND ALL INDUCTOR VALUES ARE IN HENRIES.

REFERENCE DESIGNATIONS

NO PREFIX	A4
J2,4 W2,3,6	C16-27,45-47,55, 68,69 J3-6 D6 R37-48,50-55,57, 92-99,115,116, 118 TP6-8,12-14,18 U3,5,8,9,12,13, 15

TRANSISTOR AND INTEGRATED CIRCUIT PART NUMBERS

REFERENCE DESIGNATIONS		PART NUMBER
D6		1854-0810
U3	6	1820-1076
U5		1820-1733
U8		1820-1590
U9		1820-0065
U12		1820-1441
U13		1820-1021
U15		1820-1174

LOGIC LEVELS

	TTL	
HIGH	>2V	>3.5V
LOW	<0.8V	<1.5V
< IS MORE NEG. THAN > IS MORE POS. THAN		
OPEN	HIGH	UNDEF.
GROUND	LOW	LOW

INTEGRATED CIRCUIT VOLTAGE, GROUND AND BYPASS CAPACITOR CONNECTIONS

REFERENCE DESIGNATION	BYPASS CAP	PIN NUMBER
U5	C27	+15V - 13 +15V - 4 VC - 5
U13	---	+15V - 13 -15V - 3 VB - 14
U15 (2801A)	---	+15V - 18 -15V - 15 VD - 9
U15 (2835A and above)	---	+5V - 18 -10V - 15 VD - 9

A4b

Figure 8-27. A4b Schematic Diagram

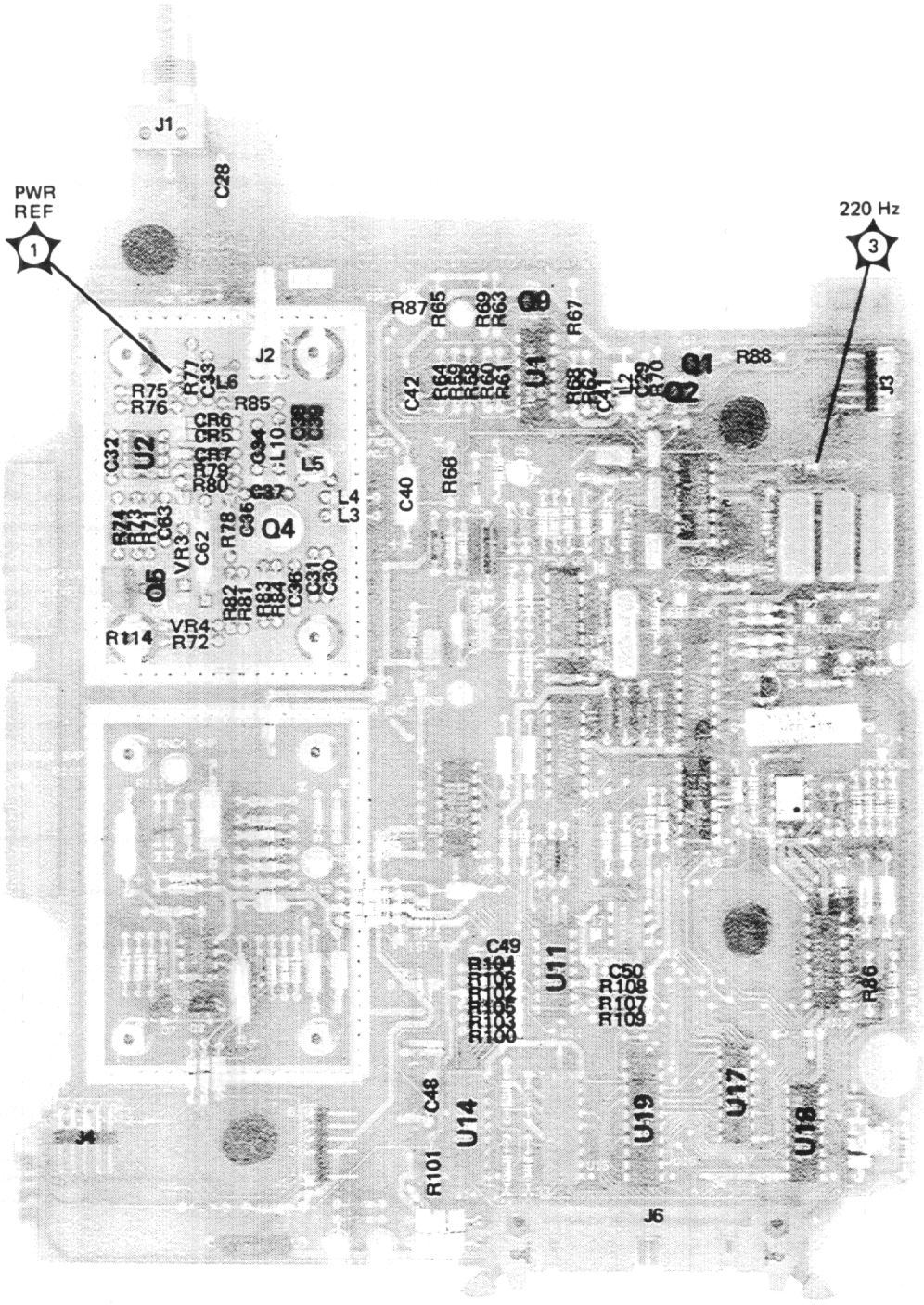
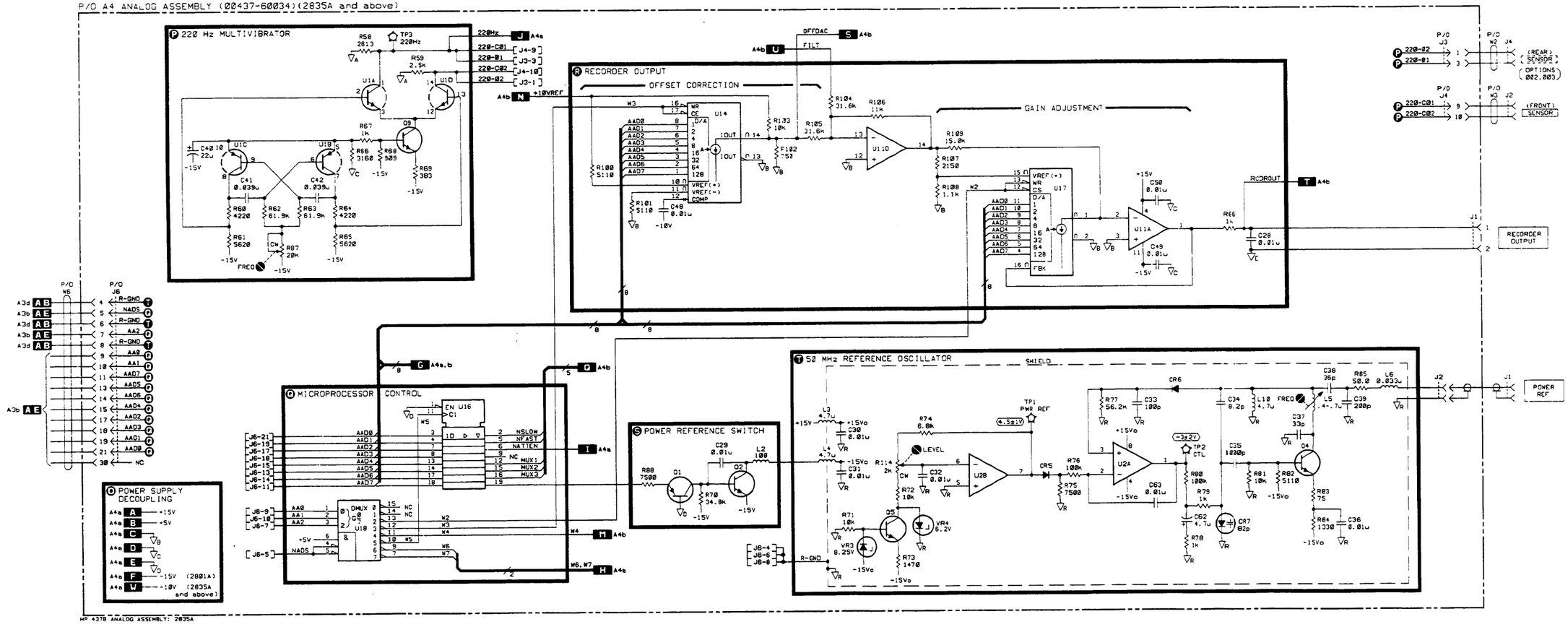


Figure 8-28. A4c Component Locations

(00437-60010)(2801A)
P/O A4 ANALOG ASSEMBLY (00437-60034)(2835A and above)



REFERENCE DESIGNATIONS

NO. PREFIX:	A4
J1, 2, 4 W2-4, 6	C28-42, 48-50, 62, 63 CR5-7 J1-4, 6 L2-6, 10 Q1, 2, 4, 5, 9 R58-88, 100-109, 114 TP1-3 U1, 2, 11, 14, 16-18 VR3, 4

TRANSISTOR AND INTEGRATED CIRCUIT PART NUMBERS

REFERENCE DESIGNATIONS	PART NUMBER
Q1	1854-0459
Q4	1854-0247
Q2, 5, 9	1854-0810
U1	1820-0086
U2	1820-1075
U11	1820-1590
U14	1820-1174
U16	1820-3082
U17	1820-0639
U18	1820-3079

LOGIC LEVELS

	TTL	
HIGH	>2V	>3.5V
LOW	<0.8V	<1.5V
< IS MORE NEG. THAN > IS MORE POS. THAN		
OPEN	HIGH	UNDEF.
GROUND	LOW	LOW

INTEGRATED CIRCUIT VOLTAGE AND GROUND CONNECTIONS

REFERENCE DESIGNATION	PIN NUMBER
U14 (2801A)	+15V - 18 -15V - 15 ∇_D - 9
U14 (2835A and above)	+5V - 18 -10V - 15 ∇_D - 9
U16	+5V - 20 ∇_D - 10
U17	+5V - 14 ∇_B - 3
U18	+5V - 16 ∇_C - 8

A4c

Figure 8-29. A4c Schematic Diagram

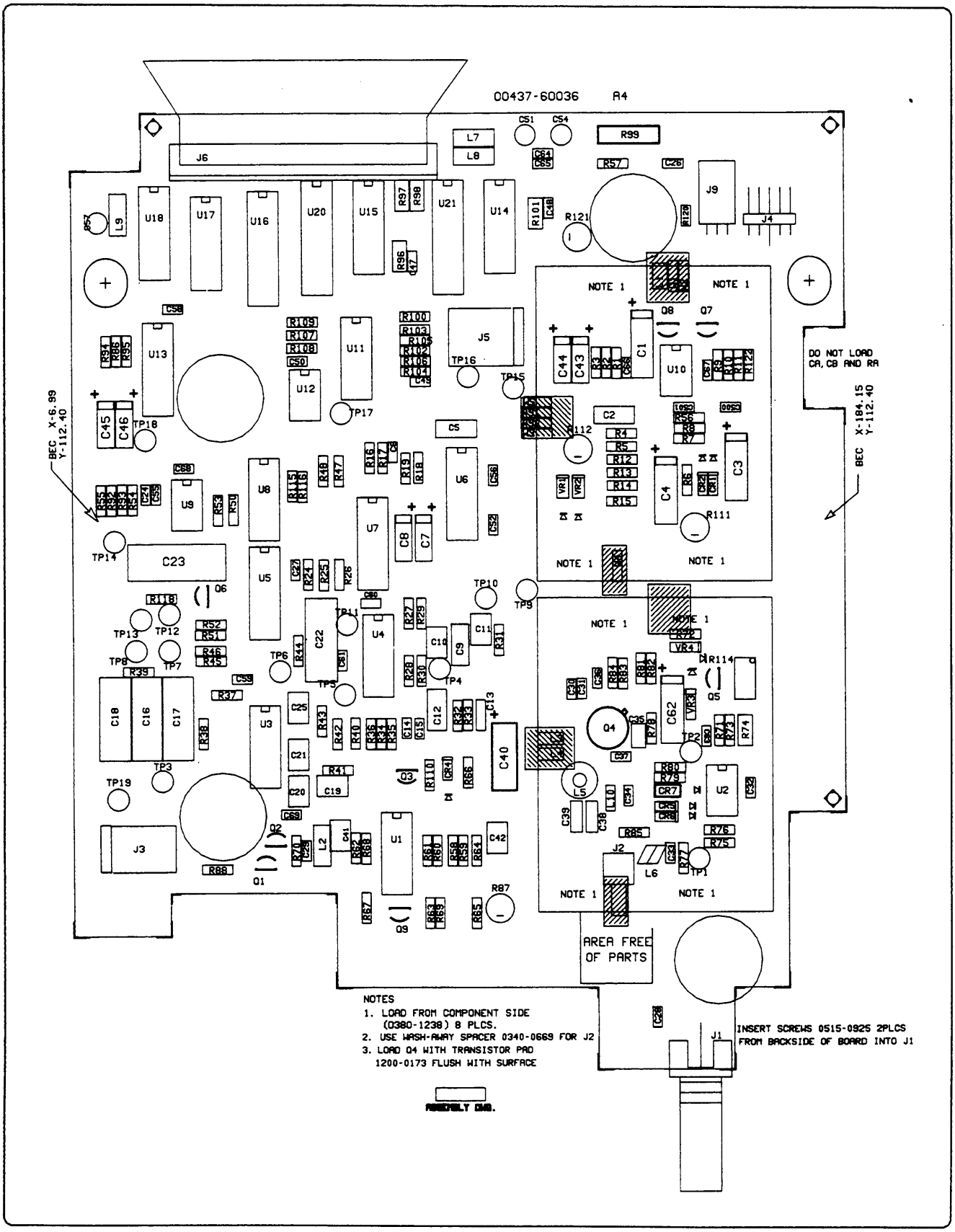


Figure 8-28. A4c Component Locations

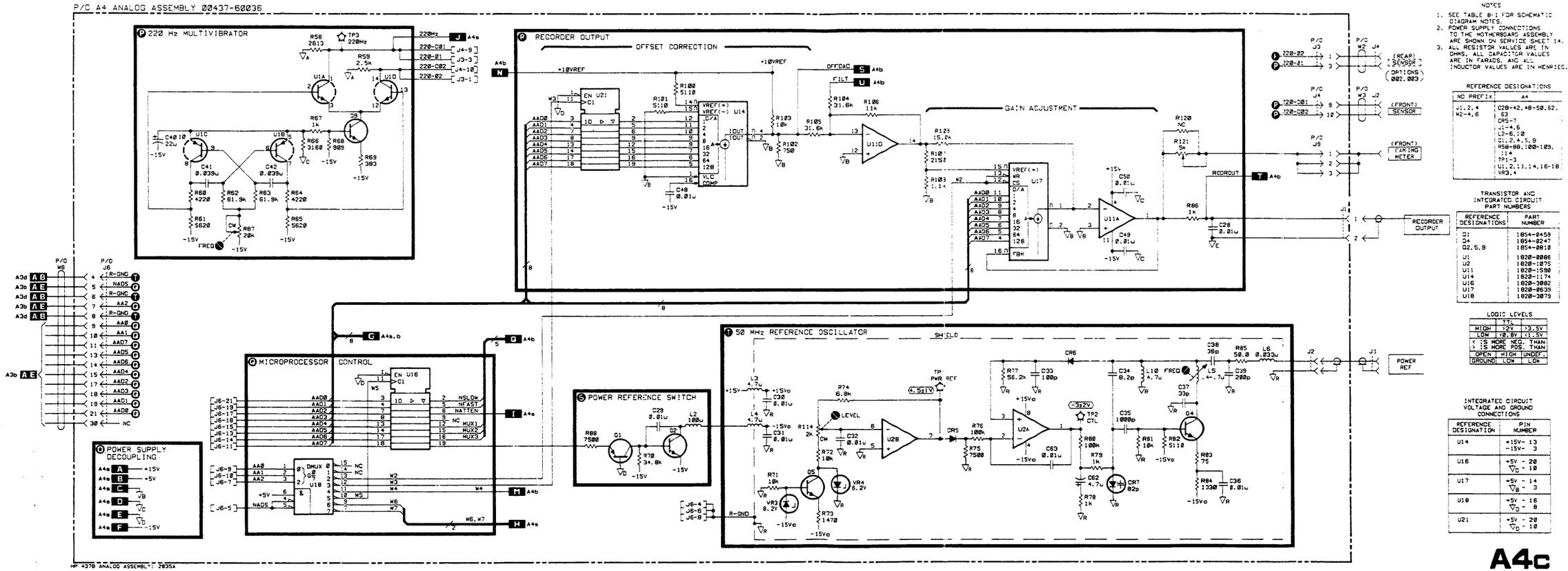


Figure 8-29. A4c Schematic Diagram

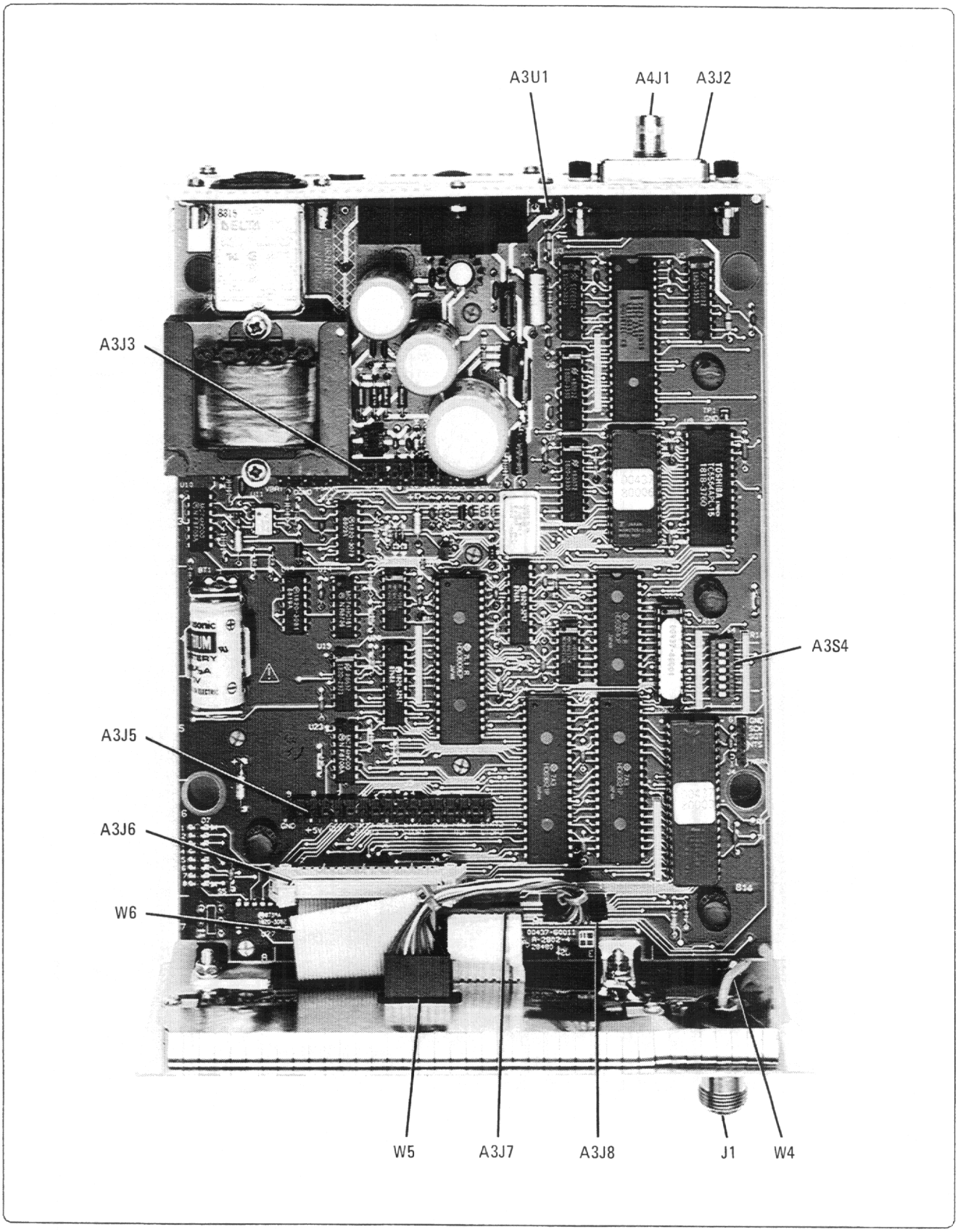


Figure 8-30. Internal Top View

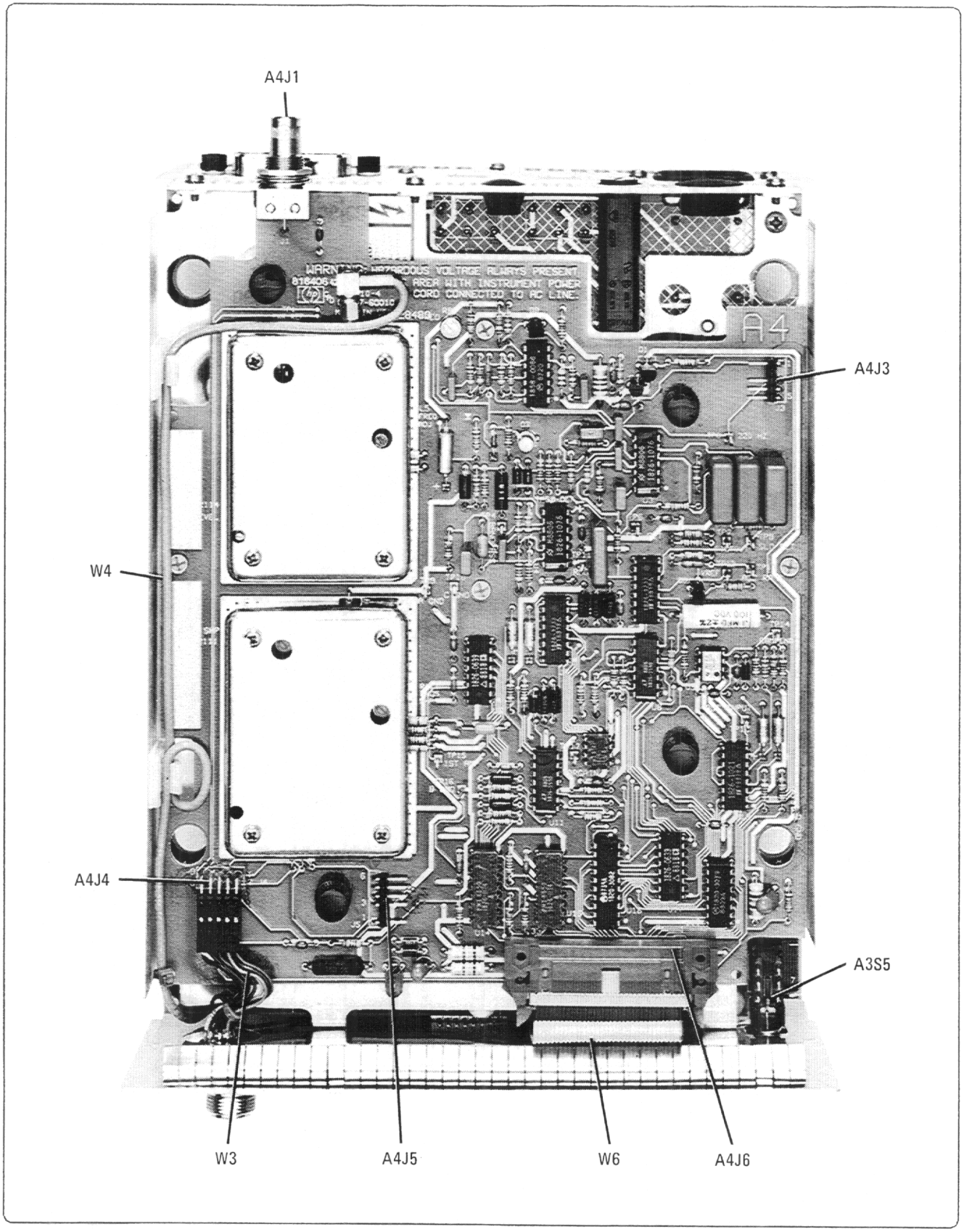


Figure 8-31. Internal Bottom View

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