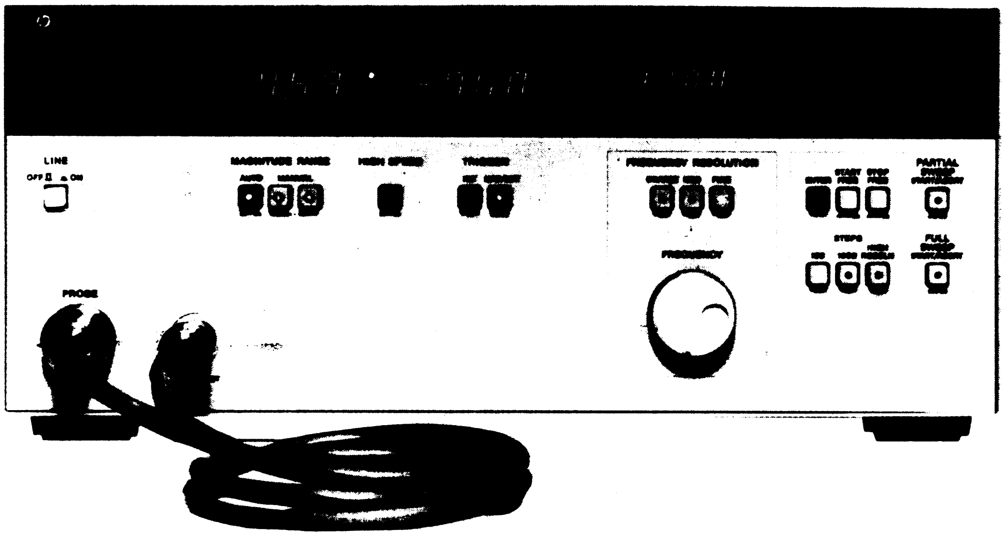
OPERATION AND SERVICE MANUAL

# 4193A
# VECTOR IMPEDANCE METER



HEWLETT PACKARD

HP 4193A

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## SAFETY SUMMARY

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

### GROUND THE INSTRUMENT

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

### DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

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

### KEEP AWAY FROM LIVE CIRCUITS

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

### DO NOT SERVICE OR ADJUST ALONE

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

### DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

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

### DANGEROUS PROCEDURE WARNINGS

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

**WARNING**

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

## CERTIFICATION

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

## WARRANTY

This Hewlett-Packard instrument product is warranted against defects in material and workmanship for a period of one year from date of shipment, except that in the case of certain components listed in Section 1 of this manual, the warranty shall be for the specified period. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

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

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

## LIMITATION OF WARRANTY

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

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

## EXCLUSIVE REMEDIES

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

## ASSISTANCE

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

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

## SAFETY SYMBOLS

General Definitions of Safety Symbols Used On Equipment or In Manuals.

| | |
|---|---|
| ⚠ | Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the instrument. |
| ϟ | Indicates dangerous voltage (terminals fed from the interior by voltage exceeding 1000 volts must be so marked). |
| ⏚ OR (⏚) | Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating equipment. |
| (⏚) | Low-noise or noiseless, clean ground (earth) terminal. Used for a signal common, as well as providing protection against electrical shock in case of fault. A terminal marked with this symbol must be connected to ground in the manner described in the installation (operating) manual, and before operating the equipment. |
| ⟂ OR ⊥ | Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures. |
| ∿ | Alternating current (power line). |
| ⎓ | Direct current (power line). |
| ≂ | Alternating or direct current (power line). |
| **WARNING** | A **WARNING** denotes a hazard. It calls attention to a procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in injury or death to personnel. |
| **CAUTION** | The **CAUTION** sign denotes a hazard. It calls attention to an operating procedure, practice, condition 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. |
| Note | A Note denotes important information. It calls attention to a procedure, practice, condition or the like, which is essential to highlight. |

# MANUAL CHANGES

# 4193A

## VECTOR IMPEDANCE METER

**MANUAL IDENTIFICATION**

**Model Number:** 4193A
**Date Printed:** AUG. 1983
**Part Number:** 04193-90000

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

To use this supplement:
Make all ERRATA corrections.
Make all appropriate serial number related changes indicated in the tables below.

| SERIAL PREFIX OR NUMBER | MAKE MANUAL CHANGES | SERIAL PREFIX OR NUMBER | MAKE MANUAL CHANGES |
|---|---|---|---|
| ALL | ERRATA | | |
| ALL | 1 | | |
| 2206J00470 and above | 2 | | |
| | | | |

► NEW ITEM

## ERRATA

▶ Page 8-5, Paragraph 8-30
Partially change line 16 to read:
signal fed back from the A9 board to the A7

▶ Page 8-6, Figure 8-5. Signal Source Operation
Partially change line 5 to read:
the front-panel, the ÷N circuit outputs a stable 1KHz, 10KHz,

**NOTE**

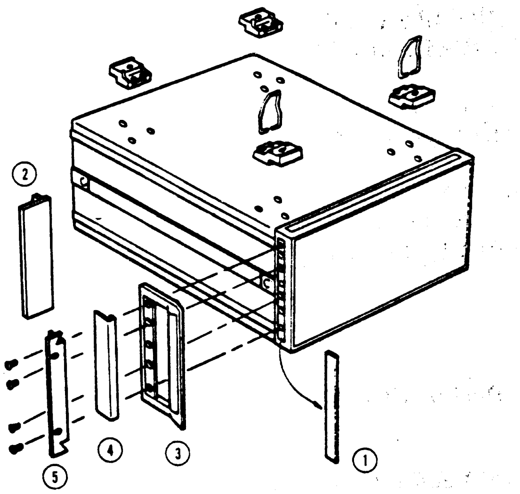
Manual change supplements are revised as often as necessary to keep manuals as current and accurate as possible. Hewlett-Packard recommends that you periodically request the latest edition of this supplement. Free copies are available from all HP offices. When requesting copies quote the manual identification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

**Date/Div:** JAN. 27, 1984/33

HEWLETT PACKARD

Printed in Japan

| Option | Description | Kit Part Number |
|---|---|---|
| 907 | Handle Kit | 5061-9690 |
| 908 | Rack Flange Kit | 5061-9678 |
| 909 | Rack Flange & Handle Kit | 5061-9684 |



1. Remove adhesive-backed trim strips ① from side at right and left front of instrument.
2. HANDLE INSTALLATION : Attach front handle ③ to sides at right and left front of instrument with screws provided and attach trim ④ to handle.
3. RACK MOUNTING : Attach rack mount flange ② to sides at right and left front of instrument with screws provided.
4. HANDLE AND RACK MOUNTING : Attach front handle ③ and rack mount flange ⑤ together to sides at right and left front of instrument with screws provided.
5. When rack mounting (3 and 4 above), remove all four feet (lift bar at inner side of foot, and slide foot toward the bar).

Figure 2-3. Rack Mount Kit.

## Herstellerbescheinigung

Hiermit wird bescheinigt, daß das Gerät HP 4193A (Vector Impedance Meter) in Übereinstimmung mit den Bestimmungen von Postverfügung 1046/84 funkentstört ist.

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

Anm: Werden Meß- und Testgeräte mit ungeschirmten Kabeln und/oder in offenen Meßaufbauten verwendet, so ist vom Betreiber sicherzustellen, daß die Funk-Entstörbestimmungen unter Betriebsbedingungen an seiner Grundstücksgrenze eingehalten werden.

## Manufacturer's Declaration

This is to certify that this product, the HP 4193A Vector Impedance Meter, meets the radio frequency interference requirements of directive 1046/84. The German Bundespost has been notified that this equipment was put into circulation and was granted the right to check the product type for compliance with these requirements.

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

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# SECTION I
# GENERAL INFORMATION

## 1-1. INTRODUCTION

1-2. This operation and service manual contains the information required to install, operate, test, adjust, and service the Hewlett-Packard Model 4193A Vector Impedance Meter. Figure 1-1 shows the instrument and supplied accessories. This section covers specifications, instrument identification, description, options, accessories, and other basic information.

1-3. Listed on the title page of this manual is a microfiche part number that can be used to order 4 x 6 inch microfilm transparencies of the manual. Each microfiche contains up to 60 photo-duplicates of the manual pages. The microfiche package also includes the latest manual changes supplement as well as all pertinent service notes. To order an additional manual, use the part number listed on the title page of this manual.

## 1-4. DESCRIPTION

1-5. The HP Model 4193A Vector Impedance Meter is a probe-type, fully automatic microprocessor-based test instrument designed for laboratory and production line applications. It measures and digitally displays impedance magnitude, $|Z|$, and phase angle, $\theta$, of active or passive circuits, in-circuit components, discrete components at test frequencies from 400kHz to 110MHz with 10mΩ (impedance) and 0.1° (phase) resolution. Frequency and measured impedance and phase are displayed on the front-panel with 4-digit and 3 1/2-digit resolution, respectively. Two measurement speeds are provided: NORMAL and HIGH SPEED. In NORMAL mode operation, the 4193A performs one measurement per second; in HIGH SPEED mode operation, it performs approximately seven measurements per second.

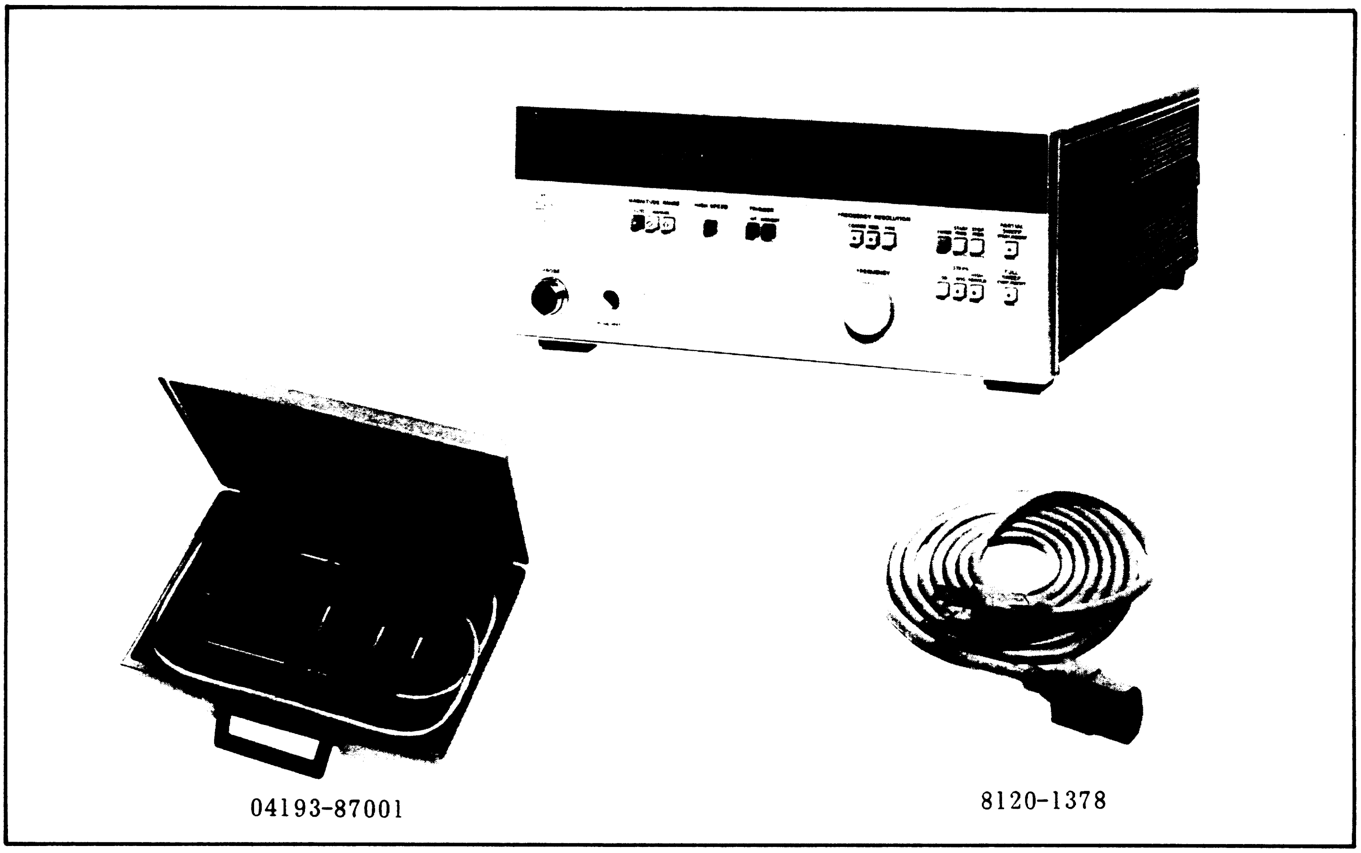


Figure 1-1. Model 4193A and Accessories.

1-6. The 4193A's built-in test signal synthesizer can be set with 1kHz (maximum) resolution to any frequency within the range of 400kHz to 110MHz for SPOT measurements, or it can be automatically or manually swept in one of two sweep modes: FULL and PARTIAL. In FULL SWEEP mode, frequency is logarithmically swept from 400kHz to 110MHz, and measurement is made at 43 frequency points. In PARTIAL SWEEP mode, frequency is swept from the selected START frequency to the selected STOP frequency. The number of measurement points is selectable at 100, 1000, or HIGH RESOLUTION. Frequency resolution is 1kHz, 10kHz, or 100kHz, depending on the selected frequency range. For measurements requiring higher frequency resolution, an external frequency synthesizer can be connected. Using this technique, 100Hz frequency resolution can be obtained over the 4193A's full frequency range, 400kHz to 110MHz.

1-7. Test frequency, auto-ranging, frequency sweep, introspective testing (SELF TEST), display, triggering, analog and HP-IB outputs, calculations, and all other instrument functions are microprocessor controlled. This microprocessor-based hardware design makes operation and measurement set-up simple.

1-8. The 4193A is equipped with complete HP-IB capabilities for remote control of all front-panel controls. This feature makes it possible to integrate the 4193A into a cost-efficient measurement system which increases DUT throughput, and improves circuit design efficiency. The 4193A is also equipped with X-Y Recorder outputs and pen lift control. Clear and accurate hard copies of the DUT's impedance-frequency or phase-frequency characteristics can be easily obtained with this capability, without an external controller.

1-9. To maximize the versatility of the 4193A, a wide selection of probe adapters and test fixtures is available. Thus, components of virtually any shape or size can be measured.

## 1-10. SPECIFICATIONS

1-11. Complete specifications of the Model 4193A Vector Impedance Meter are given in Table 1-1. These specifications are the performance standards or limits against which the instrument is tested. The test procedures for the specifications are covered in Section IV, Performance Tests. Table 1-2 lists supplemental performance characteristics. Supplemental performance characteristics are not specifications but are typical characteristics included as additional information for the operator. When the 4193A Vector Impedance Meter is shipped from the factory, it meets the specifications listed in Table 1-1.

## 1-12. SAFETY CONSIDERATIONS

1-13. The Model 4193A Vector Impedance Meter has been designed to conform to the safety requirements of an IEC (International Electromechanical Committee) Safety Class I instrument and is shipped from the factory in a safe condition.

1-14. This operation and service manual contains information, cautions, and warnings which must be followed by the user to ensure safe operation and to maintain the instrument in a safe condition.

## 1-15. INSTRUMENTS COVERED BY MANUAL

1-16. Hewlett-Packard uses a two-section nine character serial number which is stamped on the serial number plate (Figure 1-2) attached to the instrument's rear-panel. The first four digits and the letter are the serial prefix and the last five digits are the suffix. The letter placed between the two sections identifies the country where the instrument was manufactured. The prefix is the same for all identical instruments; it changes only when a change is made to the instrument. The suffix, however, is assigned sequentially and is different for each instrument. The contents of this manual apply to instruments with the serial number prefix(es) listed under SERIAL NUMBERS on the title page.

1-17. An instrument manufactured after the printing of this manual may have a serial number prefix that is not listed on the title page. This unlisted serial number prefix indicates the instrument is different from those described in this manual. The manual for this new instrument may be accompanied by a yellow Manual Changes supplement or have a different manual part number. This supplement contains "change information" that explains how to adapt the manual to the newer instrument.

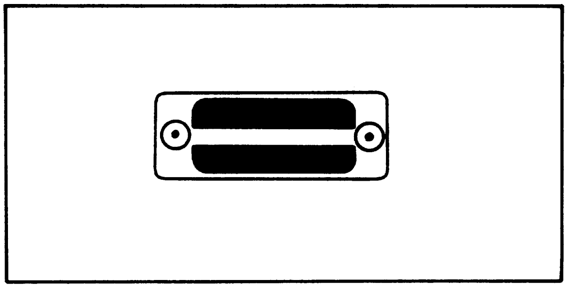


Figure 1-2. Serial Number Plate.

1-18. In addition to change information, the supplement may contain information for correcting errors (called Errata) in the manual. To keep this manual as current and accurate as possible, Hewlett-Packard recommends that you periodically request the latest Manual Changes supplement. The supplement for this manual is identified with this manual's print date and part number, both of which appear on the manual's title page. Complimentary copies of the supplement are available from Hewlett-Packard. If the serial prefix or number of an instrument is lower than that on the title page of this manul, see Section VII, Manual Changes.

1-19. For information concerning a serial number prefix that is not listed on the title page or in the Manual Change supplement, contact the nearest Hewlett-Packard office.

1-20. OPTIONS

1-21. Options are modifications to the standard instrument that implement the user's special requirements for minor functional changes. The 4193A has four options :

| | |
|---|---|
| Option 907 : | Front Handle Kit. Furnishes Carrying handles for both ends of front-panel. |
| Option 908 : | Rack Frange Kit. Furnishes flanges for rack mounting for both ends of front-panel. |
| Option 909 : | Rack Flange and Front Handle Kit. Furnishes both front handles and rack flanges for instrument. |
| Option 910 : | An extra copy of the Operation and Service Manual. |

Installation procedures for these options are given in Section II.

1-22. ACCESSORIES SUPPLIED

1-23. The Model 4193A VECTOR IMPEDANCE METER, along with its furnished accessories, is shown in Figure 1-1. The furnished accessories are also listed below :

| | |
|---|---|
| Probe Kit | HP Part No. 04193-87001 |
| Power Cable | HP Part No. 8120-1378 |
| Fuse | HP Part No. 2110-0304 |

Probe kit contents are listed in Table 1-3.

1-24. ACCESSORIES AVAILABLE

1-25. A test fixture adapter and three test fixtures are available to facilitate measurement on a wide range of discrete components. Also available is a calibration-standard set for calibration of the 4193A or similar probe-type instruments. A brief description of each available accessory is given in Table 1-4.

Table 1-1. Specifications. (Sheet 1 of 5)

## SPECIFICATIONS

### IMPEDANCE MAGNITUDE MEASUREMENT:

Range, Display, and Resolution:

| MAGNITUDE RANGE | DISPLAY RANGE | DISPLAY (digit) | RESOLUTION |
|---|---|---|---|
| 10Ω | 00.00Ω to 19.99Ω | 3 1/2 | 10mΩ |
| 100Ω | 000.0Ω to 199.9Ω | 3 1/2 | 100mΩ |
| 1kΩ | 0.000kΩ to 1.999kΩ | 3 1/2 | 1Ω |
| 10kΩ | 00.00kΩ to 19.99kΩ | 3 1/2 | 10Ω |
| 100kΩ | 000.kΩ to 120.kΩ | 2 1/2 | 1kΩ |

Accuracy: See Table A.

Range Mode: Auto and manual (up-down).

### IMPEDANCE PHASE MEASUREMENT:

Range and Resolution:

| MAGNITUDE RANGE | DISPLAY RANGE | RESOLUTION |
|---|---|---|
| 10Ω | 180.0° to -180.0° | 0.1° |
| 100Ω | 180.0° to -180.0° | 0.1° |
| 1kΩ | 180.0° to -180.0° | 0.1° |
| 10kΩ | 180.0° to -180.0° | 0.1° |
| 100kΩ | 180.° to -180.° | 1° |

Accuracy: See Table A.

Table A. Accuracies

| MAGNI-TUDE RANGE | | Test Frequency (MHz) | | | |
|---|---|---|---|---|---|
| | | 0.4 to 1 | 1 to 10 | 10 to 40 | 40 to 110 |
| 10Ω | Z | $\pm[(5.7+\frac{0.56}{f})\%$ of reading +9 counts] | $\pm[6.3\%$ of reading +6 counts] | $\pm[(4.5+0.18f)\%$ of reading +4 counts] | $\pm[(4.5+0.18)\%$ of reading +4 counts] |
| | θ | $\pm(1.7+\frac{1.8}{f}+\frac{35}{Z})$ degrees | $\pm(3.3+0.20f+\frac{35}{Z})$ degrees | $\pm(3.3+0.20f+\frac{35}{Z})$ degrees | $\pm(3.3+0.20f+\frac{35}{Z})$ degrees |
| 100Ω | Z | $\pm[(2.4+\frac{0.56}{f})\%$ of reading +4 counts] | $\pm[3.0\%$ of reading +4 counts] | $\pm[(2.6+0.037f)\%$ of reading +4 counts] | $\pm[(2.6+0.037f)\%$ of reading +4 counts] |
| | θ | $\pm(1.5+\frac{1.9}{f}+\frac{35}{Z})$ degrees | $\pm(3.3+0.035f+\frac{35}{Z})$ degrees | $\pm(3.3+0.035f+\frac{35}{Z})$ degrees | $\pm(3.3+0.035f+\frac{35}{Z})$ degrees |
| 1kΩ | Z | $\pm[(3.2+\frac{0.56}{f})\%$ of reading +4 counts] | $\pm[3.7\%$ of reading +4 counts] | $\pm[(2.7+0.11f)\%$ of reading +4 counts] | $\pm[(2.7+0.11f)\%$ of reading +4 counts] |
| | θ | $\pm(1.6+\frac{1.8}{f}+\frac{35}{Z})$ degrees | $\pm(3.3+0.11f+\frac{35}{Z})$ degrees | $\pm(3.3+0.11f+\frac{35}{Z})$ degrees | $\pm(3.3+0.11f+\frac{35}{Z})$ degrees |
| 10kΩ | Z | $\pm[(2.9+\frac{0.56}{f})\%$ of reading +4 counts] | $\pm[(3.2+0.29f)\%$ of reading +4 counts] | $\pm[(0.74+0.53f)\%$ of reading +4 counts] | |
| | θ | $\pm(1.8+\frac{1.9}{f}+\frac{35}{Z})$ degrees | $\pm(3.1+0.53f+\frac{35}{Z})$ degrees | $\pm(8.3+0.01f+\frac{35}{Z})$ degrees | |
| 100kΩ* | Z | $\pm[(3.3+\frac{0.56}{f})\%$ of reading +4 counts] | | | |
| | θ | $\pm(3.0+\frac{1.9}{f}+\frac{35}{Z})$ degrees | | | |

Where, f is test frequency in MHz, and Z is number of MAGNITUDE display counts. On the 100kΩ range, the small zero "o" is not counted in Z.

*: Measurement accuracy is not specified above 100kΩ.

Table 1-1. Specifications (Sheet 2 of 5)

TEST FREQUENCY:

Range and Resolution:

| TEST FREQUENCY RANGE | RESOLUTION |
|---|---|
| 0.400 to 9.999MHz | 1kHz |
| 10.00 to 99.99MHz | 10kHz |
| 100.0 to 110.0MHz | 100kHz |

Accuracy: ±0.01% of setting

Stability: ±100 ppm (at 0 °C to 55 °C)

Full Frequency Sweep:

Test frequency is automatically and logarithmically swept from 400kHz to 110MHz. Measurement is made at the following 43 frequency points.

400kHz, 455kHz, 500kHz, 600kHz, 700kHz, 800kHz, 900kHz, 1MHz, 1.2MHz, 1.4MHz, 1.6MHz, 1.8MHz, 2MHz, 2.333MHz, 2.666MHz, 3MHz, 3.5MHz, 4MHz, 4.5MHz, 5MHz, 6MHz, 7MHz, 8MHz, 9MHz, 10MHz, 12MHz, 14MHz, 16MHz, 18MHz, 20MHz, 23.33MHz, 26.66MHz, 30MHz, 35MHz, 40MHz, 45MHz, 50MHz, 60MHz, 70MHz, 80MHz, 90MHz, 100MHz, 110MHz.

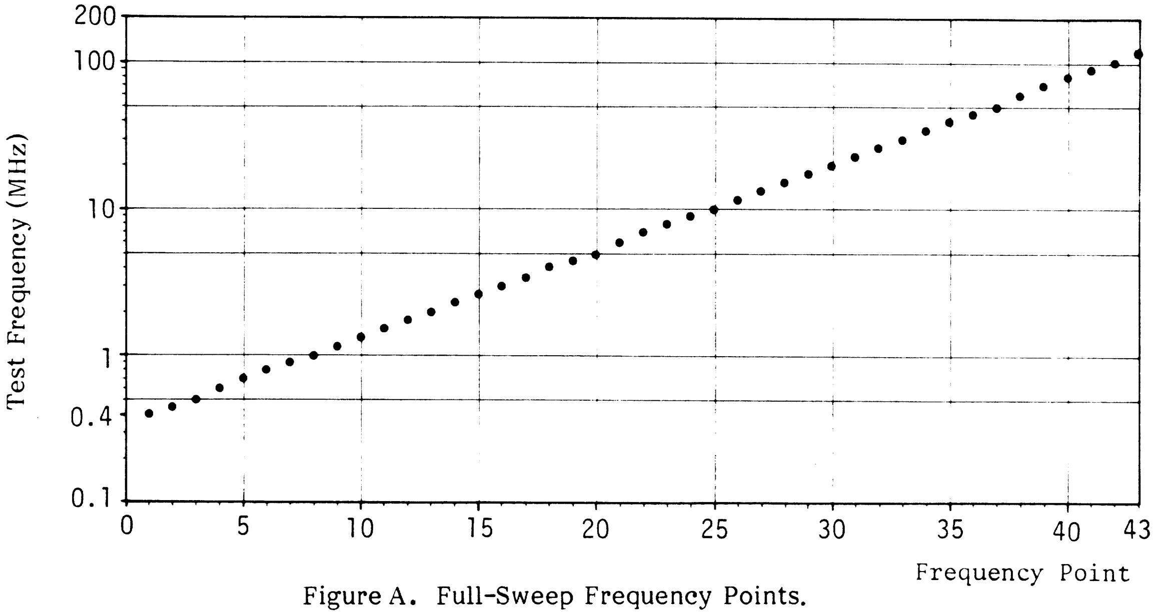


Figure A. Full-Sweep Frequency Points.

Table 1-1. Specifications (Sheet 3 of 5)

Partial Frequency Sweep :

Test frequency is automatically and linearly swept from the selected START FREQ. to the selected STOP FREQ. Number of measurement points is selectable with the STEPS keys--100, 1000, HIGH RESOLN.

| | |
|---|---|
| 100 : | One hundred measurement points. |
| 1000: | One thousand measurement points. |
| HIGH RESOLN : | Maximum step resolution for the selected sweep frequency range (START to STOP) is automatically selected. |

MEASUREMENT TERMINAL : Two-terminal low-grounded probe, connected to instrument with a coaxial cable.

REFERENCE PLANE : Probe tip without probe pin.

RECORDER OUTPUTS : DC voltage outputs proportional to displayed values.

Magnitude Output : 0 to 1 Vdc proportional to displayed MAGNITUDE value max 1 Vdc (at 2000 counts).

Phase Output : -1 Vdc to +1 Vdc proportional to displayed PHASE value max ±1 Vdc (at ±1800 counts).

Frequency Output : 0 to 1 Vdc proportional to test frequency, as follows:

$$V_F = \frac{F_{SPOT} - F_{START}}{F_{STOP} - F_{START}} \quad \text{for manual and Partial Sweep}$$

$$V_F = \frac{\log\ (F_{SPOT} / F_{START})}{\log\ (F_{STOP} / F_{START})} \quad \text{for Full Sweep}$$

where, $V_F$ is the analog output voltage.

0 Vdc and 1 Vdc for START frequency and STOP frequency, respectively.

PEN LIFT : TTL level signal. Goes LOW (PEN DOWN) at start of frequency sweep; goes HIGH (PEN UP) at completion of frequency sweep.

TRIGGER : Internal, external, or manual.

EXTERNAL TEST SIGNAL : External oscillator can be connected to obtain higher test frequency resolution.

Frequency : 400kHz to 110MHz.
Input Level : 0dBm to +5dBm.
Input Terminal : BNC connector.

Table 1-1. Specifications (Sheet 4 of 5)

SELF TEST: Checks the 4193A's basic operation and displays the test results. Initiated each time the instrument is turned on or when the SELF TEST mode is set by the SELF TEST key or via the HP-IB. Refer to paragraph 3-7.

HP-IB INTERFACE: Remote control and data output via the HP-IB (based on IEEE-Std-488 and ANSI-MC1•).

Interface Capability: SH1, AH1, T5, L4, SR1, RL1, DC1, DT1, E1

Remote Control Function: All front-panel functions except LINE ON/OFF switch

Data Output: Measured impedance magnitude and phase values, test frequency value, and measurement setting information.

WARM-UP TIME: ≧60 minutes

AMBIENT TEMPERATURE: 23 °C±5 °C (error limits double in magnitude and phase accuracies for 0 °C to 55 °C temperature range).

## GENERAL

Operating Temperature: 0 °C to +55 °C

Storage Temperature: -40 °C to +75 °C

Humidity: _95% at 40 °C

Power Requirements: 100, 120, 220V ±10%; 240V +5% -10%;
48 to 66Hz; power consumption 150VA, maximum

Probe Cable Length: Approximately 150cm, measured from the front-panel to the probe tip.

Dimensions: 426mm (W) x 177mm (H) x 513mm (D) (16.77" x 7" x 20")

Weight: Approximately 18 kg.

## OPTIONS

| | |
|---|---|
| Option 907: | Front handle kit (P/N 5061-0090) |
| Option 908: | Rack flange kit (P/N 5061-0078) |
| Option 909: | Rack flange and handle kit (P/N 5061-0084) |
| Option 910: | Extra Manual |

Table 1-1. Specifications (Sheet 5 of 5)

## ACCESSORIES

Accessories Supplied :

| Part Number | Accessory Name | Q'ty |
|---|---|---|
| 04193-61151 | Probe | 1 |
| 04193-61152 | Probe Adapter | 1 |
| 04193-61153 | Component Adapter | 1 |
| 04193-61154 | Ground Adapter | 1 |
| 04193-61629 | Ground Lead | 1 |
| 04193-21008 | Probe Socket | 1 |
| 0360-2065 | Spare Clips | 3 |
| 04193-21023 | Spare N-type Pins | 5 |
| 16095-29005 | Spare Pins | 10 |
| 04193-60152 | Probe Kit Case | 1 |
| 1540-0692 | Pin Case | 3 |

Accessories Available :

| | |
|---|---|
| 16099A TEST FIXTURE ADAPTER : | Connects Probe to one of three test fixtures, Model 16092A/16093A/16093B, for component measurement. |
| 16345A PROBE TYPE CALIBRATION BOX : | Contains 10 standards, SHORT/OPEN/ 10Ω/50Ω/100Ω/180Ω/1kΩ/1.8kΩ/10kΩ/5pF, for calibration of probe-type instruments. |
| 16092A SPRING CLIP FIXTURE : | Mounts atop the 16099A TEST FIXTURE ADAPTER. Used for discrete component measurements. |
| 16093A BINDING POST FIXTURE : | Mounts atop the 16099A TEST FIXTURE ADAPTER. Used for discrete component measurements. |
| 16093B BINDING POST FIXTURE : | Mounts atop the 16099A TEST FIXTURE ADAPTER. Used for discrete component measurements. |

Table 1-2. General Information

## SUPPLEMENTAL PERFORMANCE CHARACTERISTICS

### MEASUREMENT TIME

| | |
|---|---|
| Normal Mode : | Approximately 1 sec. (typical) |
| High Speed Mode : | Approximately 150 msec. (typical) |

### FREQUENCY SETTLING TIME

Approximately 5ms to 400ms

### RANGING TIME

Approximately 1.2s

### PROBE WITHSTAND VOLTAGE

DC : 50V maximum
AC : 5Vrms maximum

### OUTPUT IMPEDANCE

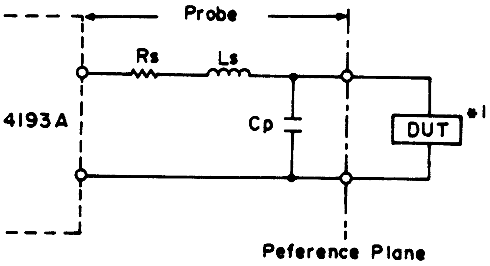
Approximately 25Ω with 0.2μF series capacitance

### RESIDUALS

Resistance in series with DUT (Rs) :$\leq 0.55\Omega$

Inductance in series with DUT (Ls) :$\leq(4.9 + \frac{10}{f})\mathrm{nH}^{*2}$

Capacitance in parallel with DUT (Cp) :$\leq 0.11\mathrm{pF}$



Note

*1 : DUT includes the probe pin.
*2 : f is test frequency in MHz.

### TEST SIGNAL LEVEL :

| MAGNITUDE RANGE | CURRENT Thru DUT (μArms) |
|---|---|
| 10Ω | 100 |
| 100Ω | 100 |
| 1kΩ | 100 |
| 10kΩ | 50 |
| 100kΩ | 10 |

Note : Current through the DUT is constant for each magnitude range.

Accuracy : ±20%

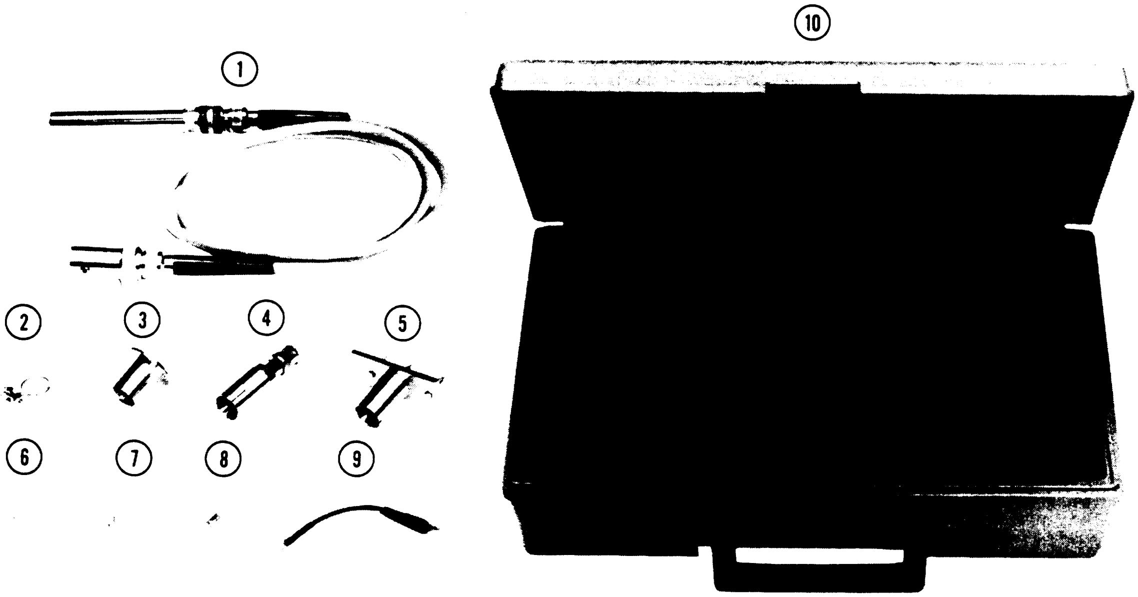
### RESIDUAL FM

100Hz$_{P-P}$ for 1 thru 110MHz at 100Hz BW.

### SKIP ERROR

10 counts maximum at 2.5MHz, 5MHz, and 10MHz.

Table 1-3. Probe Kit for 4193A



* Kit Part No.: 04193-87001

| Reference | HP Part Number | Qty | Description |
|---|---|---|---|
| ① | 04193-61151 | 1 | PROBE |
| ② | 04193-61154 | 1 | GROUND ADAPTER |
| ③ | 04193-21008 | 1 | PROBE SOCKET |
| ④ | 04193-61152 | 1 | BNC ADAPTER |
| ⑤ | 04193-61153 | 1 | COMPONENT ADAPTER |
| ⑥ | 04193-60153 | 1 | SPARE N-TYPE PIN SET<br>Contains five spare N-type pins (HP Part No.: 04193-21023) |
| ⑦ | 16095-60012 | 1 | SPARE PIN SET<br>Contains ten spare N-type pins (HP Part No.: 16095-29005 ) |
| ⑧ | 04193-60151 | 1 | SPARE CLIP SET<br>Contains three spare clips (HP Part No.: 0360-2065) |
| ⑨ | 04193-61629 | 1 | GROUND LEAD |
| ⑩ | 04193-60152 | 1 | PROBE KIT CASE |

Table 1-4. Accessories Available (Sheet 1 of 3)

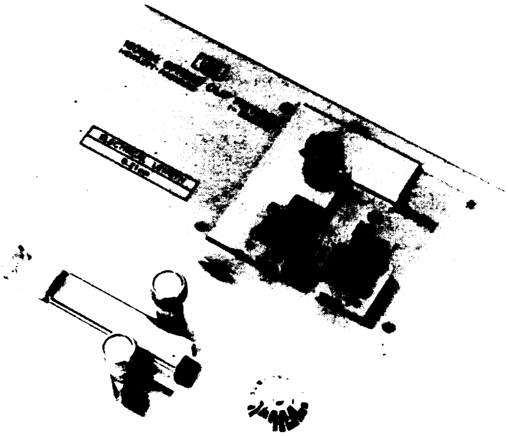
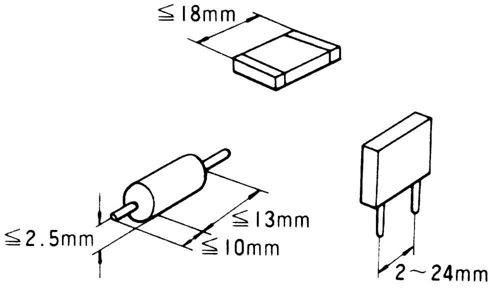
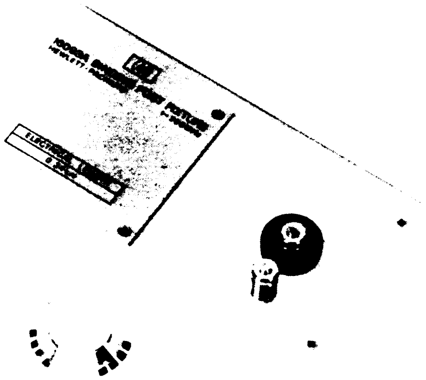
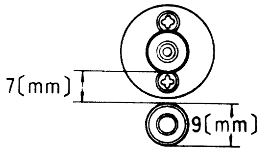
| Model | Description |
|---|---|
| HP16092A Spring Clip Fixture<br> | Test Fixture (direct attachment type) for measurement of both axial and radial lead components and lead-less chip elements. Spring clip contacts are capable of holding samples of dimensions given below :<br><br> <br>A combined slide gauge provides direct readouts of the physical length of the sample tested. Usable frequency range is DC to 500MHz. The 16099A Test Fixture Adapter is necessary to connect the 4193A Probe. |
| HP16093A Binding Post Fixture<br> | Test Fixture (direct attachment type) for measurement of both axial and radial lead miniature components. Two binding post terminals at an interval of 7mm on the terminal deck ensure optimum contact of terminals and sample leads.<br><br> <br>Usable frequency range is DC to 250MHz. The 16099A Test Fixture Adapter is necessary to connect the 4193A Probe. |

Table 1-4. Accessories Available (sheet 2 of 3)

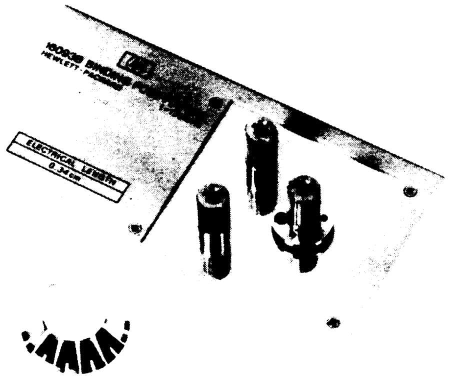
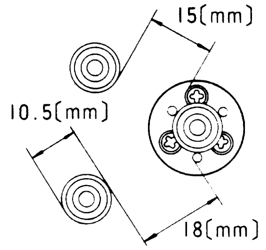
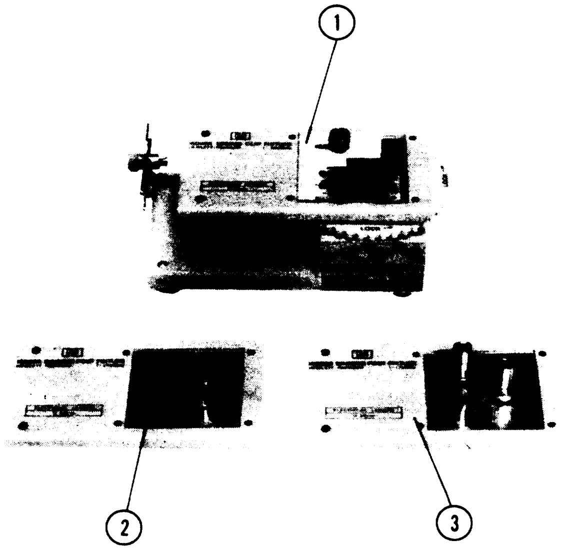
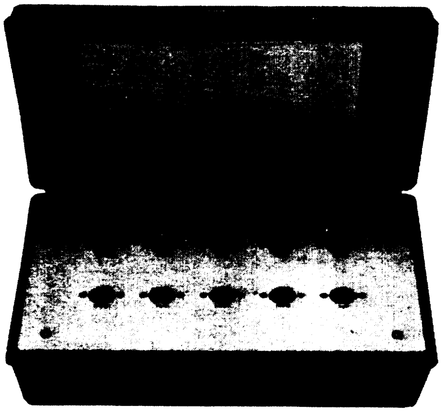
| Model | Description |
|---|---|
| HP16093B Binding Post Fixture<br> | Test Fixture (direct attachment type) for general measurement of both axial and radial lead components. Three binding post terminals are located on the terminal deck as shown below :<br> <br>Usable frequency range is DC to 125MHz. The 16099A Test Fixture Adapter is necessary to connect the 4193A Probe. |
| HP 16099A Test Fixture Adapter<br> | Test Fixture Adapter for connecting the 4193A probe to one of the three available test fixtures—16092A, 16093A, and 16093B.<br>Note : The 16099A and each of the available test fixtures must be ordered separately.<br>① :HP16092A SPRING CLIP FIXTURE<br>② :HP16093A BINDING POST FIXTURE<br>③ :HP16093B BINDING POST FIXTURE |

Table 1-4. Accessories Available (sheet 3 of 3)

| Model | Description |
|---|---|
| HP16345A Probe Type Calibration Box<br> | Calibration standard for performance testing and adjustment of the 4193A. Includes ten probe-insertable standards : OPEN, SHORT, 10Ω, 50Ω, 100Ω, 180Ω, 1kΩ, 1.8kΩ, 10kΩ, and 5pF. If a standard is damaged or fails to perform properly, contact your nearest Hewlett-Packard Sales and Service Office.<br>Dimensions : 310(W)x80(H)x205(D) [mm]<br>Weight : Approximately 2.1kg |

# SECTION II
# INSTALLATION

## 2-1. INTRODUCTION

2-2. This section provides installation instructions for the Model 4193A Vector Impedance Meter. This section also includes information on initial inspection and damage claims, preparation for using the 4193A, packaging, storage, and shipment.

## 2-3. INITIAL INSPECTION

2-4. The 4193A Vector Impedance Meter, as shipped from the factory, meets all the specifications listed in Table 1-1. On receipt, inspect the shipping container for damage. If the shipping container or cushioning material is damaged, notify the carrier as well as the nearest Hewlett-Packard office and be sure to keep the shipping materials for carrier's inspection until the contents of the shipment have been checked for completeness and the instrument has been checked mechanically and electrically. The contents of the shipment should be as shown in Figure 1-1. The procedures for checking the general electrical operation are given in Section III (Paragraph 3-7 SELF TEST) and the procedures for checking the 4193A Vector Impedance Meter against its specifications are given in Section IV. First, do the self test. If the 4193A Vector Impedance Meter is electrically questionable, then do the Performance Tests to determine whether the 4193A has failed or not.

If the contents are incomplete, if there is mechanical damage or defects (scratches, dents, broken switches, etc.), or if the performance does not meet the self test or performance tests, notify the nearest Hewlett-Packard office (see list at back of this manual). The HP office will arrange for repair or replacement without waiting for claim settlement.

## 2-5. PREPARATION FOR USE

## 2-6. POWER REQUIREMENTS

2-7. The 4193A requires a power source of 100, 120, 220Volts ac +10%, or 240Volts ac +5%-10%, 48 to 66Hz single phase; power consumption is 150VA maximum.

WARNING

IF THE INSTRUMENT IS TO BE ENERGIZED VIA AN EXTERNAL AUTOTRANSFORMER FOR VOLTAGE REDUCTION, BE SURE THAT THE COMMON TERMINAL IS CONNECTED TO THE NEUTRAL POLE OF THE POWER SUPPLY.

## 2-8. Line Voltage and Fuse Selection

CAUTION

BEFORE TURNING THE 4193A LINE SWITCH TO ON, VERIFY THAT THE INSTRUMENT IS SET TO THE VOLTAGE OF THE POWER TO BE SUPPLIED.

2-9. Figure 2-1 provides instructions for line voltage and fuse selection. The line voltage selection switch and the proper fuse are factory installed for 100 or 120 volts ac operation.

CAUTION

USE PROPER FUSE FOR LINE VOLTAGE SELECTED.

CAUTION

MAKE SURE THAT ONLY FUSES FOR THE REQUIRED RATED CURRENT AND OF THE SPECIFIED TYPE ARE USED FOR REPLACEMENT. THE USE OF MENDED FUSES AND THE SHORT-CIRCUITING OF FUSE-HOLDERS MUST BE AVOIDED.

## 2-10. POWER CABLE

2-11. To protect operating personnel, the National Electrical Manufacturer's Association (NEMA) recommends that the instrument panel and cabinet be grounded. The Model 4193A is equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cable is the ground wire.

2-12. To preserve the protection feature when operating the instrument from a two contact outlet, use a three prong to two prong adapter (HP Part No. 1251-0048) and connect the green pigtail on the adapter to power line ground.

### CAUTION

THE MAINS PLUG MUST ONLY BE INSERTED IN A SOCKET OUTLET PROVIDED WITH A PROTECTIVE EARTH CONTACT. THE PROTECTIVE ACTION MUST NOT BE NEGATED BY THE USE OF AN EXTENSION CORD (POWER CABLE) WITHOUT PROTECTIVE CONDUCTOR (GROUNDING).

2-13. Figure 2-2 shows the available power cords, which may be used in various countries including the standard power cord furnished with the instrument. HP Part number, applicable standards for power plug, power cord color, electrical characteristics and countries using each power cord are listed in the figure. If assistance is needed for selecting the correct power cable, contact the nearest Hewlett-Packard office.

## 2-14. OPERATING ENVIRONMENT

2-15. Temperature. The instrument may be operated in temperatures from 0°C to +55°C.

2-16. Humidity. The instrument may be operated in environments with relative humidities to 90% at 40°C. However, the instrument should be protected from temperature extremes which cause condensation within the instrument.

## 2-17. INSTALLATION INSTRUCTIONS

2-18. The HP Model 4193A can be operated on the bench or in a rack mount. The 4193A is ready for bench operation as shipped from the factory. For bench operation a two-leg instrument stand is used. For use, the instrument stands are designed to be pulled towards the front of instrument.

### 2-19. Installation of Options 907, 908 and 909

2-20. The 4193A can be installed in a rack and be operated as a component of a measurement system. Rack mounting information for the 4193A is presented in Figure 2-3.

## 2-21. STORAGE AND SHIPMENT

## 2-22. ENVIRONMENT

2-23. The instrument may be stored or shipped in environments within the following limits:

Temperature ........ -40 °C to +75 °C
Humidity ............ to 95% at 40 °C

The instrument should be protected from temperature extremes which cause condensation inside the instrument.

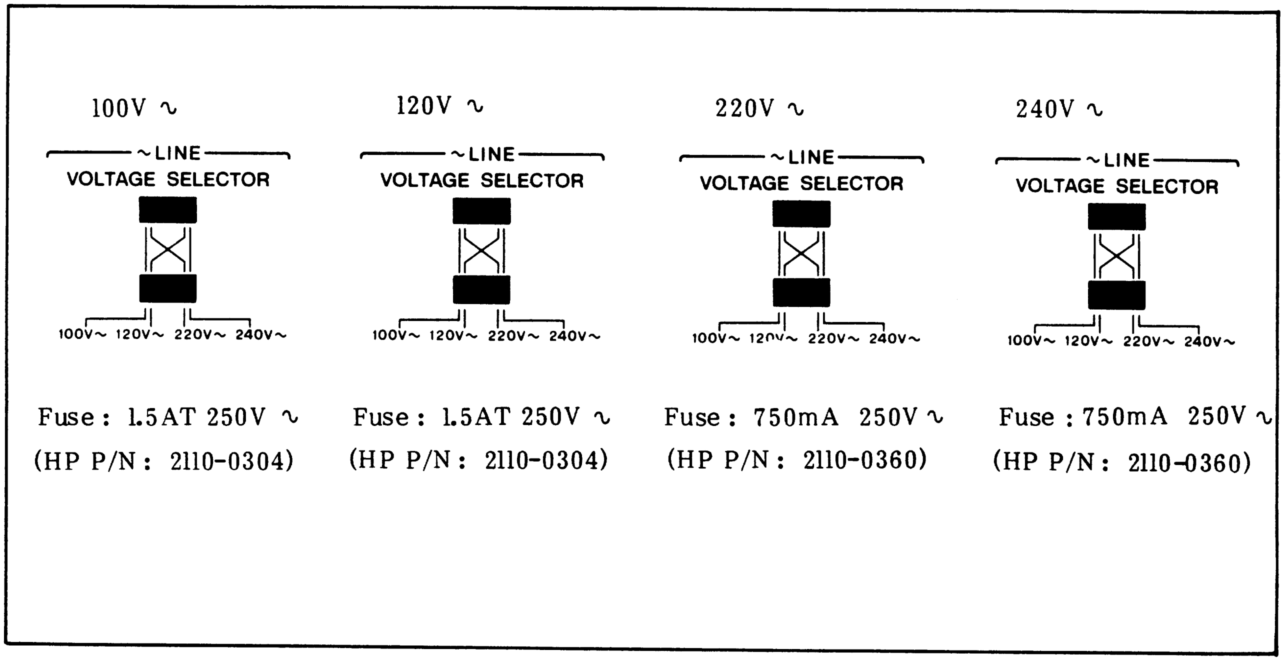
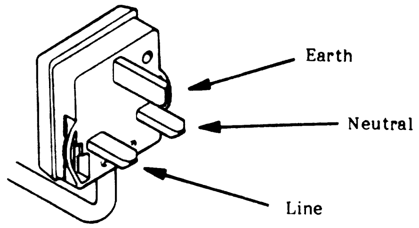


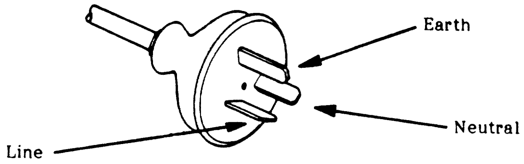
Figure 2-1. Voltage and Fuse Selection.

OPTION 900 United Kingdom



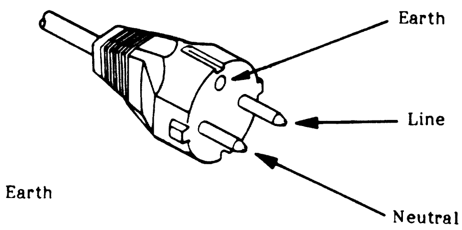
Plug : BS 1363A, 250V
Cable : HP 8120-1351

OPTION 901 Australia/New Zealand



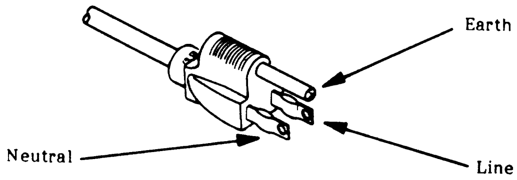
Plug : NZSS 198/AS C112, 250V
Cable : HP 8120-1369

OPTION 902 European Continent



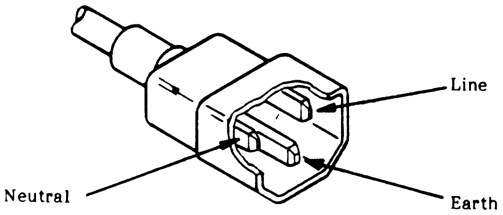
Plug : CEE-VII, 250V
Cable : HP 8120-1689

OPTION 903 U.S./Canada



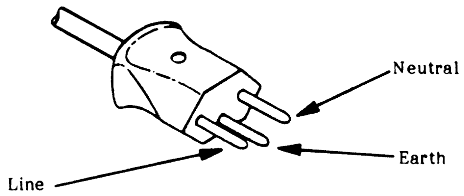
Plug : NEMA 5-15P, 125V, 15A
Cable : HP 8120-1378

OPTION 905* Any country



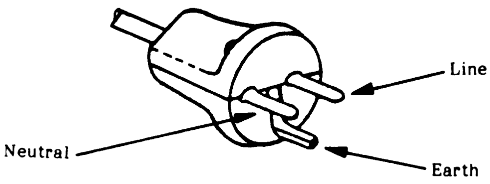
Plug : CEE 22-VI, 250V
Cable : HP 8120-1396

OPTION 906 Switzerland



Plug : SEV 1011.1959-24507 Type 12, 250V
Cable : HP 8120-2104

OPTION 912 Denmark



Plug : DHCR 107, 220V
Cable : HP 8120-2956

* Plug option 905 is frequently used for interconnecting system components and peripherals.

NOTE: Each option number includes a 'family' of cords and connectors of various materials and plug body configurations (straight, 90 ° etc.)

Figure 2-2. Power Cables Supplied.

## 2-24. PACKAGING

2-25. Original Packaging. Containers and materials identical to those used in factory packaging are available from Hewlett-Packard. If the instrument is being returned to Hewlett-Packard for servicing, attach a tag indicating the type of service required, return address, model number, and full serial number. Also mark the container FRAGILE to assure careful handling. In any correspondence, refer to the instrument by model number and full serial number.

2-26. Other Packaging. The following general instructions should be used for re-packing with commercially available materials:

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

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

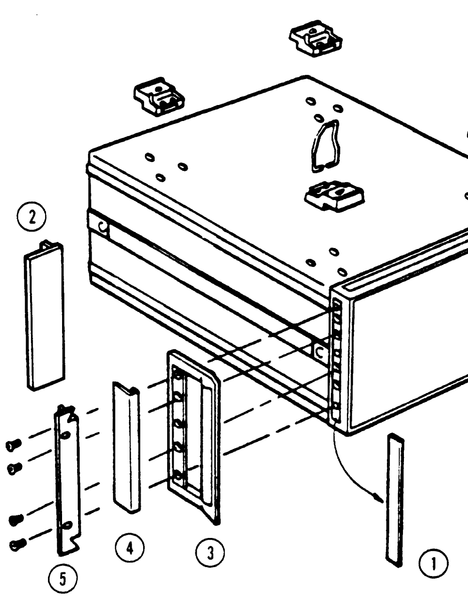
c. Use enough shock absorbing material (3 to 4 inch layer) around all sides of instrument to provide firm cushion and prevent movement inside container. Protect control panel with cardboard.

d. Seal shipping container securely.

e. Mark shipping container FRAGILE to ensure careful handling.

f. In any correspondence, refer to instrument by model number and full serial number.

| Option | Kit Part Number | Parts Included | Part Number | Q'ty | Remarks |
|---|---|---|---|---|---|
| 907 | Handle Kit<br>5061-0090 | Front Handle<br>Trim Strip<br>X8-32 x 3/8 Screw | ③ 5060-9900<br>④ 5020-8897<br>2510-0195 | 2<br>2<br>6 | <br><br>9.525mm |
| 908 | Rack Flange Kit<br>5061-0078 | Rack Mount Flange<br>X8-32 x 3/8 Screw | ② 5020-8863<br>2510-0193 | 2<br>6 | <br>9.525mm |
| 909 | Rack Flange &<br>Handle Kit<br>5061-0084 | Front handle<br>Rack Mount Flange<br>X8-32 x 3/8 Screw | ③ 5060-9900<br>⑤ 5020-8875<br>2510-0194 | 2<br>2<br>6 | <br><br>15.875mm |



1. Remove adhesive-backed trim strips ① from side at right and left front of instrument.
2. HANDLE INSTALLATION : Attach front handle ③ to sides at right and left front of instrument with screws provided and attach trim ④ to handle.
3. RACK MOUNTING : Attach rack mount flange ② to sides at right and left front of instrument with screws provided.
4. HANDLE AND RACK MOUNTING : Attach front handle ③ and rack mount flange ⑤ together to sides at right and left front of instrument with screws provided.
5. When rack mounting (3 and 4 above), remove all four feet (lift bar at inner side of foot, and slide foot toward the bar).

Figure 2-3. Rack Mount Kit.

# SECTION III
# OPERATION

## 3-1. INTRODUCTION

3-2. This section provides all the information necessary to operate the Model 4193A Vector Impedance Meter. Included are descriptions of the front- and rear-panels, displays, lamps and connectors; discussions on operating procedures and measuring techniques for various applications; and instructions on the instrument's SELF TEST function. Warnings, Cautions, and Notes are given throughout; they should be observed to insure the safety of the operator and the serviceability of the instrument.

WARNING

BEFORE THE INSTRUMENT IS SWITCHED ON, ALL PROTECTIVE EARTH TERMINALS, EXTENSION CORDS, AUTO-TRANSFORMERS AND DEVICES CONNECTED TO IT SHOULD BE CONNECTED TO A PROTECTIVE EARTH GROUNDED SOCKET. ANY INTERRUPTION OF THE PROTECTIVE EARTH GROUNDING WILL CAUSE A POTENTIAL SHOCK HAZARD THAT COULD RESULT IN SERIOUS PERSONAL INJURY.

ONLY FUSES WITH THE REQUIRED RATED CURRENT AND OF THE SPECIFIED TYPE SHOULD BE USED. DO NOT USE REPAIRED FUSES OR SHORTED FUSEHOLDERS. TO DO SO COULD CAUSE A SHOCK OR FIRE HAZARD.

CAUTION

BEFORE THE INSTRUMENT IS SWITCHED ON, IT MUST BE SET TO THE VOLTAGE OF THE POWER SOURCE (MAINS), OR DAMAGE TO THE INSTRUMENT MAY RESULT.

## 3-3. OPERATING INSTRUCTIONS

3-4. Operating instructions for the instrument's basic capabilities are given in paragraphs 3-5 through 3-44. Operating instructions for the instrument's extended capabilities (remote operation via the HP-IB, X-Y Recorder Outputs, and External Oscillator) are covered in paragraphs 3-45 through 3-80.

## 3-5. PANEL FEATURES

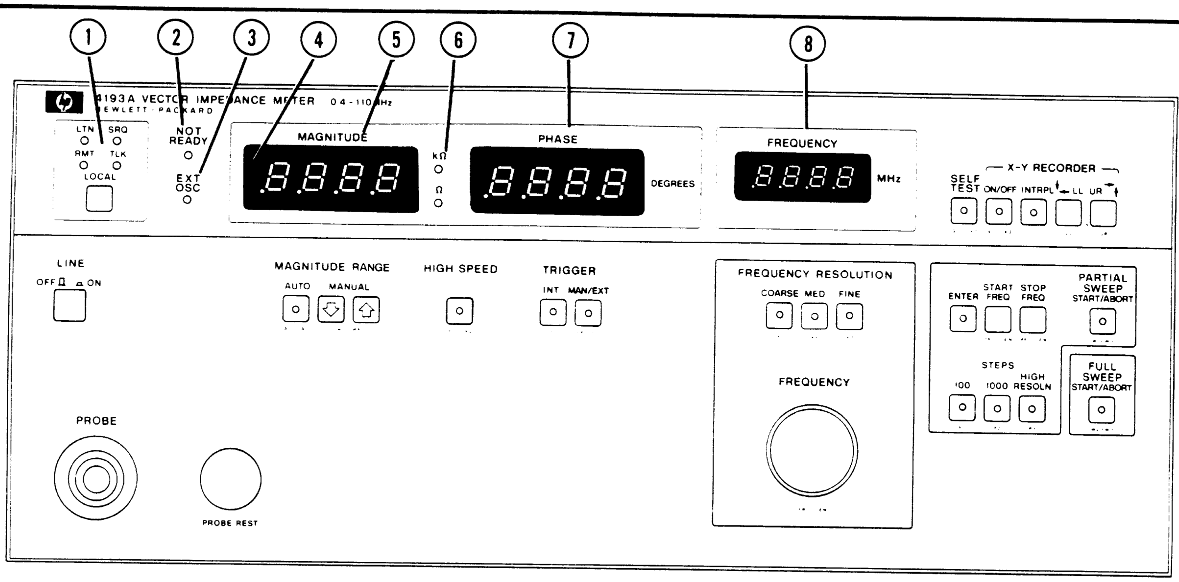
3-6. Front- and rear-panel features for the 4193A are described in Figure 3-1 and Figure 3-2, respectively. More detailed information on the panel displays and controls is given in paragraph 3-7 and below.

## 3-7. SELF TEST

3-8. The 4193A is equipped with an automatic self-diagnostic function that can be initiated at any time to confirm normal operation of the instrument's basic functions. SELF TEST can be initiated from the front-panel by pressing the SELF TEST key or via HP-IB remote control (program code S1). When SELF TEST is initiated (key indicator lamp is on), eight tests of the instruments digital section are performed and the results (pass code or one of the error codes listed in Table 3-5) are displayed on the FREQUENCY display. If no errors are detected, pass codes P1 through P7, P40, and PASS will be sequentially displayed on the FREQUENCY display and the instrument will then return to normal measurement mode (SELF TEST key indicator lamp off). If an error is detected, the corresponding error code--listed in Table 3-5—will be displayed on the FREQUENCY display and SELF TEST will stop. Error code E-61 is not an instrument failure. Refer to Table 3-3 for the cause and remedy. If the instrument fails SELF TEST (an error code other than E-61 is displayed), contact the nearest Hewlett-Packard Service Office. A list of addresses is provided at the back of this manual.

Note

An abbreviated SELF TEST is automatically performed each time the instrument is turned on. Only error codes--if an error is detected--PASS or FAIL, and the instrument's HP-IB address are displayed at the end of this SELF TEST.



① HP-IB Status Indicators and LOCAL Key :
These four LED lamps -- SRQ, LISTEN, TALK, and REMOTE -- indicate the status of the 4193A when it is interfaced with and under the control of a controller via the HP-IB.
The LOCAL key, when pressed, releases the instrument from REMOTE (HP-IB) control and enables control via the front-panel. The LOCAL key does not function when the instrument is set to "local lockout" by the controller.

② NOT READY Lamp :
Indicates that the RF test signal is unstable or that the measured value exceeds the magnitude range limit.

③ EXT OSC Lamp :
Comes on when an external signal source is connected to the EXT OSC connector on the rear-panel.

④ Trigger Lamp :
Comes on each time the instrument is internally or manually triggered. Measurement is in progress when the lamp is on. Trigger mode is set by the TRIGGER keys ⑮.

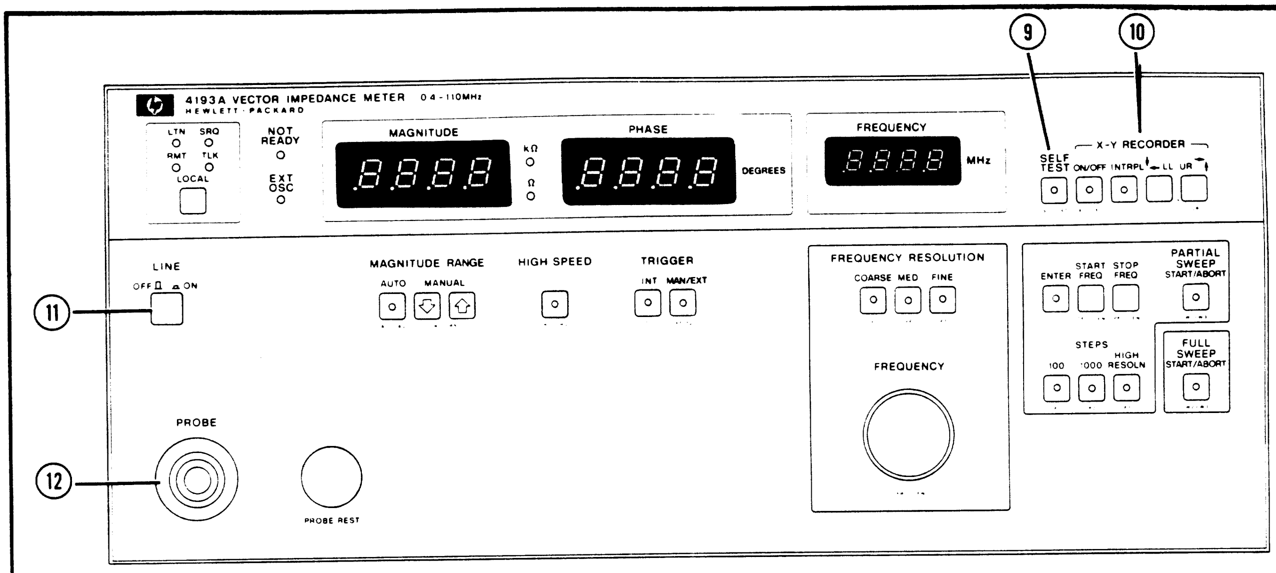
⑤ MAGNITUDE Display :
Displays absolute values of vector impedance (|Z|) in a maximum 3-1/2 digit decimal number from 0000 to 1999 (actual number of digits depends on the |Z| range). If the measured |Z| value exceeds the range limit, an alphabetic annunciation (0r - N, where N represents the range number) will appear on this display.

⑥ Unit Indicator Lamps :
Indicates the unit for the displayed magnitude value : kΩ or Ω.

⑦ PHASE Display :
Displays the measured phase angle (θ) in four digits. The range is from 000.0 to ±180.0 degrees. If " 0r - N" (where N represents the |Z| range number) appears on the MAGNITUDE display, "- - - -" is displayed on this display.

⑧ FREQUENCY Display :
Displays, in MHz, the spot test frequency, and swept frequency parameters (START and STOP frequencies). When the instrument is turned on, various SELF TEST messages and HP-IB address are sequentially displayed on this display.

Figure 3-1. Front Panel Features (Sheet 1 of 4).



⑨ SELF TEST Key and Indicator :
This key initiates the instrument's SELF TEST function. During SELF TEST (when the indicator is on), eight tests, which check the basic operation of the instrument, are automatically performed. Pass codes and error messages are displayed on the FREQUENCY display ⑧. When the SELF TEST is completed, the indicator goes off and the instrument is returned to normal measurement mode. A brief discription of each test and the meaning of each error message is given in paragraph 3-28.

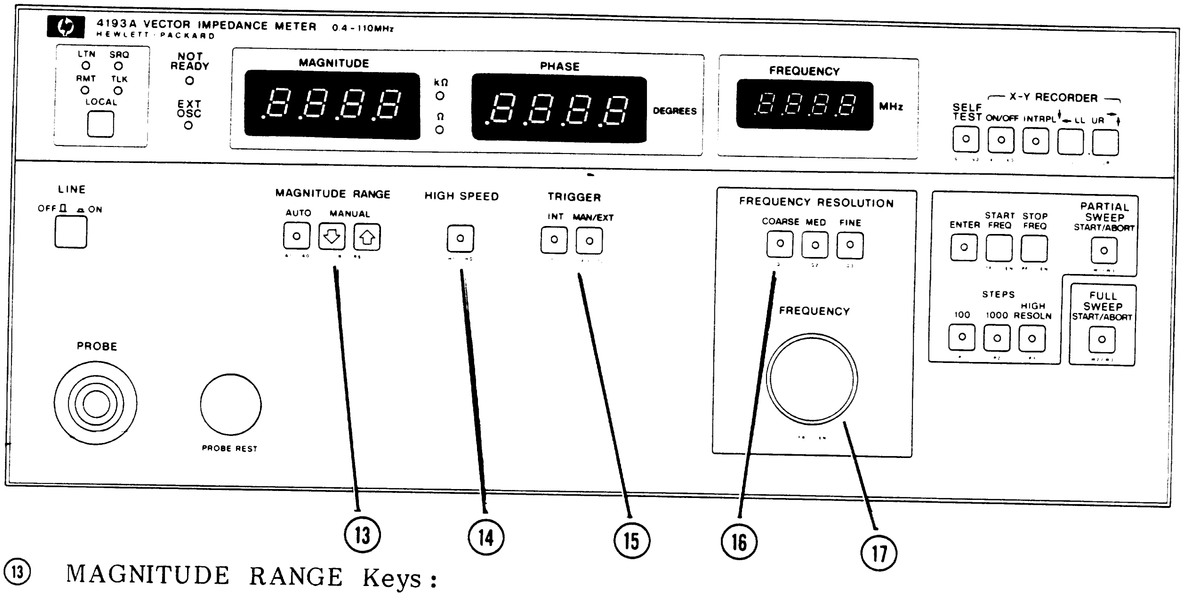
⑩ X-Y RECORDER Function Keys :
These keys control the instrument's analog output capability. Voltage proportional to the measurement results is output from the X-Y RECORDER OUTPUT connectors on the rear-panel.

| | |
|---|---|
| ON : | Analog data representing the measured impedance and phase values and the test frequency are output from the X-Y RECORDER OUTPUT connectors on the rear-panel. Indicator lamp is on in this state. |
| OFF : | No analog data are output, and X-Y RECORDER zero- and full-scale adjustments can be made. Indicator lamp is off in this state. |
| INTRPL : | Linear interpolation. Smooths curves plotted on the X-Y Recorder. |
| ↓← LL : | Provides the zero reference voltage (0V) from each rear-panel X-Y RECORDER OUTPUT connector. Used for zero positioning of the recorder pen. When this key is pressed, the recorder pen will be positioned at the lower-left (X and Y zero) of the plot area. |
| UR →↑: | Provides the full-scale reference voltage (1V) from each rear-panel X-Y RECORDER OUTPUT connector. Used for full-scale positioning of the recorder pen. When this key is pressed, the recorder pen will be positioned at the upper-right (X and Y maximum) of the plot area. |

⑪ LINE OFF/ON :
Applies ac line power to the instrument when set to the ON (in) position; removes ac line power when set to the OFF (out) position.

⑫ PROBE Connector :
Probe cable connects to this connector.

Figure 3-1. Front Panel Features (Sheet 2 of 4).



⑬ MAGNITUDE RANGE Keys:
These keys are used to select the measurement range.

AUTO: When indicator lamp is on, optimum range for the DUT's impedance is automatically selected.

MANUAL: When the AUTO indicator lamp is off, these keys are used to select the measurement range. Once selected, the range will not change even if the sample is changed. Manual ranging is done by pressing the DOWN ( ⇩ ) key or the UP ( ⇧ ) key.

⑭ HIGH SPEED MODE Key:
Shortens the measurement time and increases the measurement cycle speed.

⑮ TRIGGER Keys:
These keys select the trigger mode.

INT: Measurement is triggered by the instrument's internal trigger signal.

MAN/EXT: Measurement is triggered each time this key is pressed, and measurement data are held until the next time the key is pressed. Or the 4193A is triggered by an external trigger.

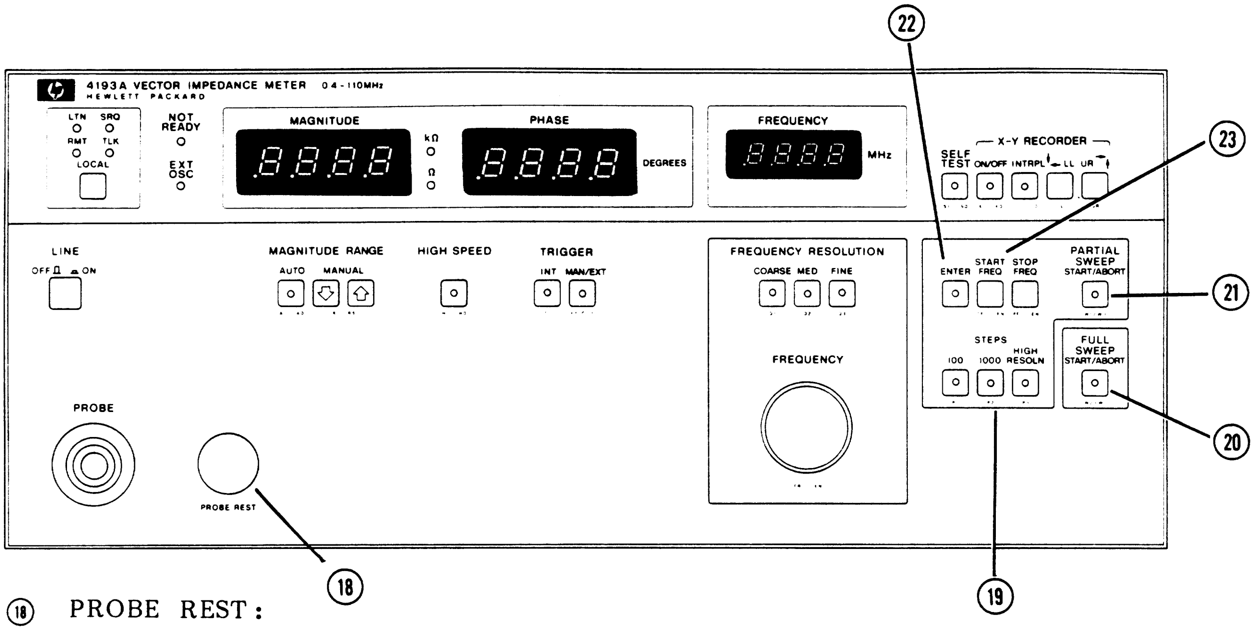
Note

An external trigger signal can be applied from the rear panel connector. External triggering is performed at the trailing edge of the applied TTL pulse. See paragraph 3-32.

⑯ FREQ. RESOLUTION Keys:
Sets the incremental/decremental value for frequency changes made with the Test Frequency Control Dial ⑰. Incremental/decremental value for COARSE, MED, and FINE is 100 counts, 10 counts, and 1 count, respectively.

⑰ Test Frequency Control Dial:
Changes the test frequency. Rotating the dial clockwise increases the frequency; rotating it counterclockwise decreases the frequency.

Figure 3-1. Front Panel Features (Sheet 3 of 4).



⑱ PROBE REST:
Holds the probe when not in use.

⑲ STEPS Keys:
These keys select the number of measurement points for a partial swept-frequency measurement. When the 100 key is pressed, measurement is made at 100 points from the selected START frequency to the selected STOP frequency. The 1000 key functions similarly to the 100 key. The HIGH RESOLUTION key automatically selects the optimum STEP frequency resolution for each frequency range. Refer to Figure 3-4 for details.

Note

There are certain restrictions related to STEP frequency selection; refer to Figure 3-4.

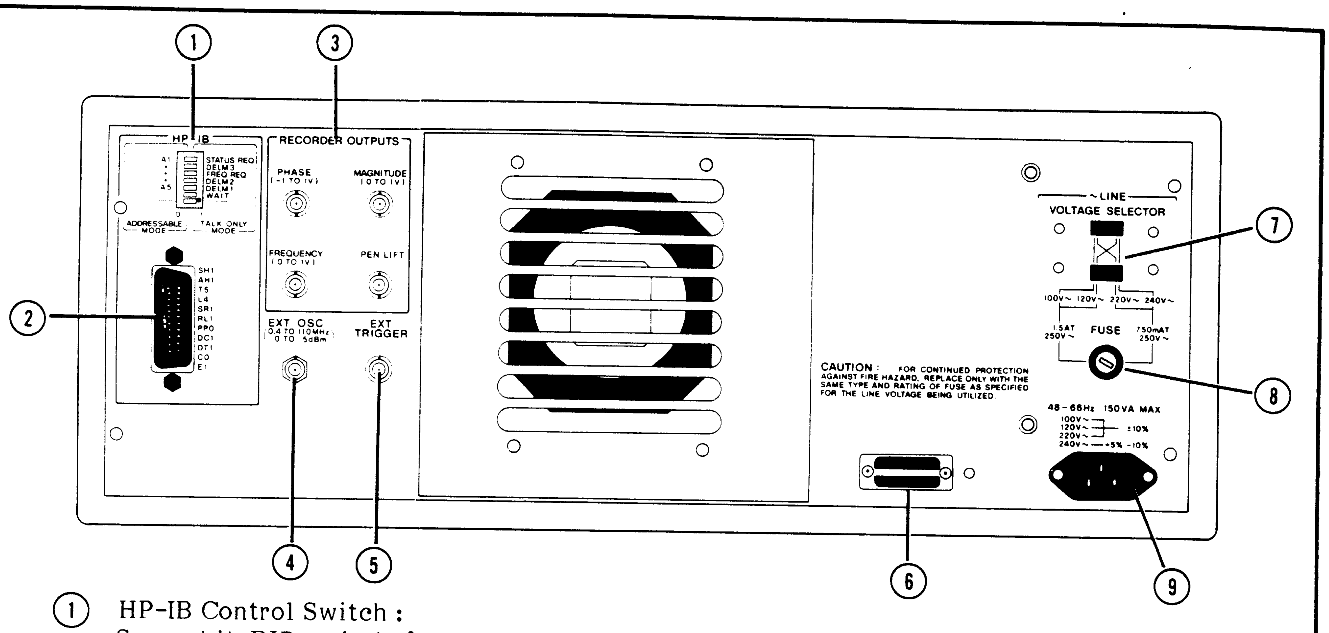
⑳ FULL SWEEP START/ABORT Key:
Starts and stops full-range (400kHz to 110MHz) swept frequency measurements. When this key is pressed, the indicator lamp comes on and the sweep begins. When this key is pressed during swept measurement (indicator lamp on), the sweep stops at the last frequency step.

㉑ PARTIAL SWEEP START/ABORT Key:
Starts and stops partial swept frequency measurements. When this key is pressed, the indicator lamp comes on and the sweep begins. When this key is pressed during swept measurement (indicator lamp on), the sweep stops at the last frequency step.

㉒ ENTER Key:
This key is used in conjunction with the adjacent START FREQ. and STOP FREQ. keys ㉓ to enter the START and STOP frequencies for partial sweeps. When this key is pressed, the indicator lamp comes on and the value displayed on the FREQUENCY display is entered when the START FREQ. key or STOP FREQ. key is pressed.

㉓ START FREQ and STOP FREQ Keys:
These keys are used in conjunction with the adjacent ENTER key ㉒ to enter the START and STOP frequencies for partial sweeps. When either of these keys are pressed while the ENTER key indicator lamp is on, the value displayed on the FREQUENCY display is entered; when pressed while the ENTER key indicator lamp is off, the previously entered START FREQ. or STOP FREQ. is displayed on the FREQUENCY display.

Figure 3-1. Front Panel Features (Sheet 4 of 4).



① HP-IB Control Switch :
Seven-bit DIP switch for setting the instrument's HP-IB address (0-30), data output format, and HP-IB function (Talk Only or Addressable). Details are given in paragraphs 3-61 and 3-62.

② HP-IB Connector :
Twenty-four pin connector; connects to an HP-IB compatible controller or strip recorder. Pin assignments are shown in Figure 3-18.

③ RECORDER OUTPUTS :
Three of these four BNC connectors output voltages proportional to displayed MAGNITUDE, PHASE, and FREQUENCY, and can be connected to an X-Y Recorder to plot impedance/frequency or phase/frequency characteristics. The fourth connector outputs a TTL level DC voltage for X-Y Recorder pen-lift control.

④ EXT OSC Connector :
This connector can be connected to an external frequency synthesizer to obtain higher resolution. Input signal level must be between 0dBm and +5dBm, inclusive.

⑤ EXT TRIGGER Connector :
For external triggering; an external triggering device or signal can be connected to this connector. Details are provided in paragraph 3-32.

⑥ Serial Number Plate :
The instrument's serial number is stamped on this plate. Refer to paragraph 1-17.

⑦ ∿ LINE VOLTAGE SELECTOR Switch :
This switch is used to select the appropriate line voltage. Refer to paragraph 2-8.

⑧ ∿ LINE FUSE Holder :
Instrument's power-line fuse is installed in this holder. Refer to paragraph 2-8.

⑨ ∿ LINE Input Receptacle :
AC power cord is connected to this receptacle. Refer to paragraph 2-10.

Figure 3-2. Rear Panel Features.

## 3-9. INITIAL CONTROL SETTINGS

3-10. To facilitate operation, the instrument is automatically set to the following initial control settings each time it is turned on :

Panel Controls :

MAGNITUDE RANGE ··········· AUTO
HIGH SPEED ······················· OFF
TRIGGER ··························· INT
FREQUENCY RESOLUTION ·· FINE
ENTER ······························ OFF
STEPS ······························· 100
PARTIAL SWEEP ················ OFF
FULL SWEEP ····················· OFF
SELF TEST ························ OFF
X-Y RECORDER ON/OFF ··· OFF
INTERPOLATION ················ OFF

Test Parameters :

SPOT FREQ. ······················ 10MHz
START FREQ ······················ .4MHz
STOP FREQ ························ 110MHz
RECORDER OUTPUTS·········· .0V

## 3-11. MEASUREMENT RANGE

3-12. As given in Table 3-1, the 4193A has five impedance magnitude ranges. When the MAGNITUDE RANGE is set to AUTO, the 4193A will automatically select the appropriate range. On the other hand, when the MAGNITUDE RANGE is set to MANUAL, the range will be fixed. If the magnitude value for the DUT exceeds the range limit, " 0r- - N" (N is 1, 2, 3, 4, or 5 corresponding to the range number) will be displayed on the MAGNITUDE display.

## 3-13. TEST SIGNAL LEVEL

3-14. The test signal current through the DUT is constant for the selected measurement range. Refer to Table 3-1. Accordingly, the voltage across the DUT depends on the DUT impedance.

## 3-15. TEST FREQUENCY

3-16. There are three test frequency ranges, as listed in Table 3-2. Frequency accuracy is 0.01% of the value displayed on the FREQUENCY display. Refer to Figure 3-3 for the frequency setting procedure.

## 3-17. SWEPT FREQUENCY MEASUREMENTS

3-18. The 4193A is capable of two types of frequency sweeps : PARTIAL, from the selected START frequency to the selected STOP frequency; and FULL, from 400kHz to 110MHz.

## 3-19. PARTIAL SWEEP MEASUREMENT

3-20. PARTIAL sweep measurements are used to determine the impedance/phase versus frequency characteristics of a sample over a preselected frequency range. For example, the pass band of a band-pass filter. The test frequency is linearly swept from the selected START frequency to the selected STOP frequency and measurement is made at the number of steps selected by the STEPS keys--100, 1000, or HIGH RES. When HIGH RES is selected, the test frequency is swept (incremented) in accordance with the selected FREQUENCY RESOLUTION key--COARSE, MED, or FINE. The HIGH RES key provides higher step frequency resolution than is possible with the 100 or 1000 STEPS key. For example, if the START frequency is 5MHz, the STOP frequency is 10MHz, and the 1000 STEPS key is selected, measurement is made at 1000 frequency points, which corresponds to a step frequency of 5kHz. But if HIGH RES is used and the FINE key is selected, measurement is made at 5000 frequency points, corresponding to a step frequency of 1kHz. With HIGH RES on, FINE is automatically selected when the PARTIAL SWEEP START/ABORT key is pressed. COARSE or MED can be selected during the sweep. When 100 or 1000 STEPS is selected, the FREQUENCY RESOLUTION keys do not function. The procedure for making a PARTIAL sweep measurement is given in Figure 3-4.

## 3-21. FULL SWEEP MEASUREMENT

3-22. In FULL sweep measurements the test frequency is logarithmically swept over the 4193A's full frequency range and measurement is made at 43 frequency points. Refer to Figure 3-5 for the frequency of each measurement point. A FULL sweep takes approximately 50 seconds in NORMAL speed mode and 15 seconds in HIGH SPEED mode. The procedure for making a FULL sweep measurement is given in Figure 3-5.

Table 3-1. Measurement Range and Test Signal Level

| Magnitude Range | Full-scale Counts | Resolution | Test Signal Level |
|---|---|---|---|
| (1) 10Ω | 19.99 Ω | 10mΩ | 100μArms |
| (2) 100Ω | 199.9 Ω | 100mΩ | 100μArms |
| (3) 1kΩ | 1.999kΩ | 1Ω | 100μArms |
| (4) 10kΩ | 19.99kΩ | 10Ω | 50μArms |
| (5) 100kΩ | 119. kΩ | 1kΩ | 10μArms |

Table 3-2. Test Frequency Range

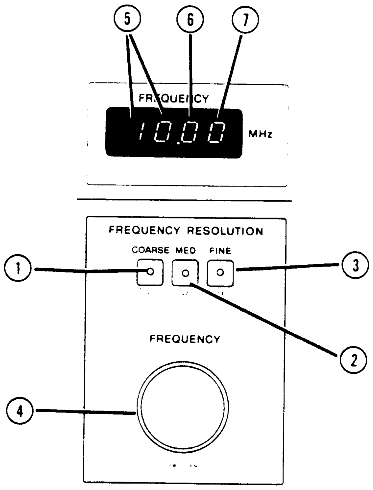
| Test Frequency Range | Resolution |
|---|---|
| .400 to 9.999MHz | 1kHz |
| 10.00 to 99.99MHz | 10kHz |
| 100.0 to 110.0MHz | 100kHz |

## SPOT FREQUENCY SETTING PROCEDURE

To manually change the spot frequency, use the procedure given below :

PROCEDURE :

1. Press the FREQUENCY RESOLUTION key labelled COARSE. The indicator lamp in the ceter of the key will come on.
2. Rotate the FREQUENCY dial (clockwise to increase the frequency, counterclockwise to decrease the frequency) until the two left-most digits of the displayed frequency are at the desired setting.
3. Press the MED key. The indicator lamp in the center of the key will come on.
4. Rotate the FREQUENCY dial until the second digit from the right is at the desired setting.
5. Press the FINE key. The indicator lamp in the center of the key will come on.
6. Rotate the FREQUENCY dial until the right-most digit is at the desired setting.



EXAMPLE

Refer to the figure. The desired spot frequency is 55.55MHz.

1. Press the COARSE key ①.
2. Rotate the FREQUENCY dial ④ clockwise until the two left-most digits ⑤ of the displayed frequency are 55.
3. Press the MED key ②.
4. Rotate the FREQUENCY dial ④ clockwise until the second digit from the right ⑥ is 5.
5. Press the FINE key ③.
6. Rotate the FREQUENCY dial ④ clockwise until the right-most digit ⑦ is 5.

Figure 3-3. Spot Frequency Setting Procedure.

## PARTIAL SWEEP MEASUREMENT

To make a PARTIAL sweep measurement, use the procedure given below :

PROCEDURE :

1. Connect the probe to the sample.
2. Select the desired START frequency. Refer to Figure 3-3 for the procedure.
3. Press the ENTER key. The indicator lamp in the center of the key will come on.
4. Press the START FREQ. key. The ENTER key indicator lamp will go off.
5. Select the desired STOP frequency. Refer to Figure 3-3 for the procedure.
6. Press the ENTER key. The indicator lamp in the center of the key will come on.
7. Press the STOP FREQ. key. The ENTER key indicator lamp will go off.
8. Press the 100, 1000, or HIGH RES STEPS key to select the number of measurement points. Refer to paragraph 3-19.
9. Press the PARTIAL SWEEP START/ABORT key to start the sweep. The indicator lamp in the center of the key will come on. To stop the sweep, press the PARTIAL SWEEP START/ABORT key. The indicator lamp will go off and the sweep will stop immediately.

Note

If the STOP frequency is lower than the START frequency, E-80 will be displayed on the FREQUENCY display when the PARTIAL SWEEP START/ABORT key is pressed.

Note

If the step frequency is too low for the selected frequency range, the 4193A automatically selects an acceptable step frequency. If, for example, the START frequency is 500kHz, the STOP frequency is 600kHz, and 1000 STEPS is selected, the 4193A automatically selects 100 steps. The 1000 STEPS indicator lamp remains on, however. This automatic adjustment can also occur during a sweep when the frequency is swept over a frequency resolution change point; that is, 10MHz and 100MHz.

Note

Manual PARTIAL sweep can be performed by presing the MANUAL TRIGGER key.

Figure 3-4. PARTIAL Sweep Measurement.

## FULL SWEEP MEASUREMENT

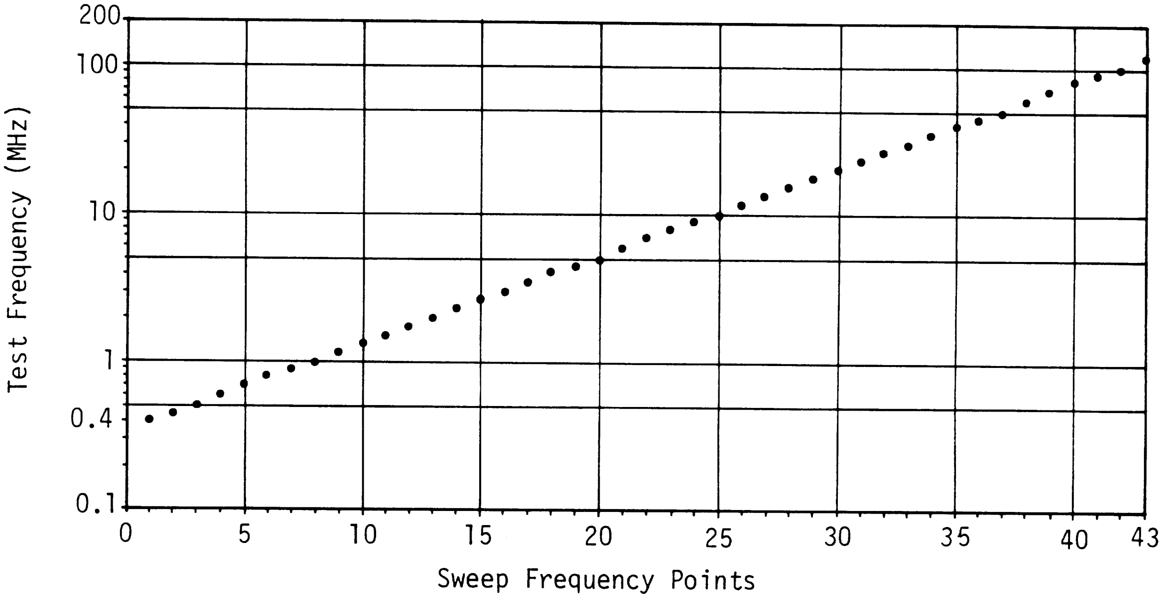
To make a FULL sweep measurement, use the procedure given below :

PROCEDURE :

1. Connect the probe to the sample.
2. Press the FULL SWEEP START/ABORT key. The indicator lamp in the center of the key will come on and the sweep will begin. To stop the sweep, press the FULL SWEEP START/ABORT key. The indicator lamp will go off and the sweep will stop immediately.

The FULL sweep measurement points are listed below :

400kHz, 455kHz, 500kHz, 600kHz, 700kHz, 800kHz, 900kHz, 1MHz, 1.2MHz, 1.4MHz, 1.6MHz, 1.8MHz, 2MHz, 2.333MHz, 2.666MHz, 3MHz, 3.5MHz, 4MHz, 4.5MHz, 5MHz, 6MHz, 7MHz, 8MHz, 9MHz, 10MHz, 12MHz, 14MHz, 16MHz, 18MHz, 20MHz, 23.33MHz, 26.66MHz, 30MHz, 35MHz, 40MHz, 45MHz, 50MHz, 60MHz, 70MHz, 80MHz, 90MHz, 100MHz, 110MHz.



Note

Manual FULL sweep can be performed by pressing the MANUAL TRIGGER key.

Figure 3-5. FULL Sweep Measurement.

## 3-23. DISPLAYS

3-24. The 4193A has three display sections : MAGNITUDE, PHASE, and FREQUENCY. They are described in paragraphs 3-25 through 3-27, respectively.

3-25. The MAGNITUDE display provides direct readout of measured impedance magnitude with 3 1/2-digit display resolution. The actual number of display digits depends on the measurement range. Maximum number of counts on the 10Ω, 100Ω, 1kΩ, and 10kΩ ranges is 1999, and 120 on the 100kΩ range. The least significant digit on the 100kΩ range may be displayed as " o " indicating that the least significant digit is meaningless. Five over-range annunciations are also displayed on this display. Refer to Table 3-4.

3-26. The PHASE display provides direct readout of measured phase angle with 3 1/2-digit display resolution. Maximum number of counts is 1800. When measurement is made on the 100kΩ range, the least significant digit of measured phase values may be displayed as " o " indicating that the least significant digit is meaningless. Also, when an over-range occurs on the MAGNITUDE display or when the measured magnitude is less than 20 counts, " - - - - " will be displayed on the PHASE display.

3-27. The FREQUENCY display provides direct readout of SPOT, START, and STOP frequencies with 4-digit display resolution. Error-codes related to mis-operation and instrument failure are also displayed here. Refer to paragraph 3-28.

## 3-28. Error-Code and Over-range Annunciations

3-29. Error-codes related to mis-operation and over-range annunciations are listed, along with a brief description, in Tables 3-3 and 3-4, respectively. Error codes related to SELF TEST and instrument failure are listed in Table 3-5. If an error listed in Table 3-5 should occur, contact the nearest Hewlett-Packard Sales/Service Office.

## 3-30. INITIAL DISPLAY TEST

3-31. All display segments and indicator lamps are lit for approximately one second each time the instrument is turned on. If a display segment or indicator lamp fails to light or does not light properly, it must be replaced.

Table 3-3. Operational Error-codes

| Error-code | Meaning |
|---|---|
| E - 5 1 | Lower-left key ( ☐ ) or upper-right key ( ☐ ) was pressed or selected via the HP-IB with the X-Y RECORDER function set to ON and TRIGGER set to INT. |
| E - 6 1 | The HP-IB Address Control Switch is set to address 31 (11111). Only addresses 0 (00000) through 30 (11110) are allowed. |
| E - 8 0 | STOP FREQ. is lower than the START FREQ. in PARTIAL SWEEP operation. |

Table 3-4. Annunciations

| MAGNITUDE Display | PHASE Display | Meaning | Treatment |
|---|---|---|---|
| Or 1 | - - - - | Measured impedance magnitude value exceeds the upper limit of 10Ω range (Range 1). | Change the MAGNITUDE range to range 2. |
| Or 2 | - - - - | Measured impedance magnitude value exceeds the upper limit of 100Ω range (Range 2). | Change the MAGNITUDE range to 3. |
| Or 3 | - - - - | Measured impedance magnitude value exceeds the upper limit of 1kΩ range (Range 3). | Change the MAGNITUDE range to 4. |
| Or 4 | - - - - | Measured impedance magnitude value exceeds the upper limit of 10kΩ range (Range 4). | Change the MAGNITUDE range to 5. |
| Or 5 | - - - - | Measured impedance magnitude value exceeds the upper limit of 100kΩ range (Range 5). | |

Table 3-5. SELF TEST Error-codes

| Code | Description |
|---|---|
| E-01 | A17U1 (RAM) is faulty. |
| E-02 | A17U2 (RAM) is faulty. |
| E-03 | A17U3 (ROM) is faulty. |
| E-04 | A17U4 (ROM) is faulty. |
| E-05 | A17U5 (ROM) is faulty. |
| E-06 | A17U6 (ROM) is faulty. |
| E-07 | A17U7 (ROM) is faulty. |
| E-30 | A13 Detection board is not functioning properly. |
| E-40 | A14 ADC board is not functioning properly. |
| E-41 | A17 Control Logic board is not functioning properly. |
| E-60 | A16 HP-IB board is not functioning properly. |
| E-70 | A17 Control Logic board is not functioning properly. |
| E-71 | A17 Control Logic board is not functioning properly. |

## 3-32. EXTERNAL TRIGGERING

3-33. The 4193A can be externally triggered by connecting a trigger device to the EXT TRIGGER connector on the rear-panel. The instrument is triggered (measurement is made) each time a low-going TTL level pulse is applied to this connector or each time the center conductor is shorted and opened to ground. The instrument must be set to the MAN/EXT trigger mode for external trigger operation.

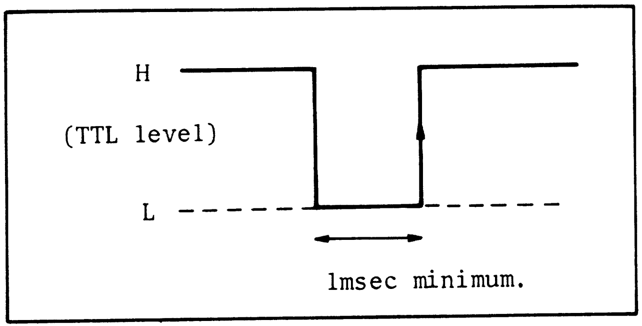


Figure 3-6. External Trigger Pulse.

## 3-34. MEASUREMENT TIME

3-35. Measurement time for a given DUT is approximately 1s in normal speed mode and 150ms in high speed mode, with the X-Y RECORDER off and the test frequency constant. Additional time is required when the test frequency is changed, the DUT is changed, or the measurement range is changed. Refer to Table 3-6 for typical values.

Table 3-6. Additional Measurement Times

| | Typical Time | Remarks |
|---|---|---|
| Freq. Settling Time | 100ms (5ms to 400ms) | Changing frequency. |
| Wait Time | 200ms | Changing DUT. |
| Ranging Time | 1.2s | Ranging up or down one range. |

## 3-36. USE OF FURNISHED PROBE ADAPTERS

3-37. Four probe adapters are furnished to facilitate connection to a wide range of DUT types. Each probe adapter is listed in Table 3-7.

Table 3-7. Furnished Probe Adapters

| Adapter | HP Part No. |
|---|---|
| BNC Adapter | 04193-61152 |
| Component Adapter | 04193-61153 |
| Ground Adapfer | 04193-61154 |
| Probe Socket | 04193-21008 |

3-38. The BNC Adapter is provided for input and output impedance measurements on circuits equipped with BNC female connectors. The Component Mounting Adapter is used for measurements on discrete axial- or radial-lead component. The Probe Socket is for user-fabricated test fixtures, as shown in Figure 3-7. It is available for supporting the probe, which is attached to the user-built fixture and is connected to ground.

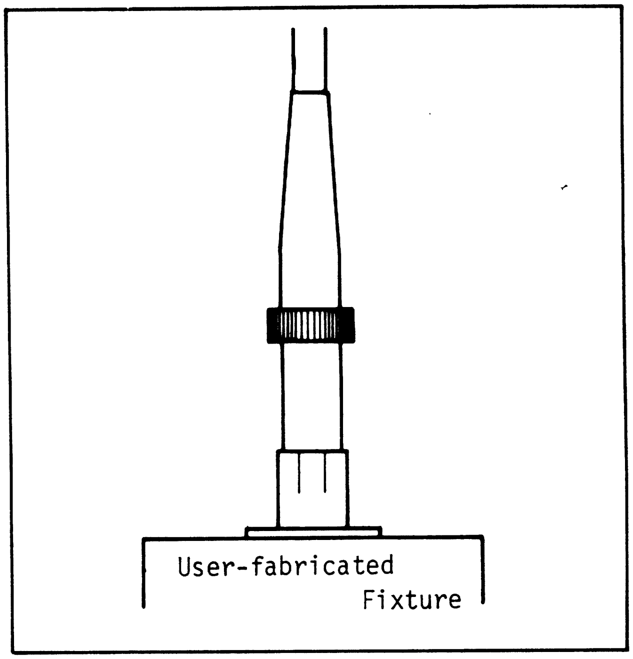


Figure 3-7. Probe Socket Usage.

## 3-39. PROBE

3-40. The instrument is adjusted to meet the specifications listed in Table 1-1, with the furnished probe connected. If the probe (HP P/N 04193-61151) is replaced or repaired, the adjustments described in Section VIII must be performed. For information on probe replacement or repair, contact the nearest Hewlett-Packard Sales/Service Office.

CAUTION

DO NOT CONNECT THE PROBE TO A COMPONENT OR CIRCUIT THAT HAS A DC BIAS EXCEEDING 50V OR AN AC VOLTAGE EXCEEDING 5V RMS. TO DO SO MAY DAMAGE THE INSTRUMENT.

Note

To ensure measurement accuracy, make sure that the coupling nuts, probe barrel, and probe tip are firmly tightened.

3-41. Probe and Test Fixture Residuals

3-42. The equivalent circuit of the 4193A's measurement port is shown in Figure 3-8. All measured values displayed on the MAGNITUDE and PHASE displays include the residuals of the probe and the test fixture. Typical values of each residual are listed in Table 3-8.

3-43. The conductive component of the open-circuit admittance of the equivalent circuit shown in Figure 3-8 is sufficiently larger than the susceptive component, c, at the frequencies below 110MHz to be negligible.

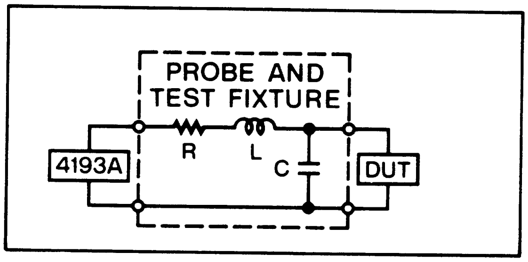


Figure 3-8. Equivalent Circuit.

3-44. Residuals compensation can be made using the following procedure :

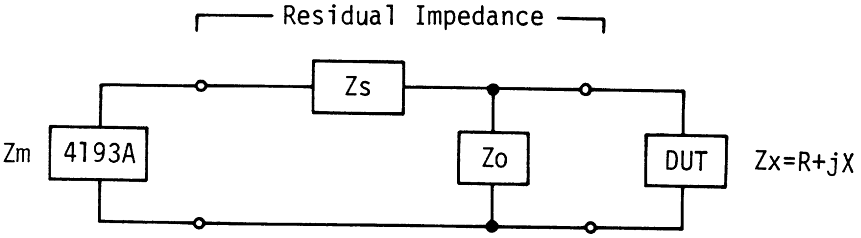
(1). Connect nothing to the test fixture (or probe) and note the value displayed as Zo.

(2) Short the test fixture (or probe) and note the value displayed as Zs.

(3) Calculate the DUT's actual impedance using the equation given in Figure 3-9.

Table 3-8. Typical Residuals at 100MHz

| PROBE AND TEST FIXTURE | R (Ω) | L (nH) | C (pF) |
|---|---|---|---|
| PROBE + 16099A | 0.5 | 10 | 2.4 |
| PROBE + 16099A + 16092A | 0.5 | 11 | 3.5 |
| PROBE + 16099A + 16093A | 0.5 | 12 | 4.2 |
| PROBE + 16099A + 16093B | 0.5 | 12 | 7.9 |



Zm =measured impedance, Zs =short-circuit impedance,
Zo =open-circuit impedance, Zx =DUT impedance.

$$|Zx| = \sqrt{R^2 + X^2}$$

$$\theta = \tan^{-1}\frac{X}{R}$$

where:

$$R = \frac{(|Z_0|\cos\theta m - |Zm|\cos\theta_0)\cdot|Zm|\cdot|Z_0|}{(|Z_0|\cos\theta m - |Zm|\cos\theta_0)^2 + (|Zm|\sin\theta_0 - |Z_0|\sin\theta m)^2} - |Zs|\cos\theta s$$

$$X = \frac{(|Z_0|\sin\theta m - |Zm|\sin\theta_0)\cdot|Zm|\cdot|Z_0|}{(|Z_0|\cos\theta m - |Zm|\cos\theta_0)^2 + (|Zm|\sin\theta_0 - |Z_0|\sin\theta m)^2} - |Zs|\sin\theta s$$

$|Z_0|$ and $\theta_0$: Open circuit impedance and phase, respectively.
$|Zs|$ and $\theta s$: Short circuit impedance and phase, respectively.

Note

These equations assume that $Z_0 >> Zs$.

Figure 3-9. Residuals Compensation.

## 3-45. EXTERNAL OSCILLATOR

3-46. An external signal source (output impedance: 50Ω ± 10%) can be connected to the EXT. OSC. connector on the rear-panel to obtain higher test signal resolution than is possible with the 4193A's internal signal source. This feature makes it possible to measure high-Q devices such as crystals. A maximum test signal resolution of 100Hz is possible when an external signal source is used. The external oscillator controls frequency only; the 4193A controls the level of the test signal applied to the DUT. The level of the external signal must be from 0 to 5dB. When the external signal source is connected to the 4193A, the EXT. OSC. indicator lamp on the front-panel comes on automatically. The difference between the 4193A's test signal frequency setting and that of the external signal source's should not exceed 10MHz. For best results the 4193A's test signal frequency should be set as close as possible to that of the external signal source.

## 3-47. X-Y RECORDER OUTPUT

3-48. The 4193A is equipped with three analog output connectors on the rear-panel (MAGNITUDE, PHASE, FREQUENCY) which output DC voltages proportional to the displayed magnitude, phase, and frequency values. These connectors can be connected to an X-Y Recorder to plot the impedance/frequency or phase/frequency characteristics of the sample impedance. A PEN LIFT connector is also provided for use with X-Y Recorders equipped with remote pen-lift control.

## 3-49. ANALOG MAGNITUDE OUTPUT

3-50. DC voltage output from the MAGNITUDE connector is proportional to the number of counts displayed on the MAGNITUDE display. Output voltage is calculated as :

$$V_M = \frac{C_M}{2000} \text{ (Volts)}$$

where $V_M$ is the analog output voltage and $C_M$ is the number of counts displayed on the MAGNITUDE display. When $C_M$ is 2000 counts (full-scale), for example, $V_M$ is +1 volt. MAGNITUDE output voltage range is 0 to 1 volt.

Note

If the sample's impedance is higher than the full-scale limit of the selected range, 0r - N (N represents the magnitude range : 1 = 10Ω range, 2 = 100Ω range, 3 = 1kΩ range, 4 = 10kΩ range, 5 = 100kΩ range) will be displayed on the MAGNITUDE display and the analog output voltage will be 1 volt.

## 3-51. ANALOG PHASE OUTPUT

3-52. DC voltage output from the PHASE connector is proportional to the number of counts displayed on the PHASE display. Output voltage is calculated as :

$$Vp = \frac{Cp}{1800} \text{ (Volts)}$$

where Vp is the analog output voltage and Cp is the number of counts (with sign) displayed on the PHASE display. When Cp is 1800 counts (full-scale positive), for example, Vp is +1 volt; conversely, when Cp is -1800 counts (full-scale negative), Vp is -1 volt. PHASE output voltage range is 0 to ±1 volt.

Note

The above equation is valid even when "----" is displayed on the PHASE display. The last valid phase value is used for Cp in this case.

## 3-53. ANALOG FREQUENCY OUTPUT

3-54. DC voltage output from the FREQUENCY connector is proportional to the displayed frequency, but is different for each sweep mode. Output voltage is calculated as :

For PARTIAL SWEEP :

$$V_F = \frac{f_{SPOT} - f_{START}}{f_{STOP} - f_{START}} \text{ (Volts)}$$

For FULL SWEEP :

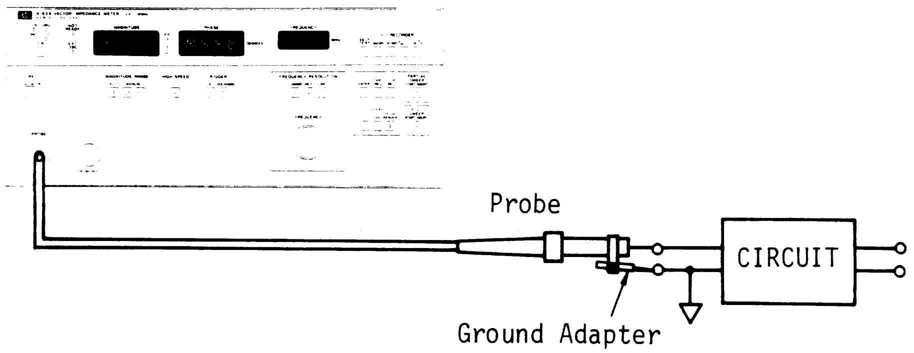
$$V_F = \frac{\log(f_{SPOT}/f_{START})}{\log(f_{STOP}/f_{START})} \text{ (Volts)}$$

where $V_F$ is the analog output voltage and $f_{SPOT}$, $f_{START}$, and $f_{STOP}$ are, respectively, the test frequency displayed the FREQUENCY display, the sweep START frequency, and the sweep STOP frequency. All frequencies are in MHz.

Note

When neither sweep mode is selected (SPOT Measurement), the output voltage is calculated using the PARTIAL SWEEP equation.

## IN-CIRCUIT IMPEDANCE MEASUREMENT

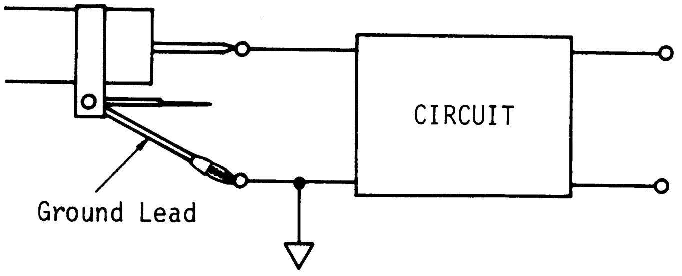


SETUP:

Attach the furnished slide-on ground adapter (HP Part No. : 04193-61154) to the probe barrel, as shown in the figure.

PROCEDURE:

1. Turn on the instrument and verify that it passes the initial display test and that "PASS" is displayed on the FREQUENCY display at the completion of the SELF TEST.
2. Set the desired test frequency by rotating the Frequency Control Dial, as described in Figure 3-3.
3. Connect the probe center pin and the ground pin to the sample circuit terminals as shown above. If the ground pin is too short to reach the sample circuit's ground terminal, use the furnished ground lead (HP Part No. : 04193-61629), as shown below :



CAUTION

DO NOT CONNECT THE PROBE TO A CIRCUIT THAT HAS A DC BIAS EXCEEDING 50V OR AN AC VOLTAGE EXCEEDING 5V RMS. TO DO SO MAY DAMAGE THE INSTRUMENT.

Note

The circuit terminal distance should be as short as possible.

Note

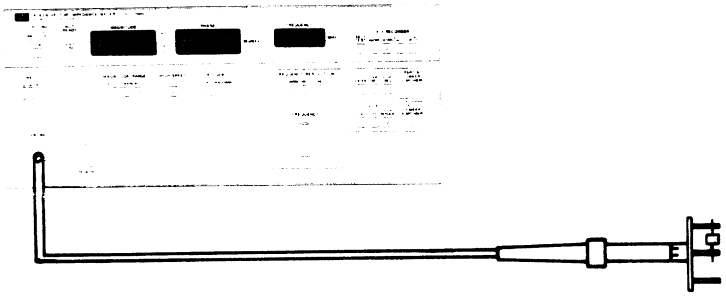
The residual impedance of the ground adapter is less than that of the ground lead.

Note

The probe pin (HP Part No. : 16095-60012) and the ground pin (HP Part No. : 0360-2066) are replaceable.

Figure 3-10. In-circuit Impedance Measurement Procedure.

## GENERAL COMPONENT MEASUREMENT



SETUP:

Attach the furnished component adapter (HP Part No. : 04193-61153) to the end of the probe, as shown in the figure.

PROCEDURE:

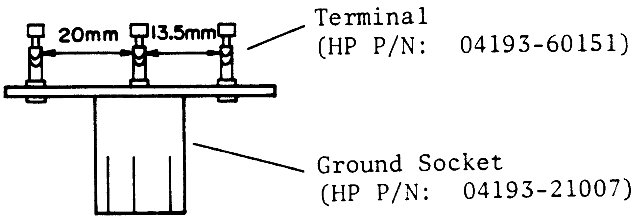
1. Turn on the instrument and verify that it passes the initial display test and that "PASS" is displayed on the FREQUENCY display at the completion of the SELF TEST.
2. Set the desired test frequency by rotating the Frequency Control Dial, as described in Figure 3-3.
3. Connect the DUT between the center terminal and one of the outer terminals of the component adapter, as shown in the figure.
4. Read the measured impedance and phase displayed on the MAGNITUDE and PHASE displays, respectively.

CAUTION

DO NOT CONNECT THE PROBE TO A COMPONENT THAT HAS A DC BIAS EXCEEDING 50V OR AN AC VOLTAGE EXCEEDING 5V RMS. TO DO SO MAY DAMAGE THE INSTRUMENT.

Note

The component adapter dimensions are shown below. The terminals (HP Part No. : 04193-60151) are replaceable.

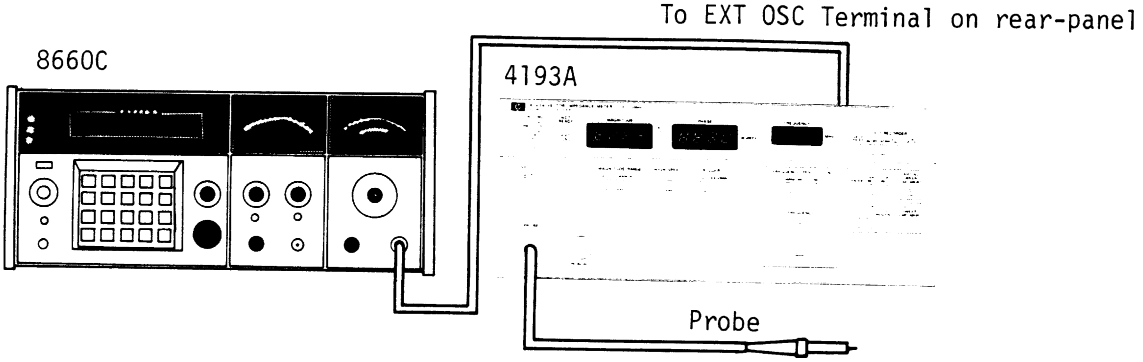


Note

For measurement of components that cannot be connected to the component adapter, the 16092A/16093A/16093B test fixtures are available. Refer to Table 1-4.

Figure 3-11. General Component Measurement Procedure.

## EXTERNAL OSCILLATOR USAGE



EQUIPMENT:

| | |
|---|---|
| Synthesized Signal Generator | Generator with 86633B and 86601B |
| TYPE N (male)-BNC (female) Adapter | HP P/N : 1250-1535 |
| BNC (male)-BNC (male) Cable | HP 10503A |

PROCEDURE:

1. Turn off both instruments.
2. Connect the synthesizer's RF section to the 4193A's EXT. OSC. connector, as shown in the figure.
3. Set the synthesizer's output level to 0dBm.

Note

DO NOT allow the synthesizer's output level to exceed +5dBm. To do so may damage the 4193A.

4. Turn on both instruments.
5. Confirm that the EXT. OSC. indicator lamp on the 4193A's front-panel comes on after completion of the initial SELF TEST.
6. Connect the probe to the device or circuit under test and set the instruments' controls as appropriate for the measurement. For best results, set the 4193A's test frequency as close as possible to the synthesizer's frequency.

Note

The maximum allowable difference between the 4193A's test frequency setting and the external synthesizer's setting is 10MHz.

Note

Maximum obtainable frequency resolution for measurements using an external frequency synthesizer is approximately 100Hz over the 4193A's full frequency range, 400kHz to 110MHz.

Figure 3-12. External Oscillator Usage Procedure.

## X-Y RECORDER SETUP

EQUIPMENT:

| | |
|---|---|
| X-Y RECORDER | HP 7046A |
| BNC (male)-Dual Banana Plug Cable | HP11001A (4 ea.) |

PROCEDURE

1. Turn off the 4193A's X-Y RECORDER function--X-Y RECORDER ON/OFF indicator lamp should be off.

2. Locate the 4193A's X-Y RECORDER OUTPUTS on the rear-panel (see Figure 3-2) and connect FREQUENCY to the recorder's X-axis, MAGNITUDE to the Y1-axis, PHASE to the Y2-axis, and PEN LIFT to the recorder's REMOTE PEN jack (rear-panel).

3. Place the chart paper on the recording platen and set the CHART switch to the HOLD Position. PEN switch should be set to LIFT.

4. Press the ↓← LL key on the 4193A and, referring to Figure A, position pen 1 at the black dot (•) and pen 2 at the cross (x).

5. Press the UR →↑ key on the 4193A and, referring to Figure A again, position both pens at the circle (o).

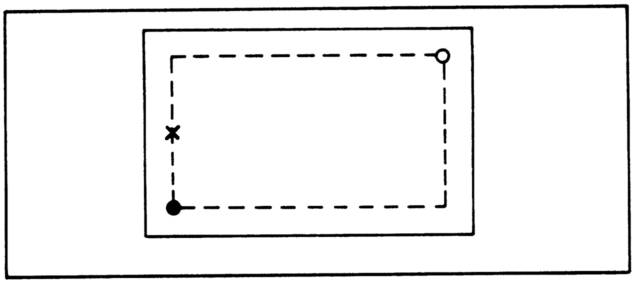


Figure A. Plot Area of RECORDER OUTPUTS.

Note

On some X-Y Recorders, zero and full-scale adjustments may be interactive. Repeat steps 4 and 5, if necessary.

6. Connect the probe to the device or circuit under test and set the 4193A's controls as appropriate for the measurement.

7. Perform one swept measurement with the X-Y RECORDER function set to OFF and note the measurement range at which the DUT's impedance is highest.

8. Using the MANUAL MEASUREMENT RANGE keys, ⇩ and ⇧, set the 4193A's measurement range to the range noted in step 7.

9. Press the X-Y RECORDER ON/OFF key--indicator lamp will come on--and press the PARTIAL SWEEP or FULL SWEEP key to start the plot.

Note

The above procedure is for 2-pen recorders equipped with remote pen-lift control. For single-pen recorders and recorders not equipped with remote pen-lift control, the above procedure must be modified slightly.

Figure 3-13. X-Y Recorder Usage Procedure.

## 3-55. HP-IB COMPATIBILITY

3-56. The 4193A can be remotely controlled via the HP-IB, a carefully defined instrument interface which simplifies integration of instruments and a calculator or computer into a system.

Note

> HP-IB is Hewlett-Packard's implementation of IEEE Std. 488, Standard Digital Interface for Programmable Instrumentation.

## 3-57. HP-IB INTERFACE CAPABILITIES

3-58. The 4193A has eight HP-IB interface functions, as listed in Table 3-9.

## 3-59. CONNECTION TO HP-IB

3-60. The 4193A can be connected into an HP-IB bus configuration with or without a controller (i.e., with or without an HP calculator). In an HP-IB system without a controller, the instrument functions as a "talk only" device.

## 3-61. HP-IB CONTROL SWITCH

3-62. The HP-IB Control Switch, located on the rear panel, has seven bit switches as shown in Figure 3-14. Each bit switch has two settings : logical 0 (left position) and logical 1 (right position). Bit switch 7 determines whether the instrument will be addressable by the controller in a multi-device system, or will function as a "talk only" device to output measurement data and/or instructions to an external "listener," e.g., printer or plotter.

When bit switch 7 is set to 0, the instrument is in ADDRESSABLE mode and bit switches 1 through 5 determine the instrument address; when this switch is set to 1, the instrument is in TALK ONLY mode.

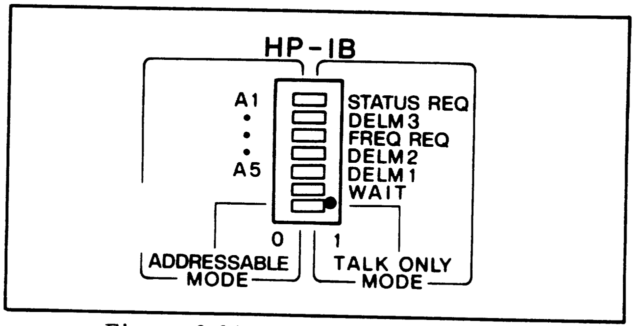


Figure 3-14. HP-IB Control Switch.

## 3-63. ADDRESSABLE MODE

3-64. When bit switch 7 is set to ADDRESSABLE (i.e., set to 0), bit switches 1 through 5 represent the HP-IB address of the instrument, in binary. These switches are set to 10001 (decimal 17) when the instrument leaves the factory but can be set to any desired address between 0 and 30. Bit switch 6 has no meaning in this mode. The HP-IB Control Switch, set to the ADDRESSABLE mode and with the factory address setting, is shown in Figure 3-15.

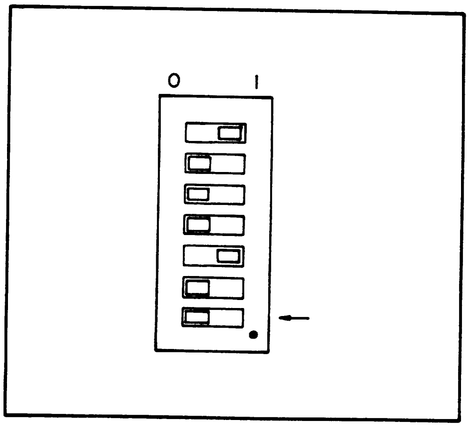


Figure 3-15. ADDRESSABLE Mode.

Table 3-9. HP-IB Interface Capabilities

| Code | Interface Function*<br>(HP-IB Capabilities) |
|---|---|
| SH1** | Source Handshake |
| AH1 | Acceptor Handshake |
| T5 | Talker (basic talker, serial poll, talk only mode, unaddress to talk if addressed to listen) |
| L4 | Listener (basic listener., unaddress to listen if addressed to talk) |
| SR1 | Service Request |
| RL1 | Remote/Local (with local lockout) |
| DC1 | Device Clear |
| DT1 | Device Trigger |

* Interface functions provide the means for a device to receive, process, and transmit messages over the bus.

** The suffix number of the interface code indicates the limitation of the function capability as defined in Appendix C of IEEE STD. 488.

Note

When the instrument is turned on, the address is displayed on FREQUENCY display after the SELF TEST. If the address switches are set to 10001, the display is as shown below :

FREQUENCY

## 3-65. TALK ONLY MODE

3-66. When bit switch 7 is set to TALK ONLY (i.e., set to 1) as shown in Figure 3-16, the other bit switches, 1 through 6, function as described in Table 3-10.

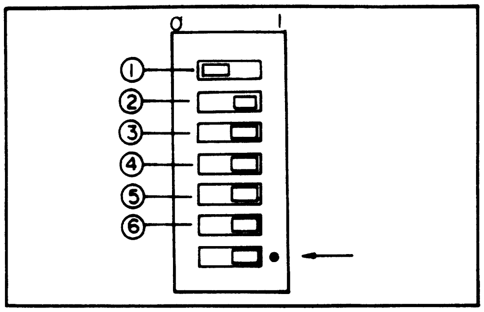


Figure 3-16. TALK ONLY Mode.

Table 3-10. Functions of Bit Switches ① through ⑥

| Bit Switch | Name | Function When Set to 1 | Function When Set to 0 |
|---|---|---|---|
| ⑥ | WAIT | After a measurement, the 4193A waits until all measurement data has been received by the listener before proceeding to the next measurement, even in internal trigger mode. | After a measurement, the 4193A proceeds to the next measurement regardless of whether the listener has received all the measurement data or not. |
| ⑤ | DELM1 | Selects CR LF as the Delimiter for the magnitude field.* When a printer is connected to the 4193A, this delimiter causes the printer to perform a carriage return and a line feed. | Selects the comma "," as the delimiter for the magnitude field.* The printer does not perform a carriage return or line feed. |
| ④ | DELM2 | Selects CR LF as the delimiter for the phase field.* This delimiter causes the printer to perform a carriage return and a line feed. | Selects the comma "," as the delimiter for the phase field.* The printer does not perform a carriage return or line feed. |
| ③ | FREQ REQ | Specifies that frequency data be output along with magnitude and phase data. | Frequency data is not output. |
| ② | DELM3 | Selects CR LF as the delimiter for the frequency field.* This delimiter causes the printer to perform a carriage return and a line feed. | Selects the comma "," as the delimiter for the frequency field.* The printer does not perform a carriage return or line feed. |
| ① | STATUS REQ | Specifies that status data be output along with magnitude and phase data. | Status data is not output. |

* Refer to para. 3-71, Data Output.

## 3-67. HP-IB STATUS INDICATORS

3-68. The HP-IB Status Indicators are four LED lamps located on the front panel. When lit, these lamps show the existing status of the 4193A in the HP-IB system as follows :

| | |
|---|---|
| SRQ : | SRQ signal from the 4193A to the controller is on the HP-IB line. Refer to paragraph 3-77. |
| LISTEN : | The 4193A is set to listener. |
| TALK : | The 4193A is set to talker. |
| REMOTE : | The 4193A is remotely controlled. |

## 3-69. LOCAL KEY

3-70. The LOCAL key releases the 4193A from HP-IB remote control and allows measurement conditions to be set from the front panel. The REMOTE lamp will go off when this key is pressed. LOCAL control is not available when the 4193A is set to "local lockout" status by the controller.

## 3-71. DATA OUTPUT

3-72. Measurement and status data are output to external devices in bit parallel, byte serial format via the eight DIO signal lines of the HP-IB. These data consist of impedance magnitude and phase data, test frequency data, and key status data. Magnitude and phase data are always output, but output of test frequency data and key status data depends on the program (ADDRESSABLE), or the setting of the HP-IB Control Switch on the rear panel, refer to Table 3-10. All characters are coded in accordance with ASCII coding conventions.

[1] Impedance Magnitude Data Field

This field contains READY/NOT READY information and the value of the measured impedance.

$$\underset{(1)}{\underline{\text{Yx}}}{}^{*},\underset{(2)}{\underline{\text{Sx}}},\underset{(3)}{\underline{\text{ZMxxxxx}}}\ \underset{(4)}{\underline{\text{Ex}}}\ \underset{(5)}{\underline{\text{,}}}$$

* x represents single digit, variable numeric data.

(1) Status of measurement : Y0 = NOT READY, Y1 = READY.

(2) Status of magnitude data : S0 = less than 18 counts, S1 = less than 180 counts, S2 = 180 to 2000 counts, S3 = over range, S4 = Er - 40 or Er - 41, S5 = Er - 30, S6 = Er - 30 and Er - 40.

(3) Magnitude display counts.

(4) Unit : E0 = Ω, E3 = kΩ

(5) Delimiter: comma in ADDRESSABLE mode. In TALK ONLY mode, (CR)(LF) or a comma depending on the setting of bit switch 5 on the HP-IB Control Switch. Refer to Table 3-10.

[2] Impedance Phase Data Field

This field contains the phase of the measured impedance.

$$\text{ZP}\underset{(1)}{\underline{\text{s}^{*}\text{xxx.x}}}\ \underset{(2)}{\underline{\text{,}}}$$

* s represents the sign (+ or -).

(1) Sign and magnitude with decimal point of the measured phase.

(2) Delimeter : See [1].

[3] Frequency Field

This field contains test frequency information.

$$\underset{(1)}{\underline{\text{Wx}}},\underset{(2)}{\underline{\text{Bx}}},\text{FR}\underset{(3)}{\underline{\text{xxxxx}}}\ \underset{(4)}{\underline{\text{Ex}}},\underset{(5)}{\underline{\text{Px}}},\underset{(6)}{\underline{\text{Qx}}}\ \underset{(7)}{\underline{\text{,}}}$$

(1) Sweep mode : W1 = partial sweep, W2 = full sweep, W3 = last frequency in sweep measurement, W4 = spot measurement.

(2) Oscillator : B0 = Internal oscillator, B1 = External oscillator.

(3) Frequency display counts.

(4) Unit : E6 = MHz

(5) Partial sweep step : P1 = 100, P2 = 1000, P3 = HIGH RESOLN.

(6) Frequency resolution : Q1 = COARSE, Q2 = MED, Q3 = FINE.

(7) Delimiter : See [1].

[4] Status Field

This field contains key status data (front panel control settings).

$$\underset{(1)}{\underline{Ax}},\underset{(2)}{\underline{Rx}},\underset{(3)}{\underline{Hx}},\underset{(4)}{\underline{Tx}},\underset{(5)}{\underline{Xx}},\underset{(6)}{\underline{Ix}},\underset{(7)}{\underline{Gx}},\underset{(8)}{\underline{Dx}}$$

(1) Magnitude range mode : A0 = HOLD, A1 = AUTO.

(2) Magnitude range : R1 = 10Ω, R2 = 100Ω, R3 = 1kΩ, R4 = 10kΩ, R5 = 100kΩ.

(3) High speed mode : H0 = OFF, H1 = ON.

(4) Trigger mode : T1 = INT, T2 = HOLD.

(5) X-Y Recorder ON/OFF : X0 = OFF, X1 = ON.

(6) Interpolation : I0 = OFF, I1 = ON.

(7) External trigger : G0 = Disable, G1 = Enable.

(8) Data ready : D0 = SRQ OFF, D1 = SRQ ON.

## 3-73. OUTPUT DATA FORMAT

3-74. There are four output data formats available on the 4193A, as listed in the table below. The format is determined by the HP-IB program (ADDRESSABLE mode). For TALK ONLY mode, see Table 3-10.

## 3-75. Programming Guide for the 4193A

3-76. Sample programs that can be run on the Model 9825A or HP-85 Desktop Computer are given in Figures 3-19 and 3-20.

Note

> Specific information on HP-IB programming with the 9825A and HP-85 can be found in the programming manual of each computer.

Following equipment are required to run the sample programs :

(1) 4193A Vector Impedance Meter

(2) 98034A/B HP-IB Interface Card

(3) 9825A Desktop Computer with 98210A String-Advanced Programming ROM and 98213A General I/O-Extended I/O ROM, or 9825B/T.

or

(2) 82937A HP-IB INTERFACE

(3) HP-85 Personal Computer with 00085-15003 INPUT/OUTPUT ROM.

## 3-77. SERVICE REQUEST STATUS BYTE

3-78. The 4193A outputs an RQS (Request Service) signal whenever it is set to one of the six possible service request states. Figure 3-17 shows the contents of the Status Byte.

Bit 7 (RQS) indicates whether or not a service request exists. Bit 8 is always zero (0). Bits 1 through 6 identify the type of service request. Following are the service request states of the 4193A.

Table 3-11. Output Data Format

| Format | Fields Output | | | |
|---|---|---|---|---|
| | Magnitude | Phase | Freq. | Status |
| FMT1 | Yes | Yes | No | No |
| FMT2 | Yes | Yes | Yes | No |
| FMT3 | Yes | Yes | No | Yes |
| FMT4 | Yes | Yes | Yes | Yes |

(1) Bit 6 : Set when no syntax error but program is inoperative as follows :

- (1) During PARTIAL/FULL SWEEP:

  Changing SPOT FREQ. (FR x EN)

  Executing LL, UR when X-Y RECORDER OUTPUT is ON

  Executing SELF TEST (S1)

- (2) During PARTIAL SWEEP:

  Changing STEPS (P1, P2, P3)

- (3) When X-Y RECORDER OUTPUT is OFF:

  Executing INTRPL (I0, I1)

- (4) When X-Y RECORDER OUTPUT is ON and TRIGGER is INT:

  Executing Lower Left (LL) or Upper Right (UR)

(2) Bit 5 : Indicates the result of the SELF TEST; 0 = FAIL, 1 = PASS.

(3) Bit 4 : Set when the 4193A is externally triggered before data has been completely output in REMOTE state.

(4) Bit 3 : Set when SELF TEST is completed.

(5) Bit 2 : Set when the remote program contains a syntax error.

(6) Bit 1 : Set when measured data is valid, independent of "D0" or "D1" setting.

3-79. PARAMETER SETTING

3-80. SPOT FREQUENCY and PARTIAL SWEEP START and STOP frequencies are set via remote programming, as follows :

SPOT FREQUENCY : $\underset{(1)}{\underline{\text{FR}}}\ \underset{(2)}{\underline{\text{x}}}\ \underset{(3)}{\underline{\text{EN}}}$

PARTIAL SWEEP

START FREQUENCY : $\underset{(1)}{\underline{\text{TF}}}\ \underset{(2)}{\underline{\text{x}}}\ \underset{(3)}{\underline{\text{EN}}}$

STOP FREQUENCY : $\underset{(1)}{\underline{\text{PF}}}\ \underset{(2)}{\underline{\text{x}}}\ \underset{(3)}{\underline{\text{EN}}}$

(1) Parameter program code

(2) Four digit (max.) number between 0.400 and 110.0; the unit is MHz.

(3) Parameter terminator

| 8<br>MSB | 7 | 6 | 5 | 4 | 3 | 2 | 1<br>LSB |
|---|---|---|---|---|---|---|---|
|  | SRQ | Prog. logic error | Self test result | Trig. too fast | Self test end | Syntax error | Data ready |

Figure 3-17. Status Byte.

Table 3-12. REMOTE PROGRAM CODE

| FUNCTION | CONTROL | CODE | DESCRIPTION |
|---|---|---|---|
| FREQUENCY RESOLUTION | COARSE | Q1 | |
| | MED | Q2 | |
| | FINE | Q3• | |
| AUTO MAGNITUDE RANGE | OFF | A0 | |
| | ON | A1• | |
| MAGNITUDE RANGE | 10Ω range | R1 | 00.00 - 19.99Ω |
| | 100Ω range | R2 | 000.0 - 199.9Ω |
| | 1kΩ range | R3 | 0.000 - 1.999kΩ |
| | 10kΩ range | R4 | 00.00 - 19.99kΩ |
| | 100kΩ range | R5 | 000. - 120. kΩ |
| HIGH SPEED MODE | OFF | H0• | ≥1 measurement/second |
| | ON | H1 | ≥3 - 10 measurement/second |
| SWEEP STEP | 100 steps | P1• | |
| | 1000 seeps | P2 | |
| | HIGH RESOLUTION | P3 | Sweep the least significant digit by 1 count. |
| AUTO SWEEP | PARTIAL SWEEP START | W1 | |
| | FULL SWEEP START | W2 | |
| | SWEEP ABORT | W3 | For both PARTIAL and FULL sweep. |
| TRIGGER | INTERNAL | T1• | |
| | MAN/EXT | T2 | Specifies MAN/EXT trigger mode. |
| EXECUTE | | EX | Triggers the 4193A. |
| EXTERNAL TRIGGER | OFF | G0 | Disables external trigger. |
| | ON | G1• | Enables external trigger. |
| RECORDER OUTPUT | OFF | X0• | |
| | ON | X1 | |
| | LOWER LEFT | LL | |
| | UPPER RIGHT | UR | |
| INTERPOLATION | OFF | I0• | |
| | ON | I1 | |
| SELF TEST | OFF | S0• | |
| | ON | S1 | |
| DATA READY SRQ | OFF | D0• | |
| | ON | D1 | Outputs SRQ when data is measured. |
| OUTPUT DATA FORMAT | | FMT1• | STANDARD FIELD* output only. |
| | | FMT2 | STANDARD + FREQUENCY FIELD* output. |
| | | FMT3 | STANDARD + STATUS FIELD* output. |
| | | FMT4 | STANDARD + FREQUENCY + STATUS FIELD output. |
| CANCEL DATA | | CL | |

•: Default code.

*: See para. 3-71 Output Data.

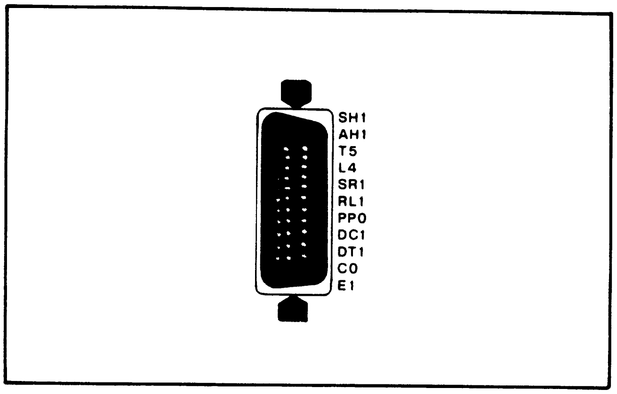


Figure 3-18. HP-IB Connector.

Sample Program 1

PURPOSE :

This program is a remote control, data output program for spot frequency measurement via the HP-IB.

9825A Program :

```
0: flt 3
1: clr 717
2: wrt 717,"FMT2T2"
3: wrt 717,"FR1EN"
4: wrt 717,"EX"
5: red 717,A,B,C,D,E,F,G
6: dsp C,D,G
7: prt C,D,G
8: end
*1785
```

HP-85 Program :

```
10 CLEAR 717
20 OUTPUT 717 "FMT2T2"
30 OUTPUT 717 "FR1EN"
40 OUTPUT 717 "EX"
50 ENTER 717 ; A,B,C,D,E,F,G
60 DISP C,D,G
70 PRINT C,D,G
80 END
```

| Line | | Description |
|---|---|---|
| 9825A | HP 85 | |
| 1 | 10 | Sets all 4193A's controls to Initial Control Settings. |
| 2 | 20 | Selects the data output format and the trigger mode. See para. 3-73. |
| 3 | 30 | Sets test frequency to 1MHz. |
| 4 | 40 | Triggers the 4193A. |
| 5 | 50 | Reads the output data from the 4193A. |
| 6 | 60 | Displays the magnitude, phase, and test frequency values on the controller's display. |
| 7 | 70 | Prints out the measurement data on the controller's printer. |

To store the complete output data, the following program can be used :

9825A Program :

```
0: dim A$[100]
1: clr 717
2: wrt 717,"FMT4T2"
3: wrt 717,"FR1EN"
4: wrt 717,"EX"
5: red 717,A$
6: prt A$
7: end
*21373
```

HP-85 Program :

```
10 DIM A$[100]
20 CLEAR 717
30 OUTPUT 717 "FMT4T2"
40 OUTPUT 717 "FR1EN"
50 OUTPUT 717 "EX"
60 ENTER 717 ; A$
70 PRINT A$
80 END
```

Figure 3-19. Sample Program 1.

Sample Program 2

PURPOSE:

This program is a remote control, data output program for swept frequency measurement via the HP-IB.

9825A Program:

```
0: flt 3
1: clr 717
2: wrt 717,"FMT2T2"
3: wrt 717,"TF10ENPF20ENW1"
4: wrt 717,"EX"
5: red 717,A,B,C,D,E,F,G
6: prt C,D,G
7: if E=3;jmp 2
8: gto 4
9: end
*5830
```

HP-85 Program:

```
10 CLEAR 717
20 OUTPUT 717 "FMT2T2"
30 OUTPUT 717 "TF10ENPF20ENW1"
40 OUTPUT 717 "EX"
50 ENTER 717 ; A,B,C,D,E,F,G
60 PRINT C,D,G
70 IF E=3 THEN 90
80 GOTO 40
90 END
```

| Line | | Description |
|---|---|---|
| 9825A | HP 85 | |
| 1 | 10 | Sets all 4193A's controls to Initial Control Settings. |
| 2 | 20 | Selects the data output format and the trigger mode. See para. 3-73. |
| 3 | 30 | Sets the START frequency and STOP frequency for a PARTIAL sweep to 10MHz and 20MHz, respectively. |
| 4 | 40 | Triggers the 4193A. |
| 5 | 50 | Reads the output data from the 4193A. |
| 6 | 60 | Prints out the magnitude, phase, and test frequency data on the controller's printer. |
| 7 | 70 | When the test frequency reaches the STOP frequency, E changes from 1 to 3. See para. 3-72. |

For FULL sweep measurement, the following program can be used:

9825A Program:

```
0: flt 3
1: clr 717
2: wrt 717,"FMT2T2W2"
3: wrt 717,"EX"
4: red 717,A,B,C,D,E,F,G
5: prt C,D,G
6: if E=3;jmp 2
7: gto 3
8: end
*12992
```

HP-85 Program:

```
10 CLEAR 717
20 OUTPUT 717 "FMT2T2W2"
30 OUTPUT 717 "EX"
40 ENTER 717 ; A,B,C,D,E,F,G
50 PRINT C,D,G
60 IF E=3 THEN 80
70 GOTO 30
80 END
```

Figure 3-20. Sample Program 2.

Table 4-1. Recommended Test Equipment (Sheet 1 of 2)

| Equipment | Critical Specifications | Recommended Model | Use* |
|---|---|---|---|
| Probe Type Standards | 10Ω ±.1Ω at dc | HP 16345A | P |
| | 50Ω ±.5Ω at dc | | P |
| | 100Ω ± 1Ω at dc | | P,A,T |
| | 180Ω±1.8Ω at dc | | P |
| | 1kΩ ±10Ω at dc | | P |
| | 1.8kΩ ±18Ω at dc | | P |
| | 10kΩ±100Ω at dc | | P |
| | 5pF ±1pFΩ at 1MHz | | P |
| Frequency Counter | Frequency Band: 400kHz thru 110MHz<br>Resolution: .1Hz maximum<br>Display: 8 digits<br>Accuracy: ≤2.5ppm of reading | HP 5382A | P,A,T |
| | Frequency Band: 300MHz maximum<br>Reactivity: 30mVrms | HP 5340A | A,T |
| Digital Voltmeter | DC Voltage Range: 10V<br>Resolution: 10mV<br>Display: 4 digits | HP 3465B | P,A,T |
| RF Voltmeter | Frequency Range: 400kHz to 110MHz<br>AC Voltage Range: 10mVrms<br>Resolution: 0.1mVrms<br>Accuracy: ≤5% | HP 3406A | P,A,T |
| Test Oscillator | Frequency Range: Up to 10MHz<br>Output Level: ≥0dBm | HP 651B | P,A,T |
| Power Supply | Voltage Range: 0 to 10Volts | HP 6214A | A,T |
| Pulse Generator | Pulse Width: 10nsec. | 8012B | A,T |
| Oscillo-scope | Frequency Range: 5MHz<br>Deflection Factor: 50mV/DIV<br>Dual-channel | HP1740A | A,T |
| Sampling Scope | Time-base: .5nsec. | HP 180C/1811A | A,T |
| Sampling Head | Bandwidth: 2GHz | HP 1430C | A,T |
| Spectrum Analyzer | Frequency Range: 50MHz to 550MHz | HP141T/8552B/8554B | A,T |
| Calculator | | HP 9825A | P |
| A12 BPF ADJ Board | | HP P/N 04193-66564 | A,T |
| 20dB Attenuator | Type N (2EA) | HP 8491A | A,T |

* USE: P = Performance Test, A = Adjustment, T = Troubleshooting

Table 4-1. Recommended Test Equipment (Sheet 2 of 2)

| Equipment | Critical Specifications | Recommended Model | Use* |
|---|---|---|---|
| Adapters | 50Ω T Adapter | HP 11063A | A |
| | BNC (female)-GR874 Adapter | HP P/N 1250-0850 | A |
| | BNC Probe Adapter | HP P/N 04193-61152 | A |
| | BNC T Adapter (2EA) | HP P/N 1250-0781 | A,T |
| | BNC(female)-SMB(female)Adapter(4EA) | HP P/N 1250-1236 | A,T |
| | BNC(female)-TYPE N(female) Adapter | HP P/N 1250-1476 | A,T |
| | BNC(female)-TYPE N(male) Adapter(2EA) | HP P/N 1250-1535 | A,T |
| | BNC(female)-BNC(female) Adapter | HP P/N 1250-0080 | A,T |
| Extender Boards | 12 pin dual in-line | HP P/N 04193-66561 | A,T |
| | 12 pin dual in-line | HP P/N 04193-66562 | A,T |
| | 24 pin dual in-line | HP P/N 04193-66563 | A,T |
| Extender Cable | SMB (male)-SMB (female) cable (3EA) | HP P/N 04193-61630 | T |
| Vise Ass'y | | HP P/N 04193-69500 | T |
| Termination | GR 874 50Ω Termination | HP P/N 0950-0090 | A |
| Phase Reference Board | | HP P/N 04193-66565 | T |

* USE: P = Performance Test, A = Adjustment, T = Troubleshooting

# SECTION IV

## PERFORMANCE TESTS

### 4-1. INTRODUCTION

4-2. This section provides the tests and procedures used to verify the 4193A specifications listed in Table 1-1. All tests can be performed without access to the interior of the instrument. The performance tests can be used when performing incoming inspection of the instrument and when verifying that the instrument meets specified performance after troubleshooting and/or adjustment. If the performance tests indicate that the instrument is operating outside specified limits, check that the controls on the instruments used in the test and the test setup itself are correct and then proceed with adjustments and/or troubleshooting.

Note

> To ensure proper test results and instrument operation, Hewlett-Packard suggests a 60 minute warm-up and stabilization period before performing any of the performance tests.

### 4-3. EQUIPMENT REQUIRED

4-4. Equipment required to perform all of the performance tests is listed in Table 4-1. Any equipment that satisfies or exceeds the critical specifications listed in the table may be used as a substitute for the recommended models. Accuracy checks described in this section use the HP Model 16345A Probe Type Calibration Box. The characteristics of the equipment satisfy the performance requirements for the accuracy checks and are especially suited for use as the 4193A's accuracy test standards.

Note

> Components used as standards should be calibrated by an instrument whose accuracy is traceable to NBS or an equivalent standards group; or calibrated directly by an authorized calibration organization such as NBS. The calibration cycle should be in accordance with the stability specifications of each component.

### 4-5. TEST RECORD

4-6. Performance test results can be recorded on the Test Record at the completion of the test. The Test Record is at the end of this section and it lists all the tested specifications and their acceptable limits. Test results recorded at incoming inspection can be used for comparison in periodic maintenance, troubleshooting, and after repair or adjustment.

### 4-7. CALIBRATION CYCLE

4-8. This instrument requires periodic verification of performance. Depending on the conditions under which the instrument is used, e.g., environmental conditions or frequency of use, the instrument should be checked, with the performance tests described here, at least once a year. To keep instrument down-time minimum and to insure optimum operation, preventive maintenance should be performed at least twice a year.

## 4-9. *INITIAL OPERATION CHECK*

PURPOSE : This check verifies that the logic section and display section are functioning properly.

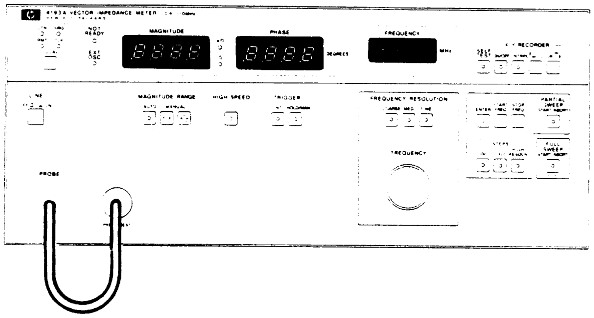


Figure 4-1. Initial Operation Check Setup.

EQUIPMENT :

None.

PROCEDURE :

1. Insert the probe into the PROBE REST as shown in Figure 4-1.
2. Turn the instrument on.

[DISPLAY TEST]

3. Confirm that all front-panel indicator lamps and display segments light for about three seconds.

[SELF TEST]

4. Confirm that the following SELF TEST codes are sequentially displayed on the FREQUENCY display :

- - - - : Indicates that the SELF TEST program is in progress.

PASS : Indicates that the instrument has passed the SELF TEST.

H - 17 : HP-IB address. Seventeen (17) is the factory-set address.

Note : If "FAIL" appears on the FREQUENCY display, the instrument needs service. Refer to Section VIII.

[INITIAL CONTROL SETTINGS]

5. Confirm that the instrument is set to the Initial Control Settings listed below.

Panel Controls :

| | |
|---|---|
| MAGNITUDE RANGE | AUTO |
| HIGH SPEED | OFF |
| TRIGGER | INT |
| FREQUENCY RESOLUTION | FINE |
| ENTER | OFF |
| STEPS | 100 |
| PARTIAL SWEEP | OFF |
| FULL SWEEP | OFF |
| SELF TEST | OFF |
| X-Y RECORDER ON/OFF | OFF |
| INTERPOLATION | OFF |

Test Parameters :

| | |
|---|---|
| SPOT FREQ | 10MHz |
| START FREQ | .4MHz |
| STOP FREQ | 110MHz |
| RECORDER OUTPUTS | .0V |

## 4-10. *TEST FREQUENCY ACCURACY TEST*

PURPOSE : This test verifies that the test frequency is within specifications.

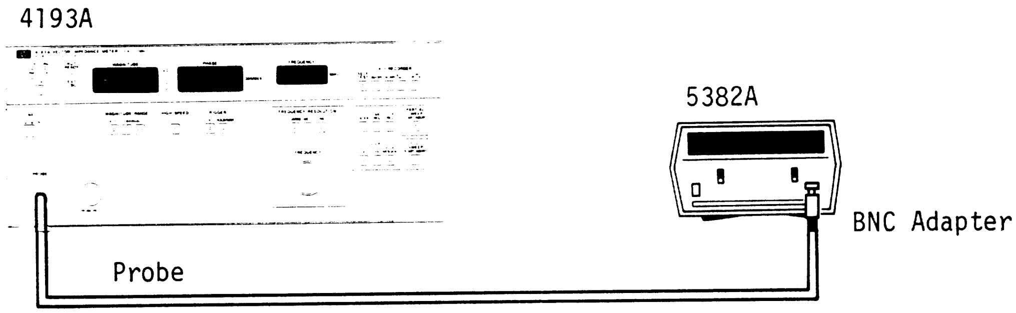


Figure 4-2. Test Frequency Accuracy Test Setup.

EQUIPMENT :

Frequency Counter ························· HP 5382A
BNC Adapter ································· HP P/N 04193-61152

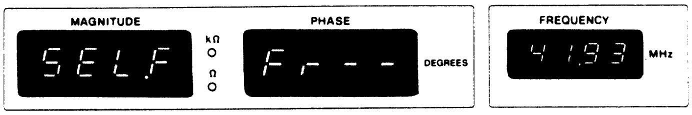
PROCEDURE :

1. Connect the 4193A's probe to the 5382A's input as shown in Figure 4-2. Use the furnished BNC adapter (HP Part No. : 04193-61152).

2. Set the 4193A and 5382A to the following control settings :

    4193A : Test Frequency ·············· 41.93MHz
    Other Controls ·············· Initial Settings
    5382A : GATE TIME ··················· .1S
    ATTENUATOR ·············· x10

3. Press the SELF TEST key and confirm that the MAGNITUDE and PHASE displays are as shown below.



4. Change the test frequency from 41.93MHz to 0.4MHz, and confirm that the 5382A displays .40000MHz ± 40Hz.

5. Successively change the test frequency to 9.999MHz, 10.00MHz, 39.99MHz, 40.00MHz, 69.99MHz, 70.00MHz, and 110.0MHz, and confirm that the frequency readings on the 5382A are within the test limits listed in Table 4-2.

Table 4-2. Test Frequency Accuracy Test Limits

| Test Frequency (MHz) | Table Limits (MHz) |
|---|---|
| 0.400 | 0.399960 to 0.400040 |
| 9.999 | 9.99800 to 9.99999 |
| 10.00 | 9.99900 to 10.0010 |
| 39.99 | 39.9860 to 39.9939 |
| 40.00 | 39.9960 to 40.0040 |
| 69.99 | 69.9830 to 69.9969 |
| 70.00 | 69.9930 to 70.0070 |
| 110.0 | 109.989 to 110.011 |

## PERFORMANCE TESTS

### 4-12. *IMPEDANCE ACCURACY TEST*

PURPOSE: This test verifies that the accuracy of impedance measurements is within specifications.

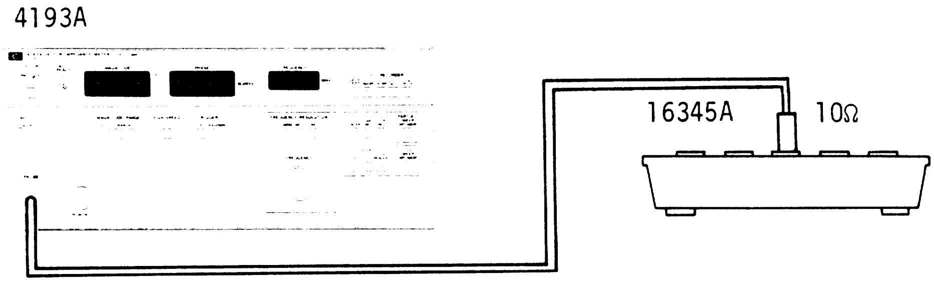


Figure 4-4. Impedance Accuracy Test Setup.

EQUIPMENT:

Probe Type Cal. Box ················· HP 16345A

PROCEDURE:

1. Turn on the instrument to establish Initial Control Settings.
2. Connect the probe to the 10Ω standard of the 16345A.
3. Read measured values displayed on the MAGNITUDE and PHASE displays when test frequency is set to 0.4MHz, 1MHz, 10MHz, 40MHz, and 110MHz, respectively.
4. Confirm that each value is within the test limits listed in Table 4-4.
5. Perform step 3 for each of the 100Ω, 1kΩ, 10kΩ, and 5pF standards, and confirm that each value is within the test limits listed in Tables 4-5 through 4-8.

Table 4-4. Impedance Accuracy Test Limits for 10Ω

| Test Frequency | Test Limits | |
|---|---|---|
| | Magnitude | Phase |
| 0.4MHz | C.V.* ±84 counts | C.V.* ±62 counts |
| 1MHz | C.V. ±72 counts | C.V. ±35 counts |
| 10MHz | C.V. ±72 counts | C.V. ±53 counts |
| 40MHz | C.V. ±133 counts | C.V. ±113 counts |
| 110MHz | C.V. ±329 counts | C.V. ±253 counts |

* : Reference value listed in the data sheet of the 16345A

## PERFORMANCE TESTS

Table 4-5. Impedance Accuracy Test Limits for 100Ω

| Test Frequency | Test Limits | |
|---|---|---|
| | Magnitude | Phase |
| 0.4MHz | C.V.* ±42 counts | C.V.* ±62 counts |
| 1MHz | C.V. ±34 counts | C.V. ±34 counts |
| 10MHz | C.V. ±34 counts | C.V. ±36 counts |
| 40MHz | C.V. ±44 counts | C.V. ±47 counts |
| 110MHz | C.V. ±71 counts | C.V. ±71 counts |

Table 4-6. Impedance Accuracy Test Limits for 1kΩ

| Test Frequency | Test Limits | |
|---|---|---|
| | Magnitude | Phase |
| 0.4MHz | C.V.* ±50 counts | C.V.* ±61 counts |
| 1MHz | C.V. ±41 counts | C.V. ±34 counts |
| 10MHz | C.V. ±41 counts | C.V. ±44 counts |
| 40MHz | C.V. ±72 counts | C.V. ±77 counts |
| 110MHz | C.V. ±122 counts | C.V. ±154 counts |

Table 4-7. Impedance Accuracy Test Limits for 10kΩ

| Test Frequency | Test Limits | |
|---|---|---|
| | Magnitude | Phase |
| 0.4MHz | C.V.* ±47 counts | C.V.* ±65 counts |
| 1MHz | C.V. ±38 counts | C.V. ±36 counts |
| 10MHz | C.V. ±46 counts | C.V. ±84 counts |
| 40MHz | C.V. ±77 counts | C.V. ±87 counts |

Table 4-8. Impedance Accuracy Test Limits for 5pF

| Test Frequency | Test Limits | |
|---|---|---|
| | Magnitude | Phase |
| 0.4MHz | C.V.* ±7 counts | C.V.* ±8 counts |
| 1MHz | C.V. ±5 counts | C.V. ±6 counts |

*: Reference value listed in the data sheet of the 16345A

## PERFORMANCE TESTS

### 4-13. *EXTERNAL OSCILLATOR USAGE CHECK*

PURPOSE: This test verifies the useability of an external signal source.

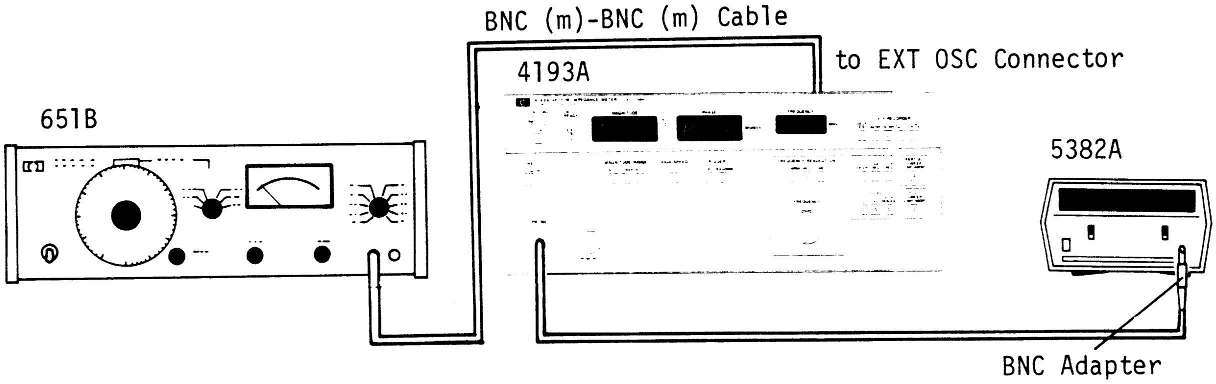


Figure 4-5. External Oscillator Usage Check Setup.

EQUIPMENT:

| | |
|---|---|
| Test Oscillator | HP 651B |
| Frequency Counter | HP 5382A |
| BNC Adapter | HP P/N 04193-61152 |

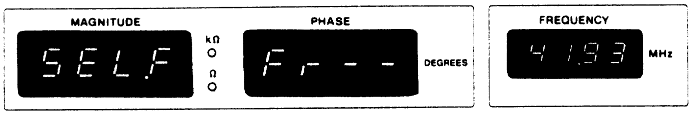
PROCEDURE:

1. Connect the probe to the 5382A's input with the furnished BNC adapter (HP Part No. : 04193-61152), and connect the 651B 50Ω output to the 4193A's EXT OSC terminal on the rear-panel as shown in Figure 4-5.

2. Set the instruments' controls as follows :

| | | |
|---|---|---|
| 4193A : | Test Frequency | 41.93MHz |
| | Other Controls | Initial Settings |
| 651B : | FREQUENCY | 10MHz |
| | OUTPUT ATTENUATOR | -70dBm |
| | OUTPUT AMPLITUDE | 0dBm |
| 5382A : | GATE TIME | .1S |
| | ATTENUATOR | x10 |

3. Press the 4193A's SELF TEST key and confirm that the MAGNITUDE and PHASE displays are as shown below :



4. Set the 4193A's test frequency to 10.00MHz.

5. Confirm that the 5382A displays 10.000MHz ±1kHz.

6. Set the 651B's OUTPUT ATTENUATOR switch to 0dBm.

7. Confirm that the 4193A's EXT OSC lamp on the front-panel turns on, and that the 5382A displays the 651B's test frequency, approximately 10MHz.

## 4-14. *RECORDER OUTPUT VOLTAGE ACCURACY TEST*

PURPOSE: This test verifies that the RECORDER OUTPUT voltages are within specifications.

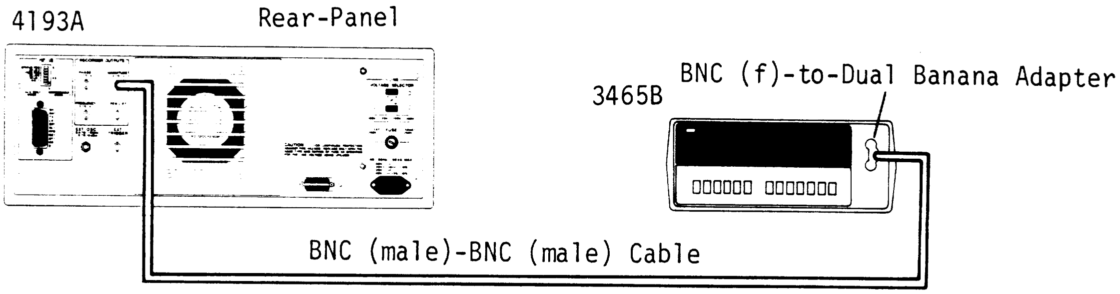


Figure 4-6. Recorder-output Voltage Accuracy Test Setup.

EQUIPMENT:

DVM ............................................. HP 3465B
BNC (female)-Dual Banana Adapter ........ HP P/N 1251-2277

PROCEDURE:

1. Connect the INPUT of the 3465B to the MAGNITUDE RECORDER OUTPUT terminal on the rear-panel of the 4193A. Refer to Figure 4-6.
2. Set the instruments' controls as follows.

3465B: FUNCTION ............ ⎓ V
RANGE ............ 2
4193A: Initial Settings

3. Press the ☐ key on the 4193A. The readout on the 3465B should be 0V±20mV.
4. Press the ☐ key on the 4193A. The readout on the 3465B should be 1V ± 30mV.
5. Repeat steps 3 and 4 for the PHASE and FREQUENCY RECORDER OUTPUTS.

Table 4-9. Recorder-output Voltage Limits

| | Minimum | Actual Value | Maximum |
|---|---|---|---|
| MAGNITUDE output: | | | |
| Lower Left (LL): | - 20mV | $V_{LL}$ : ________ | + 20mV |
| Upper Right (UR): | + 970mV | ________ | + 1030mV |
| PHASE output: | | | |
| Lower Left (LL): | - 20mV | $V_{LL}$ : ________ | + 20mV |
| Upper Right (UR): | + 970mV | ________ | + 1030mV |
| FREQUENCY output: | | | |
| Lower Left (LL): | -20mV | $V_{LL}$ : ________ | + 20mV |
| Upper Right (UR): | + 970mV | ________ | + 1030mV |

## 4-15. *HP-IB INTERFACE TEST*

PURPOSE : This test verifies the instrument's HP-IB capabilities.

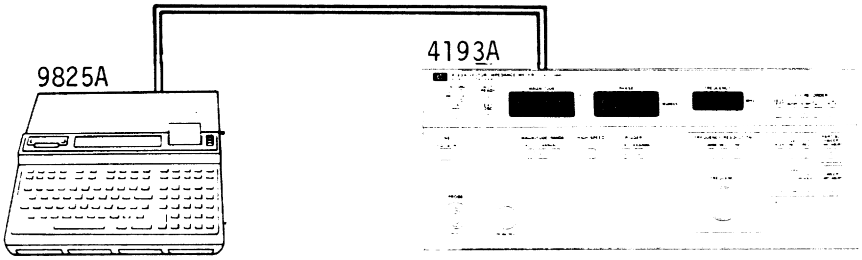


Figure 4-7. HP-IB Interface Test Setup.

EQUIPMENT :

| | |
|---|---|
| Calculator | HP9825A (9825B) |
| I/O ROM's | HP98210A, 98213A |
| Interface Cable | HP98034A (98034B) |
| 100Ω Standard | HP16345A |

PROCEDURE :

a. Turn both the 4193A and the 9825A off.

b. Connect the 98034A between the 9825A and 4193A as shown in Figure 4-7, and install the I/O ROM's in the ROM slots.

c. Set the 4193A's HP-IB control switch, located on the rear panel, as follows :

bits 1 - 5 : 10001 ($17_{10}$)
bit 6 : 0
bit 7 : 0

d. Turn the 4193A and the 9825A on.

e. Load one of the three test programs into the calculator. Test programs are listed on pages 4-10, 4-12, and 4-14.

f. Execute the program and follow the prompts and instructions that are output by the 9825A. Details on the controller's (calculator) instructions and the appropriate operator response are given in Tables 4-10 through 4-12.

## TEST PROGRAM 1

### PURPOSE:

This test verifies that the 4193A has the following HP-IB capabilities :

(1) Remote/Local Capability

(2) Local Lockout

(3) Talk Disable

(4) Listen Disable

### PROGRAM LISTING:

```
0: "REMOTE/LOCAL TEST":
1: dim A$[1]
2: 0>N
3: rds(717)>S
4: prt "REMOTE/LOCAL TEST";spc 3
5: rem 7
6: wrt 717,"T1";ent "LISTEN=1,TALK=0,REMOTE=1",A$
7: if A$="n";1>N
8: cli 7;ent "LISTEN=0,TALK=0,REMOTE=1",A$
9: if A$="n";1>N
10: lcl 7;ent "LISTEN=0,TALK=0,REMOTE=0",A$
11: if A$="n";1>N
12: rem 717;ent "LISTEN=1,TALK=0,REMOTE=1",A$
13: if A$="n";1>N
14: llo 7
15: lcl 717;ent "LISTEN=1,TALK=0,REMOTE=0",A$
16: if A$="n";1>N
17: rem 7;wrt 717,"T1";ent "LISTEN=1,TALK=0,REMOTE=1",A$
18: if A$="n";1>N
19: if N=1;prt "REMOTE/LOCAL TEST FAIL";spc 3;jmp 2
20: prt "REMOTE/LOCAL TEST PASS";spc 3
21: 0>N
22: prt "LISTEN/TALK TEST";spc 3
23: red 717,A;ent "LISTEN=0,TALK=1,REMOTE=1",A$
24: if A$="n";1>N
25: wrt 717,"T1";ent "LISTEN=1,TALK=0,REMOTE=1",A$
26: if A$="n";1>N
27: if N=1;prt "LISTEN/TALK TEST FAIL";spc 3;jmp 2
28: prt "LISTEN/TALK TEST PASS";spc 3
29: prt "END";spc 3
30: cli 7
31: lcl 7
32: end
*14058
```

Table 4-10. Controller Instructions and Operator Responses for Test Program 1

| Controller Instructions | | Operator Response |
|---|---|---|
| Status Indicators | Printout | |
| | REMOTE/LOCAL TEST | |
| LISTEN = 1*, TALK = 0, REMOTE = 1 | | If the 4193A HP-IB Status Indicators and Controller Display are the same, press Y , and CONTINUE. If not, press N and CONTINUE. |
| LISTEN = 0, TALK = 0, REMOTE = 1 | | |
| LISTEN = 0, TALK = 0, REMOTE = 0 | | |
| LISTEN = 1, TALK = 0, REMOTE = 1 | | |
| LISTEN = 1, TALK = 0, REMOTE = 0 | | |
| LISTEN = 1, TALK = 0, REMOTE = 1 | | |
| | REMOTE/LOCAL TEST PASS | If all steps are correct, this message is output. |
| | REMOTE/TALK TEST FAIL | If any step fails, this message is output. |
| | LISTEN/TALK TEST | |
| LISTEN = 0, TALK = 1, REMOTE = 1 | | If the 4193A HP-IB Status Indicators and Controller Display are the same, press Y , and CONTINUE. If not, press N and CONTINUE. |
| LISTEN = 1, TALK = 0, REMOTE = 1 | | |
| | LISTEN/TALK TEST PASS | If both steps are correct, this message is output. |
| | LISTEN/TALK TEST FAIL | If any step fails, this message is output. |
| | END | |

*1 indicates ON; 0 indicates OFF.

## TEST PROGRAM 2

### PURPOSE :

This test verifies that the 4193A has the following HP-IB capabilities :

(1) Talker

(2) Device Trigger

### PROGRAMMING :

```
0: "TALKER TEST":
1: prt "TALKER TEST";spc 3
2: dsp "Insert probe to 100ohm";stp
3: prt "DATA OUTPUT TEST";spc 3
4: dim A$[100],B$[1]
5: rds(717)>S
6: rem 7
7: cli 7
8: clr 717
9: wrt 717,"H1T2FMT2"
10: ent "Test frequency in MHz?",F
11: wrt 717,"FR",F,"EN"
12: trg 717
13: red 717,A,B,C,D,E,F,G
14: prt C,D,G;spc 2
15: ent "Is output data correct?(y or n)",B$
16: if B$="n";prt "DATA OUTPUT TEST FAIL";spc 3;jmp 2
17: prt "DATA OUTPUT TEST PASS";spc 3
18: prt "COMPLETE DATA OUTPUT TEST";spc 2
19: wrt 717,"H1T2FMT4"
20: trg 717
21: red 717,A$
22: prt A$;spc 2
23: ent "Is output data correct?(y or n)",B$
24: if B$="n";prt "COMPLETE DATA OUTPUT TEST FAIL";spc 3;jmp 2
25: prt "COMPLETE DATA OUTPUT TEST PASS";spc 3
26: end
*5970
```

Table 4-11. Controller Instructions and Operator Responses for Test Program 2

| Controller Instructions | | Operator Response |
|---|---|---|
| Displays | Printout | |
| | TALKER TEST | |
| Insert probe to 100ohm. | | Insert the probe to 100Ω standard in the 16345A. Then press CONTINUE. |
| Test Frequency in MHz? | DATA OUTPUT TEST | Type the desired test frequency value, from 0.4 to 110, and press CONTINUE. |
| Is output data correct? (y or n) | [Magnitude]<br>[Phase]<br>[Test Frequency] | If the output data is the same as the values displayed on each 4193A display, press Y and CONTINUE. If not, press N and CONTINUE. |
| | DATA OUTPUT TEST PASS | DATA OUTPUT TEST result. |
| | DATA OUTPUT TEST FAIL | |
| | COMPLETE DATA OUTPUT TEST | |
| Is output data correct? (y or n) | Y1, S2, ZM [Magnitude], ZP [Phase], W4, B0, FR [Test Frequency], P1, Q3, A1, R2, H1, T2, X0, I0, G1, D0 | If the output data is the same as the left values, press Y and CONTINUE. If not, press N and CONTINUE. |
| | COMPLETE DATA OUTPUT TEST PASS | COMPLETE DATA OUTPUT TEST result. |
| | COMPLETE DATA OUTPUT TEST FAIL | |

## TEST PROGRAM 3

### PURPOSE :

This test program verifies that the 4193A has the following HP-IB capabilities :

(1) Service Request

(2) Serial Poll

### PROGRAM LISTING :

```
0: "SRQ TEST":
1: prt "SRQ TEST";spc 3
2: fxd 0
3: oni 7,"SRQ"
4: rem 7
5: cli 7
6: clr 717
7: wrt 717,"GO"
8: 0>S;prt "DATA READY";wrt 717,"D1T2";trg 717;gsb "LOOP"
9: 0>S;prt "SYNTAX ERROR";wrt 717,"DOW4CL";gsb "LOOP"
10: 0>S;prt "SELF TEST END";wrt 717,"S1";dsp "SELF TEST in progress"
11: gsb "LOOP"
12: 0>S;prt "TRG. TOO FAST";dsp "Connect EXT TRG pin to ground";gsb "LOOP1"
13: gsb "LOOP"
14: 0>S;prt "INEFFECTIVE PROGRAM";wrt 717,"W1S1CL";gsb "LOOP"
15: prt "SRQ TEST END";spc 2
16: clr 717
17: cli 7
18: lcl 7
19: end
20: "LOOP":eir 7,128
21: if S>0;prt S;spc 1;ret
22: gto "LOOP"
23: "SRQ":rds(717)>S
24: if bit(6,S)=1;jmp 2
25: prt "OTHER DEVICE SRQ";spc 3
26: "IRET":eir 7,128
27: iret
28: "LOOP1":wrt 717,"FMT1G1CL"
29: trg 717
30: red 717,A,B,C,D
31: if S=0;gto "LOOP1"
32: wrt 717,"GO"
33: ret
*19486
```

Table 4-12. Controller Instructions and Operator Responses for Test Program 3

| Controller Instructions | | Operator Response |
|---|---|---|
| Displays | Printout | |
| | SRQ TEST | |
| | DATA READY<br>65 | SRQ Status Byte data should be 65 (= 01000001). |
| | SYNTAX ERROR<br>66 | SRQ Status Byte data should be 66 (= 01000010). |
| SELF TEST in progress | SELF TEST END<br>84 | SRQ Status Byte data should be 84 (= 01010100). If the instrument fails SELF TEST, it should be 68 (= 01000100). |
| Connect EXT TRG pin to ground | TRG. TOO FAST<br>72 | Connect the EXT TRG pin on the rear-panel to ground. SRQ Status Byte data should be 72 (= 01001000). |
| | INEFFECTIVE PROGRAM<br>96 | SRQ Status Byte data should be 96 (= 01100000). |
| | SRQ TEST END | |

# PERFORMANCE TEST RECORD

Hewlett-Packard
Model 4193A
Vector Impedance Meter
Serial No. ____________

Tested by ____________
Date ____________

| Paragraph Number | Test | Minimum | Actual Results | Maximum |
|---|---|---|---|---|
| 4-9 | INITIAL OPERATION CHECK | | | |
| | DISPLAY TEST result (Pass/Fail) | | ________ | |
| | SELF TEST result (Pass/Fail) | | ________ | |
| | INITIAL CONTROL SETTINGS result (Pass/Fail) | | ________ | |
| 4-10 | TEST FREQUENCY ACCURACY CHECK | | | |
| | Frequency Setting: | | | |
| | .400 MHz | 0.399960 MHz | ________ | 0.400040 MHz |
| | 9.999 MHz | 9.99800 MHz | ________ | 9.99999 MHz |
| | 10.00 MHz | 9.99900 MHz | ________ | 10.0010 MHz |
| | 39.99 MHz | 39.9860 MHz | ________ | 39.9939 MHz |
| | 40.00 MHz | 39.9960 MHz | ________ | 40.0040 MHz |
| | 69.99 MHz | 69.9830 MHz | ________ | 69.9969 MHz |
| | 70.00 MHz | 69.9930 MHz | ________ | 70.0070 MHz |
| | 110.0 MHz | 109.989 MHz | ________ | 110.011 MHz |
| 4-11 | | | | |

| Paragraph Number | Test | Calibrated Value | Minimum | Actual Results | Maximum |
|---|---|---|---|---|---|
| 4-12 | IMPEDANCE ACCURACY TEST | | | | |
| | 10Ω range: 10Ω standard (____Ω, ____mH) | | | | |
| | Frequency Setting: | | | | |
| | 0.4MHz Magnitude | ________ Ω | C.V. -84 counts | ________ Ω | C.V. +84 counts |
| | Phase | ________ ° | C.V. -62 counts | ________ ° | C.V. +62 counts |
| | 1 MHz Magnitude | ________ Ω | C.V. -72 counts | ________ Ω | C.V. +72 counts |
| | Phase | ________ ° | C.V. -35 counts | ________ ° | C.V. +35 counts |
| | 10 MHz Magnitude | ________ Ω | C.V. -72 counts | ________ Ω | C.V. +72 counts |
| | Phase | ________ ° | C.V. -53 counts | ________ ° | C.V. +53 counts |
| | 40 MHz Magnitude | ________ Ω | C.V. 138 counts | ________ Ω | C.V.+138 counts |
| | Phase | ________ ° | C.V.-133 counts | ________ ° | C.V.+133 counts |
| | 110 MHz Magnitude | ________ Ω | C.V.-329 counts | ________ Ω | C.V.+329 counts |
| | Phase | ________ ° | C.V.-253 counts | ________ ° | C.V.+253 counts |
| | 100Ω range: 100Ω standard (____Ω, ____pF) | | | | |
| | Frequency Setting: | | | | |
| | 0.4MHz Magnitude | ________ Ω | C.V. -42 counts | ________ Ω | C.V. +42 counts |
| | Phase | ________ ° | C.V. -62 counts | ________ ° | C.V. +62 counts |
| | 1 MHz Magnitude | ________ Ω | C.V. -34 counts | ________ Ω | C.V. +34 counts |
| | Phase | ________ ° | C.V. -34 counts | ________ ° | C.V. +34 counts |
| | 10 MHz Magnitude | ________ Ω | C.V. -34 counts | ________ Ω | C.V. +34 counts |
| | Phase | ________ ° | C.V. -36 counts | ________ ° | C.V. +36 counts |
| | 40 MHz Magnitude | ________ Ω | C.V. -44 counts | ________ Ω | C.V. +44 counts |
| | Phase | ________ ° | C.V. -47 counts | ________ ° | C.V. +47 counts |
| | 110 MHz Magnitude | ________ Ω | C.V. -71 counts | ________ Ω | C.V. +71 counts |
| | Phase | ________ ° | C.V. -71 counts | ________ ° | C.V. +71 counts |

# PERFORMANCE TEST RECORD

| Paragraph Number | Test | | Calibrated Value | Minimum | Actual Results | Maximum |
|---|---|---|---|---|---|---|
| | 1kΩ range: 1kΩ standard (____Ω, ____pF) | | | | | |
| | Frequency Setting: | | | | | |
| | 0.4MHz | Magnitude | ______Ω | C.V. -50 counts | ______Ω | C.V. +50 counts |
| | | Phase | ______° | C.V. -61 counts | ______° | C.V. +61 counts |
| | 1 MHz | Magnitude | ______Ω | C.V. -41 counts | ______Ω | C.V. +41 counts |
| | | Phase | ______° | C.V. -34 counts | ______° | C.V. +34 counts |
| | 10 MHz | Magnitude | ______Ω | C.V. -41 counts | ______Ω | C.V. +41 counts |
| | | Phase | ______° | C.V. -44 counts | ______° | C.V. +44 counts |
| | 40 MHz | Magnitude | ______Ω | C.V. -72 counts | ______Ω | C.V. +72 counts |
| | | Phase | ______° | C.V. -77 counts | ______° | C.V. +77 counts |
| | 110 MHz | Magnitude | ______Ω | C.V.-122 counts | ______Ω | C.V. +122 counts |
| | | Phase | ______° | C.V.-154 counts | ______° | C.V. +154 counts |
| | 10kΩ range: 10kΩ standard (____Ω, ____pF) | | | | | |
| | Frequency Setting: | | | | | |
| | 0.4MHz | Magnitude | ______Ω | C.V. -47 counts | ______Ω | C.V. +47 counts |
| | | Phase | ______° | C.V. -65 counts | ______° | C.V. +65 counts |
| | 1 MHz | Magnitude | ______Ω | C.V. -38 counts | ______Ω | C.V. +38 counts |
| | | Phase | ______° | C.V. -36 counts | ______° | C.V. +36 counts |
| | 10 MHz | Magnitude | ______Ω | C.V. -46 counts | ______Ω | C.V. +46 counts |
| | | Phase | ______° | C.V. -84 counts | ______° | C.V. +84 counts |
| | 40 MHz | Magnitude | ______Ω | C.V. -77 counts | ______Ω | C.V. +77 counts |
| | | Phase | ______° | C.V. -87 counts | ______° | C.V. +87 counts |
| | 100kΩ range: 5pF standard (____pF) | | | | | |
| | Frequency Setting: | | | | | |
| | 0.4MHz | Magnitude | ______Ω | C.V. -7 counts | ______Ω | C.V. +7 counts |
| | | Phase | ______° | C.V. -3 counts | ______° | C.V. +3 counts |
| | 1 MHz | Magnitude | ______Ω | C.V. -5 counts | ______Ω | C.V. +5 counts |
| | | Phase | ______° | C.V. -4 counts | ______° | C.V. +4 counts |
| 4-13 | EXTERNAL OSCILLATOR USAGE CHECK | | | | | |
| | Test result (Pass/Fail) | | | | ______ | |
| 4-14 | RECORDER-OUTPUT VOLTAGE ACCURACY TEST | | | | | |
| | MAGNITUDE RECORDER-OUTPUT | | | | | |
| | Lower Left (↓← LL) | | | -20mV | ______ | +20mV |
| | Upper Right (UR →↑) | | | +970mV | ______ | +1030mV |
| | PHASE RECORDER-OUTPUT | | | | | |
| | Lower Left (↓← LL) | | | -20mV | ______ | +20mV |
| | Upper Right (UR →↑) | | | +970mV | ______ | +1030mV |
| | FREQUENCY RECORDER-OUTPUT | | | | | |
| | Lower Left (↓← LL) | | | -20mV | ______ | +20mV |
| | Upper Right (UR →↑) | | | +970mV | ______ | +1030mV |
| 4-15 | HP-IB INTERFACE TEST | | | | | |
| | REMOTE/LOCAL TEST result (Pass/Fail) | | | | ______ | |
| | LISTEN/TALK TEST result (Pass/Fail) | | | | ______ | |
| | DATA OUTPUT TEST result (Pass/Fail) | | | | ______ | |
| | COMPLETE DATA OUTPUT TEST result (Pass/Fail) | | | | ______ | |
| | SRQ TEST result (Pass/Fail) | | | | ______ | |

Table 5-1. Adjustable Components

| Reference Designation | Name of Control | Purpose |
|---|---|---|
| A1C3 (Para. 5-28) | Vp ADJ | Equalizes the height of the V-Channel and I-Channel sampling pulses in order to maximize sampling efficiency in both channels. |
| A2R58 (Para. 5-27) | BIAS ADJ | Eliminates test signal harmonics in order to minimize measurement error. |
| A3R9 (Para. 5-33) | VB | Adjusts the dc bias voltage applied to sampling diodes. |
| A3R6 (Para. 5-34) | MAG ADJ | Adjusts the V channel gain in order to adjust the amplitude of the magnitude signal. |
| A4R10 (Para. 5-31) | IB | Adjusts the dc bias voltage applied to sampling diodes. |
| A4R30 (Para. 5-32) | GAIN | Adjusts the I channel gain in order to adjust the current level through the DUT. |
| A4R6 (Para. 5-34) | PHASE ADJ | Eliminates the phase shift in the medium frequency range. |
| A6C8 (Para. 5-25) | VCXO ADJ | Adjusts the VCXO frequency range. |
| A6C7 (Para. 5-26) | BPF ADJ | Adjusts the center frequency of the BPF to 299.99MHz. |
| A8C28 (Para. 5-21) | 100MHz ADJ | Adjusts the reference frequency of the Crystal Oscillator to 100MHz. |
| A8C3 (Para. 5-22) | BPF ADJ | Adjusts the center frequency of the BPF to 300MHz. |
| A8R1 (Para. 5-23) | LEVEL ADJ | Controls the output signal level to the MIXER on the A9 board. |
| A11R3 (Para. 5-24) | OFFSET | Eliminate any dc offset voltage in the Integrator Circuit on the A11 board in order to maximize measurement accuracy. |
| A12R11 (Para. 5-30) | GAIN I | Adjusts the gain of the IF BPF in the I channel. |
| A12R12 (Para. 5-30) | PHASE I | Adjusts the center frequency of the IF BPF in the I channel. |
| A12R3 (Para. 5-30) | GAIN V/I | Adjusts the gain of the IF BPF in the V/I channel. |
| A12R4 (Para. 5-30) | PHASE V/I | Adjusts the center frequency of the IF BPF in V/I channel. |
| A13R1 (Para. 5-29) | ALC BIAS | Adjusts ALC reference voltage in the Integrator Circuit. |
| A15R1 (Para. 5-35) | F FS ADJ | Adjusts the full-scale output voltage for frequency analog output. |
| A15R2 (Para. 5-35) | M FS ADJ | Adjusts the full-scale output voltage for magnitude analog output. |
| A15R3 (Para. 5-35) | P FS ADJ | Adjusts the full-scale output voltage for phase analog output. |
| A41 (Para. 5-34) | LENGTH ADJ | Eliminate the phase difference between V and I channels in the high frequency range. |

# SECTION V
# ADJUSTMENT

## 5-1. INTRODUCTION

5-2. This section describes the adjustments and checks required to return the 4193A to the specifications listed in Table 1-1 after repairs have been made. These adjustments and checks can also be performed along with periodic maintenance to keep the instrument in optimum operating condition. The recommended adjustment cycle for the 4193A is twice a year. All adjustable components referred to in the adjustment procedures are listed in Table 5-1. If proper performance cannot be achieved after adjustment, refer to the troubleshooting procedures described in Section VIII.

Note

> To ensure proper results and instrument operation, Hewlett-Packard suggests a 60 minute warm-up and stabilization period before performing any of the adjustments described here.

## 5-3. SAFETY REQUIREMENTS

5-4. Although the 4193A was designed in accordance with international safety standards, this manual contains information, cautions, and warnings which must be followed to ensure operator safety and to keep the instrument in a safe and serviceable condition. Adjustments described in this section should be performed by qualified service personnel only.

WARNING

> ANY INTERRUPTION OF THE PROTECTIVE (GROUNDED) CONDUCTOR (INSIDE OR OUTSIDE THE INSTRUMENT) OR DISCONNECTION OF THE PROTECTIVE EARTH TERMINAL IS LIKELY TO MAKE THE INSTRUMENT DANGEROUS. INTENTIONAL INTERRUPTION, FOR ANY REASON, IS PROHIBITED.

5-5. The removal or opening of covers for removal or adjustment of parts, other than those which are accessible by hand, will expose live parts.

5-6. Capacitors in the instrument may still be charged even if the instrument has been disconnected from the power source (AC line) for an extended period of time.

WARNING

> ADJUSTMENTS DESCRIBED IN THIS SECTION ARE PERFORMED WITH POWER SUPPLIED AND PROTECTIVE COVERS REMOVED. ENERGY EXISTING AT MANY POINTS MAY, IF CONTACTED, RESULT IN SERIOUS PERSONAL INJURY.

## 5-7. EQUIPMENT REQUIRED

5-8. All the equipment required to perform the adjustments described in this section are listed in Table 4-1 on page 4-0. Each piece of equipment listed in Table 4-1 should be calibrated to satisfy its own specifications, as well as those of the required characteristics. If the recommended model is not available, any instrument whose specifications equal or surpass those of the recommended model may be used instead.

## 5-9. FACTORY SELECTED COMPONENTS

5-10. Factory selected components are identifiable by an asterisk (*) adjacent to the reference designator on the schematic diagrams in Section VIII (only nominal values are given). Table 5-2 lists the reference designators of all factory selected components. Also listed in Table 5-2 are the nominal value range of each component and a brief description of how each component affects instrument performance.

Adjustable components, with reference designators, are listed in Table 5-1. This table also lists the name of the adjustment and its purpose.

## 5-11. ADJUSTMENT RELATIONSHIPS

5-12. The adjustment procedures described in this section, beginning with paragraph 5-21, are interactive and therefore should be performed in the sequence given. Ignoring or changing the order of the procedures may make it impossible to obtain optimum instrument performance. Table 5-3 lists the necessary adjustment procedures to follow after the instrument has been repaired.

## 5-13. ADJUSTMENT LOCATIONS

5-14. To help locate the appropriate adjustment points, the locations of the components to be adjusted are illustrated throughout the adjustment procedures. The locations of factory selected components, connectors, and other components related to the adjustments are shown in the individual board assembly-component illustrations (fold-out service sheets) in Section VIII.

## 5-15. INITIAL OPERATING PROCEDURE

5-16. Before proceeding with the adjustments described starting in paragraph 5-21, perform the following three preliminary procedures. These procedures provide access to the various adjustment points and facilitate a thoroughgoing adjustment. Initial Control Settings, described in paragraph 3-9, must be used for each adjustment. Exceptions to these settings will be noted as they occur. After completing an adjustment, return the 4193A's controls to the initial control settings.

### [BASIC OPERATING CHECK]

Check that the instrument's line voltage selector switches, located on the rear panel, are set to the positions appropriate for the local line voltage. This should be performed before proceeding with any of the adjustments.
After the recommended 60 minute warm-up period, the instrument should pass the SELF TEST (no error message should appear), and the initial control settings listed in paragraph 3-9 should be automatically set in preparation for measurements. If the instrument displays an error message or does not have the correct initial control settings, refer to the troubleshooting procedures given in Section VIII.

### [TOP COVER REMOVAL]

a. Fully loosen the top-cover retaining screw located at the rear of the top cover.

b. Slide the top cover towards the rear and lift off.

WARNING

DC VOLTAGES, ±15V AND ±5V, ARE PRESENT AT EXPOSED TERMINALS ON THE EXTRUSION BOARDS. DO NOT TOUCH THESE TERMINALS. AS A SAFETY PRECAUTION AGAINST POSSIBLE ELECTRICAL SHOCK HAZARDS AND RESULTANT INJURY, USE INSULATED TOOLS FOR ALL ADJUSTMENTS.

## 5-17. EXTRUSION BOARD REMOVAL

5-18. To prepare for a thoroughgoing adjustment, remove all screws securing the A1, A2, A3, A4, A6, and A8 extrusion boards. These boards will require removal at least once during adjustment.

## 5-19. BOARD EXTENSION

5-20. The extrusion boards are interconnected with SMB (female)-to-SMB (female) cables of various lengths, some of which are not long enough for connection to an extended board. When this situation occurs during adjustment or troubleshooting, use an extension cable, HP P/N: 04193-61630.

Note

The yellow cable between A1P2 and A4P2 has a precise electrical length matching that of the probe cable. DO NOT use a blue cable to connect A1P2 and A4P2.

## Table 5-2. Factory Selected Components

| Component | Nominal Value Range | Effect on Performance |
|---|---|---|
| A8C29 | 2.4pF (HP P/N: 0160-2242)<br>• 2.7pF (HP P/N: 0160-2243)<br>3.0pF (HP P/N: 0160-2244) | Sets the Crystal Oscillator frequency close to 100MHz. |
| A1P2-A4P2 Cable | 10cm (HP P/N: 04193-61615, red)<br>• 15cm (HP P/N: 04193-61616, yellow)<br>20cm (HP P/N: 04193-61617, blue) | Minimizes phase shift error at high frequencies caused by the cable length difference between V and I channels. |
| A10C69 | 3.9pF (HP P/N: 0160-4518)<br>• 4.7pF (HP P/N: 0160-3873)<br>5.6pF (HP P/N: 0160-4498) | Sets the VCO frequency range. |
| A11R1 | min: 0Ω<br>• 9.09k (HP P/N: 0757-0288)<br>max: 17·8kΩ | Narrows the INTEGRATOR offset adjustable range to facilitate the offset adjustment. |
| A11R2 | min: 0Ω<br>• 9.09kΩ (HP P/N: 0757-0288)<br>max: 17.8kΩ | |

• : typical value

## Table 5-3. Adjustment Requirements

| Assembly Repaired or Replaced | Required Adjustments |
|---|---|
| A1 Sampling PUlse Generator (SPG)<br>(P/N 04193-66501) | para. 5-28 thru 5-35. |
| A2 Automatic Level Control Amplifier (ALC AMP)<br>(P/N 04193-66502) | para. 5-27 thru 5-35. |
| A3 V Channel Amplifier (V CHAN AMP)<br>(P/N 04193-66503) | para. 5-33 thru 5-35. |
| A4 I Channel Amplifier (I CHAN AMP)<br>(P/N 04193-66504) | para. 5-31 thru 5-35. |
| A5 Mixer and Divider (MXR & DIVR)<br>(P/N 04193-66505) | para. 5-28 thru 5-35. |
| A6 Voltage Controlled Crystal Oscillator (VCXO)<br>(P/N 04193-66506) | para. 5-25 thru 5-35. |
| A7 Divider (DIVIDER)<br>(P/N 04193-66507) | None. |
| A8 Crystal Oscillator (XTAL OSC)<br>(P/N 04193-66508) | para. 5-21 thru 5-35. |
| A9 Mixer (MIXER)<br>(P/N 04193-66509) | None. |
| A10 Voltage Controlled Oscillator (VCO)<br>(P/N 04193-66510) | None. |
| A11 Integrator<br>(P/N 04193-66511) | para. 5-24 thru 5-35. |
| A12 IF BPF<br>(P/N 04193-66512) | para. 5-30 thru 5-35. |
| A13 Detector<br>(P/N 04193-66513) | para. 5-29 thru 5-35. |
| A14 Analog-to-Digital Converter<br>(P/N 04193-66514) | None. |
| A15 Analog Output<br>(P/N 04193-66515) | para. 5-35 only. |
| A16 HP-IB<br>(P/N 04193-66516) | None. |
| A17 Control Logic<br>(P/N 04193-66517) | None. |
| A18 Display<br>(P/N 04193-66518) | None. |
| A20 POWER SUPPLY<br>(P/N 04193-66520) | para. 5-21 thru 5-35. |
| A41 Delay<br>(P/N 04193-66541) | para. 5-28 and 5-35. |
| A51 Probe I Channel<br>(P/N 04193-66551) | para. 5-31 thru 5-35. |
| A52 Probe V Channel<br>(P/N 04193-66552) | para. 5-33 thru 5-35. |

## 5-21. *100MHz REFERENCE FREQUENCY ADJUSTMENT (A8)*

PURPOSE: This adjustment sets the frequency of the 100MHz Crystal Oscillator to an accurate 100MHz.

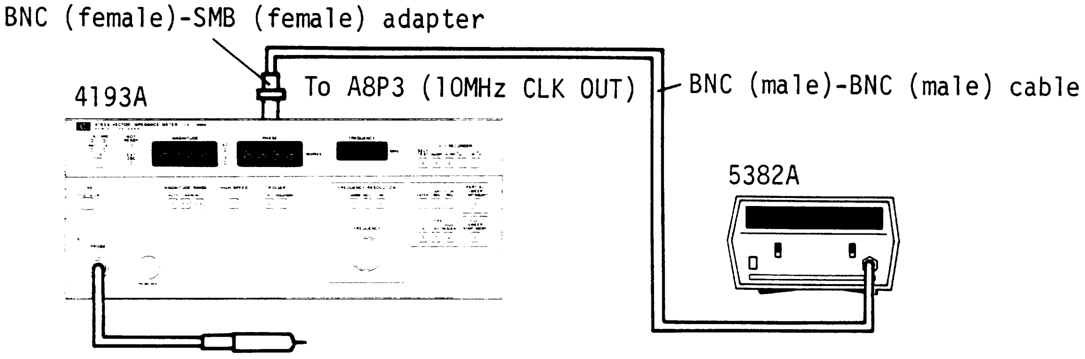


Figure 5-1. 100MHz Reference Frequency Adjustment Setup.

EQUIPMENT:

| | |
|---|---|
| Frequency Counter | HP5382A |
| BNC (female)-SMB (female) Adapter | HPP/N 1250-1236 |

PROCEDURE:

1. Disconnect the cable from A8P3 (10MHz CLK OUT).

2. Connect the INPUT terminal of the 5382A to A8P3 (10MHz CLK OUT) as shown in Figure 5-1.

3. Set the 5382A's controls as follows:

| | |
|---|---|
| GATE TIME | .1S |
| ATTENUATOR | x10 |

4. Adjust A8C28 (100MHz ADJ) until the reading on the 5382A is 10MHz±10Hz.

5. Reconnect the cable that was disconnected in step 1, and turn the 4193A off and on to return to normal operation.

## 5-22. *300MHz BPF ADJUSTMENT (A8)*

PURPOSE: This adjustment maximizes the level of the 300MHz signal output from the 300MHz BPF on the A8 board by setting the center frequency of the 300MHz BPF to 300MHz.

## ADJUSTMENTS

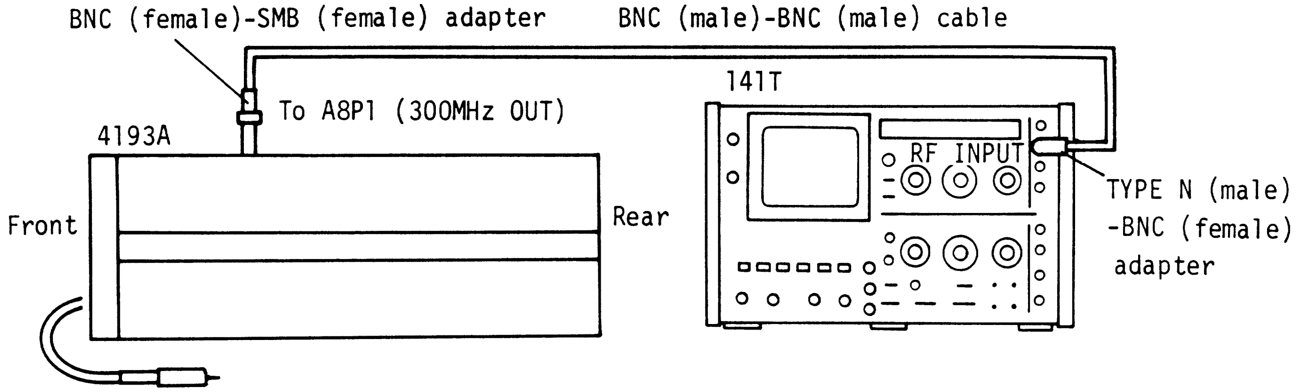


Figure 5-2. 300MHz BPF Adjustment Setup.

EQUIPMENT :

| | |
|---|---|
| Spectrum Analyzer | HP 141T with 8552B and 8554B Plug-ins. |
| Type N (male)-BNC (female) Adapter | HP P/N 1250-1476 |
| BNC (female)-SMB (female) Adapter | HP P/N 1250-1236 |
| BNC(male)-BNC(male) Cable | HP 11170C |

PROCEDURE :

1. Disconnect the cable from A8P1 (300MHz OUT).

2. Connect the RF INPUT terminal of the spectrum analyzer to A8P1 (300MHz OUT) as shown in Figure 5-2.

3. Set the spectrum analyzer's controls as follows :

| | | |
|---|---|---|
| 141T : | PERSISTANCE | NORMAL |
| | WRITING RATE | NORMAL |
| 8554B : | CENTER FREQUENCY | 300MHz |
| | BANDWIDTH | 300kHz |
| | SCAN WIDTH | 50MHz, PER DIVISION |
| | INPUT ATTENUATION | 20dB |
| 8552B : | SCAN TIME | 5ms |
| | LOG REF LEVEL | 0dBm |
| | LOG REF LEVEL SWITCH | 10dB LOG |
| | LINEAR SENSITIVITY | 0 |
| | VIDEO FILTER | OFF |
| | SCAN MODE | INT |
| | SCAN TRIGGER | AUTO |

4. Adjust A8C3 (BPF ADJ) until the level of the 300MHz spectral display on the 141T CRT is maximum. Refer to Figure 5-3.

Note

Leave all connections and control settings as they are, and proceed to paragraph 5-23.

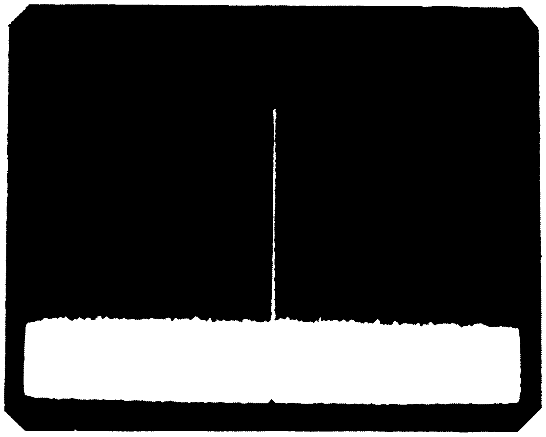


Figure 5-3. 300MHz Level.

## ADJUSTMENTS

### 5-23. *300MHz OUTPUT LEVEL ADJUSTMENT (A8)*

PURPOSE: This adjustment sets the level of the 300MHz signal (output from the A8 BPF) supplied to the mixer on the A9 board.

Note

The adjustment described in paragraph 5-22 must be performed before this adjustment.

PROCEDURE:

1. Use the same connections and control settings as those used in paragraph 5-22.
2. Adjust A8R1 (LEVEL ADJ) until the level of the 300MHz spectral display on the 141T CRT is -22dBm. Refer to Figure 5-4.

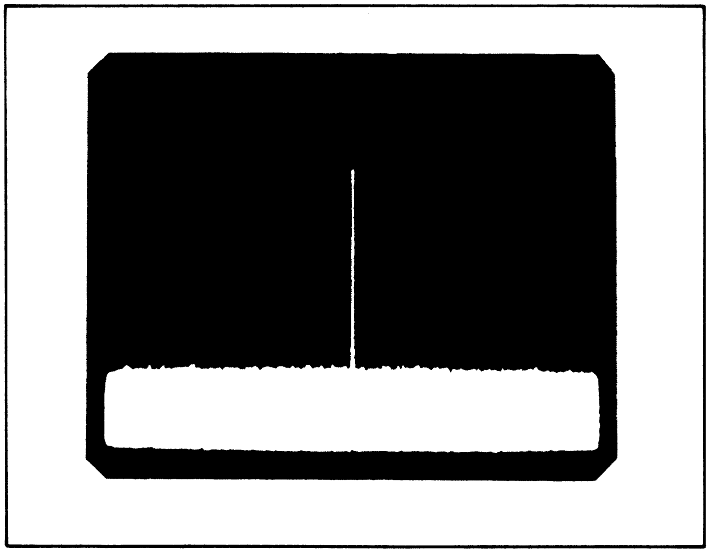


Figure 5-4. 300MHz Level.

### 5-24. *INTEGRATOR OFFSET ADJUSTMENT (A11)*

PURPOSE : This adjustment provides appropriate offset compensation for the integrator on the A11 board.

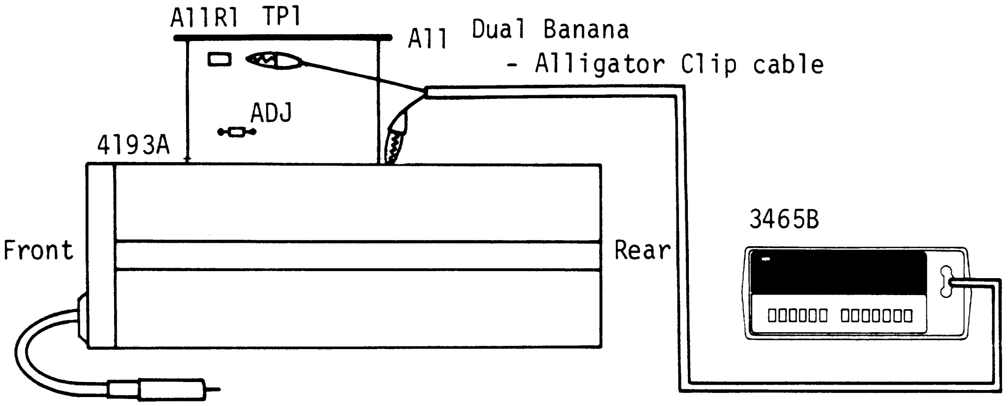


Figure 5-5. Integrator Offset Adjustment Setup.

EQUIPMENT :

| | |
|---|---|
| Digital Voltmeter | HP 3465B |
| Extender Board | HP P/N 04193-66561 |
| Dual Banana Plug to Alligator Clip Cable | HP 11002A |

PROCEDURE :

1. Turn off the 4193A.

2. Extend the A11 board with an extender board.

3. Turn on the 4193A.

4. Move the jumpers A11J1 and J2 from OPE to ADJ.

5. Connect the INPUT terminal of the 3465B to A11TP1 and chassis, as shown in Figure 5-5.

6. Set the 3465B's controls as follows :

3465B : FUNCTION ················ ⎓V
RANGE ···················· 200mV

7. Adjust A11R3 (OFFSET) until the reading on the 3465B is -2mV±0.2mV.

Note

If correct adjustment cannot be obtained in step 7, A11R1 and A11R2 must be changed. Measure the voltage at A11TP1 with A11R3 (OFFSET) set fully CCW and then fully CW. The reading on the 3465B at each setting should be lower than (more negative) 0mV and higher than (more positive) -3mV, respectively. If either reading is incorrect, replace A11R1 and A11R2 as described in Table A and Table B. Then repeat step 7.

8. Replace A11J1 and A11J2 to their normal positions, OPE.

Table A

| Reading on the 3465B When A11R3 is Fully CCW | A11R1 | | A11 R2 | |
|---|---|---|---|---|
| | Resistance | HP Part No. | Resistance | HP Part No. |
| 0mV to -5mV | 10.0kΩ | 0757-0442 | 7.50kΩ | 0757-0440 |
| -5mV to -15mV | 11.0kΩ | 0757-0443 | 6.81kΩ | 0757-0439 |
| -15mV to -25mV | 12.1kΩ | 0757-0444 | 5.62kΩ | 0757-0200 |
| -25mV to -35mV | 13.3kΩ | 0757-0289 | 4.64kΩ | 0698-3155 |
| -35mV to -45mV | 14.7kΩ | 0698-3156 | 3.83kΩ | 0698-3153 |
| -45mV to -55mV | 14.7kΩ | 0698-3156 | 2.87kΩ | 0698-3151 |
| -55mV to -65mV | 16.2kΩ | 0757-0447 | 1.78kΩ | 0757-0278 |
| -65mV to -75mV | 16.2kΩ | 0757-0447 | 825Ω | 0757-0421 |
| -75mV to -85mV | 17.8kΩ | 0698-3136 | 0Ω | 8159-0005 |

Table B

| Reading on the 3465B When A11 R3 is Fully CW | A11 R1 | | A11R2 | |
|---|---|---|---|---|
| | Resistance | HP Part No. | Resistance | HP Part No. |
| -3mV to +5mV | 7.50kΩ | 0757-0440 | 10.0kΩ | 0757-0442 |
| +5mV to +15mV | 6.81kΩ | 0757-0439 | 11.0kΩ | 0757-0443 |
| +15mV to +25mV | 5.62kΩ | 0757-0200 | 12.1kΩ | 0757-0444 |
| +25mV to +35mV | 4.64kΩ | 0698-3155 | 13.3kΩ | 0757-0289 |
| +35mV to +45mV | 3.83kΩ | 0698-3153 | 14.7kΩ | 0698-3156 |
| +45mV to +55mV | 2.87kΩ | 0698-3151 | 16.2kΩ | 0698-3156 |
| +55mV to +65mV | 1.78kΩ | 0757-0278 | 16.2kΩ | 0757-0447 |
| +65mV to +75mV | 825Ω | 0757-0421 | 16.2kΩ | 0757-0447 |
| +75mV to +85mV | 0Ω | 8159-0005 | 17.8kΩ | 0698-3136 |

## 5-25. *VCXO ADJUSTMENT (A6)*

PURPOSE: This adjustment sets the control voltage for the VCXO so as to set the center frequency of the VCXO to 100MHz.

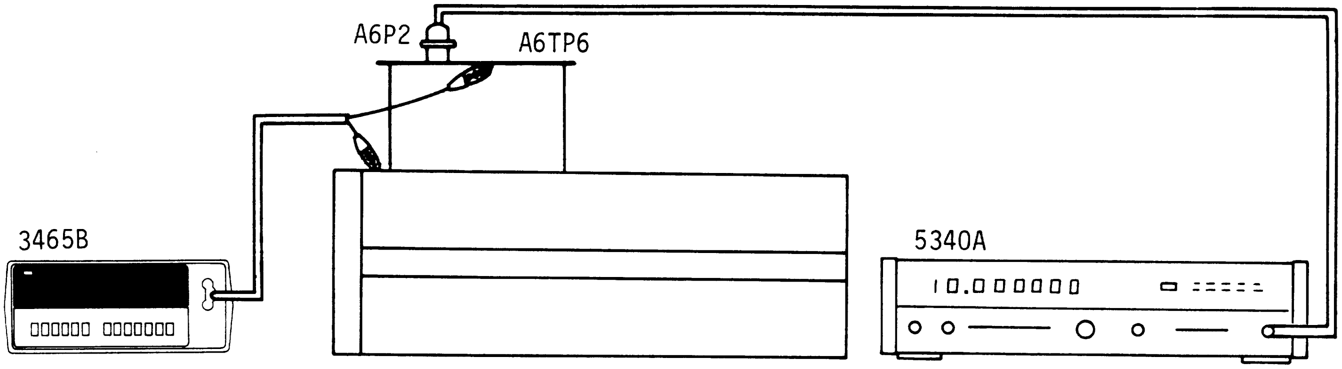


Figure 5-6. VCXO Adjustment Setup.

EQUIPMENT:

| | |
|---|---|
| Frequency Counter | HP 5340A |
| DVM | HP 3465B |
| BNC (female)-SMB (female) adapter | HP P/N 1250-1236 |
| Extender Board | HP P/N 04193-66561 |
| Dual Banana Plug to Alligator Clip Cable | HP 11002A |

PROCEDURE:

1. Turn off the 4193A.
2. Disconnect the cables from A6P1 (100MHz REF) and P2 (299.99MHz).
3. Extend the A6 board with an extender board.
4. Connect A6U5 pin 2 to ground.
5. Turn on the 4193A.
6. Connect the DVM input to A6TP6, and the 5340A input to A6P2. Refer to Figure 5-6.
7. Confirm that the dc voltage at A6TP6 is 3.5V±0.35V.
8. Adjust A6C8 (VCXO ADJ) until the 5340A displays 300MHz±300Hz.
9. Remove the jumper from between A6U5 pin 2 and ground and confirm that the 5340A displays 299.960MHz±15kHz. If the displayed frequency is out of range, adjust A6C8 until the 5340A displays 299.960MHz±15kHz and then return to step 8.
10. Reinstall the A6 board to its normal position and reconnect the cables (step 2) to A6P1 and P2, respectively.

## ADJUSTMENTS

### 5-26. *BPF OUTPUT LEVEL ADJUSTMENT (A6)*

PURPOSE: This adjustment maximizes the level of the center frequency (299.990MHz) of the BPF on the A6 board which is supplied to the Mixer on the A5 board.

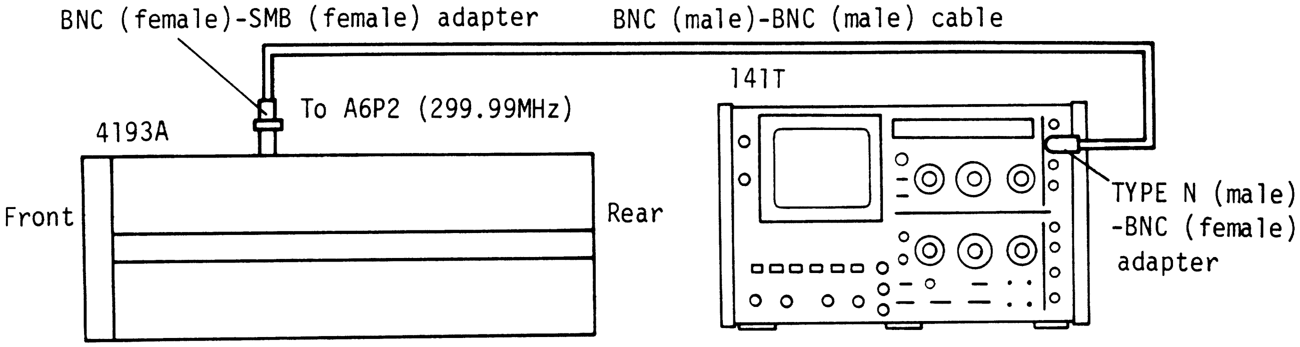


Figure 5-7. BPF Output Level Adjustment Setup.

EQUIPMENT:

| | |
|---|---|
| Spectrum Analyzer ···························· | HP 141T with 8552B and 8554B Plug-ins |
| TYPE N (male)-BNC (female) Adapter ·· | HP P/N 1250-1476 |
| BNC (female)-SMB (female) Adapter ···· | HP P/N 1250-1236 |
| BNC(male) - BNC(male) Cable·············· | HP 11170C |

PROCEDURE:

1. Disconnect the cable from A6P2 (299.99MHz).
2. Connect the RF INPUT terminal of the spectrum analyzer to A6P2 (299.99MHz) as shown in Figure 5-7.
3. Set the spectrum analyzer's controls as described in paragraph 5-22.
4. Adjust A6C7 (BPF ADJ) until the level of the 299.99MHz spectral display on the 141TCRT is maximum.

### 5-27. *A2 OUTPUT AMPLIFIER BIAS ADJUSTMENT (A2)*

PURPOSE: This adjustment sets the bias voltage for the output amplifier in order to minimize test signal distortion.

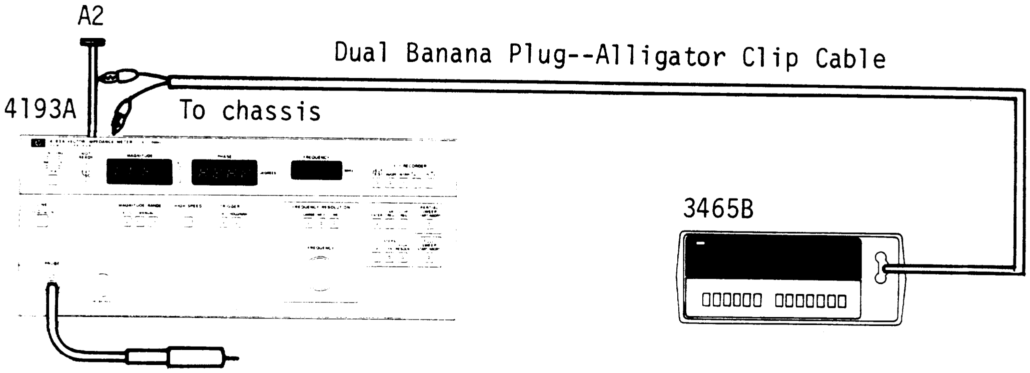


Figure 5-8. A2 Output Amplifier Bias Adjustment Setup.

EQUIPMENT:

Digital Voltmeter .................................. HP 3465B
Extender Board ...................................... HP P/N 04193-66561
Dual Banana Plug to Alligator Clip Cable HP 11002A

PROCEDURE:

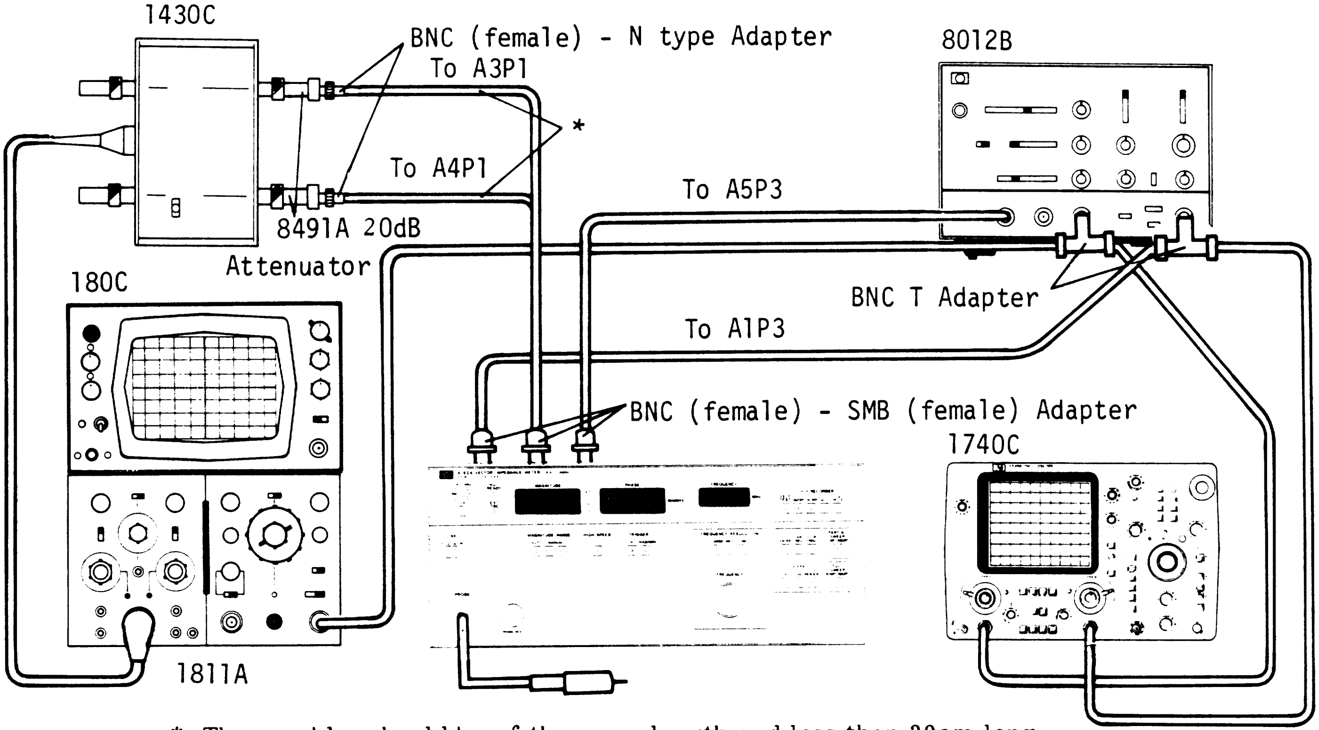
1. Turn off the 4193A.
2. Extend the A2 board with the extender board.
   SMB connector cables need not to be connected to A2P1 and P2.
3. Connect the INPUT terminal of the 3465B to A2TP2 as shown in Figure 5-8.
4. Turn on the 4193A.
5. Set the 3465B's controls as follows:

   FUNCTION ......................... $\overline{\underline{\ \ }}$ V
   RANGE ................................ 20V

6. Adjust A2R58 (BIAS ADJ) until the reading on the 3465B is 3V±0.03V.

### 5-28. *SAMPLING PULSE HEIGHT ADJUSTMENT (A1)*

PURPOSE: This adjustment sets the height of the V CHANNEL sampling pulse to that of the I CHANNEL sampling pulse in order to equalize sampling efficiency in both channels.



* These cables should be of the same length and less than 30cm long.

Figure 5-9. Sampling Pulse Height Adjustment Setup.

EQUIPMENT:

| | | |
|---|---|---|
| Sampling Oscilloscope System | HP 180C/1811A | |
| Sampling Head | HP 1430C | |
| Pulse Generator | HP 8012B | |
| Oscilloscope | HP 1740A | |
| 20dB Attenuator (TYPE N) | HP 8491A | 2ea. |
| BNC (female)-TYPE N (male) Adapter | HP P/N 1250-1535 | 2ea. |
| BNC (female)-SMB (female) Adapter | HP P/N 1250-1236 | 4ea. |
| BNC T Adapter | HP P/N 1250-0781 | 2ea. |
| BNC(male) - BNC(male) Cable | HP 11170C,7ea | |

PROCEDURE

1. Connect all instruments as shown in Figure 5-9.
2. Set the instruments' controls as follows :

| | | |
|---|---|---|
| 4193A : | Trigger | MAN/EXT |
| | Other Controls | Initial Settings |
| 8012B : | PULSE PERIOD(s) | EXT |
| | PULSE | NORMAL |
| | PULSE DELAY(s) | 35n - 1µ |
| | PULSE WIDTH | 10n - 1µ |
| | TRANSITION TIME(s) | 5n - 0.5µ |
| | AMPLITUDE (V) | 5.0 - 2.0 |
| | OFFSET (V) | OFF |
| | POLARITY | - |
| | SYM/NORM/COMPL | SYM |
| | INT LOAD | OUT |
| | All VERNIER Controls | Fully CCW |
| 180C : | MAGNIFIER | x1 |
| | DISPLAY | INT |
| 1811A : | DISPLAY | FILTERED |
| | MODE | ALT |
| | POLARITY (Both Channels) | +UP |
| | mV/DIV (Both Channels) | 200 |
| | EXPANDED/DIRECT | DIRECT |
| | TIME/DIV | .05µsec |
| | EXPANDED TIME/DIV | .5nsec |
| | TRIGGER | AUTO |
| | MANUAL/SWEEP | SWEEP |
| | CW SLOPE | + |
| 1740A : | DISPLAY | ALT |
| | TRIGGER | A |
| | CHAN A | 2V/DIV (DC) |
| | CHAN B | 2V/DIV (DC) |
| | TIME/DIV | 0.2µsec |
| | COUPLING | GND |

3. Set the ground reference for CHAN A and CHAN B of the 1740A and the 180C as shown in ① and ②, respectively, of Figure 5-10.
4. Set the 8012B's AMPLITUDE VERNIER to $3V_{p-p}$.
5. Set the 1740A's coupling selectors to DC and confirm that the waveforms displayed on the 1740A and 180C are as shown in ③ and ④, respectively, of Figure 5-10.
6. Adjust the 8012B's PULSE WIDTH VERNIER until the duty cycle of the CHAN B waveform is 50%, as shown in ⑤ of Figure 5-10. The 180C should be as shown in ⑥.
7. Adjust the 8012B's PULSE DELAY VERNIER until the time difference between the peak of the CHAN A waveform and the trailing edge of the CHAN B pulse is 300ns, as shown in ⑦ of Figure 5-10.
8. Rotate the 180C's INTENSITY control knob CCW until the sampling pulses and the marker are displayed on the 180C, as shown in ⑧ of Figure 5-10.
9. Using the 1811A's POSITION control knob, position the marker at the sampling pulses, as shown in ⑩ of Figure 5-10. The 1740A's display should be as shown in ⑨ of Figure 5-10.

## ADJUSTMENTS

10. Set the 1811A's TIME/DIV switch to EXPANDED, and adjust the POSITION control knob until the I CHANNEL and V CHANNEL sampling pulses are displayed on the 180C as shown in ⑫ of Figure 5-10.

11. Adjust A1C3(Vp ADJ) until the height of the V CHANNEL sampling pulse is equal to the I CHANNEL sampling pulse height.

12. Confirm that both pulse heights are more than 6.8V.

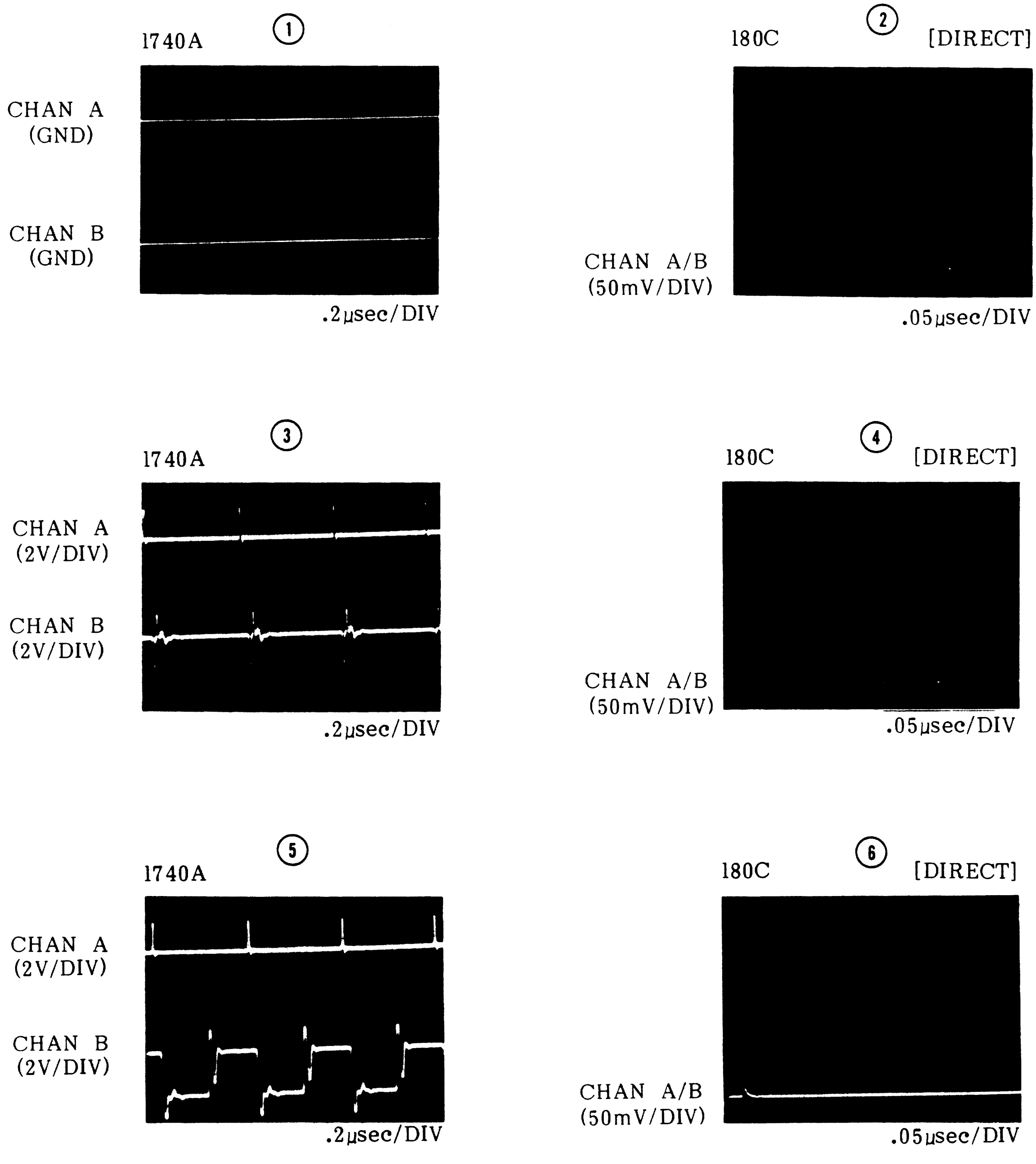


Figure 5-10. Scope Displays (Sheet 1 of 2).

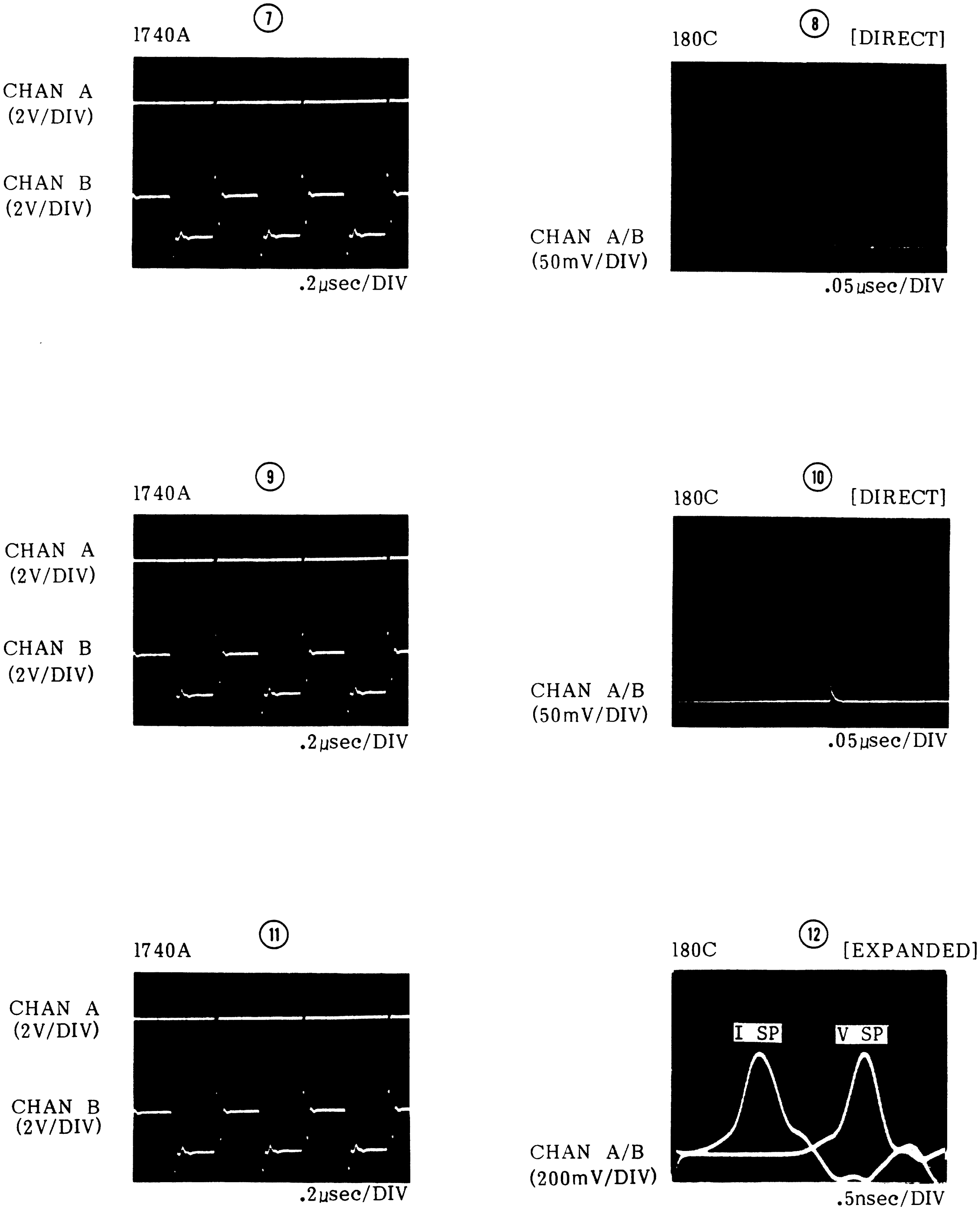


Figure 5-10. Scope Displays (Sheet 2 of 2).

### 5-29. *ALC REFERENCE VOLTAGE ADJUSTMENT (A13)*

PURPOSE: This adjustment sets the ALC reference voltage so as to supply a precise current level to the DUT.

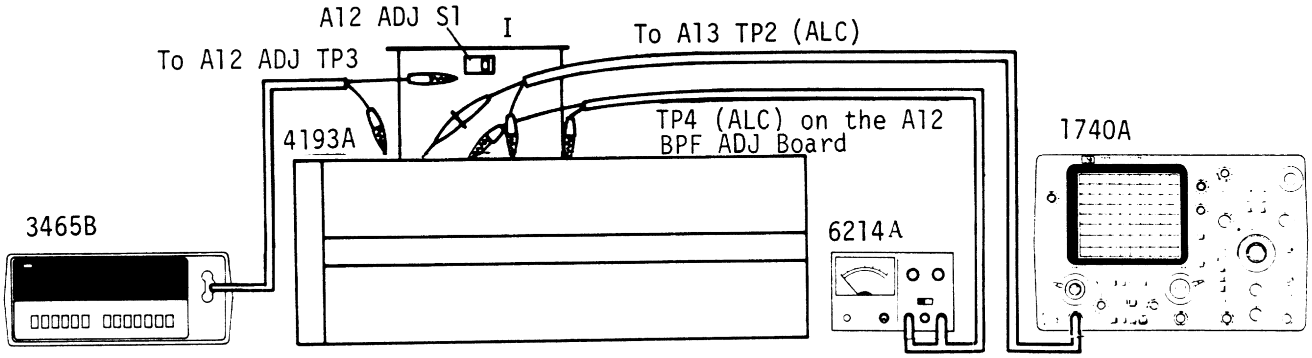


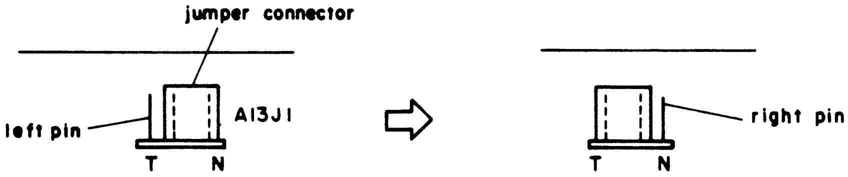
Figure 5-11. ALC Reference Voltage Adjustment Setup.

EQUIPMENT:

| | |
|---|---|
| DC Power Supply | HP 6214A |
| Digital Voltmeter | HP 3465B |
| Oscilloscope | HP 1740A |
| A12 BPF ADJ Board | HP P/N 04193-66564 |
| Extender Board | HP P/N 04193-66561 |
| Dual Banana Plug to Alligator Clip Cable | HP 11002A,2ea |

PROCEDURE:

1. Turn off the 4193A.
2. Remove the A12 and A13 boards.
3. Set the switch on the A12 BPF ADJ board to the I position.
4. Set A13J1 to the T position as shown below :



5. Insert the A13 board into the A13 slot.
6. Insert the extender board into the A12 slot and insert the A12 BPF ADJ board into the extender.
7. Connect the 6214A to TP4 on the A12 BPF ADJ Board as shown in the figure

8. Connect Channel A of the 1740A to A13TP2, and connect the 3465B to TP3 of A12 BPF ADJ Board as shown in Figure 5-11.

9. Turn on all the instruments and set their controls as follows :

| | | |
|---|---|---|
| 4193A : | TRIGGER | MAN/EXT |
| | Other Controls | Initial Settings |
| 6214A: | METER SELECTION | VOLTS |
| 3465B : | FUNCTION | ≃ AC |
| | RANGE | 2V |
| 1740A : | DISPLAY | A (DC Coupling) |
| | TRIGGER | A |
| | VOLTS/DIV | 50mV |
| | TIME/DIV | 1ms |

10. Adjust the 6214A until the reading on the 3465B is 0.707Vrms±1mVrms.

11. Adjust A13R1 (ALC BIAS) until the trace on the 1740A is 0V±100mV.

Note

If the IF BPF GAIN/PHASE ADJUSTMENT is to be performed immediately after this adjustment, do not reset A13J1 to the N position.

### 5-30. *IF BPF GAIN/PHASE ADJUSTMENT (A12)*

PURPOSE : This adjustment sets the gain and the center frequency of BPF's in the I and V/I channels on the A12 board.

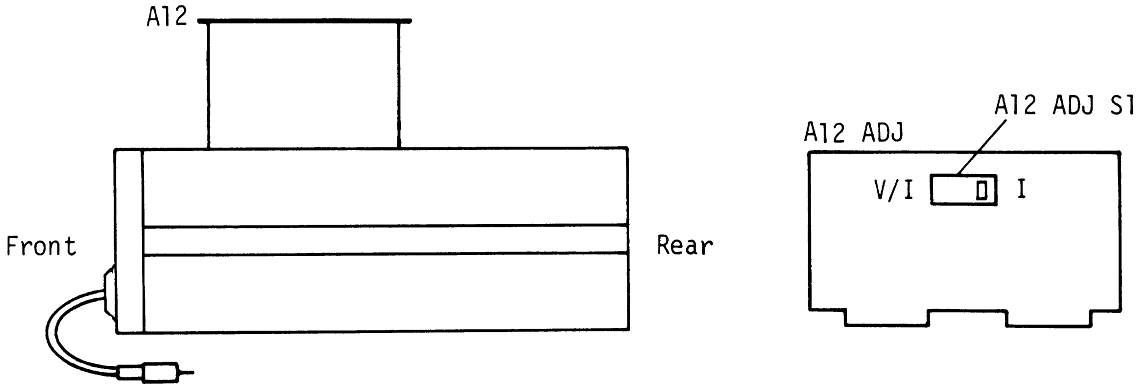


Figure 5-12. IF BPF GAIN/PHASE Adjustment Setup.

EQUIPMENT :

| | |
|---|---|
| A12 BPF ADJ Board | HP P/N 04193-66564 |

PROCEDURE :

1. Turn off the 4193A.

2. Extend the A12 board with the A12 BPF ADJ board. Set A13J1 to the T position.

3. Turn on the 4193A.

[I channel GAIN and PHASE Adjustment]

4. Set A12 BPF ADJ S1 to the I position.

5. Adjust A12R12 (PHASE I) until the displayed phase is -7.2 degrees±2 counts.

6. Adjust A12R11 (GAIN I) until the displayed magnitude is 100.0Ω±3 counts.

[V/I Channel GAIN and PHASE Adjustment]

7. Set A12 BPF ADJ S1 to the V/I position.

8. Adjust A12R4 (PHASE V/I) until the displayed phase is -7.2 degrees±2 counts.

9. Adjust A12R3 (GAIN V/I) until the displayed magnitude is 100.0Ω±3 counts. Reset A13J1 to the N position.

### 5-31. *I CHANNEL SAMPLING DIODE BIAS ADJUSTMENT (A4)*

PURPOSE: This adjustment sets the dc bias voltage applied to the I CHANNEL sampling diodes on the A51 board.

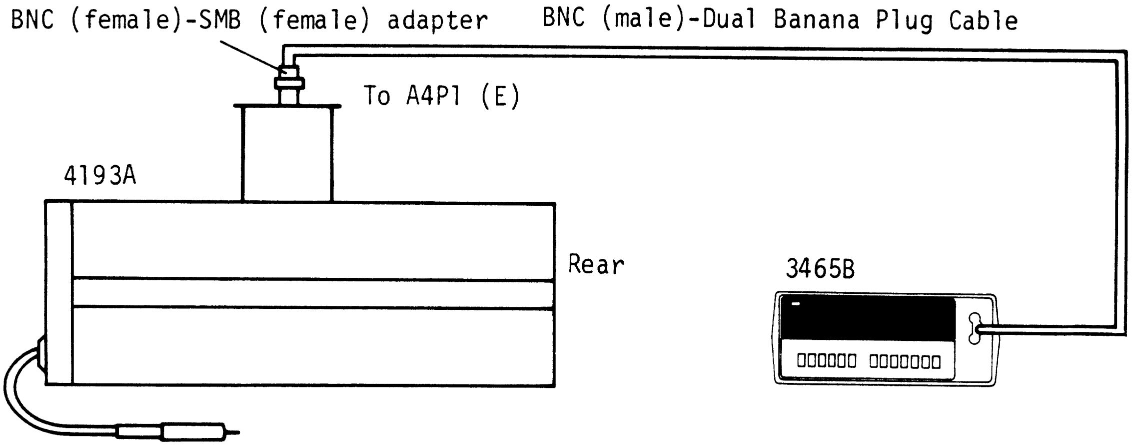


Figure 5-13. I Channel Sampling Diode DC Bias Adjustment Setup.

EQUIPMENT:

| | |
|---|---|
| Digital Voltmeter | HP3465B |
| BNC (female)-SMB (female) Adapter | HP P/N 1250-1236 |
| Extender Board | HP P/N 04193-66562 |
| BNC to Dual Banana Plug Cable | HP 11001A |

PROCEDURE:

1. Turn off the 4193A.

2. Disconnect the cables from A4P1 (E), A4P2 (I SP IN), and A4P3 (F).

3. Extend the A4 board with the extender board.

4. Connect the INPUT terminal of the 3465B to A4P1 (E) as shown in Figure 5-13.

5. Set the 3465B's controls as follows:

   FUNCTION ........ ⎓ V
   RANGE ........ 20V

6. Turn on the 4193A : Before turning on, check that the cables are not touching the DC supply terminal.

7. Adjust A4R10 (IB) until the reading on the 3465B is -3.8V±20mV.

8. Check that the voltage at A4P3 (F) is +3.8V±50mV.

### 5-32. *TEST SIGNAL LEVEL ADJUSTMENT (A4)*

PURPOSE : This adjustment is made on the ALC so as to supply the specified current to DUT.

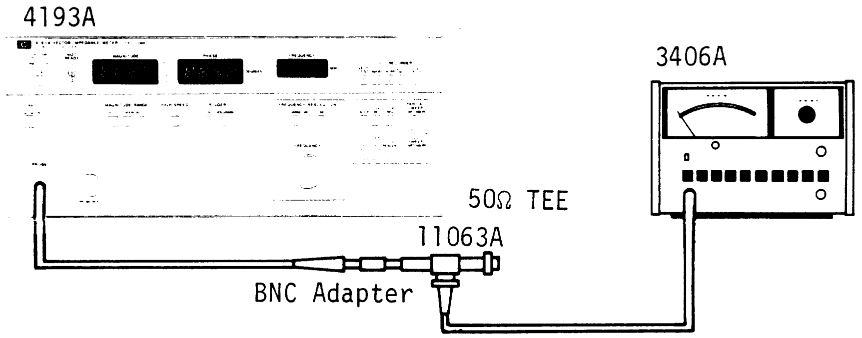


Figure 5-14. Drive Current Level Adjustment Setup.

EQUIPMENT :

| | |
|---|---|
| RF Voltmeter | HP 3406A |
| 50Ω TEE Adapter | HP 11063A |
| 50Ω Termination (GR 874) | HP P/N 0950-0090 |
| BNC Adapter for 4193A | HP P/N 04193-61152 |
| BNC (female)-GR 874 Adapter | HP P/N 1250-0850 |

PROCEDURE :

1. Connect the 3406A's probe to the 4193A's probe. Disconnect the cable from A1P1 (V SP). Extend the A4 board.
2. Set the instruments' controls as follows :

   4193A : Initial Settings
   3406A : Range .................... .01V

3. Adjust A4R30 (GAIN) until the reading on the 3406A is 5mV±.1mV.
4. Confirm that the readings on the 3406A are 5mV±.5mV in the frequency range from .4MHz to 110MHz.

### 5-33. *V CHANNEL SAMPLING DIODE BIAS ADJUSTMENT (A3)*

PURPOSE : This adjustment sets the dc bias voltage applied to the V CHANNEL sampling diodes on the A52 board.

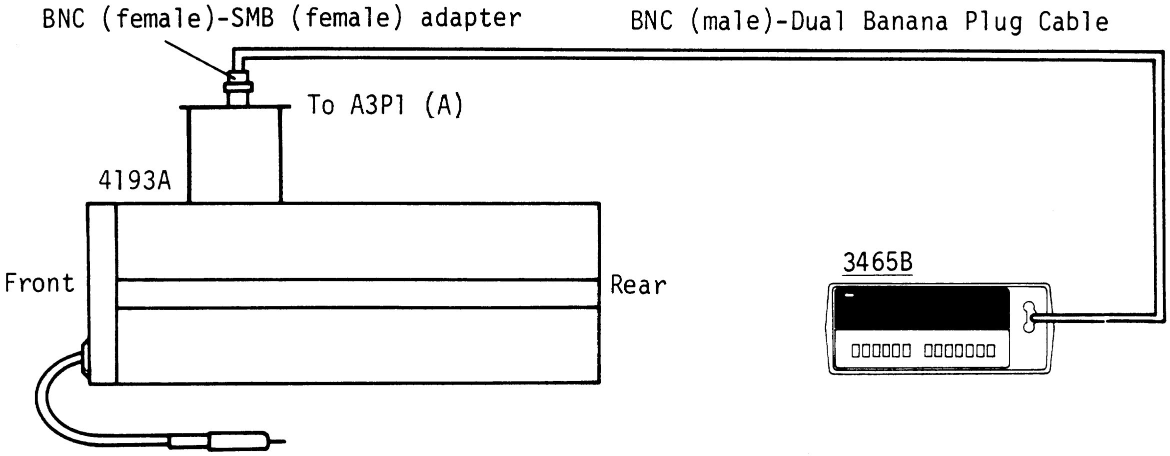


Figure 5-15. V Channel Sampling Diode DC Bias Adjustment Setup.

EQUIPMENT :

Digital Voltmeter ........................................ HP3465B
BNC (female)-SMB (female) Adapter ................. HP P/N 1250-1236
Extender Board ............................................ HP P/N 04193-66562
BNC(male) - Dual Banana Plug Cable ................ HP 11001A

PROCEDURE :

1. Turn off the 4193A.
2. Disconnect the cables from A3P1 (A), A3P2 (V SP IN) and A3P3 (B).
3. Extend the A3 board with the extender board.
4. Connect the INPUT terminal of the 3465B to A3P1 (A) as shown in Figure 5-15.
5. Set the 3465B's controls as follows :

FUNCTION .............................. ⎓ V
RANGE .................................. 20V

6. Turn on the 4193A.
7. Adjust A3R9 (VB) until the reading on the 3465B is -3.8V±20mV.
8. Check that the voltage at A3P3 (B) is +3.8V±50mV.

### 5-34. *MAGNITUDE AND PHASE ACCURACY ADJUSTMENT (A3/A4/A41)*

PURPOSE : This adjustment minimizes MAGNITUDE/PHASE measurement errors. Electrical length is also adjusted.

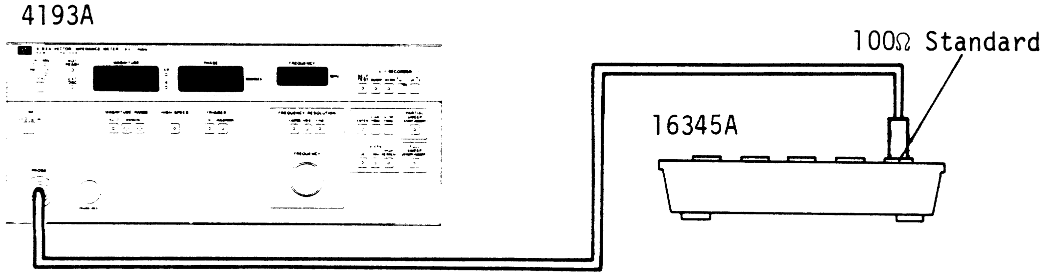


Figure 5-16. Magnitude and Phase Accuracy Adjustment Setup.

EQUIPMENT :

Calibration Standard ........................................................... HP16345A

PROCEDURE :

1. Insert the probe into the 100Ω standard of the 16345A.
2. Set the test frequency to 10MHz.
3. Adjust A3R6 (MAG ADJ) until the value displayed on the MAGNITUDE display is 100.5Ω±1 count.
4. Adjust A4R6 (PHASE ADJ) until the value displayed on the PHASE display is 0.0 degrees±1 count.

Note

The displayed MAGNITUDE value may drift slightly out of the range specified in step 3 when the PHASE adjustment (step 4) is being performed. This is normal, and can be ignored for now. MAGNITUDE accuracy is readjusted in step 8.

5. Set the test frequency to 100MHz, and insert the probe into the OPEN standard of the 16345A.
6. Adjust A41 Delay Line (LENGTH ADJ) until the value displayed on the PHASE display is -90.0 degrees±1 count.
7. Reperform steps 1, 2, 4, 5, and 6.
8. Reperform steps 1, 2 and 3.

Note

If a 0.0° (step 4) or -90.0° (step 6) phase display cannot be obtained by adjusting PHASE ADJ, replace the cable between A1P2 and A4P2 with one of the cables listed below, and re-perform this adjustment :

| HP Part No. | Cable Length | Remarks |
|---|---|---|
| 04193-61615 | 10cm | Increases phase |
| 04193-61616 | 15cm | Standard cable |
| 04193-61617 | 20cm | Decreases phase |

### 5-35. *RECORDER OUTPUT VOLTAGE ADJUSTMENT (A15)*

PURPOSE : This adjustment sets the recorder output voltages for MAGNITUDE, PHASE, and FREQUENCY.

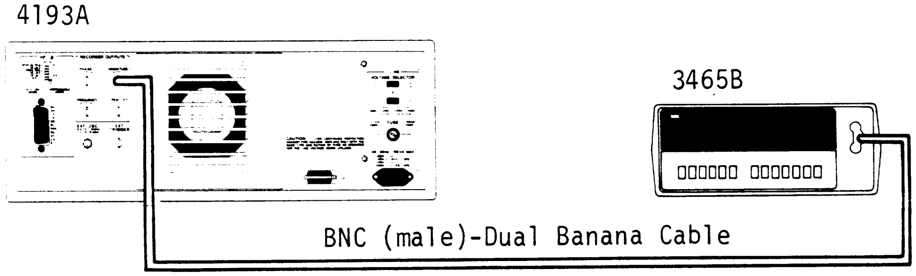


Figure 5-17. Recorder Output Voltage Adjustment Setup.

EQUIPMENT :

| | |
|---|---|
| Digital Voltmeter | HP3465B |
| BNC(male) - Dual Banana Plug Cable | HP 11001A |

PROCEDURE :

1. Set the 3465B's controls as follows :

FUNCTION ........... ⎓ V
RANGE ................ 2 V

2. Connect the INPUT terminal of the 3465B to the MAGNITUDE RECORDER OUTPUT terminal of the 4193A (located on the rear panel).

3. The value displayed on the 3465B should be within ±20mV.

4. Press the $\overset{\text{UR}}{\square}$ key on the 4193A.

5. Adjust A15R2 (M F.S. ADJ) until the reading on the 3465B is + 1V.

6. Connect the INPUT terminal of the 3465B to the PHASE RECORDER OUTPUT terminal.

7. Press the $\overset{\text{LL}}{\square}$ key.

8. The value displayed on the 3465B should be within ±20mV.

9. Press the $\overset{\text{UR}}{\square}$ key.

10. Adjust A15R3 (P F.S. ADJ) until the reading on the 3465B is + 1V.

11. Connect the INPUT terminal of the 3465B to the FREQUENCY RECORDER OUTPUT terminal.

12. Press the $\overset{\text{LL}}{\square}$ key.

13. The value displayed on the 3465B should be within ±20mV.

14. Press the $\overset{\text{UR}}{\square}$ key.

15. Adjust A15R1 (F F.S. ADJ) until the reading on the 3465B is + 1V.

# SECTION VI
# REPLACEABLE PARTS

## 6-1. INTRODUCTION

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

## 6-3. ABBREVIATIONS

6-4. Table 6-1 lists abbreviations used in parts list, schematics and throughout the manual. In some cases, two forms of abbreviations are used, one in all capital letters, and one in partial capitals or no capitals. This occurs because the abbreviations in parts list are always all capitals. However, in the schematic and in other parts of the manual, other abbreviation forms with both lower case and upper case letters are used.

## 6-5. REPLACEABLE PARTS LIST

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

a. Electrical assemblies and their components in alphanumerical order by reference designation.
b. Chassis-mounted parts in alphanumerical order by reference designation.
c. Miscellaneous parts.
d. Illustrated parts breakdowns, if appropriate.

The information for each part includes :

a. The Hewlett-Packard part number.
b. The total quantity (Qty) in the instrument.
c. A description of the part.
d. A typical manufacturer of the part in a five-digit code.
e. The manufacturer's number for the part.

Table 6-1. List of Reference Designators and Abbreviations

### REFERENCE DESIGNATORS

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

### ABBREVIATIONS

A = amperes
A. F. C. = automatic frequency control
AMPL = amplifier

B. F. O. = beat frequency oscillator
BE CU = beryllium copper
BH = binder head
BP = bandpass
BRS = brass
BWO = backward wave oscillator

CCW = counter-clockwise
CER = ceramic
CMO = cabinet mount only
COEF = coefficient
COM = common
COMP = composition
COMPL = complete
CONN = connector
CP = cadmium plate
CRT = cathode-ray tube
CW = clockwise

DEPC = deposited carbon
DR = drive

ELECT = electrolytic
ENCAP = encapsulated
EXT = external

F = farads
f = femto = $10^{-15}$
FH = flat head
FIL H = fillister head
FXD = fixed

G = giga = $10^{9}$
GE = germanium
GL = glass
GRD = ground(ed)

H = henries
HEX = hexagonal
HG = mercury
HR = hour(s)
Hz = hertz

IF = intermediate freq.
IMPG = impregnated
INCD = incandescent
INCL = include(s)
INS = insulation(ed)
INT = internal

k = kilo = 1000

LH = left hand
LIN = linear taper
LK WASH = lock washer
LOG = logarithmic taper
LPF = low pass filter

m = milli = $10^{-3}$
M = meg = $10^{6}$
MET FLM = metal film
MET OX = metallic oxide
MFR = manufacturer
MINAT = miniature
MOM = momentary
MTG = mounting
MY = "mylar"

n = nano = $10^{-9}$
N/C = normally closed
NE = neon
NI PL = nickel plate
N/O = normally open
NPO = negative positive zero (zero temperature coefficient)

NPN = negative-positive-negative
NRFR = not recommended for field replacement
NSR = not separately replaceable

OBD = order by description
OH = oval head
OX = oxide

P = peak
PC = printed circuit
p = pico = $10^{-12}$
PH BRZ = phosphor bronze
PHL = Phillips
PIV = peak inverse voltage
PNP = positive-negative-positive
P/O = part of
POLY = polystyrene
PORC = porcelain
POS = position(s)
POT = potentiometer
PP = peak-to-peak
PT = point
PWV = peak working voltage

RECT = rectifier
RF = radio frequency
RH = round head or right hand
RMO = rack mount only
RMS = root-mean square

RWV = reverse working voltage

S-B = slow-blow
SCR = screw
SE = selenium
SECT = section(s)
SEMICON = semiconductor
SI = silicon
SIL = silver
SL = slide
SPG = spring
SPL = special
SST = stainless steel
SR = split ring
STL = steel

TA = tantalum
TD = time delay
TGL = toggle
THD = thread
TI = titanium
TOL = tolerance
TRIM = trimmer
TWT = traveling wave tube

$\mu$ = micro = $10^{-6}$

VAR = variable
VDCW = dc working volts

W/ = with
W = watts
WIV = working inverse voltage
WW = wirewound
W/O = without

0001-9700

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

Part numbers for the shield cases, screws, cable clamps, and cables (except for wiring on a board) on each board assembly, are not listed in Table 6-3. If required these parts must be ordered separately when ordering a complete board assembly. They are listed in Table 6-4 and 6-5 as Board Mounted Hardware and Cable Assemblies respectively.

## 6-7. ORDERING INFORMATION

6-8. To order a part listed in the replaceable parts table, give the Hewlett-Packard part number, indicate the quantity required, and address the order to the nearest Hewlett-Packard office.

6-9. To order a part that is not listed in the replaceable parts table, state the full instrument model and serial number, and description and function of the part, and the number of parts required. Address your order to the nearest Hewlett-Packard office.

## 6-10. SPARE PARTS KIT

6-11. Stocking spare parts for an instrument is often done to insure quick return to service after a malfunction occurs. Hewlett-Packard has a Spare Parts Kit available for this purpose. The kit consists of selected replaceable assemblies and components for this instrument. The contents of the kit and the Recommended Spares List are based on failure reports and repair data, and parts support for one year. A complimentary Recommended Spares List for this instrument may be obtained on request and the Spare Parts Kit may be ordered through your nearest Hewlett-Packard office.

## 6-12. DIRECT MAIL ORDER SYSTEM

6-13. Within the USA, Hewlett-Packard can supply parts through a direct mail order system. Advantages of using the system are :

a. Direct ordering and shipment from the HP Parts Center in Mountain View, California.

b. No maximum or minimum on any mail order (there is a minimum order amount for parts ordered through a local HP Office when the orders require billing and invoicing).

c. Prepaid transportation (there is a small handling charge for each order).

d. No invoices—to provide these advantages, a check or money order must accompany each order.

6-14. Mail order forms and specific ordering information are available through your local HP Office. Addresses and phone numbers are located at the back of this manual.

Table 6-2. Manufacturers Code Lists

| MFR NO. | MANUFACTURER NAME | ADDRESS | | ZIP CODE |
|---|---|---|---|---|
| 00000 | ANY SATISFACTORY SUPPLIER | | | |
| 01121 | ALLEN-BRADLEY CO | MILWAUKEE | WI | 53204 |
| 01295 | TEXAS INSTR INC SEMICOND CMPNT DIV | DALLAS | TX | 75222 |
| 0192B | RCA CORP SOLID STATE DIV | SOMERVILLE | NJ | 08876 |
| 02111 | SPECTROL ELECTRONICS CORP | CITY OF IND | CA | 91745 |
| 02114 | FERROXCUBE CORP | SAUGERTIES | NY | 12477 |
| 02768 | ILLINOIS TOOL WORKS INC FASTEX DIV | DES PLAINES | IL | 60016 |
| 03888 | KDI PYROFILM CORP | WHIPPANY | NJ | 07981 |
| 04713 | MOTOROLA SEMICONDUCTOR PRODUCTS | PHOENIX | AZ | 85062 |
| 06383 | PANDUIT CORP | TINLEY PARK | IL | 60477 |
| 06665 | PRECISION MONOLITHICS INC | SANTA CLARA | CA | 95050 |
| 07716 | TRW INC BURLINGTON DIV | BURLINGTON | IA | 52601 |
| 19701 | MEPCO/ELECTRA CORP | MINERAL WELLS | TX | 76067 |
| 24046 | TRANSITRON ELECTRONIC CORP | WAKEFIELD | MA | 01880 |
| 24355 | ANALOG DEVICES INC | NORWOOD | MA | 02062 |
| 24546 | CORNING GLASS WORKS (BRADFORD) | BRADFORD | PA | 16701 |
| 26654 | VARADYNE INC | SANTA MONICA | CA | 90404 |
| 27014 | NATIONAL SEMICONDUCTOR CORP | SANTA CLARA | CA | 95051 |
| 27167 | CORNING GLASS WORKS (WILMINGTON) | WILMINGTON | NC | 28401 |
| 28480 | HEWLETT-PACKARD CO CORPORATE HQ | PALO ALTO | CA | 94304 |
| 51642 | CENTRE ENGINEERING INC | STATE COLLEGE | PA | 16801 |
| 56289 | SPRAGUE ELECTRIC CO | NORTH ADAMS | MA | 01247 |
| 72136 | ELECTRO MOTIVE CORP SUB IEC | WILLIMANTIC | CT | 06226 |
| 72982 | ERIE TECHNOLOGICAL PRODUCTS INC | ERIE | PA | 16512 |
| 74970 | JOHNSON E F CO | WASECA | MN | 56093 |
| 75915 | LITTELFUSE INC | DES PLAINES | IL | 60016 |
| 8E175 | BURR BROWN CO | HUNTSVILLE | AL | 35801 |
| 98291 | SEALECTRO CORP | MAMARONECK | NY | 10544 |

## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| **A1** | | | | | | |
| A1 | 04193-66501 | 0 | 1 | SAMPLING PULSE GENERATOR BOARD ASSEMBLY | 28480 | 04193-66501 |
| A1C1 | 0160-2437 | 1 | 2 | CAPACITOR-FDTHRU 5000PF +80 -20% 200V | 28480 | 0160-2437 |
| A1C2 | 0160-2437 | 1 | | CAPACITOR-FDTHRU 5000PF +80 -20% 200V | 28480 | 0160-2437 |
| A1C3 | 0121-0453 | 5 | 1 | CAPACITOR-V TRMR-AIR 1.3-5.4PF 175V | 74970 | 187-0303-125 |
| A1C4 | 0160-4791 | 4 | 1 | CAPACITOR-FXD 10PF +-5% 100VDC CER 0+-30 | 28480 | 0160-4791 |
| A1C5 | 0180-0116 | 1 | 2 | CAPACITOR-FXD 6.8UF+-10% 35VDC TA | 56289 | 150D685X9035B2 |
| A1C6 | 0180-0116 | 1 | | CAPACITOR-FXD 6.8UF+-10% 35VDC TA | 56289 | 150D685X9035B2 |
| A1C7 | 0160-4793 | 7 | 1 | CAPACITOR-FXD 5.6PF +-.5PF 100VDC CER | 28480 | 0160-4794 |
| A1C8 | 0160-0127 | 2 | 6 | CAPACITOR-FXD 1UF +-20% 25VDC CER | 28480 | 0160-0127 |
| A1C9 | 0160-0174 | 9 | 4 | CAPACITOR-FXD .47UF +80-20% 25VDC CER | 28480 | 0160-0174 |
| A1C10 | 0160-0174 | 9 | | CAPACITOR-FXD .47UF +80-20% 25VDC CER | 28480 | 0160-0174 |
| A1C11 | 0160-0174 | 9 | | CAPACITOR-FXD .47UF +80-20% 25VDC CER | 28480 | 0160-0174 |
| A1C12 | 0180-0094 | 4 | 1 | CAPACITOR-FXD 100UF+75-10% 25VDC AL | 56289 | 30D107G025DD2 |
| A1C13 | 0180-1061 | 7 | 2 | CAPACITOR-FXD 220 UF 16VDC AL | 28480 | 0180-1061 |
| A1C14 | 0160-0127 | 2 | | CAPACITOR-FXD 1UF +-20% 25VDC CER | 28480 | 0160-0127 |
| A1C15 | 0160-0127 | 2 | | CAPACITOR-FXD 1UF +-20% 25VDC CER | 28480 | 0160-0127 |
| A1C16 | 0160-0174 | 9 | | CAPACITOR-FXD .47UF +80-20% 25VDC CER | 28480 | 0160-0174 |
| A1C17 | 0160-0127 | 2 | | CAPACITOR-FXD 1UF +-20% 25VDC CER | 28480 | 0160-0127 |
| A1C18 | 0160-0127 | 2 | | CAPACITOR-FXD 1UF +-20% 25VDC CER | 28480 | 0160-0127 |
| A1C19 | 0180-2981 | 7 | | CAPACITOR-FXD 220 UF 16VDC AL | 28480 | 0180-1061 |
| A1C20 | 0160-4835 | 7 | 2 | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A1C21 | 0160-0127 | 2 | | CAPACITOR-FXD 1UF +-20% 25VDC CER | 28480 | 0160-0127 |
| A1C22 | 0160-4801 | 7 | 1 | CAPACITOR-FXD 100PF +-5% 100VDC CER | 28480 | 0160-4801 |
| A1C23 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A1CR1 | 1901-0179 | 7 | 2 | DIODE-SWITCHING 15V 50MA 750PS DO-7 | 28480 | 1901-0179 |
| A1CR2 | 1901-0179 | 7 | | DIODE-SWITCHING 15V 50MA 750PS DO-7 | 28480 | 1901-0179 |
| A1CR3 | 1901-0441 | 6 | 1 | DIODE-STEP RECOVERY | 28480 | 1901-0441 |
| A1CR4 | 1901-0040 | 1 | 1 | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A1L1 | 9140-0114 | 4 | 1 | INDUCTOR RF-CH-MLD 100UH 10% .166DX.385LG | 28480 | 9140-0114 |
| A1L2 | 9100-3139 | 5 | 1 | INDUCTOR 75UH 15% .50X.875LG | 28480 | 9100-3139 |
| A1Q1 | 1854-0247 | 9 | 6 | TRANSISTOR NPN SI TO-39 PD=1W FT=800MHZ | 28480 | 1854-0247 |
| A1Q2 | 1854-0247 | 9 | | TRANSISTOR NPN SI TO-39 PD=1W FT=800MHZ | 28480 | 1854-0247 |
| A1Q3 | 1854-0019 | 3 | 1 | TRANSISTOR NPN SI TO-18 PD=360MW | 28480 | 1854-0019 |
| A1Q4 | 1854-0247 | 9 | | TRANSISTOR NPN SI TO-39 PD=1W FT=800MHZ | 28480 | 1854-0247 |
| A1Q5 | 1853-0010 | 2 | 2 | TRANSISTOR PNP SI TO-18 PD=360MW | 28480 | 1853-0010 |
| A1Q6 | 1853-0010 | 2 | | TRANSISTOR PNP SI TO-18 PD=360MW | 28480 | 1853-0010 |
| A1Q7 | 1854-0247 | 9 | | TRANSISTOR NPN SI TO-39 PD=1W FT=800MHZ | 28480 | 1854-0247 |
| A1Q8 | 1854-0247 | 9 | | TRANSISTOR NPN SI TO-39 PD=1W FT=800MHZ | 28480 | 1854-0247 |
| A1Q7 | 1854-0247 | 9 | | TRANSISTOR NPN SI TO-39 PD=1W FT=800MHZ | 28480 | 1854-0247 |
| A1Q10 | 1853-0015 | 7 | 1 | TRANSISTOR PNP SI PD=200MW FT=500MHZ | 28480 | 1853-0015 |
| A1R1 | 0683-4725 | 2 | 2 | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A1R2 | 0683-6815 | 5 | 2 | RESISTOR 680 5% .25W FC TC=-400/+600 | 01121 | CB6815 |
| A1R3 | 0683-4725 | 2 | | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A1R4 | 0683-5605 | 9 | 7 | RESISTOR 56 5% .25W FC TC=-400/+500 | 01121 | CB5605 |
| A1R5 | 0757-0420 | 3 | 1 | RESISTOR 750 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-751-F |
| A1R6 | 0757-0442 | 9 | 1 | RESISTOR 10K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1002-F |
| A1R7 | 0683-5605 | 9 | | RESISTOR 56 5% .25W FC TC=-400/+500 | 01121 | CB5605 |
| A1R8 | 0683-5605 | 9 | | RESISTOR 56 5% .25W FC TC=-400/+500 | 01121 | CB5605 |
| A1R9 | 0683-5605 | 9 | | RESISTOR 56 5% .25W FC TC=-400/+500 | 01121 | CB5605 |
| A1R10 | 0683-5605 | 9 | | RESISTOR 56 5% .25W FC TC=-400/+500 | 01121 | CB5605 |
| A1R11 | 0757-0280 | 3 | 2 | RESISTOR 1K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1001-F |
| A1R12 | 0757-0401 | 0 | 1 | RESISTOR 100 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-101-F |
| A1R13 | 0698-3153 | 9 | 1 | RESISTOR 3.83K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-3831-F |
| A1R14 | 0683-5605 | 9 | | RESISTOR 56 5% .25W FC TC=-400/+500 | 01121 | CB5605 |
| A1R15 | 0757-0277 | 8 | 1 | RESISTOR 49.9 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-49R9-F |
| A1R16 | 0757-0417 | 8 | 1 | RESISTOR 562 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-562R-F |
| A1R17 | 0683-2705 | 4 | 2 | RESISTOR 27 5% .25W FC TC=-400/+500 | 01121 | CB2705 |
| A1R18 | 0757-0346 | 2 | 2 | RESISTOR 10 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-10R0-F |
| A1R19 | 0683-2705 | 4 | | RESISTOR 27 5% .25W FC TC=-400/+500 | 01121 | CB2705 |
| A1R20 | 0757-0346 | 2 | | RESISTOR 10 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-10R0-F |

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

## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| A1R21 | 0683-6815 | 5 | | RESISTOR 680 5% .25W FC TC=-400/+600 | 01121 | CB6815 |
| A1R22 | 0757-0280 | 3 | | RESISTOR 1K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1001-F |
| A1R23 | 0683-5605 | 9 | | RESISTOR 56 5% .25W FC TC=-400/+500 | 01121 | CB5605 |
| A1R24 | 0698-3613 | 6 | 2 | RESISTOR 39 5% 2W MO TC=0+-200 | 27167 | FP42-2-T00-39R0-J |
| A1R25 | 0698-3613 | 6 | | RESISTOR 39 5% 2W MO TC=0+-200 | 27167 | FP42-2-T00-39R0-J |
| | 04193-26501 | 0 | 1 | PCBD BLANK | 28480 | 04193-26501 |
| | | | | MISCELLANEOUS PARTS | | |
| | 9170-0029 | 3 | 6 | CORE-SHIELDING BEAD | 28480 | 9170-0029 |
| | 1205-0050 | 7 | 2 | HEAT SINK TO-5/TO-39-CS | 28480 | 1205-0050 |
| | 04193-60001 | 3 | 1 | COVER | 28480 | 04193-60001 |
| | 04193-61623 | 7 | 1 | CABLE ASSEMBLY | 28480 | 04193-61623 |
| | 04193-66541 | 8 | 1 | PCB ASSEMBLY-DELAY | 28480 | 04193-66541 |
| A1R26 | 2100-3212 | | 1 | RESISTOR -TRMR 200 10% | | |
| A1R27 | 0757-0442 | | 1 | RESISTOR 10K 1% .125W | | |

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

## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| **A2** | | | | | | |
| A2 | 04193-66502 | 1 | 1 | ALC AMPLIFIER BOARD ASSEMBLY | 28480 | 04193-66502 |
| A2C1 | 0160-2437 | 1 | 2 | CAPACITOR-FDTHRU 5000PF +80 -20% 200V | 28480 | 0160-2437 |
| A2C2 | 0160-2437 | 1 | | CAPACITOR-FDTHRU 5000PF +80 -20% 200V | 28480 | 0160-2437 |
| A2C3 | 0160-4387 | 4 | 2 | CAPACITOR-FXD 47PF +-5% 200VDC CER 0+-30 | 28480 | 0160-4387 |
| A2C4 | 0160-4832 | 4 | 7 | CAPACITOR-FXD .01UF +-10% 100VDC CER | 28480 | 0160-4832 |
| A2C5 | 0160-4835 | 7 | 23 | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A2C6 | 0160-4387 | 4 | | CAPACITOR-FXD 47PF +-5% 200VDC CER 0+-30 | 28480 | 0160-4387 |
| A2C7 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A2C8 | 0160-0263 | 7 | 2 | CAPACITOR-FXD .22UF +-20% 50VDC CER | 28480 | 0160-0263 |
| A2C9 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A2C10 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A2C11 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A2C12 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A2C13 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A2C14 | 0160-4832 | 4 | | CAPACITOR-FXD .01UF +-10% 100VDC CER | 28480 | 0160-4832 |
| A2C15 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A2C16 | 0160-0263 | 7 | | CAPACITOR-FXD .22UF +-20% 50VDC CER | 28480 | 0160-0263 |
| A2C17 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A2C18 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A2C19 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A2C20 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A2C21 | 0160-4832 | 4 | | CAPACITOR-FXD .01UF +-10% 100VDC CER | 28480 | 0160-4832 |
| A2C22 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A2C23 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A2C24 | 0160-4832 | 4 | | CAPACITOR-FXD .01UF +-10% 100VDC CER | 28480 | 0160-4832 |
| A2C25 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A2C26 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A2C27 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A2C28 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A2C29 | 0160-4787 | | | CAPACITOR-FXD 22PF | | 0160-4787 |
| A2C30 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A2C31 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A2C32 | 0160-4832 | 4 | | CAPACITOR-FXD .01UF +-10% 100VDC CER | 28480 | 0160-4832 |
| A2C33 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A2C34 | 0180-0116 | 1 | | CAPACITOR-FXD 6.8UF+-10% 35VDC | 56289 | 150D685X9035B2 |
| A2C35 | 0160-4792 | 5 | | CAPACITOR-FXD 8.2PF +-.5PF 100VDC CER | 28480 | 0160-4792 |
| A2C36 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A2C37 | 0180-1083 | 3 | 2 | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A2C38 | 0180-0197 | 8 | 1 | CAPACITOR-FXD 2.2UF+-10% 20VDC TA | 56289 | 150D225X9020A2 |
| A2C39 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A2C40 | 0160-4832 | 4 | | CAPACITOR-FXD .01UF +-10% 100VDC CER | 28480 | 0160-4832 |
| A2C41 | 0160-4832 | 4 | | CAPACITOR-FXD .01UF +-10% 100VDC CER | 28480 | 0160-4832 |
| A2C42 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A2CR1 | 1901-0639 | 4 | 8 | DIODE-PIN | 28480 | 5082-3080 |
| A2CR2 | 1901-0639 | 4 | | DIODE-PIN | 28480 | 5082-3080 |
| A2CR3 | 1901-0639 | 4 | | DIODE-PIN | 28480 | 5082-3080 |
| A2CR4 | 1901-0639 | 4 | | DIODE-PIN | 28480 | 5082-3080 |
| A2CR5 | 1901-0639 | 4 | | DIODE-PIN | 28480 | 5082-3080 |
| A2CR6 | 1901-0639 | 4 | | DIODE-PIN | 28480 | 5082-3080 |
| A2CR7 | 1901-0639 | 4 | | DIODE-PIN | 28480 | 5082-3080 |
| A2CR8 | 1901-0639 | 4 | | DIODE-PIN | 28480 | 5082-3080 |
| A2CR9 | 1901-0040 | 1 | 3 | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A2CR10 | 1901-0040 | 1 | | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A2CR11 | 1901-0040 | 1 | | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A2CR12 | 1902-3005 | 6 | 1 | DIODE-ZNR 2.43V 5% DO-7 PD=.4W TC=-.076% | 28480 | 1902-3005 |
| A2J1 | 1251-5862 | 6 | 1 | CONNECTOR 4-PIN M METRIC POST TYPE | 28480 | 1251-5862 |
| A2K1 | 0490-1269 | 4 | 2 | RELAY 1C 12VDC-COIL .66A 30VDC | 28480 | 0490-1269 |
| A2K2 | 0490-1269 | 4 | | RELAY 1C 12VDC-COIL .66A 30VDC | 28480 | 0490-1269 |
| A2L1 | 9100-1615 | 8 | 4 | INDUCTOR RF-CH-MLD 1.2UH 10% | 28480 | 9100-1615 |
| A2L2 | 9100-1615 | 8 | | INDUCTOR RF-CH-MLD 1.2UH 10% | 28480 | 9100-1615 |
| A2L3 | 9100-1615 | 8 | | INDUCTOR RF-CH-MLD 1.2UH 10% | 28480 | 9100-1615 |
| A2L4 | 9100-1615 | 8 | | INDUCTOR RF-CH-MLD 1.2UH 10% | 28480 | 9100-1615 |
| | | | | | | 9100 |
| A2L6 | 9100-1618 | 1 | 2 | INDUCTOR RF-CH-MLD 5.6UH 10% | 28480 | 9100-1618 |
| A2L7 | 9100-1618 | 1 | | INDUCTOR RF-CH-MLD 5.6UH 10% | 28480 | 9100-1618 |
| A2L8 | 9100-2249 | 6 | | INDUCTOR RF-CH-MLD 150NH 10% .105DX.26LG | 28480 | 9100-2249 |
| A2Q1 | 1854-0345 | 8 | 6 | TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW | 04713 | 2N5179 |
| A2Q2 | 1854-0810 | 2 | 2 | TRANSISTOR NPN SI PD=625MW FT=200MHZ | 28480 | 1854-0810 |
| A2Q3 | 1854-0345 | 8 | | TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW | 04713 | 2N5179 |
| A2Q4 | 1854-0810 | 2 | | TRANSISTOR NPN SI PD=625MW FT=200MHZ | 28480 | 1854-0810 |
| A2Q5 | 1854-0345 | 8 | | TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW | 04713 | 2N5179 |

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

## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| A2Q6 | 1854-0345 | 8 | | TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW | 04713 | 2N5179 |
| A2Q7 | 1854-0345 | 8 | | TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW | 04713 | 2N5179 |
| A2Q8 | 1854-0247 | 8 | | TRANSISTOR NPN | | |
| A2Q9 | 1854-0597 | 2 | 2 | TRANSISTOR NPN 2N5943 SI TO-39 PD=1W | 04713 | 2N5943 |
| A2Q10 | 1854-0597 | 2 | | TRANSISTOR NPN 2N5943 SI TO-39 PD=1W | 04713 | 2N5943 |
| A2R1 | 0683-4705 | 8 | 5 | RESISTOR 47 5% .25W FC TC=-400/+500 | 01121 | CB4705 |
| A2R2 | 0683-5605 | 9 | 1 | RESISTOR 56 5% .25W FC TC=-400/+500 | 01121 | CB5605 |
| A2R3 | 0698-3152 | 8 | 2 | RESISTOR 3.48K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-3481-F |
| A2R4 | 0757-0428 | 1 | 2 | RESISTOR 1.62K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1621-F |
| A2R5 | 0683-6815 | 5 | 3 | RESISTOR 680 5% .25W FC TC=-400/+600 | 01121 | CB6815 |
| A2R6 | 0683-2215 | 1 | 5 | RESISTOR 220 5% .25W FC TC=-400/+600 | 01121 | CB2215 |
| A2R7 | 0683-2215 | 1 | | RESISTOR 220 5% .25W FC TC=-400/+600 | 01121 | CB2215 |
| A2R8 | 0698-4037 | 0 | 1 | RESISTOR 46.4 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-46R4-F |
| A2R9 | 0698-3152 | 8 | | RESISTOR 3.48K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-3481-F |
| A2R10 | 0757-0428 | 1 | | RESISTOR 1.62K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1621-F |
| A2R11 | 0757-0394 | 0 | 3 | RESISTOR 51.1 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-51R1-F |
| A2R12 | 0698-3155 | 1 | 4 | RESISTOR 4.64K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4641-F |
| A2R13 | 0698-3155 | 1 | | RESISTOR 4.64K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4641-F |
| A2R14 | 0683-4705 | 8 | | RESISTOR 47 5% .25W FC TC=-400/+500 | 01121 | CB4705 |
| A2R15 | 0683-2215 | 1 | | RESISTOR 220 5% .25W FC TC=-400/+600 | 01121 | CB2215 |
| A2R16 | 0683-6815 | 5 | | RESISTOR 680 5% .25W FC TC=-400/+600 | 01121 | CB6815 |
| A2R17 | 0698-4386 | 2 | 1 | RESISTOR 59 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-59R0-F |
| A2R18 | 0683-2215 | 1 | | RESISTOR 220 5% .25W FC TC=-400/+600 | 01121 | CB2215 |
| A2R19 | 0757-0394 | 0 | | RESISTOR 51.1 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-51R1-F |
| A2R20 | 0698-3155 | 1 | | RESISTOR 4.64K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4641-F |
| A2R21 | 0698-3155 | 1 | | RESISTOR 4.64K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4641-F |
| A2R22 | 0757-0417 | 8 | 1 | RESISTOR 562 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-562R-F |
| A2R23 | 0757-0280 | 3 | 1 | RESISTOR 1K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1001-F |
| A2R24 | 0698-4442 | 1 | 3 | RESISTOR 4.42K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4421-F |
| A2R25 | 0698-4014 | 3 | 1 | RESISTOR 787 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-787R-F |
| A2R26 | 0698-4469 | 2 | 2 | RESISTOR 1.15K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1151-F |
| A2R27 | 0698-4442 | 1 | | RESISTOR 4.42K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4421-F |
| A2R28 | 0757-0422 | 5 | 1 | RESISTOR 909 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-909R-F |
| A2R29 | 0698-4442 | 1 | | RESISTOR 4.42K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4421-F |
| A2R30 | 0683-4705 | 8 | | RESISTOR 47 5% .25W FC TC=-400/+500 | 01121 | CB4705 |
| A2R31 | 0683-2215 | 1 | | RESISTOR 220 5% .25W FC TC=-400/+600 | 01121 | CB2215 |
| A2R32 | 0698-3432 | 7 | 1 | RESISTOR 26.1 1% .125W F TC=0+-100 | 03888 | PME55 1/8-T0-26R1-F |
| A2R33 | 0757-0412 | 3 | 1 | RESISTOR 365 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-365R-F |
| A2R34 | 0757-0409 | 8 | 1 | RESISTOR 274 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-274R-F |
| A2R35 | 0683-1005 | 5 | 1 | RESISTOR 10 5% .25W FC TC=-400/+500 | 01121 | CB1005 |
| A2R36 | 0698-4469 | 2 | | RESISTOR 1.15K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1151-F |
| A2R37 | 0698-3443 | 0 | 1 | RESISTOR 287 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-287R-F |
| A2R38 | 0683-1015 | 0 | 1 | RESISTOR 100 | | |
| A2R39 | 0698-3444 | 1 | 1 | RESISTOR 316 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-316R-F |
| A2R41 | 0683-5615 | 5 | | RESISTOR 560 | | |
| A2R42 | 0683-4705 | 8 | | RESISTOR 47 5% .25W FC TC=-400/+500 | 01121 | CB4705 |
| A2R43 | 0698-3402 | 1 | 2 | RESISTOR 316 1% .5W F TC=0+-100 | 28480 | 0698-3402 |
| A2R44 | 0698-3402 | 1 | | RESISTOR 316 1% .5W F TC=0+-100 | 28480 | 0698-3402 |
| A2R45 | 0683-1055 | 5 | 1 | RESISTOR 1M 5% .25W FC TC=-800/+900 | 01121 | CB1055 |
| A2R46 | 0698-4413 | 6 | 2 | RESISTOR 154 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-154R-F |
| A2R47 | 0698-4413 | 6 | | RESISTOR 154 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-154R-F |
| A2R48 | 0683-4705 | 8 | | RESISTOR 47 5% .25W FC TC=-400/+500 | 01121 | CB4705 |
| A2R49 | 0698-3437 | 2 | 4 | RESISTOR 133 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-133R-F |
| A2R50 | 0698-3437 | 2 | | RESISTOR 133 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-133R-F |
| A2R51 | 0698-3437 | 2 | | RESISTOR 133 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-133R-F |
| A2R52 | 0698-3437 | 2 | | RESISTOR 133 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-133R-F |
| A2R53 | 0683-1215 | | | RESISTOR 120 5% .25W FC TC=-4001+600 | 01121 | CB1215 |
| A2R54 | 0757-0394 | 0 | | RESISTOR 51.1 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-51R1-F |
| A2R55 | 0683-3315 | 4 | 1 | RESISTOR 330 5% .25W FC TC=-400/+600 | 01121 | CB3315 |
| A2R56 | 0698-4460 | 3 | 1 | RESISTOR 649 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-649R-F |
| A2R57 | 0698-4467 | 0 | 1 | RESISTOR 1.05K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1051-F |
| A2R58 | 2100-0567 | 0 | 1 | RESISTOR-TRMR 2K 10% C TOP-ADJ 1-TRN | 28480 | 2100-0567 |
| A2U1 | 1820-1144 | 6 | 1 | IC GATE TTL LS NOR QUAD 2-INP | 01295 | SN74LS02N |
| A2U2 | 1820-0471 | 0 | 1 | IC INV TTL HEX 1-INP | 01295 | SN7406N |
| | 1205-0050 | 7 | 2 | HEAT SINK TO-5/TO-39-CS | 28480 | 1205-0050 |
| | 5001-0176 | 7 | 2 | STRAP-GROUND | 28480 | 5001-0173 |
| | 04193-60002 | 4 | 1 | COVER | 28480 | 04193-60002 |
| | 04193-26502 | 0 | 1 | PCBD BLANK | 28480 | 04193-26502 |
| A2W1 | 8159-0005 | | 1 | JUMPER | | |

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

## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| **A3** | | | | | | |
| A3 | 04193-66503 | 2 | 1 | V-CHANNEL AMPLIFIER BOARD ASSEMBLY | 28480 | 04193-66503 |
| A3C1 | 0160-0570 | 2 | 2 | CAPACITOR-FXD 220PF +-20% 100VDC CER | 28480 | 0160-0570 |
| A3C2 | 0160-3877 | 5 | 2 | CAPACITOR-FXD 100PF +-20% 100VDC CER | 28480 | 0160-3877 |
| A3C3 | 0160-0570 | 2 | | CAPACITOR-FXD 220PF +-20% 100VDC CER | 28480 | 0160-0570 |
| A3C4 | 0160-3877 | 5 | | CAPACITOR-FXD 100PF +-20% 100VDC CER | 28480 | 0160-3877 |
| A3C5 | 0160-3878 | 6 | 1 | CAPACITOR-FXD 1000PF +-20% 100VDC CER | 28480 | 0160-3878 |
| A3C6 | 0160-4835 | 7 | 6 | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A3C7 | 0160-0127 | 2 | 3 | CAPACITOR-FXD 1UF +-20% 25VDC CER | 28480 | 0160-0127 |
| A3C8 | 0160-0127 | 2 | | CAPACITOR-FXD 1UF +-20% 25VDC CER | 28480 | 0160-0127 |
| A3C9 | 0180-1083 | 3 | 5 | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A3C10 | 0160-4386 | 3 | 1 | CAPACITOR-FXD 33PF +-5% 200VDC CER 0+-30 | 51642 | 200-200-NP0-330J |
| A3C11 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A3C12 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A3C13 | 0160-0127 | 2 | | CAPACITOR-FXD 1UF +-20% 25VDC CER | 28480 | 0160-0127 |
| A3C14 | 0160-4832 | 4 | 1 | CAPACITOR-FXD .01UF +-10% 100VDC CER | 28480 | 0160-4832 |
| A3C15 | 0180-0373 | | 1 | CAPACITOR-FXD .68UF +-10% 35VDC TA | 56289 | 150D684X9035A2 |
| A3C16 | 0180-0291 | 3 | 1 | CAPACITOR-FXD 1UF+-10% 35VDC TA | 56289 | 150D105X9035A2 |
| A3C17 | 0180-3153 | | 1 | CAPACITOR-FXD 10UF +-20% 25VDC TA | | |
| A3C18 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A3C19 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A3C20 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A3C21 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A3C22 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A3C23 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A3C24 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A3CR1 | 1901-0179 | 7 | 1 | DIODE-SWITCHING 15V 50MA 750PS DO-7 | 28480 | 1901-0179 |
| A3J1 | 1251-5862 | 6 | 1 | CONNECTOR 4-PIN M METRIC POST TYPE | 28480 | 1251-5862 |
| A3J2 | 1251-6527 | 2 | 1 | CONNECTOR 6-PIN M METRIC POST TYPE | 28480 | 1251-6527 |
| A3L1 | 9140-0114 | 4 | 4 | INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG | 28480 | 9140-0114 |
| A3L2 | 9140-0114 | 4 | | INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG | 28480 | 9140-0114 |
| A3L3 | 9140-0114 | 4 | | INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG | 28480 | 9140-0114 |
| A3L4 | 9140-0114 | 4 | | INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG | 28480 | 9140-0114 |
| A3Q1 | 1854-0129 | 6 | 1 | TRANSISTOR-NPN 2SC1636 | 28480 | 1854-0129 |
| A3Q2 | 1854-0477 | 7 | 1 | TRANSISTOR NPN 2N2222A SI TO-18 PD=500MW | 04713 | 2N2222A |
| A3Q3 | 1853-0281 | 9 | 1 | TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW | 04713 | 2N2907A |
| A3R1 | 0698-3155 | | | RESISTOR 4.7K 1% .25W FC TC=-400/+600 | 01121 | |
| A3R2 | 0698-7205 | | | RESISTOR 51 .25W FC TC=-400/+500 | 01121 | |
| A3R3 | 0683-4715 | 0 | 1 | RESISTOR 470 5% .25W FC TC=-400/+600 | 01121 | CB4715 |
| A3R4 | 0698-7205 | | | RESISTOR 51 .25W FC TC=-400/+500 | 01121 | |
| A3R5 | 0698-3155 | 2 | | RESISTOR 4.7 .25W FC TC=-400/+600 | 01121 | |
| A3R6 | 2100-3109 | | 1 | RESISTOR-TRMR 2K 10% C SIDE-ADJ 1-TRN | 28480 | 2100-3109 |
| A3R7 | 0683-5105 | 4 | | RESISTOR 51 5% .25W FC TC=-400/+500 | 01121 | CB5105 |
| A3R8 | 0683-5105 | 4 | | RESISTOR 51 5% .25W FC TC=-400/+500 | 01121 | CB5105 |
| A3R9 | 2100-3352 | 7 | 1 | RESISTOR-TRMR 1K 10% C SIDE-ADJ 1-TRN | 28480 | 2100-3352 |
| A3R10 | 0698-4158 | 6 | 2 | RESISTOR 100K .1% .125W F TC=0+-50 | 28480 | 0698-4158 |
| A3R11 | 0698-4158 | 6 | | RESISTOR 100K .1% .125W F TC=0+-50 | 28480 | 0698-4158 |
| A3R12 | 0683-1025 | 9 | 1 | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| A3R13 | 0698-3152 | 8 | 1 | RESISTOR 3.48K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-3481-F |
| A3R14 | 0757-0421 | 4 | 1 | RESISTOR 825 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-825R-F |
| A3R15 | 0757-0465 | 6 | 1 | RESISTOR 100K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1003-F |
| A3R16 | 0757-0317 | 7 | 1 | RESISTOR 1.33K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1331-F |
| A3R17 | 0698-3153 | 9 | 1 | RESISTOR 3.83K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-3831-F |
| A3R18 | 0683-4725 | 2 | | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A3R19 | 0683-4725 | 2 | | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A3R20 | 0683-2225 | 3 | 2 | RESISTOR 2.2K 5% .25W FC TC=-400/+700 | 01121 | CB2225 |
| A3R21 | 0683-2225 | 3 | | RESISTOR 2.2K 5% .25W FC TC=-400/+700 | 01121 | CB2225 |
| A3R22 | 0683-1055 | 5 | 1 | RESISTOR 1M 5% .25W FC TC=-800/+900 | 01121 | CB1055 |
| A3R23 | 0699-0277 | 8 | 2 | RESISTOR 10K .02% .1W F TC=0+-15 | 28480 | 0699-0277 |
| A3R24 | 0699-0277 | 4 | 1 | RESISTOR 10K .025% .1W F TC=0+-15 | 28480 | 0699-0277 |
| A3R25 | 0683-4725 | 2 | | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A3R26 | 0698-8474 | 7 | 1 | RESISTOR 800 .1% .1W F TC=0+-5 | 28480 | 0698-8474 |
| A3R27 | 0699-0287 | 6 | 3 | RESISTOR 100 .1% .1W F TC=0+-15 | 28480 | 0699-0287 |
| A3R28 | 0699-0287 | 6 | | RESISTOR 100 .1% .1W F TC=0+-15 | 28480 | 0699-0287 |
| A3R29 | 0698-3628 | 3 | 2 | RESISTOR 220 5% 2W MO TC=0+-200 | 28480 | 0698-3628 |
| A3R30 | 0698-3628 | 3 | | RESISTOR 220 5% 2W MO TC=0+-200 | 28480 | 0698-3628 |
| A3R31 | 0699-0057 | 8 | | RESISTOR 2K .1% .1W F TC=0+-5 | 28480 | 0699-0057 |
| A3R32 | 0698-2207 | 2 | 1 | RESISTOR:FXD 900 OHM 0.05% 1/8W MF | 28480 | 0698-2207 |
| A3R33 | 0699-0287 | 6 | | RESISTOR 100 .1% .1W F TC=0+-15 | 28480 | 0699-0287 |
| A3R34 | 0698-3150 | 6 | 2 | RESISTOR 2.37K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-2371-F |
| A3R35 | 0698-0085 | 0 | 2 | RESISTOR 2.61K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-2611-F |

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

## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| A3R36 | 0698-0085 | 0 | | RESISTOR 2.61K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-2611-F |
| A3R37 | 0698-3150 | 6 | | RESISTOR 2.37K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-2371-F |
| A3R38 | 1810-0205 | 7 | 1 | NETWORK-RES 8-SIP4.7K OHM X 7 | 01121 | 208A472 |
| A3R39 | 0683-1825 | 7 | 1 | RESISTOR 1.8K 5% .25W FC TC=-400/+700 | 01121 | CB1825 |
| A3R40* | 0757-0464 | | | 90.9K 1% | | |
| A3T1 | 04193-61501 | 0 | 1 | BALUN | 28480 | 04193-61501 |
| A3U1 | 1826-0712 | 4 | 1 | IC OP AMP LOW-BIAS-H-IMPD DUAL 8-DIP-P | 27014 | LF353N |
| A3U2 | 1826-0319 | 7 | 2 | IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG | 04713 | LF356G |
| A3U3 | 1820-1958 | 0 | 3 | IC SWITCH ANLG QUAD 14-DIP-P PKG | 01928 | CD4016BE |
| A3U4 | 1820-1958 | 0 | | IC SWITCH ANLG QUAD 14-DIP-P PKG | 01928 | CD4016BE |
| A3U5 | 1826-0319 | 7 | | IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG | 04713 | LF356G |
| A3U6 | 1820-1958 | 0 | | IC SWITCH ANLG QUAD 14-DIP-P PKG | 01928 | CD4016BE |
| A3U7 | 1826-0138 | 8 | 1 | IC COMPARATOR GP QUAD 14-DIP-P PKG | 01295 | LM339N |
| A3U8 | 1820-1745 | 3 | 1 | IC GATE CMOS NOR QUAD 2-INP | 04713 | MC14001BCP |
| | 04193-60003 | 5 | 1 | COVER | 28480 | 04193-60003 |
| | 04193-26503 | 0 | 1 | PCBD BLANK | 28480 | 04193-26503 |

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

## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| **A4** | | | | | | |
| A4 | 04193-66504 | 3 | 1 | I CHANNEL AMPLIFIER BOARD ASSEMBLY | 28480 | 04193-66504 |
| A4C1 | 0160-0570 | 2 | 2 | CAPACITOR-FXD 220PF +-20% 100VDC CER | 28480 | 0160-0570 |
| A4C2 | 0160-3877 | 5 | 2 | CAPACITOR-FXD 100PF +-20% 100VDC CER | 28480 | 0160-3877 |
| A4C3 | 0160-0570 | 2 | | CAPACITOR-FXD 220PF +-20% 100VDC CER | 28480 | 0160-0570 |
| A4C4 | 0160-3877 | 5 | | CAPACITOR-FXD 100PF +-20% 100VDC CER | 28480 | 0160-3877 |
| A4C5 | 0160-3878 | 6 | 1 | CAPACITOR-FXD 1000PF +-20% 100VDC CER | 28480 | 0160-3878 |
| A4C6 | 0160-4835 | 7 | 8 | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A4C7 | 0160-0127 | 2 | 3 | CAPACITOR-FXD 1UF +-20% 25VDC CER | 28480 | 0160-0127 |
| A4C8 | 0160-0127 | 2 | | CAPACITOR-FXD 1UF +-20% 25VDC CER | 28480 | 0160-0127 |
| A4C9 | 0160-4386 | 3 | 1 | CAPACITOR-FXD 33PF +-5% 200VDC CER 0+-30 | 51642 | 200-200-NP0-330J |
| A4C10 | 0160-4832 | 4 | 1 | CAPACITOR-FXD .01UF +-10% 100VDC CER | 28480 | 0160-4832 |
| A4C11 | 0180-1083 | 3 | 5 | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A4C12 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A4C13 | 0160-0127 | 2 | | CAPACITOR-FXD 1UF +-20% 25VDC CER | 28480 | 0160-0127 |
| A4C14 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A4C15 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A4C16 | 0180-0291 | 3 | 1 | CAPACITOR-FXD 1UF+-10% 35VDC TA | 56289 | 150D105X9035A2 |
| A4C17 | 0180-0374 | 3 | 1 | CAPACITOR-FXD 10UF+-10% 20VDC TA | 56289 | 150D106X9020B2 |
| A4C18 | 0180-0116 | 1 | 1 | CAPACITOR-FXD 6.8UF+-10% 35VDC TA | 56289 | 150D685X9035B2 |
| A4C19 | 0160-2206 | 2 | 1 | CAPACITOR-FXD 160PF +-5% 300VDC MICA | 28480 | 0160-2206 |
| A4C20 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A4C21 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A4C22 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A4C23 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A4C24 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A4C25 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A4C26 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A4C27 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A4CR1 | 1901-0179 | 7 | 1 | DIODE-SWITCHING 15V 50MA 750PS DO-7 | 28480 | 1901-0179 |
| A4J1 | 1251-5862 | 6 | 2 | CONNECTOR 4-PIN M METRIC POST TYPE | 28480 | 1251-5862 |
| A4J2 | 1251-5862 | 6 | | CONNECTOR 4-PIN M METRIC POST TYPE | 28480 | 1251-5862 |
| A4L1 | 9140-0114 | 4 | 4 | INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG | 28480 | 9140-0114 |
| A4L2 | 9140-0114 | 4 | | INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG | 28480 | 9140-0114 |
| A4L3 | 9140-0114 | 4 | | INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG | 28480 | 9140-0114 |
| A4L4 | 9140-0114 | 4 | | INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG | 28480 | 9140-0114 |
| A4Q1 | 1854-0129 | 6 | 1 | TRANSISTOR-NPN 2SC1636 | 28480 | 1854-0129 |
| A4R1 | 0698-3155 | 2 | 5 | RESISTOR 4.7K 1% .25W FC TC=-400/+600 | 01121 | |
| A4R2 | 0698-7205 | 4 | 4 | RESISTOR 51 .25W FC TC=-400/+500 | 01121 | |
| A4R3 | 0683-4715 | 0 | 1 | RESISTOR 470 5% .25W FC TC=-400/+600 | 01121 | CB4715 |
| A4R4 | 0698-7205 | 4 | | RESISTOR 51 .25W FC TC=-400/+500 | 01121 | |
| A4R5 | 0698-3155 | 2 | | RESISTOR 4.7K .25W FC TC=-400/+600 | 01121 | |
| A4R6 | 2100-3103 | | 1 | RESISTOR-TRMR 10K 10% C SIDE-ADJ 1-TRN | 28480 | 2100-3103 |
| A4R7 | 0683-5105 | 4 | | RESISTOR 51 5% .25W FC TC=-400/+500 | 01121 | CB5105 |
| A4R8 | 0683-1025 | 9 | 1 | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| A4R9 | 0683-5105 | 4 | | RESISTOR 51 5% .25W FC TC=-400/+500 | 01121 | CB5105 |
| A4R10 | 2100-3352 | 7 | 1 | RESISTOR-TRMR 1K 10% C SIDE-ADJ 1-TRN | 28480 | 2100-3352 |
| A4R11 | 0698-4158 | 6 | 2 | RESISTOR 100K .1% .125W F TC=0+-50 | 28480 | 0698-4158 |
| A4R12 | 0698-4158 | 6 | | RESISTOR 100K .1% .125W F TC=0+-50 | 28480 | 0698-4158 |
| A4R13 | 0683-4725 | 2 | 3 | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A4R14 | 0683-4725 | 2 | | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A4R15 | 0683-2225 | 3 | 2 | RESISTOR 2.2K 5% .25W FC TC=-400/+700 | 01121 | CB2225 |
| A4R16 | 0683-2225 | 3 | | RESISTOR 2.2K 5% .25W FC TC=-400/+700 | 01121 | CB2225 |
| A4R17 | 0683-1055 | 5 | 1 | RESISTOR 1M 5% .25W FC TC=-800/+900 | 01121 | CB1055 |
| A4R18 | 0698-3152 | 8 | 1 | RESISTOR 3.48K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-3481-F |
| A4R19 | 0757-0421 | 4 | 1 | RESISTOR 825 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-825R-F |
| A4R20 | 0757-0465 | 6 | 1 | RESISTOR 100K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1003-F |
| A4R21 | 0757-0317 | 7 | 1 | RESISTOR 1.33K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1331-F |
| A4R22 | 0698-3153 | 9 | 1 | RESISTOR 3.83K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-3831-F |
| A4R23 | 0698-8474 | 7 | 1 | RESISTOR 800 .1% .1W F TC=0+-5 | 28480 | 0698-8474 |
| A4R24 | 0699-0287 | 6 | 2 | RESISTOR 100 .1% .1W F TC=0+-15 | 28480 | 0699-0287 |
| A4R25 | 0699-0287 | 6 | | RESISTOR 100 .1% .1W F TC=0+-15 | 28480 | 0699-0287 |
| A4R26 | 0698-2199 | 1 | 1 | R:FXD MET FLM 40K OHM 0.1% 1/8W | 28480 | 0698-2199 |
| A4R27* | 0757-0482 | 7 | 2 | RESISTOR 511K 1% .125W F TC=0+-100 | 28480 | 0757-0482 |
| A4R28 | 0698-6414 | 1 | 1 | RESISTOR 1K .1% .1W F TC=0+-5 | 28480 | 0698-6414 |
| A4R29 | 0683-4725 | 2 | | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A4R30 | 2100-3252 | 6 | 1 | RESISTOR-TRMR 5K 10% C TOP-ADJ 1-TRN | 28480 | 2100-3252 |
| A4R31 | 0757-0442 | 9 | 4 | RESISTOR 10K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1002-F |
| A4R32 | 0757-0442 | 9 | | RESISTOR 10K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1002-F |
| A4R33 | 0757-0442 | 9 | | RESISTOR 10K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1002-F |
| A4R34 | 0757-0482 | 7 | | RESISTOR 511K 1% .125W F TC=0+-100 | 28480 | 0757-0482 |
| A4R35 | 0757-0442 | 9 | | RESISTOR 10K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1002-F |

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

## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| A4R36 | 0757-0401 | 0 | 1 | RESISTOR 100 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-101-F |
| A4R37 | 1810-0205 | 7 | 1 | NETWORK-RES 8-SIP4.7K OHM X 7 | 01121 | 208A472 |
| A4R38 | 0683-1825 | 7 | 1 | RESISTOR 1.8K 5% .25W FC TC=-400/+700 | 01121 | CB1825 |
| A4T1 | 04193-61501 | 0 | 1 | BALUN | 28480 | 04193-61501 |
| A4U1 | 1826-0271 | 0 | 1 | IC OP AMP GP 8-DIP-P PKG | 01295 | SN72741P |
| A4U2 | 1826-0081 | 0 | 1 | IC OP AMP WB TO-99 PKG | 27014 | LM318H |
| A4U3 | 1826-0712 | 4 | 1 | IC OP AMP LOW-BIAS-H-IMPD DUAL 8-DIP-P | 27014 | LF353N |
| A4U4 | 1820-1958 | 0 | 1 | IC SWITCH ANLG QUAD 14-DIP-P PKG | 01928 | CD4016BE |
| A4U5 | 1826-0319 | 7 | 1 | IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG | 04713 | LF356G |
| A4U6 | 1826-0138 | 8 | 1 | IC COMPARATOR GP QUAD 14-DIP-P PKG | 01295 | LM339N |
|  | 5001-0176 | 7 | 1 | STRAP-GROUND | 28480 | 5001-0173 |
|  | 04193-60004 | 6 | 1 | COVER | 28480 | 04193-60004 |
|  | 04193-26504 | 0 | 1 | PCBD BLANK | 28480 | 04193-26504 |

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

## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| **A5** | | | | | | |
| A5 | 04193-66505 | 4 | 1 | MIXER & DIVIDER BOARD ASSEMBLY | 28480 | 04193-66505 |
| A5C1 | 0160-2437 | 1 | 2 | CAPACITOR-FDTHRU 5000PF +80 -20% 200V | 28480 | 0160-2437 |
| A5C2 | 0160-2437 | 1 | | CAPACITOR-FDTHRU 5000PF +80 -20% 200V | 28480 | 0160-2437 |
| A5C3 | 0180-0228 | 6 | 3 | CAPACITOR-FXD 22UF+-10% 15VDC TA | 56289 | 150D226X9015B2 |
| A5C4 | 0160-4835 | 7 | 9 | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A5C5 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A5C6 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A5C7 | 0160-4386 | 3 | 4 | CAPACITOR-FXD 33PF +-5% 200VDC CER 0+-30 | 51642 | 200-200-NP0-330J |
| A5C8 | 0160-4801 | 7 | 1 | CAPACITOR-FXD 100PF +-5% 100VDC CER | 28480 | 0160-4801 |
| A5C9 | 0180-0228 | 6 | | CAPACITOR-FXD 22UF+-10% 15VDC TA | 56289 | 150D226X9015B2 |
| A5C10 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A5C11 | 0160-4386 | 3 | | CAPACITOR-FXD 33PF +-5% 200VDC CER 0+-30 | 51642 | 200-200-NP0-330J |
| A5C12 | 0160-4386 | 3 | | CAPACITOR-FXD 33PF +-5% 200VDC CER 0+-30 | 51642 | 200-200-NP0-330J |
| A5C13 | 0160-4386 | 3 | | CAPACITOR-FXD 33PF +-5% 200VDC CER 0+-30 | 51642 | 200-200-NP0-330J |
| A5C14 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A5C15 | 0160-4832 | 4 | 4 | CAPACITOR-FXD .01UF +-10% 100VDC CER | 28480 | 0160-4832 |
| A5C16 | 0160-4832 | 4 | | CAPACITOR-FXD .01UF +-10% 100VDC CER | 28480 | 0160-4832 |
| A5C17 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A5C18 | 0180-0228 | 6 | | CAPACITOR-FXD 22UF+-10% 15VDC TA | 56289 | 150D226X9015B2 |
| A5C19 | 0180-0374 | 3 | 1 | CAPACITOR-FXD 10UF+-10% 20VDC TA | 56289 | 150D106X9020B2 |
| A5C20 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A5C21 | 0160-4832 | 4 | | CAPACITOR-FXD .01UF +-10% 100VDC CER | 28480 | 0160-4832 |
| A5C22 | 0160-4832 | 4 | | CAPACITOR-FXD .01UF +-10% 100VDC CER | 28480 | 0160-4832 |
| A5C23 | 0160-4574 | 1 | 8 | CAPACITOR-FXD 1000PF +-10% 100VDC CER | 28480 | 0160-4574 |
| A5C24 | 0160-4574 | 1 | | CAPACITOR-FXD 1000PF +-10% 100VDC CER | 28480 | 0160-4574 |
| A5C25 | 0160-4574 | 1 | | CAPACITOR-FXD 1000PF +-10% 100VDC CER | 28480 | 0160-4574 |
| A5C26 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A5C27 | 0160-4574 | 1 | | CAPACITOR-FXD 1000PF +-10% 100VDC CER | 28480 | 0160-4574 |
| A5C28 | 0160-4574 | 1 | | CAPACITOR-FXD 1000PF +-10% 100VDC CER | 28480 | 0160-4574 |
| A5C29 | 0180-1083 | 3 | 1 | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A5C30 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A5C31 | 0160-4574 | 1 | | CAPACITOR-FXD 1000PF +-10% 100VDC CER | 28480 | 0160-4574 |
| A5C32 | 0160-4574 | 1 | | CAPACITOR-FXD 1000PF +-10% 100VDC CER | 28480 | 0160-4574 |
| A5C33 | 0160-4574 | 1 | | CAPACITOR-FXD 1000PF +-10% 100VDC CER | 28480 | 0160-4574 |
| A5CR1 | 1901-0040 | 1 | 1 | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A5E1 | 1906-0235 | 6 | 1 | DIODE-DOUBLE BALANCED MIXER | 28480 | 1906-0235 |
| A5L1 | 9100-2817 | 4 | 2 | INDUCTOR RF-CH-MLD 100NH 5% .105DX.26LG | 28480 | 9100-2817 |
| A5L2 | 9100-2251 | 0 | 1 | INDUCTOR RF-CH-MLD 220NH 10% .105DX.26LG | 28480 | 9100-2251 |
| A5L3 | 9100-2249 | 6 | 2 | INDUCTOR RF-CH-MLD 150NH 10% .105DX.26LG | 28480 | 9100-2249 |
| A5L4 | 9100-2817 | 4 | | INDUCTOR RF-CH-MLD 100NH 5% .105DX.26LG | 28480 | 9100-2817 |
| A5L5 | 9100-2249 | 6 | | INDUCTOR RF-CH-MLD 150NH 10% .105DX.26LG | 28480 | 9100-2249 |
| A5Q1 | 1854-0247 | 9 | 1 | TRANSISTOR NPN SI TO-39 PD=1W FT=800MHZ | 28480 | 1854-0247 |
| A5Q2 | 1854-0345 | 8 | 2 | TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW | 04713 | 2N5179 |
| A5Q3 | 1854-0345 | 8 | | TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW | 04713 | 2N5179 |
| A5R1 | 0683-4715 | 0 | 3 | RESISTOR 470 5% .25W FC TC=-400/+600 | 01121 | CB4715 |
| A5R2 | 0683-4715 | 0 | | RESISTOR 470 5% .25W FC TC=-400/+600 | 01121 | CB4715 |
| A5R3 | 0683-4715 | 0 | | RESISTOR 470 5% .25W FC TC=-400/+600 | 01121 | CB4715 |
| A5R4 | 0683-1005 | 5 | 1 | RESISTOR 10 5% .25W FC TC=-400/+500 | 01121 | CB1005 |
| A5R5 | 0757-0279 | 0 | 8 | RESISTOR 3.16K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-3161-F |
| A5R6 | 0698-0084 | 9 | 8 | RESISTOR 2.15K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-2151-F |
| A5R7 | 0757-0279 | 0 | | RESISTOR 3.16K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-3161-F |
| A5R8 | 0698-0084 | 9 | | RESISTOR 2.15K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-2151-F |
| A5R9 | 0757-0279 | 0 | | RESISTOR 3.16K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-3161-F |
| A5R10 | 0698-0084 | 9 | | RESISTOR 2.15K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-2151-F |
| A5R11 | 0698-3441 | 8 | 1 | RESISTOR 215 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-215R-F |
| A5R12 | 0757-0394 | 0 | 1 | RESISTOR 51.1 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-51R1-F |
| A5R13 | 0698-3440 | 7 | 1 | RESISTOR 196 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-196R-F |
| A5R14 | 0757-0401 | 0 | 1 | RESISTOR 100 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-101-F |
| A5R15 | 0683-2705 | 4 | 1 | RESISTOR 27 5% .25W FC TC=-400/+500 | 01121 | CB2705 |
| A5R16 | 0683-6805 | 3 | 1 | RESISTOR 68 5% .25W FC TC=-400/+500 | 01121 | CB6805 |
| A5R17 | 0698-0085 | 0 | 1 | RESISTOR 2.61K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-2611-F |
| A5R18 | 0683-1815 | 5 | 2 | RESISTOR 180 5% .25W FC TC=-400/+600 | 01121 | CB1815 |
| A5R19 | 0698-0082 | 7 | 1 | RESISTOR 464 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4640-F |
| A5R20 | 0683-1815 | 5 | | RESISTOR 180 5% .25W FC TC=-400/+600 | 01121 | CB1815 |
| A5R21 | 0698-0084 | 9 | | RESISTOR 2.15K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-2151-F |
| A5R22 | 0757-0279 | 0 | | RESISTOR 3.16K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-3161-F |
| A5R23 | 0683-4725 | 2 | 1 | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A5R24 | 0698-0084 | 9 | | RESISTOR 2.15K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-2151-F |
| A5R25 | 0757-0279 | 0 | | RESISTOR 3.16K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-3161-F |

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

## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| A5R26 | 0683-5615 | 1 | 17 | RESISTOR 560 5% .25W FC TC=-400/+600 | 01121 | CB5615 |
| A5R27 | 0683-5615 | 1 | | RESISTOR 560 5% .25W FC TC=-400/+600 | 01121 | CB5615 |
| A5R28 | 0683-5615 | 1 | | RESISTOR 560 5% .25W FC TC=-400/+600 | 01121 | CB5615 |
| A5R29 | 0683-5615 | 1 | | RESISTOR 560 5% .25W FC TC=-400/+600 | 01121 | CB5615 |
| A5R30 | 0683-5615 | 1 | | RESISTOR 560 5% .25W FC TC=-400/+600 | 01121 | CB5615 |
| A5R31 | 0683-5615 | 1 | | RESISTOR 560 5% .25W FC TC=-400/+600 | 01121 | CB5615 |
| A5R32 | 0683-5615 | 1 | | RESISTOR 560 5% .25W FC TC=-400/+600 | 01121 | CB5615 |
| A5R33 | 0683-5615 | 1 | | RESISTOR 560 5% .25W FC TC=-400/+600 | 01121 | CB5615 |
| A5R34 | 0683-5615 | 1 | | RESISTOR 560 5% .25W FC TC=-400/+600 | 01121 | CB5615 |
| A5R35 | 0698-0084 | 9 | | RESISTOR 2.15K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-2151-F |
| A5R36 | 0757-0279 | 0 | | RESISTOR 3.16K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-3161-F |
| A5R37 | 0698-0084 | 9 | | RESISTOR 2.15K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-2151-F |
| A5R38 | 0757-0279 | 0 | | RESISTOR 3.16K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-3161-F |
| A5R39 | 0698-0084 | 9 | | RESISTOR 2.15K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-2151-F |
| A5R40 | 0757-0279 | 0 | | RESISTOR 3.16K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-3161-F |
| A5R41 | 0683-2215 | 1 | 1 | RESISTOR 220 5% .25W FC TC=-400/+600 | 01121 | CB2215 |
| A5R42 | 0683-3315 | 4 | 1 | RESISTOR 330 5% .25W FC TC=-400/+600 | 01121 | CB3315 |
| A5R43 | 0683-5615 | 1 | | RESISTOR 560 5% .25W FC TC=-400/+600 | 01121 | CB5615 |
| A5R44 | 0683-5615 | 1 | | RESISTOR 560 5% .25W FC TC=-400/+600 | 01121 | CB5615 |
| A5R45 | 0683-5615 | 1 | | RESISTOR 560 5% .25W FC TC=-400/+600 | 01121 | CB5615 |
| A5R46 | 0683-5615 | 1 | | RESISTOR 560 5% .25W FC TC=-400/+600 | 01121 | CB5615 |
| A5R47 | 0683-5615 | 1 | | RESISTOR 560 5% .25W FC TC=-400/+600 | 01121 | CB5615 |
| A5R48 | 0683-5615 | 1 | | RESISTOR 560 5% .25W FC TC=-400/+600 | 01121 | CB5615 |
| A5R49 | 0683-5615 | 1 | | RESISTOR 560 5% .25W FC TC=-400/+600 | 01121 | CB5615 |
| A5R50 | 0683-5615 | 1 | | RESISTOR 560 5% .25W FC TC=-400/+600 | 01121 | CB5615 |
| A5U1 | 1820-1200 | 5 | 1 | IC INV TTL LS HEX | 01295 | SN74LS05N |
| A5U2 | 1820-0817 | 8 | 2 | IC FF ECL D-M/S DUAL | 04713 | MC10131P |
| A5U3 | 1820-1198 | 0 | 1 | IC GATE TTL LS NAND QUAD 2-INP | 01295 | SN74LS03N |
| A5U4 | 1820-1224 | 3 | 1 | IC RCVR ECL LINE RCVR TPL 2-INP | 04713 | MC10216P |
| A5U5 | 1820-0817 | 8 | | IC FF ECL D-M/S DUAL | 04713 | MC10131P |
| A5U6 | 1820-0804 | 3 | 1 | IC GATE ECL NOR TPL | 04713 | MC10106P |
| A5U7 | 1820-0821 | 4 | 1 | IC CNTR ECL BIN UP/DOWN SYNCHRO | 04713 | MC10136L |
| | 1205-0011 | 0 | 1 | HEAT SINK TO-5/TO-39-CS | 28480 | 1205-0011 |
| | 5001-0173 | 7 | 2 | STRAP-GROUND | 28480 | 5001-0173 |
| | 04193-60005 | 7 | 1 | COVER | 28480 | 04193-60005 |
| | 04193-26505 | 0 | 1 | PCBD BLANK | 28480 | 04193-26505 |

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

## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| **A6** | | | | | | |
| A6 | 04193-66506 | 5 | 1 | VCXO BOARD ASSEMBLY | 28480 | 04193-66506 |
| A6C1 | 0160-2437 | 1 | 3 | CAPACITOR-FDTHRU 5000PF +80 -20% 200V | 28480 | 0160-2437 |
| A6C2 | 0160-2437 | 1 | | CAPACITOR-FDTHRU 5000PF +80 -20% 200V | 28480 | 0160-2437 |
| A6C3 | 0160-2437 | 1 | | CAPACITOR-FDTHRU 5000PF +80 -20% 200V | 28480 | 0160-2437 |
| A6C4 | 0160-5495 | 3 | 5 | CAPACITOR-FXD 3.9PF +-.5PF 200VDC CER | | |
| A6C5 | 0160-5620 | 2 | 3 | CAPACITOR-FXD 15PF +-5% 200VDC CER 0+-30 | 51642 | 200-200-NPO-150J |
| A6C6 | 0160-5495 | 3 | | CAPACITOR-FXD 3.9PF +-.5PF 200VDC CER | | |
| A6C7 | 0121-0453 | 5 | 2 | CAPACITOR-V TRMR-AIR 1.3-5.4PF 175V | 74970 | 187-0303-125 |
| A6C8 | 0121-0453 | 5 | | CAPACITOR-V TRMR-AIR 1.3-5.4PF 175V | 74970 | 187-0303-125 |
| A6C9 | 0160-5617 | 3 | | CAPACITOR-FXD 3PF +-.5PF 200VDC CER | | |
| A6C10 | 0160-4103 | 2 | 2 | CAPACITOR-FXD 220PF +-5% 100VDC CER | 72982 | 8121-M100-COG-221J |
| A6C11 | 0160-4103 | 2 | | CAPACITOR-FXD 220PF +-5% 100VDC CER | 72982 | 8121-M100-COG-221J |
| A6C12 | 0160-4822 | 2 | 2 | CAPACITOR-FXD 1000PF +-5% 100VDC CER | 28480 | 0160-4822 |
| A6C13 | 0160-4832 | 4 | 8 | CAPACITOR-FXD .01UF +-10% 100VDC CER | 28480 | 0160-4832 |
| A6C14 | 0160-4832 | 4 | | CAPACITOR-FXD .01UF +-10% 100VDC CER | 28480 | 0160-4832 |
| A6C15 | 0160-3872 | 0 | 1 | CAPACITOR-FXD 2.2PF +-.25PF 200VDC CER | 28480 | 0160-3872 |
| A6C16 | 0160-3879 | 7 | 8 | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A6C17 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A6C18 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A6C19 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A6C20 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A6C21 | 0160-4835 | 7 | 10 | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A6C22 | 0160-4832 | 4 | | CAPACITOR-FXD .01UF +-10% 100VDC CER | 28480 | 0160-4832 |
| A6C23 | 0160-4832 | 4 | | CAPACITOR-FXD .01UF +-10% 100VDC CER | 28480 | 0160-4832 |
| A6C24 | 0160-4832 | 4 | | CAPACITOR-FXD .01UF +-10% 100VDC CER | 28480 | 0160-4832 |
| A6C25 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A6C26 | 0160-5620 | 2 | | CAPACITOR-FXD 15PF +-5% 200VDC CER 0+-30 | 51642 | 200-200-NPO-150J |
| A6C27 | 0160-5621 | 3 | 1 | CAPACITOR-FXD 22PF +-5% 200VDC CER 0+-30 | 28480 | 0160-3875 |
| A6C28 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A6C29 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A6C30 | 0160-4822 | 2 | | CAPACITOR-FXD 1000PF +-5% 100VDC CER | 28480 | 0160-4822 |
| A6C31 | 0160-4832 | 4 | | CAPACITOR-FXD .01UF +-10% 100VDC CER | 28480 | 0160-4832 |
| A6C32 | 0180-0374 | 3 | 1 | CAPACITOR-FXD 10UF+-10% 20VDC TA | 56289 | 150D106X9020B2 |
| A6C33 | 0160-5620 | 2 | | CAPACITOR-FXD 15PF +-5% 200VDC CER 0+-30 | 51642 | 200-200-NPO-150J |
| A6C34 | 0160-5495 | 3 | | CAPACITOR-FXD 3.9PF +-.5PF 200VDC CER | 51642 | 200-200-NPO-399D |
| A6C35 | 0160-5495 | 3 | | CAPACITOR-FXD 3.9PF +-.5PF 200VDC CER | 51642 | 200-200-NPO-399D |
| A6C36 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A6C37 | 0160-3877 | 5 | 1 | CAPACITOR-FXD 100PF +-20% 200VDC CER | 28480 | 0160-3877 |
| A6C38 | 0160-4801 | 7 | 1 | CAPACITOR-FXD 100PF +-5% 100VDC CER | 28480 | 0160-4801 |
| A6C39 | 0160-4832 | 4 | | CAPACITOR-FXD .01UF +-10% 100VDC CER | 28480 | 0160-4832 |
| A6C40 | 0160-4832 | 4 | | CAPACITOR-FXD .01UF +-10% 100VDC CER | 28480 | 0160-4832 |
| A6C41 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A6C42 | 0160-0161 | 4 | 2 | CAPACITOR-FXD .01UF +-10% 200VDC POLYE | 28480 | 0160-0161 |
| A6C43 | 0160-2201 | 7 | 1 | CAPACITOR-FXD 51PF +-5% 300VDC MICA | 28480 | 0160-2201 |
| A6C44 | 0180-1083 | 3 | 6 | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A6C45 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A6C46 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A6C47 | 0160-2204 | 0 | 1 | CAPACITOR-FXD 100PF +-5% 300VDC MICA | 28480 | 0160-2204 |
| A6C48 | 0180-0197 | 8 | 2 | CAPACITOR-FXD 2.2UF+-10% 20VDC TA | 56289 | 150D225X9020A2 |
| A6C49 | 0180-0197 | 8 | | CAPACITOR-FXD 2.2UF+-10% 20VDC TA | 56289 | 150D225X9020A2 |
| A6C50 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A6C51 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A6C52 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A6C53 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A6C54 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A6C55 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A6C56 | 0160-0362 | 7 | 1 | CAPACITOR-FXD 510PF +-5% 300VDC MICA | 28480 | 0160-0362 |
| A6C57 | 0160-0161 | 4 | | CAPACITOR-FXD .01UF +-10% 200VDC POLYE | 28480 | 0160-0161 |
| A6C58 | 0160-0127 | 2 | 2 | CAPACITOR-FXD 1UF +-20% 25VDC CER | 28480 | 0160-0127 |
| A6C59 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A6C60 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A6C61 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A6C62 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A6C63 | 0160-0127 | 2 | | CAPACITOR-FXD 1UF +-20% 25VDC CER | 28480 | 0160-0127 |
| A6E1 | 1906-0235 | 6 | 1 | DIODE-DOUBLE BALANCED MIXER | 28480 | 1906-0235 |
| A6CR1 | 0122-0072 | 6 | 1 | DIODE-VVC 2.2PF 5% C3/C25 MIN=4.5 | 04713 | 8B105B |
| A6CR2 | 1901-0040 | 1 | 5 | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A6CR3 | 1901-0040 | 1 | | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A6CR4 | 1901-0040 | 1 | | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A6CR5 | 1901-0040 | 1 | | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A6CR6 | 1901-0040 | 1 | | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A6CR7 | 1902-0786 | 4 | 1 | DIODE-ZNR 1N937 9V 5% DO-7 PD=.5W | 24046 | 1N937 |
| A6CR8 | 1902-3036 | 3 | 4 | DIODE-ZNR 3.16V 5% DO-7 PD=.4W TC=-.064% | 28480 | 1902-3036 |
| A6CR9 | 1902-3097 | 6 | 1 | DIODE-ZNR 5.23V 2% DO-35 PD=.4W | 28480 | 1902-3097 |

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

## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| A6CR10 | 1902-3149 | 9 | 1 | DIODE-ZNR 9.09V 5% DO-35 PD=.4W | 28480 | 1902-3149 |
| A6CR11 | 1902-3036 | 3 | | DIODE-ZNR 3.16V 5% DO-7 PD=.4W TC=-.064% | 28480 | 1902-3036 |
| A6CR12 | 1902-3036 | 3 | | DIODE-ZNR 3.16V 5% DO-7 PD=.4W TC=-.064% | 28480 | 1902-3036 |
| A6CR13 | 1902-3036 | 3 | | DIODE-ZNR 3.16V 5% DO-7 PD=.4W TC=-.064% | 28480 | 1902-3036 |
| A6J1 | 1250-0257 | 1 | 1 | CONNECTOR-RF SMB M PC 50-OHM | 28480 | 1250-0257 |
| A6J2 | 1251-4822 | 6 | 1 | CONNECTOR 3-PIN M POST TYPE | 28480 | 1251-4822 |
| A6J3 | 1258-0141 | 8 | 1 | JUMPER-REM | 28480 | 1258-0141 |
| A6L1 | 9100-2251 | 0 | 5 | INDUCTOR RF-CH-MLD 220NH 10% .105DX.26LG | 28480 | 9100-2251 |
| A6L2 | 9100-2247 | 4 | 1 | INDUCTOR RF-CH-MLD 100NH 10% .105DX.26LG | 28480 | 9100-2247 |
| A6L3 | 9100-2250 | 9 | 1 | INDUCTOR RF-CH-MLD 180NH 10% .105DX.26LG | 28480 | 9100-2250 |
| A6L4 | 9100-2891 | 4 | 2 | INDUCTOR RF-CH-MLD 50NH 10% .105DX.26LG | 28480 | 9100-2891 |
| A6L5 | 9100-2891 | 4 | | INDUCTOR RF-CH-MLD 50NH 10% .105DX.26LG | 28480 | 9100-2891 |
| A6L6 | 9140-0641 | 8 | 1 | RF TRANSFORMER | 28480 | 9140-0641 |
| A6L7 | 9140-0141 | 7 | 1 | INDUCTOR RF-CH-MLD 680NH 10% .105DX.26LG | 28480 | 9140-0141 |
| A6L8 | 9100-0368 | 6 | 1 | INDUCTOR RF-CH-MLD 330NH 10% .105DX.26LG | 28480 | 9100-0368 |
| A6L9 | 9100-2249 | 6 | 3 | INDUCTOR RF-CH-MLD 150NH 10% .105DX.26LG | 28480 | 9100-2249 |
| A6L10 | 9100-2251 | 0 | | INDUCTOR RF-CH-MLD 220NH 10% .105DX.26LG | 28480 | 9100-2251 |
| A6L11 | 9100-2251 | 0 | | INDUCTOR RF-CH-MLD 220NH 10% .105DX.26LG | 28480 | 9100-2251 |
| A6L12 | 9100-2249 | 6 | | INDUCTOR RF-CH-MLD 150NH 10% .105DX.26LG | 28480 | 9100-2249 |
| A6L13 | 9100-2248 | 5 | 2 | INDUCTOR RF-CH-MLD 120NH 10% .105DX.26LG | 28480 | 9100-2248 |
| A6L14 | 9100-2251 | 0 | | INDUCTOR RF-CH-MLD 220NH 10% .105DX.26LG | 28480 | 9100-2251 |
| A6L15 | 9100-2251 | 0 | | INDUCTOR RF-CH-MLD 220NH 10% .105DX.26LG | 28480 | 9100-2251 |
| A6L16 | 9100-2248 | 5 | | INDUCTOR RF-CH-MLD 120NH 10% .105DX.26LG | 28480 | 9100-2248 |
| A6L17 | 9100-2249 | 6 | | INDUCTOR RF-CH-MLD 150NH 10% .105DX.26LG | 28480 | 9100-2249 |
| A6Q1 | 1854-0345 | 8 | 7 | TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW | 04713 | 2N5179 |
| A6Q2 | 1854-0345 | 8 | | TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW | 04713 | 2N5179 |
| A6Q3 | 1854-0345 | 8 | | TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW | 04713 | 2N5179 |
| A6Q4 | 1854-0345 | 8 | | TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW | 04713 | 2N5179 |
| A6Q5 | 1854-0345 | 8 | | TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW | 04713 | 2N5179 |
| A6Q6 | 1854-0345 | 8 | | TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW | 04713 | 2N5179 |
| A6Q7 | 1854-0345 | 8 | | TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW | 04713 | 2N5179 |
| A6R1 | 0683-1015 | 7 | 1 | RESISTOR 100 5% .25W FC TC=-400/+500 | 01121 | CB1015 |
| A6R2 | 0683-6815 | 5 | 1 | RESISTOR 680 5% .25W FC TC=-400/+600 | 01121 | CB6815 |
| A6R3 | 0683-2225 | 3 | 5 | RESISTOR 2.2K 5% .25W FC TC=-400/+700 | 01121 | CB2225 |
| A6R4 | 0757-0439 | 4 | 3 | RESISTOR 6.81K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-6811-F |
| A6R5 | 0698-3155 | 1 | 2 | RESISTOR 4.64K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4641-F |
| A6R6 | 0698-3132 | 4 | 1 | RESISTOR 261 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-2610-F |
| A6R7 | 0698-3155 | 1 | | RESISTOR 4.64K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4641-F |
| A6R8 | 0757-0439 | 4 | | RESISTOR 6.81K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-6811-F |
| A6R9 | 0757-0421 | 4 | 1 | RESISTOR 825 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-825R-F |
| A6R10 | 0698-3444 | 1 | 1 | RESISTOR 316 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-316R-F |
| A6R11 | 0757-0274 | 5 | 2 | RESISTOR 1.21K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1211-F |
| A6R12 | 0757-0439 | 4 | | RESISTOR 6.81K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-6811-F |
| A6R13 | 0683-6805 | 3 | 3 | RESISTOR 68 5% .25W FC TC=-400/+500 | 01121 | CB6805 |
| A6R14 | 0757-0419 | 0 | 1 | RESISTOR 681 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-681R-F |
| A6R15 | 0757-0428 | 1 | 1 | RESISTOR 1.62K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1621-F |
| A6R16 | 0757-0290 | 5 | 1 | RESISTOR 6.19K 1% .125W F TC=0+-100 | 19701 | MF4C1/8-T0-6191-F |
| A6R17 | 0683-6805 | 3 | | RESISTOR 68 5% .25W FC TC=-400/+500 | 01121 | CB6805 |
| A6R18 | 0683-4715 | 0 | 2 | RESISTOR 470 5% .25W FC TC=-400/+600 | 01121 | CB4715 |
| A6R19 | 0698-3441 | 8 | 2 | RESISTOR 215 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-215R-F |
| A6R20 | 0757-1094 | 9 | 1 | RESISTOR 1.47K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1471-F |
| A6R21 | 0757-0200 | 7 | 2 | RESISTOR 5.62K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-5621-F |
| A6R22 | 0683-2205 | 9 | 1 | RESISTOR 22 5% .25W FC TC=-400/+500 | 01121 | CB2205 |
| A6R23 | 0698-3441 | 8 | | RESISTOR 215 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-215R-F |
| A6R24 | 0757-0417 | 8 | 1 | RESISTOR 562 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-562R-F |
| A6R25 | 0683-1045 | 3 | 2 | RESISTOR 100K 5% .25W FC TC=-400/+800 | 01121 | CB1045 |
| A6R26 | 0757-0279 | 0 | 1 | RESISTOR 3.16K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-3161-F |
| A6R27 | 0683-5605 | 9 | 1 | RESISTOR 56 5% .25W FC TC=-400/+500 | 01121 | CB5605 |
| A6R28 | 0683-6805 | 3 | | RESISTOR 68 5% .25W FC TC=-400/+500 | 01121 | CB6805 |
| A6R29 | 0683-4705 | 8 | 1 | RESISTOR 47 5% .25W FC TC=-400/+500 | 01121 | CB4705 |
| A6R30 | 0683-3305 | 2 | 5 | RESISTOR 33 5% .25W FC TC=-400/+500 | 01121 | CB3305 |
| A6R31 | 0683-3305 | 2 | | RESISTOR 33 5% .25W FC TC=-400/+500 | 01121 | CB3305 |
| A6R32 | 0683-4715 | 0 | | RESISTOR 470 5% .25W FC TC=-400/+600 | 01121 | CB4715 |
| A6R33 | 0683-2215 | 1 | 1 | RESISTOR 220 5% .25W FC TC=-400/+600 | 01121 | CB2215 |
| A6R34 | 0757-0442 | 9 | 2 | RESISTOR 10K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1002-F |
| A6R35 | 0698-3157 | 3 | 1 | RESISTOR 19.6K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1962-F |
| A6R36 | 0683-3305 | 2 | | RESISTOR 33 5% .25W FC TC=-400/+500 | 01121 | CB3305 |
| A6R37 | 0683-2225 | 3 | | RESISTOR 2.2K 5% .25W FC TC=-400/+700 | 01121 | CB2225 |
| A6R38 | 0683-1045 | 3 | | RESISTOR 100K 5% .25W FC TC=-400/+800 | 01121 | CB1045 |
| A6R39 | 0683-4725 | 2 | 1 | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A6R40 | 0683-1825 | 7 | 2 | RESISTOR 1.8K 5% .25W FC TC=-400/+700 | 01121 | CB1825 |
| A6R41 | 0683-1825 | 7 | | RESISTOR 1.8K 5% .25W FC TC=-400/+700 | 01121 | CB1825 |
| A6R42 | 0683-1225 | 1 | 1 | RESISTOR 1.2K 5% .25W FC TC=-400/+700 | 01121 | CB1225 |
| A6R43 | 0683-2225 | 3 | | RESISTOR 2.2K 5% .25W FC TC=-400/+700 | 01121 | CB2225 |
| A6R44 | 0683-1235 | 3 | 1 | RESISTOR 12K 5% .25W FC TC=-400/+800 | 01121 | CB1235 |
| A6R45 | 0683-6825 | 7 | 1 | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |

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

## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| A6R46 | 0757-0200 | 7 |  | RESISTOR 5.62K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-5621-F |
| A6R47 | 0757-0440 | 7 | 1 | RESISTOR 7.5K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-7501-F |
| A6R48 | 0757-0274 | 5 |  | RESISTOR 1.21K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1211-F |
| A6R49 | 0683-2225 | 3 |  | RESISTOR 2.2K 5% .25W FC TC=-400/+700 | 01121 | CB2225 |
| A6R50 | 0683-3305 | 2 |  | RESISTOR 33 5% .25W FC TC=-400/+500 | 01121 | CB3305 |
| A6R51 | 0683-3305 | 2 |  | RESISTOR 33 5% .25W FC TC=-400/+500 | 01121 | CB3305 |
| A6R52 | 0757-0442 | 9 |  | RESISTOR 10K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1002-F |
| A6R53 | 0698-3153 | 9 | 1 | RESISTOR 3.83K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-3831-F |
| A6R54 | 0683-2225 | 3 |  | RESISTOR 2.2K 5% .25W FC TC=-400/+700 | 01121 | CB2225 |
| A6R55 | 0683-1525 | 4 | 1 | RESISTOR 1.5K 5% .25W FC TC=-400/+700 | 01121 | CB1525 |
| A6U1 | 1826-0139 | 9 | 1 | IC OP AMP GP DUAL 8-DIP-P PKG | 01928 | CA1458G |
| A6U2 | 1826-0065 | 0 | 1 | IC COMPARATOR PRCN 8-DIP-P PKG | 01295 | SN72311P |
| A6U3 | 1820-1443 |  | 1 | IC CNTR TTL LS 4-BIT BINARY ASYNCHRO | 01295 | SN57204 |
| A6U4 | 1820-0630 | 3 | 1 | IC MISC TTL | 04713 | MC4044P |
| A6U5 | 1826-0319 | 7 | 1 | IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG | 04713 | LF356G |
| A6Y1 | 0410-1379 | 9 | 1 | CRYSTAL-QUARTZ 99.99M | 28480 | 0410-1379 |
|  | 1400-0249 | 0 | 1 | CABLE TIE .062-.625-DIA .091-WD NYL | 06383 | PLT1M-8 |
|  | 5001-0176 | 7 | 2 | STRAP-GROUND | 28480 | 5001-0173 |
|  | 9170-0029 | 3 | 3 | CORE-SHIELDING BEAD | 28480 | 9170-0029 |
|  | 04193-00604 | 6 | 3 | SHIELD BOX | 28480 | 04193-00604 |
|  | 04193-00607 | 9 | 3 | SHIELD-BOX | 28480 | 04193-00607 |
|  | 04193-60006 | 8 | 1 | COVER | 28480 | 04193-60006 |
|  | 04193-26506 | 0 | 1 | PCBD BLANK | 28480 | 04193-26506 |

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

## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| **A7** | | | | | | |
| A7 | 04193-66507 | 6 | 1 | DIVIDER BOARD ASSEMBLY | 28480 | 04193-66507 |
| A7C1 | 0160-2437 | 1 | 1 | CAPACITOR-FDTHRU 5000PF +80 -20% 200V | 28480 | 0160-2437 |
| A7C2 | 0160-4832 | 4 | 5 | CAPACITOR-FXD .01UF +-10% 100VDC CER | 28480 | 0160-4832 |
| A7C3 | 0160-4835 | 7 | 3 | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A7C4 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A7C5 | 0160-4832 | 4 | | CAPACITOR-FXD .01UF +-10% 100VDC CER | 28480 | 0160-4832 |
| A7C6 | 0180-0228 | 6 | 3 | CAPACITOR-FXD 22UF+-10% 15VDC TA | 56289 | 150D226X9015B2 |
| A7C7 | 0180-0228 | 6 | | CAPACITOR-FXD 22UF+-10% 15VDC TA | 56289 | 150D226X9015B2 |
| A7C8 | 0180-0291 | 3 | 3 | CAPACITOR-FXD 1UF+-10% 35VDC TA | 56289 | 150D105X9035A2 |
| A7C9 | 0180-0291 | 3 | | CAPACITOR-FXD 1UF+-10% 35VDC TA | 56289 | 150D105X9035A2 |
| A7C10 | 0180-0291 | 3 | | CAPACITOR-FXD 1UF+-10% 35VDC TA | 56289 | 150D105X9035A2 |
| A7C11 | 0160-4832 | 4 | | CAPACITOR-FXD .01UF +-10% 100VDC CER | 28480 | 0160-4832 |
| A7C12 | 0160-4574 | 1 | 3 | CAPACITOR-FXD 1000PF +-10% 100VDC CER | 28480 | 0160-4574 |
| A7C13 | 0160-4832 | 4 | | CAPACITOR-FXD .01UF +-10% 100VDC CER | 28480 | 0160-4832 |
| A7C14 | 0160-4574 | 1 | | CAPACITOR-FXD 1000PF +-10% 100VDC CER | 28480 | 0160-4574 |
| A7C15 | 0160-4574 | 1 | | CAPACITOR-FXD 1000PF +-10% 100VDC CER | 28480 | 0160-4574 |
| A7C16 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A7C17 | 0180-0228 | 6 | | CAPACITOR-FXD 22UF+-10% 15VDC TA | 56289 | 150D226X9015B2 |
| A7C18 | 0160-4832 | 4 | | CAPACITOR-FXD .01UF +-10% 100VDC CER | 28480 | 0160-4832 |
| A7L1 | 9140-0114 | 4 | 2 | INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG | 28480 | 9140-0114 |
| A7L2 | 9100-1618 | 1 | 2 | INDUCTOR RF-CH-MLD 5.6UH 10% | 28480 | 9100-1618 |
| A7L3 | 9100-1618 | 1 | | INDUCTOR RF-CH-MLD 5.6UH 10% | 28480 | 9100-1618 |
| A7L4 | 9140-0114 | 4 | | INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG | 28480 | 9140-0114 |
| A7R1 | 0683-1025 | 9 | 1 | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| A7R2 | 0683-2245 | 7 | 2 | RESISTOR 220K 5% .25W FC TC=-800/+900 | 01121 | CB2245 |
| A7R3 | 0683-2245 | 7 | | RESISTOR 220K 5% .25W FC TC=-800/+900 | 01121 | CB2245 |
| A7R4 | 0683-1845 | 1 | 1 | RESISTOR 180K 5% .25W FC TC=-800/+900 | 01121 | CB1845 |
| A7R5 | 0757-0277 | 8 | 1 | RESISTOR 49.9 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4992-F |
| A7R6 | 0683-2745 | 2 | 1 | RESISTOR 270K 5% .25W FC TC=-800/+900 | 01121 | CB2745 |
| A7R7 | 0683-2715 | 6 | 2 | RESISTOR 270 5% .25W FC TC=-400/+600 | 01121 | CB2715 |
| A7R8 | 0683-2715 | 6 | | RESISTOR 270 5% .25W FC TC=-400/+600 | 01121 | CB2715 |
| A7R9 | 1810-0204 | 6 | 1 | NETWORK-RES 8-SIP1.0K OHM X 7 | 01121 | 208A102 |
| A7U1 | 1820-1430 | 3 | 1 | IC CNTR TTL LS BIN SYNCHRO POS-EDGE-TRIG | 01295 | SN74LS161AN |
| A7U2 | 1820-1423 | 4 | 2 | IC MV TTL LS MONOSTBL RETRIG DUAL | 01295 | SN74LS123N |
| A7U3 | 1820-1112 | 8 | 4 | IC FF TTL LS D-TYPE POS-EDGE-TRIG | 01295 | SN74LS74AN |
| A7U4 | 1820-1194 | 6 | 2 | IC CNTR TTL LS BIN UP/DOWN SYNCHRO | 01295 | SN74LS193N |
| A7U5 | 1820-1888 | 5 | 1 | IC PRESCR ECL | 04713 | MC12013L |
| A7U6 | 1820-1429 | 0 | 8 | IC CNTR TTL LS DECD SYNCHRO | 01295 | SN74LS160AN |
| A7U7 | 1820-1144 | 6 | 1 | IC GATE TTL LS NOR QUAD 2-INP | 01295 | SN74LS02N |
| A7U8 | 1820-1423 | 4 | | IC MV TTL LS MONOSTBL RETRIG DUAL | 01295 | SN74LS123N |
| A7U9 | 1820-1197 | 9 | 1 | IC GATE TTL LS NAND QUAD 2-INP | 01295 | SN74LS00N |
| A7U10 | 1820-1206 | 1 | 1 | IC GATE TTL LS NOR TPL 3-INP | 01295 | SN74LS27N |
| A7U11 | 1820-1194 | 6 | | IC CNTR TTL LS BIN UP/DOWN SYNCHRO | 01295 | SN74LS193N |
| A7U12 | 1820-0630 | 3 | 1 | IC MISC TTL | 04713 | MC4044P |
| A7U13 | 1820-1202 | 7 | 1 | IC GATE TTL LS NAND TPL 3-INP | 01295 | SN74LS10N |
| A7U14 | 1820-1429 | 0 | | IC CNTR TTL LS DECD SYNCHRO | 01295 | SN74LS160AN |
| A7U15 | 1820-1429 | 0 | | IC CNTR TTL LS DECD SYNCHRO | 01295 | SN74LS160AN |
| A7U16 | 1820-1204 | 9 | 1 | IC GATE TTL LS NAND DUAL 4-INP | 01295 | SN74LS20N |
| A7U17 | 1820-1112 | 8 | | IC FF TTL LS D-TYPE POS-EDGE-TRIG | 01295 | SN74LS74AN |
| A7U18 | 1820-1199 | 1 | 2 | IC INV TTL LS HEX 1-INP | 01295 | SN74LS04N |
| A7U19 | 1820-1416 | 5 | 1 | IC SCHMITT-TRIG TTL LS INV HEX 1-INP | 01295 | SN74LS14N |
| A7U20 | 1820-1470 | 1 | 1 | IC MUXR/DATA-SEL TTL LS 2-TO-1-LINE QUAD | 01295 | SN74LS157N |
| A7U21 | 1820-1244 | 7 | 1 | IC MUXR/DATA-SEL TTL LS 4-TO-1-LINE DUAL | 01295 | SN74LS153N |
| A7U22 | 1820-1429 | 0 | | IC CNTR TTL LS DECD SYNCHRO | 01295 | SN74LS160AN |
| A7U23 | 1820-1429 | 0 | | IC CNTR TTL LS DECD SYNCHRO | 01295 | SN74LS160AN |
| A7U24 | 1820-1429 | 0 | | IC CNTR TTL LS DECD SYNCHRO | 01295 | SN74LS160AN |
| A7U25 | 1820-1429 | 0 | | IC CNTR TTL LS DECD SYNCHRO | 01295 | SN74LS160AN |
| A7U26 | 1820-1429 | 0 | | IC CNTR TTL LS DECD SYNCHRO | 01295 | SN74LS160AN |
| A7U27 | 1820-1112 | 8 | | IC FF TTL LS D-TYPE POS-EDGE-TRIG | 01295 | SN74LS74AN |
| A7U28 | 1820-1112 | 8 | | IC FF TTL LS D-TYPE POS-EDGE-TRIG | 01295 | SN74LS74AN |
| A7U29 | 1820-1199 | 1 | | IC INV TTL LS HEX 1-INP | 01295 | SN74LS04N |
| A7U30 | 1820-1251 | 6 | 1 | IC CNTR TTL LS DECD ASYNCHRO | 01295 | SN74LS196N |
| | 5001-0176 | 7 | 2 | STRAP-GROUND | 28480 | 5001-0173 |
| | 04193-60007 | 9 | 1 | COVER | 28480 | 04193-60007 |
| | 04193-26507 | 0 | 1 | PCBD BLANK | 28480 | 04193-26507 |

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

## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| **A8** | | | | | | |
| A8 | 04123-66508 | 7 | 1 | CRYSTAL OSCILLATOR BOARD ASSEMBLY | 28480 | 04123-66508 |
| A8C1 | 0160-2437 | 1 | 2 | CAPACITOR-FDTHRU 5000PF +80 -20% 200V | 28480 | 0160-2437 |
| A8C2 | 0160-2437 | 1 | | CAPACITOR-FDTHRU 5000PF +80 -20% 200V | 28480 | 0160-2437 |
| A8C3 | 0121-0453 | 5 | 2 | CAPACITOR-V TRMR-AIR 1.3-5.4PF 175V | 74970 | 187-0303-125 |
| A8C4 | 0160-4385 | 2 | 3 | CAPACITOR-FXD 15PF +-5% 200VDC CER 0+-30 | 51642 | 200-200-NPO-150J |
| A8C5 | 0160-5495 | 3 | 7 | CAPACITOR-FXD 3.9PF +-.5PF 200VDC CER | | |
| A8C6 | 0160-3879 | 7 | 28 | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A8C7 | 0160-5495 | 3 | | CAPACITOR-FXD 3.9PF +-.5PF 200VDC CER | | |
| A8C8 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A8C9 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A8C10 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A8C11 | 0160-3878 | 6 | 3 | CAPACITOR-FXD 1000PF +-20% 100VDC CER | 28480 | 0160-3878 |
| A8C12 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A8C13 | 0160-4385 | 2 | | CAPACITOR-FXD 15PF +-5% 200VDC CER 0+-30 | 51642 | 200-200-NPO-150J |
| A8C14 | 0160-5495 | 3 | | CAPACITOR-FXD 3.9PF +-.5PF 200VDC CER | | |
| A8C15 | 0160-5495 | 3 | | CAPACITOR-FXD 3.9PF +-.5PF 200VDC CER | | |
| A8C16 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A8C17 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A8C18 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A8C19 | 0160-4385 | 2 | | CAPACITOR-FXD 15PF +-5% 200VDC CER 0+-30 | 51642 | 200-200-NPO-150J |
| A8C20 | 0160-5495 | 3 | | CAPACITOR-FXD 3.9PF +-.5PF 200VDC CER | | |
| A8C21 | 0160-5495 | 3 | | CAPACITOR-FXD 3.9PF +-.5PF 200VDC CER | | |
| A8C22 | 0160-5495 | 3 | | CAPACITOR-FXD 3.9PF +-.5PF 200VDC CER | | |
| A8C23 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A8C24 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A8C25 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A8C26 | 0160-4835 | 7 | 9 | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A8C27 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A8C28 | 0121-0453 | 5 | | CAPACITOR-V TRMR-AIR 1.3-5.4PF 175V | 74970 | 187-0303-125 |
| A8C29 * | 0160-5617 | 7 | 1 | CAPACITOR-FXD 3PF +-.25PF 500VDC CER | 28480 | 0160-2243 |
| A8C30 | 0160-5619 | 7 | 1 | CAPACITOR-FXD 8PF +-.25PF 500VDC CER | | |
| A8C31 | 0160-5618 | 1 | 1 | CAPACITOR-FXD 5PF +-.25PF 500VDC CER | | |
| A8C32 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A8C33 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A8C34 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A8C35 | 0180-1083 | 3 | 3 | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A8C36 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A8C37 | 0180-0229 | 7 | 3 | CAPACITOR-FXD 33UF+-10% 10VDC TA | 56289 | 150D336X9010B2 |
| A8C38 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A8C39 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A8C40 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A8C41 | 0180-0229 | 7 | | CAPACITOR-FXD 33UF+-10% 10VDC TA | 56289 | 150D336X9010B2 |
| A8C42 | 0180-2979 | 8 | 1 | CAPACITOR-FXD 220UF+-20% 16VDC AL | 28480 | 0180-2979 |
| A8C43 | 0180-1746 | 5 | 1 | CAPACITOR-FXD 15UF+-10% 20VDC TA | 56289 | 150D156X9020B2 |
| A8C44 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A8C45 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A8C46 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A8C47 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A8C48 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A8C49 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A8C50 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A8C51 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A8C52 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A8C53 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28490 | 0180-1083 |
| A8C54 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A8C55 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A8C56 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A8C57 | 0160-3878 | 6 | | CAPACITOR-FXD 1000PF +-20% 100VDC CER | 28480 | 0160-3878 |
| A8C58 | 0160-3878 | 6 | | CAPACITOR-FXD 1000PF +-20% 100VDC CER | 28480 | 0160-3878 |
| A8C59 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A8C60 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A8C61 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A8C62 | 0180-0229 | 7 | | CAPACITOR-FXD 33UF+-10% 10VDC TA | 56289 | 150D336X9010B2 |
| A8C63 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A8C64 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A8C65 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A8CR1 | 1902-3171 | 7 | 1 | DIODE-ZNR 11V 5% DO-35 PD=.4W TC=+.062% | 28480 | 1902-3171 |
| A8L1 | 9100-2247 | 4 | 2 | INDUCTOR RF-CH-MLD 100NH 10% .105DX.26LG | 28480 | 9100-2247 |
| A8L2 | 9100-2250 | 9 | 1 | INDUCTOR RF-CH-MLD 180NH 10% .105DX.26LG | 28480 | 9100-2250 |
| A8L3 | 9100-2891 | 4 | 3 | INDUCTOR RF-CH-MLD 50NH 10% .105DX.26LG | 28480 | 9100-2891 |
| A8L4 | 9100-2891 | 4 | | INDUCTOR RF-CH-MLD 50NH 10% .105DX.26LG | 28480 | 9100-2891 |
| A8L5 | 9100-2251 | 0 | 1 | INDUCTOR RF-CH-MLD 220NH 10% .105DX.26LG | 28480 | 9100-2251 |

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

## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| A8L6 | 9100-2248 | 5 | 4 | INDUCTOR RF-CH-MLD 120NH 10% .105DX.26LG | 28480 | 9100-2248 |
| A8L7 | 9100-2249 | 6 | 4 | INDUCTOR RF-CH-MLD 150NH 10% .105DX.26LG | 28480 | 9100-2249 |
| A8L8 | 9100-2248 | 5 | | INDUCTOR RF-CH-MLD 120NH 10% .105DX.26LG | 28480 | 9100-2248 |
| A8L9 | 9100-2249 | 6 | | INDUCTOR RF-CH-MLD 150NH 10% .105DX.26LG | 28480 | 9100-2249 |
| A8L10 | 9100-2248 | 5 | | INDUCTOR RF-CH-MLD 120NH 10% .105DX.26LG | 28480 | 9100-2248 |
| A8L11 | 9100-2249 | 6 | | INDUCTOR RF-CH-MLD 150NH 10% .105DX.26LG | 28480 | 9100-2249 |
| A8L12 | 9100-2248 | 5 | | INDUCTOR RF-CH-MLD 120NH 10% .105DX.26LG | 28480 | 9100-2248 |
| A8L13 | 9100-2249 | 6 | | INDUCTOR RF-CH-MLD 150NH 10% .105DX.26LG | 28480 | 9100-2249 |
| A8L14 | 9100-2891 | 4 | | INDUCTOR RF-CH-MLD 50NH 10% .105DX.26LG | 28480 | 9100-2891 |
| A8L15 | 9140-0158 | 6 | 5 | INDUCTOR RF-CH-MLD 1UH 10% .105DX.26LG | 28480 | 9140-0158 |
| A8L16 | 9100-2247 | 4 | | INDUCTOR RF-CH-MLD 100NH 10% .105DX.26LG | 28480 | 9100-2247 |
| A8L17 | 9140-0158 | 6 | | INDUCTOR RF-CH-MLD 1UH 10% .105DX.26LG | 28480 | 9140-0158 |
| A8L18 | 9140-0158 | 6 | | INDUCTOR RF-CH-MLD 1UH 10% .105DX.26LG | 28480 | 9140-0158 |
| A8L19 | 9140-0114 | 4 | 3 | INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG | 28480 | 9140-0114 |
| A8L20 | 9140-0114 | 4 | | INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG | 28480 | 9140-0114 |
| A8L21 | 9140-0158 | 6 | | INDUCTOR RF-CH-MLD 1UH 10% .105DX.26LG | 28480 | 9140-0158 |
| A8L22 | 9140-0158 | 6 | | INDUCTOR RF-CH-MLD 1UH 10% .105DX.26LG | 28480 | 9140-0158 |
| A8L23 | 9140-0114 | 4 | | INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG | 28480 | 9140-0114 |
| A8Q1 | 1854-0345 | 8 | 7 | TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW | 04713 | 2N5179 |
| A8Q2 | 1854-0345 | 8 | | TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW | 04713 | 2N5179 |
| A8Q3 | 1854-0345 | 8 | | TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW | 04713 | 2N5179 |
| A8Q4 | 1854-0345 | 8 | | TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW | 04713 | 2N5179 |
| A8Q5 | 1854-0345 | 8 | | TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW | 04713 | 2N5179 |
| A8Q6 | 1854-0810 | 2 | 1 | TRANSISTOR NPN SI PD=625MW FT=200MHZ | 28480 | 1854-0810 |
| A8Q7 | 1854-0345 | 8 | | TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW | 04713 | 2N5179 |
| A8Q8 | 1854-0345 | 8 | | TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW | 04713 | 2N5179 |
| A8R1 | 2100-3349 | 2 | 1 | RESISTOR-TRMR 100 10% C SIDE-ADJ 1-TRN | 28480 | 2100-3349 |
| A8R2 | 0757-0316 | 6 | 1 | RESISTOR 42.2 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4222-F |
| A8R3 | 0757-0439 | 4 | 3 | RESISTOR 6.81K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-6811-F |
| A8R4 | 0698-3155 | 1 | 2 | RESISTOR 4.64K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4641-F |
| A8R5 | 0683-3305 | 2 | 1 | RESISTOR 33 5% .25W FC TC=-400/+500 | 01121 | CB3305 |
| A8R6 | 0757-0439 | 4 | | RESISTOR 6.81K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-6811-F |
| A8R7 | 0698-3155 | 1 | | RESISTOR 4.64K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4641-F |
| A8R8 | 0698-3132 | 4 | 1 | RESISTOR 261 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-2610-F |
| A8R9 | 0757-0397 | 3 | 1 | RESISTOR 68.1 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-68R1-F |
| A8R10 | 0683-4705 | 8 | 3 | RESISTOR 47 5% .25W FC TC=-400/+500 | 01121 | CB4705 |
| A8R11 | 0683-6805 | 3 | 2 | RESISTOR 68 5% .25W FC TC=-400/+500 | 01121 | CB6805 |
| A8R12 | 0757-0419 | 1 | 1 | RESISTOR 681 1% .125W F TC=0+-100 | 28480 | 0757-0419 |
| A8R13 | 0698-3153 | 9 | 2 | RESISTOR 3.83K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-3831-F |
| A8R14 | 0698-0085 | 0 | 1 | RESISTOR 2.61K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-2611-F |
| A8R15 | 0683-3315 | 4 | 4 | RESISTOR 330 5% .25W FC TC=-400/+600 | 01121 | CB3315 |
| A8R16 | 0683-3315 | 4 | | RESISTOR 330 5% .25W FC TC=-400/+600 | 01121 | CB3315 |
| A8R17 | 0757-0412 | 3 | 1 | RESISTOR 365 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-365R-F |
| A8R18 | 0683-5615 | 1 | 5 | RESISTOR 560 5% .25W FC TC=-400/+600 | 01121 | CB5615 |
| A8R19 | 0757-0280 | 3 | 1 | RESISTOR 1K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1001-F |
| A8R20 | 0698-3153 | 9 | | RESISTOR 3.83K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-3831-F |
| A8R21 | 0757-0439 | 4 | | RESISTOR 6.81K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-6811-F |
| A8R22 | 0698-3435 | 9 | 1 | RESISTOR 38.3 5% .25W FC TC=-400/+500 | 01121 | |
| A8R23 | 0683-5615 | 1 | | RESISTOR 560 5% .25W FC TC=-400/+600 | 01121 | CB5615 |
| A8R24 | 0683-1025 | 9 | 1 | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| A8R25 | 0683-5615 | 1 | | RESISTOR 560 5% .25W FC TC=-400/+600 | 01121 | CB5615 |
| A8R26 | 0757-0277 | 8 | 1 | RESISTOR 49.9 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4992-F |
| A8R27 | 0683-5615 | 1 | | RESISTOR 560 5% .25W FC TC=-400/+600 | 01121 | CB5615 |
| A8R28 | 0683-3915 | 0 | 1 | RESISTOR 390 5% .25W FC TC=-400/+600 | 01121 | CB3915 |
| A8R29 | 0683-3315 | 4 | | RESISTOR 330 5% .25W FC TC=-400/+600 | 01121 | CB3315 |
| A8R30 | 0683-4705 | 8 | | RESISTOR 47 5% .25W FC TC=-400/+500 | 01121 | CB4705 |
| A8R31 | 0698-3447 | 4 | 1 | RESISTOR 422 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-422R-F |
| A8R32 | 0757-0398 | 4 | 1 | RESISTOR 75 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-75R0-F |
| A8R33 | 0698-3432 | 7 | 1 | RESISTOR 26.1 1% .125W F TC=0+-100 | 03888 | PME55-1/8-T0-26R1-F |
| | | 4 | | | | |
| A8R34 | 0698-3434 | 9 | 1 | RESISTOR 34.8 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-34R8-F |
| A8R35 | 0683-4705 | 8 | | RESISTOR 47 5% .25W FC TC=-400/+500 | 01121 | CB4705 |
| A8R36 | 0698-0082 | 7 | 1 | RESISTOR 464 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4640-F |
| A8R37 | 0757-0200 | 7 | 1 | RESISTOR 5.62K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-5621-F |
| A8R38 | 0757-0428 | 1 | 1 | RESISTOR 1.62K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1621-F |
| A8R39 | 0698-0084 | 9 | 1 | RESISTOR 2.15K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-2151-F |
| A8R40 | 0698-3152 | 8 | 1 | RESISTOR 3.48K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-3481-F |
| A8R41 | 0683-3315 | 4 | | RESISTOR 330 5% .25W FC TC=-400/+600 | 01121 | CB3315 |
| A8R42 | 0698-3446 | 3 | 1 | RESISTOR 383 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-383R-F |
| A8R43 | 0683-6805 | 3 | | RESISTOR 68 5% .25W FC TC=-400/+500 | 01121 | CB6805 |
| A8R44 | 0683-2715 | 6 | 1 | RESISTOR 270 5% .25W FC TC=-400/+600 | 01121 | CB2715 |
| A8R45 | 0683-4715 | 0 | 1 | RESISTOR 470 5% .25W FC TC=-400/+600 | 01121 | CB4715 |
| A8R46 | 0683-5615 | 1 | | RESISTOR 560 5% .25W FC TC=-400/+600 | 01121 | CB5615 |
| A8T1 | 9140-0641 | 8 | 1 | RF TRANSFORMER | 28480 | 9140-0641 |

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

## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| A8U1 | 1820-1888 | 5 | 1 | IC PRESCR ECL | 04713 | MC12013L |
| A8U2 | 1820-0809 | 8 | 2 | IC RCVR ECL LINE RCVR QUAD 2-INP | 04713 | MC10115P |
| A8U3 | 1820-0809 | 8 |  | IC RCVR ECL LINE RCVR QUAD 2-INP | 04713 | MC10115P |
| A8Y1 | 0410-1338 | 4 | 1 | CRYSTAL-QUARTZ 100MHZ | 28480 | 0410-1338 |
|  | 5001-0173 | 7 | 2 | STRAP-GROUND | 28480 | 5001-0173 |
|  | 04193-00604 | 6 | 2 | SHIELD BOX | 28480 | 04193-00604 |
|  | 04193-00606 | 8 | 1 | SHIELD BOX | 28480 | 04193-00606 |
|  | 04193-00607 | 9 | 3 | SHIELD BOX | 28480 | 04193-00607 |
|  | 04193-60008 | 0 | 1 | COVER | 28480 | 04193-60008 |
|  | 9170-0029 | 3 | 2 | CORE-SHIELDING BEAD | 28480 | 9170-0029 |
|  | 04193-26508 | 0 | 1 | PCBD BLANK | 28480 | 04193-26508 |

See introduction to this section for ordering information
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## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| **A9** | | | | | | |
| A9 | 04193-66509 | 8 | 1 | MIXER BOARD ASSEMBLY | 28480 | 04193-66509 |
| A9C1 | 0160-2437 | 1 | 2 | CAPACITOR-FDTHRU 5000PF +80 -20% 200V | 28480 | 0160-2437 |
| A9C2 | 0160-2437 | 1 | | CAPACITOR-FDTHRU 5000PF +80 -20% 200V | 28480 | 0160-2437 |
| A9C3 | 0160-3875 | 3 | 3 | CAPACITOR-FXD 22PF +-5% 200VDC CER 0+-30 | 28480 | 0160-3875 |
| A9C4 | 0160-3875 | 3 | | CAPACITOR-FXD 22PF +-5% 200VDC CER 0+-30 | 28480 | 0160-3875 |
| A9C5 | 0160-3875 | 3 | | CAPACITOR-FXD 22PF +-5% 200VDC CER 0+-30 | 28480 | 0160-3875 |
| A9C6 | 0160-0263 | 7 | 5 | CAPACITOR-FXD .22UF +-20% 50VDC CER | 28480 | 0160-0263 |
| A9C7 | 0160-3879 | 7 | 8 | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A9C8 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A9C9 | 0160-4835 | 7 | 15 | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A9C10 | 0160-0263 | 7 | | CAPACITOR-FXD .22UF +-20% 50VDC CER | 28480 | 0160-0263 |
| A9C11 | 0160-2246 | 0 | 1 | CAPACITOR-FXD 3.6PF +-.25PF 500VDC CER | 28480 | 0160-2246 |
| A9C12 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A9C13 | 0160-2265 | 3 | 1 | CAPACITOR-FXD 22PF +-5% 500VDC CER 0+-30 | 28480 | 0160-2265 |
| A9C14 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A9C15 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A9C16 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A9C17 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A9C18 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A9C19 | 0160-2250 | 6 | 2 | CAPACITOR-FXD 5.1PF +-.25PF 500VDC CER | 28480 | 0160-2250 |
| A9C20 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A9C21 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A9C22 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A9C23 | 0160-4386 | 5 | 1 | CAPACITOR-FXD 33PF +-5% 300VDC MICA | 28480 | 0160-4386 |
| A9C24 | 0160-4832 | 4 | 2 | CAPACITOR-FXD .01UF +-10% 100VDC CER | 28480 | 0160-4832 |
| A9C25 | 0160-3877 | 5 | 2 | CAPACITOR-FXD 100PF +-20% 200VDC CER | 28480 | 0160-3877 |
| A9C26 | 0160-0263 | 7 | | CAPACITOR-FXD .22UF +-20% 50VDC CER | 28480 | 0160-0263 |
| A9C27 | 0180-0229 | 7 | 3 | CAPACITOR-FXD 33UF+-10% 10VDC TA | 56289 | 150D336X9010B2 |
| A9C28 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A9C29 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A9C30 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A9C31 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A9C32 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A9C33 | 0160-2250 | 6 | | CAPACITOR-FXD 5.1PF +-.25PF 500VDC CER | 28480 | 0160-2250 |
| A9C34 | 0160-2264 | 2 | 2 | CAPACITOR-FXD 20PF +-5% 500VDC CER 0+-30 | 28480 | 0160-2264 |
| A9C35 | 0160-3335 | 0 | 1 | CAPACITOR-FXD 470PF +-10% 100VDC CER | 28480 | 0160-3335 |
| A9C36 | 0160-0263 | 7 | | CAPACITOR-FXD .22UF +-20% 50VDC CER | 28480 | 0160-0263 |
| A9C37 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A9C38 | 0160-3877 | 5 | | CAPACITOR-FXD 100PF +-20% 200VDC CER | 28480 | 0160-3877 |
| A9C39 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A9C40 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC | 28480 | 0160-4835 |
| A9C41 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A9C42 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A9C43 | 0160-0263 | 7 | | CAPACITOR-FXD .22UF +-20% 50VDC CER | 28480 | 0160-0263 |
| A9C44 | 0160-2264 | 2 | | CAPACITOR-FXD 20PF +-5% 500VDC CER 0+-30 | 28480 | 0160-2264 |
| A9C45 | 0160-4832 | 4 | | CAPACITOR-FXD .01UF +-10% 100VDC CER | 28480 | 0160-4832 |
| A9C46 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A9C47 | 0180-0229 | 7 | | CAPACITOR-FXD 33UF+-10% 10VDC TA | 56289 | 150D336X9010B2 |
| A9C48 | 0180-0229 | 7 | | CAPACITOR-FXD 33UF+-10% 10VDC TA | 56289 | 150D336X9010B2 |
| A9C49 | 0180-1746 | 5 | 4 | CAPACITOR-FXD 15UF+-10% 20VDC TA | 56289 | 150D156X9020B2 |
| A9C50 | 0180-1746 | 5 | | CAPACITOR-FXD 15UF+-10% 20VDC TA | 56289 | 150D156X9020B2 |
| A9C51 | 0180-1746 | 5 | | CAPACITOR-FXD 15UF+-10% 20VDC TA | 56289 | 150D156X9020B2 |
| A9C52 | 0180-1746 | 5 | | CAPACITOR-FXD 15UF+-10% 20VDC TA | 56289 | 150D156X9020B2 |
| A9CR1 | 1901-0050 | 1 | 2 | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| A9CR2 | 1901-0050 | 1 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| A9E1 | 1906-0235 | 6 | 1 | DIODE-DOUBLE BALANCED MIXER | 28480 | 1906-0235 |
| A9L1 | 9100-2247 | 4 | 5 | INDUCTOR RF-CH-MLD 100NH 10% .105DX.26LG | 28480 | 9100-2247 |
| A9L2 | 9100-2249 | 6 | 2 | INDUCTOR RF-CH-MLD 150NH 10% .105DX.26LG | 28480 | 9100-2249 |
| A9L3 | 9100-2249 | 6 | | INDUCTOR RF-CH-MLD 150NH 10% .105DX.26LG | 28480 | 9100-2249 |
| A9L4 | 9100-2247 | 4 | | INDUCTOR RF-CH-MLD 100NH 10% .105DX.26LG | 28480 | 9100-2247 |
| A9L5 | 9140-0158 | 6 | 3 | INDUCTOR RF-CH-MLD 1UH 10% .105DX.26LG | 28480 | 9140-0158 |
| A9L6 | 9140-0158 | 6 | | INDUCTOR RF-CH-MLD 1UH 10% .105DX.26LG | 28480 | 9140-0158 |
| A9L7 | 9100-2247 | 4 | | INDUCTOR RF-CH-MLD 100NH 10% .105DX.26LG | 28480 | 9100-2247 |
| A9L8 | 9140-0114 | 4 | 4 | INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG | 28480 | 9140-0114 |
| A9L9 | 9100-2247 | 4 | | INDUCTOR RF-CH-MLD 100NH 10% .105DX.26LG | 28480 | 9100-2247 |
| A9L10 | 9100-2247 | 4 | | INDUCTOR RF-CH-MLD 100NH 10% .105DX.26LG | 28480 | 9100-2247 |
| A9L11 | 9140-0114 | 4 | | INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG | 28480 | 9140-0114 |
| A9L12 | 9140-0158 | 6 | | INDUCTOR RF-CH-MLD 1UH 10% .105DX.26LG | 28480 | 9140-0158 |
| A9L13 | 9140-0114 | 4 | | INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG | 28480 | 9140-0114 |
| A9L14 | 9140-0114 | 4 | | INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG | 28480 | 9140-0114 |

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

## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| A9Q1 | 1854-0247 | 9 | 1 | TRANSISTOR NPN SI TO-39 PD=1W FT=800MHZ | 28480 | 1854-0247 |
| A9Q2 | 1853-0018 | 0 | 4 | TRANSISTOR PNP SI TO-72 PD=200MW FT=1GHZ | 28480 | 1853-0018 |
| A9Q3 | 1854-0345 | 8 | 3 | TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW | 04713 | 2N5179 |
| A9Q4 | 1853-0018 | 0 | | TRANSISTOR PNP SI TO-72 PD=200MW FT=1GHZ | 28480 | 1853-0018 |
| A9Q5 | 1854-0345 | 8 | | TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW | 04713 | 2N5179 |
| A9Q6 | 1853-0018 | 0 | | TRANSISTOR PNP SI TO-72 PD=200MW FT=1GHZ | 28480 | 1853-0018 |
| A9Q7 | 1854-0345 | 8 | | TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW | 04713 | 2N5179 |
| A9Q8 | 1853-0018 | 0 | | TRANSISTOR PNP SI TO-72 PD=200MW FT=1GHZ | 28480 | 1853-0018 |
| A9R1 | 0757-0277 | 8 | 5 | RESISTOR 49.9 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4992-F |
| A9R2 | 0757-0398 | 4 | 1 | RESISTOR 75 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-75R0-F |
| A9R3 | 0757-0277 | 8 | | RESISTOR 49.9 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4992-F |
| A9R4 | 0757-0180 | 2 | 2 | RESISTOR 31.6 1% .125W F TC=0+-100 | 28480 | 0757-0180 |
| A9R5 | 0757-0180 | 2 | | RESISTOR 31.6 1% .125W F TC=0+-100 | 28480 | 0757-0180 |
| A9R6 | 0757-0401 | 0 | 8 | RESISTOR 100 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-101-F |
| A9R7 | 0757-0274 | 5 | 4 | RESISTOR 1.21K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1211-F |
| A9R8 | 0698-3153 | 9 | 4 | RESISTOR 3.83K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-3831-F |
| A9R9 | 0757-0401 | 0 | | RESISTOR 100 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-101-F |
| A9R10 | 0698-3446 | 3 | 3 | RESISTOR 383 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-383R-F |
| A9R11 | 0757-0405 | 4 | 3 | RESISTOR 162 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-162R-F |
| A9R12 | 0698-3440 | 7 | 5 | RESISTOR 196 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-196R-F |
| A9R13 | 0698-3439 | 4 | 2 | RESISTOR 178 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-178R-F |
| A9R14 | 0757-0274 | 5 | | RESISTOR 1.21K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1211-F |
| A9R15 | 0698-3153 | 9 | | RESISTOR 3.83K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-3831-F |
| A9R16 | 0757-0316 | 6 | 3 | RESISTOR 42.2 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-42R2-F |
| A9R17 | 0698-3446 | 3 | | RESISTOR 383 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-383R-F |
| A9R18 | 0757-0401 | 0 | | RESISTOR 100 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-101-F |
| A9R19 | 0757-0417 | 8 | 3 | RESISTOR 562 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-562R-F |
| A9R20 | 0757-0401 | 0 | | RESISTOR 100 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-101-F |
| A9R21 | 0683-3315 | 4 | 2 | RESISTOR 330 5% .25W FC TC=-400/+600 | 01121 | CB3315 |
| A9R22 | 0683-2215 | 1 | 2 | RESISTOR 220 5% .25W FC TC=-400/+600 | 01121 | CB2215 |
| A9R23 | 1810-0203 | 5 | 2 | NETWORK-RES 8-SIP470.0 OHM X 7 | 01121 | 208A471 |
| A9R24 | 0698-3440 | 7 | | RESISTOR 196 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-196R-F |
| A9R25 | 0757-0401 | 0 | | RESISTOR 100 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-101-F |
| A9R26 | 0757-0277 | 8 | | RESISTOR 49.9 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4992-F |
| A9R27 | 0698-3153 | 9 | | RESISTOR 3.83K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-3831-F |
| A9R28 | 0757-0274 | 5 | | RESISTOR 1.21K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1211-F |
| A9R29 | 0757-0316 | 6 | | RESISTOR 42.2 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-42R2-F |
| A9R30 | 0698-3440 | 7 | | RESISTOR 196 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-196R-F |
| A9R31 | 0757-0405 | 4 | | RESISTOR 162 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-162R-F |
| A9R32 | 0698-3446 | 3 | | RESISTOR 383 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-383R-F |
| A9R33 | 0698-3439 | 4 | | RESISTOR 178 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-178R-F |
| A9R34 | 0757-0417 | 8 | | RESISTOR 562 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-562R-F |
| A9R35 | 0757-0401 | 0 | | RESISTOR 100 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-101-F |
| A9R36 | 0683-4715 | 0 | 1 | RESISTOR 470 5% .25W FC TC=-400/+600 | 01121 | CB4715 |
| A9R37 | 0683-3315 | 4 | | RESISTOR 330 5% .25W FC TC=-400/+600 | 01121 | CB3315 |
| A9R38 | 0683-2215 | 1 | | RESISTOR 220 5% .25W FC TC=-400/+600 | 01121 | CB2215 |
| A9R39 | 1810-0203 | 5 | | NETWORK-RES 8-SIP470.0 OHM X 7 | 01121 | 208A471 |
| A9R40 | 0757-0401 | 0 | | RESISTOR 100 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-101-F |
| A9R41 | 0698-3440 | 7 | | RESISTOR 176 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-196R-F |
| A9R42 | 0757-0277 | 8 | | RESISTOR 49.9 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4992-F |
| A9R43 | 0698-3440 | 7 | | RESISTOR 196 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-196R-F |
| A9R44 | 0698-3447 | 4 | 1 | RESISTOR 422 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-422R-F |
| A9R45 | 0698-3153 | 9 | | RESISTOR 3.83K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-3831-F |
| A9R46 | 0757-0274 | 5 | | RESISTOR 1.21K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1211-F |
| A9R47 | 0757-0316 | 6 | | RESISTOR 42.2 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-42R2-F |
| A9R48 | 0757-0405 | 4 | | RESISTOR 162 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-162R-F |
| A9R49 | 0757-0277 | 8 | | RESISTOR 49.9 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4992-F |
| A9R50 | 0757-0346 | 2 | 1 | RESISTOR 10 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-10R0-F |
| A9R51 | 0757-0401 | 0 | | RESISTOR 100 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-101-F |
| A9R52 | 0757-0417 | 8 | | RESISTOR 562 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-562R-F |
| A9U1 | 1820-0810 | 1 | 2 | IC RCVR ECL LINE RCVR TPL 2-INP | 04713 | MC10116P |
| A9U2 | 1820-1888 | 5 | 1 | IC PRESCR ECL | 04713 | MC12013L |
| A9U3 | 1820-0810 | 1 | | IC RCVR ECL LINE RCVR TPL 2-INP | 04713 | MC10116P |
| | 5001-0176 | 7 | 2 | STRAP-GROUND | 28480 | 5001-0173 |
| | 04191-00614 | 6 | 1 | SHIELD | 28480 | 04191-00614 |
| | 04193-00604 | 6 | 2 | SHIELD BOX | 28480 | 04193-00604 |
| | 04193-00607 | 9 | 1 | SHIELD BOX | 28480 | 04193-00607 |
| | 04193-00608 | 0 | 2 | SHIELD BOX | 28480 | 04193-00608 |
| | 04193-60009 | 1 | 1 | COVER | 28480 | 04193-60009 |
| | 04193-26509 | 0 | 1 | PCBD BLANK | 28480 | 04193-26509 |

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

## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| **A10** | | | | | | |
| A10 | 04193-66510 | 1 | 1 | VOLTAGE CONTROLLED OSCILLATOR BD. ASSY | 28480 | 04193-66510 |
| A10C1 | 0160-2437 | 1 | 3 | CAPACITOR-FDTHRU 5000PF +80 -20% 200V | 28480 | 0160-2437 |
| A10C2 | 0160-2437 | 1 | | CAPACITOR-FDTHRU 5000PF +80 -20% 200V | 28480 | 0160-2437 |
| A10C3 | 0160-2437 | 1 | | CAPACITOR-FDTHRU 5000PF +80 -20% 200V | 28480 | 0160-2437 |
| A10C4 | 0160-3879 | 7 | 47 | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C5 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C6 | 0160-3878 | 6 | 12 | CAPACITOR-FXD 1000PF +-20% 100VDC CER | 28480 | 0160-3878 |
| A10C7 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C8 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C9 | 0160-3878 | 6 | | CAPACITOR-FXD 1000PF +-20% 100VDC CER | 28480 | 0160-3878 |
| A10C10 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C11 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C12 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C13 | 0160-3878 | 6 | | CAPACITOR-FXD 1000PF +-20% 100VDC CER | 28480 | 0160-3878 |
| A10C14 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C15 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C16 | 0160-3878 | 6 | | CAPACITOR-FXD 1000PF +-20% 100VDC CER | 28480 | 0160-3878 |
| A10C17 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C18 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C19 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C20 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C21 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C22 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C23 | 0160-3877 | 5 | 5 | CAPACITOR-FXD 100PF +-20% 200VDC CER | 28480 | 0160-3877 |
| A10C24 | 0160-3878 | 6 | | CAPACITOR-FXD 1000PF +-20% 100VDC CER | 28480 | 0160-3878 |
| A10C25 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C26 | 0160-3878 | 6 | | CAPACITOR-FXD 1000PF +-20% 100VDC CER | 28480 | 0160-3878 |
| A10C27 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C28 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C29 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C30 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C31 | 0160-5495 | | 2 | CAPACITOR-FXD 3.9PF +-.5PF 200VDC CER | | |
| A10C32 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C33 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C34 | 0160-3878 | 6 | | CAPACITOR-FXD 1000PF +-20% 100VDC CER | 28480 | 0160-3878 |
| A10C35 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C36 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C37 | 0160-3878 | 6 | | CAPACITOR-FXD 1000PF +-20% 100VDC CER | 28480 | 0160-3878 |
| A10C38 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C39 | 0180-1083 | 3 | 1 | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A10C40 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C41 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C42 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C43 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C44 | 0160-5495 | | | CAPACITOR-FXD 3.9PF +-.5PF 200VDC CER | | |
| A10C45 | 0160-3877 | 5 | | CAPACITOR-FXD 100PF +-20% 200VDC CER | 28480 | 0160-3877 |
| A10C46 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C47 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C48 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C49 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C50 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C51 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C52 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C53 | 0180-2979 | 8 | 2 | CAPACITOR-FXD 220UF+-20% 16VDC AL | 28480 | 0180-2979 |
| A10C54 | 0180-2979 | 8 | | CAPACITOR-FXD 220UF+-20% 16VDC AL | 28480 | 0180-2979 |
| A10C55 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C56 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C57 | 0160-3877 | 5 | | CAPACITOR-FXD 100PF +-20% 200VDC CER | 28480 | 0160-3877 |
| A10C58 | 0160-3877 | 5 | | CAPACITOR-FXD 100PF +-20% 200VDC CER | 28480 | 0160-3877 |
| A10C59 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C60 | 0160-3878 | 6 | | CAPACITOR-FXD 1000PF +-20% 100VDC CER | 28480 | 0160-3878 |
| A10C61 | 0160-3878 | 6 | | CAPACITOR-FXD 1000PF +-20% 100VDC CER | 28480 | 0160-3878 |
| A10C62 | 0160-3878 | 6 | | CAPACITOR-FXD 1000PF +-20% 100VDC CER | 28480 | 0160-3878 |
| A10C63 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C64 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C65 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C66 | 0160-2055 | 9 | 4 | CAPACITOR-FXD .01UF +80-20% 100VDC CER | 28480 | 0160-2055 |
| A10C67 | 0160-2055 | 9 | | CAPACITOR-FXD .01UF +80-20% 100VDC CER | 28480 | 0160-2055 |
| A10C68 | 0160-2055 | 9 | | CAPACITOR-FXD .01UF +80-20% 100VDC CER | 28480 | 0160-2055 |
| A10C69 * | 0160-3873 | 1 | 1 | CAPACITOR-FXD 4.7PF +-.5PF 200VDC CER | 28480 | 0160-3873 |
| A10C70 | 0160-4385 | 2 | 1 | CAPACITOR-FXD 15PF +-5% 200VDC CER 0+-30 | 51642 | 200-200-NPO-150J |
| A10C71 | 0160-2055 | 9 | | CAPACITOR-FXD .01UF +80-20% 100VDC CER | 28480 | 0160-2055 |
| A10C72 | 0160-0690 | 4 | 1 | CAPACITOR-FXD 1PF +-.5PF 100VDC CER | 28480 | 0160-0690 |
| A10C73 | 0160-3872 | 0 | 1 | CAPACITOR-FXD 2.2PF +-.25PF 200VDC CER | 28480 | 0160-3872 |
| A10C74 | 0160-3878 | 6 | | CAPACITOR-FXD 1000PF +-20% 100VDC CER | 28480 | 0160-3878 |

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

## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| A10C75 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C76 | 0160-3877 | 5 | | CAPACITOR-FXD 100PF +-20% 200VDC CER | 28480 | 0160-3877 |
| A10C77 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C78 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C79 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10C80 | 0160-3879 | 7 | | CAPACITOR-FXD .01UF +-20% 100VDC CER | 28480 | 0160-3879 |
| A10CR1 | 1902-3171 | 7 | 1 | DIODE-ZNR 11V 5% DO-35 PD=.4W TC=+.062% | 28480 | 1902-3171 |
| A10CR2 | 1901-0948 | 8 | 3 | DIODE-1S2222 | 28480 | 1901-0948 |
| A10CR3 | 1901-0948 | 8 | | DIODE-1S2222 | 28480 | 1901-0948 |
| A10CR4 | 1901-0948 | 8 | | DIODE-1S2222 | 28480 | 1901-0948 |
| A10CR5 | 0122-0109 | 0 | 1 | DIODE-VVC | 28480 | 0122-0109 |
| A10CR6 | 1901-0040 | 1 | 1 | DIODE-SWITCHING 30V 50MA 2NS DO 35 | 28480 | 1901-0040 |
| A10Q1 | 1854-0345 | 8 | 5 | TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW | 04713 | 2N5179 |
| A10Q2 | 1854-0345 | 8 | | TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW | 04713 | 2N5179 |
| A10Q3 | 1854-0345 | 8 | | TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW | 04713 | 2N5179 |
| A10Q4 | 1853-0459 | 3 | 1 | TRANSISTOR PNP SI PD=625MW FT=200MHZ | 28480 | 1853-0459 |
| A10Q5 | 1854-0247 | 9 | 1 | TRANSISTOR NPN SI TO-39 PD=1W FT=800MHZ | 28480 | 1854-0247 |
| A10Q6 | 1854-0345 | 8 | | TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW | 04713 | 2N5179 |
| A10Q7 | 1854-0130 | 9 | 1 | TRANSISTOR-NPN 2SC1988 | 28480 | 1854-0130 |
| A10Q8 | 1855-0124 | 3 | 1 | TRANSISTOR-FET 3SK48 | 28480 | 1855-0124 |
| A10Q9 | 1854-0345 | 8 | | TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW | 04713 | 2N5179 |
| A10R1 | 0683-4715 | 0 | 1 | RESISTOR 470 5% .25W FC TC=-400/+600 | 01121 | CB4715 |
| A10R2 | 0683-1025 | 9 | 8 | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| A10R3 | 0757-0346 | 2 | 3 | RESISTOR 10 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-10R0-F |
| A10R4 | 0698-3437 | 2 | 1 | RESISTOR 133 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-133R-F |
| A10R5 | 0683-2215 | 1 | 1 | RESISTOR 220 5% .25W FC TC=-400/+600 | 01121 | CB2215 |
| A10R6 | 0757-0277 | 8 | 4 | RESISTOR 49.9 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4992-F |
| A10R7 | 0683-1025 | 9 | | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| A10R8 | 0757-0346 | 2 | | RESISTOR 10 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-10R0-F |
| A10R9 | 0698-7205 | 0 | 4 | RESISTOR 51.1 1% .05W F TC=0+-100 | 24546 | C3-1/8-T00-51R1-G |
| A10R10 | 0757-0401 | 0 | 4 | RESISTOR 100 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-101-F |
| A10R11 | 0757-0401 | 0 | | RESISTOR 100 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-101-F |
| A10R12 | 0757-0277 | 8 | | RESISTOR 49.9 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4992-F |
| A10R13 | 0683-1025 | 9 | | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| A10R14 | 0757-0346 | 2 | | RESISTOR 10 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-10R0-F |
| A10R15 | 0757-0401 | 0 | | RESISTOR 100 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-101-F |
| A10R16 | 0698-7205 | 0 | | RESISTOR 51.1 1% .05W F TC=0+-100 | 24546 | C3-1/8-T00-51R1-G |
| A10R17 | 0757-0401 | 0 | | RESISTOR 100 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-101-F |
| A10R18 | 0757-0277 | 8 | | RESISTOR 49.9 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4992-F |
| A10R19 | 0683-1025 | 9 | | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| A10R20 | 0683-3915 | 0 | 1 | RESISTOR 390 5% .25W FC TC=-400/+600 | 01121 | CB3915 |
| A10R21 | 0683-3315 | 4 | 1 | RESISTOR 330 5% .25W FC TC=-400/+600 | 01121 | CB3315 |
| A10R22 | 0683-4705 | 8 | 1 | RESISTOR 47 5% .25W FC TC=-400/+500 | 01121 | CB4705 |
| A10R23 | 0757-0403 | 2 | 2 | RESISTOR 121 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-121R-F |
| A10R24 | 0757-0403 | 2 | | RESISTOR 121 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-121R-F |
| A10R25 | 0698-0082 | 7 | 1 | RESISTOR 464 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4640-F |
| A10R26 | 0757-0200 | 7 | 2 | RESISTOR 5.62K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-5621-F |
| A10R27 | 0757-0428 | 1 | 2 | RESISTOR 1.62K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1621-F |
| A10R28 | 0698-7205 | 0 | | RESISTOR 51.1 1% .05W F TC=0+-100 | 24546 | C3-1/8-T00-51R1-G |
| A10R29 | 0757-0416 | 7 | 1 | RESISTOR 511 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-511R-F |
| A10R30 | 0683-1025 | 9 | | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| A10R31 | 0683-1025 | 9 | | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| A10R32 | 0683-1025 | 9 | | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| A10R33 | 0683-1025 | 9 | | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| A10R34 | 0698-7205 | 0 | | RESISTOR 51.1 1% .05W F TC=0+-100 | 24546 | C3-1/8-T00-51R1-G |
| A10R35 | 0757-1094 | 9 | 1 | RESISTOR 1.47K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1471-F |
| A10R36 | 0698-3154 | 0 | 1 | RESISTOR 4.22K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4221-F |
| A10R37 | 0698-0085 | 0 | 1 | RESISTOR 2.61K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-2611-F |
| A10R38 | 0698-3155 | 1 | 1 | RESISTOR 4.64K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4641-F |
| A10R39 | 0757-0280 | 3 | 1 | RESISTOR 1K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1001-F |
| A10R40 | 0683-3305 | 2 | 1 | RESISTOR 33 5% .25W FC TC=-400/+500 | 01121 | CB3305 |
| A10R41 | 0757-0277 | 8 | | RESISTOR 49.9 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4992-F |
| A10R42 | 0757-0417 | 8 | 1 | RESISTOR 562 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-562R-F |
| A10R43 | 0757-0428 | 1 | | RESISTOR 1.62K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1621-F |
| A10R44 | 0757-0200 | 7 | | RESISTOR 5.62K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-5621-F |
| A10U1 | 1820-0693 | 8 | 1 | IC FF TTL S D-TYPE POS-EDGE-TRIG | 01295 | SN74S74N |
| A10U2 | 1820-1868 | 5 | 1 | IC PRESCR ECL | 04713 | MC12013L |
| A10U3 | 1826-0372 | 2 | 3 | IC 5GHZ TRANSISTOR PAIR | 28480 | 1826-0372 |
| A10U4 | 1826-0372 | 2 | | IC 5GHZ TRANSISTOR PAIR | 28480 | 1826-0372 |
| A10U5 | 1826-0372 | 2 | | IC 5GHZ TRANSISTOR PAIR | 28480 | 1826-0372 |
| | 0380-1007 | 5 | 11 | STANDOFF-RIVET ON | 00000 | ORDER BY DESCRIPTION |
| | 5001-0176 | 7 | 2 | STRAP-GROUND | 28480 | 5001-0173 |
| | 04191-00601 | 1 | 1 | SHIELD-BOX | 28480 | 04171-00601 |
| | 04193-00604 | 6 | 3 | SHIELD-BOX | 28480 | 04193-00604 |
| | 04193-00607 | 9 | 2 | SHIELD-BOX | 28480 | 04193-00607 |

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

### Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| | 04193-20006 | 4 | 1 | SHIELD-BOX | 28480 | 04193-20006 |
| | 04193-60010 | 4 | 1 | COVER | 28480 | 04193-60010 |
| | 04193-26510 | 0 | 1 | PCBD BLANK | 28480 | 04193-26510 |

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

## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| **A11** | | | | | | |
| A11 | 04193-66511 | 2 | 1 | INTEGRATOR AMPLIFIER BOARD ASSEM | 28480 | 04193-66511 |
| A11C1 | 0180-1083 | 3 | 6 | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A11C2 | 0160-4832 | 4 | 5 | CAPACITOR-FXD .01UF +-10% 100VDC CER | 28480 | 0160-4832 |
| A11C3 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A11C4 | 0160-4835 | 7 | 9 | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A11C5 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A11C6 | 0180-0228 | 6 | 2 | CAPACITOR-FXD 22UF+-10% 15VDC TA | 56289 | 150D226X9015B2 |
| A11C7 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A11C8 | 0160-4832 | 4 | | CAPACITOR-FXD .01UF +-10% 100VDC CER | 28480 | 0160-4832 |
| A11C9 | 0180-0116 | 1 | 3 | CAPACITOR-FXD 6.8UF+-10% 35VDC TA | 56289 | 150D685X9035B2 |
| A11C10 | 0180-0228 | 6 | | CAPACITOR-FXD 22UF+-10% 15VDC TA | 56289 | 150D226X9015B2 |
| A11C11 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A11C12 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A11C13 | 0180-0116 | 1 | | CAPACITOR-FXD 6.8UF+-10% 35VDC TA | 56289 | 150D685X9035B2 |
| A11C14 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A11C15 | 0180-0116 | 1 | | CAPACITOR-FXD 6.8UF+-10% 35VDC TA | 56289 | 150D685X9035B2 |
| A11C16 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A11C17 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A11C18 | 0160-3501 | 2 | 1 | CAPACITOR-FXD 4UF +-10% 50VDC MET-POLYC | 28480 | 0160-3501 |
| A11C19 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A11C20 | 0160-4832 | 4 | | CAPACITOR-FXD .01UF +-10% 100VDC CER | 28480 | 0160-4832 |
| A11C21 | 0160-4832 | 4 | | CAPACITOR-FXD .01UF +-10% 100VDC CER | 28480 | 0160-4832 |
| A11C22 | 0160-4832 | 4 | | CAPACITOR-FXD .01UF +-10% 100VDC CER | 28480 | 0160-4832 |
| A11C23 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A11C24 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A11C25 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A11C26 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A11CR1 | 1901-0040 | 1 | 6 | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A11CR2 | 1902-3165 | 9 | 1 | DIODE-ZNR 10.5V 5% DO-35 PD=.4W | 28480 | 1902-3165 |
| A11CR3 | 1901-0040 | 1 | | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A11CR4 | 1901-0040 | 1 | | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A11CR5 | 1901-0040 | 1 | | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A11CR6 | 1902-3263 | 8 | 1 | DIODE-ZNR 24.9V 2% DO-35 PD=.4W | 28480 | 1902-3263 |
| A11CR7 | 1901-0040 | 1 | | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A11CR8 | 1901-0040 | 1 | | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A11J1 | 1251-4822 | 6 | 2 | CONNECTOR 3-PIN M POST TYPE | 28480 | 1251-4822 |
| A11J2 | 1251-4822 | 6 | | CONNECTOR 3-PIN M POST TYPE | 28480 | 1251-4822 |
| A11L1 | 9140-0210 | 1 | 2 | INDUCTOR RF-CH-MLD 100UH 5% .166DX.385LG | 28480 | 9140-0210 |
| A11L2 | 9140-0210 | 1 | | INDUCTOR RF-CH-MLD 100UH 5% .166DX.385LG | 28480 | 9140-0210 |
| A11L3 | 9140-0114 | 4 | 1 | INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG | 28480 | 9140-0114 |
| A11Q1 | 1854-0810 | 2 | 5 | TRANSISTOR NPN SI PD=625MW FT=200MHZ | 28480 | 1854-0810 |
| A11Q2 | 1854-0810 | 2 | | TRANSISTOR NPN SI PD=625MW FT=200MHZ | 28480 | 1854-0810 |
| A11Q3 | 1855-0111 | 8 | 2 | TRANSISTOR-FET 2SK43SD | 28480 | 1855-0111 |
| A11Q4 | 1855-0111 | 8 | | TRANSISTOR-FET 2SK43SD | 28480 | 1855-0111 |
| A11Q5 | 1853-0459 | 3 | 5 | TRANSISTOR PNP SI PD=625MW FT=200MHZ | 28480 | 1853-0459 |
| A11Q6 | 1853-0459 | 3 | | TRANSISTOR PNP SI PD=625MW FT=200MHZ | 28480 | 1853-0459 |
| A11Q7 | 1853-0459 | 3 | | TRANSISTOR PNP SI PD=625MW FT=200MHZ | 28480 | 1853-0459 |
| A11Q8 | 1853-0459 | 3 | | TRANSISTOR PNP SI PD=625MW FT=200MHZ | 28480 | 1853-0459 |
| A11Q9 | 1854-0810 | 2 | | TRANSISTOR NPN SI PD=625MW FT=200MHZ | 28480 | 1854-0810 |
| A11Q10 | 1854-0810 | 2 | | TRANSISTOR NPN SI PD=625MW FT=200MHZ | 28480 | 1854-0810 |
| A11Q11 | 1854-0810 | 2 | | TRANSISTOR NPN SI PD=625MW FT=200MHZ | 28480 | 1854-0810 |
| A11Q12 | 1853-0459 | 3 | | TRANSISTOR PNP SI PD=625MW FT=200MHZ | 28480 | 1853-0459 |
| A11R1 * | 0757-0288 | 1 | 2 | RESISTOR 9.09K 1% .125W F TC=0+-100 | 19701 | MF4C1/8-T0-9091-F |
| A11R2 * | 0757-0288 | 1 | | RESISTOR 9.09K 1% .125W F TC=0+-100 | 19701 | MF4C1/8-T0-9091-F |
| A11R3 | 2100-3273 | 1 | 1 | RESISTOR-TRMR 2K 10% C SIDE-ADJ 1-TRN | 28480 | 2100-3273 |
| A11R4 | 0698-3558 | 8 | 2 | RESISTOR 4.02K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4021-F |
| A11R5 | 0698-3499 | 6 | 2 | RESISTOR 40.2K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4022-F |
| A11R6 | 0683-1025 | 9 | 6 | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| A11R7 | 0683-1025 | 9 | | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| A11R8 | 0683-1015 | 7 | 2 | RESISTOR 100 5% .25W FC TC=-400/+500 | 01121 | CB1015 |
| A11R9 | 0698-3153 | 9 | 3 | RESISTOR 3.83K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-3831-F |
| A11R10 | 0683-3305 | 2 | 3 | RESISTOR 33 5% .25W FC TC=-400/+500 | 01121 | CB3305 |
| A11R11 | 0698-3447 | 4 | 1 | RESISTOR 422 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-422R-F |
| A11R12 | 0683-2225 | 3 | 2 | RESISTOR 2.2K 5% .25W FC TC=-400/+700 | 01121 | CB2225 |
| A11R13 | 0683-2225 | 3 | | RESISTOR 2.2K 5% .25W FC TC=-400/+700 | 01121 | CB2225 |
| A11R14 | 0757-0280 | 3 | 3 | RESISTOR 1K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1001-F |
| A11R15 | 0683-3305 | 2 | | RESISTOR 33 5% .25W FC TC=-400/+500 | 01121 | CB3305 |
| A11R16 | 0698-0083 | 8 | 1 | RESISTOR 1.96K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1961-F |
| A11R17 | 0683-4725 | 2 | 9 | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A11R18 | 0683-4725 | 2 | | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A11R19 | 0683-4725 | 2 | | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A11R20 | 0683-1025 | 9 | | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |

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

## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| A11R21 | 0683-1025 | 9 |  | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| A11R22 | 0683-4705 | 8 | 1 | RESISTOR 47 5% .25W FC TC=-400/+500 | 01121 | CB4705 |
| A11R23 | 0698-3558 | 8 |  | RESISTOR 4.02K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4021-F |
| A11R24 | 0757-0277 | 8 | 1 | RESISTOR 49.9 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4992-F |
| A11R25 | 0683-1055 | 5 | 2 | RESISTOR 1M 5% .25W FC TC=-800/+900 | 01121 | CB1055 |
| A11R26 | 0683-1015 | 7 |  | RESISTOR 100 5% .25W FC TC=-400/+500 | 01121 | CB1015 |
| A11R27 | 0698-3153 | 9 |  | RESISTOR 3.83K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-3831-F |
| A11R28 | 0683-3305 | 2 |  | RESISTOR 33 5% .25W FC TC=-400/+500 | 01121 | CB3305 |
| A11R29 | 0683-4725 | 2 |  | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A11R30 | 0683-4725 | 2 |  | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A11R31 | 0683-4725 | 2 |  | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A11R32 | 0683-1025 | 9 |  | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| A11R33 | 0698-3444 | 1 | 1 | RESISTOR 316 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-316R-F |
| A11R34 | 0757-0280 | 3 |  | RESISTOR 1K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1001-F |
| A11R35 | 0698-3499 | 6 |  | RESISTOR 40.2K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4022-F |
| A11R36 | 0683-1025 | 9 |  | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| A11R37 | 0757-0280 | 3 |  | RESISTOR 1K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1001-F |
| A11R38 | 0683-5625 | 3 | 8 | RESISTOR 5.6K 5% .25W FC TC=-400/+700 | 01121 | CB5625 |
| A11R39 | 0683-5625 | 3 |  | RESISTOR 5.6K 5% .25W FC TC=-400/+700 | 01121 | CB5625 |
| A11R40 | 0683-5625 | 3 |  | RESISTOR 5.6K 5% .25W FC TC=-400/+700 | 01121 | CB5625 |
| A11R41 | 0683-5625 | 3 |  | RESISTOR 5.6K 5% .25W FC TC=-400/+700 | 01121 | CB5625 |
| A11R42 | 0683-5625 | 3 |  | RESISTOR 5.6K 5% .25W FC TC=-400/+700 | 01121 | CB5625 |
| A11R43 | 0683-5625 | 3 |  | RESISTOR 5.6K 5% .25W FC TC=-400/+700 | 01121 | CB5625 |
| A11R44 | 0683-4725 | 2 |  | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A11R45 | 0683-4725 | 2 |  | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A11R46 | 0683-4725 | 2 |  | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A11R47 | 0698-3153 | 9 |  | RESISTOR 3.83K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-3831-F |
| A11R48 | 0757-0274 | 5 | 1 | RESISTOR 1.21K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1211-F |
| A11R49 | 0683-1825 | 7 | 1 | RESISTOR 1.8K 5% .25W FC TC=-400/+700 | 01121 | CB1825 |
| A11R50 | 0683-1035 | 1 | 2 | RESISTOR 10K 5% .25W FC TC=-400/+700 | 01121 | CB1035 |
| A11R51 | 0683-1055 | 5 |  | RESISTOR 1M 5% .25W FC TC=-800/+900 | 01121 | CB1055 |
| A11R52 | 0683-5625 | 3 |  | RESISTOR 5.6K 5% .25W FC TC=-400/+700 | 01121 | CB5625 |
| A11R53 | 0683-1035 | 1 |  | RESISTOR 10K 5% .25W FC TC=-400/+700 | 01121 | CB1035 |
| A11R54 | 0683-5625 | 3 |  | RESISTOR 5.6K 5% .25W FC TC=-400/+700 | 01121 | CB5625 |
| A11R55 | 0683-6805 | 3 | 1 | RESISTOR 68 5% .25W FC TC=-400/+500 | 01121 | CB6805 |
|  |  |  | 1 |  |  |  |
| A11U1 | 1826-0266 | 3 | 1 | IC OP AMP LOW-DRIFT TO-99 PKG | 06665 | OP-05EJ |
| A11U2 | 1820-1958 | 0 | 1 | IC SWITCH ANLG QUAD 14-DIP-P PKG | 01928 | CD4016BC |
| A11U3 | 1826-0138 | 8 | 2 | IC COMPARATOR GP QUAD 14-DIP-P PKG | 01295 | LM339N |
| A11U4 | 1820-1197 | 9 | 2 | IC GATE TTL LS NAND QUAD 2-INP | 01295 | SN74LS00N |
| A11U5 | 1820-1418 | 7 | 1 | IC DCDR TTL LS BCD-TO-DEC 4-TO-10-LINE | 01295 | SN74LS42N |
| A11U6 | 1826-0138 | 8 |  | IC COMPARATOR GP QUAD 14-DIP-P PKG | 01295 | LM339N |
| A11U7 | 1820-1201 | 6 | 1 | IC GATE TTL LS AND QUAD 2-INP | 01295 | SN74LS08N |
| A11U8 | 1820-1197 | 9 |  | IC GATE TTL LS NAND QUAD 2-INP | 01295 | SN74LS00N |
| A11U9 | 1820-0630 | 3 | 1 | IC MISC TTL | 04713 | MC4044P |
| A11U10 | 1820-1144 | 6 | 1 | IC GATE TTL LS NOR QUAD 2-INP | 01295 | SN74LS02N |
| A11U11 | 1820-1208 | 3 | 1 | IC GATE TTL LS OR QUAD 2-INP | 01295 | SN74LS32N |
| A11W1 | 8159-0005 | 8 | 4 | WIRE 22W | 28480 |  |
| A11W2 | 8159-0005 | 8 |  | WIRE 22W | 28480 |  |
| A11W3 | 8159-0005 | 8 |  | WIRE 22W | 28480 |  |
| A11W4 | 8159-0005 | 8 |  | WIRE 22W | 28480 |  |
|  | 1258-0141 |  | 2 | JUMPER-REMOVABLE |  |  |
|  | 0340-0060 | 4 | 4 | TERMINAL-STUD SPCL-FDTHRU PRESS MTG | 98291 | 011-6809 000 209 |
|  | 04193-26511 | 0 | 1 | PCBD BLANK | 28480 | 04193-26511 |

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

## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| **A12** | | | | | | |
| A12 | 04193-66512 | 3 | 1 | IF BPF BOARD ASSEMBLY | 28480 | 04193-66512 |
| A12C1 | 0160-3766 | 1 | 4 | CAPACITOR-FXD 1000PF +-1% 100VDC MICA | 28480 | 0160-3766 |
| A12C2 | 0160-2454 | 2 | 4 | CAPACITOR-FXD 620PF +-1% 300VDC MICA | 28480 | 0160-2454 |
| A12C3 | 0160-3766 | 1 | | CAPACITOR-FXD 1000PF +-1% 100VDC MICA | 28480 | 0160-3766 |
| A12C4 | 0160-2454 | 2 | | CAPACITOR-FXD 620PF +-1% 300VDC MICA | 28480 | 0160-2454 |
| A12C5 | 0160-3766 | 1 | | CAPACITOR-FXD 1000PF +-1% 100VDC MICA | 28480 | 0160-3766 |
| A12C6 | 0160-2454 | 2 | | CAPACITOR-FXD 620PF +-1% 300VDC MICA | 28480 | 0160-2454 |
| A12C7 | 0160-3766 | 1 | | CAPACITOR-FXD 1000PF +-1% 100VDC MICA | 28480 | 0160-3766 |
| A12C8 | 0160-2454 | 2 | | CAPACITOR-FXD 620PF +-1% 300VDC MICA | 28480 | 0160-2454 |
| A12C9 | 0160-4835 | 7 | 14 | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A12C10 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A12C11 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A12C12 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A12C13 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A12C14 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A12C15 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A12C16 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A12C17 | 0180-0291 | 3 | 2 | CAPACITOR-FXD 1UF+-10% 35VDC TA | 56289 | 150D105X9035A2 |
| A12C18 | 0180-0291 | 3 | | CAPACITOR-FXD 1UF+-10% 35VDC TA | 56289 | 150D105X9035A2 |
| A12C19 | 0180-1083 | 3 | 4 | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A12C20 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A12C21 | 0160-4831 | 3 | 4 | CAPACITOR-FXD 4700PF +-10% 100VDC CER | 28480 | 0160-4831 |
| A12C22 | 0160-4831 | 3 | | CAPACITOR-FXD 4700PF +-10% 100VDC CER | 28480 | 0160-4831 |
| A12C23 | 0160-4831 | 3 | | CAPACITOR-FXD 4700PF +-10% 100VDC CER | 28480 | 0160-4831 |
| A12C24 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A12C25 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A12C26 | 0160-4831 | 3 | | CAPACITOR-FXD 4700PF +-10% 100VDC CER | 28480 | 0160-4831 |
| A12C27 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A12C28 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A12C29 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A12C30 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A12C31 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A12C32 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A12C33 | 0180-2951 | 6 | 2 | CAPACITOR-FXD 33UF+-20% 16VDC AL | 28480 | 0180-2951 |
| A12C34 | 0180-2951 | 6 | | CAPACITOR-FXD 33UF+-20% 16VDC AL | 28480 | 0180-2951 |
| A12L1 | 9140-0129 | 1 | 4 | INDUCTOR RF-CH-MLD 220UH 5% .166DX.385LG | 28480 | 9140-0129 |
| A12L2 | 9140-0129 | 1 | | INDUCTOR RF-CH-MLD 220UH 5% .166DX.385LG | 28480 | 9140-0129 |
| A12L3 | 9100-2259 | 8 | 4 | INDUCTOR RF-CH-MLD 1.5UH 10% .105DX.26LG | 28480 | 9100-2259 |
| A12L4 | 9100-2259 | 8 | | INDUCTOR RF-CH-MLD 1.5UH 10% .105DX.26LG | 28480 | 9100-2259 |
| A12L5 | 9100-2259 | 8 | | INDUCTOR RF-CH-MLD 1.5UH 10% .105DX.26LG | 28480 | 9100-2259 |
| A12L6 | 9140-0129 | 1 | | INDUCTOR RF-CH-MLD 220UH 5% .166DX.385LG | 28480 | 9140-0129 |
| A12L7 | 9140-0129 | 1 | | INDUCTOR RF-CH-MLD 220UH 5% .166DX.385LG | 28480 | 9140-0129 |
| A12L8 | 9100-2259 | 8 | | INDUCTOR RF-CH-MLD 1.5UH 10% .105DX.26LG | 28480 | 9100-2259 |
| A12Q1 | 1853-0314 | 9 | 1 | TRANSISTOR PNP 2N2905A SI TO-39 PD=600MW | 04713 | 2N2905A |
| A12Q2 | 1853-0281 | 9 | 1 | TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW | 04713 | 2N2907A |
| A12Q3 | 1854-0637 | 1 | 1 | TRANSISTOR NPN 2N2219A SI TO-5 PD=800MW | 01295 | 2N2219A |
| A12Q4 | 1854-0477 | 7 | 1 | TRANSISTOR NPN 2N2222A SI TO-18 PD=500MW | 04713 | 2N2222A |
| A12R1 | 0698-3136 | 8 | 2 | RESISTOR 17.8K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1782-F |
| A12R2 | 0698-8004 | 9 | 2 | RESISTOR 200K .1% .1W F TC=0+-15 | 07716 | MAR-1/10-T10-2003-B |
| A12R3 | 2100-3207 | 1 | 2 | RESISTOR-TRMR 5K 10% C SIDE-ADJ 1-TRN | 28480 | 2100-3207 |
| A12R4 | 2100-3123 | 0 | 2 | RESISTOR-TRMR 500 10% C SIDE-ADJ 17-TRN | 02111 | 43P501 |
| A12R5 | 0698-8833 | 2 | 8 | RESISTOR-FXD 10K OHM 0.1% | 28480 | 0698-8833 |
| A12R6 | 0698-3460 | 1 | 2 | RESISTOR 422K 1% .125W F TC=0+-100 | 28480 | 0698-3460 |
| A12R7 | 0698-8833 | 2 | | RESISTOR-FXD 10K OHM 0.1% | 28480 | 0698-8833 |
| A12R8 | 0683-2215 | 1 | 2 | RESISTOR 220 5% .25W FC TC=-400/+600 | 01121 | CB2215 |
| A12R9 | 0698-3136 | 8 | | RESISTOR 17.8K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1782-F |
| A12R10 | 0698-8004 | 9 | | RESISTOR 200K .1% .1W F TC=0+-15 | 07716 | MAR-1/10-T10-2003-B |
| A12R11 | 2100-3207 | 1 | | RESISTOR-TRMR 5K 10% C SIDE-ADJ 1-TRN | 28480 | 2100-3207 |
| A12R12 | 2100-3123 | 0 | | RESISTOR-TRMR 500 10% C SIDE-ADJ 17-TRN | 02111 | 43P501 |
| A12R13 | 0698-8833 | 2 | | RESISTOR-FXD 10K OHM 0.1% | 28480 | 0698-8833 |
| A12R14 | 0698-3460 | 1 | | RESISTOR 422K 1% .125W F TC=0+-100 | 28480 | 0698-3460 |
| A12R15 | 0698-8833 | 2 | | RESISTOR-FXD 10K OHM 0.1% | 28480 | 0698-8833 |
| A12R16 | 0683-2215 | 1 | | RESISTOR 220 5% .25W FC TC=-400/+600 | 01121 | CB2215 |
| A12R17 | 0698-8833 | 2 | | RESISTOR-FXD 10K OHM 0.1% | 28480 | 0698-8833 |
| A12R18 | 0698-8833 | 2 | | RESISTOR-FXD 10K OHM 0.1% | 28480 | 0698-8833 |
| A12R19 | 0698-8833 | 2 | | RESISTOR-FXD 10K OHM 0.1% | 28480 | 0698-8833 |
| A12R20 | 0698-8833 | 2 | | RESISTOR-FXD 10K OHM 0.1% | 28480 | 0698-8833 |
| A12R21 | 0757-0280 | 3 | 4 | RESISTOR 1K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1001-F |
| A12R22 | 0757-0438 | 3 | 4 | RESISTOR 5.11K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-5111-F |
| A12R23 | 0757-0438 | 3 | | RESISTOR 5.11K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-5111-F |
| A12R24 | 0757-0280 | 3 | | RESISTOR 1K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1001-F |
| A12R25 | 0757-0280 | 3 | | RESISTOR 1K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1001-F |

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

## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| A12R26 | 0757-0438 | 3 | | RESISTOR 5.11K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-5111-F |
| A12R27 | 0757-0438 | 3 | | RESISTOR 5.11K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-5111-F |
| A12R28 | 0757-0280 | 3 | | RESISTOR 1K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1001-F |
| A12R29 | 0683-1035 | 1 | 2 | RESISTOR 10K 5% .25W FC TC=-400/+700 | 01121 | CB1035 |
| A12R30 | 0683-1035 | 1 | | RESISTOR 10K 5% .25W FC TC=-400/+700 | 01121 | CB1035 |
| A12R31 | 0698-3620 | 5 | 2 | RESISTOR 100 5% 2W MO TC=0+-200 | 28480 | 0698-3620 |
| A12R32 | 0698-3226 | 7 | 2 | RESISTOR 6.49K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-6491-F |
| A12R33 | 0698-3498 | 5 | 2 | RESISTOR 8.66K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-866R-F |
| A12R34 | 0698-3498 | 5 | | RESISTOR 8.66K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-866R-F |
| A12R35 | 0698-3226 | 7 | | RESISTOR 6.49K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-6491-F |
| A12R36 | 0698-3620 | 5 | | RESISTOR 100 5% 2W MO TC=0+-200 | 28480 | 0698-3620 |
| A12U1 | 1826-0081 | 0 | 6 | IC OP AMP WB TO-99 PKG | 27014 | LM318H |
| A12U2 | 1826-0081 | 0 | | IC OP AMP WB TO-99 PKG | 27014 | LM318H |
| A12U3 | 1826-0081 | 0 | | IC OP AMP WB TO-99 PKG | 27014 | LM318H |
| A12U4 | 1826-0081 | 0 | | IC OP AMP WB TO-99 PKG | 27014 | LM318H |
| A12U5 | 1826-0081 | 0 | | IC OP AMP WB TO-99 PKG | 27014 | LM318H |
| A12U6 | 1826-0081 | 0 | | IC OP AMP WB TO-99 PKG | 27014 | LM318H |
| A12U7 | 1826-0521 | 3 | 2 | IC OP AMP DUAL 8-DIP-P PKG | 01295 | TL072CP |
| A12U8 | 1820-1958 | 0 | 2 | IC SWITCH ANLG QUAD 14-DIP-P PKG | 01928 | CD4016BE |
| A12U9 | 1820-1958 | 0 | | IC SWITCH ANLG QUAD 14-DIP-P PKG | 01928 | CD4016BE |
| A12U10 | 1826-0521 | 3 | | IC OP AMP DUAL 8-DIP-P PKG | 01295 | TL072CP |
| | 1205-0050 | 7 | 2 | HEAT SINK TO-5/TO-39-CS | 28480 | 1205-0050 |
| | 04193-26512 | 0 | 1 | PCBD BLANK | 28480 | 04193-26512 |

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

## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| **A13** | | | | | | |
| A13 | 04193-66513 | 4 | 1 | DETECTOR BOARD ASSEMBLY | 28480 | 04193-66513 |
| | | | | | | |
| A13C1 | 0180-0116 | 1 | 1 | CAPACITOR-FXD 6.8UF+-10% 35VDC TA | 56289 | 150D685X9035B2 |
| A13C2 | 0160-4835 | 7 | 20 | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A13C3 | 0160-2208 | 4 | 2 | CAPACITOR-FXD 330PF +-5% 300VDC MICA | 28480 | 0160-2208 |
| A13C4 | 0160-2208 | 4 | | CAPACITOR-FXD 330PF +-5% 300VDC MICA | 28480 | 0160-2208 |
| A13C5 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| | | | | | | |
| A13C6 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A13C7 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A13C8 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A13C9 | 0180-2951 | 6 | 7 | CAPACITOR-FXD 33UF+-20% 16VDC AL | 28480 | 0180-2951 |
| A13C10 | 0180-2951 | 6 | | CAPACITOR-FXD 33UF+-20% 16VDC AL | 28480 | 0180-2951 |
| | | | | | | |
| A13C11 | 0160-4833 | 5 | 1 | CAPACITOR-FXD .022UF +-10% 100VDC CER | 28480 | 0160-4833 |
| A13C12 | 0160-4535 | 4 | 5 | CAPACITOR-FXD 1UF +-10% 50VDC CER | 28480 | 0160-4535 |
| A13C13 | 0160-2201 | 7 | 1 | CAPACITOR-FXD 51PF +-5% 300VDC MICA | 28480 | 0160-2201 |
| A13C14 | 0180-1083 | 3 | 2 | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A13C15 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| | | | | | | |
| A13C16 | 0160-4535 | 4 | | CAPACITOR-FXD 1UF +-10% 50VDC CER | 28480 | 0160-4535 |
| A13C17 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A13C18 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A13C19 | 0160-4535 | 4 | | CAPACITOR-FXD 1UF +-10% 50VDC CER | 28480 | 0160-4535 |
| A13C20 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| | | | | | | |
| A13C21 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A13C22 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A13C23 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A13C24 | 0180-2951 | 6 | | CAPACITOR-FXD 33UF+-20% 16VDC AL | 28480 | 0180-2951 |
| A13C25 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| | | | | | | |
| A13C26 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A13C27 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A13C28 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A13C29 | 0160-4834 | 6 | 4 | CAPACITOR-FXD .047UF +-10% 100VDC CER | 28480 | 0160-4834 |
| A13C30 | 0160-4834 | 6 | | CAPACITOR-FXD .047UF +-10% 100VDC CER | 28480 | 0160-4834 |
| | | | | | | |
| A13C31 | 0180-2951 | 6 | | CAPACITOR-FXD 33UF+-20% 16VDC AL | 28480 | 0180-2951 |
| A13C32 | 0180-2951 | 6 | | CAPACITOR-FXD 33UF+-20% 16VDC AL | 28480 | 0180-2951 |
| A13C33 | 0180-2951 | 6 | | CAPACITOR-FXD 33UF+-20% 16VDC AL | 28480 | 0180-2951 |
| A13C34 | 0180-2951 | 6 | | CAPACITOR-FXD 33UF+-20% 16VDC AL | 28480 | 0180-2951 |
| A13C35 | 0140-0178 | 1 | 1 | CAPACITOR-FXD 560PF +-2% 300VDC MICA | 72136 | DM15F561G0300WV1CR |
| | | | | | | |
| A13C36 | 0160-4535 | 4 | | CAPACITOR-FXD 1UF +-10% 50VDC CER | 28480 | 0160-4535 |
| A13C37 | 0160-4535 | 4 | | CAPACITOR-FXD 1UF +-10% 50VDC CER | 28480 | 0160-4535 |
| A13C38 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A13C39 | 0160-4834 | 6 | | CAPACITOR-FXD .047UF +-10% 100VDC CER | 28480 | 0160-4834 |
| A13C40 | 0160-4834 | 6 | | CAPACITOR-FXD .047UF +-10% 100VDC CER | 28480 | 0160-4834 |
| | | | | | | |
| A13C41 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A13C42 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A13C43 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A13C44 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| | | | | | | |
| A13CR1 | 1901-0040 | 1 | 9 | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A13CR2 | 1901-0040 | 1 | | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A13CR3 | 1902-0064 | 1 | 3 | DIODE-ZNR 7.5V 5% DO-35 PD=.4W TC=+.05% | 28480 | 1902-0064 |
| A13CR4 | 1901-0040 | 1 | | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A13CR5 | 1902-0049 | 2 | 1 | DIODE-ZNR 6.19V 5% DO-35 PD=.4W | 28480 | 1902-0049 |
| | | | | | | |
| A13CR6 | 1901-0040 | 1 | | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A13CR7 | 1901-0040 | 1 | | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A13CR8 | 1902-0064 | 1 | | DIODE-ZNR 7.5V 5% DO-35 PD=.4W TC=+.05% | 28480 | 1902-0064 |
| A13CR9 | 1902-0064 | 1 | | DIODE-ZNR 7.5V 5% DO-35 PD=.4W TC=+.05% | 28480 | 1902-0064 |
| A13CR10 | 1901-0040 | 1 | | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| | | | | | | |
| A13CR11 | 1901-0040 | 1 | | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A13CR12 | 1901-0040 | 1 | | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A13CR13 | 1901-0040 | 1 | | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| | | | | | | |
| A13J1 | 1251-4822 | 6 | 1 | CONNECTOR 3-PIN M POST TYPE | 28480 | 1251-4822 |
| | | | | | | |
| A13L1 | 9140-0114 | 4 | 2 | INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG | 28480 | 9140-0114 |
| A13L2 | 9140-0114 | 4 | | INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG | 28480 | 9140-0114 |
| A13L3 | 9140-0129 | 1 | 6 | INDUCTOR RF-CH-MLD 220UH 5% .166DX.385LG | 28480 | 9140-0129 |
| A13L4 | 9140-0129 | 1 | | INDUCTOR RF-CH-MLD 220UH 5% .166DX.385LG | 28480 | 9140-0129 |
| A13L5 | 9140-0129 | 1 | | INDUCTOR RF-CH-MLD 220UH 5% .166DX.385LG | 28480 | 9140-0129 |
| | | | | | | |
| A13L6 | 9140-0129 | 1 | | INDUCTOR RF-CH-MLD 220UH 5% .166DX.385LG | 28480 | 9140-0129 |
| A13L7 | 9140-0129 | 1 | | INDUCTOR RF-CH-MLD 220UH 5% .166DX.385LG | 28480 | 9140-0129 |
| A13L8 | 9140-0129 | 1 | | INDUCTOR RF-CH-MLD 220UH 5% .166DX.385LG | 28480 | 9140-0129 |
| | | | | | | |
| A13R1 | 2100-3352 | 7 | 1 | RESISTOR-TRMR 1K 10% C SIDE-ADJ 1-TRN | 28480 | 2100-3352 |
| A13R2 | 0757-0442 | 9 | 8 | RESISTOR 10K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1002-F |
| A13R3 | 0757-0279 | 0 | 2 | RESISTOR 3.16K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-3161-F |
| A13R4 | 0698-3160 | 8 | 2 | RESISTOR 31.6K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-3162-F |
| A13R5 | 0698-3160 | 8 | | RESISTOR 31.6K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-3162-F |

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

## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| A13R6 | 0698-3279 | 0 | 1 | RESISTOR 4.99K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4991-F |
| A13R7 | 0757-0424 | 7 | 2 | RESISTOR 1.1K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1101-F |
| A13R8 | 0757-0424 | 7 |  | RESISTOR 1.1K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1101-F |
| A13R9 | 0698-3155 | 1 | 5 | RESISTOR 4.64K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4641-F |
| A13R10 | 0757-0442 | 9 |  | RESISTOR 10K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1002-F |
| A13R11 | 0698-0083 | 8 | 1 | RESISTOR 1.96K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1961-F |
| A13R12 | 0757-0465 | 6 | 1 | RESISTOR 100K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1003-F |
| A13R13 | 0683-1535 | 6 | 1 | RESISTOR 15K 5% .25W FC TC=-400/+800 | 01121 | CB1535 |
| A13R14 | 0698-3155 | 1 |  | RESISTOR 4.64K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4641-F |
| A13R15 | 0698-3359 | 7 | 1 | RESISTOR 12.7K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1272-F |
| A13R16 | 0698-3155 | 1 |  | RESISTOR 4.64K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4641-F |
| A13R17 | 0698-3162 | 0 | 3 | RESISTOR 46.4K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4642-F |
| A13R18 | 0683-1035 | 1 | 4 | RESISTOR 10K 5% .25W FC TC=-400/+700 | 01121 | CB1035 |
| A13R19 | 1810-0205 | 7 | 3 | NETWORK-RES 8-SIP4.7K OHM X 7 | 01121 | 208A472 |
| A13R20 | 0698-3162 | 0 |  | RESISTOR 46.4K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4642-F |
| A13R21 | 0757-0279 | 0 |  | RESISTOR 3.16K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-3161-F |
| A13R22 | 0698-3162 | 0 |  | RESISTOR 46.4K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4642-F |
| A13R23 | 1810-0205 | 7 |  | NETWORK-RES 8-SIP4.7K OHM X 7 | 01121 | 208A472 |
| A13R24 | 0683-6815 | 5 | 4 | RESISTOR 680 5% .25W FC TC=-400/+600 | 01121 | CB6815 |
| A13R25 | 0683-6815 | 5 |  | RESISTOR 680 5% .25W FC TC=-400/+600 | 01121 | CB6815 |
| A13R26 | 0683-6815 | 5 |  | RESISTOR 680 5% .25W FC TC=-400/+600 | 01121 | CB6815 |
| A13R27 | 0683-6815 | 5 |  | RESISTOR 680 5% .25W FC TC=-400/+600 | 01121 | CB6815 |
| A13R28 | 0683-1035 | 1 |  | RESISTOR 10K 5% .25W FC TC=-400/+700 | 01121 | CB1035 |
| A13R29 | 0683-1025 | 9 | 9 | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| A13R30 | 0683-1025 | 9 |  | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| A13R31 | 0683-1045 | 3 | 2 | RESISTOR 100K 5% .25W FC TC=-400/+800 | 01121 | CB1045 |
| A13R32 | 0683-1025 | 9 |  | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| A13R33 | 0683-1025 | 9 |  | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| A13R34 | 0757-0442 | 9 |  | RESISTOR 10K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1002-F |
| A13R35 | 0698-4431 | 8 | 2 | RESISTOR 2.05K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-2051-F |
| A13R36 | 0698-4431 | 8 |  | RESISTOR 2.05K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-2051-F |
| A13R37 | 0683-1045 | 3 |  | RESISTOR 100K 5% .25W FC TC=-400/+800 | 01121 | CB1045 |
| A13R38 | 0683-1025 | 9 |  | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| A13R39 | 0683-1025 | 9 |  | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| A13R40 | 0683-1025 | 9 |  | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| A13R41 | 0757-0280 | 3 | 2 | RESISTOR 1K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1001-F |
| A13R42 | 0698-3155 | 1 |  | RESISTOR 4.64K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4641-F |
| A13R43 | 0683-1035 | 1 |  | RESISTOR 10K 5% .25W FC TC=-400/+700 | 01121 | CB1035 |
| A13R44 | 1810-0205 | 7 |  | NETWORK-RES 8-SIP4.7K OHM X 7 | 01121 | 208A472 |
| A13R45 | 0683-1825 | 7 | 1 | RESISTOR 1.8K 5% .25W FC TC=-400/+700 | 01121 | CB1825 |
| A13R46 | 0757-0280 | 3 |  | RESISTOR 1K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1001-F |
| A13R47 | 0698-3155 | 1 |  | RESISTOR 4.64K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4641-F |
| A13R48 | 0757-0442 | 9 |  | RESISTOR 10K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1002-F |
| A13R49 | 0757-0442 | 9 |  | RESISTOR 10K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1002-F |
| A13R50 | 0757-0442 | 9 |  | RESISTOR 10K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1002-F |
| A13R51 | 0757-0290 | 5 | 1 | RESISTOR 6.19K 1% .125W F TC=0+-100 | 19701 | MF4C1/8-T0-6191-F |
| A13R52 | 0683-1025 | 9 |  | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| A13R53 | 0683-1025 | 9 |  | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| A13R54 | 0683-1035 | 1 |  | RESISTOR 10K 5% .25W FC TC=-400/+700 | 01121 | CB1035 |
| A13R55 | 0757-0442 | 9 |  | RESISTOR 10K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1002-F |
| A13R56 | 0757-0442 | 9 |  | RESISTOR 10K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1002-F |
| A13U1 | 1826-0521 | 3 | 2 | IC OP AMP DUAL 8-DIP-P PKG | 01295 | TL072CP |
| A13U2 | 1826-0685 | 0 | 3 | IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG | 27014 | LF351H |
| A13U3 | 1826-0138 | 8 | 2 | IC COMPARATOR GP QUAD 14-DIP-P PKG | 01295 | LM339N |
| A13U4 | 1820-1356 | 2 | 1 | IC MV CMOS MONOSTBL RETRIG/RESET DUAL | 04713 | MC14528BCP |
| A13U5 | 1826-0138 | 8 |  | IC COMPARATOR GP QUAD 14-DIP-P PKG | 01295 | LM339N |
| A13U6 | 1826-0229 | 8 | 1 | IC OP AMP LOW-DRIFT TO-99 PKG | 06665 | OP-05CJ |
| A13U7 | 1826-0685 | 0 |  | IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG | 27014 | LF351H |
| A13U8 | 1826-0521 | 3 |  | IC OP AMP DUAL 8-DIP-P PKG | 01295 | TL072CP |
| A13U9 | 1826-0175 | 3 | 1 | IC COMPARATOR GP DUAL 14-DIP-P PKG | 27014 | LM319N |
| A13U10 | 1820-1747 | 5 | 1 | IC GATE CMOS NAND QUAD 2-INP | 04713 | MC14011BCP |
| A13U11 | 1820-1601 | 0 | 1 | IC GATE CMOS EXCL-OR QUAD 2-INP | 01928 | CD4070BE |
| A13U12 | 1826-0685 | 0 |  | IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG | 27014 | LF351H |
| A13U13 | 1826-0081 | 0 | 1 | IC OP AMP WB TO-99 PKG | 27014 | LM318H |
| A13U14 | 1826-0502 | 0 | 3 | IC SWITCH ANLG QUAD 14-DIP-P PKG | 04713 | MC14066BCP |
| A13U15 | 1826-0502 | 0 |  | IC SWITCH ANLG QUAD 14-DIP-P PKG | 04713 | MC14066BCP |
| A13U16 | 1826-0502 | 0 |  | IC SWITCH ANLG QUAD 14-DIP-P PKG | 04713 | MC14066BCP |
|  | 1258-0141 |  | 1 | JUMPER-REMOVABLE |  |  |
|  | 1205-0050 | 7 | 1 | HEAT SINK TO-5/TO-39-CS | 28480 | 1205-0050 |
|  | 04193-26513 | 0 | 1 | PCBD BLANK | 28480 | 04193-26513 |

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

## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| **A14** | | | | | | |
| A14 | 04193-66514 | 5 | 1 | ADC BOARD ASSEMBLY | 28480 | 04193-66514 |
| A14C1 | 0160-0127 | 2 | 2 | CAPACITOR-FXD 1UF +-20% 25VDC CER | 28480 | 0160-0127 |
| A14C2 | 0160-0127 | 2 | | CAPACITOR-FXD 1UF +-20% 25VDC CER | 28480 | 0160-0127 |
| A14C3 | 0180-1083 | 3 | 1 | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A14C4 | 0160-0889 | 3 | 2 | CAPACITOR-FXD .33UF +-10% 80VDC POLYE | 28480 | 0160-0889 |
| A14C5 | 0160-0303 | 6 | 2 | CAPACITOR-FXD .15UF +-10% 200VDC POLYE | 28480 | 0160-0303 |
| A14C6 | 0160-0303 | 6 | | CAPACITOR-FXD .15UF +-10% 200VDC POLYE | 28480 | 0160-0303 |
| A14C7 | 0160-0889 | 3 | | CAPACITOR-FXD .33UF +-10% 80VDC POLYE | 28480 | 0160-0889 |
| A14C8 | 0160-4822 | 2 | 2 | CAPACITOR-FXD 1000PF +-5% 100VDC CER | 28480 | 0160-4822 |
| A14C9 | 0160-4822 | 2 | | CAPACITOR-FXD 1000PF +-5% 100VDC CER | 28480 | 0160-4822 |
| A14C10 | 0160-3901 | 6 | 2 | CAPACITOR-FXD 2.2UF +-20% 25VDC CER | 28480 | 0160-3901 |
| A14C11 | 0160-3901 | 6 | | CAPACITOR-FXD 2.2UF +-20% 25VDC CER | 28480 | 0160-3901 |
| A14C12 | 0160-4835 | 7 | 1 | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A14J1 | 1200-0654 | 7 | 2 | SOCKET-IC 40-CONT DIP DIP-SLDR | 28480 | 1200-0654 |
| A14J2 | 1200-0654 | 7 | | SOCKET-IC 40-CONT DIP DIP-SLDR | 28480 | 1200-0654 |
| A14Q1 | 1854-0477 | 7 | 1 | TRANSISTOR NPN 2N2222A SI TO-18 PD=500MW | 04713 | 2N2222A |
| A14R1 | 0683-1045 | 3 | 2 | RESISTOR 100K 5% .25W FC TC=-400/+800 | 01121 | CB1045 |
| A14R2 | 0683-1045 | 3 | | RESISTOR 100K 5% .25W FC TC=-400/+800 | 01121 | CB1045 |
| A14R3 | 0683-2225 | 3 | 1 | RESISTOR 2.2K 5% .25W FC TC=-400/+700 | 01121 | CB2225 |
| A14R4 | 0757-0274 | 5 | 1 | RESISTOR 1.21K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1211-F |
| A14R5 | 0757-0280 | 3 | 1 | RESISTOR 1K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1001-F |
| A14R6 | 0683-4715 | 0 | 2 | RESISTOR 470 5% .25W FC TC=-400/+600 | 01121 | CB4715 |
| A14R7 | 0683-4715 | 0 | | RESISTOR 470 5% .25W FC TC=-400/+600 | 01121 | CB4715 |
| A14R8 | 0683-4725 | 2 | 1 | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A14R9 | 0683-3315 | 4 | 1 | RESISTOR 330 5% .25W FC TC=-400/+600 | 01121 | CB3315 |
| A14U1 | 1820-1197 | 9 | 1 | IC GATE TTL LS NAND QUAD 2-INP | 01295 | SN74LS00N |
| A14U2 | 1820-1112 | 8 | 3 | IC FF TTL LS D-TYPE POS-EDGE-TRIG | 01295 | SN74LS74AN |
| A14U3 | 1826-0746 | | 2 | IC A/D CONVERTER CMOS 40-DIP-P PKG | 28480 | 1826-0746 |
| A14U4 | 1826-0746 | | | IC A/D CONVERTER CMOS 40-DIP-P PKG | 28480 | 1826-0746 |
| A14U5 | 1820-1199 | 1 | 1 | IC INV TTL LS HEX 1-INP | 01295 | SN74LS04N |
| A14U6 | 1820-2024 | 3 | 1 | IC DRVR TTL LS LINE DRVR OCTL | 01295 | SN74LS244N |
| A14U7 | 1820-1216 | 3 | 1 | IC DCDR TTL LS 3-TO-8-LINE 3-INP | 01295 | SN74LS138N |
| A14U8 | 1820-1204 | 9 | 1 | IC GATE TTL LS NAND DUAL 4-INP | 01295 | SN74LS20N |
| A14U9 | 1820-1112 | 8 | | IC FF TTL LS D-TYPE POS-EDGE-TRIG | 01295 | SN74LS74AN |
| A14U10 | 1820-1112 | 8 | | IC FF TTL LS D-TYPE POS-EDGE-TRIG | 01295 | SN74LS74AN |
| A14U11 | 1820-1432 | 5 | 2 | IC CNTR TTL LS BIN SYNCHRO POS-EDGE-TRIG | 01295 | SN74LS163AN |
| A14U12 | 1820-1432 | 5 | | IC CNTR TTL LS BIN SYNCHRO POS-EDGE-TRIG | 01295 | SN74LS163AN |
| | 04193-26514 | 0 | 1 | PCBD BLANK | 28480 | 04193-26514 |

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

## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| **A15** | | | | | | |
| A15 | 04193-66515 | 6 | 1 | ANALOG OUTPUT BOARD ASSEMBLY | 28480 | 04193-66515 |
| A15C1 | 0140-0208 | 8 | 6 | CAPACITOR-FXD 680PF +-5% 300VDC MICA | 28480 | 0140-0208 |
| A15C2 | 0140-0208 | 8 | | CAPACITOR-FXD 680PF +-5% 300VDC MICA | 28480 | 0140-0208 |
| A15C3 | 0140-0208 | 8 | | CAPACITOR-FXD 680PF +-5% 300VDC MICA | 72136 | DM15F681J0300WV1CR |
| A15C4 | 0140-0208 | 8 | | CAPACITOR-FXD 680PF +-5% 300VDC MICA | 72136 | DM15F681J0300WV1CR |
| A15C5 | 0140-0208 | 8 | | CAPACITOR-FXD 680PF +-5% 300VDC MICA | 28480 | 0140-0208 |
| A15C6 | 0140-0208 | 8 | | CAPACITOR-FXD 680PF +-5% 300VDC MICA | 28480 | 0140-0208 |
| A15C7 | 0160-0127 | 2 | 6 | CAPACITOR-FXD 1UF +-20% 25VDC CER | 28480 | 0160-0127 |
| A15C8 | 0160-0127 | 2 | | CAPACITOR-FXD 1UF +-20% 25VDC CER | 28480 | 0160-0127 |
| A15C9 | 0160-0127 | 2 | | CAPACITOR-FXD 1UF +-20% 25VDC CER | 28480 | 0160-0127 |
| A15C10 | 0160-4835 | 7 | 3 | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A15C11 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A15C12 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A15C13 | 0180-1083 | 3 | 5 | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A15C14 | 0160-0127 | 2 | | CAPACITOR-FXD 1UF +-20% 25VDC CER | 28480 | 0160-0127 |
| A15C15 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A15C16 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A15C17 | 0160-0127 | 2 | | CAPACITOR-FXD 1UF +-20% 25VDC CER | 28480 | 0160-0127 |
| A15C18 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A15C19 | 0160-0127 | 2 | | CAPACITOR-FXD 1UF +-20% 25VDC CER | 28480 | 0160-0127 |
| A15C20 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A15L1 | 9140-0210 | 1 | 2 | INDUCTOR RF-CH-MLD 100UH 5% .166DX.385LG | 28480 | 9140-0210 |
| A15L2 | 9140-0210 | 1 | | INDUCTOR RF-CH-MLD 100UH 5% .166DX.385LG | 28480 | 9140-0210 |
| A15R1 | 2100-3273 | 1 | 3 | RESISTOR-TRMR 2K 10% C SIDE-ADJ 1-TRN | 28480 | 2100-3273 |
| A15R2 | 2100-3273 | 1 | | RESISTOR-TRMR 2K 10% C SIDE-ADJ 1-TRN | 28480 | 2100-3273 |
| A15R3 | 2100-3273 | 1 | | RESISTOR-TRMR 2K 10% C SIDE-ADJ 1-TRN | 28480 | 2100-3273 |
| A15R4 | 0683-4725 | 2 | 3 | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A15R5 | 0683-1025 | 9 | 6 | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| A15R6 | 0683-2235 | 5 | 3 | RESISTOR 22K 5% .25W FC TC=-400/+800 | 01121 | CB2235 |
| A15R7 | 0683-1025 | 9 | | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| A15R8 | 0683-2235 | 5 | | RESISTOR 22K 5% .25W FC TC=-400/+800 | 01121 | CB2235 |
| A15R9 | 0683-1025 | 9 | | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| A15R10 | 0683-2235 | 5 | | RESISTOR 22K 5% .25W FC TC=-400/+800 | 01121 | CB2235 |
| A15R11 | 0683-4725 | 2 | | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A15R12 | 0683-2735 | 0 | 2 | RESISTOR 27K 5% .25W FC TC=-400/+800 | 01121 | CB2735 |
| A15R13 | 0683-2735 | 0 | | RESISTOR 27K 5% .25W FC TC=-400/+800 | 01121 | CB2735 |
| A15R14 | 0683-4725 | 2 | | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A15R15 | 1810-0279 | 5 | 2 | NETWORK-RES 10-SIP4.7K OHM X 9 | 01121 | 210A472 |
| A15R16 | 1810-0279 | 5 | | NETWORK-RES 10-SIP4.7K OHM X 9 | 01121 | 210A472 |
| A15R17 | 0683-1025 | 9 | | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| A15R18 | 0683-1025 | 9 | | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| A15R19 | 0683-1025 | 9 | | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| A15U1 | 1820-1278 | 7 | 2 | IC CNTR TTL LS BIN UP/DOWN SYNCHRO | 01295 | SN74LS191N |
| A15U2 | 1820-1278 | 7 | | IC CNTR TTL LS BIN UP/DOWN SYNCHRO | 01295 | SN74LS191N |
| A15U3 | 1820-1199 | 1 | 2 | IC INV TTL LS HEX 1-INP | 01295 | SN74LS04N |
| A15U4 | 1820-1204 | 9 | 2 | IC GATE TTL LS NAND DUAL 4-INP | 01295 | SN74LS20N |
| A15U5 | 1820-1112 | 8 | 1 | IC FF TTL LS D-TYPE POS-EDGE-TRIG | 01295 | SN74LS74AN |
| A15U6 | 1820-1204 | 9 | | IC GATE TTL LS NAND DUAL 4-INP | 01295 | SN74LS20N |
| A15U7 | 1820-1423 | 4 | 1 | IC MV TTL LS MONOSTBL RETRIG DUAL | 01295 | SN74LS123N |
| A15U8 | 1820-1197 | 9 | 1 | IC GATE TTL LS NAND QUAD 2-INP | 01295 | SN74LS00N |
| A15U9 | 1820-1216 | 3 | 1 | IC DCDR TTL LS 3-TO-8-LINE 3-INP | 01295 | SN74LS138N |
| A15U10 | 1820-1144 | 6 | 1 | IC GATE TTL LS NOR QUAD 2-INP | 01295 | SN74LS02N |
| A15U11 | 1813-0105 | 2 | 1 | IC D/A CONVERTER 24-DIP-CER PKG | 8E175 | DAC80-CBI-V |
| A15U12 | 1820-1374 | 4 | 1 | IC SWITCH ANLG QUAD 16-DIP-P PKG | 24355 | AD7510DIJN |
| A15U13 | 1820-1199 | 1 | | IC INV TTL LS HEX 1-INP | 01295 | SN74LS04N |
| A15U14 | 1820-2024 | 3 | 1 | IC DRVR TTL LS LINE DRVR OCTL | 01295 | SN74LS244N |
| A15U15 | 1820-1436 | 9 | 3 | IC TTL LS 16-BIT RAM STAT 45-NS 0-C | 01295 | SN74LS170N |
| A15U16 | 1820-1436 | 9 | | IC TTL LS 16-BIT RAM STAT 45-NS 0-C | 01295 | SN74LS170N |
| A15U17 | 1820-1436 | 9 | | IC TTL LS 16-BIT RAM STAT 45-NS 0-C | 01295 | SN74LS170N |
| A15U18 | 1826-0410 | 9 | 2 | IC OP AMP LOW-BIAS-H-IMPD QUAD 14-DIP-P | 01295 | TL084CN |
| A15U19 | 1826-0410 | 9 | | IC OP AMP LOW-BIAS-H-IMPD QUAD 14-DIP-P | 01295 | TL084CN |
| A15J1 | 1200-0541 | 1 | 1 | SOCKET-IC 24-CONT DIP DIP-SLDR | 28480 | 1200-0541 |
| | 04193-26515 | 0 | 1 | PCBD BLANK | 28480 | 04193-26515 |

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

## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| **A16** | | | | | | |
| A16 | 04193-66516 | 7 | 1 | HP-IB BOARD ASSEMBLY | 28480 | 04193-66516 |
| A16C1 | 0160-0127 | 2 | 1 | CAPACITOR-FXD 1UF +-20% 25VDC CER | 28480 | 0160-0127 |
| A16C2 | 0180-1083 | 3 | 1 | CAPACITOR-FXD 32UF 25VDC AL | 28480 | 0180-1083 |
| A16J1 | 1200-0654 | 7 | 1 | SOCKET-IC 40-CONT DIP DIP-SLDR | 28480 | 1200-0654 |
| A16R1 | 1810-0279 | 5 | 1 | NETWORK-RES 10-SIP4.7K OHM X 9 | 01121 | 210A472 |
| A16R2 | 0683-4725 | 2 | 1 | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A16U1 | 1820-2024 | 3 | 1 | IC DRVR TTL LS LINE DRVR OCTL | 01295 | SN74LS244N |
| A16U2 | 1820-2549 | 7 | 1 | IC-8291A P HPIB | 28480 | 1820-2549 |
| A16U3 | 1820-2058 | 3 | 4 | IC MISC TTL S QUAD | 28480 | 1820-2058 |
| A16U4 | 1820-2058 | 3 | | IC MISC TTL S QUAD | 28480 | 1820-2058 |
| A16U5 | 1820-1199 | 1 | 1 | IC INV TTL LS HEX 1-INP | 01295 | SN74LS04N |
| A16U6 | 1820-2058 | 3 | | IC MISC TTL S QUAD | 28480 | 1820-2058 |
| A16U7 | 1820-2058 | 3 | | IC MISC TTL S QUAD | 28480 | 1820-2058 |
| A16U8 | 1820-1197 | 9 | 1 | IC GATE TTL LS NAND QUAD 2-INP | 01295 | SN74LS00N |
| | 04193-26516 | 0 | 1 | PCBD BLANK | 28480 | 04193-26516 |

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

## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| **A17** | | | | | | |
| A17 | 04193-66517 | 8 | 1 | CONTROL LOGIC BOARD ASSEMBLY | 28480 | 04193-66517 |
| A17C1 | 0180-1083 | 3 | 4 | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A17C2 | 0160-0127 | 2 | 3 | CAPACITOR-FXD 1UF +-20% 25VDC CER | 28480 | 0160-0127 |
| A17C3 | 0160-0127 | 2 | | CAPACITOR-FXD 1UF +-20% 25VDC CER | 28480 | 0160-0127 |
| A17C4 | 0160-4835 | 7 | 2 | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A17C5 | 0160-2266 | 4 | 2 | CAPACITOR-FXD 24PF +-5% 500VDC CER 0+-30 | 28480 | 0160-2266 |
| A17C6 | 0160-2009 | 4 | | CAPACITOR-FXD 820PF +-5% 500VDC CER 0+-30 | 28480 | |
| A17C7 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A17C8 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A17C9 | 0160-0127 | 2 | | CAPACITOR-FXD 1UF +-20% 25VDC CER | 28480 | 0160-0127 |
| A17C10 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A17C11 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A17C12 | 0180-0229 | 7 | 2 | CAPACITOR-FXD 33UF+-10% 15VDC TA | 56289 | 150D336X9015B2 |
| A17C13 | 0180-0229 | 7 | | CAPACITOR-FXD 33UF+-10% 10VDC TA | 56289 | 150D336X9010B2 |
| A17CR1 | 1901-0040 | 1 | 3 | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A17CR2 | 1901-0518 | 8 | 2 | DIODE-SM SIG SCHOTTKY | 28480 | 1901-0518 |
| A17CR3 | 1901-0518 | 8 | | DIODE-SM SIG SCHOTTKY | 28480 | 1901-0518 |
| A17CR4 | 1901-0040 | 1 | | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A17CR5 | 1901-0040 | 1 | | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A17CR6 | 1902-0041 | 4 | 1 | DIODE-ZNR 5.11V 5% DO-35 PD=.4W | 28480 | 1902-0041 |
| A17J1 | 1200-0541 | 1 | 5 | SOCKET-IC 24-CONT DIP DIP-SLDR | 28480 | 1200-0541 |
| A17J2 | 1200-0541 | 1 | | SOCKET-IC 24-CONT DIP DIP-SLDR | 28480 | 1200-0541 |
| A17J3 | 1200-0541 | 1 | | SOCKET-IC 24-CONT DIP DIP-SLDR | 28480 | 1200-0541 |
| A17J4 | 1200-0541 | 1 | | SOCKET-IC 24-CONT DIP DIP-SLDR | 28480 | 1200-0541 |
| A17J5 | 1200-0541 | 1 | | SOCKET-IC 24-CONT DIP DIP-SLDR | 28480 | 1200-0541 |
| A17J6 | 1200-0607 | 0 | 1 | SOCKET-IC 16-CONT DIP DIP-SLDR | 28480 | 1200-0607 |
| A17J7 | 1200-0654 | 7 | 1 | SOCKET-IC 40-CONT DIP DIP-SLDR | 28480 | 1200-0654 |
| A17L1 | 9100-3139 | 5 | 1 | INDUCTOR 75UH 15% .50X.875LG | 28480 | 9100-3139 |
| A17Q1 | 1853-0015 | 7 | 2 | TRANSISTOR PNP SI PD=200MW FT=500MHZ | 28480 | 1853-0015 |
| A17Q2 | 1853-0015 | 7 | | TRANSISTOR PNP SI PD=200MW FT=500MHZ | 28480 | 1853-0015 |
| A17R1 | 1810-0279 | 5 | 3 | NETWORK-RES 10-SIP4.7K OHM X 9 | 01121 | 210A472 |
| A17R2 | 0683-2245 | 7 | 1 | RESISTOR 220K 5% .25W FC TC=-800/+900 | 01121 | CB2245 |
| A17R3 | 0683-4725 | 2 | 4 | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A17R4 | 0683-5645 | 7 | 1 | RESISTOR 560K 5% .25W FC TC=-800/+900 | 01121 | CB5645 |
| A17R5 | 0683-1515 | 2 | 2 | RESISTOR 150 5% .25W FC TC=-400/+600 | 01121 | CB1515 |
| A17R6 | 0683-2715 | 6 | 2 | RESISTOR 270 5% .25W FC TC=-400/+600 | 01121 | CB2715 |
| A17R7 | 0683-1205 | 7 | 2 | RESISTOR 12 5% .25W FC TC=-400/+500 | 01121 | CB1205 |
| A17R8 | 0683-2205 | 9 | 2 | RESISTOR 22 5% .25W FC TC=-400/+500 | 01121 | CB2205 |
| A17R9 | 0683-1515 | 2 | | RESISTOR 150 5% .25W FC TC=-400/+600 | 01121 | CB1515 |
| A17R10 | 0683-2715 | 6 | | RESISTOR 270 5% .25W FC TC=-400/+600 | 01121 | CB2715 |
| A17R11 | 0683-1205 | 7 | | RESISTOR 12 5% .25W FC TC=-400/+500 | 01121 | CB1205 |
| A17R12 | 0683-2205 | 9 | | RESISTOR 22 5% .25W FC TC=-400/+500 | 01121 | CB2205 |
| A17R13 | 0683-3315 | 4 | 2 | RESISTOR 330 5% .25W FC TC=-400/+600 | 01121 | CB3315 |
| A17R14 | 0683-3315 | 4 | | RESISTOR 330 5% .25W FC TC=-400/+600 | 01121 | CB3315 |
| A17R15 | 0683-4725 | 2 | | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A17R16 | 0683-4725 | 2 | | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A17R17 | 1810-0279 | 5 | | NETWORK-RES 10-SIP4.7K OHM X 9 | 01121 | 210A472 |
| A17R18 | 0683-4725 | 2 | | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A17R19 | 1810-0279 | 5 | | NETWORK-RES 10-SIP4.7K OHM X 9 | 01121 | 210A472 |
| A17S1 | 3101-1856 | 5 | 1 | SWITCH-SLIDE 8-1A | 28480 | 3101-1856 |
| A17S2 | 3101-0860 | 9 | 1 | SWITCH-SLIDE DPDT-NS | 28480 | 3101-0860 |
| A17U1 | 1818-0438 | 4 | 2 | IC NMOS 4096 (4K) RAM STAT 450-NS 3-S | 01295 | TMS2114-45NL |
| A17U2 | 1818-0438 | 4 | | IC NMOS 4096 (4K) RAM STAT 450-NS 3-S | 01295 | TMS2114-45NL |
| A17U3 | 04193-85001 | 5 | 1 | IC-PROGRAMMED (PROM) | 28480 | 04193-85001 |
| A17U4 | 04193-85002 | 6 | 1 | IC-PROGRAMMED (PROM) | 28480 | 04193-85002 |
| A17U5 | 04193-85003 | 7 | 1 | IC-PROGRAMMED (PROM) | 28480 | 04193-85003 |
| A17U6 | 04193-85004 | 8 | 1 | IC-PROGRAMMED (PROM) | 28480 | 04193-85004 |
| A17U7 | 04193-85005 | 9 | 1 | IC-PROGRAMMED (PROM) | 28480 | 04193-85005 |
| A17U8 | 1820-1216 | 3 | 4 | IC DCDR TTL LS 3-TO-8-LINE 3-INP | 01295 | SN74LS138N |
| A17U9 | 1820-1199 | 1 | 2 | IC INV TTL LS HEX 1-INP | 01295 | SN74LS04N |
| A17U10 | 1820-1216 | 3 | | IC DCDR TTL LS 3-TO-8-LINE 3-INP | 01295 | SN74LS138N |
| A17U11 | 1820-1197 | 9 | 1 | IC GATE TTL LS NAND QUAD 2-INP | 01295 | SN74LS00N |
| A17U12 | 1826-0180 | 0 | 1 | IC TIMER TTL MONO/ASTBL | 01295 | NE555P |
| A17U13 | 1820-1144 | 6 | 1 | IC GATE TTL LS NOR QUAD 2-INP | 01295 | SN74LS02N |
| A17U14 | 1820-1199 | 1 | | IC INV TTL LS HEX 1-INP | 01295 | SN74LS04N |
| A17U15 | 1820-1216 | 3 | | IC DCDR TTL LS 3-TO-8-LINE 3-INP | 01295 | SN74LS138N |
| A17U16 | 1820-1112 | 8 | 1 | IC FF TTL LS D-TYPE POS-EDGE-TRIG | 01295 | SN74LS74AN |
| A17U17 | 1820-1204 | 9 | 1 | IC GATE TTL LS NAND DUAL 4-INP | 01295 | SN74LS20N |
| A17U18 | 1820-2075 | 4 | 1 | IC MISC TTL LS | 01295 | SN74LS245N |
| A17U19 | 1820-1480 | 3 | 1 | IC MICPROC NMOS 8-BIT | 04713 | MC6800L |
| A17U20 | 1820-2024 | 3 | 6 | IC DRVR TTL LS LINE DRVR OCTL | 01295 | SN74LS244N |

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

## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| A17U21 | 1820-1196 | 8 | 3 | IC FF TTL LS D-TYPE POS-EDGE-TRIG COM | 01295 | SN74LS174N |
| A17U22 | 1820-1196 | 8 |  | IC FF TTL LS D-TYPE POS-EDGE-TRIG COM | 01295 | SN74LS174N |
| A17U23 | 1820-1196 | 8 |  | IC FF TTL LS D-TYPE POS-EDGE-TRIG COM | 01295 | SN74LS174N |
| A17U24 | 1820-1730 | 6 | 2 | IC FF TTL LS D-TYPE POS-EDGE-TRIG COM | 01295 | SN74LS273N |
| A17U25 | 1820-1730 | 6 |  | IC FF TTL LS D-TYPE POS-EDGE-TRIG COM | 01295 | SN74LS273N |
| A17U26 | 1820-2024 | 3 |  | IC DRVR TTL LS LINE DRVR OCTL | 01295 | SN74LS244N |
| A17U27 | 1820-2024 | 3 |  | IC DRVR TTL LS LINE DRVR OCTL | 01295 | SN74LS244N |
| A17U28 | 1820-1416 | 5 | 1 | IC SCHMITT-TRIG TTL LS INV HEX 1-INP | 01295 | SN74LS14N |
| A17U29 | 1820-1216 | 3 |  | IC DCDR TTL LS 3-TO-8-LINE 3-INP | 01295 | SN74LS138N |
| A17U30 | 1820-2024 | 3 |  | IC DRVR TTL LS LINE DRVR OCTL | 01295 | SN74LS244N |
| A17U31 | 1820-2024 | 3 |  | IC DRVR TTL LS LINE DRVR OCTL | 01295 | SN74LS244N |
| A17U32 | 1820-2024 | 3 |  | IC DRVR TTL LS LINE DRVR OCTL | 01295 | SN74LS244N |
| A17W1 | 1251-4787 | 2 | 1 | SHUNT-DIP 8-POSITION | 28480 | 1251-4787 |
|  | 04193-26517 | 0 | 1 | PCBD BLANK | 28480 | 04193-26517 |

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

## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| **A18** | | | | | | |
| A18 | 04193-66518 | 9 | 1 | DISPLAY BOARD ASSEMBLY | 28480 | 04193-66518 |
| A18C1 | 0160-4835 | 7 | 1 | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A18C2 | 0160-0162 | 5 | 1 | CAPACITOR-FXD .022UF +-10% 200VDC POLYE | 28480 | 0160-0162 |
| A18C3 | 0160-4801 | 7 | 1 | CAPACITOR-FXD 100PF +-5% 100VDC CER | 28480 | 0160-4801 |
| A18C4 | 0160-4810 | 8 | 1 | CAPACITOR-FXD 330PF +-5% 100VDC CER | 28480 | 0160-4810 |
| A18C5 | 0180-1083 | 3 | 7 | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A18C6 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A18C7 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A18C8 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A18C9 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A18C10 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A18C11 | 0180-1083 | 3 | | CAPACITOR-FXD 33UF 25VDC AL | 28480 | 0180-1083 |
| A18C12 | 0160-4822 | 2 | 1 | CAPACITOR-FXD 1000PF +-5% 100VDC CER | 28480 | 0160-4822 |
| A18C13 | 0180-0229 | 7 | 2 | CAPACITOR-FXD 33UF+-10% 10VDC TA | 56289 | 150D336X9010B2 |
| A18C14 | 0180-0229 | 7 | | CAPACITOR-FXD 33UF+-10% 10VDC TA | 56289 | 150D336X9010B2 |
| A18C15 | 0180-2207 | 5 | 1 | CAPACITOR-FXD 100UF+-10% 10VDC TA | 56289 | 150D107X9010R2 |
| A18C16 | 0160-4830 | 2 | 1 | CAPACITOR-FXD 2200PF +-10% 100VDC CER | 28480 | 0160-4830 |
| A18CR1 | 1901-0040 | 1 | 2 | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A18CR2 | 1901-0040 | 1 | | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A18DS1 | 1990-0486 | 6 | 9 | LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V | 28480 | 5082-4684 |
| A18DS2 | 1990-0486 | 6 | | LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V | 28480 | 5082-4684 |
| A18DS3 | 1990-0486 | 6 | | LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V | 28480 | 5082-4684 |
| A18DS4 | 1990-0486 | 6 | | LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V | 28480 | 5082-4684 |
| A18DS5 | 1990-0486 | 6 | | LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V | 28480 | 5082-4684 |
| A18DS6 | 1990-0486 | 6 | | LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V | 28480 | 5082-4684 |
| A18DS7 | 1990-0486 | 6 | | LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V | 28480 | 5082-4684 |
| A18DS8 | 1990-0540 | 3 | 8 | DISPLAY-NUM-SEG 1-CHAR .43-H | 28480 | 5082-7650 |
| A18DS9 | 1990-0540 | 3 | | DISPLAY-NUM-SEG 1-CHAR .43-H | 28480 | 5082-7650 |
| A18DS10 | 1990-0540 | 3 | | DISPLAY-NUM-SEG 1-CHAR .43-H | 28480 | 5082-7650 |
| A18DS11 | 1990-0540 | 3 | | DISPLAY-NUM-SEG 1-CHAR .43-H | 28480 | 5082-7650 |
| A18DS12 | 1990-0486 | 6 | | LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V | 28480 | 5082-4684 |
| A18DS13 | 1990-0486 | 6 | | LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V | 28480 | 5082-4684 |
| A18DS14 | 1990-0540 | 3 | | DISPLAY-NUM-SEG 1-CHAR .43-H | 28480 | 5082-7650 |
| A18DS15 | 1990-0540 | 3 | | DISPLAY-NUM-SEG 1-CHAR .43-H | 28480 | 5082-7650 |
| A18DS16 | 1990-0540 | 3 | | DISPLAY-NUM-SEG 1-CHAR .43-H | 28480 | 5082-7650 |
| A18DS17 | 1990-0540 | 3 | | DISPLAY-NUM-SEG 1-CHAR .43-H | 28480 | 5082-7650 |
| A18DS18 | 1990-0531 | 2 | 4 | DISPLAY-NUM-SEG 1-CHAR .3-H | 28480 | 5082-7610 |
| A18DS19 | 1990-0531 | 2 | | DISPLAY-NUM-SEG 1-CHAR .3-H | 28480 | 5082-7610 |
| A18DS20 | 1990-0531 | 2 | | DISPLAY-NUM-SEG 1-CHAR .3-H | 28480 | 5082-7610 |
| A18DS21 | 1990-0531 | 2 | | DISPLAY-NUM-SEG 1-CHAR .3-H | 28480 | 5082-7610 |
| A18DS22 | 1990-0665 | 3 | 16 | LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V | 28480 | 1990-0665 |
| A18DS23 | 1990-0665 | 3 | | LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V | 28480 | 1990-0665 |
| A18DS24 | 1990-0665 | 3 | | LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V | 28480 | 1990-0665 |
| A18DS25 | 1990-0665 | 3 | | LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V | 28480 | 1990-0665 |
| A18DS26 | 1990-0665 | 3 | | LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V | 28480 | 1990-0665 |
| A18DS27 | 1990-0665 | 3 | | LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V | 28480 | 1990-0665 |
| A18DS28 | 1990-0665 | 3 | | LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V | 28480 | 1990-0665 |
| A18DS29 | 1990-0665 | 3 | | LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V | 28480 | 1990-0665 |
| A18DS30 | 1990-0665 | 3 | | LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V | 28480 | 1990-0665 |
| A18DS31 | 1990-0665 | 3 | | LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V | 28480 | 1990-0665 |
| A18DS32 | 1990-0665 | 3 | | LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V | 28480 | 1990-0665 |
| A18DS33 | 1990-0665 | 3 | | LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V | 28480 | 1990-0665 |
| A18DS34 | 1990-0665 | 3 | | LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V | 28480 | 1990-0665 |
| A18DS35 | 1990-0665 | 3 | | LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V | 28480 | 1990-0665 |
| A18DS36 | 1990-0665 | 3 | | LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V | 28480 | 1990-0665 |
| A18DS37 | 1990-0665 | 3 | | LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V | 28480 | 1990-0665 |
| A18J1 | 0360-1901 | 6 | 1 | CABLE-TRANSITION | 28480 | 0360-1901 |
| A18J2 | 1200-0638 | 7 | 12 | SOCKET-IC 14-CONT DIP DIP-SLDR | 28480 | 1200-0638 |
| A18J3 | 1200-0638 | 7 | | SOCKET-IC 14-CONT DIP DIP-SLDR | 28480 | 1200-0638 |
| A18J4 | 1200-0638 | 7 | | SOCKET-IC 14-CONT DIP DIP-SLDR | 28480 | 1200-0638 |
| A18J5 | 1200-0638 | 7 | | SOCKET-IC 14-CONT DIP DIP-SLDR | 28480 | 1200-0638 |
| A18J6 | 1200-0638 | 7 | | SOCKET-IC 14-CONT DIP DIP-SLDR | 28480 | 1200-0638 |
| A18J7 | 1200-0638 | 7 | | SOCKET-IC 14-CONT DIP DIP-SLDR | 28480 | 1200-0638 |
| A18J8 | 1200-0638 | 7 | | SOCKET-IC 14-CONT DIP DIP-SLDR | 28480 | 1200-0638 |
| A18J9 | 1200-0638 | 7 | | SOCKET-IC 14-CONT DIP DIP-SLDR | 28480 | 1200-0638 |
| A18J10 | 1200-0638 | 7 | | SOCKET-IC 14-CONT DIP DIP-SLDR | 28480 | 1200-0638 |
| A18J11 | 1200-0638 | 7 | | SOCKET-IC 14-CONT DIP DIP-SLDR | 28480 | 1200-0638 |
| A18J12 | 1200-0638 | 7 | | SOCKET-IC 14-CONT DIP DIP-SLDR | 28480 | 1200-0638 |
| A18J13 | 1200-0638 | 7 | | SOCKET-IC 14-CONT DIP DIP-SLDR | 28480 | 1200-0638 |
| A18L1 | 9100-3139 | 5 | 1 | COIL-75UH 15% | 28480 | 9100-3139 |
| A18Q1 | 1853-0318 | 3 | 15 | TRANSISTOR PNP SI PD=500MW FT=60MHZ | 04713 | MPS6562 |
| A18Q2 | 1853-0318 | 3 | | TRANSISTOR PNP SI PD=500MW FT=60MHZ | 04713 | MPS6562 |
| A18Q3 | 1853-0318 | 3 | | TRANSISTOR PNP SI PD=500MW FT=60MHZ | 04713 | MPS6562 |
| A18Q4 | 1853-0318 | 3 | | TRANSISTOR PNP SI PD=500MW FT=60MHZ | 04713 | MPS6562 |
| A18Q5 | 1853-0318 | 3 | | TRANSISTOR PNP SI PD=500MW FT=60MHZ | 04713 | MPS6562 |
| A18Q6 | 1853-0318 | 3 | | TRANSISTOR PNP SI PD=500MW FT=60MHZ | 04713 | MPS6562 |
| A18Q7 | 1853-0318 | 3 | | TRANSISTOR PNP SI PD=500MW FT=60MHZ | 04713 | MPS6562 |
| A18Q8 | 1853-0318 | 3 | | TRANSISTOR PNP SI PD=500MW FT=60MHZ | 04713 | MPS6562 |
| A18Q9 | 1853-0318 | 3 | | TRANSISTOR PNP SI PD=500MW FT=60MHZ | 04713 | MPS6562 |
| A18Q10 | 1853-0318 | 3 | | TRANSISTOR PNP SI PD=500MW FT=60MHZ | 04713 | MPS6562 |

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

## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| A18Q11 | 1853-0318 | 3 | | TRANSISTOR PNP SI PD=500MW FT=60MHZ | 04713 | MPS6562 |
| A18Q12 | 1853-0318 | 3 | | TRANSISTOR PNP SI PD=500MW FT=60MHZ | 04713 | MPS6562 |
| A18Q13 | 1853-0318 | 3 | | TRANSISTOR PNP SI PD=500MW FT=60MHZ | 04713 | MPS6562 |
| A18Q14 | 1853-0318 | 3 | | TRANSISTOR PNP SI PD=500MW FT=60MHZ | 04713 | MPS6562 |
| A18Q15 | 1853-0318 | 3 | | TRANSISTOR PNP SI PD=500MW FT=60MHZ | 04713 | MPS6562 |
| A18Q16 | 1854-0071 | 7 | 8 | TRANSISTOR NPN SI PD=300MW FT=200MHZ | 28480 | 1854-0071 |
| A18Q17 | 1854-0071 | 7 | | TRANSISTOR NPN SI PD=300MW FT=200MHZ | 28480 | 1854-0071 |
| A18Q18 | 1854-0071 | 7 | | TRANSISTOR NPN SI PD=300MW FT=200MHZ | 28480 | 1854-0071 |
| A18Q19 | 1854-0071 | 7 | | TRANSISTOR NPN SI PD=300MW FT=200MHZ | 28480 | 1854-0071 |
| A18Q20 | 1854-0071 | 7 | | TRANSISTOR NPN SI PD=300MW FT=200MHZ | 28480 | 1854-0071 |
| A18Q21 | 1854-0071 | 7 | | TRANSISTOR NPN SI PD=300MW FT=200MHZ | 28480 | 1854-0071 |
| A18Q22 | 1854-0071 | 7 | | TRANSISTOR NPN SI PD=300MW FT=200MHZ | 28480 | 1854-0071 |
| A18Q23 | 1854-0071 | 7 | | TRANSISTOR NPN SI PD=300MW FT=200MHZ | 28480 | 1854-0071 |
| A18R1 | 0683-3315 | 4 | 7 | RESISTOR 330 5% .25W FC TC=-400/+600 | 01121 | CB3315 |
| A18R2 | 0683-3315 | 4 | | RESISTOR 330 5% .25W FC TC=-400/+600 | 01121 | CB3315 |
| A18R3 | 0683-3315 | 4 | | RESISTOR 330 5% .25W FC TC=-400/+600 | 01121 | CB3315 |
| A18R4 | 0683-3315 | 4 | | RESISTOR 330 5% .25W FC TC=-400/+600 | 01121 | CB3315 |
| A18R5 | 0683-3315 | 4 | | RESISTOR 330 5% .25W FC TC=-400/+600 | 01121 | CB3315 |
| A18R6 | 0683-3315 | 4 | | RESISTOR 330 5% .25W FC TC=-400/+600 | 01121 | CB3315 |
| A18R7 | 0683-3315 | 4 | | RESISTOR 330 5% .25W FC TC=-400/+600 | 01121 | CB3315 |
| A18R8 | 0683-1025 | 9 | 2 | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| A18R9 | 0683-1025 | 9 | | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| | | 1 | 3 | | | |
| A18R10 | 0683-4715 | 0 | 4 | RESISTOR 470 5% .25W FC TC=-400/+600 | 01121 | CB4715 |
| A18R11 | 0683-3305 | 2 | 8 | RESISTOR 33 5% .25W FC TC=-400/+500 | 01121 | CB3305 |
| A18R12 | 0683-3305 | 2 | | RESISTOR 33 5% .25W FC TC=-400/+500 | 01121 | CB3305 |
| A18R13 | 0683-3305 | 2 | | RESISTOR 33 5% .25W FC TC=-400/+500 | 01121 | CB3305 |
| A18R14 | 0683-3305 | 2 | | RESISTOR 33 5% .25W FC TC=-400/+500 | 01121 | CB3305 |
| A18R15 | 0683-3305 | 2 | | RESISTOR 33 5% .25W FC TC=-400/+500 | 01121 | CB3305 |
| A18R16 | 0683-3305 | 2 | | RESISTOR 33 5% .25W FC TC=-400/+500 | 01121 | CB3305 |
| A18R17 | 0683-3305 | 2 | | RESISTOR 33 5% .25W FC TC=-400/+500 | 01121 | CB3305 |
| A18R18 | 0683-3305 | 2 | | RESISTOR 33 5% .25W FC TC=-400/+500 | 01121 | CB3305 |
| A18R19 | 1810-0275 | 1 | 3 | NETWORK-RES 10-SIP1.0K OHM X 9 | 01121 | 210A102 |
| A18R20 | 1810-0275 | 1 | | NETWORK-RES 10-SIP1.0K OHM X 9 | 01121 | 210A102 |
| A18R21 | 1810-0283 | 1 | 2 | NETWORK-RES 16-DIP270.0 OHM X 8 | 28480 | 1810-0283 |
| A18R22 | 0683-2235 | 5 | 1 | RESISTOR 22K 5% .25W FC TC=-400/+800 | 01121 | CB2235 |
| A18R23 | 0683-1045 | 3 | 1 | RESISTOR 100K 5% .25W FC TC=-400/+800 | 01121 | CB1045 |
| A18R24 | 1810-0275 | 1 | | NETWORK-RES 10-SIP1.0K OHM X 9 | 01121 | 210A102 |
| A18R25 | 1810-0283 | 1 | | NETWORK-RES 16-DIP270.0 OHM X 8 | 28480 | 1810-0283 |
| A18R26 | 1810-0279 | 5 | 3 | NETWORK-RES 10-SIP4.7K OHM X 9 | 01121 | 210A472 |
| A18R27 | 1810-0279 | 5 | | NETWORK-RES 10-SIP4.7K OHM X 9 | 01121 | 210A472 |
| A18R28 | 1810-0279 | 5 | | NETWORK-RES 10-SIP4.7K OHM X 9 | 01121 | 210A472 |
| A18R29 | 0683-1015 | 7 | 1 | RESISTOR 100 5% .25W FC TC=-400/+500 | 01121 | CB1015 |
| A18R30 | 0693-1515 | 2 | 1 | RESISTOR 150 5% .25W FC TC=-400/+600 | 01121 | CB1515 |
| A18R31 | 0683-4715 | 0 | | RESISTOR 470 5% .25W FC TC=-400/+600 | 01121 | CB4715 |
| A18R32 | 0683-4715 | 0 | | RESISTOR 470 5% .25W FC TC=-400/+600 | 01121 | CB4715 |
| A18R33 | 0683-4715 | 0 | | RESISTOR 470 5% .25W FC TC=-400/+600 | 01121 | CB4715 |
| A18S1 | 5060-9436 | 7 | 23 | PUSHBUTTON SWITCH P.C. MOUNT | 28480 | 5060-9436 |
| A18S2 | 5060-9436 | 7 | | PUSHBUTTON SWITCH P.C. MOUNT | 28480 | 5060-9436 |
| A18S3 | 5060-9436 | 7 | | PUSHBUTTON SWITCH P.C. MOUNT | 28480 | 5060-9436 |
| A18S4 | 5060-9436 | 7 | | PUSHBUTTON SWITCH P.C. MOUNT | 28480 | 5060-9436 |
| A18S5 | 5060-9436 | 7 | | PUSHBUTTON SWITCH P.C. MOUNT | 28480 | 5060-9436 |
| A18S6 | 5060-9436 | 7 | | PUSHBUTTON SWITCH P.C. MOUNT | 28480 | 5060-9436 |
| A18S7 | 5060-9436 | 7 | | PUSHBUTTON SWITCH P.C. MOUNT | 28480 | 5060-9436 |
| A18S8 | 5060-9436 | 7 | | PUSHBUTTON SWITCH P.C. MOUNT | 28480 | 5060-9436 |
| A18S9 | 5060-9436 | 7 | | PUSHBUTTON SWITCH P.C. MOUNT | 28480 | 5060-9436 |
| A18S10 | 5060-9436 | 7 | | PUSHBUTTON SWITCH P.C. MOUNT | 28480 | 5060-9436 |
| A18S11 | 5060-9436 | 7 | | PUSHBUTTON SWITCH P.C. MOUNT | 28480 | 5060-9436 |
| A18S12 | 5060-9436 | 7 | | PUSHBUTTON SWITCH P.C. MOUNT | 28480 | 5060-9436 |
| A18S13 | 5060-9436 | 7 | | PUSHBUTTON SWITCH P.C. MOUNT | 28480 | 5060-9436 |
| A18S14 | 5060-9436 | 7 | | PUSHBUTTON SWITCH P.C. MOUNT | 28480 | 5060-9436 |
| A18S15 | 5060-9436 | 7 | | PUSHBUTTON SWITCH P.C. MOUNT | 28480 | 5060-9436 |
| A18S16 | 5060-9436 | 7 | | PUSHBUTTON SWITCH P.C. MOUNT | 28480 | 5060-9436 |
| A18S17 | 5060-9436 | 7 | | PUSHBUTTON SWITCH P.C. MOUNT | 28480 | 5060-9436 |
| A18S18 | 5060-9436 | 7 | | PUSHBUTTON SWITCH P.C. MOUNT | 28480 | 5060-9436 |
| A18S19 | 5060-9436 | 7 | | PUSHBUTTON SWITCH P.C. MOUNT | 28480 | 5060-9436 |
| A18S20 | 5060-9436 | 7 | | PUSHBUTTON SWITCH P.C. MOUNT | 28480 | 5060-9436 |
| A18S21 | 5060-9436 | 7 | | PUSHBUTTON SWITCH P.C. MOUNT | 28480 | 5060-9436 |
| A18S22 | 5060-9436 | 7 | | PUSHBUTTON SWITCH P.C. MOUNT | 28480 | 5060-9436 |
| A18S23 | 5060-9436 | 7 | | PUSHBUTTON SWITCH P.C. MOUNT | 28480 | 5060-9436 |
| A18U1 | 1826-0180 | 0 | 1 | IC TIMER TTL MONO/ASTBL | 01295 | NE555P |
| A18U2 | 1820-0495 | 8 | 1 | IC DCDR TTL 4-10-16-LINE 4-INP | 01295 | SN74154N |
| A18U3 | 1820-1423 | 4 | 1 | IC MV TTL LS MONOSTBL RETRIG DUAL | 01295 | SN74LS123N |
| A18U4 | 1820-1197 | 9 | 1 | IC GATE TTL LS NAND QUAD 2-INP | 01295 | SN74LS00N |
| A18U5 | 1820-1851 | 2 | 3 | IC ENCDR TTL LS | 01295 | SN74LS148N |

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

## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| A18U6 | 1820-1851 | 2 | | IC ENCDR TTL LS | 01295 | SN74LS148N |
| A18U7 | 1820-1851 | 2 | | IC ENCDR TTL LS | 01295 | SN74LS148N |
| A18U8 | 1820-1278 | 7 | 1 | IC CNTR TTL LS BIN UP/DOWN SYNCHRO | 01295 | SN74LS191N |
| A18U9 | 1820-0628 | 9 | 2 | IC TTL 64-BIT RAM STAT 60-NS 0-C | 01295 | SN7489N |
| A18U10 | 1820-0628 | 9 | | IC TTL 64-BIT RAM STAT 60-NS 0-C | 01295 | SN7489N |
| A18U11 | 1820-1425 | 6 | 2 | IC SCHMITT-TRIG TTL LS NAND QUAD 2-INP | 01295 | SN74LS132N |
| A18U12 | 1820-1204 | 9 | 1 | IC GATE TTL LS NAND DUAL 4-INP | 01295 | SN74LS20N |
| A18U13 | 1820-1199 | 1 | 1 | IC INV TTL LS HEX 1-INP | 01295 | SN74LS04N |
| A18U14 | 1820-1202 | 7 | 2 | IC GATE TTL LS NAND TPL 3-INP | 01295 | SN74LS10N |
| A18U15 | 1820-1203 | 8 | 1 | IC GATE TTL LS AND TPL 3-INP | 01295 | SN74LS11N |
| A18U16 | 1820-1202 | 7 | | IC GATE TTL LS NAND TPL 3-INP | 01295 | SN74LS10N |
| A18U17 | 1820-1200 | 5 | 1 | IC INV TTL LS HEX | 01295 | SN74LS05N |
| A18U18 | 1820-1997 | 7 | 1 | IC FF TTL LS D-TYPE POS-EDGE-TRIG PRL-IN | 01295 | SN74LS374N |
| A18U19 | 1820-1730 | 6 | 1 | IC FF TTL LS D-TYPE POS-EDGE-TRIG COM | 01295 | SN74LS273N |
| A18U20 | 1820-1425 | 6 | | IC SCHMITT-TRIG TTL LS NAND QUAD 2-INP | 01295 | SN74LS132N |
| A18U21 | 1820-1112 | 8 | 3 | IC FF TTL LS D-TYPE POS-EDGE-TRIG | 01295 | SN74LS74AN |
| A18U22 | 1820-1112 | 8 | | IC FF TTL LS D-TYPE POS-EDGE-TRIG | 01295 | SN74LS74AN |
| A18U23 | 1820-1112 | 8 | | IC FF TTL LS D-TYPE POS-EDGE-TRIG | 01295 | SN74LS74AN |
| A18W1 | 04193-61601 | 1 | 1 | CABLE ASSEMBLY-FLAT | 28480 | 04193-61601 |
| | 1400-0249 | 0 | 1 | CABLE TIE .062-.625-DIA .091-WD NYL | 06383 | PLT1M-8 |
| | 5040-3322 | 6 | 8 | INSULATOR | 28480 | 5040-3322 |
| | 5041-0276 | 5 | 2 | KEY CAP-PEARL GRAY | 28480 | 5041-0276 |
| | 5041-0265 | 6 | 8 | KEY CAP-QUARTER LIGHT GRAY | 28480 | 5041-0265 |
| | 5041-0318 | 6 | 4 | KEY CAP | 28480 | 5041-0318 |
| | 5041-0375 | 5 | 2 | KEY CAP-QUARTER SMK | 28480 | 5041-0375 |
| | 5041-0384 | 6 | 3 | KEY CAP-QUARTER SMOKE GRAY | 28480 | 5041-0384 |
| | 5041-0408 | 5 | 1 | KEY CAP | 28480 | 5041-0408 |
| | 5041-0450 | 7 | 1 | KEY CAP | 28480 | 5041-0450 |
| | 5041-0922 | 8 | 2 | KEY CAP-QUARTER EBY-PRL | 28480 | 5041-0922 |
| | 5060-9444 | 7 | 1 | ROTARY PULSE GENERATOR | 28480 | 5060-9444 |
| | 04193-26518 | | 1 | PCBD BLANK | 28480 | 04193-26518 |

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

## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| **A20** | | | | | | |
| A20 | 04193-66520 | 3 | 1 | POWER SUPPLY BOARD ASSEMBLY | 28480 | 04193-66520 |
| A20C1 | 0180-3180 | 4 | 2 | CAPACITOR-FXD 10000UF 16VDC | 28480 | 0180-3180 |
| A20C2 | 0180-3180 | 4 | | CAPACITOR-FXD 10000UF 16VDC | 28480 | 0180-3180 |
| A20C3 | 0180-3181 | 5 | 1 | CAPACITOR-FXD 6800UF 35VDC | 28480 | 0180-3181 |
| A20C4 | 0180-1075 | 3 | 1 | CAPACITOR-FXD 2200 UF 16VDC AL | 28480 | 0180-1075 |
| A20C5 | 0180-3183 | 7 | 2 | CAPACITOR-FXD 470UF 50VDC | 28480 | 0180-3183 |
| A20C6 | 0180-2205 | 3 | 1 | CAPACITOR-FXD .33UF+-10% 35VDC TA | 56289 | 150D334X9035A2 |
| A20C7 | 0180-0374 | 3 | 6 | CAPACITOR-FXD 10UF+-10% 20VDC TA | 56289 | 150D106X9020B2 |
| A20C8 | 0180-0374 | 3 | | CAPACITOR-FXD 10UF+-10% 20VDC TA | 56289 | 150D106X9020B2 |
| A20C9 | 0180-0374 | 3 | | CAPACITOR-FXD 10UF+-10% 20VDC TA | 56289 | 150D106X9020B2 |
| A20C10 | 0180-0374 | 3 | | CAPACITOR-FXD 10UF+-10% 20VDC TA | 56289 | 150D106X9020B2 |
| A20C11 | 0180-0374 | 3 | | CAPACITOR-FXD 10UF+-10% 20VDC TA | 56289 | 150D106X9020B2 |
| A20C12 | 0180-0374 | 3 | | CAPACITOR-FXD 10UF+-10% 20VDC TA | 56289 | 150D106X9020B2 |
| A20C13 | 0160-4835 | 7 | 2 | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A20C14 | 0180-3182 | 6 | 1 | CAPACITOR-FXD 2200UF 35VDC | 28480 | 0180-3182 |
| A20C15 | 0180-0291 | 3 | 1 | CAPACITOR-FXD 1UF+-10% 35VDC TA | 56289 | 150D105X9035A2 |
| A20C16 | 0180-3183 | 7 | | CAPACITOR-FXD 470UF 50VDC | 28480 | 0180-3183 |
| A20C17 | 0180-2141 | 6 | 1 | CAPACITOR-FXD 3.3UF+-10% 50VDC TA | 56289 | 150D335X9050B2 |
| A20C18 | 0160-4835 | 7 | | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A20C19 | 0180-0291 | | | CAPACITOR-FXD 1UF 35VDC TA | | |
| A20C20 | 0180-0291 | | 2 | CAPACITOR-FXD 1UF 35VDC TA | | |
| A20CR3 | 1901-0731 | 7 | 2 | DIODE-PWR RECT 400V 1A | 28480 | 1901-0731 |
| A20CR4 | 1901-0731 | 7 | | DIODE-PWR RECT 400V 1A | 28480 | 1901-0731 |
| A20CR5 | 1901-0237 | 8 | 1 | DIODE:SI, RECTIFIER BRIDGE, 200V | 28480 | 1901-0237 |
| A20CR6 | 1902-3086 | 3 | 1 | DIODE-ZNR 4.75V 2% DO-35 PD=.4W | 28480 | 1902-3086 |
| A20CR7 | 1901-0040 | 1 | 2 | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A20CR8 | 1901-0040 | 1 | | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A20CR9 | 1906-0096 | 7 | 1 | DIODE-FW BRDG 200V 2A | 04713 | MDA202 |
| A20CR10 | 1902-0048 | 1 | 1 | DIODE-ZNR 6.81V 5% DO-35 PD=.4W | 28480 | 1902-0048 |
| A20CR11 | 1902-1217 | 8 | 1 | DIODE-ZNR 6.2V 5% DO-4 PD=10W TC=+.035% | 28480 | 1902-1217 |
| A20F1 | 2110-0007 | 4 | 2 | FUSE 1A 250V TD 1.25X.25 UL | 75915 | 313001 |
| A20F2 | 2110-0201 | 0 | 1 | FUSE .25A 250V TD 1.25X.25 UL | 75915 | 313.250 |
| A20F3 | 2110-0015 | 6 | 1 | FUSE 2.5A 250V TD 1.25X.25 | 28480 | 2110-0015 |
| A20F4 | 2110-0003 | | 1 | FUSE 3A 250V TD 1.25X.25 | 28480 | 2110-0003 |
| A20F5 | 2110-0303 | 3 | 1 | FUSE 2A 250V TD 1.25X.25 UL | 28480 | 2110-0303 |
| A20F6 | 2110-0007 | 4 | | FUSE 1A 250V TD 1.25X.25 UL | 75915 | 313001 |
| A20J1 | 1251-5862 | 6 | 8 | CONNECTOR 4-PIN M METRIC POST TYPE | 28480 | 1251-5862 |
| A20J2 | 1251-5862 | 6 | | CONNECTOR 4-PIN M METRIC POST TYPE | 28480 | 1251-5862 |
| A20J5 | 1251-5862 | 6 | | CONNECTOR 4-PIN M METRIC POST TYPE | 28480 | 1251-5862 |
| A20J6 | 1251-5862 | 6 | | CONNECTOR 4-PIN M METRIC POST TYPE | 28480 | 1251-5862 |
| A20J7 | 1251-5862 | 6 | | CONNECTOR 4-PIN M METRIC POST TYPE | 28480 | 1251-5862 |
| A20J8 | 1251-5862 | 6 | | CONNECTOR 4-PIN M METRIC POST TYPE | 28480 | 1251-5862 |
| A20J9 | 1251-5862 | 6 | | CONNECTOR 4-PIN M METRIC POST TYPE | 28480 | 1251-5862 |
| A20J10 | 1251-5862 | 6 | | CONNECTOR 4-PIN M METRIC POST TYPE | 28480 | 1251-5862 |
| A20J11 | 1251-3198 | 7 | 1 | CONNECTOR 15-PIN M POST TYPE | 28480 | 1251-3198 |
| A20J12 | 1251-3197 | 6 | 1 | CONNECTOR 12-PIN M POST TYPE | 28480 | 1251-3197 |
| A20R1 | 0683-6825 | 7 | 4 | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| A20R2 | 0698-7457 | | | RESISTOR 18 2% 2W | | |
| A20R3 | 0698-7457 | | | RESISTOR 18 2% 2W | | |
| A20R6 | 0698-3444 | 1 | 2 | RESISTOR 316 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-316R-F |
| A20R7 | 0683-0685 | 5 | 2 | RESISTOR 6.8 5% .25W FC TC=-400/+500 | 01121 | CB68G5 |
| A20R8 | 0698-3444 | 1 | | RESISTOR 316 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-316R-F |
| A20R9 | 0683-0685 | 5 | | RESISTOR 6.8 5% .25W FC TC=-400/+500 | 01121 | CB68G5 |
| A20R10 | 0757-0401 | 0 | 1 | RESISTOR 100 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-101-F |
| A20R11 | 0757-0274 | 5 | 1 | RESISTOR 1.21K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1211-F |
| A20R12 | 0683-1025 | 5 | 1 | RESISTOR 1K 1% .25W F TC=0+-100 | 03888 | PME55-1/8-T0-21R5-F |
| A20R13 | 0683-4705 | 8 | 1 | RESISTOR 47 5% .25W FC TC=-400/+500 | 01121 | CB4705 |
| A20R14 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| A20R15 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| A20R16 | 0683-1025 | 9 | 2 | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| A20R17 | 0683-1535 | 6 | 1 | RESISTOR 15K 5% .25W FC TC=-400/+800 | 01121 | CB1535 |
| A20R18 | 0683-2215 | 1 | 1 | RESISTOR 220 5% .25W FC TC=-400/+600 | 01121 | CB2215 |
| A20R19 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| A20R20 | 0757-0398 | 4 | 1 | RESISTOR 75 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-75R0-F |
| A20R21 | 0757-0277 | 8 | 1 | RESISTOR 49.9 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4992-F |
| A20R22 | 0698-0024 | 7 | 1 | RESISTOR 2.61K 1% .5W F TC=0+-100 | 28480 | 0698-0024 |
| A20R23 | 0683-2225 | 3 | 1 | RESISTOR 2.2K 5% .25W FC TC=-400/+700 | 01121 | CB2225 |
| A20R24 | 2100-3210 | 6 | 1 | RESISTOR-TRMR 10K 10% C TOP-ADJ 1-TRN | 28480 | 2100-3210 |
| A20R25 | 0757-0442 | 9 | 1 | RESISTOR 10K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1002-F |
| A20R26 | 0683-1825 | 9 | | RESISTOR 1.8K 5% .25W FC TC=-400/+600 | | |
| A20R27 | 0683-1825 | | | RESISTOR 1.8K 5% .25W FC TC=-400/+600 | | |

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

## Table 6-3. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| A20U1 | 1826-0215 | 2 | 1 | IC V RGLTR TO-220 | 04713 | MC7905.2CT |
| A20U2 | 1820-0493 | 6 | 1 | IC OP AMP GP 8-DIP-P PKG | 27014 | LM307N |
| A20U3 | 1826-0527 | 9 | 1 | IC 337 V RGLTR TO-220 | 27014 | LM337T |
| A20U4 | 1826-0065 | 0 | 1 | IC COMPARATOR PRCN 8-DIP-P PKG | 01295 | SN72311P |
| A20U5 | 1826-0106 |  | 1 | IC V RGLTR 7815 |  |  |
|  | 2110-0269 | 0 | 12 | FUSEHOLDER-CLIP TYPE.25D-FUSE | 28480 | 2110-0269 |
| A20W3 | 8159-0005 |  | 1 | JUMPER WIRE |  |  |
|  | 04193-26520 | 0 | 1 | PCBD BLANK | 28480 | 04193-26520 |

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

## Table 6-3. Replaceable Parts

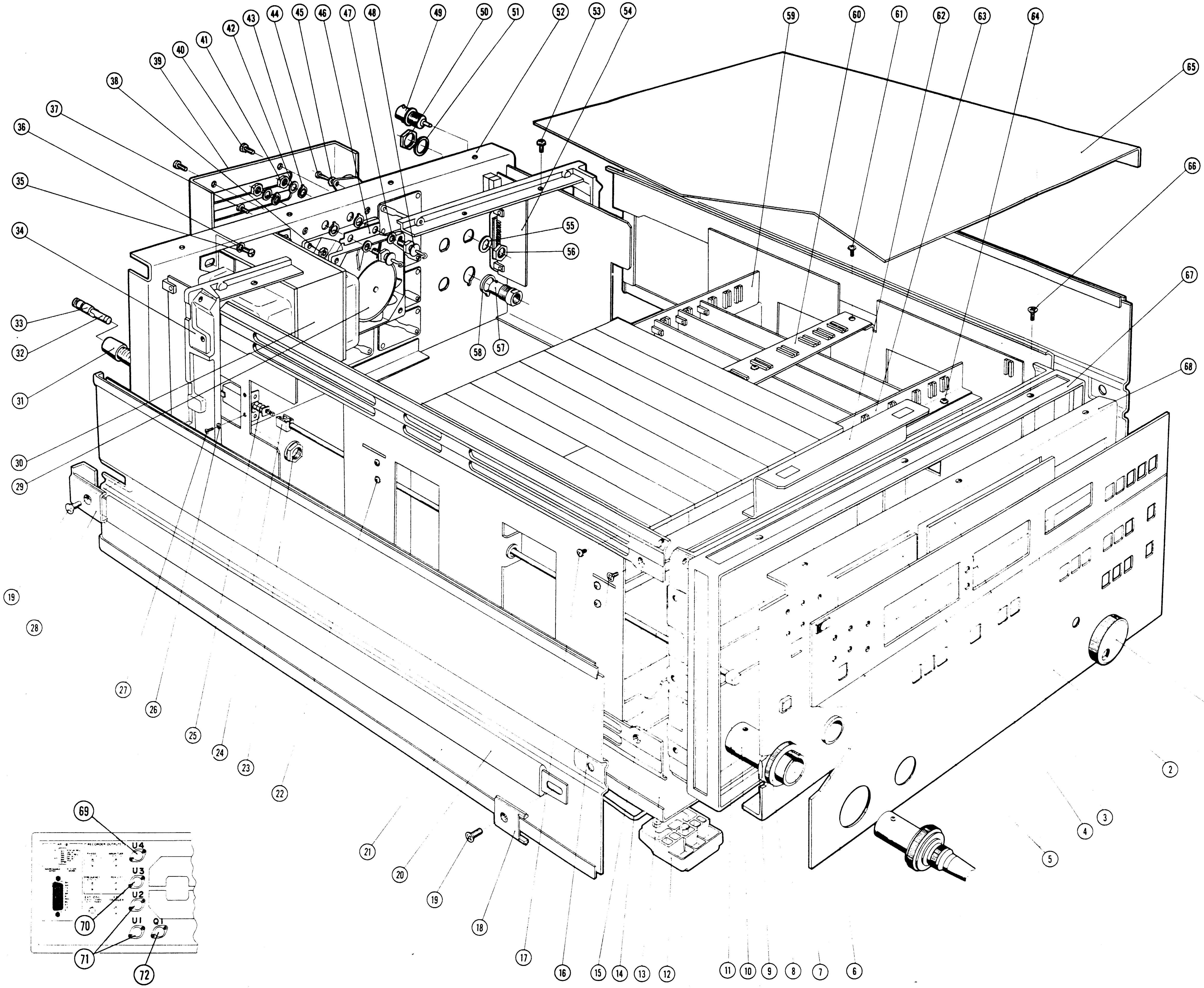
| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| **A41 A51 A52** | | | | | | |
| A41 | 04193-66541 | 8 | 1 | DELAY BOARD ASSEMBLY | 28480 | 04193-66541 |
| | 04193-26541 | 0 | 1 | PCBD BLANK | 28480 | 04193-26541 |
| A51 | 04193-66551 | 0 | 1 | PROBE I CHANNEL BOARD ASSEMBLY | 28480 | 04193-66551 |
| A51C1 | 0160-4249 | 7 | 2 | CAPACITOR-FXD 4.7PF +-.5PF 50VDC CER | 26654 | 3BN050S4R7D(D) |
| A51CR1 | 5080-3829 | 8 | 8 | DIODE-SM SIG SCHOTTKY | 28480 | 5080-3829 |
| A51CR2 | 5080-3829 | 8 | | DIODE-SM SIG SCHOTTKY | 28480 | 5080-3829 |
| A51CR3 | 5080-3829 | 8 | | DIODE-SM SIG SCHOTTKY | 28480 | 5080-3829 |
| A51CR4 | 5080-3829 | 8 | | DIODE-SM SIG SCHOTTKY | 28480 | 5080-3829 |
| A51Q1 | 1855-0465 | | 4 | TRANSISTOR-FET N-CHANNEL | | |
| A51R1 | 0699-0920 | | | RESISTOR-FXD 50 OHM 1% 1/16W | | |
| A51T1 | 04193-61552 | 1 | 2 | BALUN | 28480 | 04193-61552 |
| | 04193-26551 | 0 | 1 | PCBD BLANK | 28480 | 04193-26551 |
| A52 | 04193-66552 | 1 | 1 | PROBE V CHANNEL BOARD ASSEMBLY | 28480 | 04193-66552 |
| A52C1 | 0160-4249 | 7 | | CAPACITOR-FXD 4.7PF +-.5PF 50VDC CER | 26654 | 3BN050S4R7D(D) |
| A52C2 | 0160-5427 | 3 | 1 | CAPACITOR-FXD 0.1UF +-10% 100VDC | 28480 | 0160-5427 |
| A52CR1 | 5080-3829 | 8 | | DIODE-SM SIG SCHOTTKY | 28480 | 5080-3829 |
| A52CR2 | 5080-3829 | 8 | | DIODE-SM SIG SCHOTTKY | 28480 | 5080-3829 |
| A52CR3 | 5080-3829 | 8 | | DIODE-SM SIG SCHOTTKY | 28480 | 5080-3829 |
| A52CR4 | 5080-3829 | 8 | | DIODE-SM SIG SCHOTTKY | 28480 | 5080-3829 |
| A52Q1 | 1855-0465 | | | TRANSISTOR-FET N CHANNEL | | |
| A52R1 | 0699-0920 | | | RESISTOR-50 OHM 1% .1/16W | | |
| A52T1 | 04193-61552 | 1 | | BALUN | 28480 | 04193-61552 |
| | 04193-26552 | 0 | 1 | PCDB BLANK | 28480 | 04193-26552 |

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

## Table 6-4. Parts Identification

| Reference Designation | HP Part Number | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|
| 1 | 0370-3033 | 1 | KNOB | | |
| 2 | 04193-00201 | 1 | FRONT PANEL (HP) | | |
| | 04193-00202 | 1 | FRONT PANEL (YHP) | | |
| 3 | 04262-40002 | 1 | WINDOW | | |
| 4 | 04140-25001 | 1 | WINDOW | | |
| 5 | 7120-1254 | 1 | TRADE MARK (HP) | | |
| | 7120-0478 | 1 | TRADE MARK (YHP) | | |
| 6 | 04193-40001 | 1 | PROBE HOLDER | | |
| 7 | 04191-40001 | 1 | GUIDE | | |
| 8 | 04193-24002 | 1 | NUT | | |
| 9 | 04193-24001 | 1 | NUT | | |
| 10 | 04193-21001 | 1 | BODY RECEPTACLE | | |
| 11 | 5041-0564 | 1 | KEY CAP | | |
| 12 | 5040-7201 | 4 | FOOT | | |
| 13 | 5060-9847 | 1 | BOTTOM COVER | | |
| 14 | 1460-1345 | 2 | STAND | | |
| 15 | 04193-25101 | 1 | ROD | | |
| 16 | 2510-0192 | 16 | SCREW | | |
| 17 | 2360-0115 | 15 | SCREW | | |
| 18 | 5040-7219 | 2 | FRONT CAP | | |
| 19 | 2680-0172 | 4 | SCREW | | |
| 20 | 5060-9804 | 2 | HANDLE | | |
| 21 | 5060-9942 | 2 | SIDE COVER | | |
| 22 | 2360-0115 | 4 | SCREW | | |
| 23 | 2110-0569 | 1 | NUT | | |
| 24 | 04192-40002 | 1 | COUPLER | | |
| 25 | 3101-2216 | 1 | POWER SWITCH | | |
| 26 | 3050-0235 | 2 | WASHER (F) | | |
| | 2190-0225 | 2 | WASHER (S) | | |
| 27 | 0515-0150 | 2 | SCREW | | |
| 28 | 5040-7220 | 2 | REAR CAP | | |
| 29 | 3160-0390 | 1 | FAN | | |
| 30 | 9100-4176 | 1 | TRANSFORMER | | |
| 31 | 2110-0564 | 1 | FUSE HOLDER | | |
| 32 | 2110-0304 | 1 | FUSE | | |
| 33 | 2110-0565 | 1 | CAP | | |
| 34 | 5020-8806 | 1 | REAR FRAME | | |
| 35 | 2510-0045 | 4 | SCREW | | |
| 36 | 3050-0139 | 4 | WASHER | | |
| 37 | 2360-0117 | 4 | SCREW | | |
| 38 | 2420-0006 | 4 | NUT | | |
| 39 | 04193-04001 | 1 | COVER | | |
| 40 | 2360-0113 | 8 | SCREW | | |
| 41 | 2740-0003 | 2 | NUT | | |
| 42 | 3050-0226 | 2 | WASHER | | |
| 43 | 1200-0080 | 4 | INSULATOR | | |
| 44 | 0624-0260 | 10 | SCREW | | |
| 45 | 2190-0008 | 10 | WASHER | | |
| 46 | 5000-4207 | 1 | SHORT BAR | | |
| 47 | 2190-0057 | 2 | WASHER | | |
| 48 | 1901-0496 | 2 | DIODE | | |
| 49 | 1250-0118 | 5 | BNC CONNECTOR (FEMALE) | | |
| 50 | 2950-0035 | 1 | NUT | | |
| 51 | 04271-50024 | 1 | INSULATOR | | |
| 52 | 04193-60101 | 1 | REAR PANEL | | |
| 53 | 2360-0113 | 8 | SCREW | | |
| 54 | 04262-66503 | 1 | HP-IB CONNECTOR | | |
| 55 | 2190-0016 | 8 | WASHER | | |
| 56 | 2950-0001 | 5 | NUT | | |
| 57 | 1250-0252 | 1 | BNC CONNECTOR (FEMALE) | | |
| 58 | 04271-50025 | 1 | INSULATOR | | |
| 59 | 04193-01204 | 1 | ANGLE | | |
| 60 | 04193-00605 | 1 | PLATE | | |
| 61 | 2360-0113 | 2 | SCREW | | |
| 62 | 04193-01205 | 1 | SUPPORT | | |
| 63 | 04193-01203 | 1 | ANGLE | | |
| 64 | 2360-0113 | 3 | SCREW | | |
| 65 | 5060-9835 | 1 | TOP COVER | | |
| 66 | 2360-0333 | 6 | SCREW | | |
| 67 | 5020-8805 | 1 | FRONT FRAME | | |
| 68 | 04193-00203 | 1 | SUB PANEL | | |
| 69 | 1826-0203 | 1 | TRANSISTOR (U4) | | |
| 70 | 1826-0169 | 1 | TRANSISTOR (U3) | | |
| 71 | 1820-0430 | 2 | TRANSISTOR (U1 and U2) | | |
| 72 | 1854-0611 | 1 | TRANSISTOR (Q1) | | |

See introduction to this section for ordering information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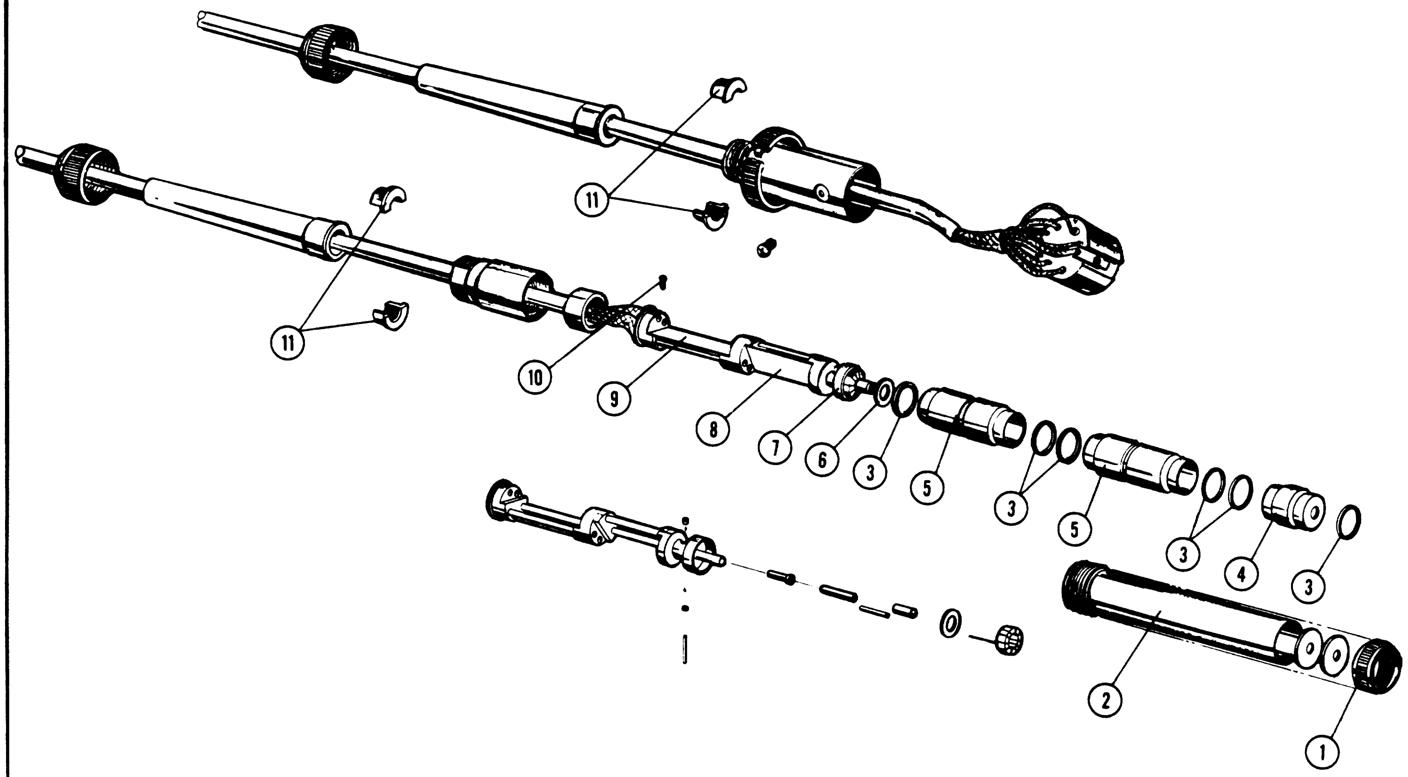
RECORDER OUTPUT



* Probe Part No. : 04193-61151

| Reference | HP Part No. | Qty | Description |
|---|---|---|---|
| 1 | 04193-24012 | 1 | NUT |
| 2 | 04193-21018 | 1 | PROBE HOUSING |
| 3 | 04193-21016 | 6 | RING |
| 4 | 04193-21014 | 1 | INNER SHELL (TOP) |
| 5 | 04193-21015 | 2 | INNER SHELL |
| 6 | 3050-1080 | 1 | WASHER |
| 7 | 04193-61551 | 1 | CURRENT TRANSFORMER |
| 8 | 04193-66551 | 1 | A51 BOARD ASS'Y |
| 9 | 04193-66552 | 1 | A52 BOARD ASS'Y |
| 10 | 0516-0003 | 4 | SCREW |
| 11 | 04193-40012 | 4 | CABLE COLLAR |

Figure 6-1. Exploded View of Probe Assembly.

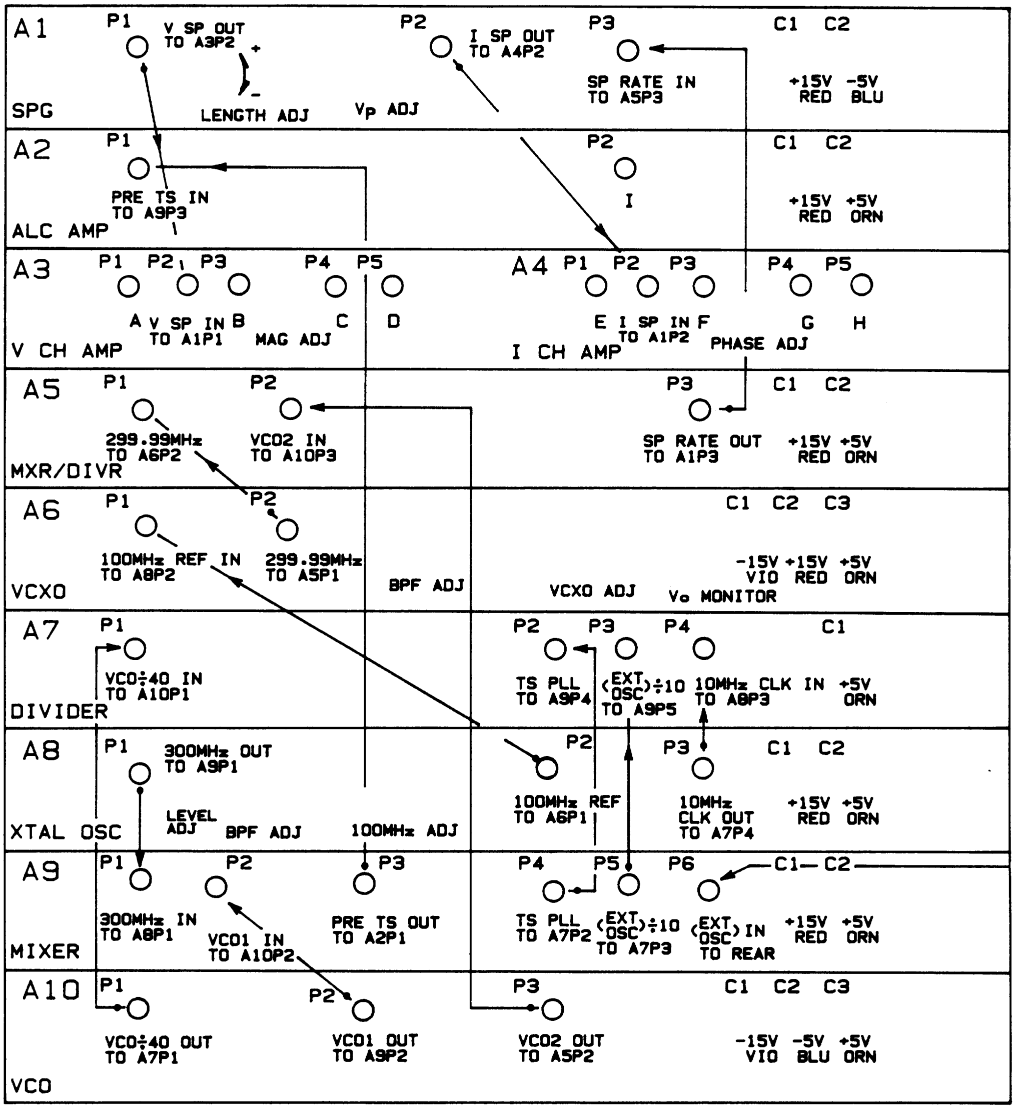


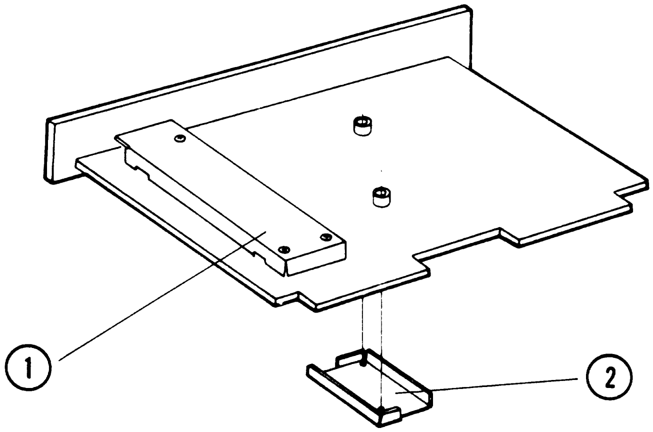
Figure 6-2. Top View of Extrusion Boards.

Table 6-5. Cables on Extrusion Boards.

| Terminals | Cable Part No. | Cable Length | Color | |
|---|---|---|---|---|
| | | | Cable | Heat shrink |
| A1P1 — A3P2 | 04193-61631 | 380 mm | blue | black |
| A1P2 — A4P2* | 04193-61615 | 100 mm | yellow | red |
| | 04193-61616 | 150 mm | | yellow |
| | 04193-61617 | 200 mm | | blue |
| A1P3 — A5P3 | 04193-61619 | 180 mm | blue | yellow |
| A2P1 — A9P3 | 04193-61620 | 220 mm | blue | blue |
| A2P2 — Probe (I) | — | — | blue | blue |
| A3P1 — Probe (A) | — | — | blue | blue |
| A3P3 — Probe (B) | — | — | blue | blue |
| A3P4 — Probe (C) | — | — | blue | blue |
| A3P5 — Probe (D) | — | — | blue | blue |
| A4P1 — Probe (E) | — | — | blue | blue |
| A4P3 — Probe (F) | — | — | blue | blue |
| A4P4 — Probe (G) | — | — | blue | blue |
| A4P5 — Probe (H) | — | — | blue | blue |
| A5P1 — A6P2 | 04193-61618 | 70 mm | blue | red |
| A5P2 — A10P3 | 04193-61620 | 220 mm | blue | blue |
| A6P1 — A8P2 | 04193-61619 | 180 mm | blue | yellow |
| A7P1 — A10P1 | 04193-61619 | 180 mm | blue | yellow |
| A7P2 — A9P4 | 04193-61618 | 70 mm | blue | red |
| A7P3 — A9P5 | 04193-61618 | 70 mm | blue | red |
| A7P4 — A8P3 | 04193-61618 | 70 mm | blue | red |
| A8P1 — A9P1 | 04193-61618 | 70 mm | blue | red |
| A9P2 — A10P2 | 04193-61618 | 70 mm | blue | red |
| A9P6 — EXT OSC | 04193-61603 | 600 mm | blue | blue |

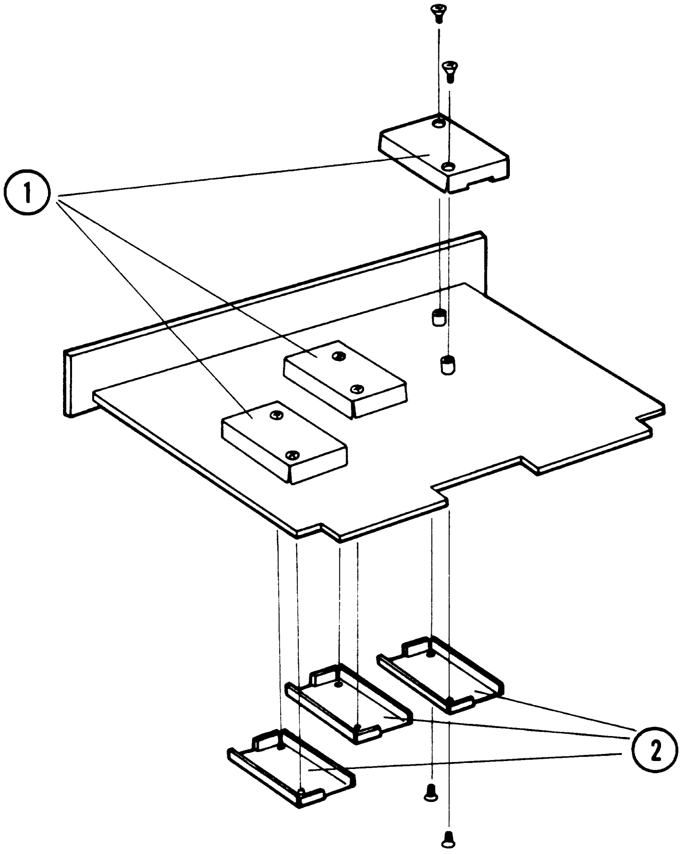
* : cables for adjustment

**A1**



| Reference | HP Part No. | Qty | Description |
|---|---|---|---|
| 1 | 04193-00606 | 1 | SHIELD BOX 40x120x12.3 |
| 2 | 04193-00607 | 1 | SHIELD BOX 36x55x4 |

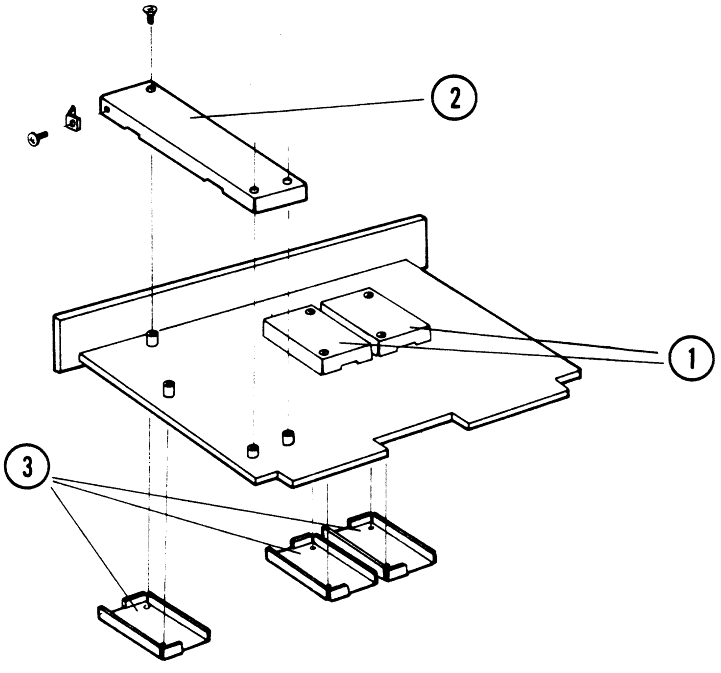
**A6**



| Reference | HP Part No. | Qty | Description |
|---|---|---|---|
| 1 | 04193-00604 | 3 | SHIELD BOX 36x55x12.3 |
| 2 | 04193-00607 | 3 | SHIELD BOX 36x55x4 |

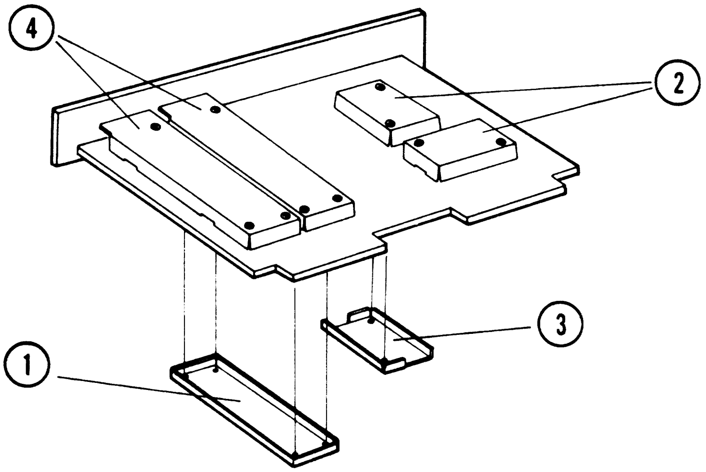
Figure 6-3. Shield Box (Sheet 1 of 3).

**A8**



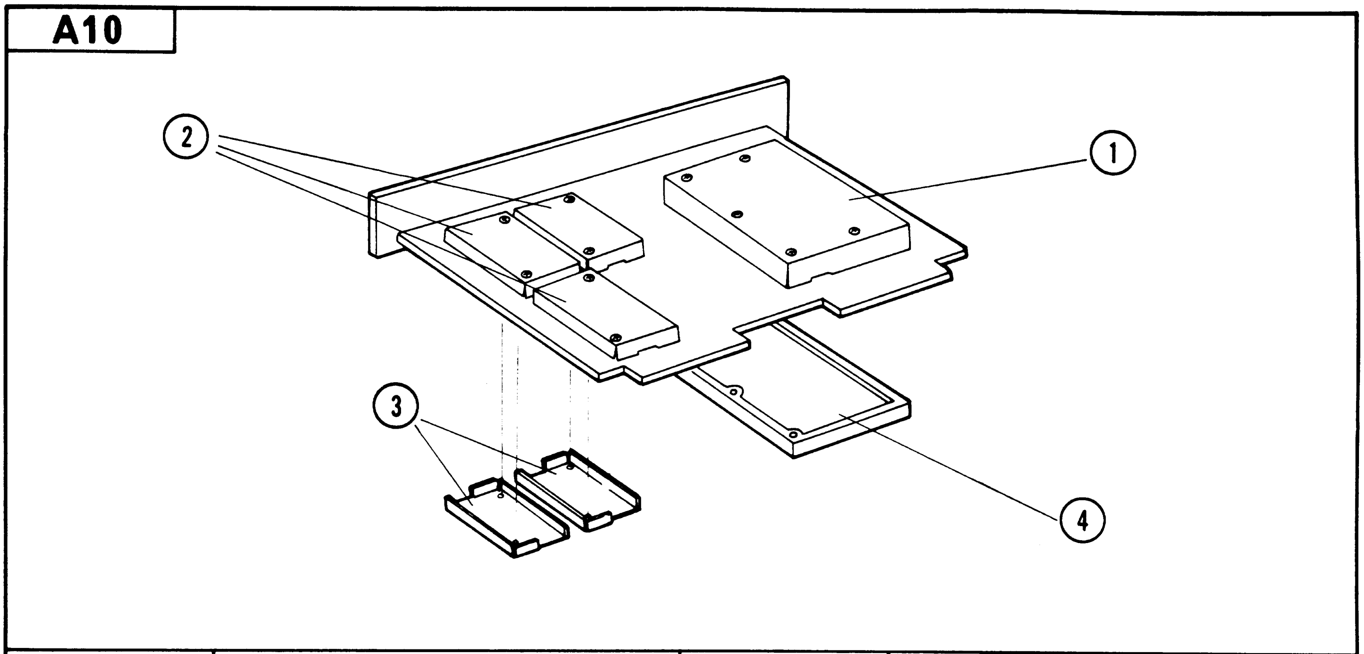
| Reference | HP Part No. | Qty | Description |
|---|---|---|---|
| 1 | 04193-00604 | 2 | SHIELD BOX 36x55x12.3 |
| 2 | 04193-00606 | 1 | SHIELD BOX 40x120x12.3 |
| 3 | 04193-00607 | 3 | SHIELD BOX 36x55x4 |

**A9**



| Reference | HP Part No. | Qty | Description |
|---|---|---|---|
| 1 | 04191-00614 | 1 | SHIELD BOX 36x97x4 |
| 2 | 04193-00604 | 2 | SHIELD BOX 36x55x12.3 |
| 3 | 04193-00607 | 1 | SHIELD BOX 36x55x4 |
| 4 | 04193-00608 | 2 | SHIELD BOX 36x110.5x12.3 |

Figure 6-3. Shield Box (Sheet 2 of 3).



| Reference | HP Part No. | Qty | Description |
|---|---|---|---|
| 1 | 04191-00601 | 1 | SHIELD BOX 56x91x12.3 |
| 2 | 04193-00604 | 3 | SHIELD BOX 36x55x12.3 |
| 3 | 04193-00607 | 2 | SHIELD BOX 36x55x4 |
| 4 | 04193-20006 | 1 | SHIELD BOX 46.5x91x4 |

Figure 6-3. Shield Box (Sheet 3 of 3).

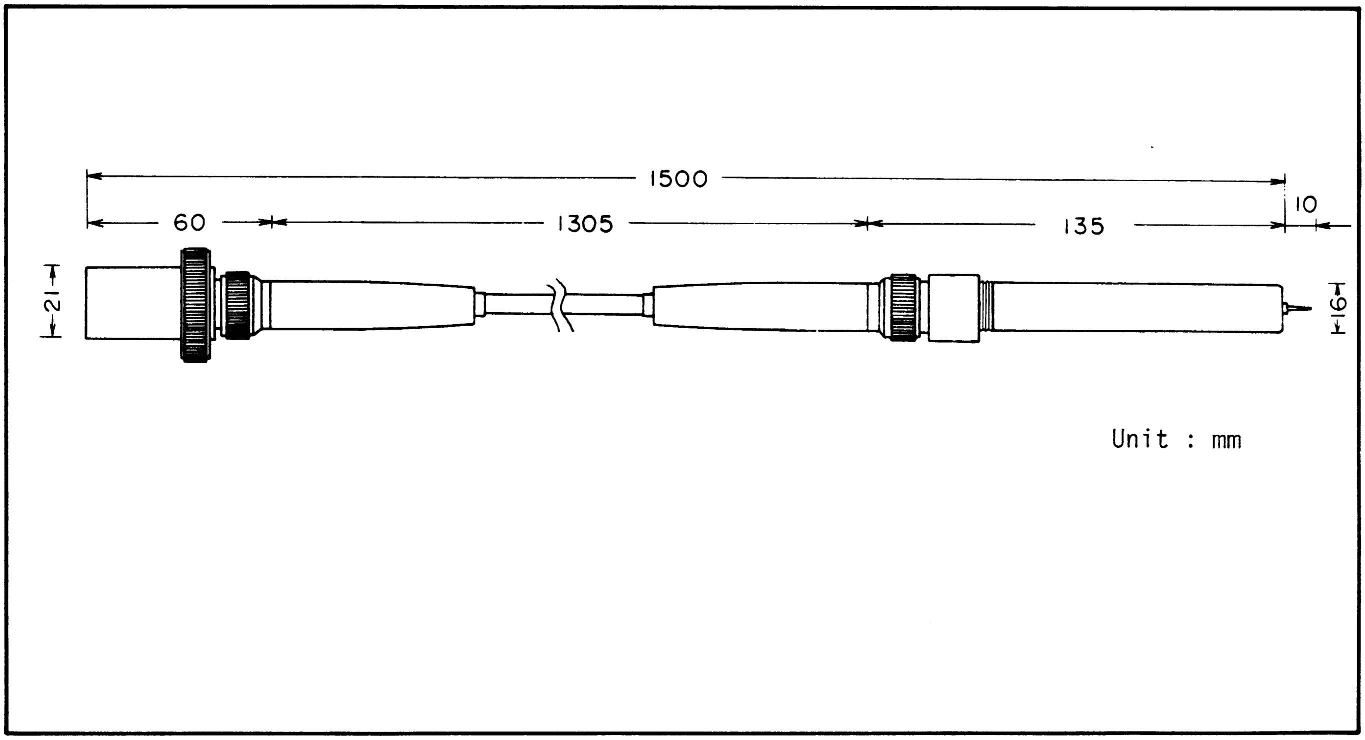


Figure 6-4. Probe Dimensions.

# SECTION VII
# MANUAL CHANGES

## 7-1. INTRODUCTION

7-2. This section contains information for adapting this manual to instruments to which the contents do not directly apply. The following paragraphs explain how to adapt this manual to apply to older instruments with a lower serial prefix.

## 7-3. MANUAL CHANGES

7-4. To adapt this manual to your particular instrument, refer to Table 7-1 and make all of the manual changes listed opposite your instrument serial number. Perform these changes in the summary by assembly.

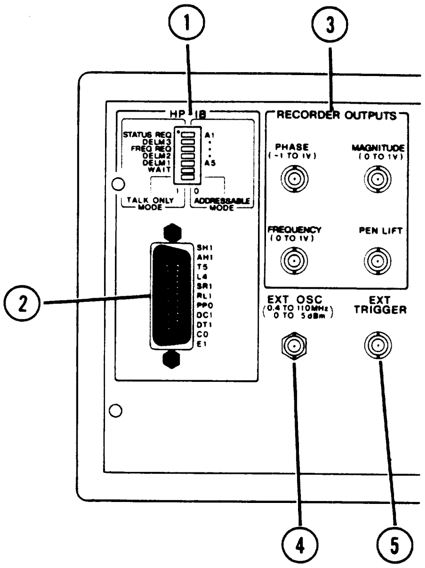
7-5. If your instrument serial number is not listed on the title page of this manual or in Table 7-1 to the right, it may be documented in a yellow MANUAL CHANGES supplement. For additional information about serial number coverage, refer to INSTRUMENT COVERED BY MANUAL in Section I.

Table 7-1. Manual Changes by Serial Number

| Serial Prefix or Number | Make Manual Changes |
|---|---|
| 2136J00106 and below | 1 |
| 2136J00124 and below | 2 |
| 2022J00144 and below | 3 |
| 2022J00264 and below | 4 |

## CHANGE 1

Page 3-6, Figure 3-2 :
Partially change the figure as follows :



Page 3-20, para. 3-62, line 4 :
Change the line as follows :

logical 0 (right position) and logical 1 (left)

Page 3-20, Figure 3-14 :
Change the figure as follows :

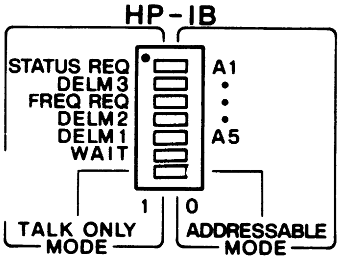


Figure 3-14. HP-IB Control Switch.

Page 3-20, Figure 3-15 :
Change the figure as follows :

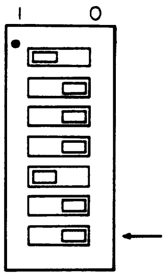


Figure 3-15. ADDRESSABLE Mode.

Page 3-21, Figure 3-16 :
Change the figure as follows :

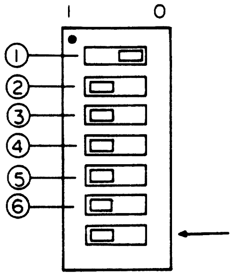
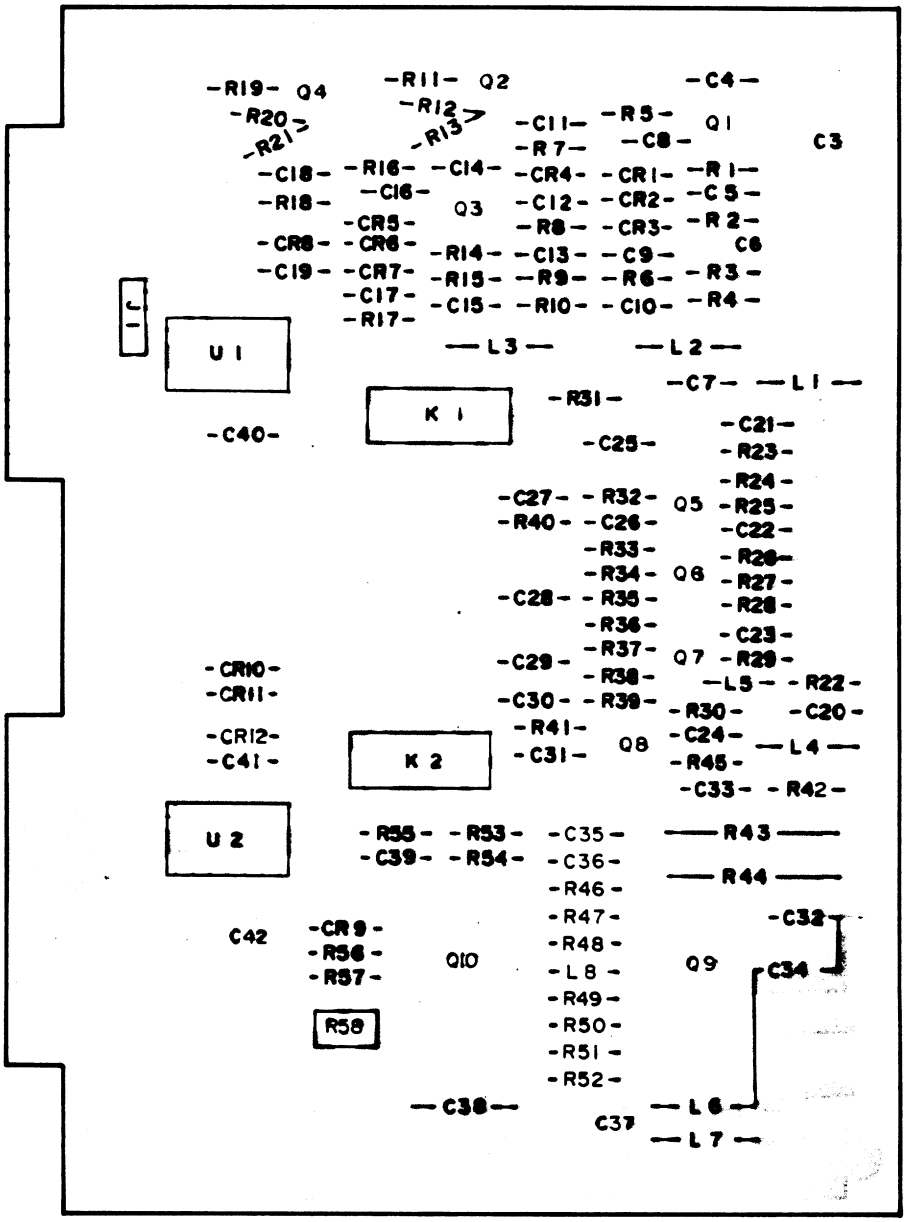
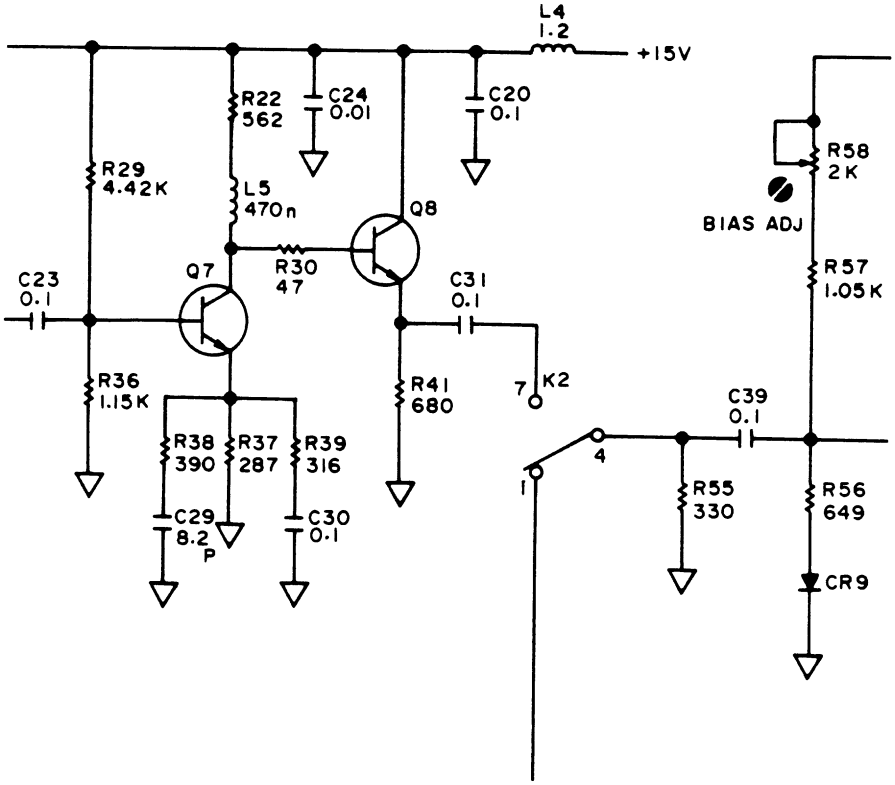


Figure 3-16. TALK ONLY Mode.

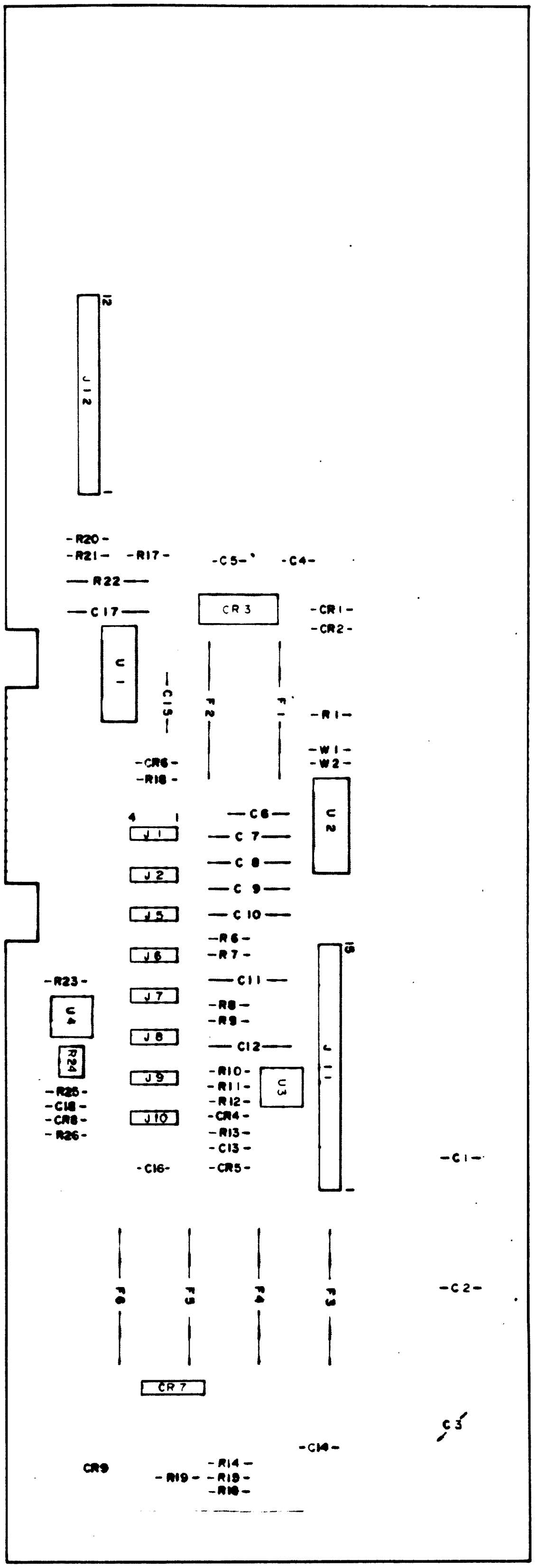
Page 8-47, Figure 8-28. A2 ALC Amplifier Board Assembly Component Locations:
Partially change the figure as follows:



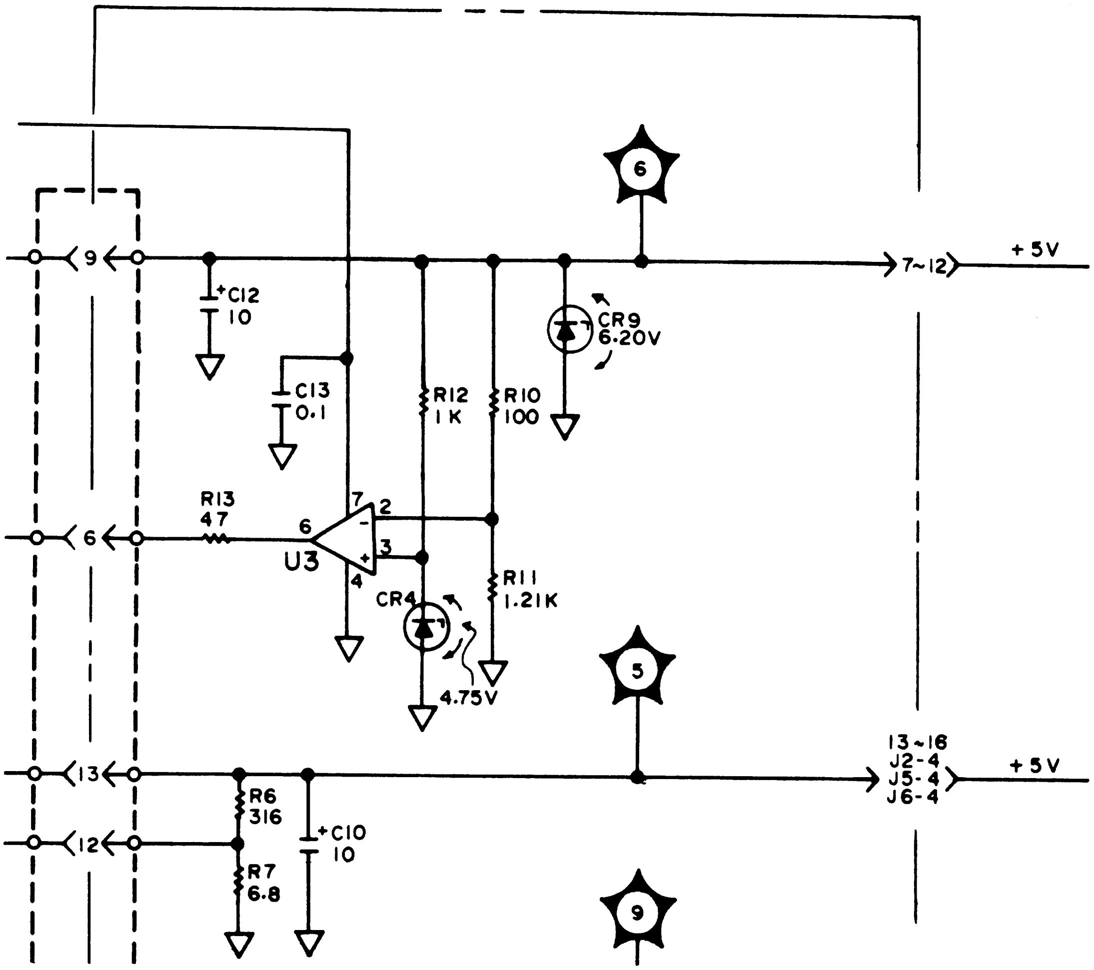
Page 8-47, Figure 8-29. A2 ALC Amplifier Board Assembly Schematic Diagram: Partially change the diagram as follows:



Page 8-131, Figure 8-75. A20 Power Supply Board Assembly Component Locations: Partially change the diagram as follows:



Page 8-131, Figure 8-76. A20 Power Supply Board Assembly Schematic Diagram:
Partially change the diagram as follows:



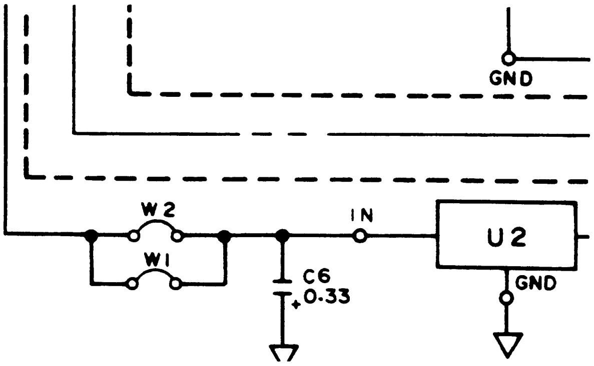
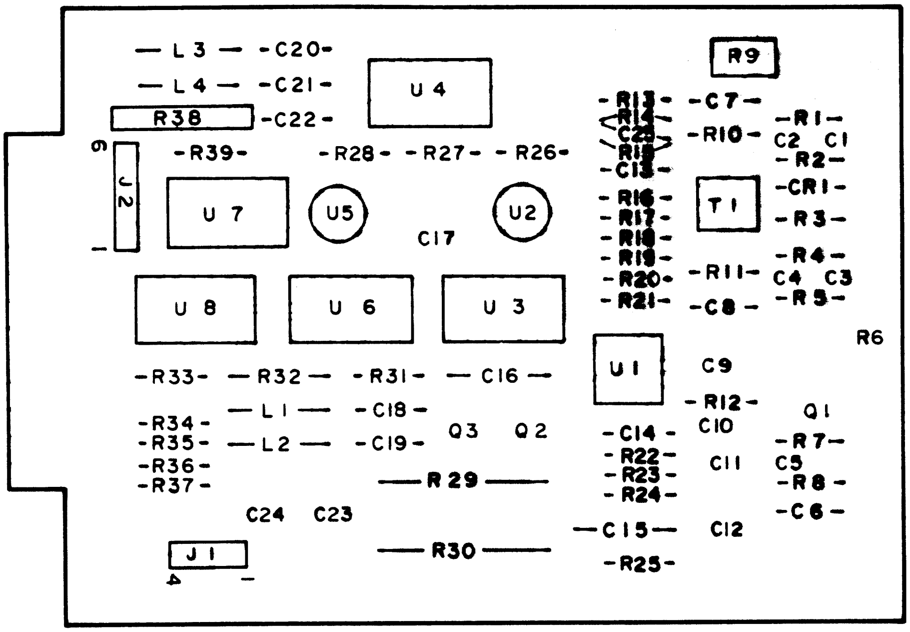


Table 6-3. Replaceable Parts:
See Table 7-2.

CHANGE 2

Page 8-53, Figure 8-31. V-Channel Amplifier Board Assembly Component Locations: Partially change the diagram as follows:



Page 8-53, Figure 8-33. V-Channel Amplifier/A52 Probe V-Channel Board Assembly Schematic Diagram:
Delete A3R40.

Page 8-59, Figure 8-37. A4 I-Channel Amplifier/A51 Probe I-Channel Board Assembly Schematic Diagram:
Partially change the diagram as follows:

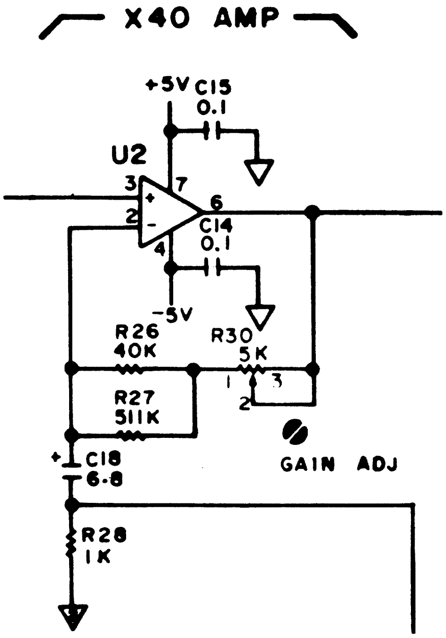
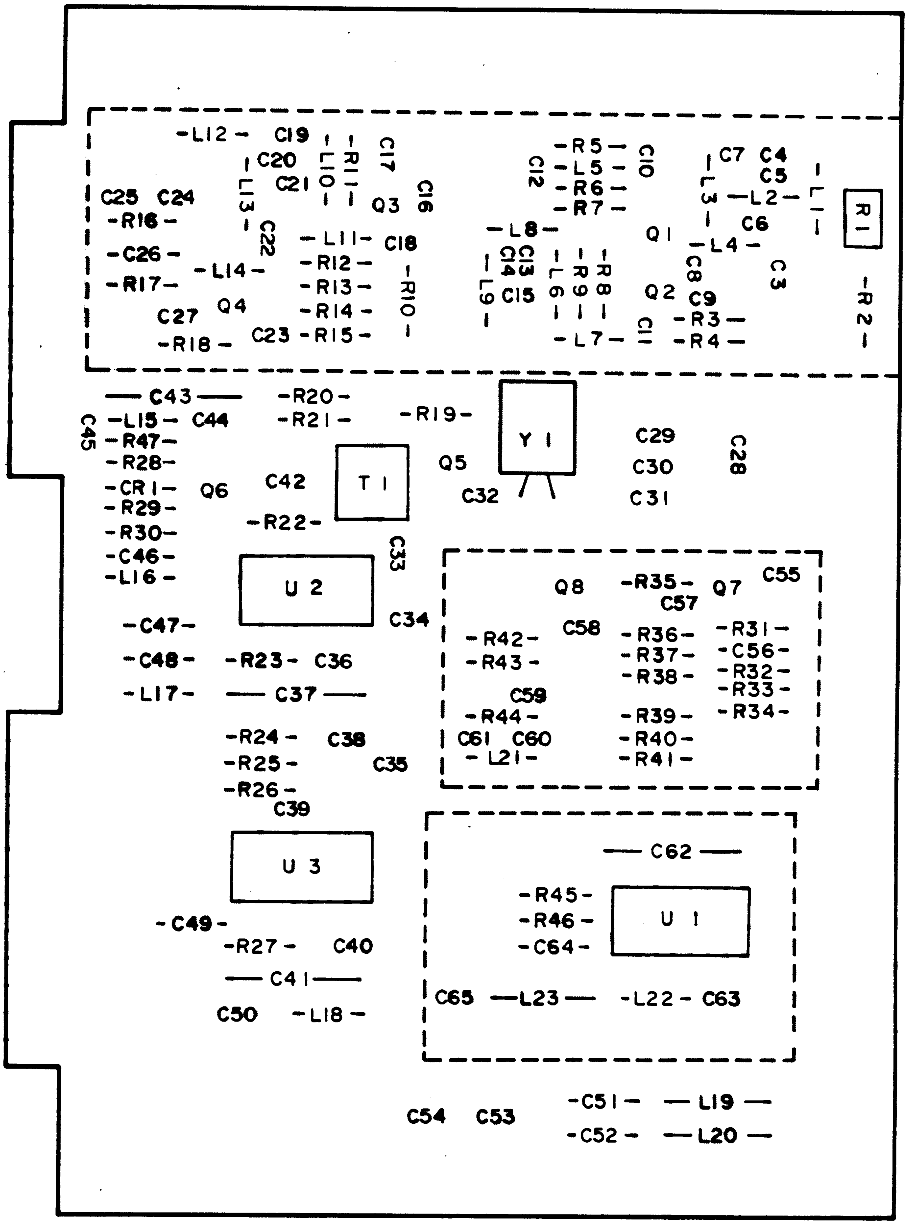


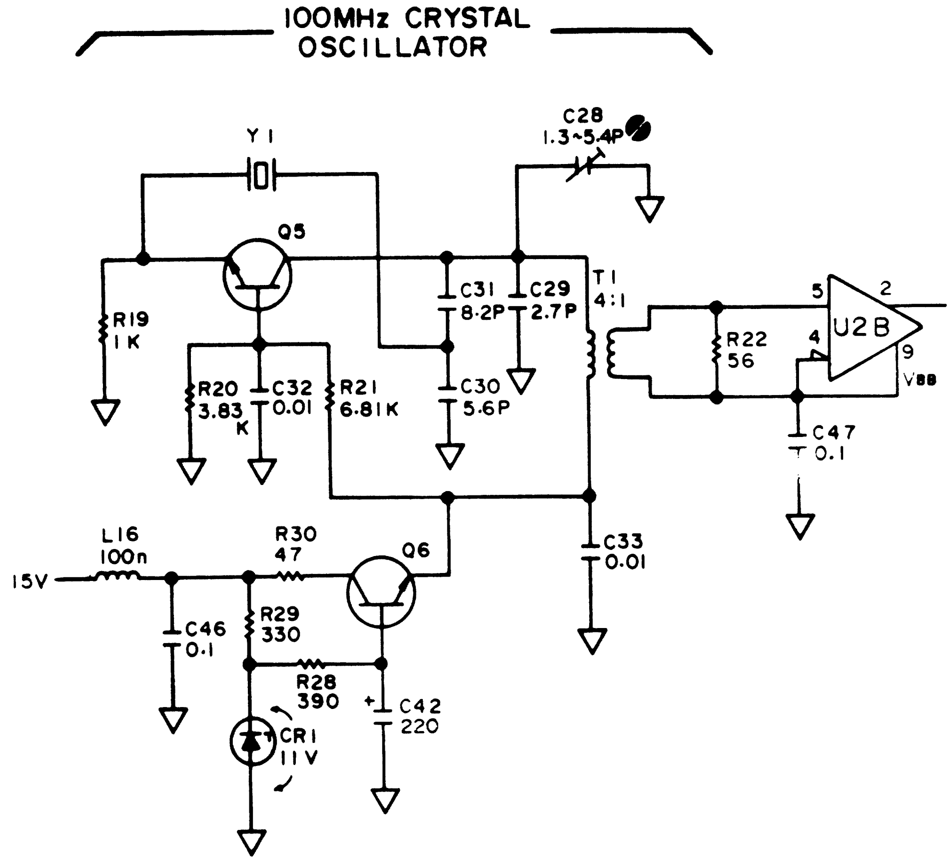
Table 6-3. Replaceable Parts:
See Table 7-2.

## CHANGE 3

Page 8-77, Figure 8-46. A8 Crystal Oscillator Board Assembly Component Locations: Partially change the diagram as follows:



Page 8-77, Figure 8-47. A8 Crystal Oscillator Board Assembly Schematic Diagram:
Partially change the diagram as follows:



Page 8-85, Figure 8-50. A10 Voltage Controlled Oscillator Board Assembly Component Locations:

Partially change the diagram as follows:

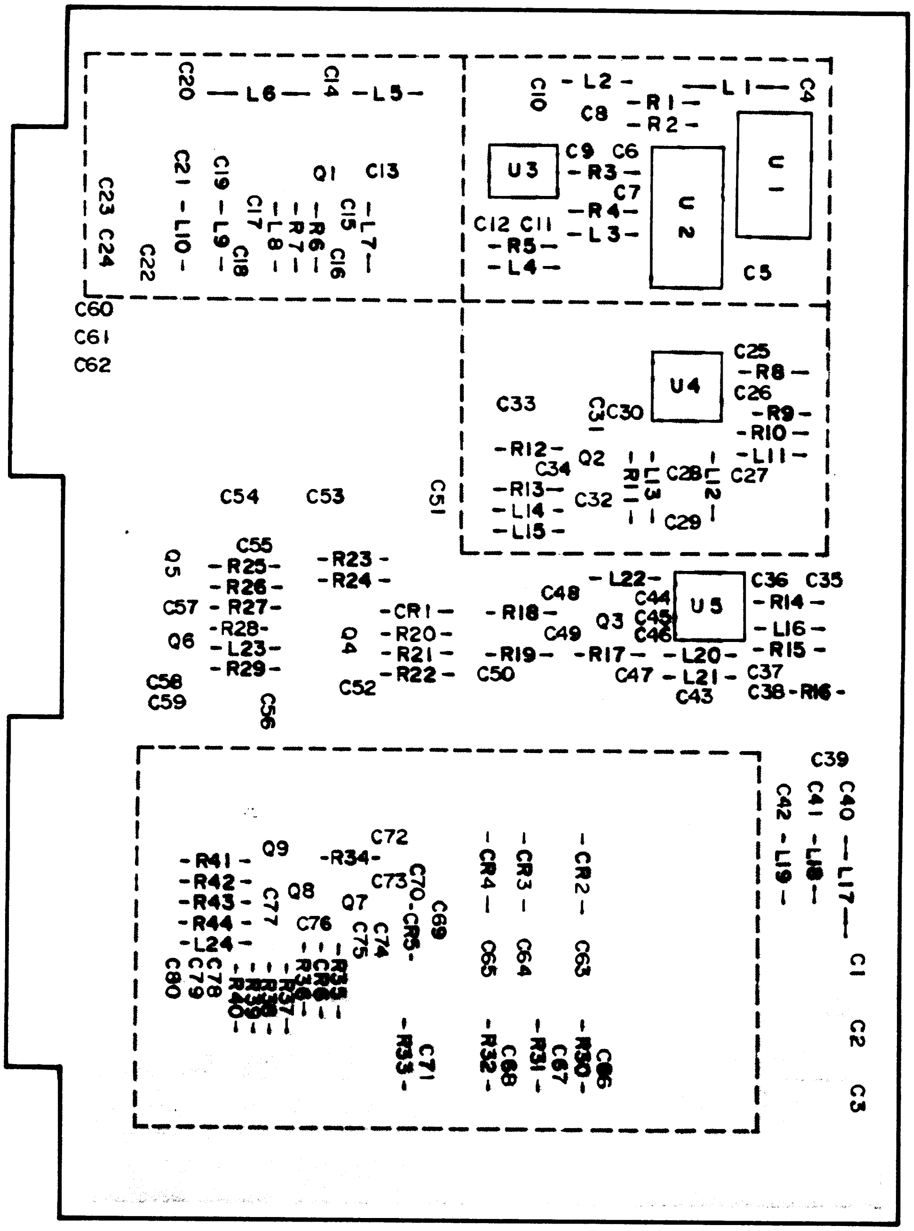


Table 6-3. Replaceable Parts:

See Table 7-2.

Page 8-85, Figure 8-51. A10 Voltage Controlled Oscillator Board Assembly Schematic Diagram:

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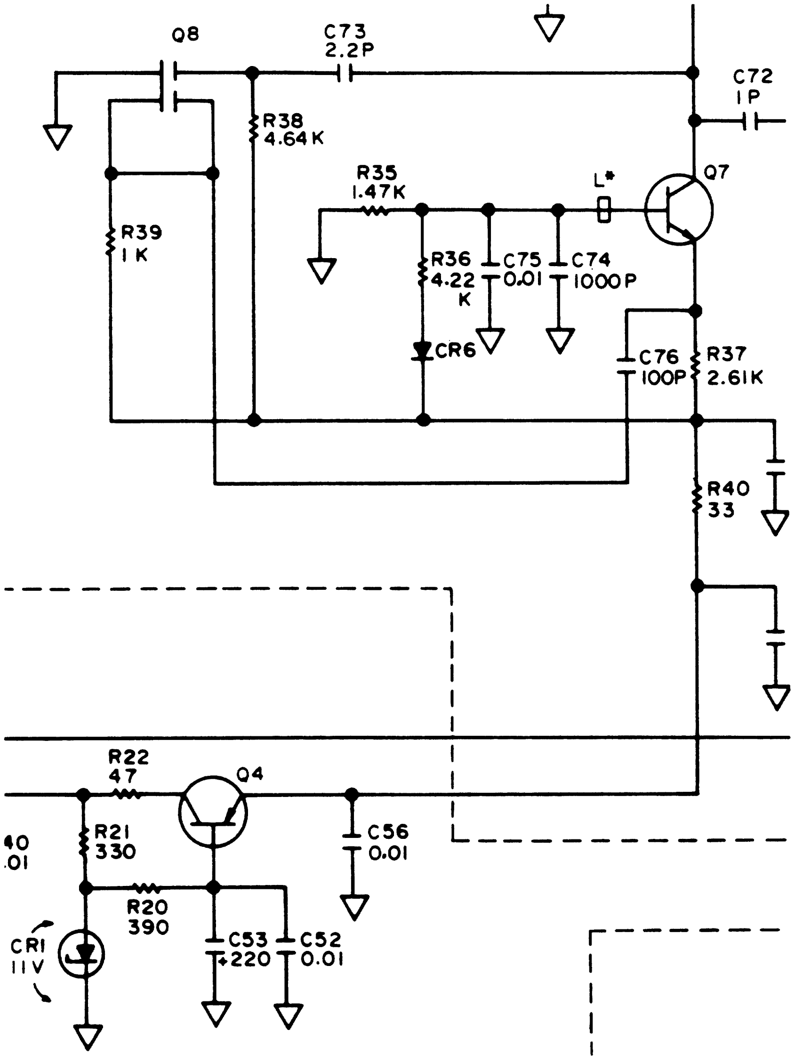


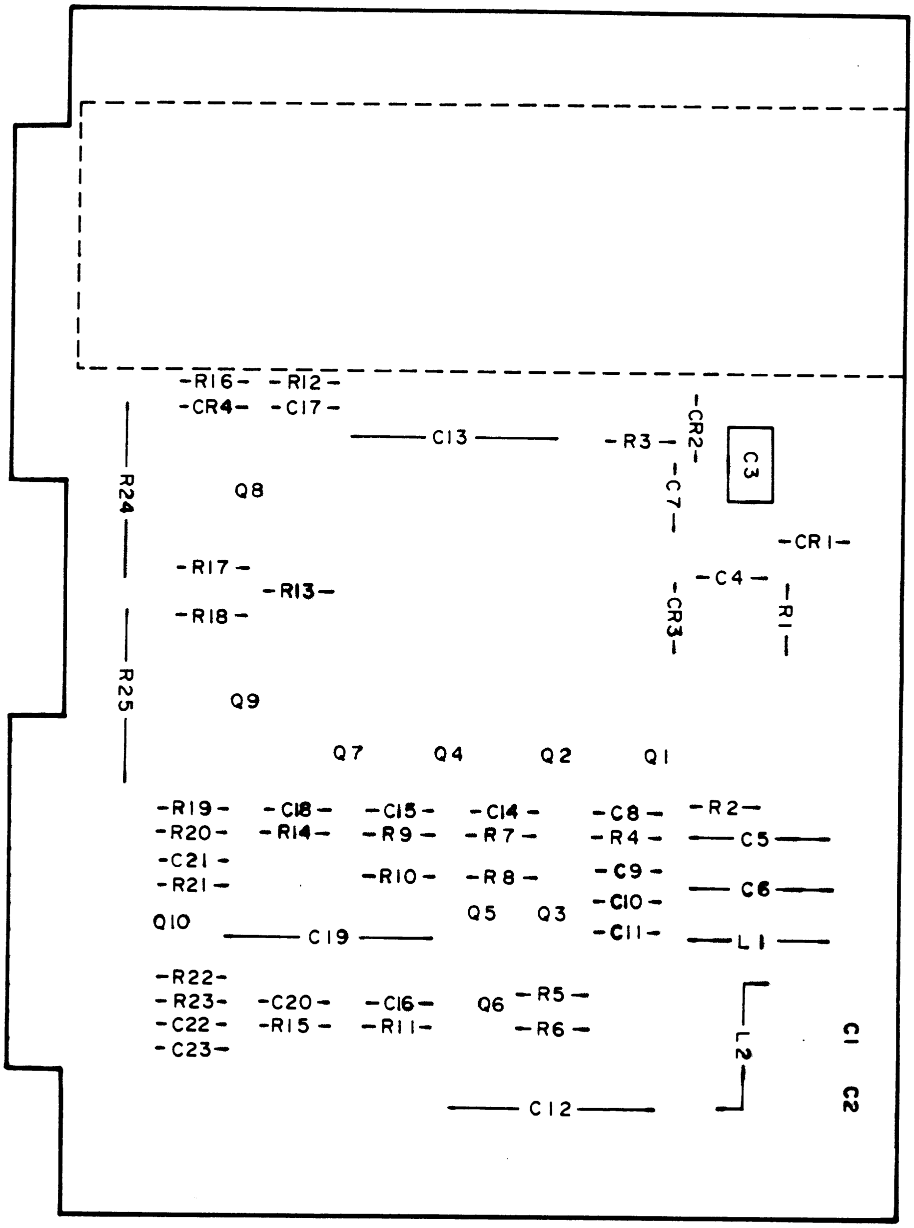
Page 8-131, Figure 8-75. A20 Power Supply Board Assembly Component Locations:
Delete A20R27.

Page 8-131, Figure 8-76. A20 Power Supply Board Assembly Component Locations:
Delete A20R27.

CHANGE 4

Page 8-41, Figure 8-25. A1 Sampling Pulse Generator Board Assembly Component Locations:

Partially change the diagram as follows:



Page 8-41, Figure 8-26. A1 Sampling Pulse Generator Board Assembly Schematic Diagram:

Partially change the diagram as follows:

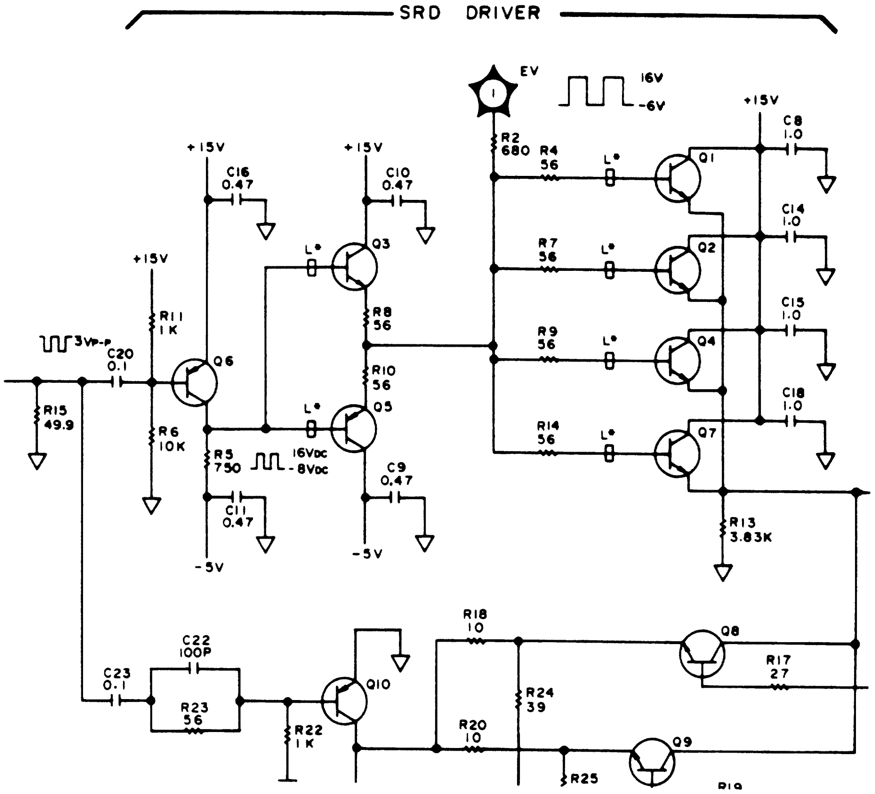
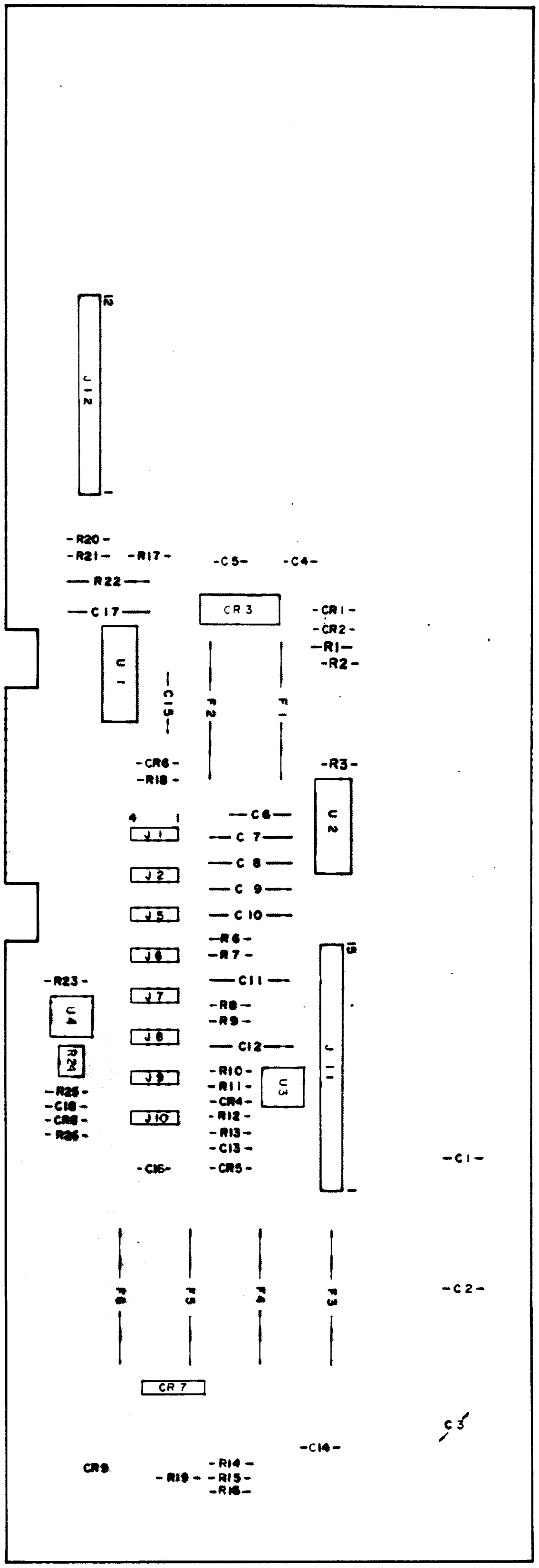


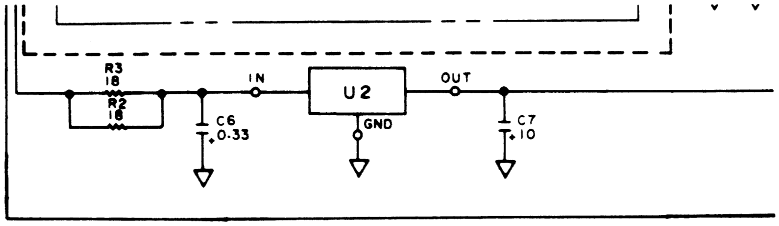
Table 6-3. Replaceable Parts:

See Table 7-2.

Page 8-131, Figure 8-75. A20 Power Supply Board Assembly Component Locations: Partially change the diagram as follows:



Page 8-131, Figure 8-76. A20 Power Supply Board Assembly Schematic Diagram: Partially change the diagram as follows:



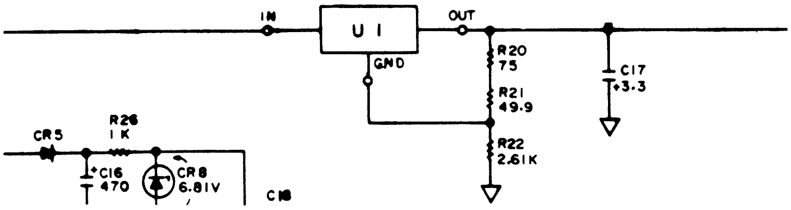


Table 7-2

| Change | Page | Note | Reference Designation | HP Part Number | Description |
|---|---|---|---|---|---|
| 1 | 6-5 | C | A2C29 | 0160-4792 | CAPACITOR-FXD 8.2PF +-.5pF 100VDC CER |
| | | A | A2L5 | 9100-2255 | INDUCTOR 470NH 10% |
| | 6-6 | C | A2Q8 | 1854-0345 | TRANSISTOR NPN 2N5179 SI TO-72 |
| | | C | A2R38 | 0683-3915 | RESISTOR 390 5% .25W |
| | | C | A2R41 | 0683-6815 | RESISTOR 680 5% .25W |
| | | D | A2W1 | 8159-0005 | JUMPER |
| | 6-7 | C | A3R1 | 0683-4725 | RESISTOR 4.7K 5% .25W |
| | | C | A3R5 | 0683-4725 | RESISTOR 4.7K 5% .25W |
| | 6-18 | C | A8R12 | 0757-0816 | RESISTOR 681 1% .5W |
| | 6-26 | A | A11S1 | 3101-4341 | SWITCH SLIDE SPDT-NG |
| | 6-39 | D | A20R2 | 0698-7457 | RESISTOR 18 2% 2W |
| | | D | A20R3 | 0698-7457 | RESISTOR 18 2% 2W |
| | 6-40 | A | A20W1 | 8159-0005 | JUMPER WIRE |
| | | A | A20W2 | 8159-0005 | JUMPER WIRR |
| | 6-42 | C | 54 | 04193-66600 | HP-IB CONNECTOR |
| 2 | 6-7 | C | A3R2 | 0683-5105 | RESISTOR 51 5% .25W |
| | | C | A3R4 | 0683-5105 | RESISTOR 51 5% .25W |
| | | C | A3R23 | 0699-0057 | RESISTOR 9K .1% .1W |
| | 6-8 | D | A3R40* | 0757-0464 | RESISTOR 90.9K 1% |
| | 6-9 | C | A4R1 | 0683-4275 | RESISTOR 4.7K 5% .25W |
| | | C | A4R2 | 0683-5105 | RESISTOR 51 5% .25W |
| | | C | A4R4 | 0683-5105 | RESISTOR 51 5% .25W |
| | | C | A4R5 | 0683-4275 | RESISTOR 4.7K 5% .25W |
| | | C | A4R27 | No change | No change |
| 3 | 6-39 | C | A20R26 | 0683-1025 | RESISTOR 1K 5% .25W |
| | | D | A20R27 | 0683-1825 | RESISTOR 1.8K 5% .25W |
| 4 | 6-4 | D | A1R26 | 2100-3212 | RESISTOR |
| | | C | A1R27 | 0757-0442 | RESISTOR |
| | 6-17 | C | A6C29 | 0160-2243 | CAPACITOR-FXD 2.7PF +-.25PF 500VDC CER |
| | | C | A6C30 | 0160-2255 | CAPACITOR-FXD 8.2PF +-.25PF 500VDC CER |
| | | C | A6C31 | 0160-2251 | CAPACITOR-FXD 5.6PF +-.25PF 500VDC CER |
| | 6-39 | D | A20C19 | 0180-0291 | CAPACITOR-FXD 1UF 35VDC TA |
| | | D | A20C20 | 0180-0291 | CAPACITOR-FXD 1UF 35VDC TA |
| | 6-40 | D | A20U5 | 1826-0106 | IC V RGLTR 7815 |
| | | D | A20W3 | 8159-0005 | JUMPER WIRE |

A: Added D: Changed D: Deleted

# SECTION VIII

# SERVICE

## 8-1. INTRODUCTION

8-2. This section provides the information and instructions required to service the Model 4193A Vector Impedance Meter. Included are the Theory of Operation and Circuit Schematics. The Theory of Operation describes fundamental principles and circuit operating theory of the 4193A with block diagrams. Circuit schematics, locator illustrations, board level block diagrams and other technical data necessary for repairs are integrated into the service sheet foldouts. An illustration of the instrument interior is shown in Figure 8-19.

## 8-3. SAFETY CONSIDERATIONS

8-4. This section contains warnings and cautions that must be followed for your protection and to avoid damage to the instrument.

WARNING

MAINTENANCE DESCRIBED HEREIN IS PERFORMED WITH POWER SUPPLIED TO THE INSTRUMENT AND PROTECTIVE COVERS REMOVED. SUCH MAINTENANCE SHOULD BE PERFORMED ONLY BY SERVICE-TRAINED PERSONNEL AWARE OF THE HAZARDS INVOLVED (FOR EXAMPLE, FIRE AND ELECTRICAL SHOCK). WHERE MAINTENANCE CAN BE PERFORMED WITHOUT POWER APPLIED, THE POWER SHOULD BE REMOVED. BEFORE ANY REPAIR IS COMPLETED, ENSURE THAT ALL SAFETY FEATURES ARE INTACT AND FUNCTIONING AND THAT ALL NECESSARY PARTS ARE CONNECTED TO THEIR MEANS OF PROTECTIVE GROUNDING.

## 8-5. THEORY OF OPERATION

8-6. The theory of operation discussion is organized into two sections : basic theory and block diagram discussion. The basic theory, beginning with paragraph 8-13, explains the concepts and fundamental theory of the 4193A instrument technique adapted for accurately measuring the DUT and for fully achieving automated measurement performance. The block diagram discussion describes the overall circuit operating theory of the 4193A with block-to-block signal flow. Included are block and timing diagrams.

## 8-7. RECOMMENDED TEST EQUIPMENT

8-8. The test equipment required to perform operations outlined in this section is listed in Table 4-1. The table includes type of instrument required, critical specifications, use, and recommended model. If the recommended model is not available, equipment which meets or exceeds the critical specifications listed may be substituted.

## 8-9. TROUBLESHOOTING

8-10. The troubleshooting guide provides instructions and information for locating a faulty circuit component. All instructions consider the safety of service personnal performing the procedures. The diagnostic guides are in the form flow diagrams. The board level troubleshooting diagrams are used to isolate failures to an individual malfunctioning circuit board assembly. The guides for locating a defective component are given on the individual board service sheets and integrate service support data-- test point locations, waveform illustrations, voltage data, timing diagrams, and other technical information in addition to providing schematic diagrams for each board. To facilitate troubleshooting of the 4276A Digital Section, the troubleshooting guide for the logic cercuits uses signature analysis.

Note

To facilitate troubleshooting, remove all screws from the extrusion boards.

## 8-11. REPAIR

8-12. Repair explanations tell how to replace defective circuit components. The recommended replacement procedures for components and parts which require special repair, replacement tools, or test equipment should be observed. Correct disassembly and the exchange procedures for such special parts are outlined in paragraphs 8-81 through 8-91. To prevent damage resulting from improper repair procedure, refer to the appropriate manual section before proceeding with repair.

## 8-13. BASIC THEORY

8-14. The HP Model 4193A Vector Impdance Meter applies a constant test current to the DUT and measures two vector voltages, $\dot{V}_I$ and $\dot{V}_V$, to obtain the DUT impedance, $\dot{Z}$. $\dot{V}_I$ is the voltage drop across known resistance Ro, and $\dot{V}_V$ is the voltage drop across the DUT. Refer to Figure 8-1. The vector current $\dot{I}$ through Ro is proportional to the vector current $\dot{I}$ through the DUT. Therefore, the vector impedance $\dot{Z}$ of the DUT is given by the vector voltage ratio $\dot{V}_V/\dot{V}_I$ as follows:

$$\dot{Z} = \frac{\dot{V}_V}{\dot{I}} \propto \frac{\dot{V}_V}{\dot{I}'} = \frac{\dot{V}_V}{\dot{V}_I/R_0} = R_0 \cdot \frac{\dot{V}_V}{\dot{V}_I}$$

$$\therefore \dot{Z} \propto \frac{\dot{V}_V}{\dot{V}_I}$$

In the actual circuit, both the magnitude and the phase of each vector voltage are detected to calculate the magnitude ratio and the phase difference between $\dot{V}_V$ and $\dot{V}_I$. The impedance and the phase of $\dot{Z}$ are given below :

$$|\dot{Z}| = k \cdot \frac{|\dot{V}_V|}{|\dot{V}_I|} \quad \text{(k: constant)}$$

$$\angle\dot{Z} = \angle\dot{V}_V - \angle\dot{V}_I$$

Figure 8-2 shows the relation between $\dot{Z}$, $\dot{V}_V$, and $\dot{V}_I$.

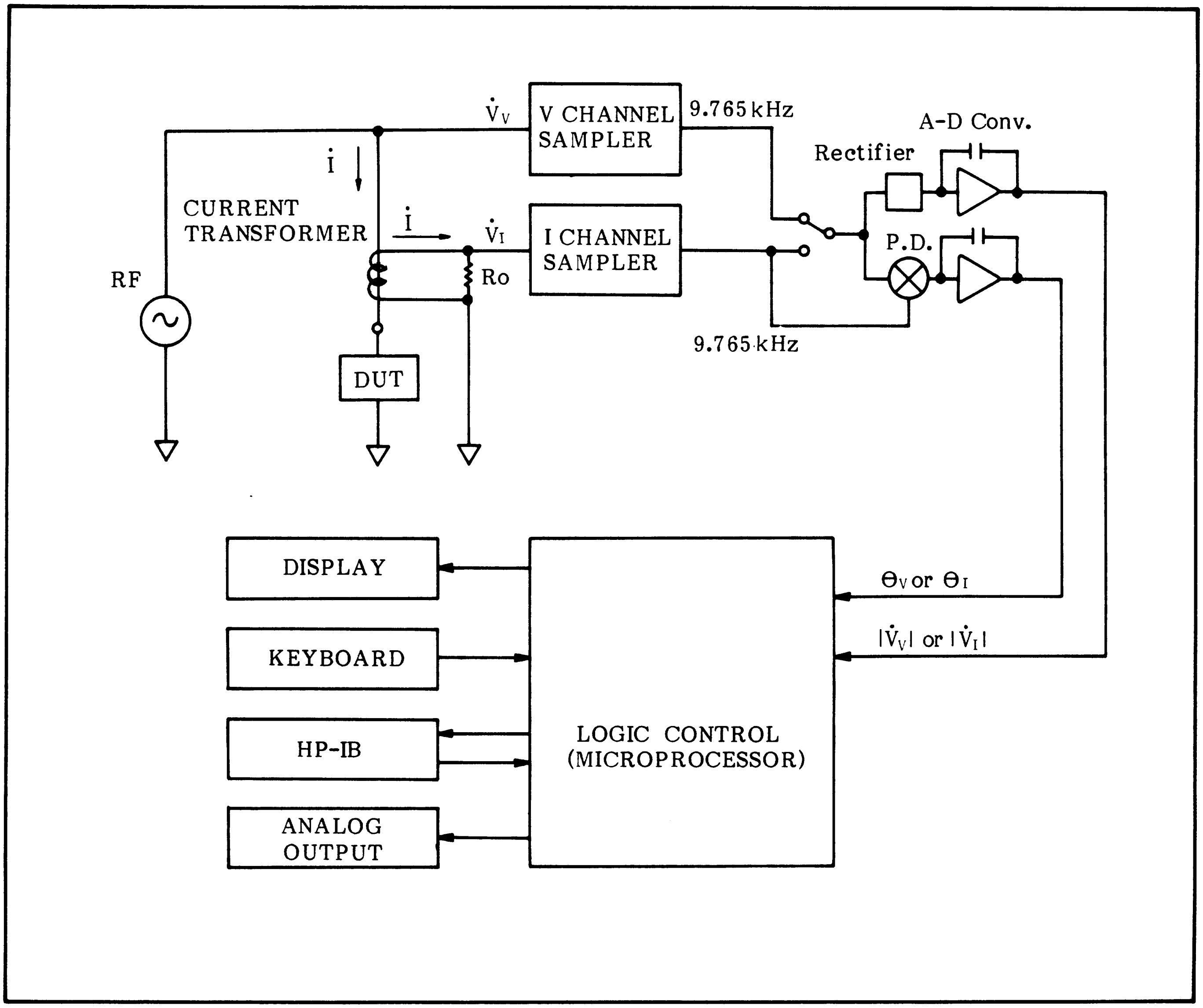


Figure 8-1. Basic Block Diagram.

The test frequency, RF, is a radio frequency between 0.4 to 110MHz. Therefore, sampling is performed in the $\dot{V}_I$ and $\dot{V}_V$ detecting stage to facilitate accurate detection of the vector voltage ratio. The 4193A uses a unique sampling method called synchronized mixed-down sampling pulse generation. It enables the 4193A to perform stable sampling operation to convert the RF measurement signals into two 9.765625kHz IF signals, even when the RF test frequency is changed. The relationship between the magnitudes of $\dot{V}_I$ and $\dot{V}_V$ and the phase differences between $\dot{V}_I$ and $\dot{V}_V$ remain unchanged, even after sampling.

$\dot{V}_I$ and $\dot{V}_V$ are alternately measured to provide magnitude and phase information. Either $\dot{V}_I$ or $\dot{V}_V$ is selected and channeled into two paths; one to a magnitude-ADC through a full-wave rectifier and the other to a phase-ADC through the phase detector. The reference signal of the phase detector is $\dot{V}_I$ and the input signal is alternately $\dot{V}_V$ and $\dot{V}_I$. This means that $\dot{V}_I$ is phase detected in reference to itself in order to provide compensation for any phase offset error introduced by the detection circuits. In each of the two ADCs, dual-slope (type) analog to digital conversion is executed 17 times per measurement for $\dot{V}_V$ and 12 times per measurement for $\dot{V}_I$ in normal speed mode. See Figure 8-3.

The 4193A contains a 6800 microprocessor that controls the frequencies, range selection, measurement sequence, data manipulation, and other functions. It also performs introspective testing of the 4193A.

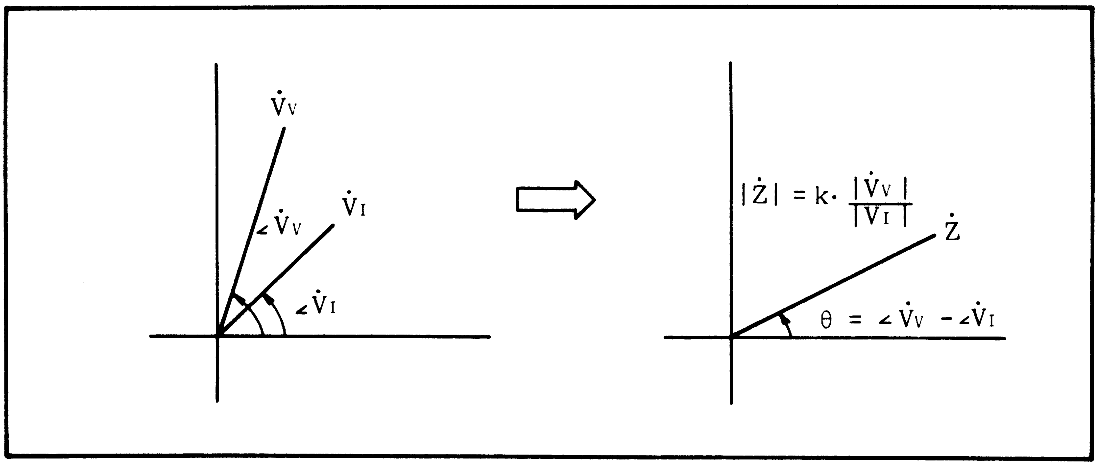


Figure 8-2. Relation between $\dot{Z}$, $\dot{V}_V$, and $\dot{V}_I$.

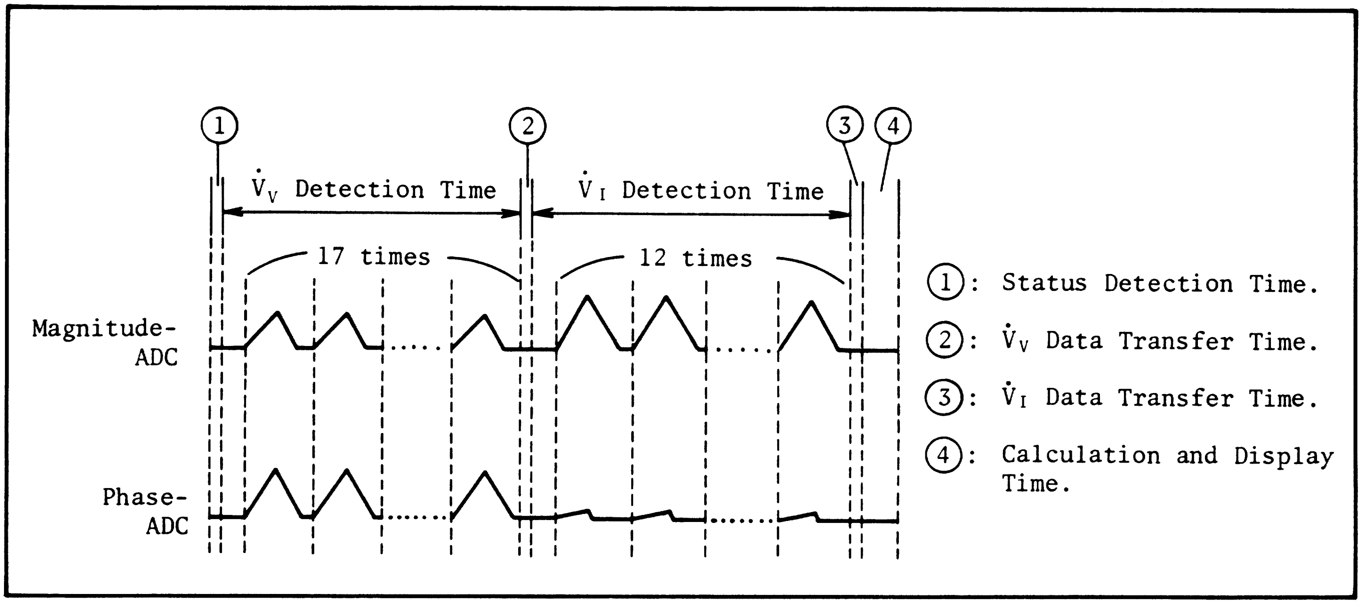


Figure 8-3. Measurement Cycle.

### 8-15. Analog Section Block Diagram Discussion

8-16. The following paragraphs describe the structure and functions of the 4193A's Analog Section. The Analog Section consists of the Signal Source, Sampling Block, and Detection Block. The block diagram of the Analog Section is shown in Figure 8-10.

### 8-17. SIGNAL SOURCE BLOCK

8-18. Figure 8-4 is the block diagram of the Signal Source, consisting of the A8 Crystal Oscillator, A10 Voltage Controlled Oscillator, A9 Mixer, A2 ALC Amplifier, A7 Divider, and A11 Integrator. The A8 Crystal Oscillator generates an accurate 100MHz signal which is used as the reference on the A6 board. The A8 board also outputs a 10MHz signal to the A7 Divider and a 300MHz signal to the A9 Mixer. The A10 Voltage Controlled Oscillator outputs a 300MHz+RF signal to the A9 Mixer and the A5 Mixer/Divider. The VCO on the A10 board is controlled by the A11 Integrator, which phase-detects a reference signal from the A7 board and the RF test signal fed back from the A9 board. The A7 Divider has several functions. It divides down the RF test signal fed back from the A9 board for phase-detection on the A11 board, provides the reference signal for the phase-detector on the A11 board, provides PLL control, and provides a 2MHz clock signal and a 2.5MHz clock signal for various operations throughout the instrument. The A9 Mixer mixes the 300MHz+RF signal from the A10 board with the 300MHz signal from the A8 board to provide the RF test signal. The A2 ALC Amplifier provides ranging and level control of the RF signal in order to maintain a constant RF current through the DUT.

### 8-19. A2 ALC AMPLIFIER

8-20. A2 board maintains the test signal current constant for each magnitude range. The PIN diode attenuator is controlled by the ALC voltage fed from the A13 board and attenuates the RF test signal to a level appropriate for input to the amplifier stage. Depending on the magnitude range, the amplifier stage provides 10dB or 40dB amplification of the attenuated signal. When the magnitude range is 1kΩ, 10kΩ, or 100kΩ, the RF test signal is fed to a 30dB amplifier through two relays and then amplified by a 10dB output amplifier. For the lower magnitude ranges, the 30dB amplifier is bypassed and only the 10dB output amplifier is used. The two relays that feed the RF signal to the 30dB amplifier are controlled by the A17 board.

### 8-21. A7 DIVIDER

8-22. The A7 board divides down the RF signal fed back from the A9 Mixer to provide a 1kHz, 10kHz, or 100kHz signal, FV, for the phase detector on the A11 board. The N divisor is controlled by the microprocessor and is selected so that FV will be 1kHz when the RF is less than 10MHz, 10kHz when the RF is 10MHz to 99.99MHz, and 100kHz when the RF is 100MHz or higher. A second signal, FR, which is used as the reference for the phase detector on the A11 board, is generated from the 10MHz signal from the A8 board or from an external oscillator. Like FV, FR is 1kHz, 10kHz, or 100kHz depending on the RF frequency. To shorten the time required for the PLL to settle in response to large test frequency changes, two signals, $\overline{\text{FU}}$ and $\overline{\text{FD}}$, are provided. $\overline{\text{FU}}$ also prevents the 300MHz+RF signal from dropping below 300.4MHz. The A7 board also provides a 2MHz clock signal for the A17 board and a 2.5MHz clock signal for the A14 board, signal source ready signal (SSRDY), and external oscillator monitor signal (EXTOSC).

### 8-23. A8 CRYSTAL OSCILLATOR

8-24. The A8 board provides 10MHz, 100MHz, and 300MHz outputs which are used as reference signals in various mixing and phase-detection operations in the Signal Source and Sampling Circuit. All three signals are generated from the same 100MHz crystal oscillator. The 300MHz signal is derived from the third harmonic of the 100MHz signal. The 10MHz signal is produced by dividing down the 100MHz signal.

### 8-25. A9 MIXER

8-26. The A9 board has three functions : (1) mix the 300MHz+RF from the A10 board with the 300MHz reference from the A8 board to provide the RF signal for the A2 board, (2) feedback the RF signal to the A7 board, and (3) divide down the external oscillator signal (if present) before it is output to the A7 board.

### 8-27. A10 Voltage Controlled Oscillator

8-28. The A10 board outputs a 300MHz+RF signal generated from a voltage-controlled oscillator. Control voltage for the oscillator is fed from the integrator on the A11 board. There are three frequency ranges : 300.4MHz to 309.999MHz, 310MHz to 399.99MHz, and 400MHz to 410MHz. The frequency range is determined by the FS1, FS2, and FS3 frequency select lines (from the A11 board), which are the result of decoding the 2-bit frequency range data from the A17 board.

## 8-29. A11 INTEGRATOR

8-30. The A11 board provides two control signals, VCS and frequency range select (FS1, FS2, FS3), for the voltage-controlled oscillator on the A10 board. VCS is the control voltage for the VCO, and is produced by a phase-detector and an integrator in response to differences between the phase-detector's reference signal, FR, and input signal, FV. The reference, FR, is 1kHz, 10kHz, or 100kHz depending on the frequency range, and is derived from the 10MHz signal output from the A8 board to the A7 board, where it is divided down to the appropriate frequency. The phase-detector's input signal, FV, is also 1kHz, 10kHz, or 100kHz depending on the frequency range, and is derived from the RF signal fed back from the A2 board to the A7 board, where it is divided down to the appropriate frequency. When the FREQUENCY CONTROL DIAL on the front-panel is rotated, the microprocessor detects this and changes the value of the divisor used to divide down the RF signal on the A7 board. This causes the frequency of FV to be higher or lower (depending on which direction the dial is rotated) than that of FR. The phase-detector detects this difference and closes one of two analog switches, allowing the integrator to charge (or discharge) from a +5v (-5V) voltage source. The output voltage from the integrator is the control voltage, VCS, for the voltage-controlled oscillator on the A10 board. When a large frequency change is detected, the $\overline{\text{FU}}$ (frequency up) or $\overline{\text{FD}}$ (frequency down) signal goes LOW, closing two FET switches. With these switches closed, the integrator charges (discharges) more rapidly, shortening the time required to settle the signal source at the new frequency. FB0 and FB1 are sent from the A17 board and control the frequency range of the voltage-controlled oscillator on the A11 board. FB0 and FB1 are decoded into three signals—FS1, FS2, and FS3—and then output to the A11 board.

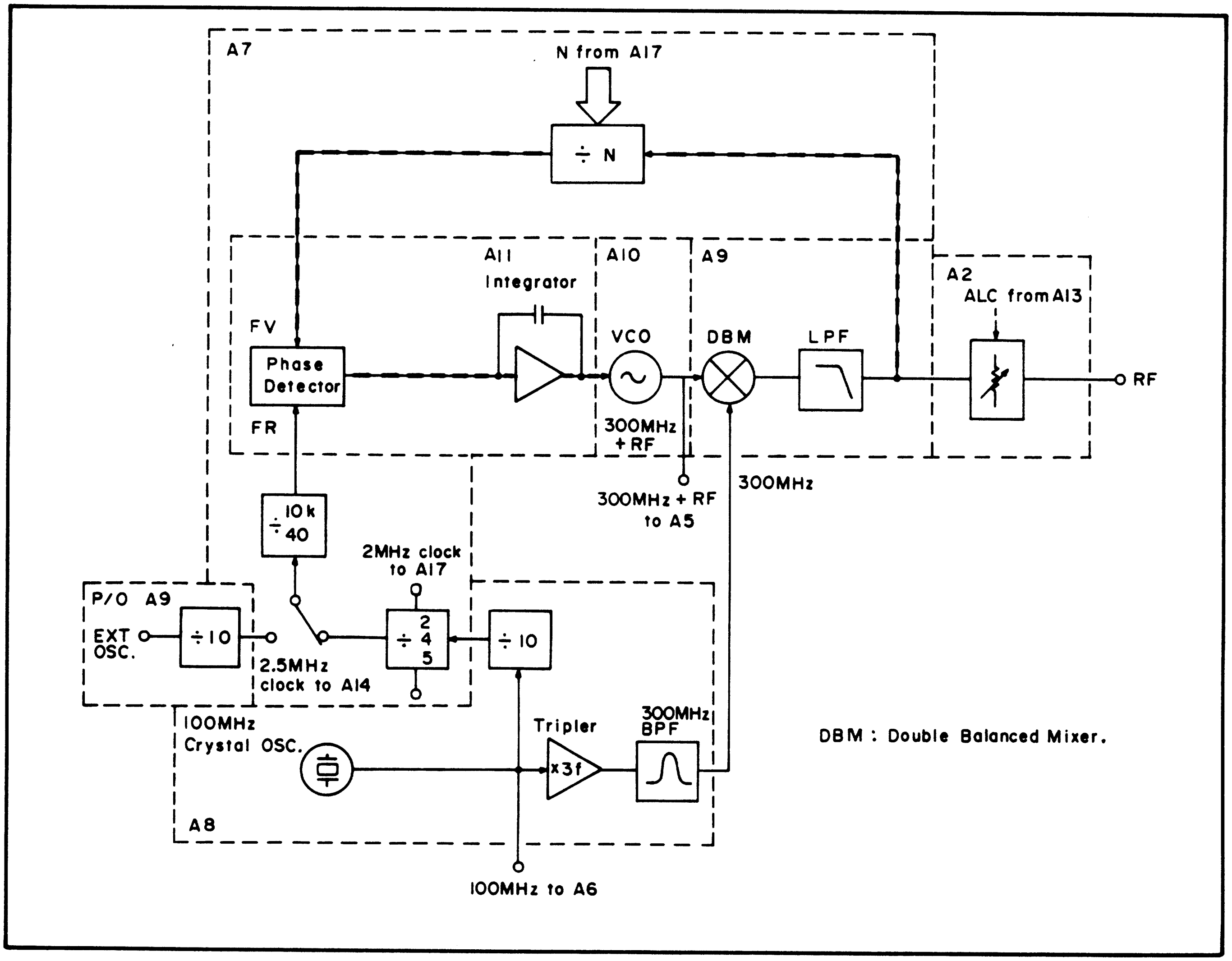


Figure 8-4. Signal Source Block Diagram.

## Signal Source Operation

The frequency of the RF signal output from the 4193A's signal source is controlled by the ÷N circuit on the A7 board. This circuit consists of a two-modulus prescaler and four programmable counters. Refer to the block diagram in Figure A.

When the signal source is locked (NOT READY lamp off) at the frequency displayed on the front-panel, the N circuit outputs a stable 1kHz, 10kHz, or 100kHz signal, Fv, which is fed to the input of the phase detector on the A11 board. Since the phase detector's reference signal, FR, is also 1kHz, 10kHz, or 100kHz, the phase detector outputs a constant VCO control voltage; thus, the RF signal stays at the selected test frequency. If the RF should drift, even slightly, from the selected test frequency, FV will change, causing the phase detector to increase or decrease the VCO control voltage until the RF returns to the selected frequency. The frequency of the phase detector's reference signal, FR depends on the range of the selected test frequency.

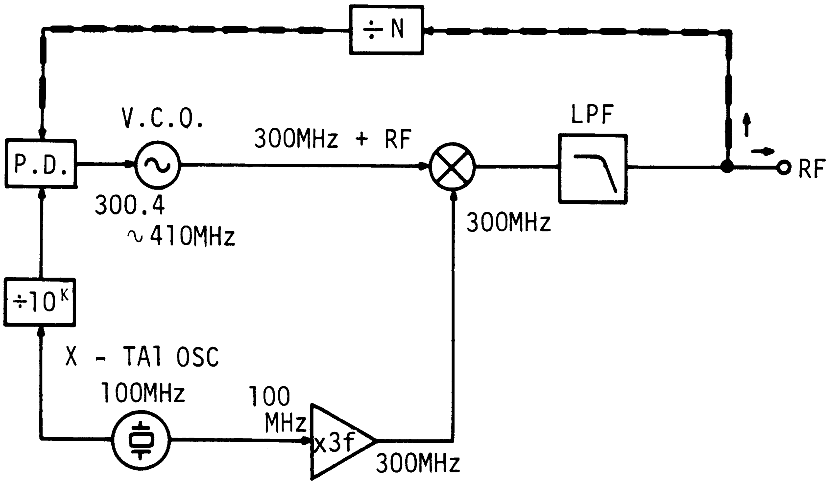


Figure A. Signal Source Simple Block Diagram.

Table A. Test Freq. vs FR

| Test Freq. (MHz) | FR |
|---|---|
| .400 to 9.999 | 1kHz |
| 10.00 to 99.99 | 10kHz |
| 100.0 to 110.0 | 100kHz |

When the FREQUENCY DIAL on the front-panel is rotated, the microprocessor changes the value of the N divisor. Consequently, FV changes, causing the phase detector to increase or decrease the VCO control voltage until the signal source settles at the new frequency.

As an example, let's assume that the signal source is stable at a selected test frequency of 400kHz. FR, then, is 1kHz and the N divisor must be 400 to obtain the requisite 1kHz FV (400k/400 = 1k). Now, if the test frequency is changed to, say, 401kHz by rotating the FREQUENCY DIAL, the microprocessor will change the N divisor to 401. Since the test signal at this time is still 400kHz, FV will be 400kHz/401, or 997.51Hz. There is now a difference of 2.49Hz between FV and FR. The phase detector detects this difference and adjusts the VCO control voltage until the test signal is 401kHz, at which time FV will return to 1kHz (401k/401 = 1k).

Figure 8-5. Signal Source Operation (Sheet 1 of 2).

### ÷ N Circuit

The ÷N circuit (see Figure B) functions as a programmable 4x4-bit BCD decade up-counter. The count starts at the value of N and continues until the maximum count of the counter, 9999, is reached, at which time one count cycle is completed and one pulse is output. N is the four-digit 9's complement of the number of counts on the FREQUENCY display. For example, if the test frequency is set to 400kHz, the number of counts on the FREQUENCY display is 400. The four-digit 9's complement of this number is calculated as

9999 - 400 = 9599 — D
C
B
A

Some frequencies, 1MHz, 10MHz, and 100MHz, for example, have the same N divisors. This means that FV will be 1kHz, 10kHz, and 100kHz, respectively, as will FR (see Table A). This is true for all test frequencies that have the same number of display counts.

### Two-Modulus Prescaler

The prescaler in the ÷N circuit operates in one of two modes, ÷10 or ÷11, depending on the state of the Scaler Control Line. When the line is HIGH, the prescaler operates in the ÷10 mode; and when the line is LOW, in the ÷11 mode. Initially, the Scaler Control Line is LOW, setting the prescaler to the ÷11 mode and enabling the D counter. When the D counter reaches maximum count, 9, the Scaler Control Line goes HIGH, setting the prescaler to the ÷10 mode and disabling (stopping) the D counter. The content of the ABC counter at this time is 100A + 10B + C - D. The total number of input pulses required to output one pulse from the ÷N circuit is calculated as

$$9999 - (11D + 10\,(100A + 10B + C - D)) = 9999 - 1000A - 100A - 10C - D$$

where A, B, and C are the three most significant digits of the N divisor and D is the least significant digit.

At the end of one cycle the output pulse is fed back to the counters and the prescaler to reset the entire circuit.

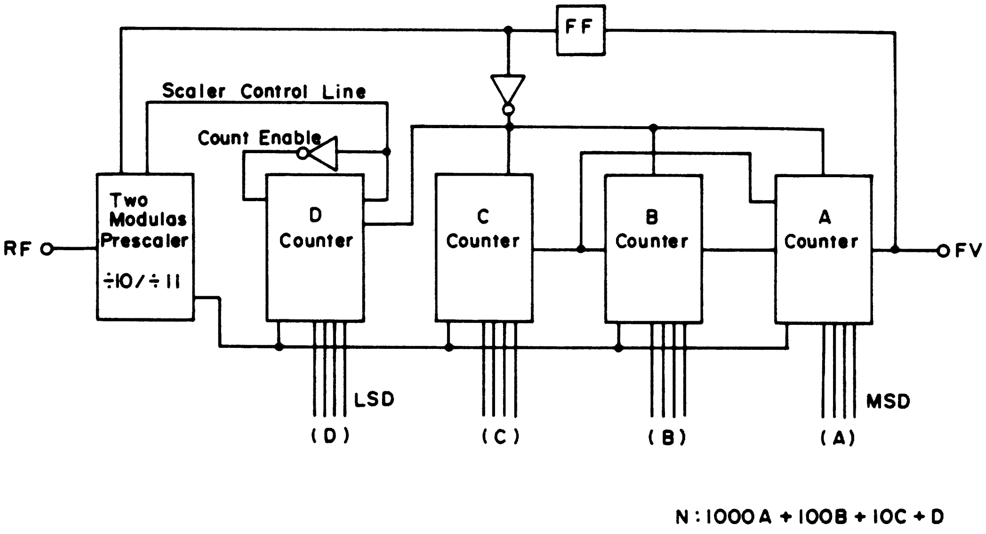


Figure B. ÷N Circuit.

Figure 8-5. Signal Source Operation (Sheet 2 of 2).

## 8-31. SAMPLING BLOCK

8-32. The Sampling Circuit consists of the A1 Sampling Pulse Generator, A5 Mixer/Divider, A6 Voltage Controlled Oscillator, A51 Probe I-channel, and A52 Probe V-Channel. Overall Sampling Circuit operation will be discussed first, followed by simplified board level discussions.

8-33. Refer to the Sampling Circuit block diagram in Figure 8-6. Two RF signals, $V_{DUT}$ (RF) and $I_{DUT}$ (RF), which represent the voltage across and the current through the DUT are each converted into a 9.765625kHz IF to facilitate measurement. RF-to-IF conversion is performed in the A51 Probe I-Channel and the A52 Probe I-Channel by sampling the injected RF signal at different points of the waveform. This produces two waveforms, $V_{DUT}$ (IF) and $I_{DUT}$ (IF), whose relative amplitudes and relative phase are identical to those of the original RF signals, but at a frequency more convenient for measurement.

A 100MHz reference from the A8 board and a 2IF (19.53125kHz) from the A14 board are input to the phase-locked loop on the A6 board which outputs an accurate 300MHz-IF (299.990MHz) signal. This 300MHz-IF is output to the A5 board where it is mixed with a 300MHz + RF from the A10 board. The mixer output is filtered, leaving only an RF + IF signal, and then amplified, clipped, and divided down to provide the appropriate RF + IF/N sampling frequency. The output from the A5 board is sent to the A1 Sampling Pulse Generator where it is amplified to drive a step-recovery-diode, and then input to two differentiators to provide the required pulse height and width. The I-Channel and V-Channel Sampling pulses are identical except that the V-Channel sampling pulse is slightly delayed in reference to the I-Channel sampling pulse. The A3 and A4 boards each provide two complementary sampling pulses for their respective channel.

## 8-34. A1 SAMPLING PULSE GENERATOR

8-35. The A1 board outputs the sampling pulses required for the sampling operations in the I and V channels. For maximum sampling efficiency, the pulses must have an extremely short rise time. To accomplish this, the A1 board has a step recovery diode (SRD), strip-inductor, forward current source, SRD driver, and two differentiators. The forward current source turns on the SRD and stores a charge in the SRD. The SRD driver circuit reverse biases the SRD with a periodic square wave whose frequency is (RF+IF)/N. The SRD allows reverse bias current to momentarily flow and it snaps off as soon as the stored charge is lost. The waveform across the SRD is, thus, a square wave with very sharp leading edge. This signal is then applied to two differentiators which provide the sampling pulses for the I channel and V channel respectively.

## 8-36. A51 PROBE I-CHANNEL

8-37. The RF current through the DUT is detected by a toroid current transformer shunted by a 50Ω resistor. The resulting voltage drop across the shunt resistor is applied to a four-diode sampling gate which is controlled (opened and closed) by two complementary sampling pulses. When the diodes are forward biased by the sampling pulses, the gate is open for approximately 700ps. During this time, the instantaneous voltage across the 50Ω shunt resistor charges a capacitor, where it is held until the next sample is taken. Because the sampling pulses are so short, the capacitor can only charge to approximately 70%. To improve sampling efficiency to between 90% and 100%, IF feedback is used.

## 8-38. A52 PROBE V-CHANNEL

8-39. The RF voltage across the DUT is applied to a four-diode sampling gate which is controlled (opened and closed) by two complementary sampling pulses. When the diodes are forward-biased by the sampling pulses, the gate is open for approximately 700ps. During this time, the instataneous RF voltage across the DUT charges a capacitor, where it is held until the next sample is taken. Because the sampling pulses are so short, the capacitor can only charge to approximately 70%. To improve sampling efficiency to between 90% and 100%, IF feedback is used.

## 8-40. A5 MIXER/DIVIDER

8-41. The A5 board has two functions : (1) mix the 300MHz-IF from the A6 board with the 300MHz+RF from the A10 board to produce an RF+IF signal and (2) divide the RF+IF by Ns. The double-balanced mixer hetrodynes the two input signals, producing a 300MHz-IF, 300MHz+RF, 600MHz+RF-IF, and RF+IF. The three higher-frequencies are blocked by a 120MHz low-pass filter, leaving only the RF+IF, which is then amplified and squared for input to the Ns divider. The Ns divisor is selected by the microprocessor, and, depending on the frequency of the test signal (RF), will have a value from 1 to 44. After division, the sampling signal, (RF+IF)/Ns, is input to a transfer buffer for output to the A1 Sampling Pulse Generator.

8-42. A6 Voltage Controlled Crystal Oscillator

8-43. The A6 board is the initial stage of the Sampling Circuit. It produces the requisite 300MHz-IF reference signal for the mixer on the A5 board. The phase-locked loop on the A6 board outputs a precise 100MHz-IF/3 signal which is converted into the 300MHz-IF signal by a tripler and a 300MHz BPF.

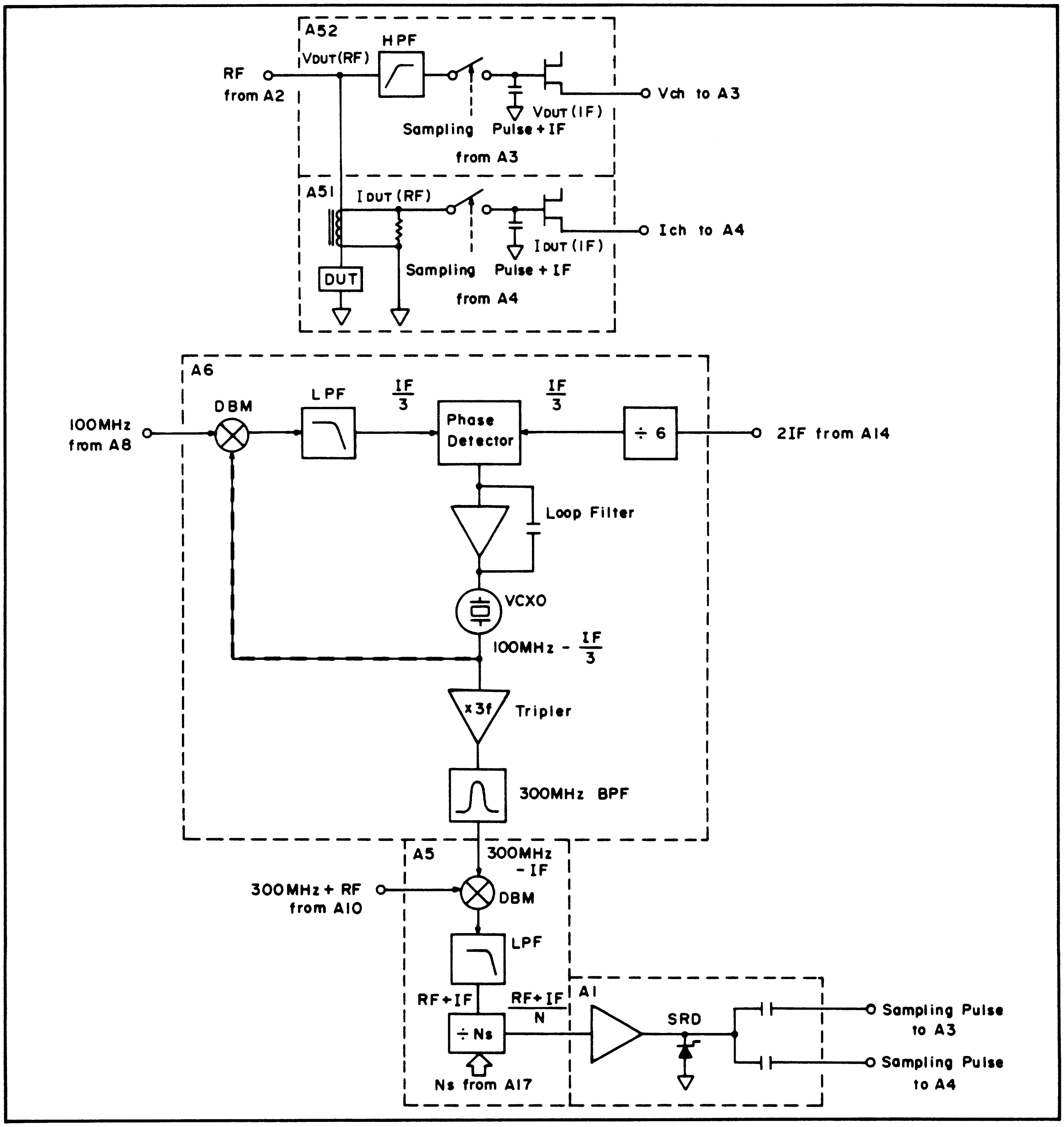


Figure 8-6. Sampling Block Diagram.

## Synchronized Mixed Down Sampling Pulse Generation

In conventional sampling circuits, a phase locked loop is usually used to generate a sampling signal whose frequency must be (RF+IF)/N, where N is a positive integer, as shown in Figure A. It takes time to lock the PLL when the test frequency is changed. In the 4193A, however, a mixing down method using no feedback loop and no presampling is used to generate the sampling pulses as shown in Figure B. Two signals, a 300MHz + RF and a 300MHz-IF, are used to generate the sampling signal. They are mixed to produce an RF+IF signal and converted to RF+IF/N by a frequency divider, the denominator N is determined by the logic control board. Therefore, the sampling pulse frequency is fixed at RF+IF/N even if the test frequency is changed, which is the determinant of stable sampling in RF test frequency changes. This feature enables the 4193A to sweep the RF test frequency is the wide frequency range from 0.4 to 110MHz.

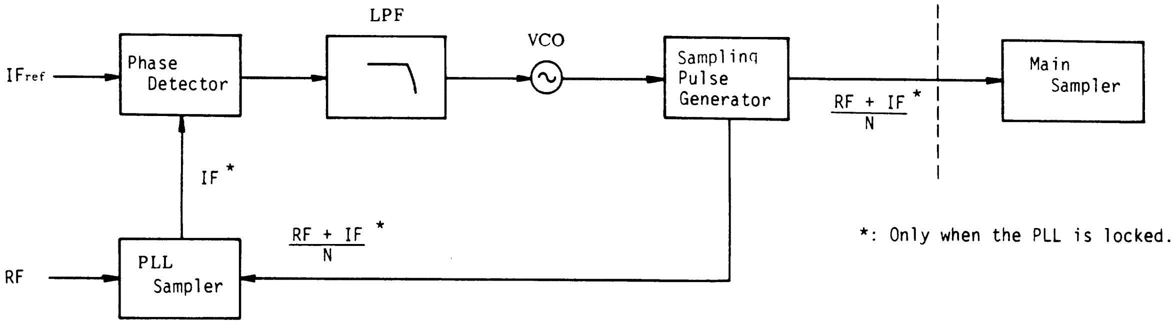


Figure A. Phase Locked Loop Method.

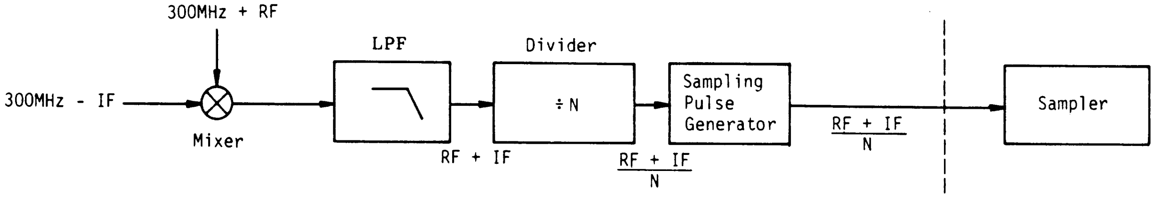


Figure B. Mixing Down Method.

Figure 8-7. Sampling Pulse Generation.

Sampling Pulses

Figure A shows the sampling pulses applied to the V-Channel and I-Channel samplers. Normally, the sampling diodes are reverse biased by 3.8 volts. To turn the sampling diodes fully on and, thus, maximize sampling efficiency, the height of the sampling pulses is 4.5 volts (in reference to the reverse bias voltage). Sampler on-time, when all diodes are conducting, is approximately 700 picoseconds. Sampling pulse height at the output of the Al SPG is approximately 24 volts, which is attenuated to the requisite 4.5 volts by the transmission paths.

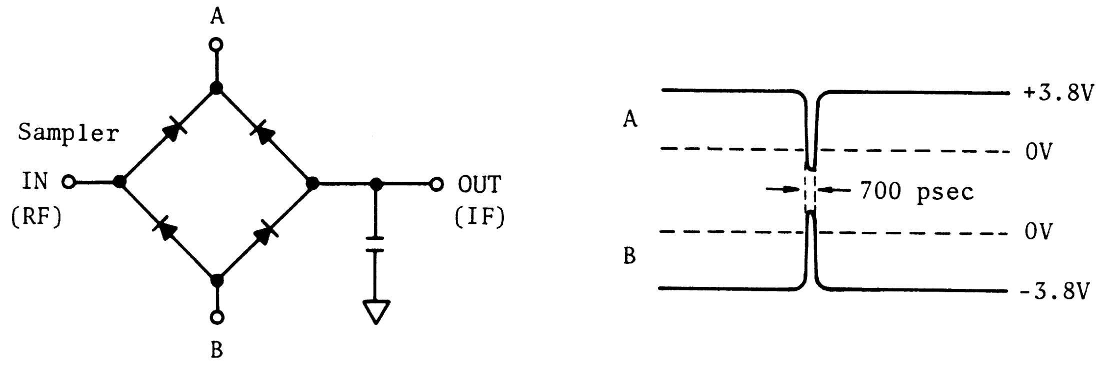


Figure A. Sampling Pulses.

To eliminate inter-channel interference, sampling in the V-Channel is delayed 2.2 nanoseconds in reference to sampling in the I-Channel. The phase error caused by this delay is compensated for by the logic section. Delay is introduced by the A41 Delay Line (on the Al board) and the cable between A1P1 and A3P2. The delay line causes a 1.2 nanosecond delay and the cable causes a 1 nanosecond delay.

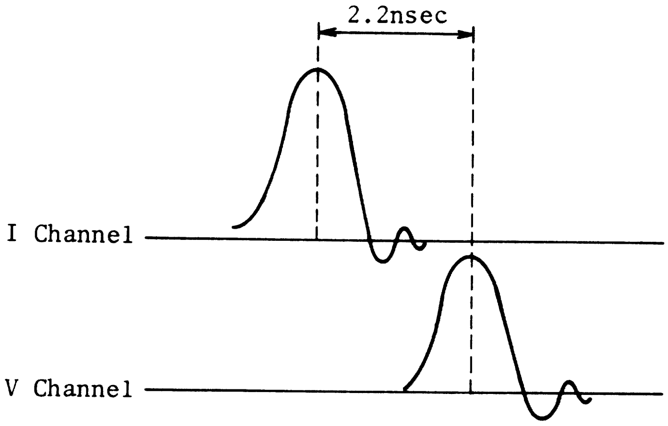


Figure B. Sampling Delay Time (at Samplers).

Figure 8-8. Sampling Pulses.

## 8-44. DETECTION BLOCK

8-45. The Detection Block consists of the A3 V-Channel, A4 I-Channel, A12 IF BPF, A13 Detector, and A14 ADC. Overall operation is as follows.

Two IF signals, one representing DUT current (Ich) and one representing DUT voltage (Vch), are fed from the probe to the A3 and A4 boards where they are amplified and attenuated in accordance with the magnitude range information provided by the A17 board. The A12 board is divided into two channels : I channel and V/I channel. The I channel continuously outputs the Ich signal to the control circuit on the A13 board where it is used for ALC feedback, and range control. The V/I channel is identical to the I channel except that it contains an analog switch. This switch is controlled by a signal from the A14 board and it alternately selects the incoming Ich and Vch signals for output to the magnitude and phase detection circuits on the A13 board. Since the Ich and Vch signals are both fed through the V/I channel to the detection circuits, no measurement error results. Also, any error introduced by the I channel is detected during phase detection (the Ich signal is phase detected in reference to itself) and compensated by the microprocessor.

On the A13 board, the Ich signal fed from the I channel on the A12 board is rectified and squared for use as the reference in the phase detector. The rectified Ich signal is also applied to an integrator whose output is used for automatic level control and magnitude range control. The V/I signal (this signal is either Ich and Vch) fed from the A12 board is input to the magnitude detector and the phase detector. Detected magnitude and phase are then output to the A14 board.

The A14 board contains two AD converters, one for magnitude and one for phase. The integrator outputs--$\dot{V}_V$ magnitude, $\dot{V}_I$ magnitude, $\dot{V}_V$ phase, and $\dot{V}_I$ phase--are sent to the A17 board.

## 8-46. A3 IF V-CHANNEL AMPLIFIER

8-47. The A3 board has three functions. One is to convert the sampling pulse fed from the A1 board into two complementary sampling pulses. The second is to provide IF feedback and reverse DC bias to the V-Channel sampling diodes in the probe. IF feedback stabilizes the sampling operation and raises sampling efficiency. The third is to attenuate the IF signal by 1, 10, 100, 500, or 1000. The amount of attenuation is determined by the selected magnitude range.

## 8-48. A4 IF I-CHANNEL AMPLIFIER

8-49. The A4 board has three functions. One is to convert the sampling pulse fed from the A1 board into two complementary sampling pulses. The second is to provide IF feedback and reverse DC bias to the I-Channel sampling diodes in the probe. IF feedback stabilizes the sampling operation and raises sampling efficiency. The third is to amplify the IF signal by 4, 8, or 40. The amount of amplification is determined by the selected magnitude range. This board also contains a phase-shifter which prevents synchronization error between the I-Channel and V-Channel.

## 8-50. A12 IF BPF

8-51. The A12 board is the first IF detection stage, and it has two functions. The first is to amplify and filter the I-Channel IF signal from the A4 board. This signal is then output to the A13 board, where it is converted into the ALC signal, RANGE UP signal, and RANGE DOWN signal. The second function is to alternately select the I-Channel and V-Channel signals, amplify and filter them, and then output them to the A13 board, where they are phase detected and rectified for measurement. Selection is made by two analog switches which are controlled by the Imeas and Vmeas signals from the A14 board. The amplifiers used in both functions are identical, as are the bi-quad type filters.

## 8-52. A13 DETECTOR

8-53. The A13 board is the second IF detection stage and has two main functions : phase detect the Vch signal in reference to the Ich signal and rectify and output the Vch and Ich signals to the A14 board for measurement. The Ich and V/I signals fed from the A12 board are each squared and input to one half of a dual one-shot multivibrator. The duty cycles of the multivibrator's outputs are identical and determined by two RC networks connected to the multivibrator. The multivibrator outputs are connected to the inputs of an RS flip-flop that outputs a pulse whose width is proportional to the phase difference between the two inputs. This pulse controls an analog switch which provides the PHASE+ and PHASE- signals to the phase A/D converter on the A14 board. The V/I signal is actually two signals, Ich and Vch, alternately selected on the A12 board for output to the A13 board. This Ich signal is identical to the Ich signal used as the reference in the phase detector. When the V/I signal is the Ich signal, it is phase detected in reference to the other Ich signal in order to measure any phase offset error that may have been introduced. This offset error is subtracted from the measured DUT phase to ensure measurement accuracy.

The V/I signal is half-wave rectified into two signals, MAG+ and MAG-, which are output to the magnitude integrator on the A14 board.

The Ich signal used as the reference in the phase detector is also used to provide ALC control voltage for the PIN diode attenuators on the A2 board and to provide the RNG UP and RNG DN signals.

8-54. A14 Analog-to-Digital Converter (ADC)

8-55. The A14 board contains two A/D converters, one for magnitude measurement and one for phase measurement. The magnitude (phase) integrator is charged for a constant period, T1, by a differential input voltage, MAG+ + MAG- (PHASE+ + PHASE-), and is then discharged by a +2V reference, VREF. The time required to discharge the integrator is proportional to the input voltage and is measured (counted) by the A/D converter's internal control logic. The measurement result consists of 14 bits--12 bits for measurement data, 1 bit for over-range, and 1 bit for polarity--and is output to the A17 board via an 8-bit parallel data bus in a 6-bit parallel then 8-bit parallel fashion. The 6-bit data consists of the over-range bit, polarity bit, and the four high-order bits; the 8-bit data consists of the eight low-order bits. The 2.5MHz clock signal from the A7 board is divided down to a 156.25kHz signal and a 19.53125kHz signal. The 156.25kHz signal is used as the clock for both A/D converters, and the 19.53125kHz signal, which is 2IF, is fed back to the A6 board. The A14 board also controls I-Channel/V-Channel selection on the A12 board.

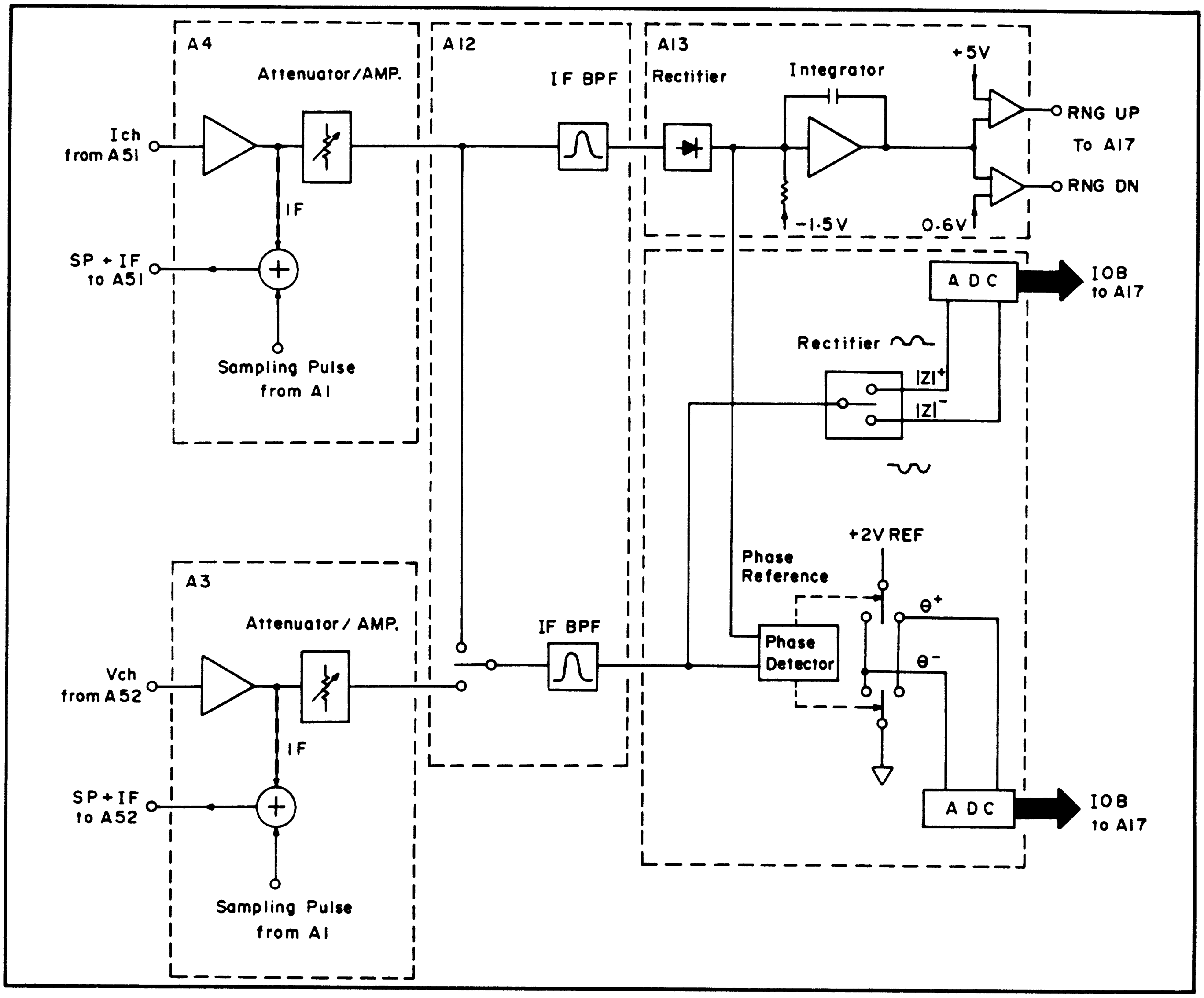
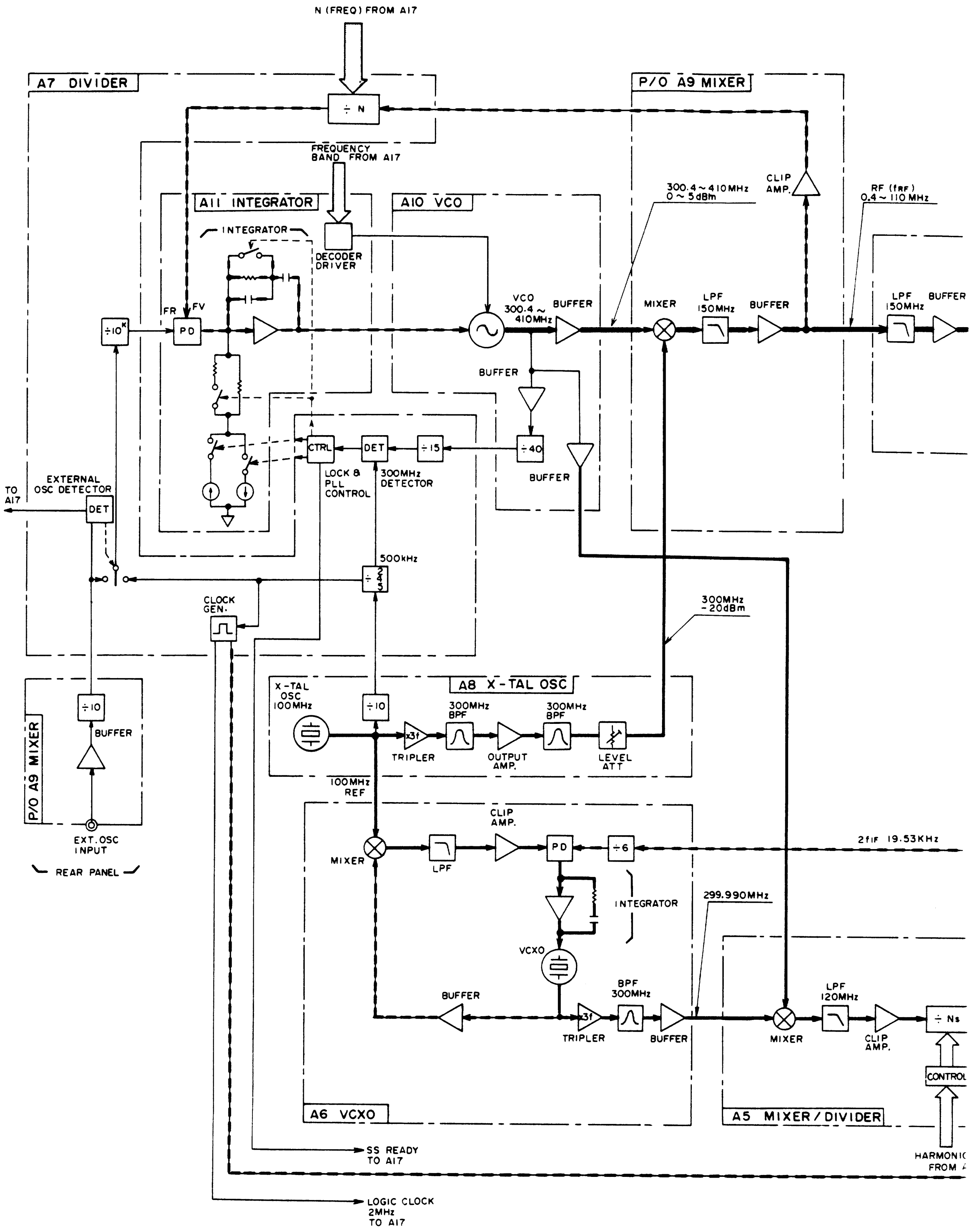


Figure 8-9. Detection Block Diagram.


N (FREQ) FROM A17
A7 DIVIDER
÷ N
P/O A9 MIXER
FREQUENCY BAND FROM A17
CLIP AMP.
300.4 ~ 410MHz 0 ~ 5dBm
RF (fRF) 0.4 ~ 110MHz
A11 INTEGRATOR
A10 VCO
INTEGRATOR
DECODER DRIVER
FR
FV
÷10K
PD
VCO 300.4 ~ 410MHz
BUFFER
MIXER
LPF 150MHz
BUFFER
LPF 150MHz
BUFFER
BUFFER
CTRL
DET
÷15
÷40
LOCK & PLL CONTROL
300MHz DETECTOR
BUFFER
TO A17
EXTERNAL OSC DETECTOR
DET
500kHz
÷ 2 4 5
300MHz -20dBm
CLOCK GEN.
P/O A9 MIXER
÷10
BUFFER
EXT. OSC INPUT
REAR PANEL
A8 X-TAL OSC
X-TAL OSC 100MHz
÷10
300MHz BPF
300MHz BPF
x3f
TRIPLER
OUTPUT AMP.
LEVEL ATT
100MHz REF
CLIP AMP.
MIXER
LPF
PD
÷6
2fIF 19.53KHz
INTEGRATOR
299.990MHz
VCXO
BUFFER
BPF 300MHz
TRIPLER
BUFFER
MIXER
LPF 120MHz
CLIP AMP.
÷ Ns
CONTROL
A6 VCXO
A5 MIXER/DIVIDER
SS READY TO A17
HARMONIC FROM
LOGIC CLOCK 2MHz TO A17

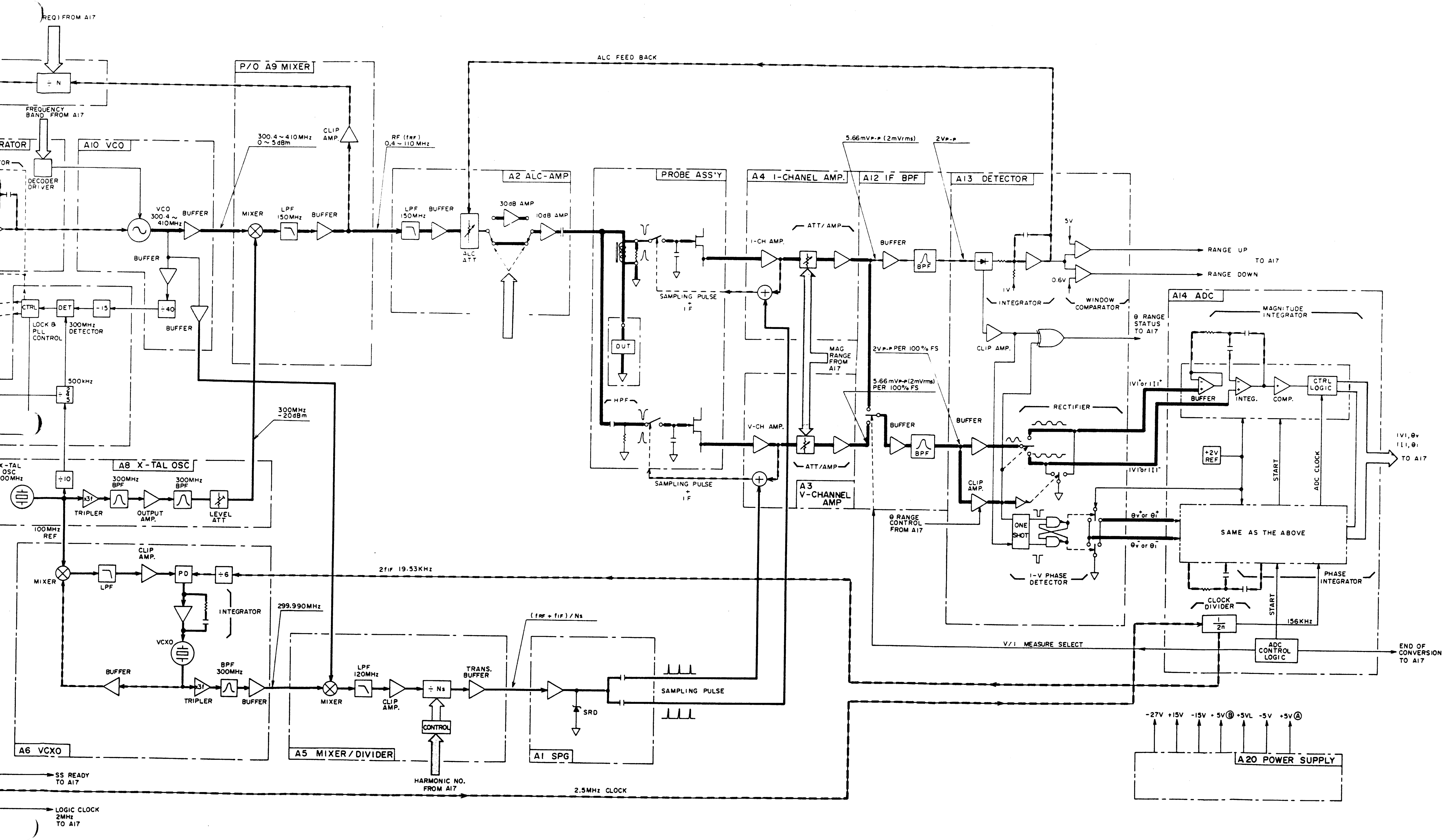


Figure 8-10. Analog Section Block Diagram.

## 8-56. Digital Section Block Diagram Discussion

-57. The following paragraphs describe the structure and functions of the 4193A's Digital Section.

## 8-58. A15 ANALOG OUTPUT

8-59. Twelve-bit data representing one of the displayed values--frequency, impedance, or phase--is output from the A17 board via an 8-bit parallel data bus (IOB0 ~ IOB7) in a 4-bit/8-bit serial pattern ; that is, the data is sent in two parts : first the 4 MSBs, and then the 8 LSBs. The 4 MSBs are stored in U15, and the 8 LSBs are stored in U16 and U17. RAM selection is controlled by the R/$\overline{\mathrm{W}}$, ϕ2, AB2, and IOG7 signals applied to U6. When the 4 MSBs are being sent, U6 pin 6 is LOW and pin 8 is HIGH, write-enabling U15 and write-disabling U16 and U17. Conversely, when the 8 LSBs are being sent, U6 pin 6 and pin 8 change states, write-disabling U15 and write-enabling U16 and U17. The write-address is determined by the AB0 and AB1 signals. Thus, 12 bits, representing one of the three displayed values, are stored in U15, U16, and U17.

This process is repeated for each of the other displayed values. After the three displayed values have been stored, each is read by the DAC (U11), which converts the 12-bit data into an analogous dc voltage. The read-address is determined by two signals output from U2.

The DAC output, AOUT, is input to a 1-of-4 demultiplexer, consisting of U9, U10, and U12, which selects the correct output channel—FOUT for frequency, ZOUT for impedance and ϕOUT for phase. A voltage buffer (U19) is connected to each of U12's outputs. U18 is an adjustable negative-gain amplifier whose output is connected to the RECORDER OUTPUTS on the rear-panel.

The 1MHz ϕ2 clock signal is divided down by U1 and U2 to a 7.8kHz signal and a 3.9kHz signal which are used to drive the demultiplexer and to provide the read-address. U7 and U8 provide appropriate delay to allow the DAC to settle. U4 and U5 provide a TTL level pen lift control signal from the PEN LIFT connector on the rear-panel.

## 8-60. A16 HP-IB

8-61. All HP-IB functions and data transfer operations between the 4193A's microprocessor and an external controller or "listen-only" device are managed by U2, a general purpose interface bus. When the 4193A is turned on, $\overline{\mathrm{PON}}$ (power on) and $\overline{\mathrm{ASE}}$ (address switch enable) go LOW, clearing all registers in U2 and enabling U1. With U1 enabled, the 4193A's HP-IB address, set by the 7-bit DIP switch on the rear-panel, is sent to the microprocessor to be displayed on the front-panel and to U2 to be stored in the address register. After the address has been stored, $\overline{\mathrm{ASE}}$ goes HIGH, disabling U1.

U2 has sixteen registers : eight for write operations and eight for read operations. One write register and one read register are used for direct data transfer operations. The remaining seven write registers are used for chip control, and the remaining read registers are used by the microprocessor to monitor HP-IB status and bus conditions. Register addressing is controlled by the R/$\overline{\mathrm{W}}$, AB0, AB1, AB2, ϕ2, and $\overline{\mathrm{IOG6}}$ signals from the microprocessor.

Command and data transfer between the 4193A and the external device is via a 16-line bus. Eight lines, DIO1 through DIO8, function as a bidirectional data bus; three lines—NDAC, NRFD, and DAV--are for data byte transfer control ; and five lines—EOI, SRQ, REW, IFC, and ATN—are for general interface management.

## 8-62. A17 CONTROL LOGIC

8-63. The microprocessor is driven by a single 2MHz TTL-level clock (MPUCLK) from the A7 board. MPUCLK is first divided down to 1MHz by U16A and then input to a flip-flop consisting of U13A/C and U14A/B/E. The flip-flop outputs two complementary 1MHz signals, one for DBE (data bus enable) and ϕ1, and the other for ϕ2. Q1 and Q2 square the pulses before input to the microprocessor. DBE and ϕ1 are used by the microprocessor only ; ϕ2, however, is used by the microprocessor and other digital circuits.

When the instrument is turned on, the $\overline{\mathrm{RESET}}$ signal from the A20 board is held LOW for 500 to 700ms, to reset the microprocessor. When $\overline{\mathrm{RESET}}$ goes HIGH, execution of a routine to initialize the microprocessor from its reset condition is started.

The microprocessor has two busses, an 8-line bidirectional I/O bus and a 16-line address bus. The I/O bus, IOB0 through IOB7, carries measurement data and control signals between the microprocessor and the A14, A15, A16, and A18 boards. It also functions as a memory bus, MB0 through MB7, for transferring measurement data between the microprocessor and the RAMs, and for accessing programs stored in the ROMs. The address bus, AB0 through AB15, is used for RAM/ROM addressing. Four of the address bus lines, AB0 through AB3, are also used for various control and addressing functions on the A14, A15, A16, and A18 boards. Memory consists of two RAMs and five ROMs. The RAMs store intermediate results of calculations performed by the microprocessor, and the ROMs contain the instrument's various control programs.

## 8-64. A18 DISPLAY/KEY CONTROL

8-65. The A18 board is divided into three sections : Display RAM/Address Counter, Display, and Frequency Control Dial/Key Control. In the Display RAM/Address Counter section, address information and data to be displayed are received from the A17 board via the 4-line address bus (AB0 - AB3) and the 8-line IO bus (IOB0 - IOB7). When U12 pin 8 goes LOW, the address on the address bus is loaded into the Address Counter (U8), which then begins counting from the loaded address. Counting is controlled by the U1/U22 clock. The output from the Address Counter is sent to the select inputs of the 4X32-bit Display Data RAM (U9, U10) and to the inputs of the Anode Driver (U2). At the same time that the address is loaded into the Address Counter, 8-bit data on the IO bus is stored into the Display Data RAM and output to the Cathode Driver for display on the 7-segment common anode displays. The address counter continues counting, selecting stored data to be displayed, until U12 pin 8 goes LOW again, at which time a new address is loaded and the data stored in the RAM is updated. The clock circuit--consisting of U1, U3, U4, a U22—provides address-count control and display strobe.

In the Display section, 8-bit display data is output from the RAM and directly applied to the inputs of the Cathode Driver, which consists of resistor network R19 and transistors Q16 through Q23. The outputs of the Cathode Driver are connected to the cathodes of the 7-segment displays and all key indicator lamps. NOT READY, EXT OSC, TRIGGER, and HP-IB status indicator lamps are controlled by the microprocessor via an 8-bit register, U19. The Anode Driver, U2, is a 4-line to 1-of-16-line decoder. The outputs from the Address Counter are connected directly to the address inputs of U2, which decodes the address into 16 mutually exclusive outputs. A LOW at one of these outputs turns on the corresponding driver transistor, Q1 through Q15, turning on the corresponding 7-segment display or key indicator lamp(s).

In the Frequency Control Dial/Key Control section the twenty-three front-panel keys are divided into three groups—two groups of eight and one group of seven—for connection to the three 8-line-to-3-line priority encoders (U5, U6, and U7). All keys are of the normally-open pushbutton type. When no key is pressed, all encoder inputs are held HIGH through resistor networks R26, R27, and R28. Encoder outputs at this time are all HIGH. When a key is pressed the corresponding encoder input goes LOW, causing the encoded key address to appear at the outputs of U16 (A, B, C) and the key-group (U5, U6, U7) address to appear at the outputs of U15 (A, B), and forcing the KEYINT line to go LOW. When $\overline{\text{KEYINT}}$ goes LOW, 5-bit data representing the key address (3 bits) and the key group address (2 bits) is stored in an 8-bit register (U18), the microprocessor clears the IO bus and sends a READ signal to U18. The key address data is then output onto the IO bus to be processed by the microprocessor. When the Frequency Control Dial is rotated the $\overline{\text{RPGINT}}$ line goes LOW, instructing the microprocessor to examine the level of the RPGUD line. If RPGUD is HIGH, the microprocessor increases the test frequency by a constant factor determined by the selected FREQUENCY RESOLUTION key; if RPGUD is LOW, the microprocessor decreases the test frequency.

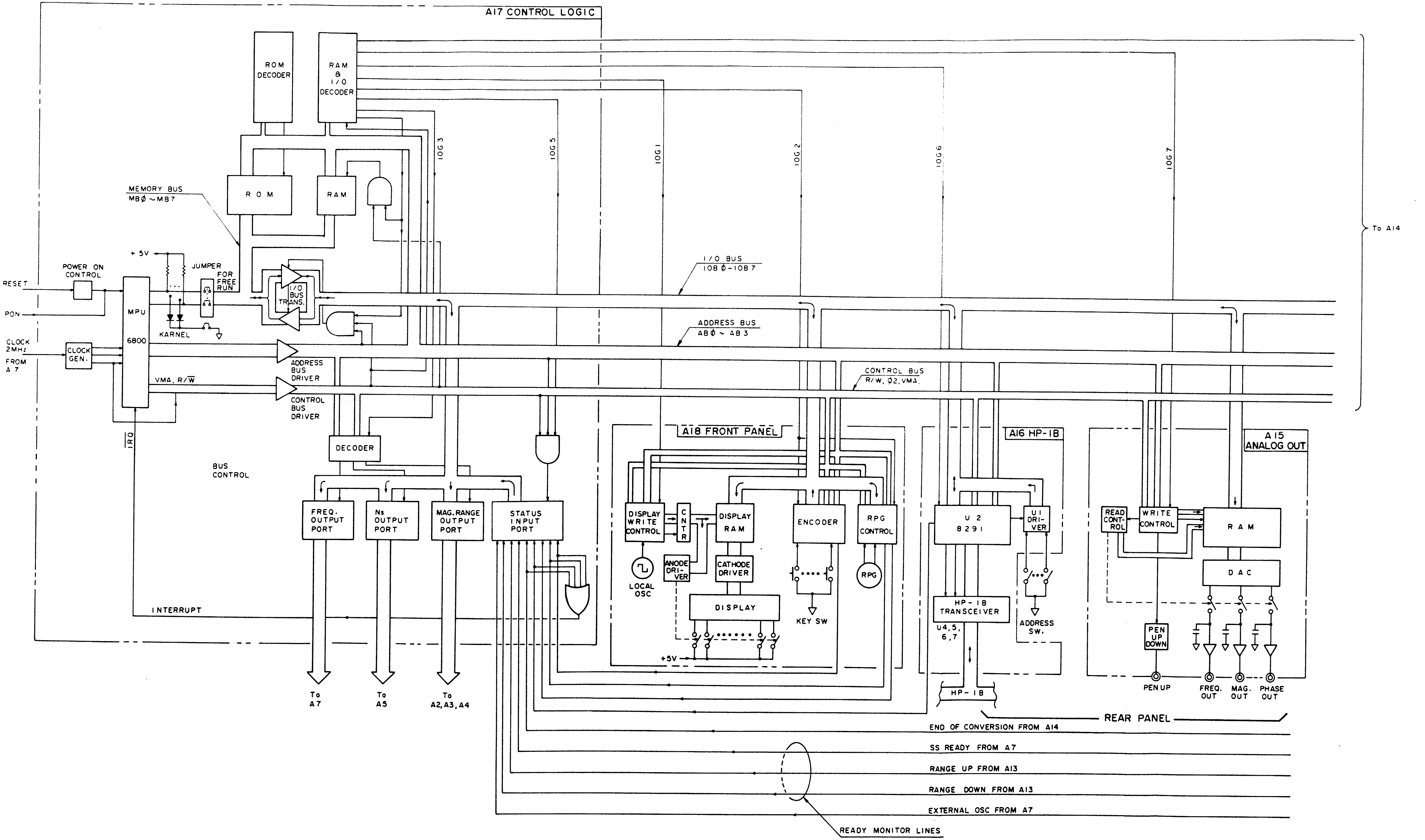


Figure 8-11. Digital Section Block Diagram.

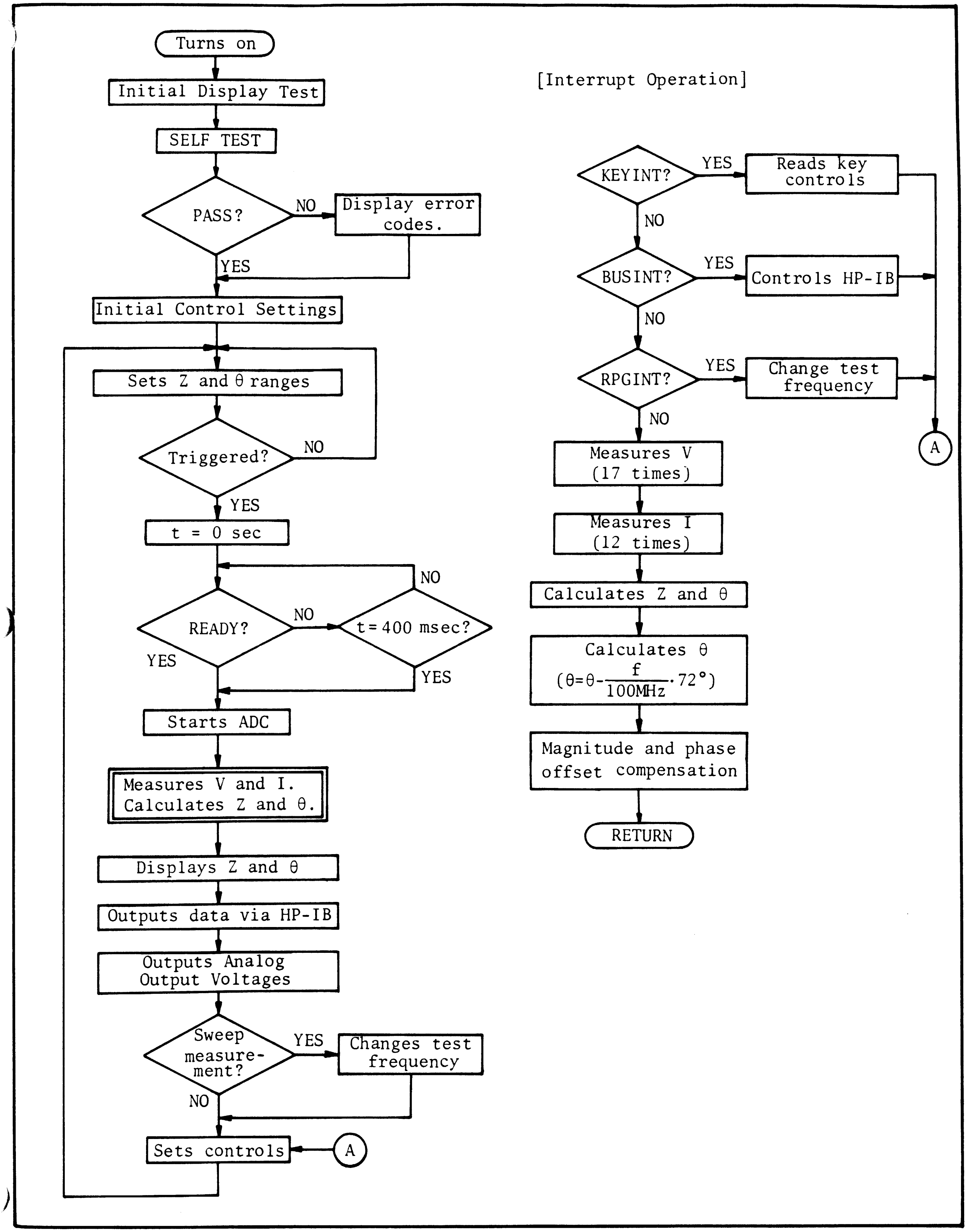


Figure 8-12. Measurement Sequence Flow Diagram.

## 8-66. OVERALL MEASUREMENT SEQUENCE

8-67. All instrument functions are controlled by the microprocessor on the A17 board in accordance with the programs stored in the five 2k byte ROMs. The basic measurement cycle is shown in Figure 8-12. When line 14 of the address bus (AB14) goes HIGH, the ROM whose address appears on AB11 through AB13 is selected and the program instruction at the address appearing on AB0 through AB10 is read into the microproessor via the 8-line memory bus, MB0 through MB7. The I/O bus is disabled at this time.

8-68. For data transfer between the microprocessor and the instrument's various circuits, there are seven mutually exclusive I/O control lines, I0G1 through I0G7. Refer to Table 8-1 for the function of each. Selection is made by the microprocessor via AB11 through AB14, as shown in Figure 8-13. When AB14 goes LOW, the decoder is enabled, selcting one of the I/O control lines, I0G1 through I0G7, or the RAM select line, $\overline{\text{RAMSLCT}}$, in accordance with the address on AB11 through AB13. Refer to Table 8-2.

8-69. I0G7 is used for X-Y RECORDER analog output. It, along with AB0 and AB1, controls PEN LIFT output and data transfer from the microprocessor to the RAMs on the A15 board. When the instrument's X-Y RECORDER function is set to on, the digital data representing the number of counts displayed on the MAGNITUDE, PHASE, and FREQUENCY displays are successively converted into dc voltage by the DA converter and output to the appropriate rear-panel connector.

8-70. I0G6 is used for HP-IB operation. When this line goes LOW, the read/write registers in the HP-IB chip, A16U2, are enabled, as is bidirectional data transfer between the remote device and the microprocessor. AB0 through AB2 control addressing of the on-chip registers.

8-71. I0G5 is used by the microprocessor to monitor internal control signals—$\overline{\text{ADCINT}}$, $\overline{\text{BUSINT}}$, $\overline{\text{KEYINT}}$, RPGUD, $\overline{\text{RPGINT}}$, EXTRIG, RNGUP, RNGDN, SSRDY, EXTOSC, and R IN—via the I/O bus. It is also used to read the HP-IB address control switch and to clear the external trigger flip-flop.

8-72. I0G4 is used for AD conversion of magnitude and phase on the A14 board and for transfer of the 14-bit magnitude and phase data to the microprocessor. It also control I-channel/V-channel selection on the A12 board.

8-73. I0G3, along with AB0 through AB2, is used for magnitude and frequency ranging, Ns control, and frequency control. It sends frequency band signals, FB0 and FB1, to the A11 board to control the output range of the VCO; frequency range signals, FR0 and FR1, to the A7 board to control the frequency of FV; N divisor signals, F01 to F38, to the A7 board to control frequency; Ns signals, NS1 through NS6, to the A5 board to control the sampling frequency; magnitude range signals, ZR1, ZR2, ZR4, ZR5, to the A3 and A4 boards to control magnitude range; and a phase range signal, R, to the A13 board to select phase range (0 ° to ±90 ° or ±90 ° to 180 °).

8-74. I0G2 controls LED lamps and control keys on the front-panel.

8-75. I0G1 controls the 7-segment displays and LED's on the front-panel.

Table 8-1. I/O Group Functions

| I/O Group | Functions |
|---|---|
| I0G7 | X-Y Recorder Outputs |
| I0G6 | HP-IB |
| I0G5 | Status Input |
| I0G4 | ADC |
| I0G3 | Internal Control |
| I0G2 | Front-Panel Control |
| I0G1 | Display Control |

Table 8-2. Address Assignments

| | Address (AB15 - AB0) | | | | | | | Note |
|---|---|---|---|---|---|---|---|---|
| | 15 | 14 | 13 | 12 | 11 | 10 | 9-0 | |
| ROMs | - | 1 | 1 | 1 | 1 | x | x | A17U7 |
| | - | 1 | 1 | 1 | 0 | x | x | A17U6 |
| | - | 1 | 1 | 0 | 1 | x | x | A17U5 |
| | - | 1 | 1 | 0 | 0 | x | x | A17U4 |
| | - | 1 | 0 | 1 | 1 | x | x | A17U3 |
| I/O Groups | - | 0 | 1 | 1 | 1 | x | x | I0G7 |
| | - | 0 | 1 | 1 | 0 | x | x | I0G6 |
| | - | 0 | 1 | 0 | 1 | x | x | I0G5 |
| | - | 0 | 1 | 0 | 0 | x | x | I0G4 |
| | - | 0 | 0 | 1 | 1 | x | x | I0G3 |
| | - | 0 | 0 | 1 | 0 | x | x | I0G2 |
| | - | 0 | 0 | 0 | 1 | x | x | I0G1 |
| RAMs | - | 0 | 0 | 0 | 0 | - | x | A17U1, U2 |

-: Not used
x: Irrelevant

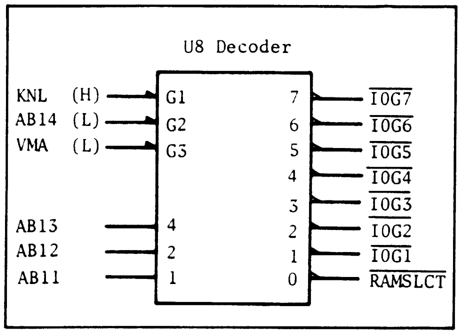


Figure 8-13. IOG Lines.

8-76. TIMING DIAGRAM DISCUSSION

8-77. When I0G4 goes LOW, the RUN/HOLD signals in both magnitude and phase ADCs go HIGH to start AD conversion. Measured signals supplied to these two ADCs are selected by the V/IMEAS signal, which controls the selection switch on the A12 board. When V/IMEAS is LOW, the V-Channel signal is input into the ADCs; when it is high, the I-channel signal is selected. Each time the instrument is turned on, or when the trigger is set to MAN/EXT, V/IMEAS is set LOW or held LOW. When RUN/HOLD goes HIGH, the integrator outputs, MI and PI, are offset by the INL inputs. See Figure 8-14. But when the end of the integration period, which is equivalent to 2048 counts of the CLOCK, is reached, the integrator offset voltages are rejected because INL inputs are isolated from the integrator inputs. The integrator discharge period, when the integrated voltage is discharged by the reference dc voltage (+2Vdc), continues until the integrator output voltage reaches zero volts. This period is counted by the on-chip counter, and the number of counts is proportional to the differential voltage between INH and INL. In V measurement mode, AD conversion is repeated 17 times (normal mode) or once (high speed mode) per one trigger. In I measurement mode, AD conversion is repeated 12 times (normal mode) or once (high speed mode) per one trigger. Before each conversion an auto zero operation is performed to reject any internal offset error. The first auto zero operation occurs after the first AD conversion for V measurement. That is, auto zero is not performed for the first conversion.

8-78. RUN/HOLD goes LOW when the last of the two AD conversions is completed. Before the first conversion is performed, there is a period for reading the control signals and for setting all controls. The length of this period depends on instrument status; if there are no control setting changes, it is 2.5msec.

8-79. In the I measurement cycle, the output of the PHASE ADC, PI, is nearly a square wave because the phase difference between the I signals in I channel and V/I channel is approximately zero degrees.

8-80. The STATUS signal represents the ADC status. It is HIGH when conversion is in progress, and LOW when not in progress. Each time both STATUS signals go LOW, INT signal is generated and fed to A17 board to perform ADC interrupt operation which has several functions : stores ADC data, calculates magnitude and phase data, and calibrates the calculated values with phase shift and frequency characteristics.

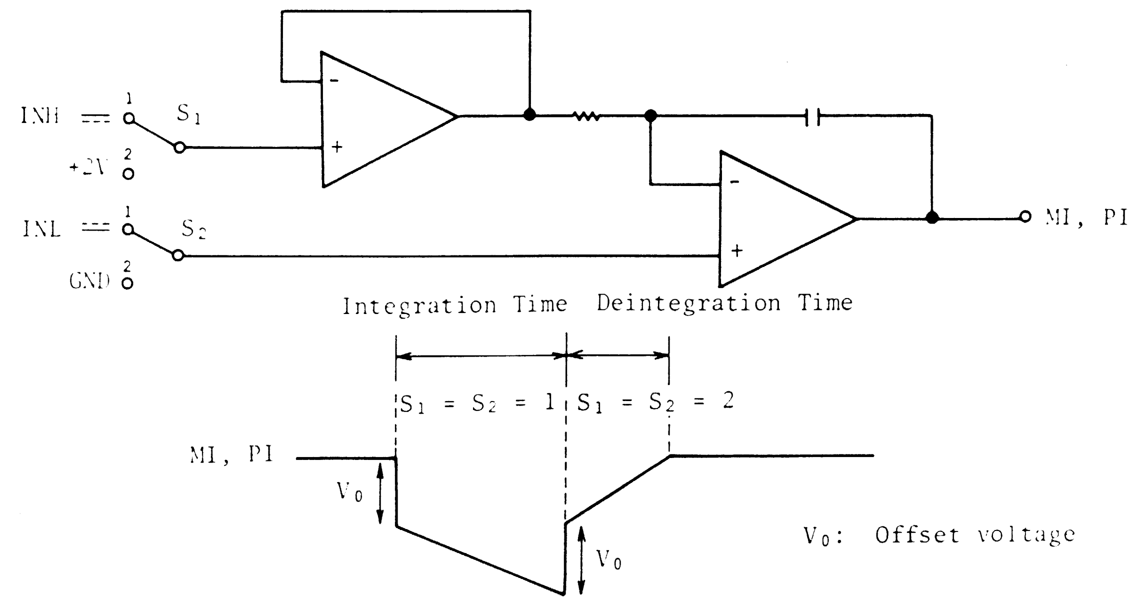


Figure 8-14. Integrator Output.

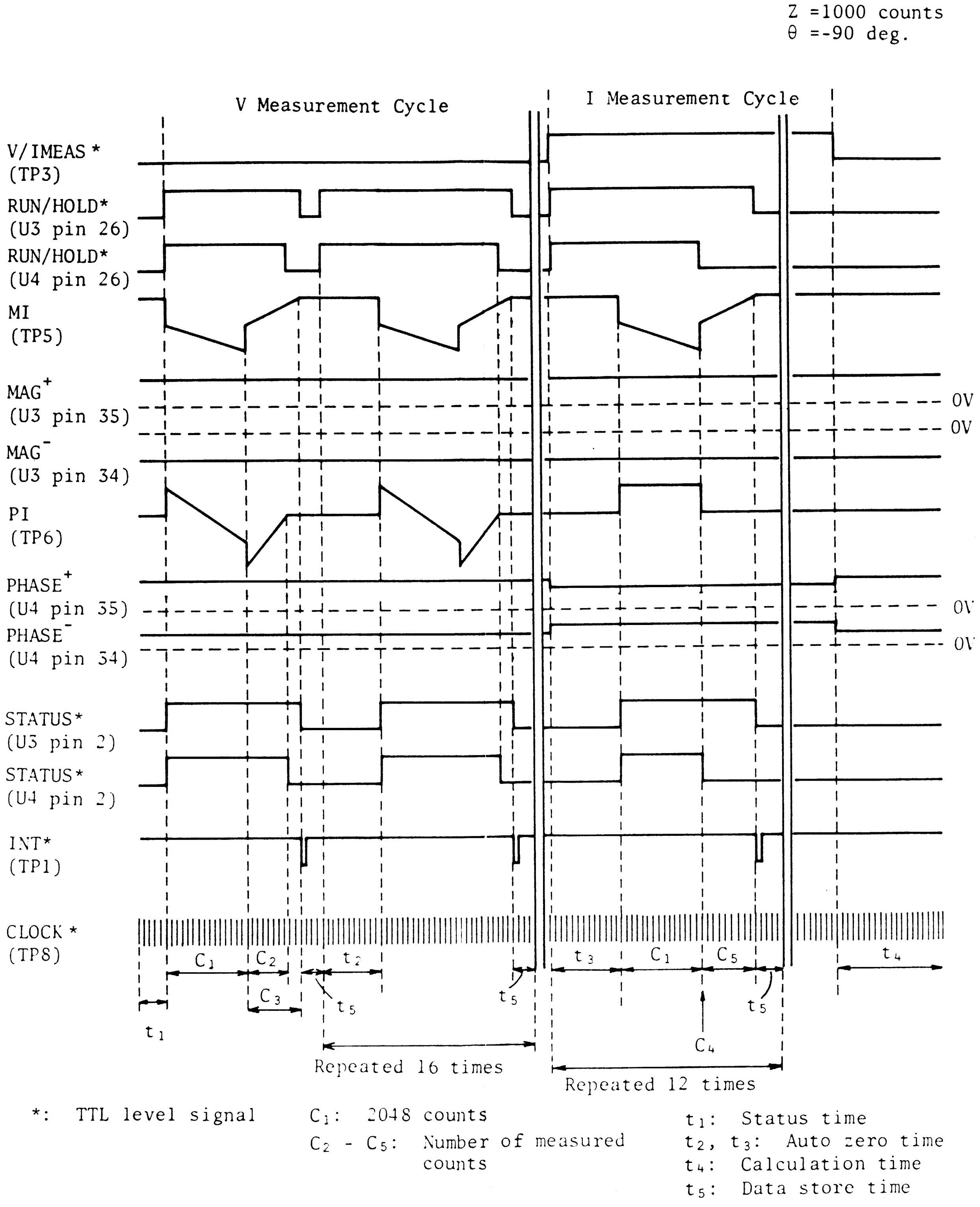


Figure 8-15. Timing Diagram.

## 81. PROBE REPAIR

8-82. When an instrument failure is isolated to the A51 board or the A52 board (inside the probe), replace all four sampling diodes (HP Part No. : 1901-0518) on the board. If the failure persists, replace the entire board. Probe disassembly is described in paragraph 8-84.

8-83. If the probe cable is damaged, replace the entire probe assembly (HP Part No.: 04193-61152).

## 8-84. PROBE DISASSEMBLY

8-85. To access the A51 and A52 boards inside the probe, use the procedure given below. Refer to Figures 8-16 and 8-17.

1. Loosen the coupling nut labelled ① in Figure 8-16.
2. Unscrew the barrel ②, and remove it from the probe. The 3-section brass housing secured by six phosphor-bronze rings will be visible.
3. Place the probe in the vise ② as shown in Figure 8-17. The ring closest to the probe tip must be inserted into chuck B, and the groove between the first and second rings must inserted into chuck A.
4. Slowly turn the vice handle counterclockwise until the ring is clear of the probe. Remove the ring and the probe from the vise chucks.
5. Place the probe in the vise so that the probe tip is pointing toward the vise handle (opposite from step 3). The second ring must be inserted into chuck B and the groove used in step 3 must be inserted into chuck A.
6. Slowly turn the vice handle counterclockwise until the ring is loose.
7. Remove the probe from the vise and slide the first section of the brass-housing 3 off the probe.

CAUTION

WHEN REMOVING THE BRASS-HOUSING, USE HAND PRESSURE ONLY. DO NOT USE PLIERS OR SIMILAR TOOLS.

8. Repeat steps 3 through 7 for the remaining two sections, 4 and 5 .

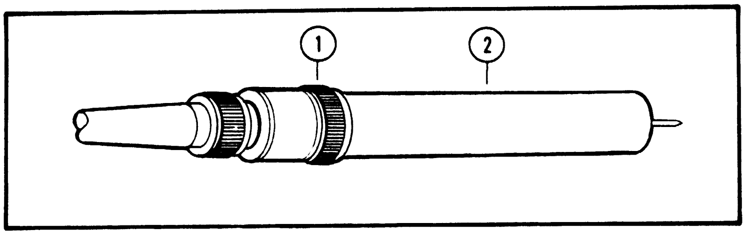


Figure 8-16. Probe.

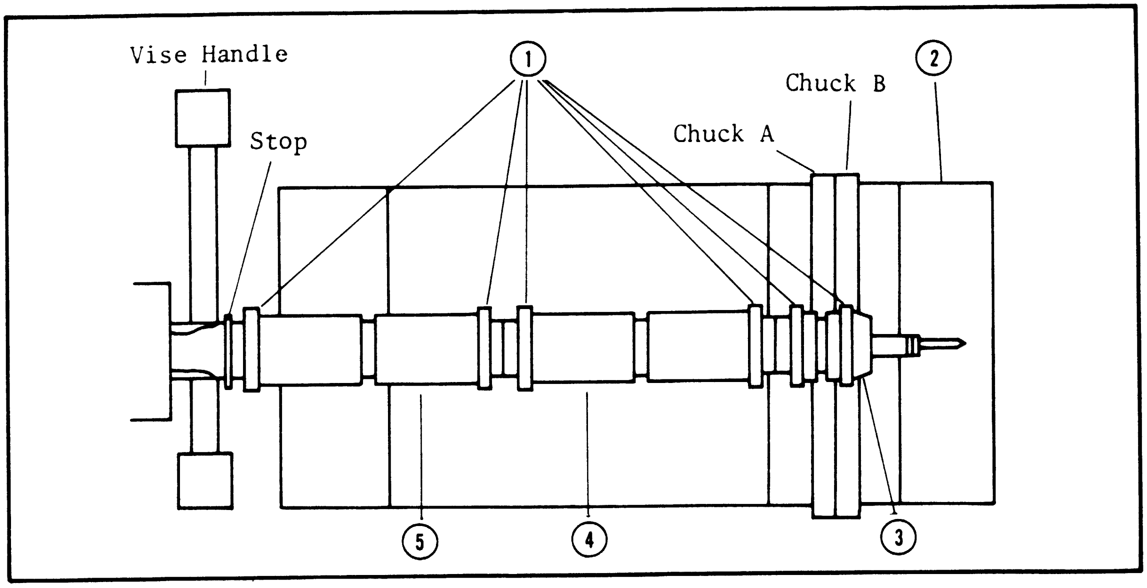


Figure 8-17. Probe Assembly.

### 8-86. PROBE ASSEMBLY

8-87. To reassemble the probe, use the procedure given below. Refer to Figure 8-17.

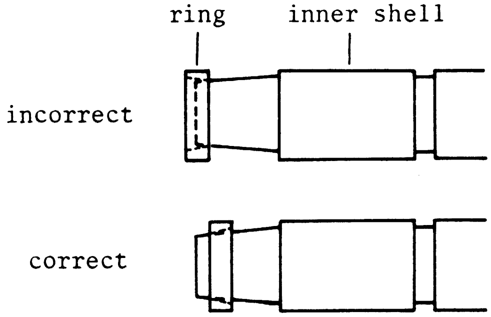
1. Using hand pressure, slide one ring onto each end of each section of the brass-housing.

Note

When reassembling the probe, use new rings ① (HP Part No. : 04193-21016). Do not reassemble using the old rings.

Note

The inner surface of each ring is tapered to match the taper of the brass-housing. The rings must be inserted in the correct direction to insure proper seating.



2. Slide the section labelled ⑤ in Figure 8-17 onto the probe until flush against the stop.

3. Place the probe in the vise so that the ring nearest the stop is inserted into chuck B and the groove at the center of the section is inserted into chuck A.

4. Close the vise until the ring is fully seated.

5. Repeat steps 2 through 4 for the remaining two sections, ③ and ④.

6. Insert the probe into the probe barrel and screw the barrel into the probe collar. Tighten the barrel with 15kgf·cm of torque.

7. Tighten the coupling nut.

### 8-88. Adjustments Related to Probe Replacement and Repair

8-89. When replacing the A51 board, A52 board, or the sampling diodes on each board, be careful not to shorten the wires connected to each board. Also, after board repair or replacement, the following adjustments must be performed :

1. Test Signal Level Adjustment (para. 5-32)

2. Magnitude and Phase Accuracy Adjustment (para. 5-34)

3. Frequency Characteristics Adjustment (para. 8-90)

These adjustments are required when the probe assembly (HP Part NO. : 04193-61151) is replaced.

### 8-90. Frequency Characteristics Adjustment

8-91. When the probe assembly, A51 board, or A52 board is replaced, the adjustment described in Figure 8-18 must be performed. Do not perform this adjustment unless the probe has been repaired or replaced.

## FREQUENCY CHARACTERISTICS ADJUSTMENT

PURPOSE : This adjustment compensates the 4193A's measurement circuit for probe and cable residuals at low frequencies (below 2MHz) and high frequencies (above 40MHz).

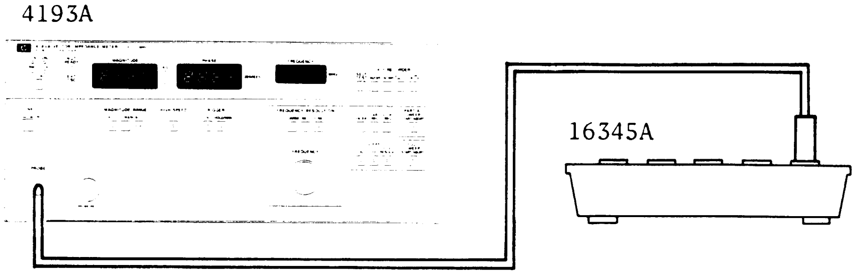


Figure A. Frequency Characteristics Adjustment Setup.

EQUIPMENT :

Calibration Standard ······································ HP 16345A

PROCEDURE :

[PHASE Adjustment]

1. Remove the top cover.

2. Insert the probe into the 100Ω standard (16345A).

3. Set the 4193A's controls as follows :

   FREQ. ·························· .400MHz
   Other Settings··············· Initial Settings

4. Set all bits of A17S1 to zero, as shown in Figure B.

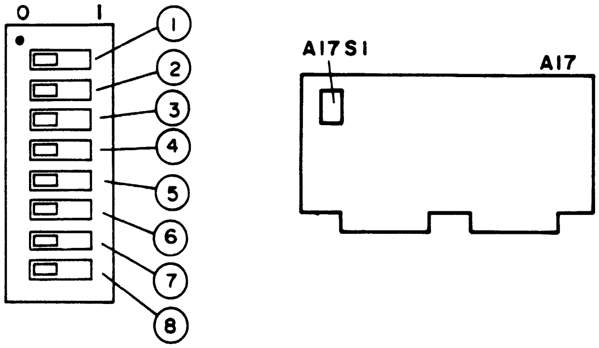


Figure B. Initial Setting of A17S1.

5. If the number of counts on the PHASE display is > +1, set A17S1 bit ⑧ to 1 (right-position); if the number of counts is <-1, set bit ⑧ to 0 (left-position). If the number of counts is ±1, go to step 7; if otherwise, go to step 6.

Figure 8-18. Frequency Characteristics Adjustment (Sheet 1 of 2).

6. Set A17S1 bits⑤,⑥and⑦in accordance with the table below :

Table A. A17S1 Bits ⑤ thru ⑦ Settings

| Display Counts | Switch Setting | | |
|---|---|---|---|
| | Bit ⑤ | Bit ⑥ | Bit ⑦ |
| 2 or 3 | 1 | 0 | 0 |
| 4 or 5 | 0 | 1 | 0 |
| 6 or 7 | 1 | 1 | 0 |
| 8 or 9 | 0 | 0 | 1 |
| 10 or 11 | 1 | 0 | 1 |
| 12 or 13 | 0 | 1 | 1 |
| 14 or 15 | 1 | 1 | 1 |

[MAGNITUDE Adjustment]

7. Set the frequency to 40MHz and note the number of counts on the FREQUENCY display as Z1.

8. Set the frequency to 110MHz and note the number of counts on the FREQUENCY display as Z2.

9. If Z2-Z1>10, go to step 10; if Z2-Z1<10, the adjustment is completed.

10. Set A17S1bit①through④in accordance with the table below :

Table B. A17S1 Bits ① thru ④ Settings

| Z2-Z1 | Switch Settings | | | |
|---|---|---|---|---|
| | Bit ① | Bit ② | Bit ③ | Bit ④ |
| 11 | 1 | 0 | 0 | 0 |
| 12 | 0 | 1 | 0 | 0 |
| 13 | 1 | 1 | 0 | 0 |
| 14 | 0 | 0 | 1 | 0 |
| 15 | 1 | 0 | 1 | 0 |
| 16 | 0 | 1 | 1 | 0 |
| 17 | 1 | 1 | 1 | 0 |
| 18 | 0 | 0 | 0 | 1 |
| 19 | 1 | 0 | 0 | 1 |
| 20 | 0 | 1 | 0 | 1 |
| 21 | 1 | 1 | 0 | 1 |
| 22 | 0 | 0 | 1 | 1 |
| 23 | 1 | 0 | 1 | 1 |
| 24 | 0 | 1 | 1 | 1 |
| 25 | 1 | 1 | 1 | 1 |

Figure 8-18. Frequency Characteristics Adjustment (Sheet 2 of 2).

Table 8-3. Mnemonic Information (Sheet 1 of 2)

| Mnemonic | Description |
|---|---|
| AB0-3 | Address Bus Lines. |
| ADR1 | HP-IB address bit 1. |
| ADR2 | HP-IB address bit 2. |
| ADR3 | HP-IB address bit 3. |
| ADR4 | HP-IB address bit 4. |
| ADR5 | HP-IB address bit 5. |
| $\overline{\text{ADCINT}}$ | AD conversion interrupt. |
| ALC | Automatic Level Control. |
| $\overline{\text{ASE}}$ | Address Switch Enable. |
| $\overline{\text{BUSINT}}$ | HP-IB interrupt. |
| CLK0 | 2.5MHz clock. |
| DI01-8 | HP-IB data bus lines. |
| EXTOSC | External oscillator. |
| $\overline{\text{EXTRG}}$ | External trigger. |
| F01-F08 | N divisor LSD. |
| F11-F18 | N divisor 3rd SD. |
| F21-F28 | N divisor 2nd SD. |
| F31-F38 | N divisor MSD. |
| FB0, FB1 | VCO Frequency band signal. |

| FB0 | FB1 | FS1 | FS2 | FS3 |
|---|---|---|---|---|
| 0 | 0 | L | L | L |
| 1 | 0 | H | L | L |
| 0 | 1 | H | H | L |
| 1 | 1 | L | H | H |

| Mnemonic | Description |
|---|---|
| $\overline{\text{FD}}$ | Frequency Down signal to A11. |
| FOUT | FREQUENCY analog output. |
| FR | Frequency Reference signal to A11. |
| FR0, FR1 | Frequency range signal to A7. |

| FR0 | FR1 | Frequency Range |
|---|---|---|
| 0 | 0 | .400 to .999MHz |
| 1 | 0 | 1.000 to 9.999MHz |
| 0 | 1 | 10.00 to 99.99MHz |
| 1 | 1 | 100.0 to 110.0MHz |

| Mnemonic | Description |
|---|---|
| FS1,FS2,<br>FS3 | VCO frequency range control signal. |

| FS1 | FS2 | FS3 | Frequency Range |
|---|---|---|---|
| L | L | L | .400 to 9.999MHz |
| H | L | L | 10.00 to 39.99MHz. |
| H | H | H | 40.00 to 69.99MHz |
| L | H | H | 70.00 to 110.0MHz |

| Mnemonic | Description |
|---|---|
| $\overline{\text{FU}}$ | Frequency Up signal to A11. |
| FV | Variable frequency signal to A11. |
| ICH | Current channel. |
| IMEAS | +5V: Current channel measured.<br>-5V: Current channel not measured. |
| IOB 0-7 | I/O bus lines. |
| IOG1 | I/O Group 1. |
| IOG2 | I/O Group 2. |
| $\overline{\text{IOG3}}$ | I/O Group 3. |
| $\overline{\text{IOG4}}$ | I/O Group 4. |
| $\overline{\text{IOG5}}$ | I/O Group 5. |
| $\overline{\text{IOG6}}$ | I/O Group 6. |
| IOG7 | I/O Group 7. |
| IR | Current channel reference signal. |
| $\overline{\text{KEYINT}}$ | Key interrupt. |
| $\overline{\text{KNL}}$ | Karnel. |
| MAG$^+$ | Positive input to MAGNITUDE ADC. |
| MAG$^-$ | Negative input to MAGNITUDE ADC. |
| MPUCLK | 2MHz clock for the MPU. |
| NS1-NS7 | Ns control signals to A5. |
| PENUP | X-Y recorder pen up. |
| PHASE$^+$ | Positive input to PHASE ADC. |
| PHASE$^-$ | Negative input to PHASE ADC. |
| $\overline{\text{PON}}$ | Power on. |
| RNGDN | Magnitude range down. |
| RNGUP | Magnitude range up. |
| $\overline{\text{RPGINT}}$ | Interrupt from rotary pulse generator. |
| RPGUD | Rotary pulse generator up/down. |
| R/$\overline{\text{W}}$ | Read/write. |

Table 8-3. Mnemonic Information (Sheet 2 of 2)

| Mnemonic | Description |
|---|---|
| SSRDY | Signal Source Ready to A17. |
| TONLY | Talk only mode. |
| VCH | Voltage channel. |
| VCG | Ground for VCS. |
| VCS | VCO control signal. |
| V/I | Voltage and current channel. |
| VIMEAS | +5V: IMEAS +5V, VMEAS -5V.<br>-5V: VMEAS +5V, IMEAS -5V. |
| VMA | Valid Memory Address |
| VMEAS | +5V: Voltage channel measured.<br>-5V: Voltage channel not measured. |
| VREF | +2Vdc reference for A14 ADCs. |
| ZOUT | MAGNITUDE Analog output. |
| ZR1 | 10Ω range signal to A3. |
| ZR2 | 100Ω range signal to A3. |
| ZR3 | 1kΩ range signal. (Not used) |
| ZR4 | 10kΩ range signal to A3 and A4. |
| ZR5 | 100kΩ range signal to A3 and A4. |
| 2IF | 19.53kHz clock. |
| θR | PHASE range control.<br>H=±90° ∿ ±180°. L=0 ∿ ±90°. |
| θRIN | PHASE range detection.<br>H=±90° ∿ ±180°. L=0 ∿ ±90°. |
| θOUT | PHASE Analog output. |
| ϕ1 | 1MHz clock. |
| ϕ2 | 1MHz clock. |

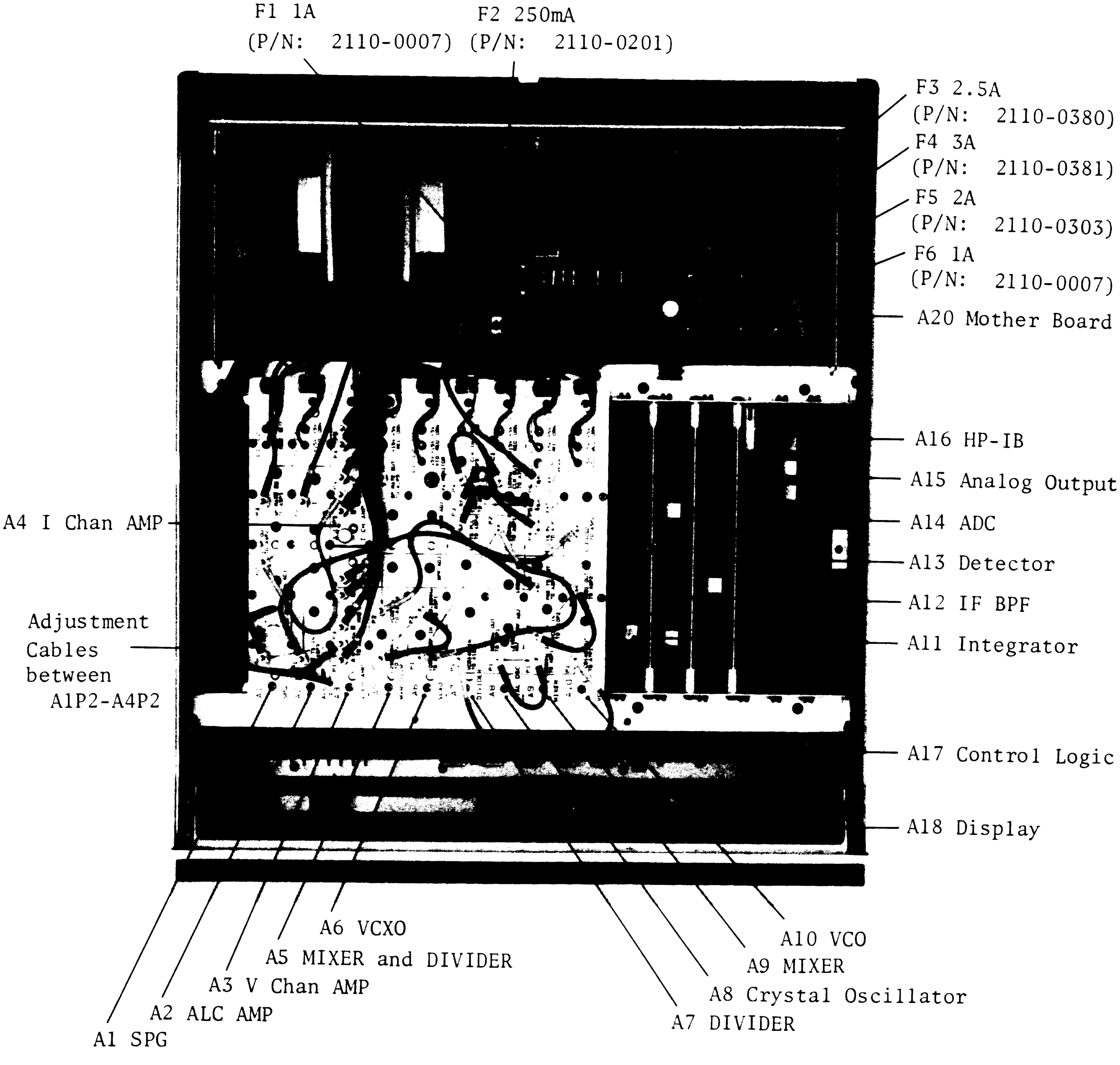
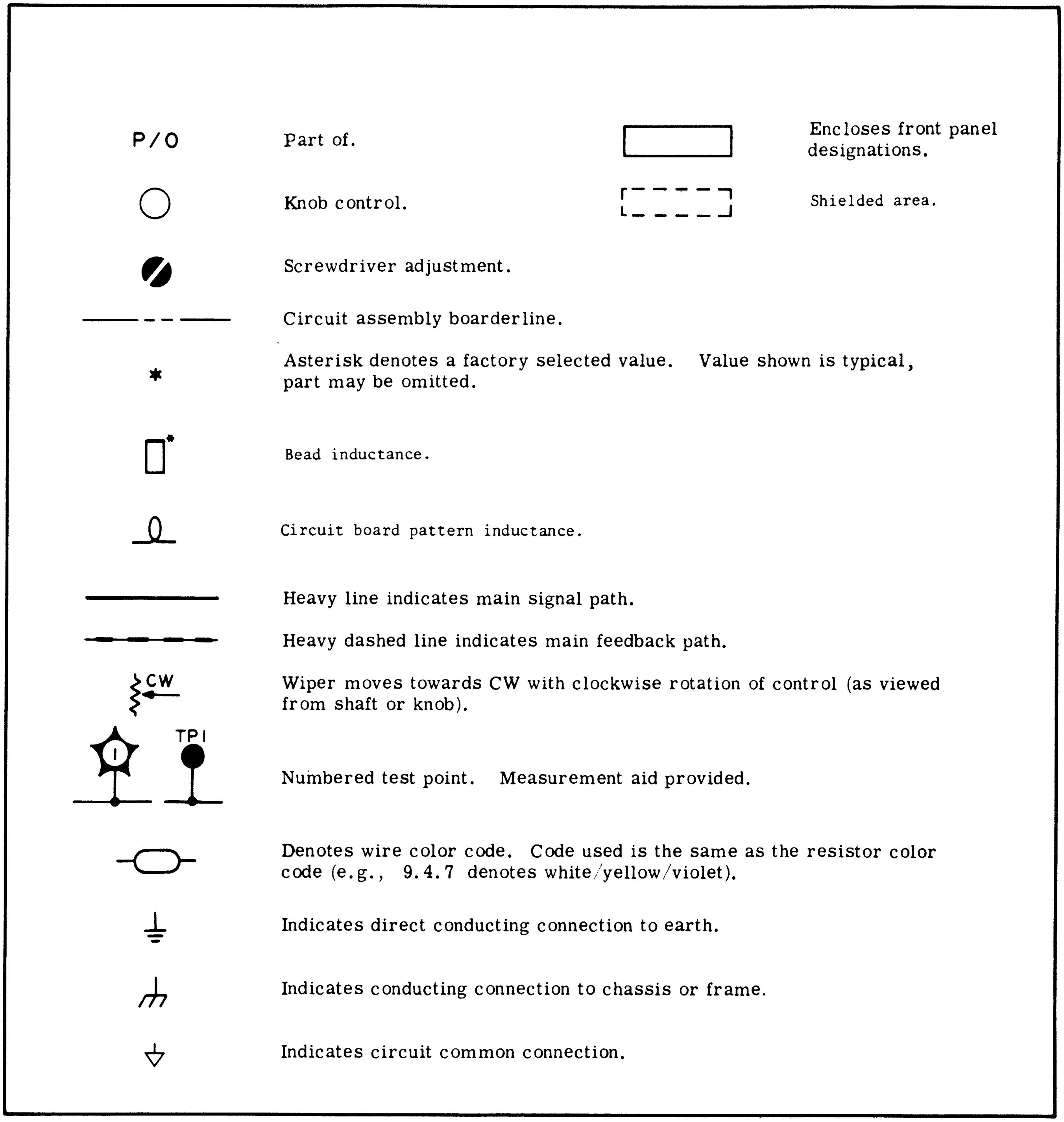


Figure 8-19. Assembly Locations (Top View).



P/O Part of.

Encloses front panel designations.

Knob control.

Shielded area.

Screwdriver adjustment.

Circuit assembly boarderline.

* Asterisk denotes a factory selected value. Value shown is typical, part may be omitted.

Bead inductance.

Circuit board pattern inductance.

Heavy line indicates main signal path.

Heavy dashed line indicates main feedback path.

Wiper moves towards CW with clockwise rotation of control (as viewed from shaft or knob).

Numbered test point. Measurement aid provided.

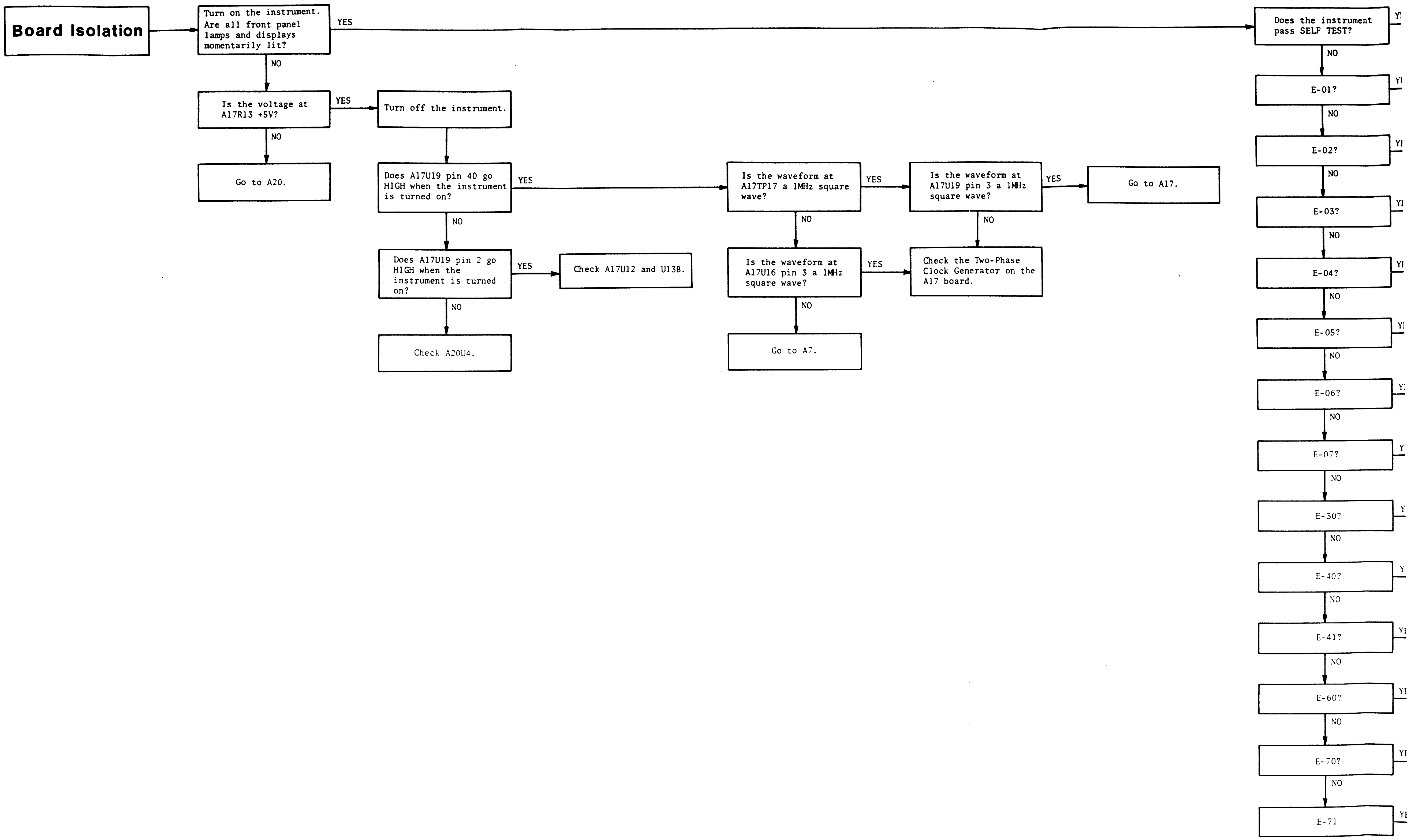
Denotes wire color code. Code used is the same as the resistor color code (e.g., 9.4.7 denotes white/yellow/violet).

Indicates direct conducting connection to earth.

Indicates conducting connection to chassis or frame.

Indicates circuit common connection.

Figure 8-20. Schematic Diagram Notes.


Board Isolation
Turn on the instrument. Are all front panel lamps and displays momentarily lit?
YES
NO
Is the voltage at A17R13 +5V?
YES
NO
Go to A20.
Turn off the instrument.
Does A17U19 pin 40 go HIGH when the instrument is turned on?
YES
NO
Does A17U19 pin 2 go HIGH when the instrument is turned on?
YES
NO
Check A17U12 and U13B.
Check A20U4.
Is the waveform at A17TP17 a 1MHz square wave?
YES
NO
Is the waveform at A17U16 pin 3 a 1MHz square wave?
YES
NO
Go to A7.
Is the waveform at A17U19 pin 3 a 1MHz square wave?
YES
NO
Go to A17.
Check the Two-Phase Clock Generator on the A17 board.
Does the instrument pass SELF TEST?
NO
E-01?
NO
E-02?
NO
E-03?
NO
E-04?
NO
E-05?
NO
E-06?
NO
E-07?
NO
E-30?
NO
E-40?
NO
E-41?
NO
E-60?
NO
E-70?
NO
E-71

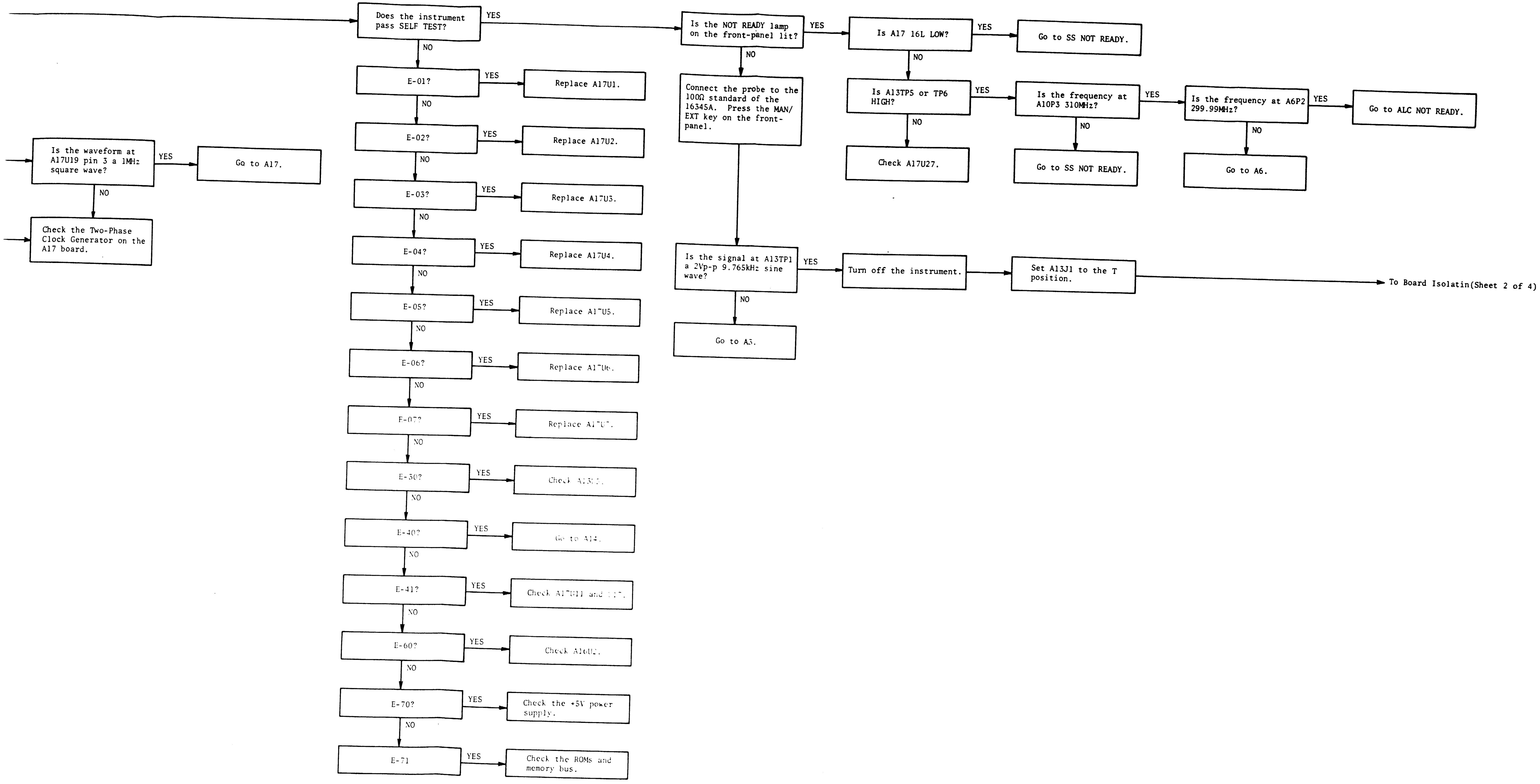


Figure 8-21. Board Isolation Flow Chart (Sheet 1 of 4).

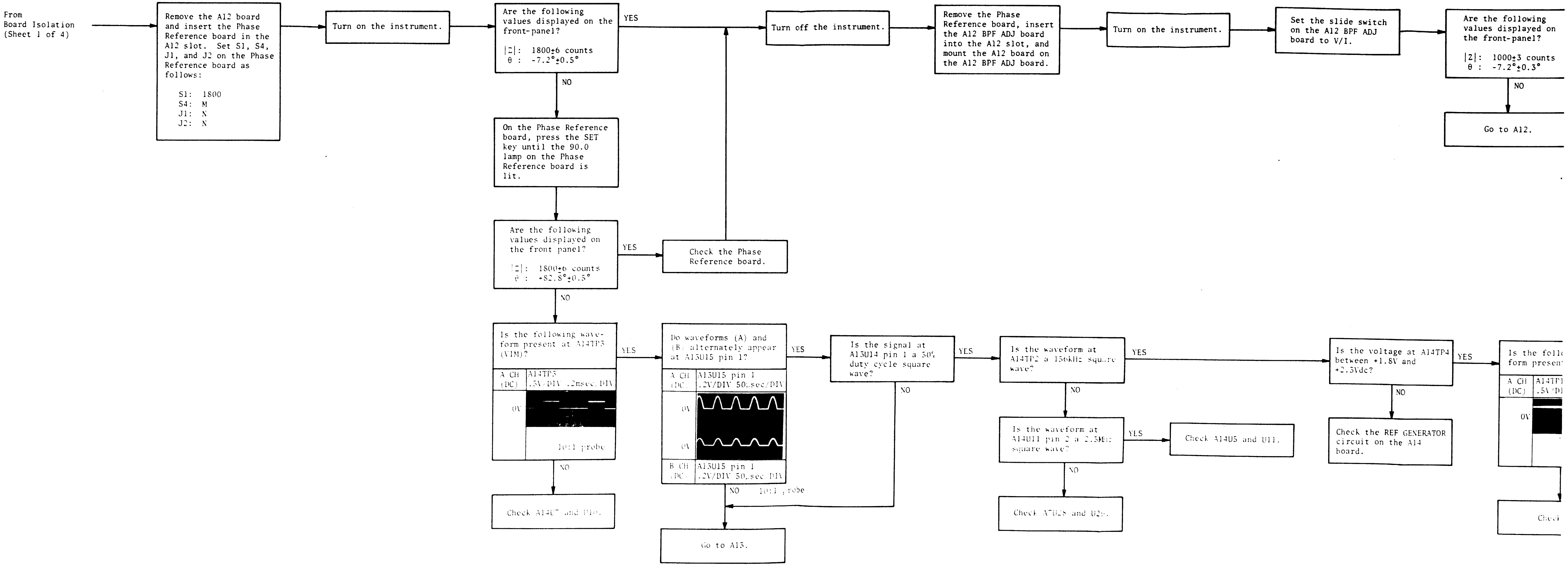
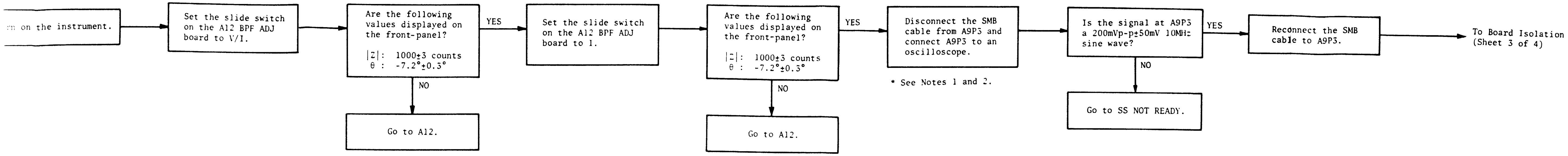
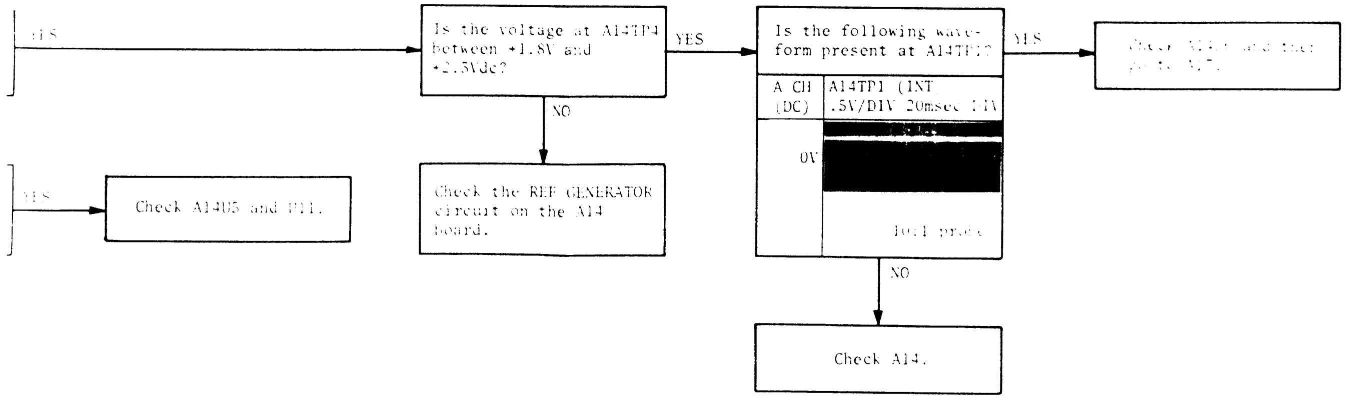


Figure 8-21. Board Isolation Flow Chart (Sheet 2 of 4).

BOARD ISO
SEE INSIDE



* See Notes 1 and 2.

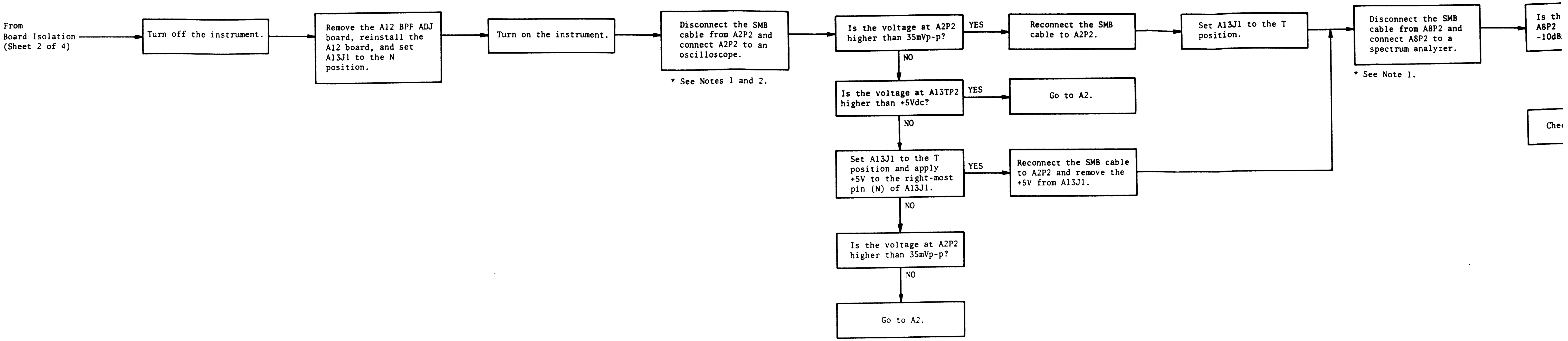


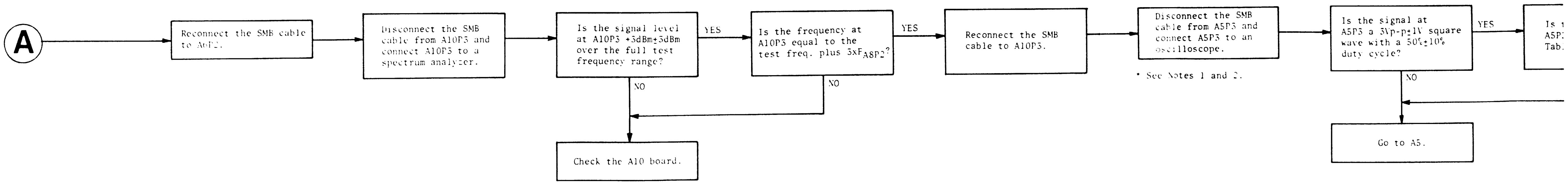
Notes:

1. Use a BNC-to-BNC cable and SMB-to-BNC adapter (P/N: 1250-1236).
2. Set the input impedance of the scope to 50Ω.
3. Set the input impedance of the scope 1MΩ.

BOARD ISOLATION FLOW CHART (Sheet 1 of 4)

SEE INSIDE


From
Board Isolation
(Sheet 2 of 4)
Turn off the instrument.
Remove the A12 BPF ADJ board, reinstall the A12 board, and set A13J1 to the N position.
Turn on the instrument.
Disconnect the SMB cable from A2P2 and connect A2P2 to an oscilloscope.
* See Notes 1 and 2.
Is the voltage at A2P2 higher than 35mVp-p?
YES
Reconnect the SMB cable to A2P2.
Set A13J1 to the T position.
Disconnect the SMB cable from A8P2 and connect A8P2 to a spectrum analyzer.
* See Note 1.
Is th
A8P2
-10dB
Che
NO
Is the voltage at A13TP2 higher than +5Vdc?
YES
Go to A2.
NO
Set A13J1 to the T position and apply +5V to the right-most pin (N) of A13J1.
YES
Reconnect the SMB cable to A2P2 and remove the +5V from A13J1.
NO
Is the voltage at A2P2 higher than 35mVp-p?
NO
Go to A2.


A
Reconnect the SMB cable to A8P2.
Disconnect the SMB cable from A10P3 and connect A10P3 to a spectrum analyzer.
Is the signal level at A10P3 +3dBm±3dBm over the full test frequency range?
YES
Is the frequency at A10P3 equal to the test freq. plus 3xF_A8P2?
YES
Reconnect the SMB cable to A10P3.
Disconnect the SMB cable from A5P3 and connect A5P3 to an oscilloscope.
* See Notes 1 and 2.
Is the signal at A5P3 a 3Vp-p±1V square wave with a 50%±10% duty cycle?
YES
Is
A5P
Tab
NO
NO
Check the A10 board.
NO
Go to A5.

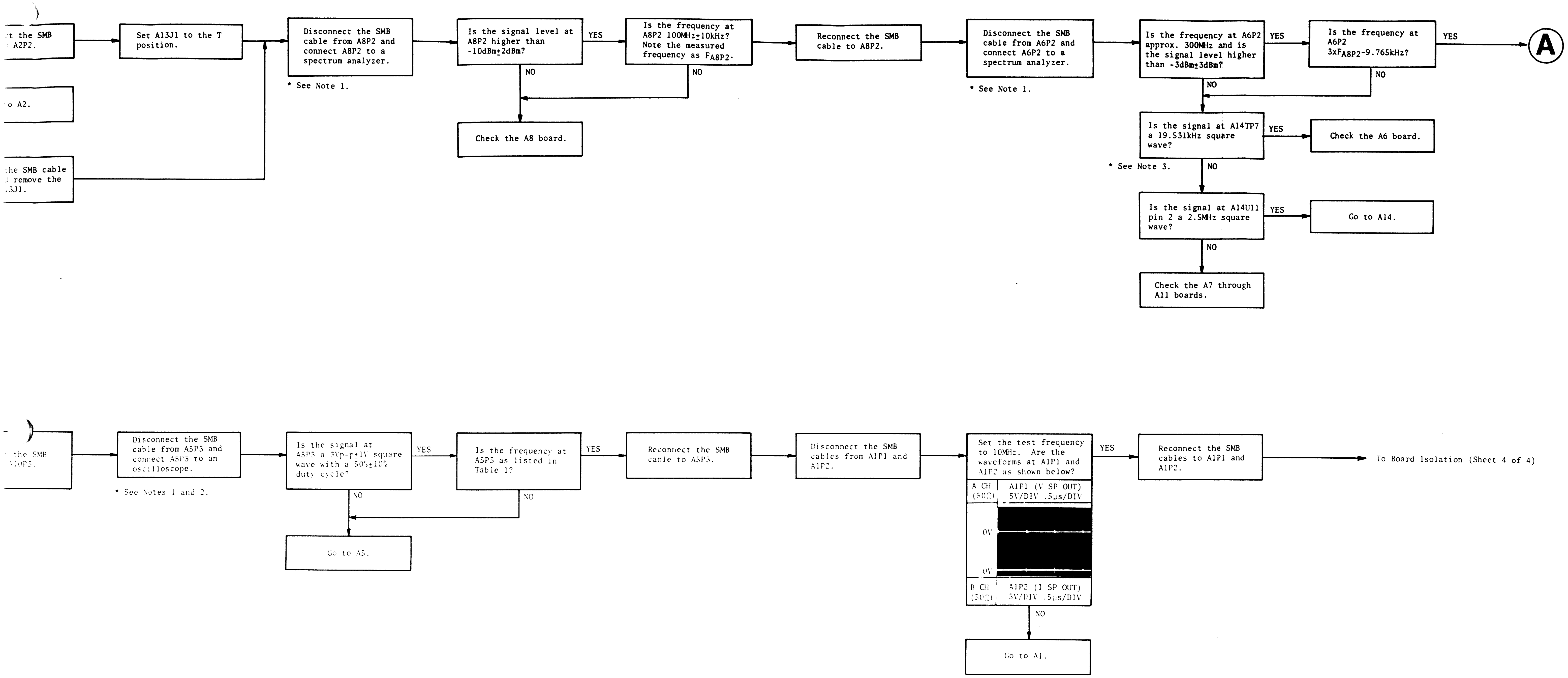
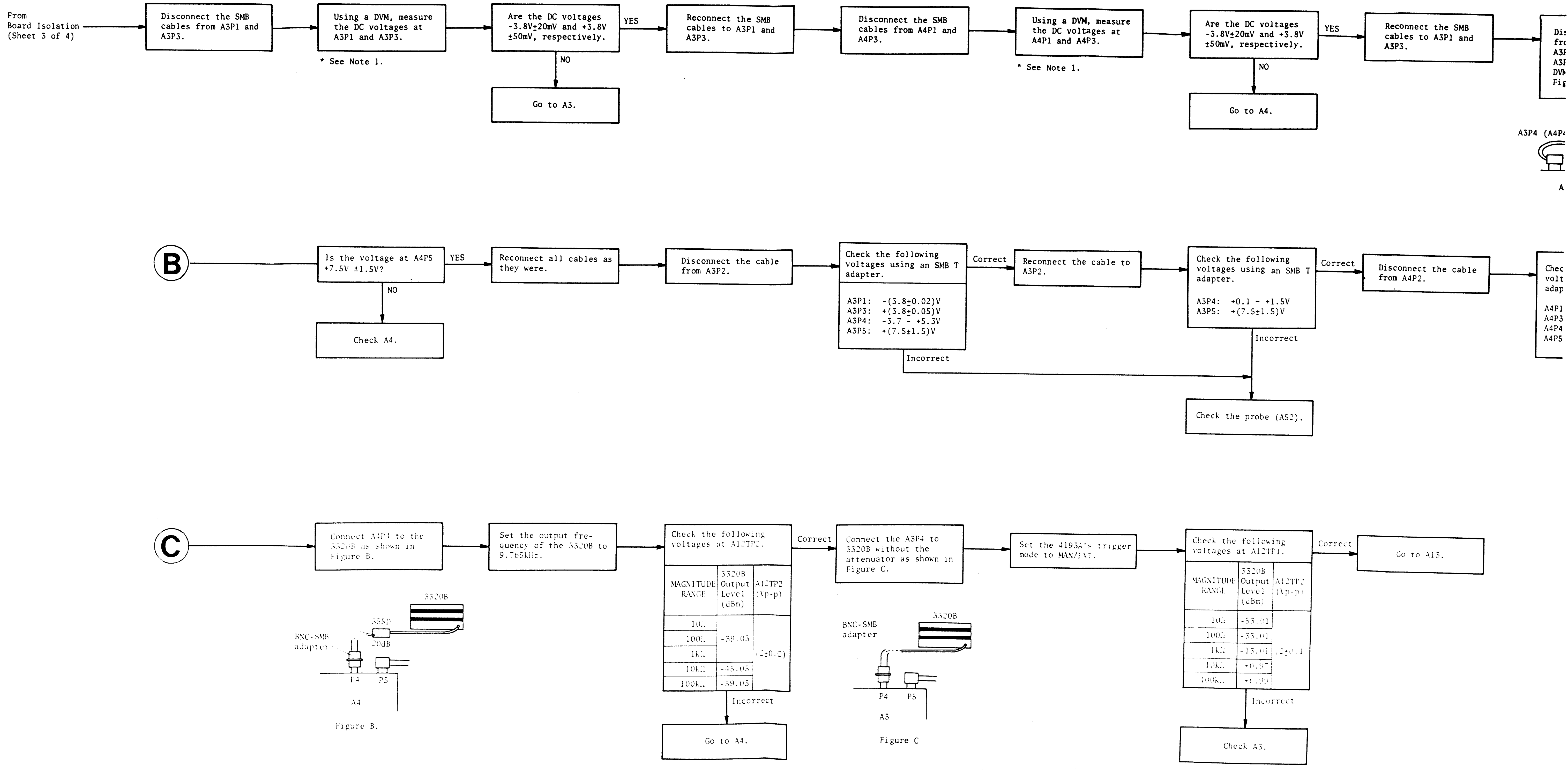


Figure 8-21. Board Isolation Flow Chart (Sheet 3 of 4).

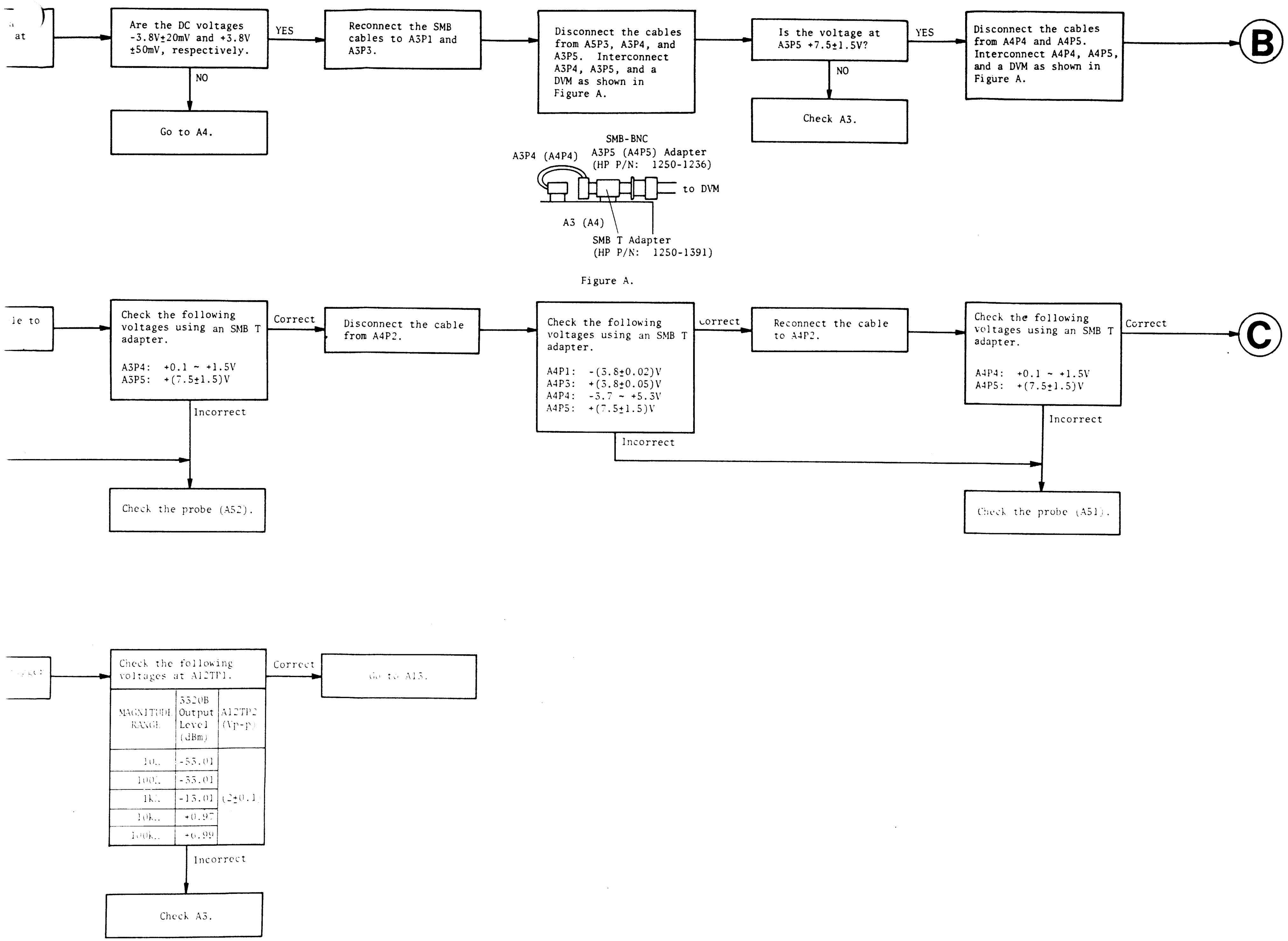


| MAGNITUDE RANGE | 3320B Output Level (dBm) | A12TP2 (Vp-p) |
|---|---|---|
| 10Ω | -39.03 | (2±0.2) |
| 100Ω | | |
| 1kΩ | | |
| 10kΩ | -45.03 | |
| 100kΩ | -39.03 | |

| MAGNITUDE RANGE | 3320B Output Level (dBm) | A12TP2 (Vp-p) |
|---|---|---|
| 10Ω | -33.01 | (2±0.1 |
| 100Ω | -33.01 | |
| 1kΩ | -13.01 | |
| 10kΩ | +0.97 | |
| 100kΩ | +0.99 | |

Figure 8-21. Board Isolation Flow Chart (Sheet 4 of 4).

BOARD ISO]
SEE INSIDE



Are the DC voltages -3.8V±20mV and +3.8V ±50mV, respectively.

Go to A4.

Reconnect the SMB cables to A3P1 and A3P3.

Disconnect the cables from A5P3, A3P4, and A3P5. Interconnect A3P4, A3P5, and a DVM as shown in Figure A.

Is the voltage at A3P5 +7.5±1.5V?

Check A3.

Disconnect the cables from A4P4 and A4P5. Interconnect A4P4, A4P5, and a DVM as shown in Figure A.

Figure A.

Check the following voltages using an SMB T adapter.

A3P4: +0.1 ~ +1.5V
A3P5: +(7.5±1.5)V

Check the probe (A52).

Disconnect the cable from A4P2.

Check the following voltages using an SMB T adapter.

A4P1: -(3.8±0.02)V
A4P3: +(3.8±0.05)V
A4P4: -3.7 ~ +5.3V
A4P5: +(7.5±1.5)V

Reconnect the cable to A4P2.

Check the following voltages using an SMB T adapter.

A4P4: +0.1 ~ +1.5V
A4P5: +(7.5±1.5)V

Check the probe (A51).

Check the following voltages at A12TP1.

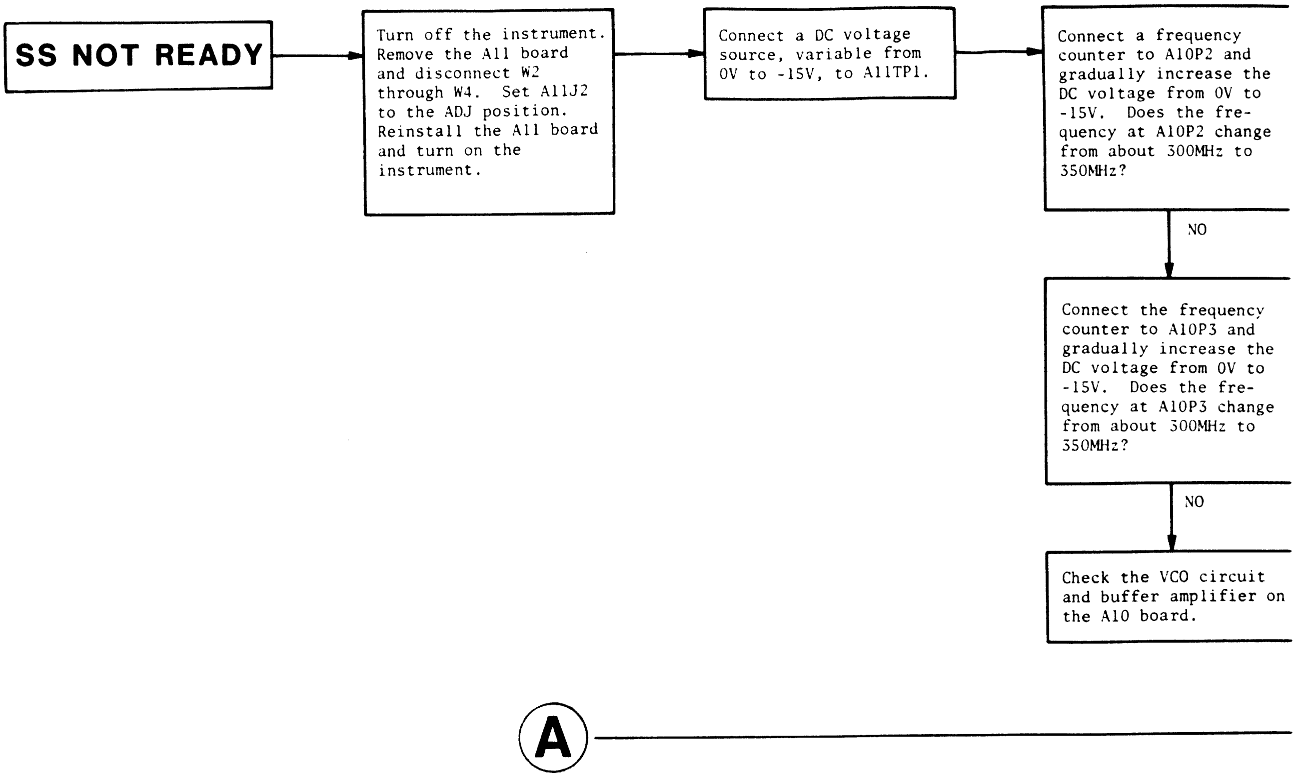
| MAGNITUDE RANGE | 3320B Output Level (dBm) | A12TP2 (Vp-p) |
|---|---|---|
| 10Ω | -53.01 | (2±0.1) |
| 100Ω | -33.01 | |
| 1kΩ | -13.01 | |
| 10kΩ | +0.97 | |
| 100kΩ | +6.99 | |

Go to A13.

Check A3.

## BOARD ISOLATION FLOW CHART (Sheet 3 of 4)

SEE INSIDE



**SS NOT READY**

Turn off the instrument. Remove the A11 board and disconnect W2 through W4. Set A11J2 to the ADJ position. Reinstall the A11 board and turn on the instrument.

Connect a DC voltage source, variable from 0V to -15V, to A11TP1.

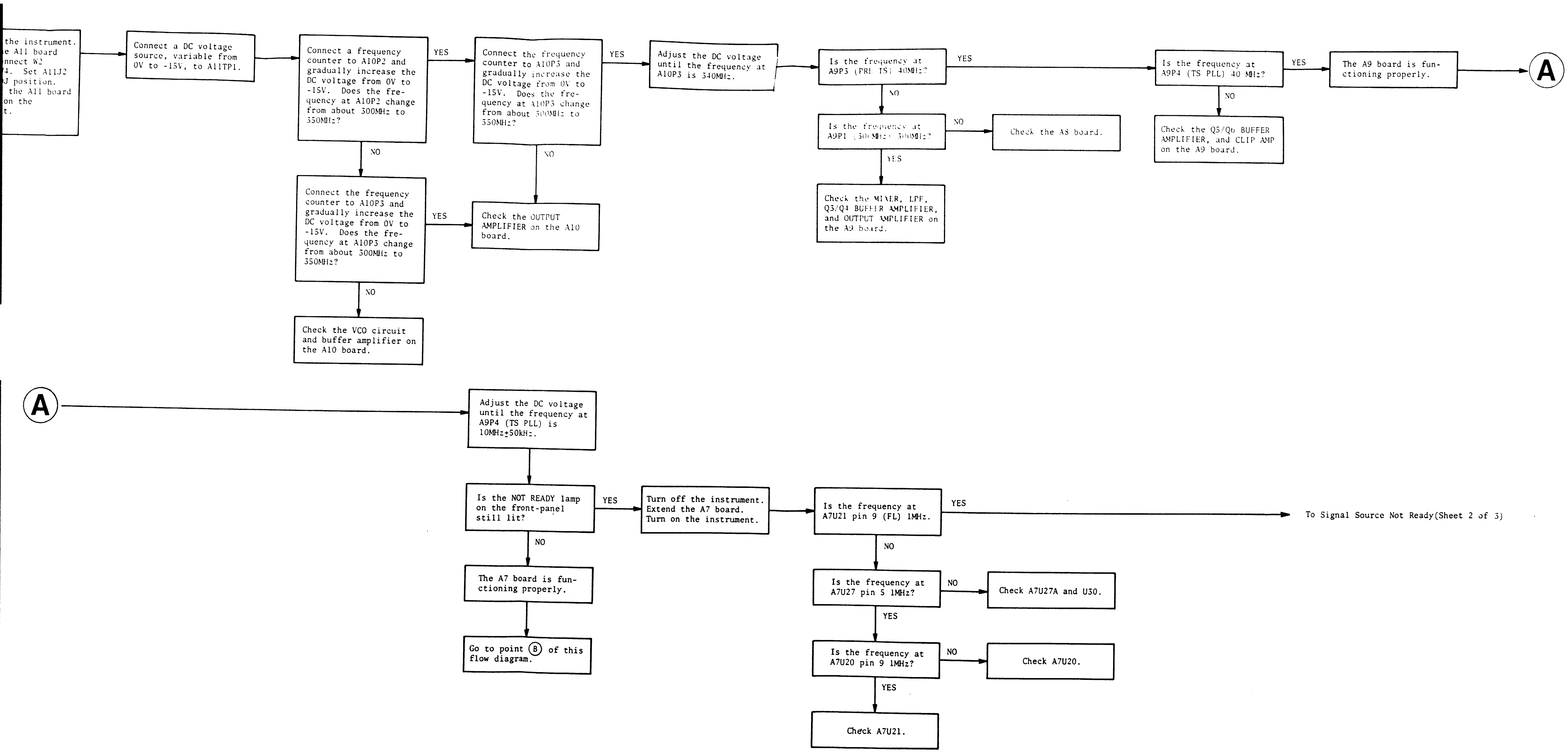
Connect a frequency counter to A10P2 and gradually increase the DC voltage from 0V to -15V. Does the frequency at A10P2 change from about 300MHz to 350MHz?

NO

Connect the frequency counter to A10P3 and gradually increase the DC voltage from 0V to -15V. Does the frequency at A10P3 change from about 300MHz to 350MHz?

NO

Check the VCO circuit and buffer amplifier on the A10 board.



the instrument.
e A11 board
nnect W2
4. Set A11J2
J position.
the A11 board
on the
t.

Connect a DC voltage source, variable from 0V to -15V, to A11TP1.

Connect a frequency counter to A10P2 and gradually increase the DC voltage from 0V to -15V. Does the frequency at A10P2 change from about 300MHz to 350MHz?

Connect the frequency counter to A10P3 and gradually increase the DC voltage from 0V to -15V. Does the frequency at A10P3 change from about 300MHz to 350MHz?

Check the VCO circuit and buffer amplifier on the A10 board.

Connect the frequency counter to A10P3 and gradually increase the DC voltage from 0V to -15V. Does the frequency at A10P3 change from about 300MHz to 350MHz?

Check the OUTPUT AMPLIFIER on the A10 board.

Adjust the DC voltage until the frequency at A10P3 is 340MHz.

Is the frequency at A9P3 (PRE TS) 40MHz?

Is the frequency at A9P1 (300MHz) 300MHz?

Check the A8 board.

Check the MIXER, LPF, Q3/Q4 BUFFER AMPLIFIER, and OUTPUT AMPLIFIER on the A9 board.

Is the frequency at A9P4 (TS PLL) 40 MHz?

Check the Q5/Q6 BUFFER AMPLIFIER, and CLIP AMP on the A9 board.

The A9 board is functioning properly.

Adjust the DC voltage until the frequency at A9P4 (TS PLL) is 10MHz±50kHz.

Is the NOT READY lamp on the front-panel still lit?

The A7 board is functioning properly.

Go to point Ⓑ of this flow diagram.

Turn off the instrument. Extend the A7 board. Turn on the instrument.

Is the frequency at A7U21 pin 9 (FL) 1MHz.

To Signal Source Not Ready(Sheet 2 of 3)

Is the frequency at A7U27 pin 5 1MHz?

Check A7U27A and U30.

Is the frequency at A7U20 pin 9 1MHz?

Check A7U20.

Check A7U21.

Figure 8-22. Signal Source Not Ready Flow Chart (Sheet 1 of 3).

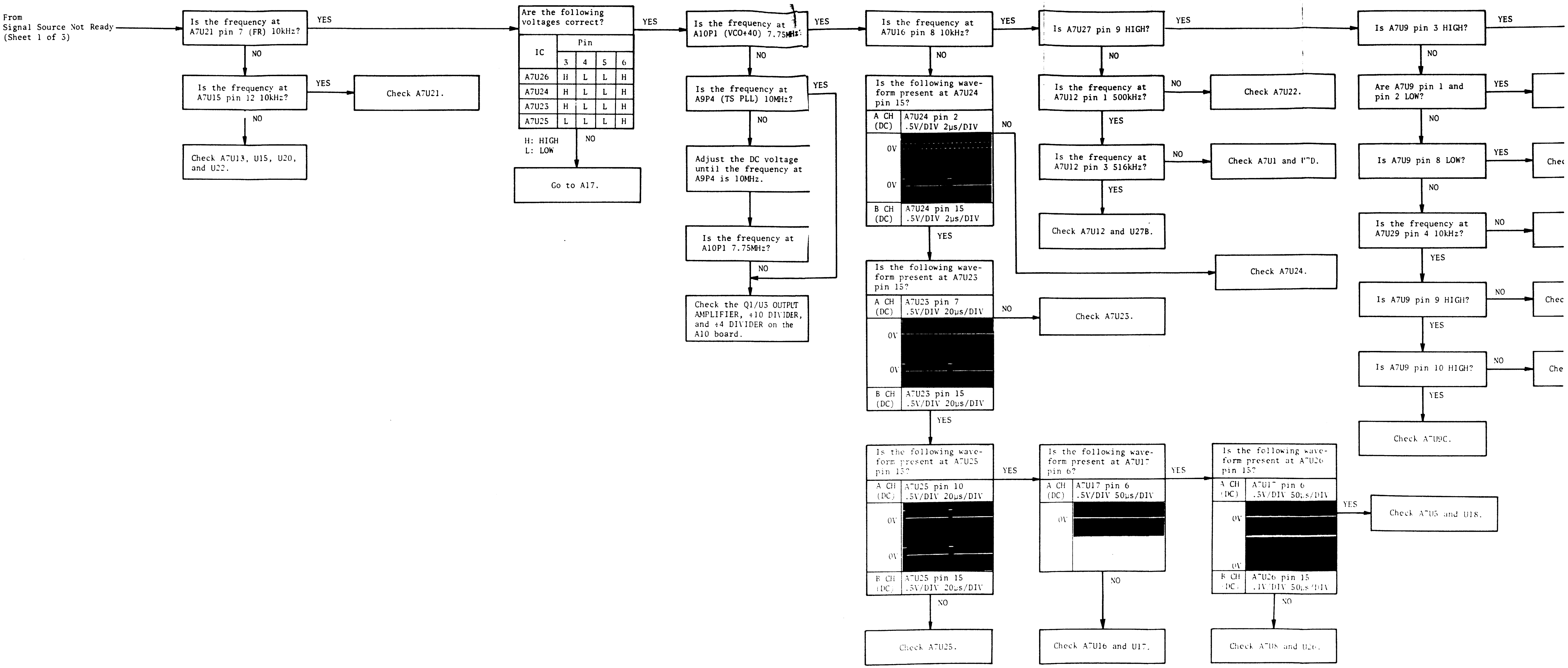
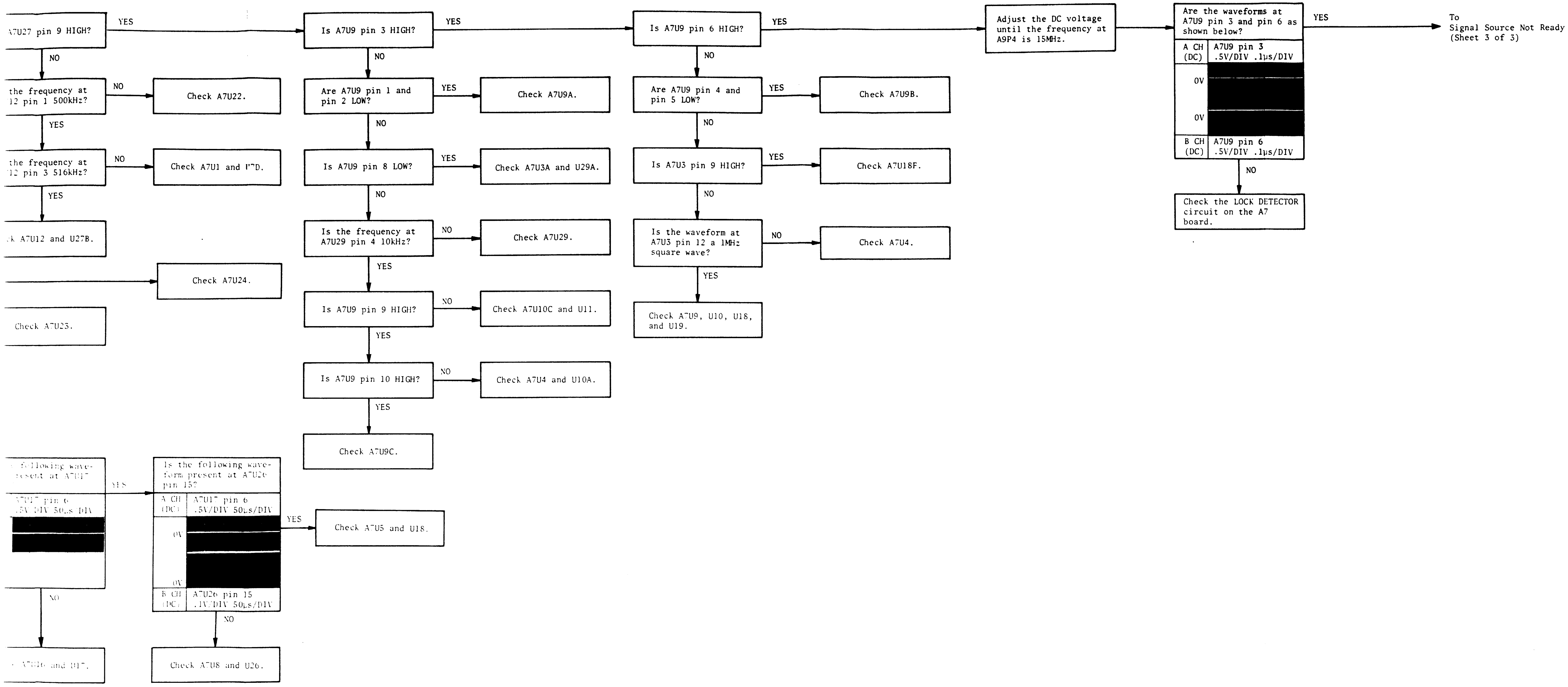


Figure 8-22. Signal Source Not Ready Flow Chart (Sheet 2 of 3).

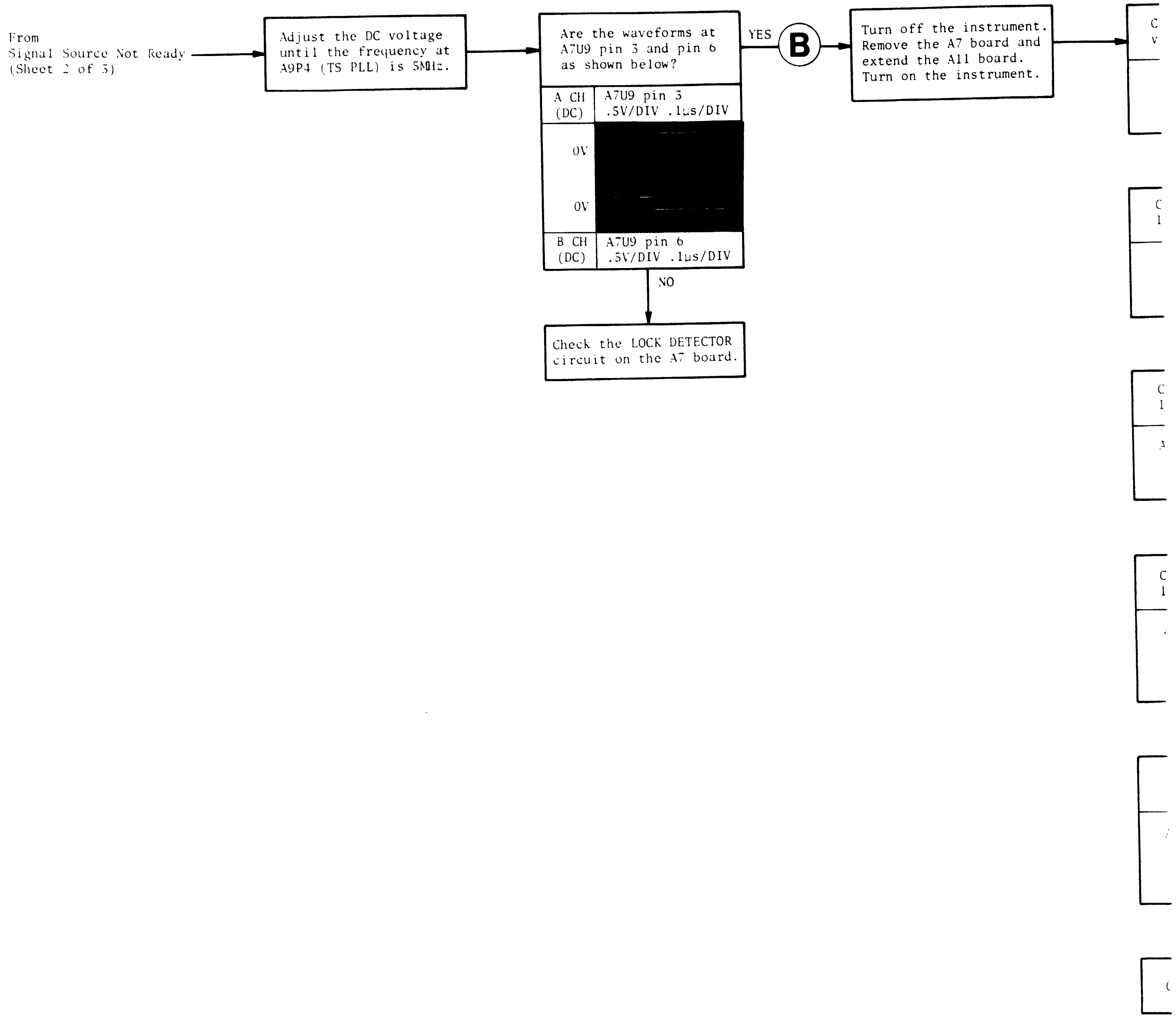
SIGNAL SOURCE NOT

SEE INSIDE



SIGNAL SOURCE NOT READY FLOW CHART (Sheet 1 of 3)

SEE INSIDE



From Signal Source Not Ready (Sheet 2 of 3)

Adjust the DC voltage until the frequency at A9P4 (TS PLL) is 5MHz.

Are the waveforms at A7U9 pin 3 and pin 6 as shown below?

| | |
|---|---|
| A CH (DC) | A7U9 pin 3<br>.5V/DIV .1μs/DIV |
| B CH (DC) | A7U9 pin 6<br>.5V/DIV .1μs/DIV |

Turn off the instrument. Remove the A7 board and extend the A11 board. Turn on the instrument.

Check the LOCK DETECTOR circuit on the A7 board.

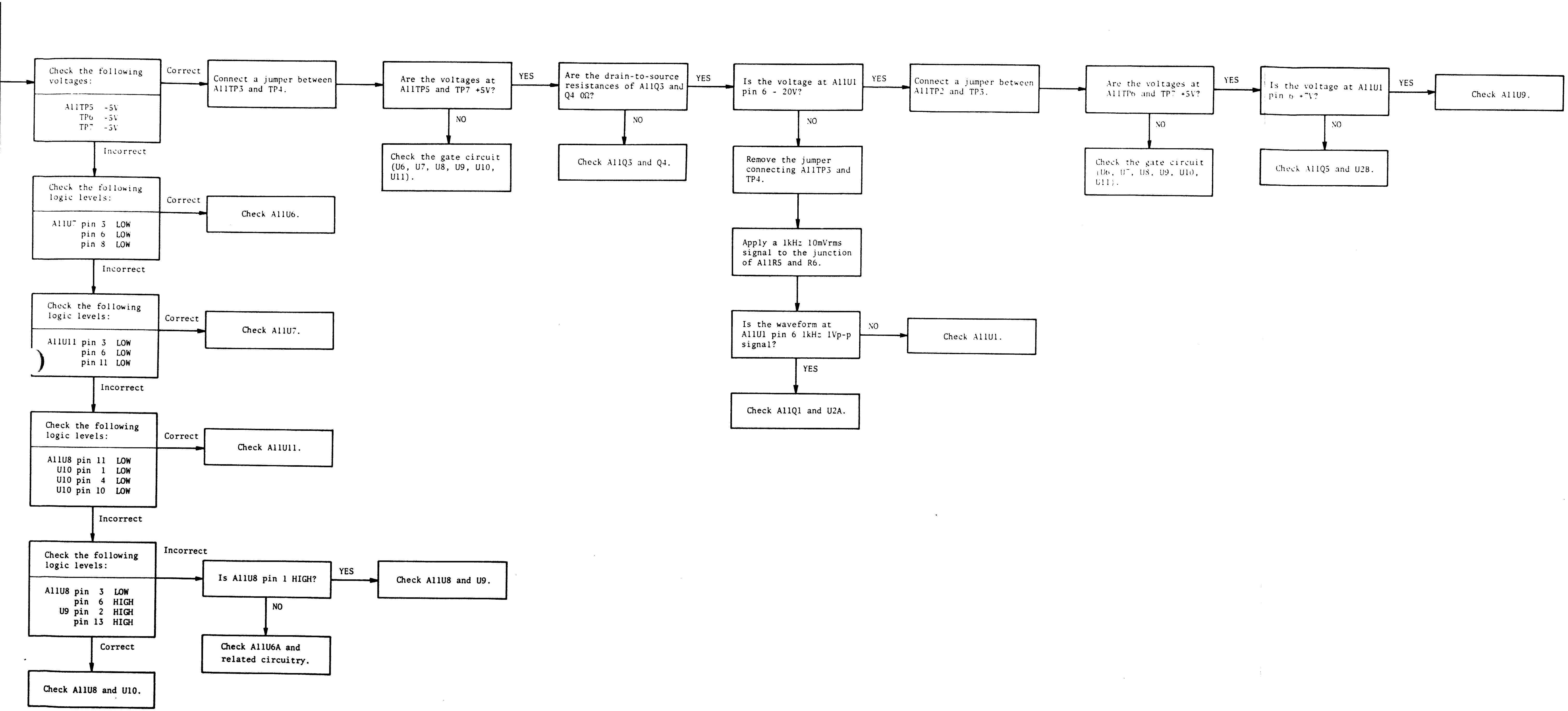
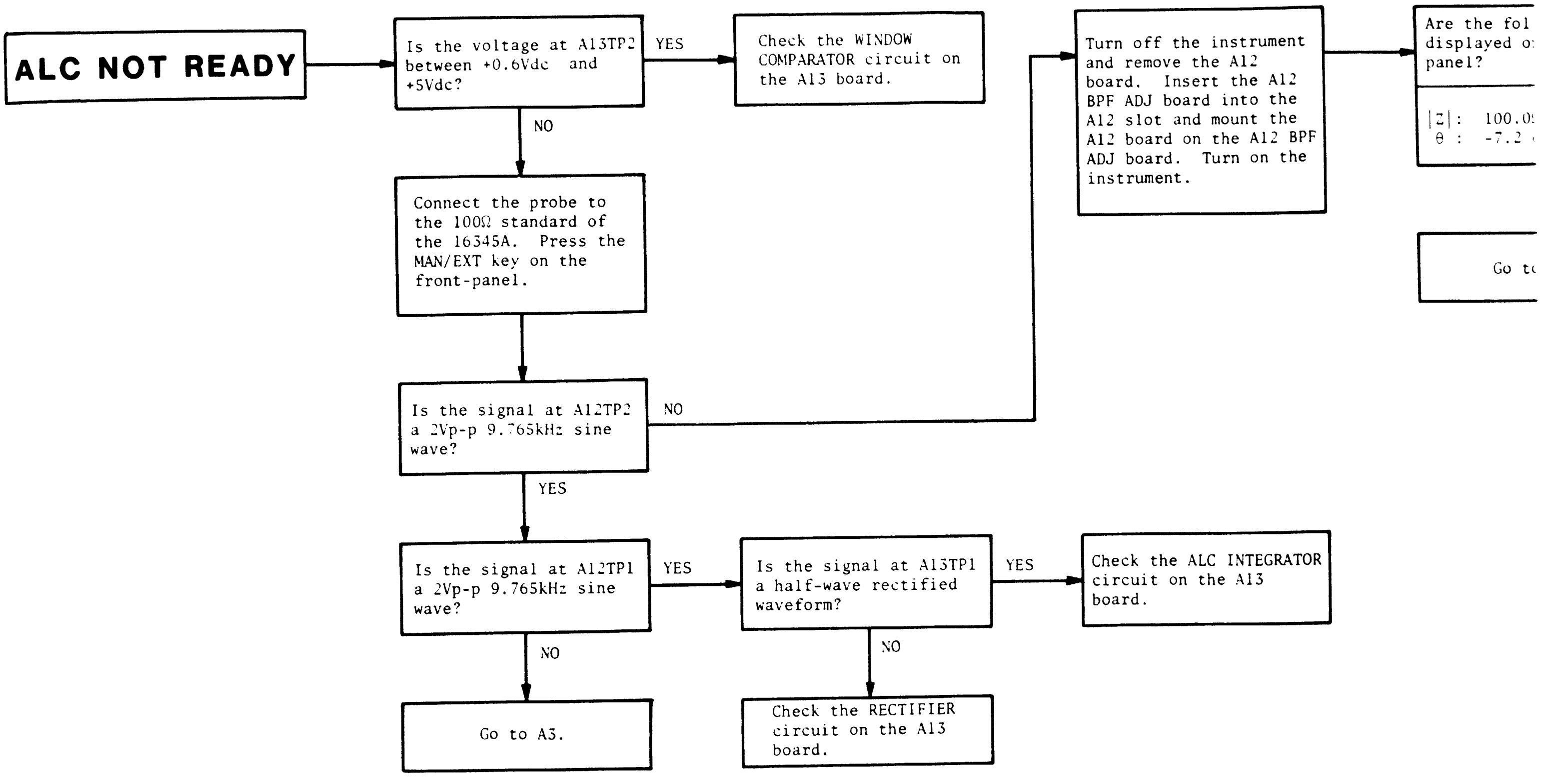


Figure 8-22. Signal Source Not Ready Flow Chart (Sheet 3 of 3).



**ALC NOT READY**

Is the voltage at A13TP2 between +0.6Vdc and +5Vdc?

Check the WINDOW COMPARATOR circuit on the A13 board.

Connect the probe to the 100Ω standard of the 16345A. Press the MAN/EXT key on the front-panel.

Is the signal at A12TP2 a 2Vp-p 9.765kHz sine wave?

Turn off the instrument and remove the A12 board. Insert the A12 BPF ADJ board into the A12 slot and mount the A12 board on the A12 BPF ADJ board. Turn on the instrument.

Are the fol displayed o panel?

|Z| : 100.0
θ : -7.2

Go t

Is the signal at A12TP1 a 2Vp-p 9.765kHz sine wave?

Is the signal at A13TP1 a half-wave rectified waveform?

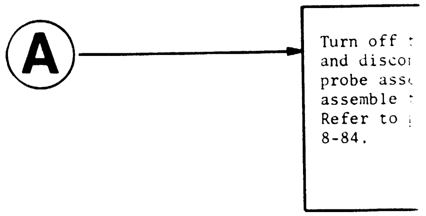
Check the ALC INTEGRATOR circuit on the A13 board.

Go to A3.

Check the RECTIFIER circuit on the A13 board.

Notes:

1. Use a BNC-to-BNC cable and SMB-to-SMB adapter (P/N: 1250-1236).
2. Set the input impedance of the scope to 50Ω.



Turn off t and disco probe ass assemble t Refer to 8-84.

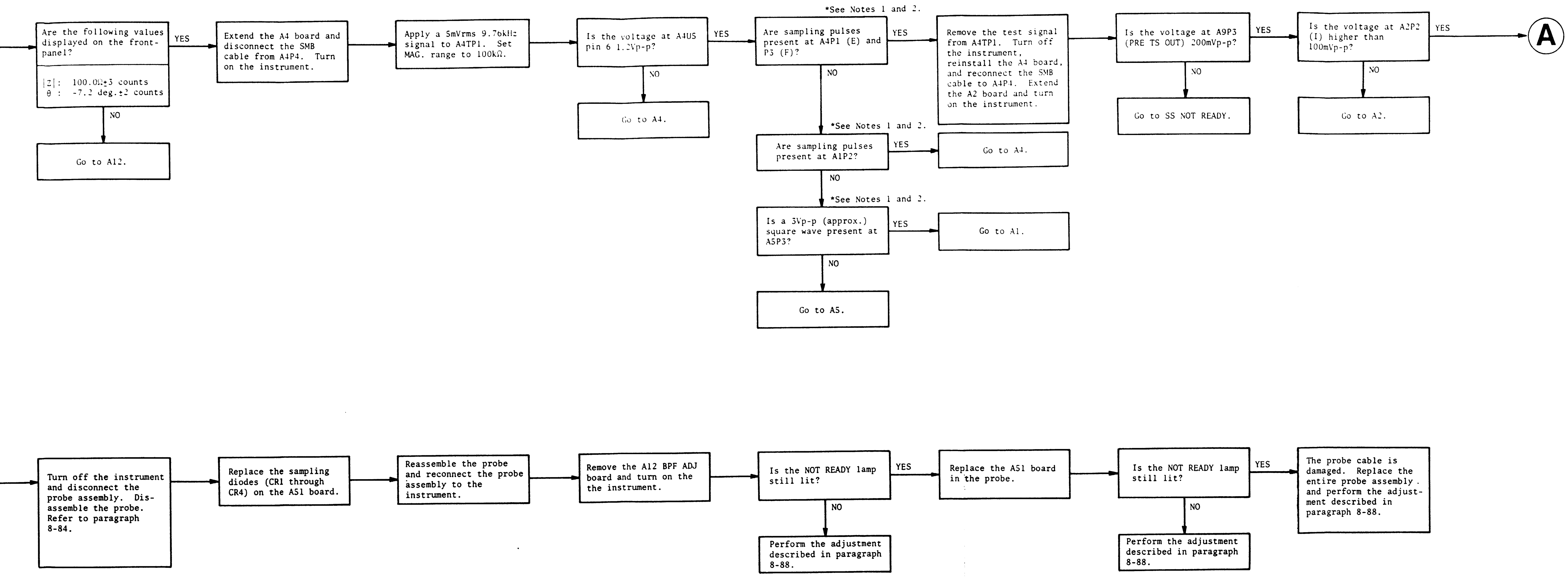
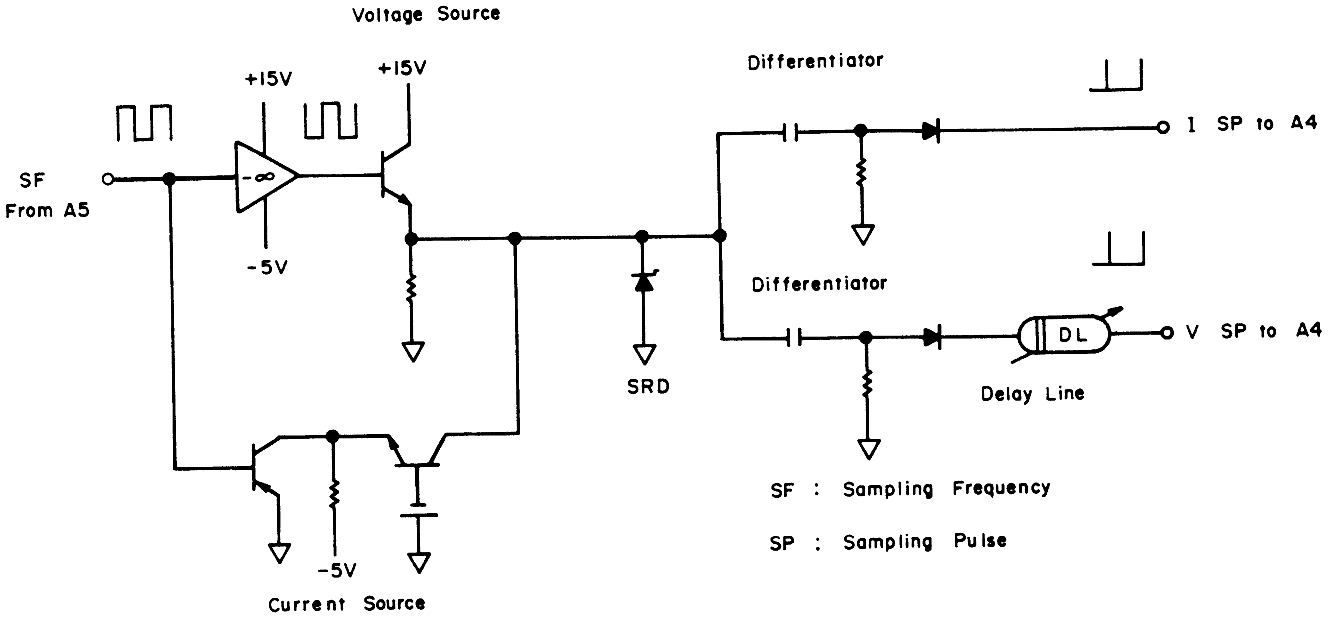


Figure 8-23. ALC Not Ready Flow Chart.

## A1 Sampling Pulse Generator

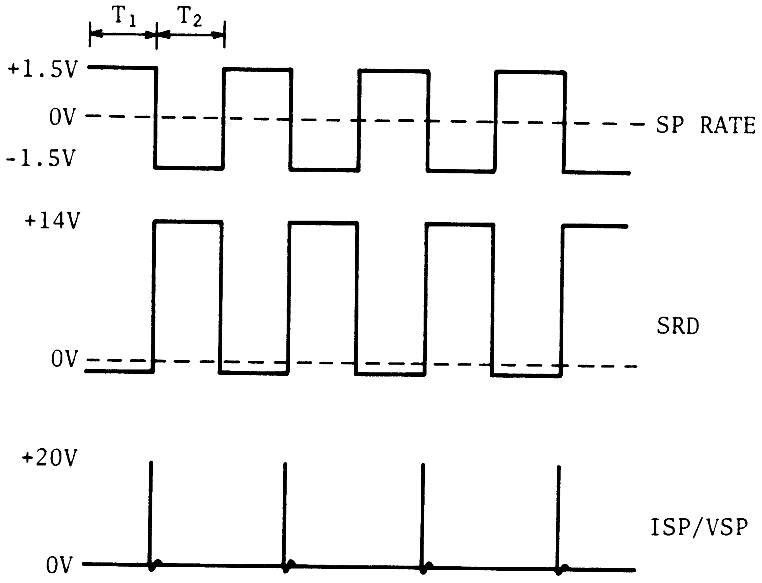


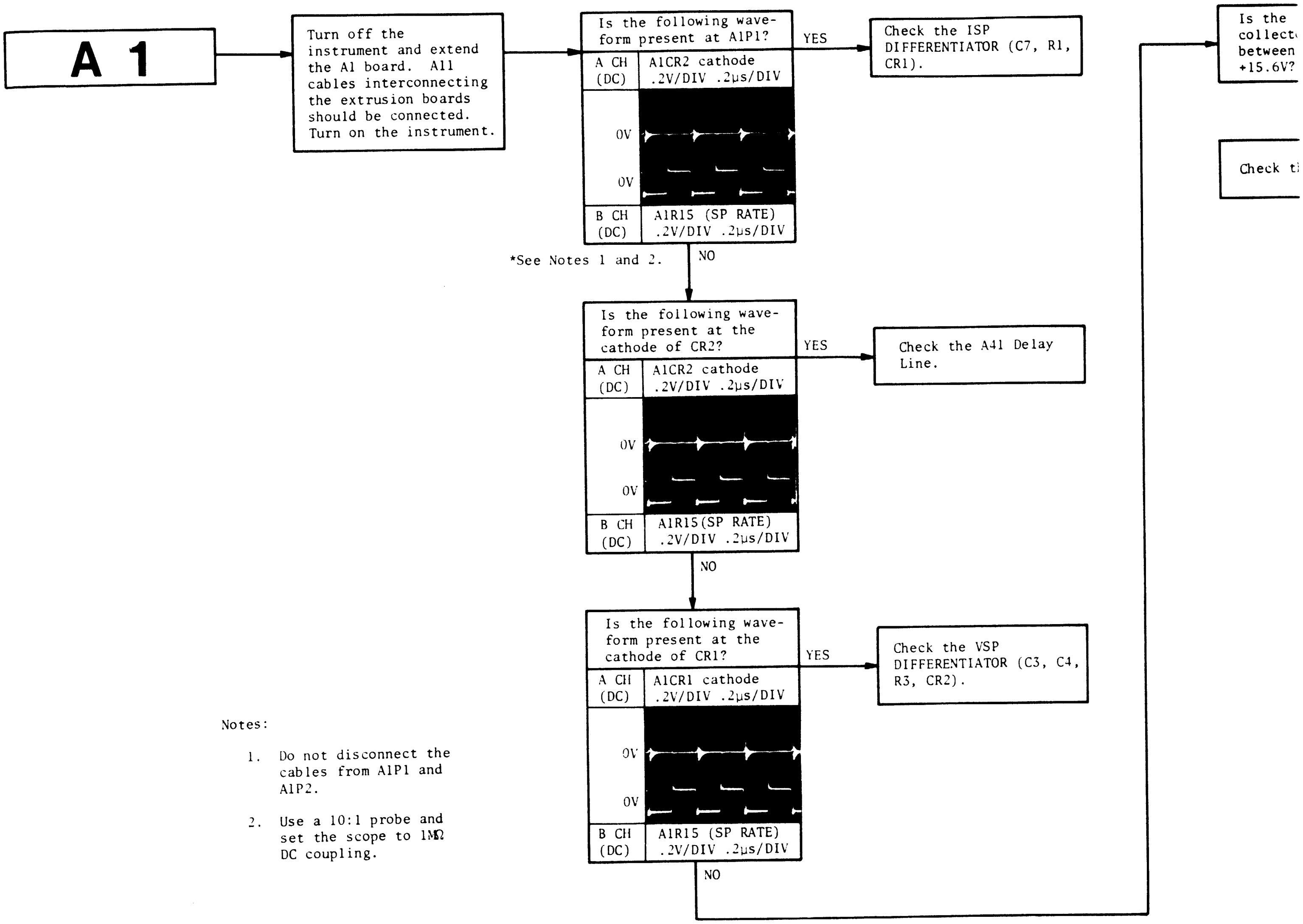
A1 Board Block Diagram

## *A1 Sampling Pulse Generator Board Theory*

The A1 board contains three circuits : step-recovery diode driver, forward current source, and differentiator. The sampling pulses, ISP and VSP, are generated from the SP RATE signal fed from the A5 board. SP RATE is a 3Vp-p square wave whose frequency is (RF+IF)/N. Duty cycle is 50%. Referring to the timing diagram below, at T1, Q6 and Q3 are off and Q5 is on. The voltage at TP1 is -5V, turning off Q1, Q2, Q4, and Q7. Q10 is off and the voltage at TP2 is approximately -1.5V. Q8 and Q9 are both on, forward biasing and charging the step-recovery diode, CR3. At T2, when SP RATE drops to -1.5V, Q6 and Q3 are on and Q5 is off. The voltage at TP1 is +15V, turning on Q1, Q2, Q4, and Q7. Q10 is on and the voltage at TP2 rises to approximately -1.2V. Q8 and Q9 are still on, but the voltage at the cathode of CR3 is rapidly rising to +14V, reverse biasing CR3. The diode continues conducting with reverse bias until the stored charge is removed, at which time it snaps off, generating a positive-going pulse. The pulses are then applied to two differentiators, (one consisting of C4 and R1 and the other consisting of C3, C7, and R3) to obtain the I-Channel sampling pulses and the V-Channel sampling pulses. C3 in the V-Channel differentiator adjusts the sampling pulse height. CR1 and CR2 remove the negative pulses from the differentiators' outputs.

To eliminate inter-channel interference, VSP is delayed 2.2 nanoseconds in reference to ISP. The A41 Delay Line provides 1.2 nanoseconds delay and the cable connected to A1P1 provides the remaining 1 nanosecond.





Notes:

1. Do not disconnect the cables from A1P1 and A1P2.
2. Use a 10:1 probe and set the scope to 1MΩ DC coupling.

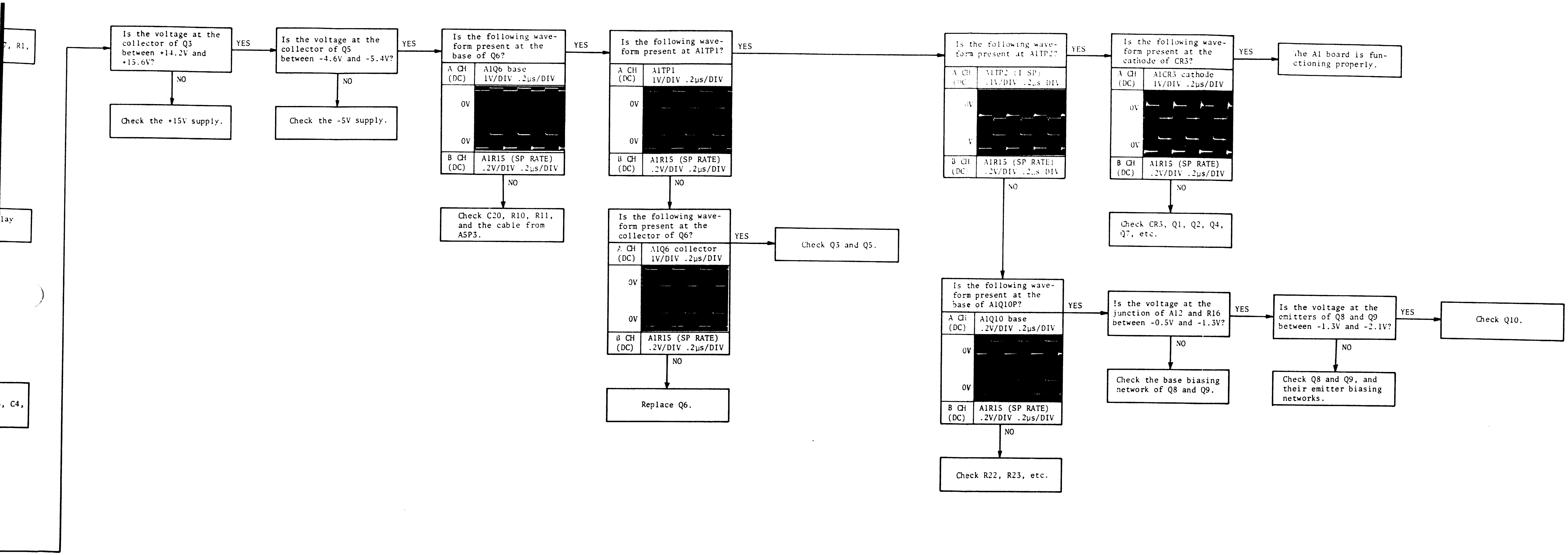


Figure 8-24. A1 Board Troubleshooting Flow Chart.

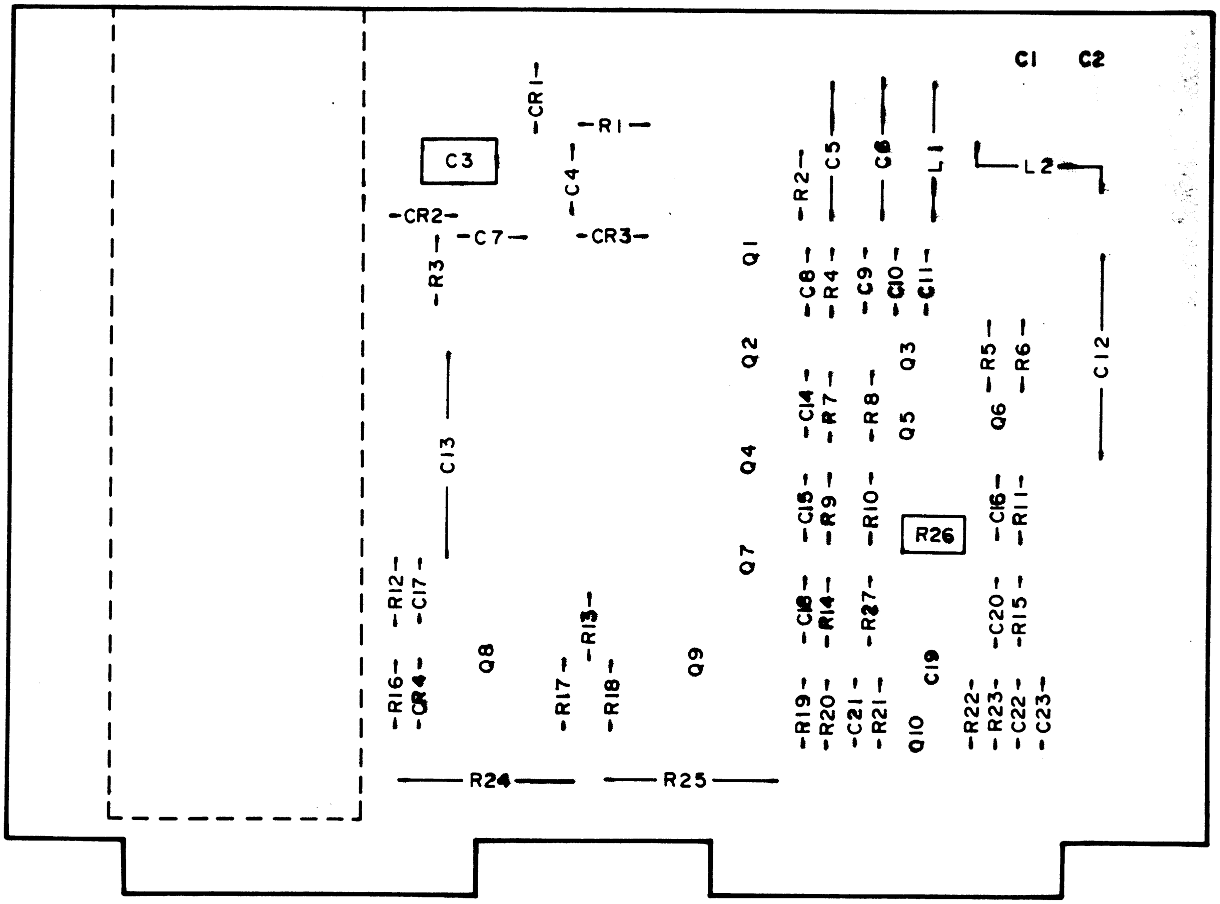
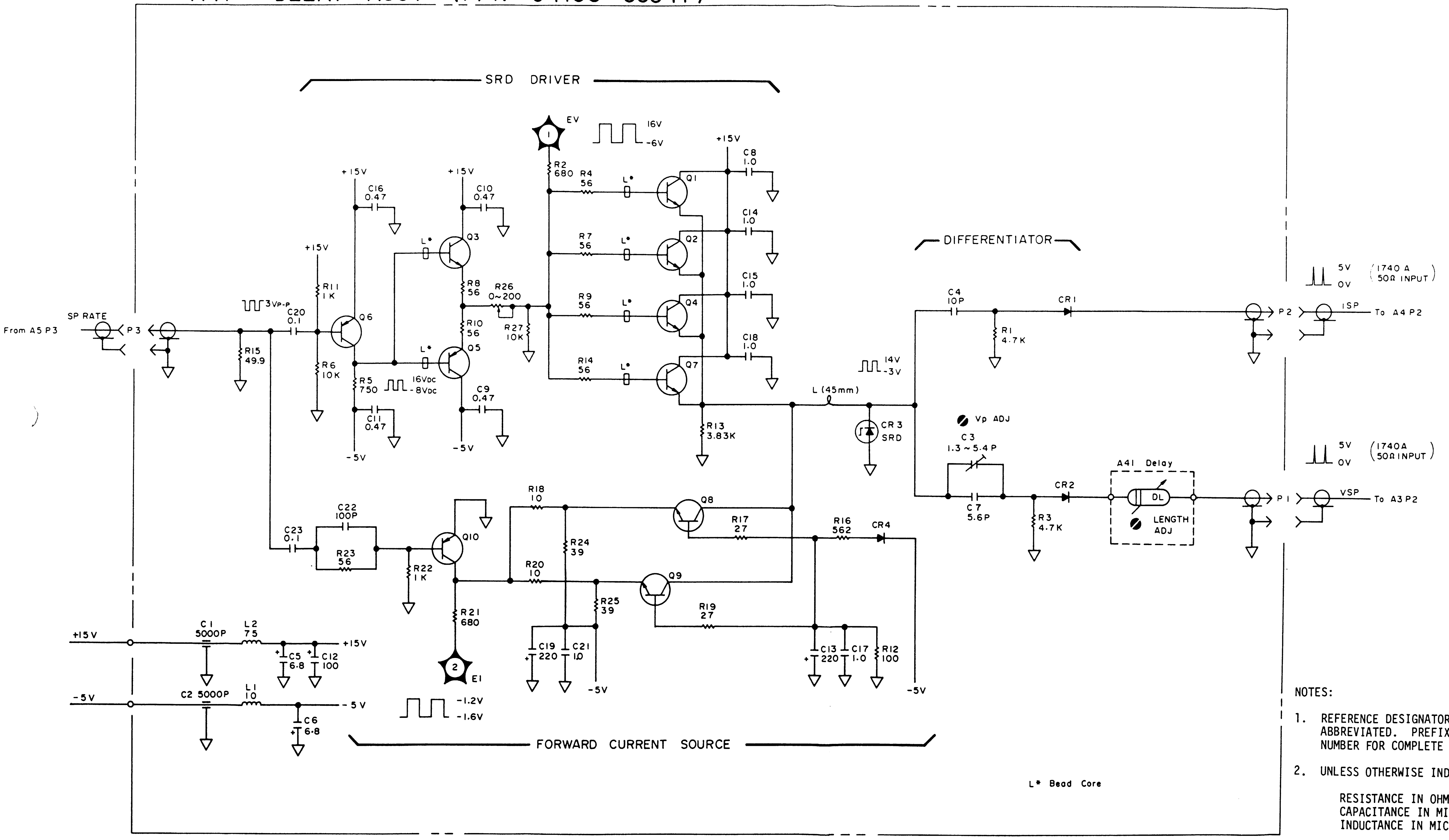


Figure 8-25. A1 Sampling Pulse Generator Board Assembly Component Locations.

A1 SPG ASSY (P/N : 04193-66501)
A41 DELAY ASSY (P/N : 04193-66541)



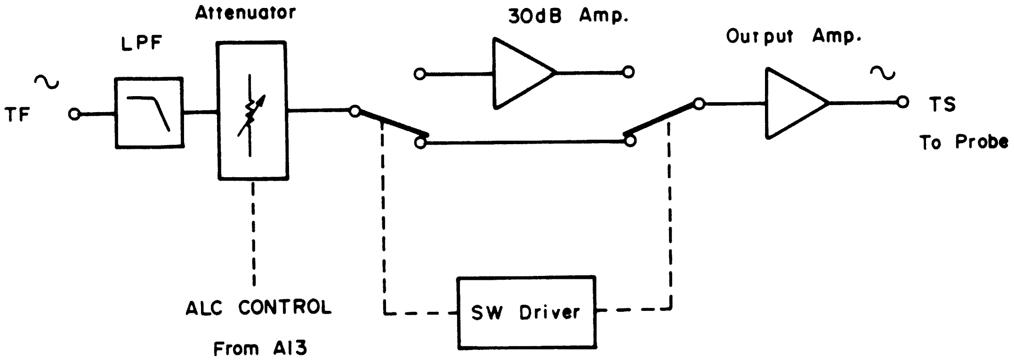
NOTES:

1. REFERENCE DESIGNATORS WITHIN THIS ASSEMBLY ARE ABBREVIATED. PREFIX ABBREVIATION WITH ASSEMBLY NUMBER FOR COMPLETE REFERENCE DESIGNATOR.
2. UNLESS OTHERWISE INDICATED:

   RESISTANCE IN OHMS (Ω)
   CAPACITANCE IN MICROFARADS (μF)
   INDUCTANCE IN MICROHENRIES (μH)

Figure 8-26. A1 Sampling Pulse Generator/A41 Delay Board Assembly Schematic Diagram.

## A2 ALC Amplifier



A2 Board Block Diagram

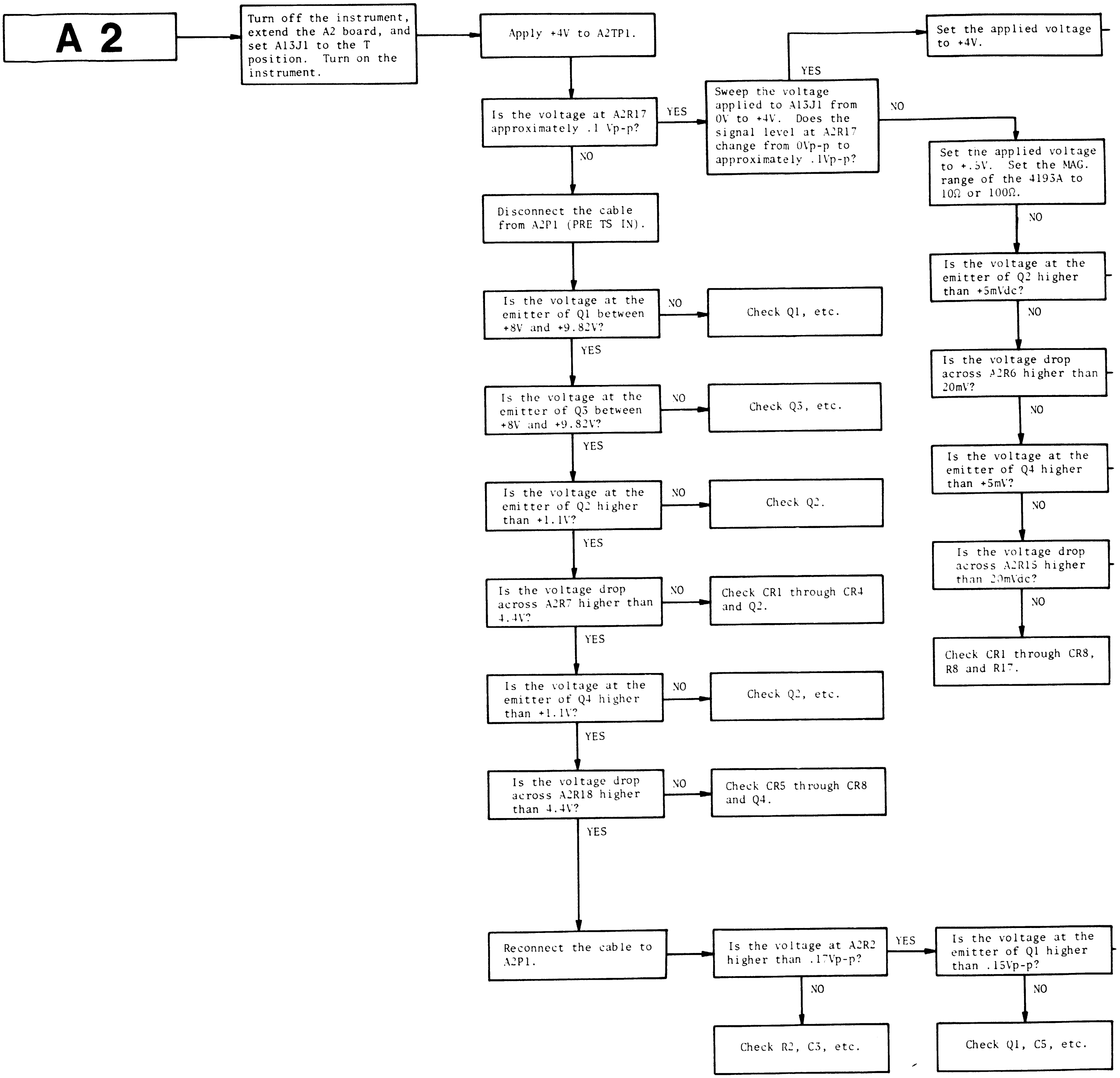
## *A2 ALC Amplifier Board Theory*

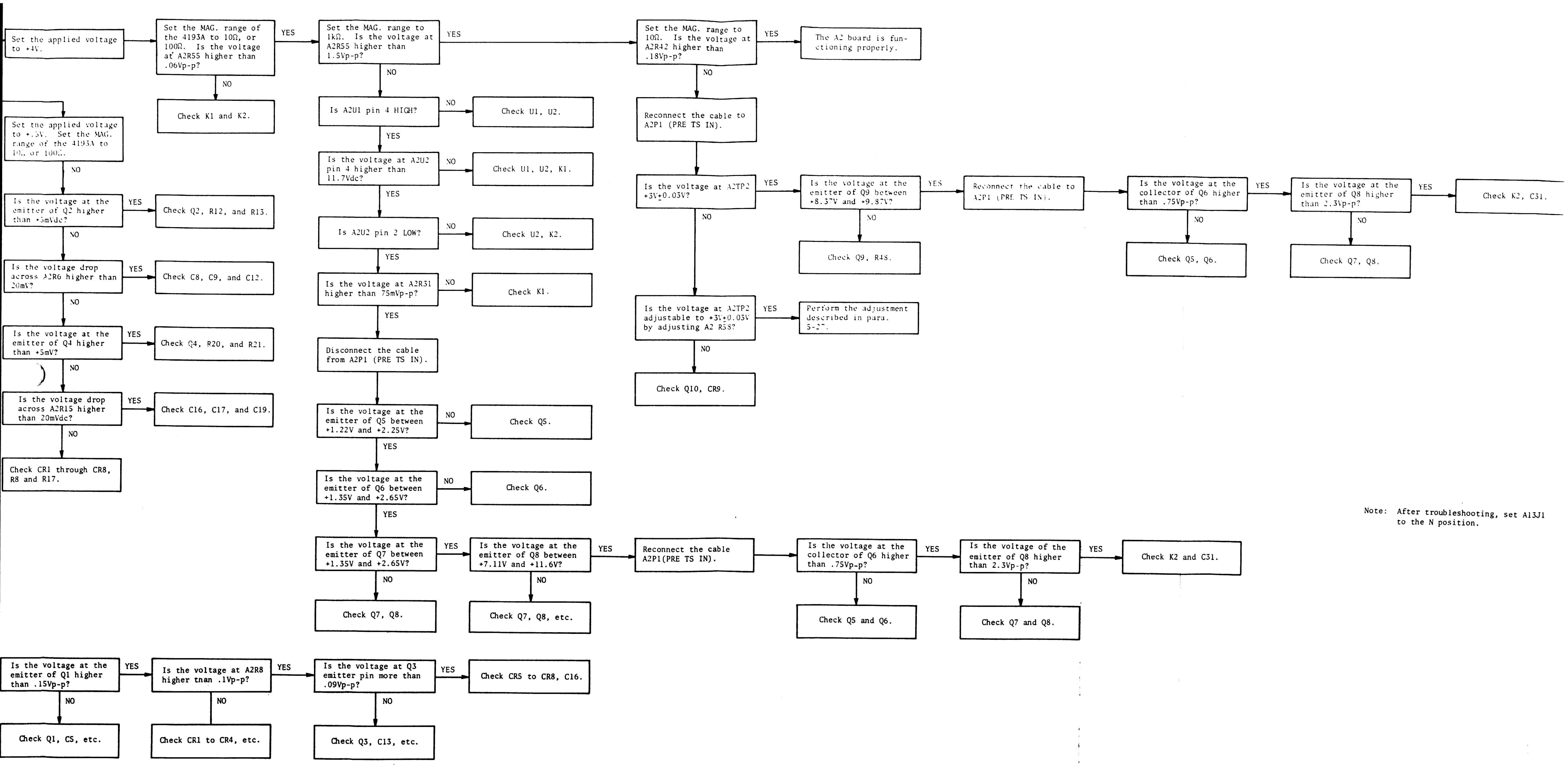
The A2 board contains a two-stage PIN diode attenuator, a 30dB amplifier, and 10dB output amplifier. It functions to maintain the RF current through the DUT constant for each magnitude range. (RF current through the DUT changes only when the magnitude range is changed.)

The PIN diode attenuator consists of two emitter followers, Q1 and Q3; two PIN diode networks, CR1 through CR4 and CR5 through CR8; and two ALC voltage switches, Q2 and Q4. The RF test signal, PRE TS, is applied to the base of Q1, whose output is fed to the base of Q3 through the first PIN diode network. The output of Q3 is also fed through a PIN diode network to the 30dB amplifier or to the output amplifier. The amount of attenuation depends on the ALC voltage fed back from the A13 board and applied to the base of Q2 and the base of Q4. As this voltage changes, so does the current through the PIN diodes, changing the dynamic resistance of each diode. Resistance varies from approximately 5Ω to 20kΩ. Attenuation is from approximately -4dB to -80dB. The ALC voltage is fed back from an integrator on the A13 board and is from approximately 0.5V to 6.2V. Only the 0.5V to 4V range is used for level control; at higher or lower ALC voltages, the level is out of range (NOT READY lamp on).

The RF signal output from the PIN diode attenuator is routed to the 30dB amplifier by relays K1 and K2 when the magnitude range is 1kΩ, 10kΩ, or 100kΩ. When the magnitude range is 10Ω or 100Ω, the relays route the RF signal around the 30dB amplifier, directly to the output amplifier. K1 and K2 are controlled by the A17 board.

The output amplifier has a gain of 10dB and a cut-off frequency of approximately 120MHz.


A 2
Turn off the instrument, extend the A2 board, and set A13J1 to the T position. Turn on the instrument.
Apply +4V to A2TP1.
Is the voltage at A2R17 approximately .1 Vp-p?
YES
Sweep the voltage applied to A13J1 from 0V to +4V. Does the signal level at A2R17 change from 0Vp-p to approximately .1Vp-p?
YES
Set the applied voltage to +4V.
NO
Set the applied voltage to +.5V. Set the MAG. range of the 4193A to 10Ω or 100Ω.
NO
Is the voltage at the emitter of Q2 higher than +5mVdc?
NO
Is the voltage drop across A2R6 higher than 20mV?
NO
Is the voltage at the emitter of Q4 higher than +5mV?
NO
Is the voltage drop across A2R15 higher than 20mVdc?
NO
Check CR1 through CR8, R8 and R17.
NO
Disconnect the cable from A2P1 (PRE TS IN).
Is the voltage at the emitter of Q1 between +8V and +9.82V?
NO
Check Q1, etc.
YES
Is the voltage at the emitter of Q3 between +8V and +9.82V?
NO
Check Q3, etc.
YES
Is the voltage at the emitter of Q2 higher than +1.1V?
NO
Check Q2.
YES
Is the voltage drop across A2R7 higher than 4.4V?
NO
Check CR1 through CR4 and Q2.
YES
Is the voltage at the emitter of Q4 higher than +1.1V?
NO
Check Q2, etc.
YES
Is the voltage drop across A2R18 higher than 4.4V?
NO
Check CR5 through CR8 and Q4.
YES
Reconnect the cable to A2P1.
Is the voltage at A2R2 higher than .17Vp-p?
YES
Is the voltage at the emitter of Q1 higher than .15Vp-p?
NO
Check R2, C3, etc.
NO
Check Q1, C5, etc.



Note: After troubleshooting, set A13J1 to the N position.

Figure 8-27. A2 Board Troubleshooting Flow Chart.

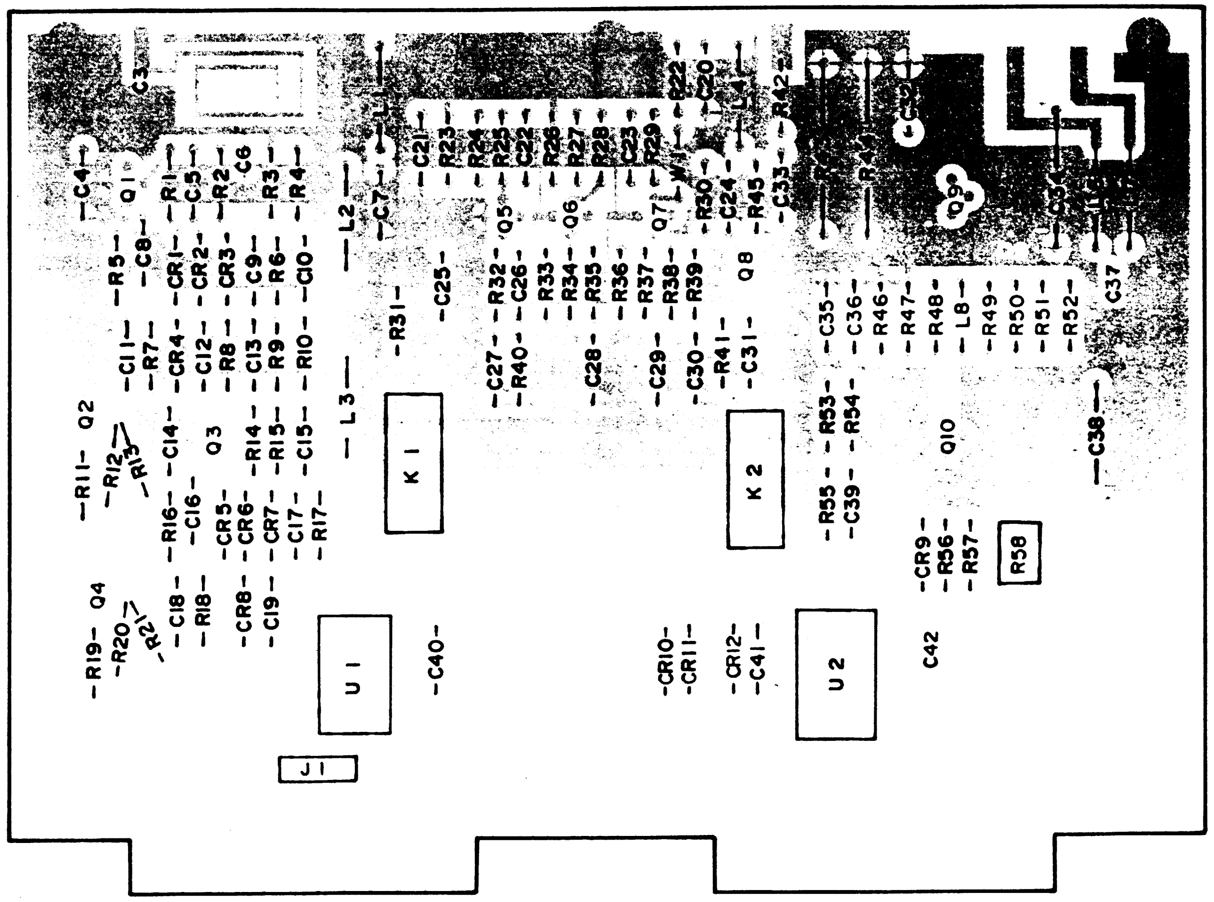
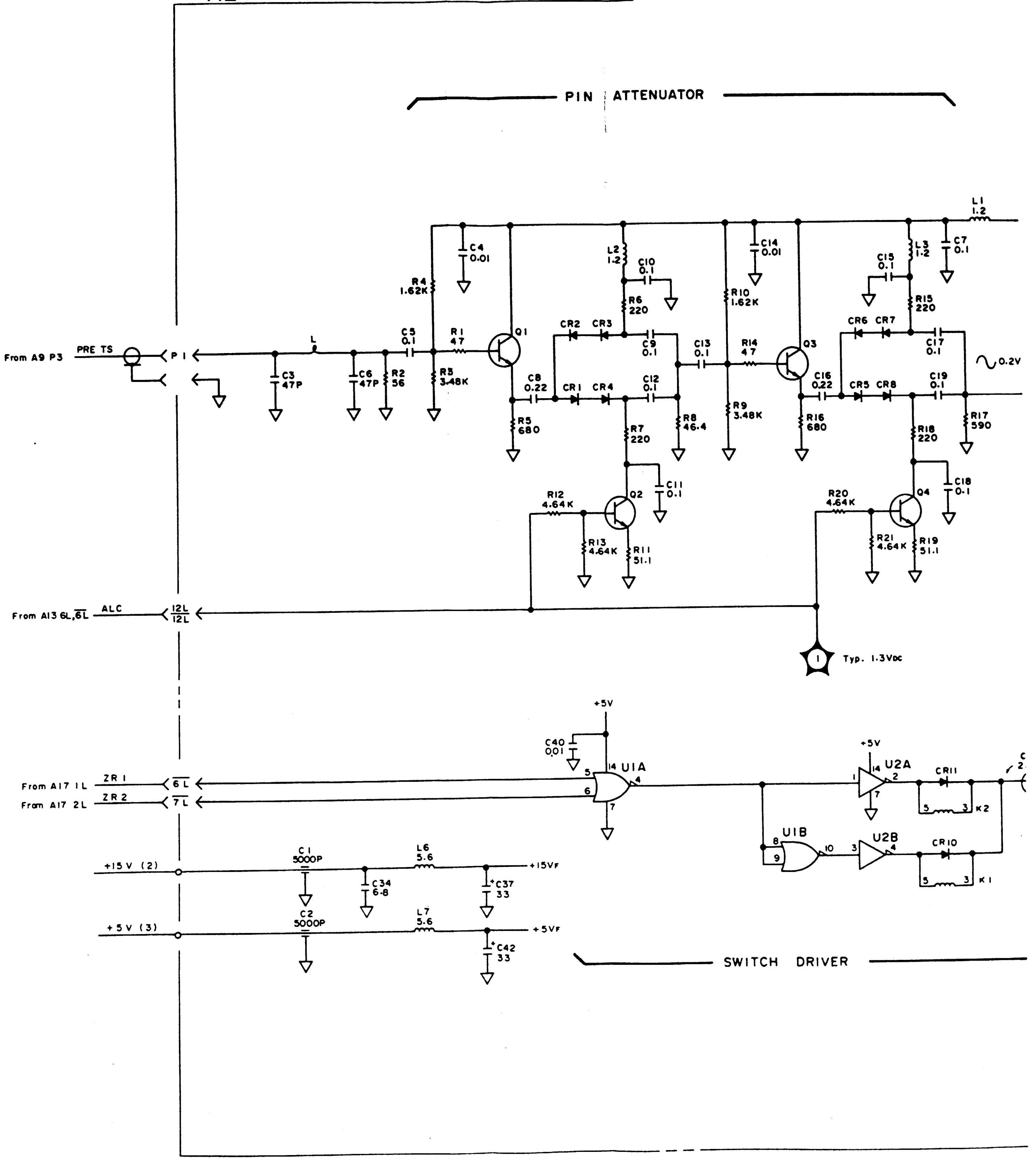
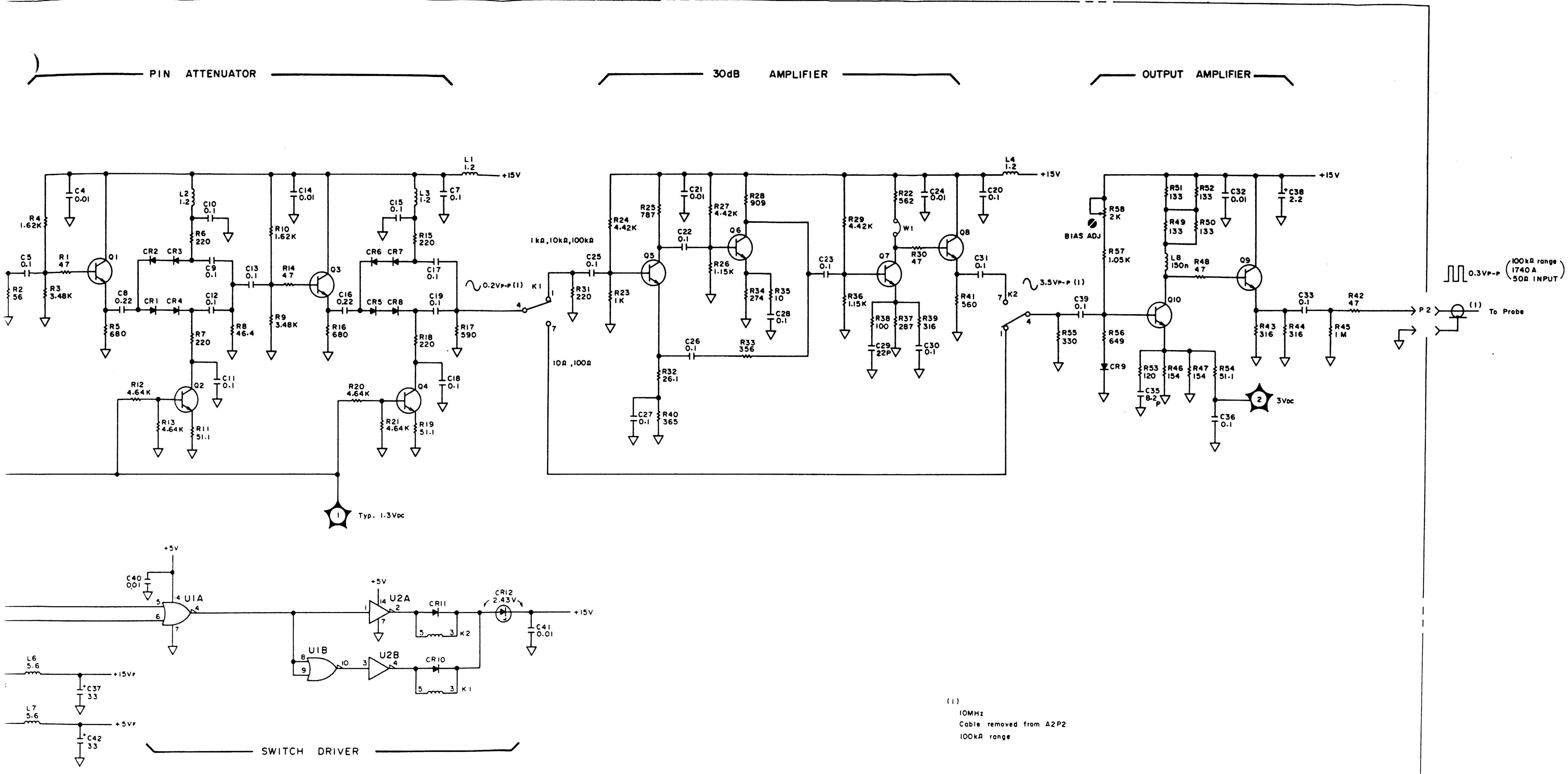


Figure 8-28. A2 ALC Amplifier Board Assembly Component Locations.

A2 ALC AMPLIFIER (P/N:04193-66502)



PLIFIER (P/N:04193-66502)



(1)
10MHz
Cable removed from A2P2
100kΩ range

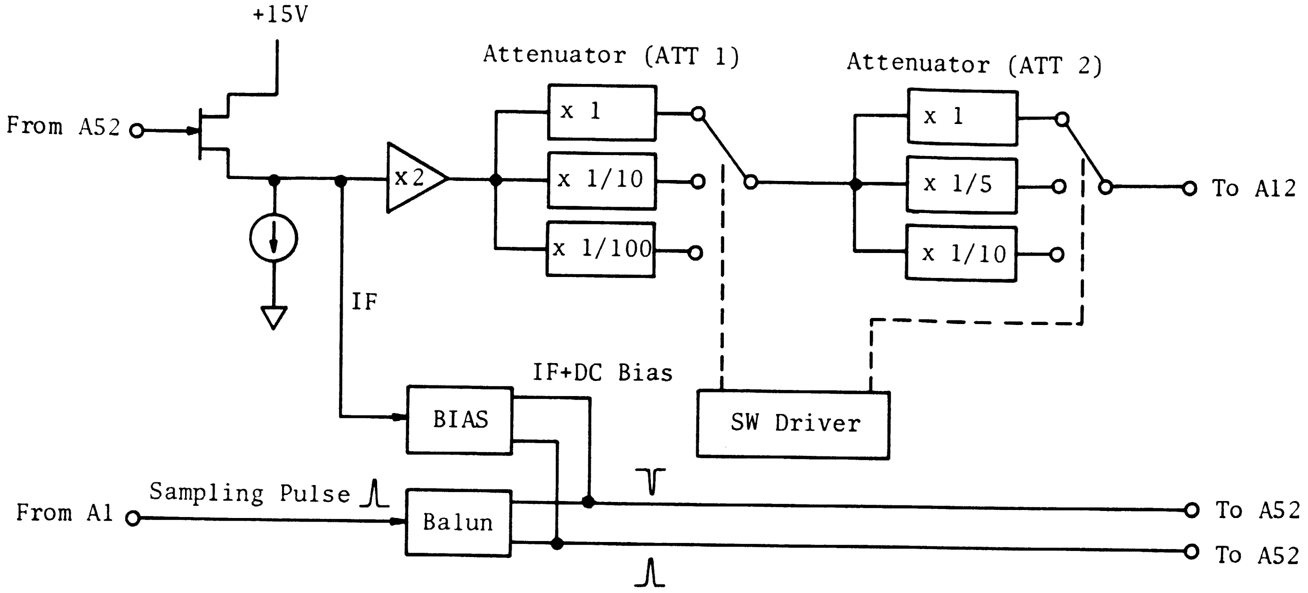
NOTES:

1. REFERENCE DESIGNATORS WITHIN THIS ASSEMBLY ARE ABBREVIATED. PREFIX ABBREVIATION WITH ASSEMBLY NUMBER FOR COMPLETE REFERENCE DESIGNATOR.
2. UNLESS OTHERWISE INDICATED:

   RESISTANCE IN OHMS (Ω)
   CAPACITANCE IN MICROFARADS (μF)
   INDUCTANCE IN MICROHENRIES (μH)

Figure 8-29. A2 ALC Amplifier Board Assembly Schematic Diagram.

## A3 V-Channel Amplifier



A3 Board Block Diagram

Attenuator Selection

| MAGNITUDE RANGE | ATT 1 | ATT 2 |
|---|---|---|
| 10Ω | x 1 | x 1 |
| 100Ω | x 1/10 | x 1 |
| 1kΩ | x 1/100 | x 1 |
| 10kΩ | x 1/100 | x 1/5 |
| 100kΩ | x 1/100 | x 1/10 |

## *A3 V-Channel Amplifier Board Theory*

The A3 board contains a constant current source, X2 amplifier, sampling diode bias circuit, switch driver, and two attenuator circuits. It has three main functions : (1) provide the requisite reverse bias voltage for the sampling diodes, (2) develop two sampling pulses of opposite polarity for the sampling operation, and (3) attenuate the amplified IF signal to a level appropriate for the selected magnitude range.

The sampling diodes - CR1, CR2, CR3, and CR4 - on the A52 board (inside the probe) are normally reverse biased by +3.8V and -3.8V supplied from the bias circuit on the A3 board. The sampling pulse, VSP, fed from the A1 board is applied to balun transformer A3T1, which develops equal but opposite polarity sampling pulses of approximately 4.5V. A second balun, A52T1, maintains the sampling pulses. When the sampling pulses are applied to the reverse-biased sampling diodes, the diodes turn-on for approximately 700 pico seconds, allowing the instantaneous RF voltage at the junction of A52 CR3/CR4 to appear at the CR1/CR2 junction. The instantaneous RF voltage charges A52C1 and is applied to the gate of source follower A52Q1. When the sampling pulses are removed, the sampling diodes are again reverse biased, stopping the flow of RF. A52C1 holds the gate of A52Q1 at the voltage of the sampled RF until the next sample is taken. A52Q1 is a source follower, and its output is controlled by the charge stored in A52C1. The drain-to-source current is kept constant by the constant current source, A3Q1. The signal output from the source follower is at IF (9.765kHz) and is applied to one half of U1, which is biased as a X2 amplifier. Part of the IF signal is fed back to the sampling diodes through the bias circuit to improve sampling efficiency. The two attenuators consist of two voltage divider networks three analog switches--U3, U4, U6—and two buffers, U2 and U5. The amount of attenuation depends on the magnitude range and is controlled by the ZR1, ZR2, ZR4, and ZR5 range control signals from the A17 board. The switch driver, U7 and U8, decodes the range control signals as appropriate for the requisite attenuation.

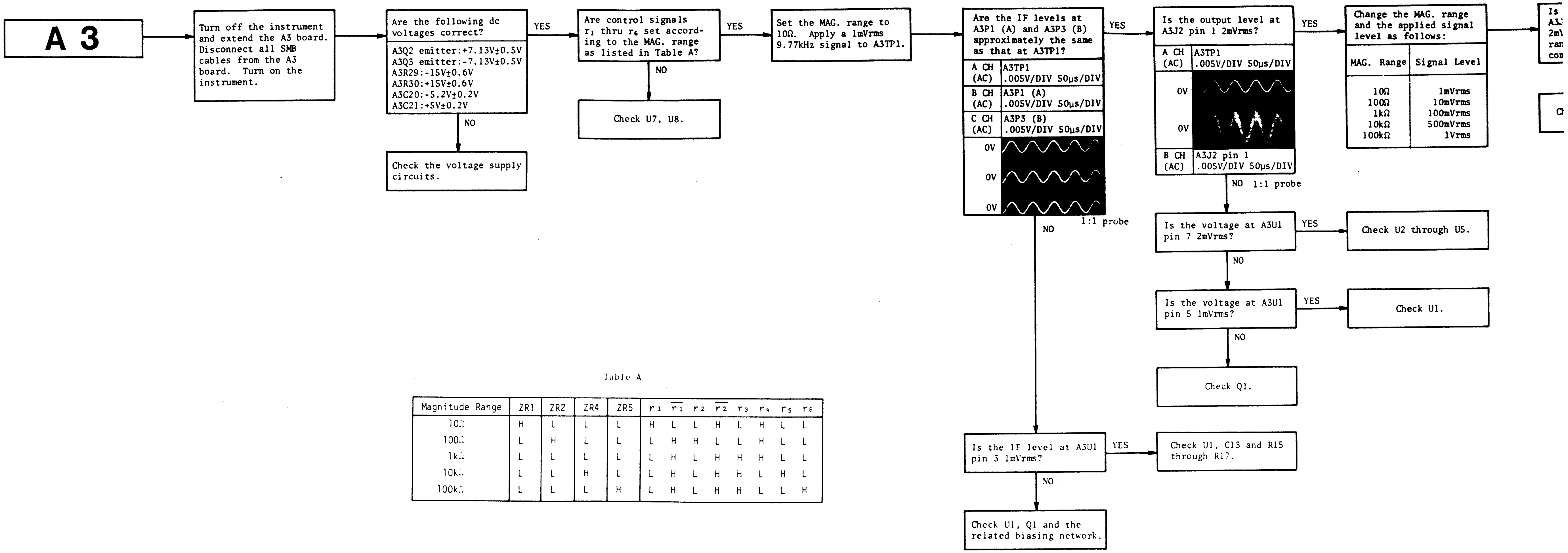


Table A

| Magnitude Range | ZR1 | ZR2 | ZR4 | ZR5 | $r_1$ | $\overline{r_1}$ | $r_2$ | $\overline{r_2}$ | $r_3$ | $r_4$ | $r_5$ | $r_6$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10Ω | H | L | L | L | H | L | L | H | L | H | L | L |
| 100Ω | L | H | L | L | L | H | H | L | L | H | L | L |
| 1kΩ | L | L | L | L | L | H | L | H | H | H | L | L |
| 10kΩ | L | L | H | L | L | H | L | H | H | L | H | L |
| 100kΩ | L | L | L | H | L | H | L | H | H | L | L | H |

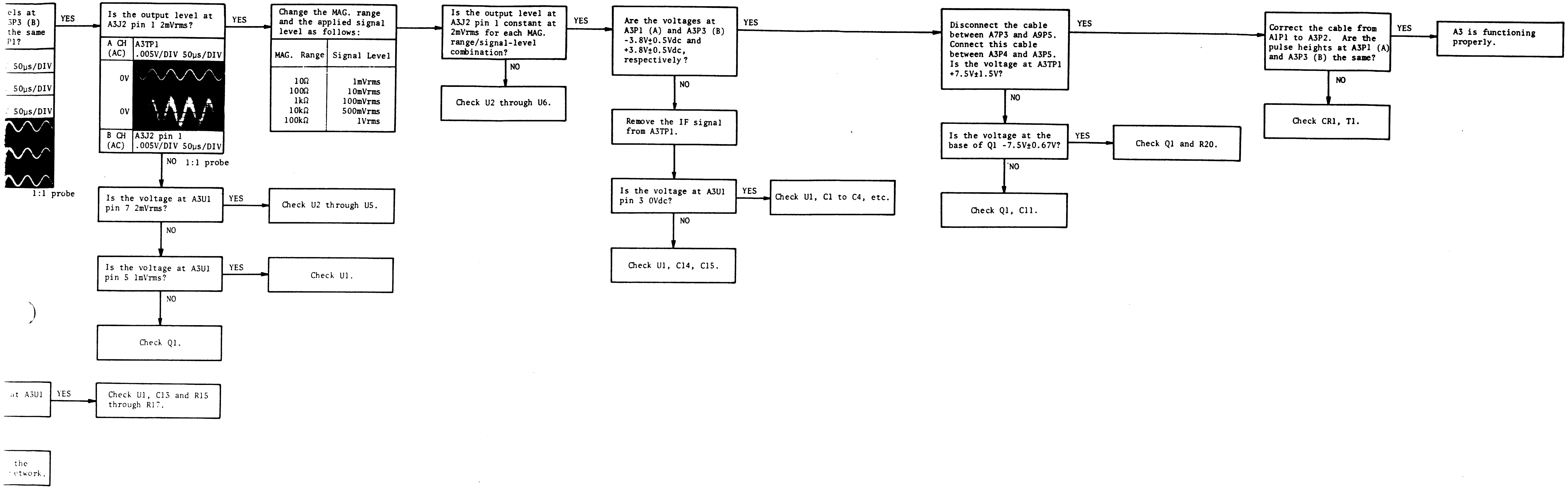


Figure 8-30. A3 Board Troubleshooting Flow Chart.

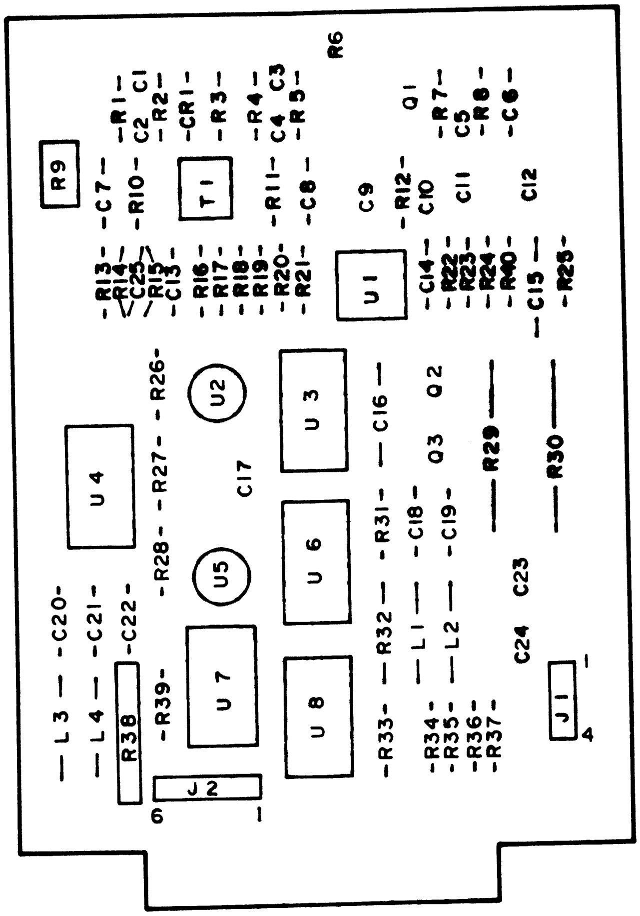


Figure 8-31. A3 V-Channel Amplifier Board Assembly Component Locations.

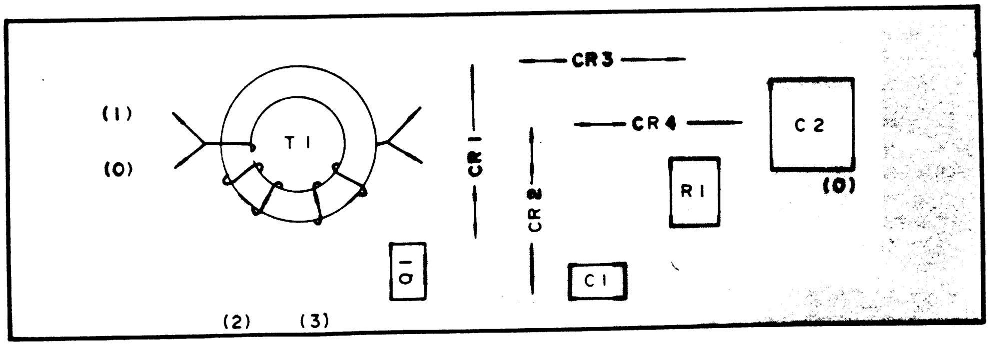
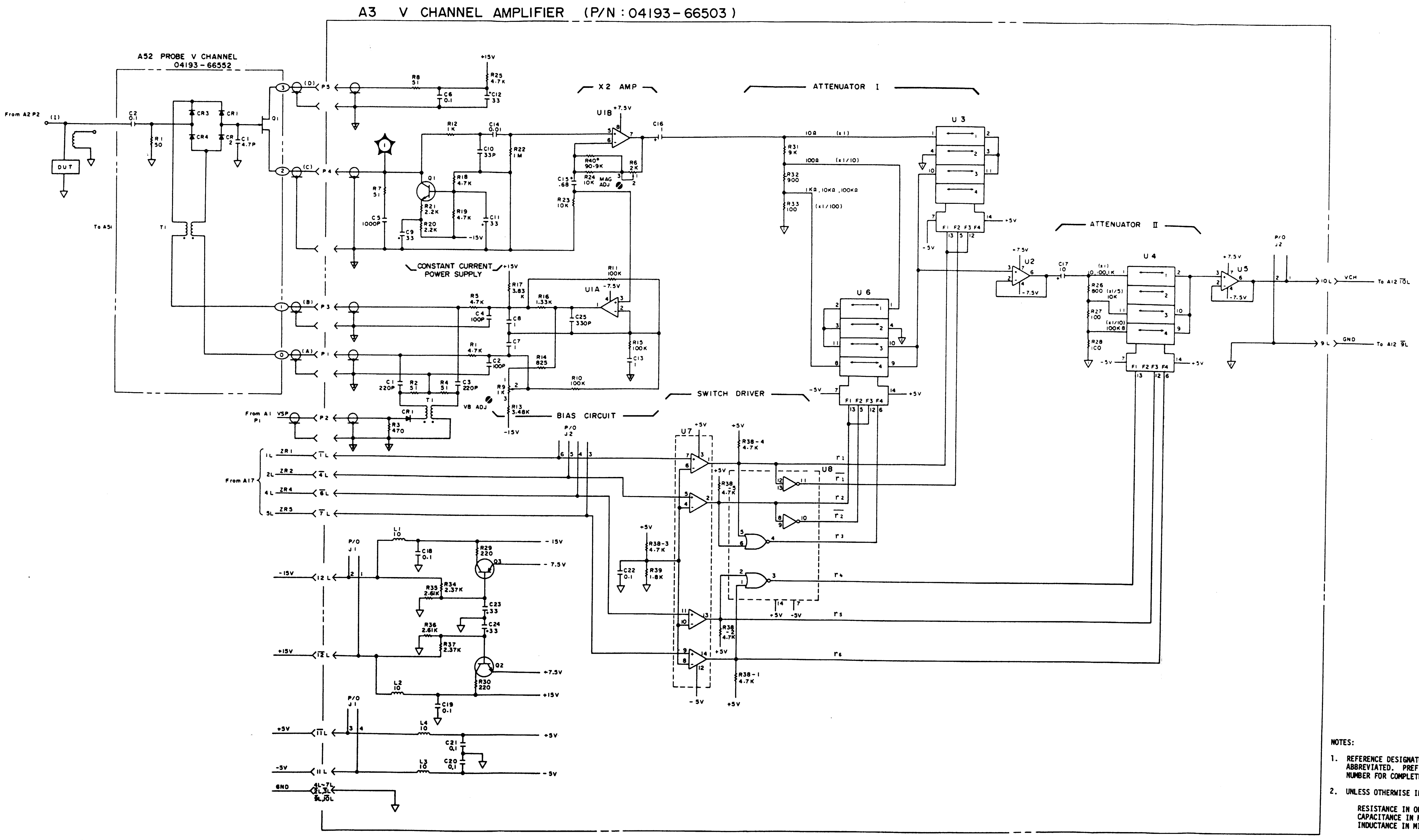


Figure 8-32. A52 Probe V-Channel Board Assembly Component Locations.



NOTES:

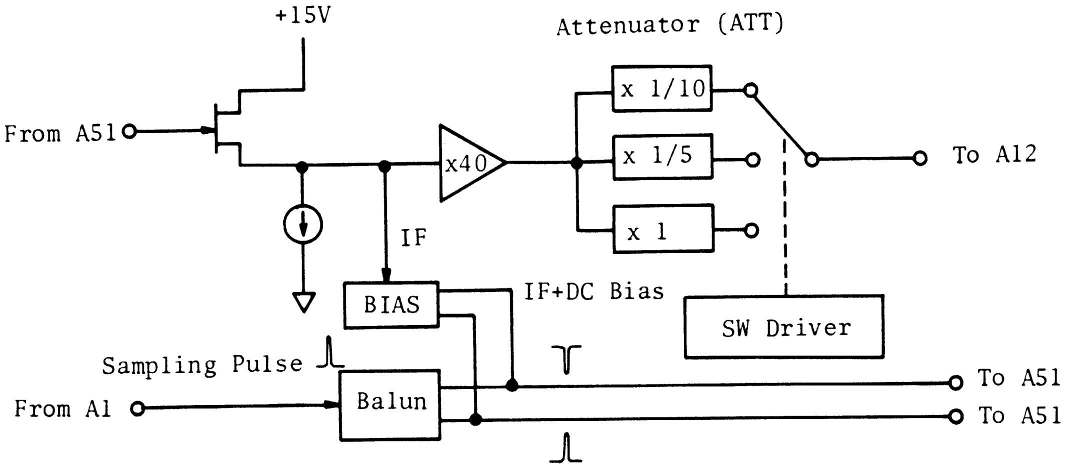
1. REFERENCE DESIGNATORS WITHIN THIS ASSEMBLY ARE ABBREVIATED. PREFIX ABBREVIATION WITH ASSEMBLY NUMBER FOR COMPLETE REFERENCE DESIGNATOR.

2. UNLESS OTHERWISE INDICATED:

RESISTANCE IN OHMS (Ω)
CAPACITANCE IN MICROFARADS (μF)
INDUCTANCE IN MICROHENRIES (μH)

**Figure 8-33.** A3 V-Channel Amplifier/A52 Probe V-Channel Board Assembly Schematic Diagram.

A4 I-Channel Amplifier



A4 Board Block Diagram

| MAGNITUDE RANGE | ATT |
|---|---|
| 10Ω | x 1/10 |
| 100Ω | x 1/10 |
| 1kΩ | x 1/10 |
| 10kΩ | x 1/5 |
| 100kΩ | x 1 |

## *A4 I-Channel Amplifier Board Theory*

The A4 board contains a constant current source, X40 amplifier, sampling diode bias circuit, switch driver, attenuator circuit, and phase shifter. It has three main functions : (1) provide the requisite reverse bias voltage for the sampling diodes, (2) develop two sampling pulses of opposite polarity for the sampling operation, and (3) attenuate the amplified IF signal to a level appropriate for the selected magnitude range.

The sampling diodes—CR1, CR2, CR3, and CR4—on the A51 board (inside the probe) are normally reverse biased by +3.8V and -3.8V supplied from the bias circuit on the A4 board. The sampling pulse, ISP, fed from the A1 board is applied to balun transformer A4T1, which develops equal but opposite polarity sampling pulses of approximately 4.5V. A second balun, A51T1, maintains the sampling pulses. When the sampling pulses are applied to the reverse-biased sampling diodes, the diodes turn-on for approximately 700 pico seconds, allowing the instantaneous RF voltage (which represents the RF current through the DUT) at the junction of A51 CR3/CR4 to appear at the CR1/CR2 junction. The instantaneous RF voltage charges A51C1 and is applied to the gate of source follower A51Q1. When the sampling pulses are removed, the sampling diodes are again reverse biased, stopping the flow of RF. A51C1 holds the gate of A51Q1 at the voltage of the sampled RF until the next sample is taken. A51Q1 is a source follower, and its output is controlled by the charge stored in A51C1. The drain-to-source current is kept constant by the constant current source, A4Q1. The signal output from the source follower is at IF (9.765kHz) and is applied the X40 amplifier, U2. Part of the IF signal is fed back to the sampling diodes through the U1 in the bias circuit to improve sampling efficiency. The attenuator circuit consists of a voltage divider network and an analog switch, U4. The amount of attenuation depends on the magnitude range and is controlled by the ZR4 and ZR5 range control signals from the A17 board. The switch driver, U6, decodes the range control signals as appropriate for the requisite attenuation. The phase shifter, U3 and U5, compensates for any difference between the phase shift caused by the A52 and A3 boards and the phase shift caused by the A51 and A4 boards. The phase error caused by the 2.2ns difference between the I channel sampling pulses and V channel sampling pulses is compensated digitally by the microprocessor, after integration.

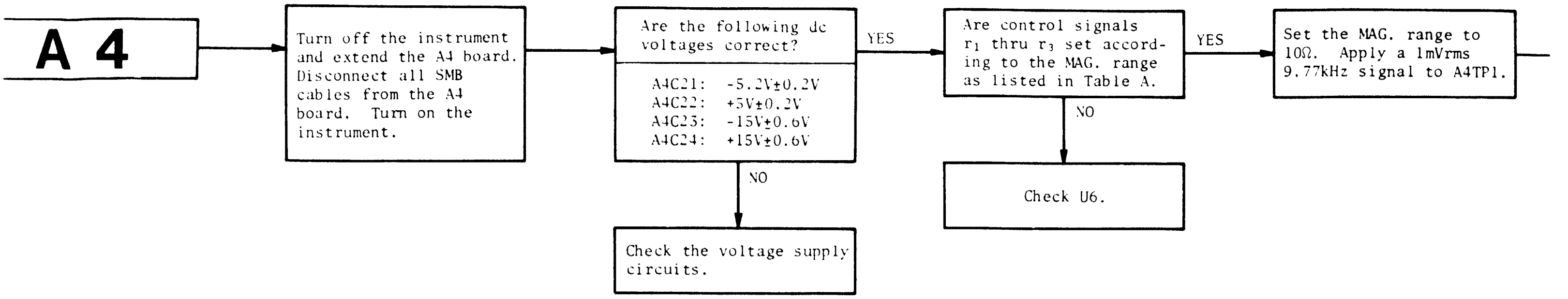


Table A

| Magnitude Range | ZR4 | ZR5 | $r_1$ | $r_2$ | $r_3$ |
|---|---|---|---|---|---|
| 10 Ω,100 Ω,1k Ω | L | L | L | L | H |
| 10k Ω | H | L | L | H | L |
| 100k Ω | L | H | H | L | L |

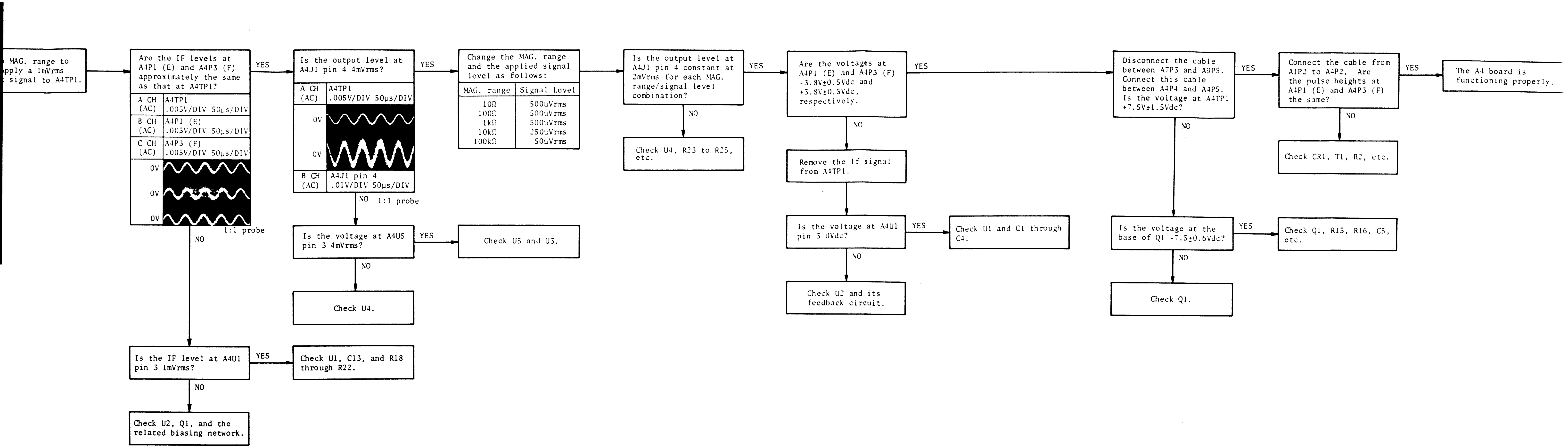


Figure 8-34. A4 Board Troubleshooting Flow Chart.

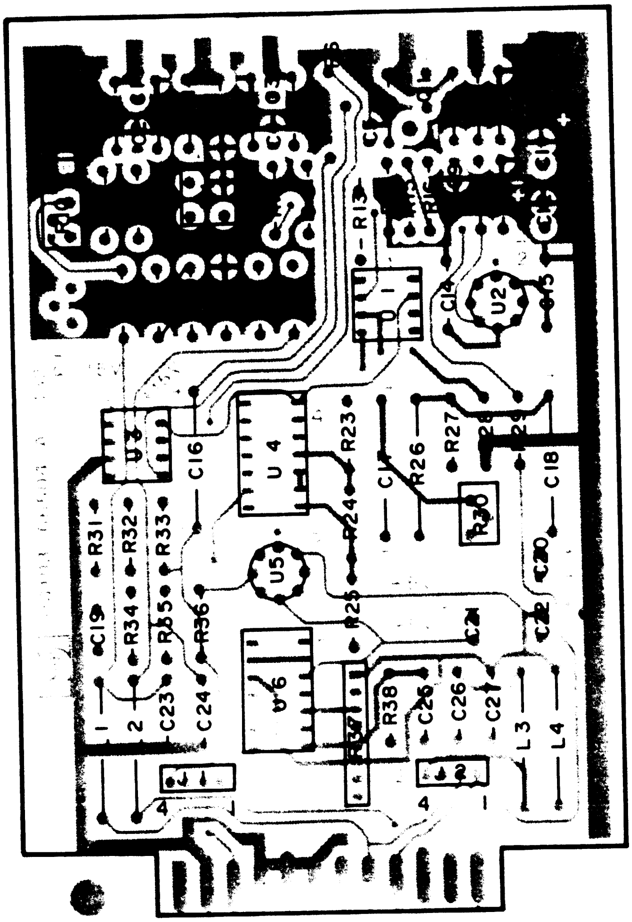


Figure 8-35. A4 I-Channel Amplifier Board Assembly Component Locations.

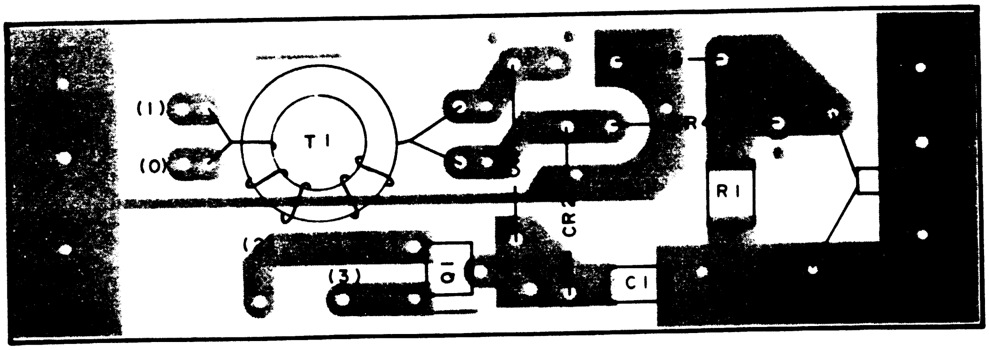


Figure 8-36. A51 Probe I-Channel Board Assembly Component Locations.

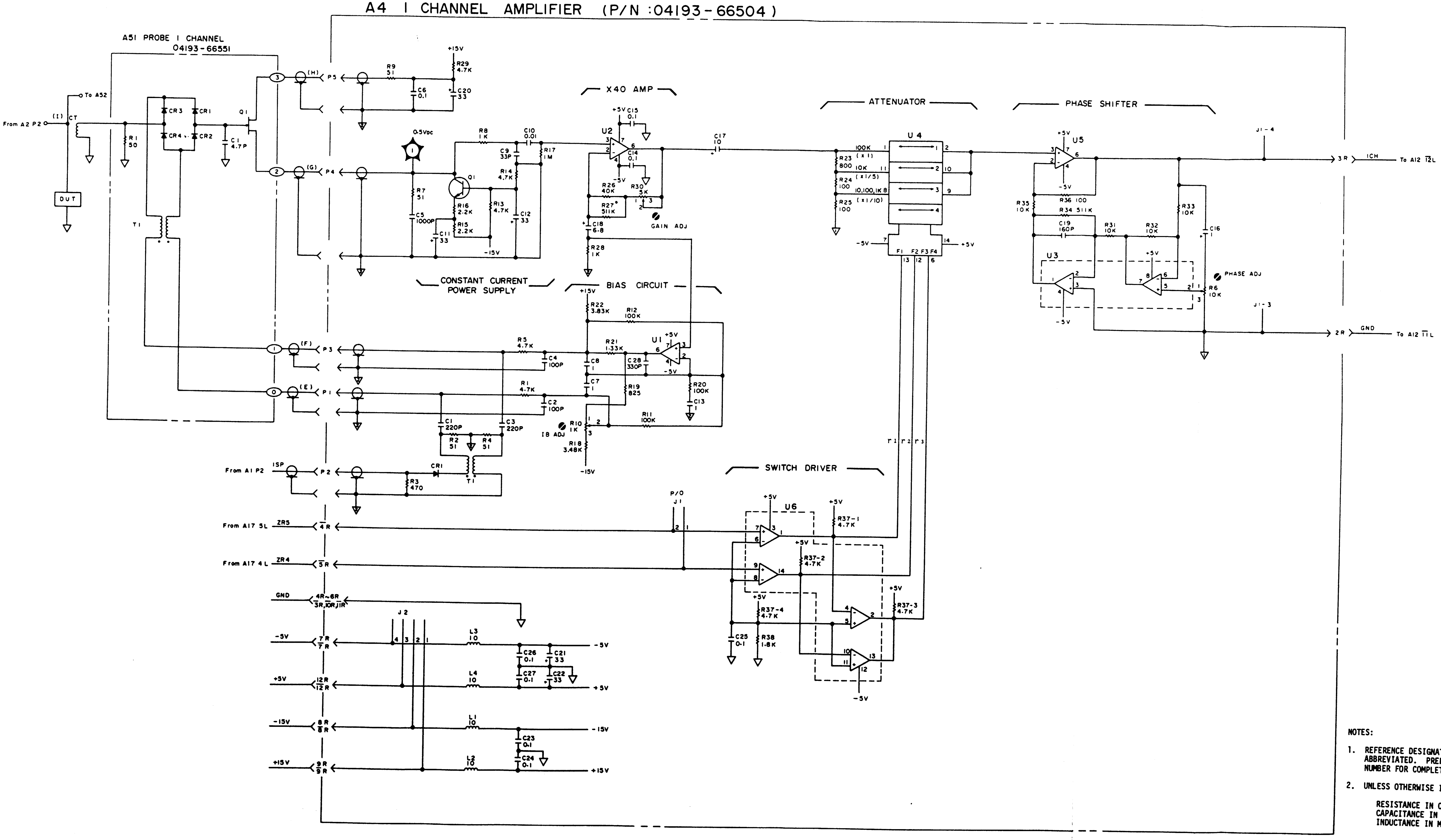


Figure 8-37. A4 I-Channel Amplifier/A51 Probe I-Channel Board Assembly Schematic Diagram.

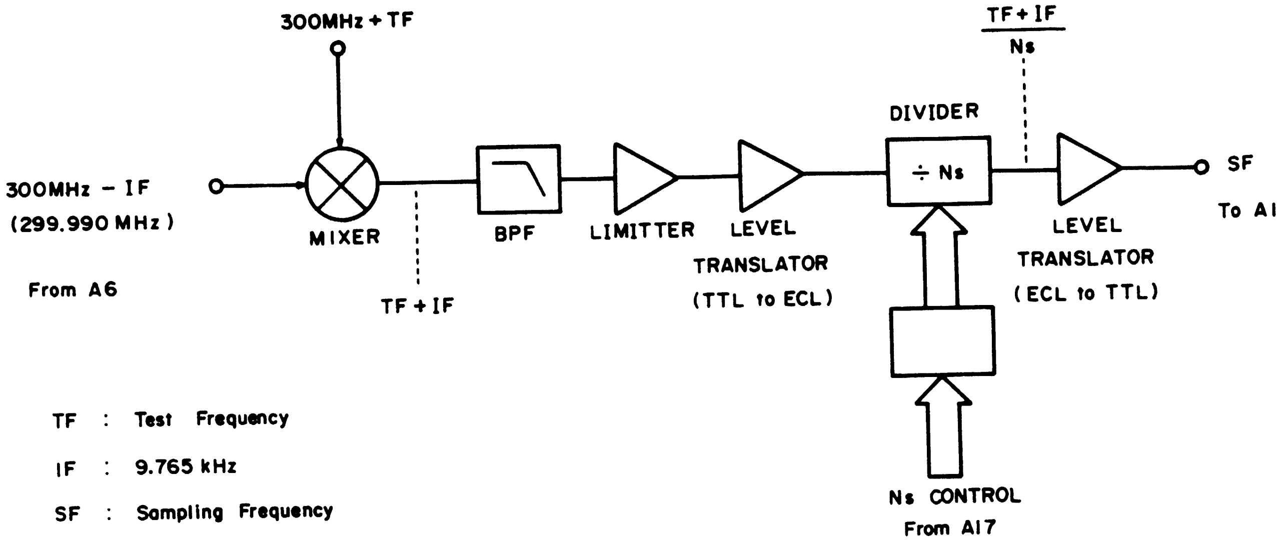
NOTES:

1. REFERENCE DESIGNATORS WITHIN THIS ASSEMBLY ARE ABBREVIATED. PREFIX ABBREVIATION WITH ASSEMBLY NUMBER FOR COMPLETE REFERENCE DESIGNATOR.

2. UNLESS OTHERWISE INDICATED:

   RESISTANCE IN OHMS (Ω)
   CAPACITANCE IN MICROFARADS (μF)
   INDUCTANCE IN MICROHENRIES (μH)

## A5 Mixer and Divider



A5 Board Block Diagram

| Test Frequency (MHz) | Divider Circuit | Ns | Sampling Frequency (MHz) |
|---|---|---|---|
| 0.400 ∿ 2.499 | — | 1 | 0.4098 ∿ 2.509 |
| 2.500 ∿ 4.999 | ÷ 2 | 2 | 1.255 ∿ 2.504 |
| 5.000 ∿ 9.999 | ÷ 2 — ÷ 2 | 4 | 1.252 ∿ 2.502 |
| 10.00 ∿ 14.99 | ÷ 3 — ÷ 2 | 6 | 1.668 ∿ 2.500 |
| 15.00 ∿ 19.99 | ÷ 4 — ÷ 2 | 8 | 1.876 ∿ 2.500 |
| 20.00 ∿ 24.99 | ÷ 5 — ÷ 2 | 10 | 2.001 ∿ 2.500 |
| 25.00 ∿ 29.99 | ÷ 6 — ÷ 2 | 12 | 2.084 ∿ 2.500 |
| 30.00 ∿ 34.99 | ÷ 7 — ÷ 2 | 14 | 2.144 ∿ 2.500 |
| 35.00 ∿ 39.99 | ÷ 8 — ÷ 2 | 16 | 2.188 ∿ 2.500 |
| 40.00 ∿ 44.99 | ÷ 9 — ÷ 2 | 18 | 2.223 ∿ 2.500 |
| 45.00 ∿ 49.99 | ÷10 — ÷ 2 | 20 | 2.250 ∿ 2.500 |
| 50.00 ∿ 54.99 | ÷11 — ÷ 2 | 22 | 2.273 ∿ 2.500 |
| 55.00 ∿ 59.99 | ÷12 — ÷ 2 | 24 | 2.292 ∿ 2.500 |
| 60.00 ∿ 64.99 | ÷13 — ÷ 2 | 26 | 2.308 ∿ 2.500 |
| 65.00 ∿ 69.99 | ÷14 — ÷ 2 | 28 | 2.322 ∿ 2.500 |
| 70.00 ∿ 79.99 | ÷ 2 — ÷ 8 — ÷ 2 | 32 | 2.188 ∿ 2.500 |
| 80.00 ∿ 89.99 | ÷ 2 — ÷ 9 — ÷ 2 | 36 | 2.222 ∿ 2.500 |
| 90.00 ∿ 99.99 | ÷ 2 — ÷10 — ÷ 2 | 40 | 2.250 ∿ 2.500 |
| 100.0 ∿ 110.0 | ÷ 2 — ÷11 — ÷ 2 | 44 | 2.273 ∿ 2.500 |

## *A5 Mixer and Divider Board Theory*

The A5 board contains a double balanced mixer, 120MHz low-pass filter, ECL translator, and Ns divider.

Two signals, 300MHz -IF and 300MHz +RF, are input to the double balanced mixer. The output is passed through the 120MHz low-pass filter, leaving only an RF+IF signal. The ECL translator, Q3 and U4, converts the sinusoidal RF+IF signal into an ECL level square wave for input to the Ns divider.

The Ns divider--U2, U5, U6, and U7--is controlled by the microprocessor and divides down the incoming RF+IF in accordance with the states of the Ns control lines, NS1 through NS7. The Ns divisor selected by the microprocessor depends entirely on the selected test frequency. SP RATE (sampling pulse rate) is calculated as (RF+IF)/Ns. The frequency of SP RATE must be such that the cw RF test signal is sampled at increasingly earlier points.

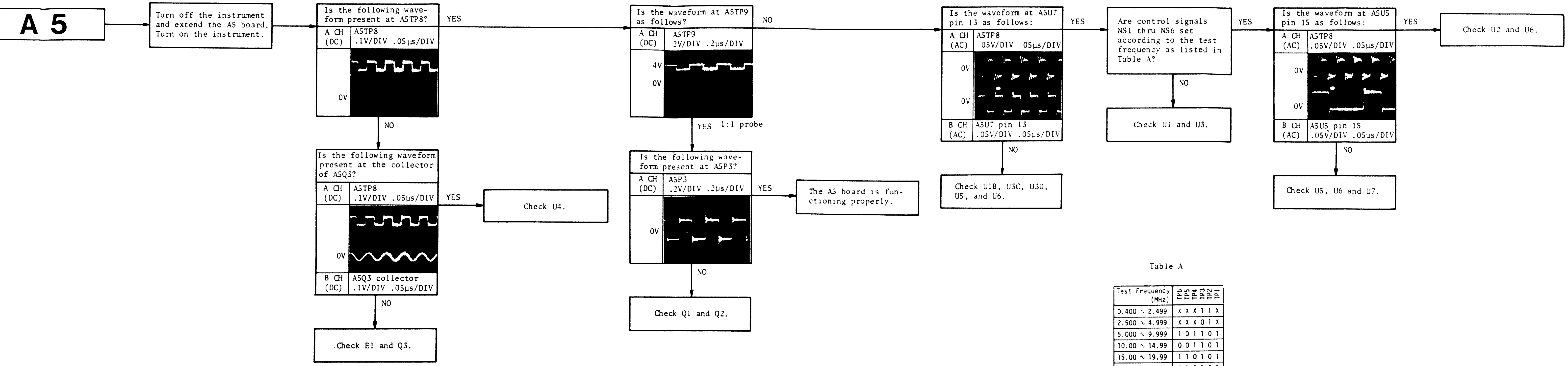


Table A

| Test Frequency (MHz) | TP6 | TP5 | TP4 | TP3 | TP2 | TP1 |
|---|---|---|---|---|---|---|
| 0.400 ~ 2.499 | X | X | X | 1 | 1 | X |
| 2.500 ~ 4.999 | X | X | X | 0 | 1 | X |
| 5.000 ~ 9.999 | 1 | 0 | 1 | 1 | 0 | 1 |
| 10.00 ~ 14.99 | 0 | 0 | 1 | 1 | 0 | 1 |
| 15.00 ~ 19.99 | 1 | 1 | 0 | 1 | 0 | 1 |
| 20.00 ~ 24.99 | 0 | 1 | 0 | 1 | 0 | 1 |
| 25.00 ~ 29.99 | 1 | 0 | 0 | 1 | 0 | 1 |
| 30.00 ~ 34.99 | 0 | 0 | 0 | 1 | 0 | 1 |
| 35.00 ~ 39.99 | 1 | 1 | 1 | 1 | 0 | 0 |
| 40.00 ~ 44.99 | 0 | 1 | 1 | 1 | 0 | 0 |
| 45.00 ~ 49.99 | 1 | 0 | 1 | 1 | 0 | 0 |
| 50.00 ~ 54.99 | 0 | 0 | 1 | 1 | 0 | 0 |
| 55.00 ~ 59.99 | 1 | 1 | 0 | 1 | 0 | 0 |
| 60.00 ~ 64.99 | 0 | 1 | 0 | 1 | 0 | 0 |
| 65.00 ~ 69.99 | 1 | 0 | 0 | 1 | 0 | 0 |
| 70.00 ~ 79.99 | 1 | 1 | 1 | 0 | 0 | 0 |
| 80.00 ~ 89.99 | 0 | 1 | 1 | 0 | 0 | 0 |
| 90.00 ~ 99.99 | 1 | 0 | 1 | 0 | 0 | 0 |
| 100.0 ~ 110.0 | 0 | 0 | 1 | 0 | 0 | 0 |

**Figure 8-38.** A5 Board Troubleshooting Flow Chart

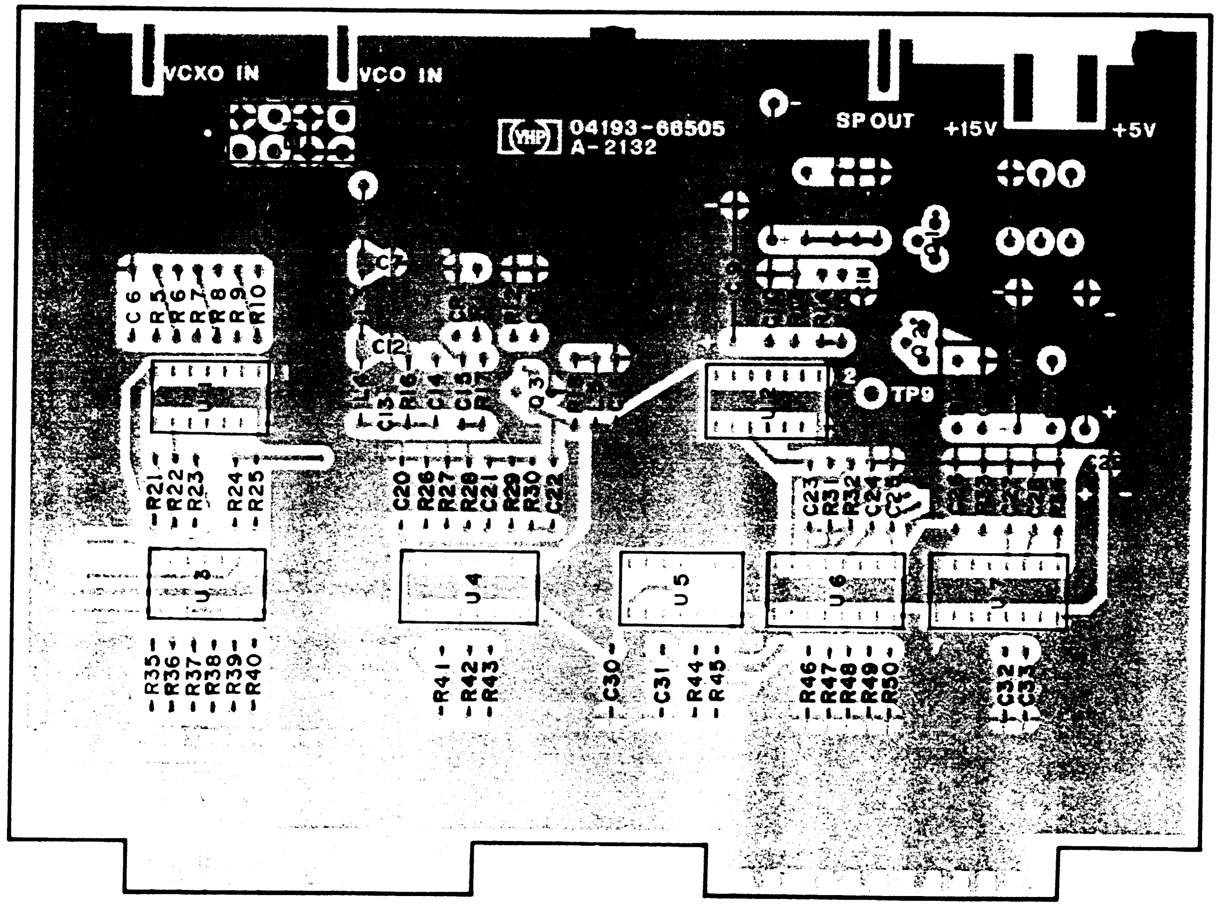
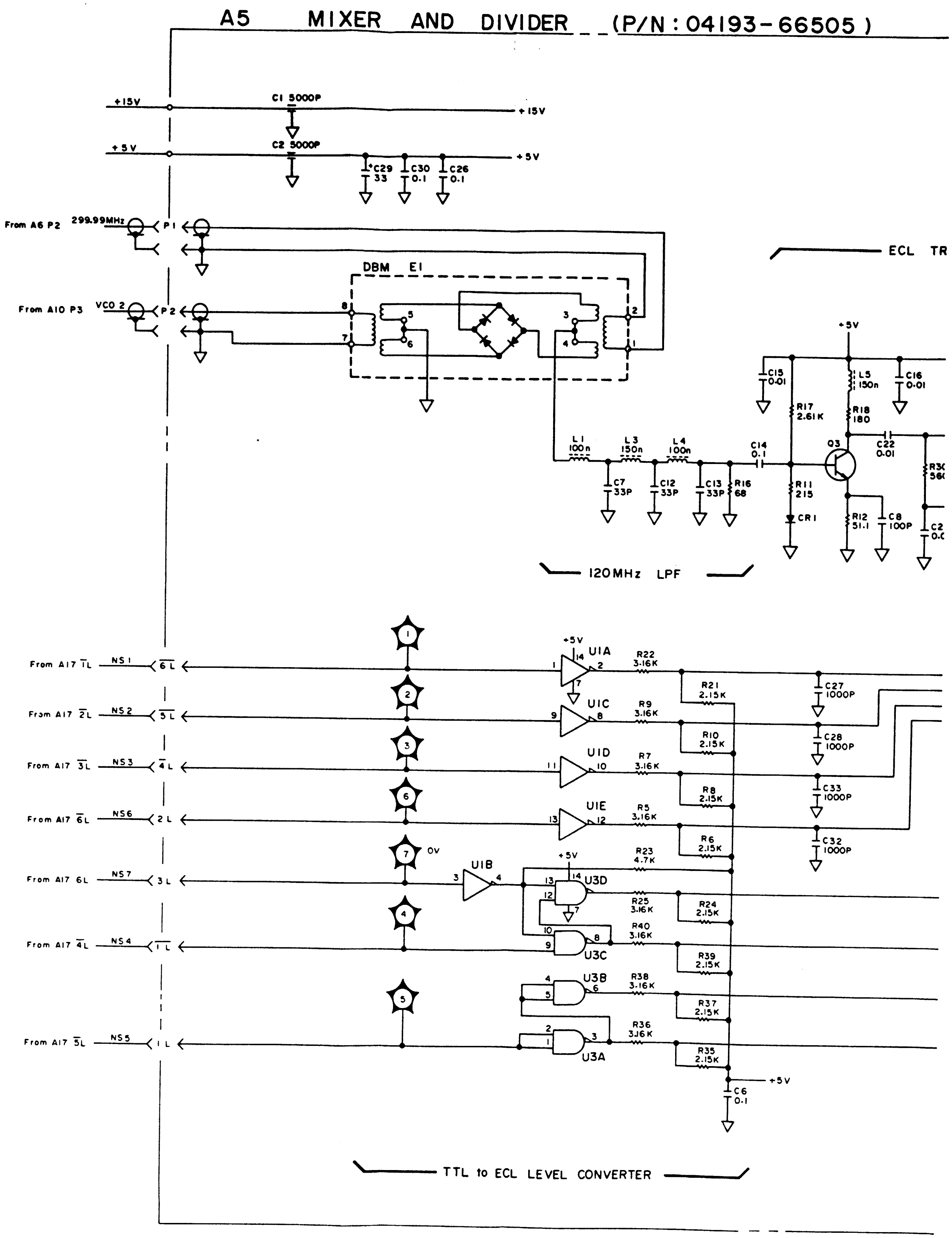
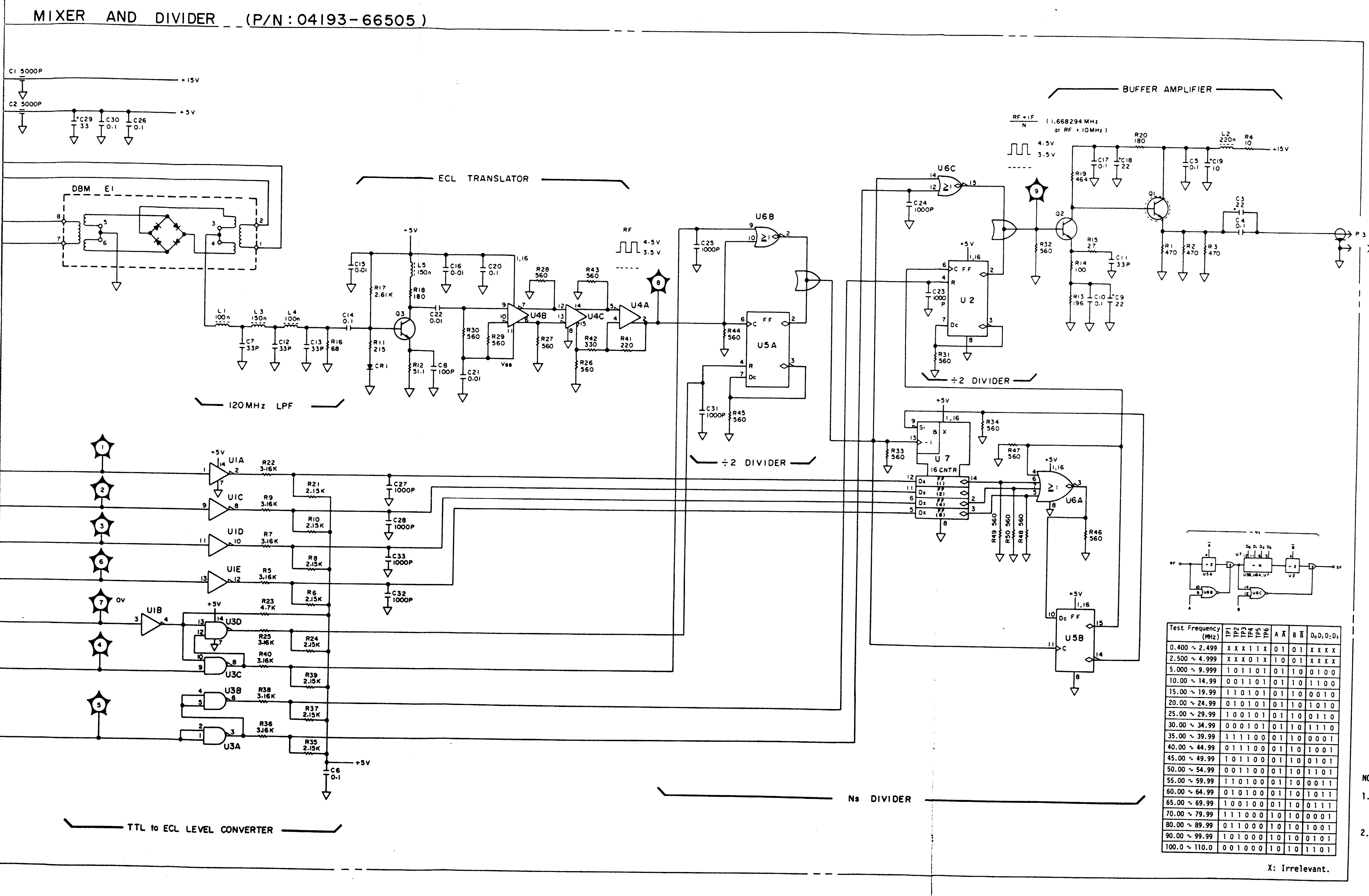


Figure 8-39. A5 Mixer and Divider Board Assembly Component Locations.



## MIXER AND DIVIDER (P/N:04193-66505)



| Test Frequency (MHz) | TP1 TP2 TP3 TP4 TP5 TP6 | A $\bar{A}$ | B $\bar{B}$ | $D_0 D_1 D_2 D_3$ |
|---|---|---|---|---|
| 0.400 ~ 2.499 | X X X 1 1 X | 0 1 | 0 1 | X X X X |
| 2.500 ~ 4.999 | X X X 0 1 X | 1 0 | 0 1 | X X X X |
| 5.000 ~ 9.999 | 1 0 1 1 0 1 | 0 1 | 1 0 | 0 1 0 0 |
| 10.00 ~ 14.99 | 0 0 1 1 0 1 | 0 1 | 1 0 | 1 1 0 0 |
| 15.00 ~ 19.99 | 1 1 0 1 0 1 | 0 1 | 1 0 | 0 0 1 0 |
| 20.00 ~ 24.99 | 0 1 0 1 0 1 | 0 1 | 1 0 | 1 0 1 0 |
| 25.00 ~ 29.99 | 1 0 0 1 0 1 | 0 1 | 1 0 | 0 1 1 0 |
| 30.00 ~ 34.99 | 0 0 0 1 0 1 | 0 1 | 1 0 | 1 1 1 0 |
| 35.00 ~ 39.99 | 1 1 1 1 0 0 | 0 1 | 1 0 | 0 0 0 1 |
| 40.00 ~ 44.99 | 0 1 1 1 0 0 | 0 1 | 1 0 | 1 0 0 1 |
| 45.00 ~ 49.99 | 1 0 1 1 0 0 | 0 1 | 1 0 | 0 1 0 1 |
| 50.00 ~ 54.99 | 0 0 1 1 0 0 | 0 1 | 1 0 | 1 1 0 1 |
| 55.00 ~ 59.99 | 1 1 0 1 0 0 | 0 1 | 1 0 | 0 0 1 1 |
| 60.00 ~ 64.99 | 0 1 0 1 0 0 | 0 1 | 1 0 | 1 0 1 1 |
| 65.00 ~ 69.99 | 1 0 0 1 0 0 | 0 1 | 1 0 | 0 1 1 1 |
| 70.00 ~ 79.99 | 1 1 1 0 0 0 | 1 0 | 1 0 | 0 0 0 1 |
| 80.00 ~ 89.99 | 0 1 1 0 0 0 | 1 0 | 1 0 | 1 0 0 1 |
| 90.00 ~ 99.99 | 1 0 1 0 0 0 | 1 0 | 1 0 | 0 1 0 1 |
| 100.0 ~ 110.0 | 0 0 1 0 0 0 | 1 0 | 1 0 | 1 1 0 1 |

X: Irrelevant.

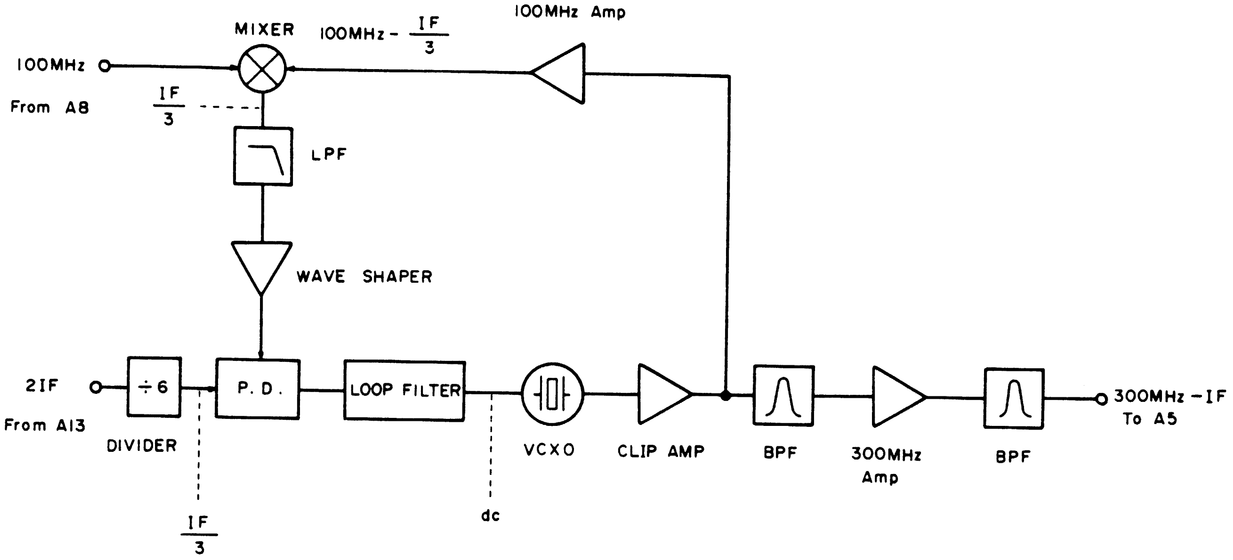
NOTES:

1. REFERENCE DESIGNATORS WITHIN THIS ASSEMBLY ARE ABBREVIATED. PREFIX ABBREVIATION WITH ASSEMBLY NUMBER FOR COMPLETE REFERENCE DESIGNATOR.
2. UNLESS OTHERWISE INDICATED:

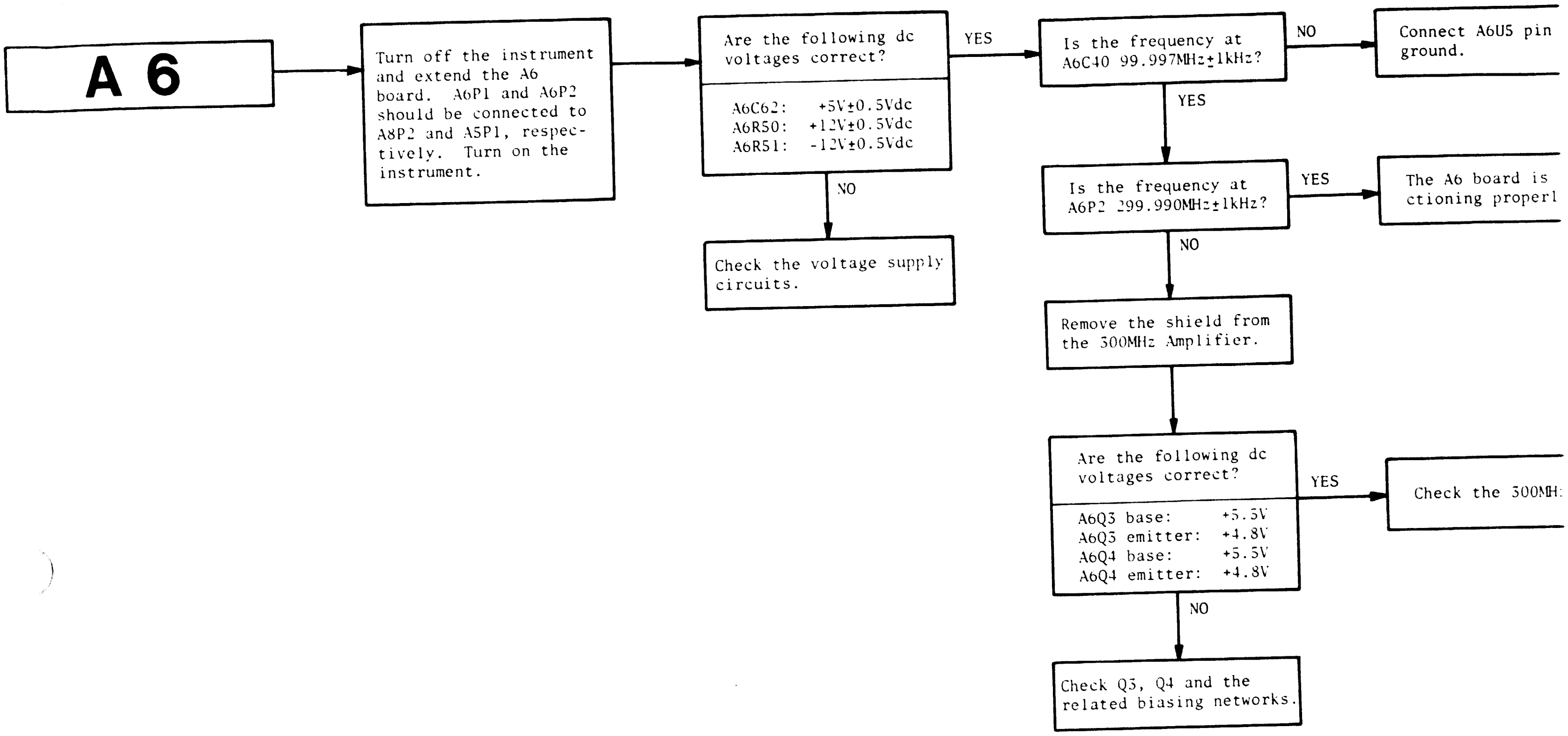
   RESISTANCE IN OHMS (Ω)
   CAPACITANCE IN MICROFARADS (μF)
   INDUCTANCE IN MICROHENRIES (μH)

Figure 8-40. A5 Mixer and Divider Board Assembly Schematic Diagram.

## A6 Voltage Controlled Crystal Oscillator



A6 Board Block Diagram


A 6
Turn off the instrument and extend the A6 board. A6P1 and A6P2 should be connected to A8P2 and A5P1, respectively. Turn on the instrument.
Are the following dc voltages correct?
A6C62: +5V±0.5Vdc
A6R50: +12V±0.5Vdc
A6R51: -12V±0.5Vdc
NO
Check the voltage supply circuits.
YES
Is the frequency at A6C40 99.997MHz±1kHz?
NO
Connect A6U5 pin ground.
YES
Is the frequency at A6P2 299.990MHz±1kHz?
YES
The A6 board is ctioning properl
NO
Remove the shield from the 300MHz Amplifier.
Are the following dc voltages correct?
A6Q3 base: +5.5V
A6Q3 emitter: +4.8V
A6Q4 base: +5.5V
A6Q4 emitter: +4.8V
YES
Check the 300MH
NO
Check Q3, Q4 and the related biasing networks.

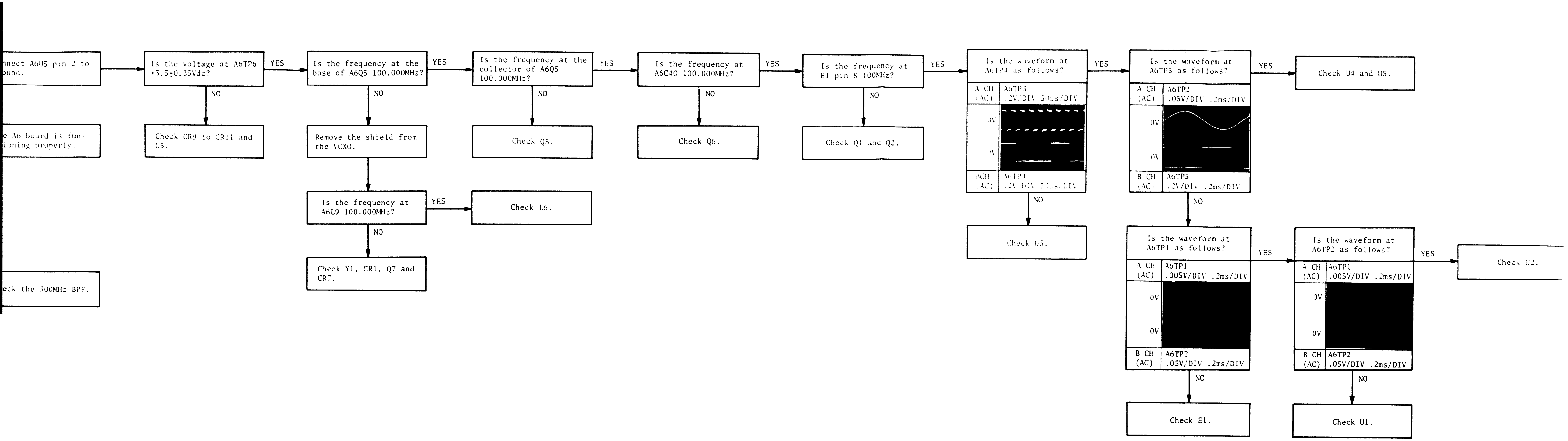


Figure 8-41. A6 Board Troubleshooting Flow Chart.

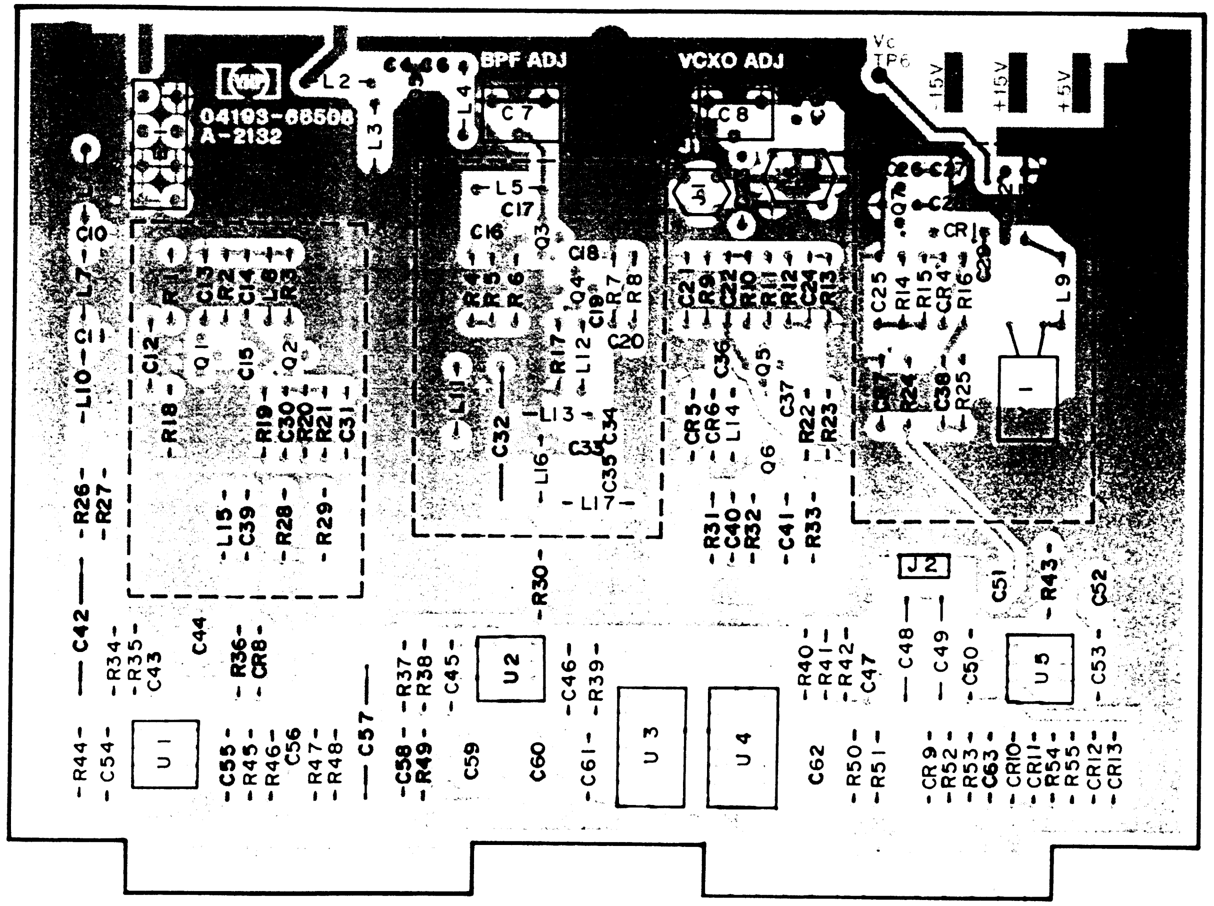
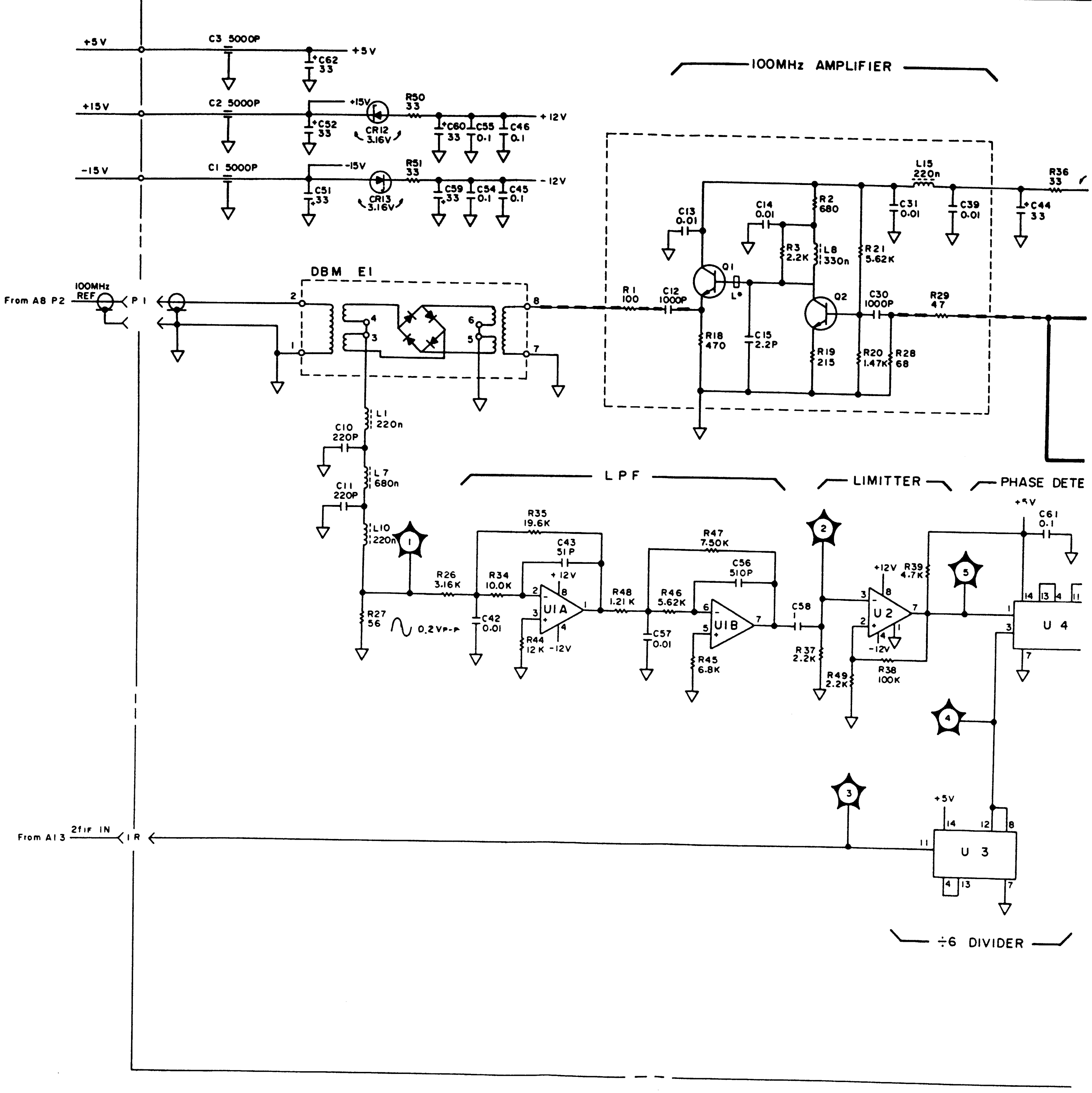
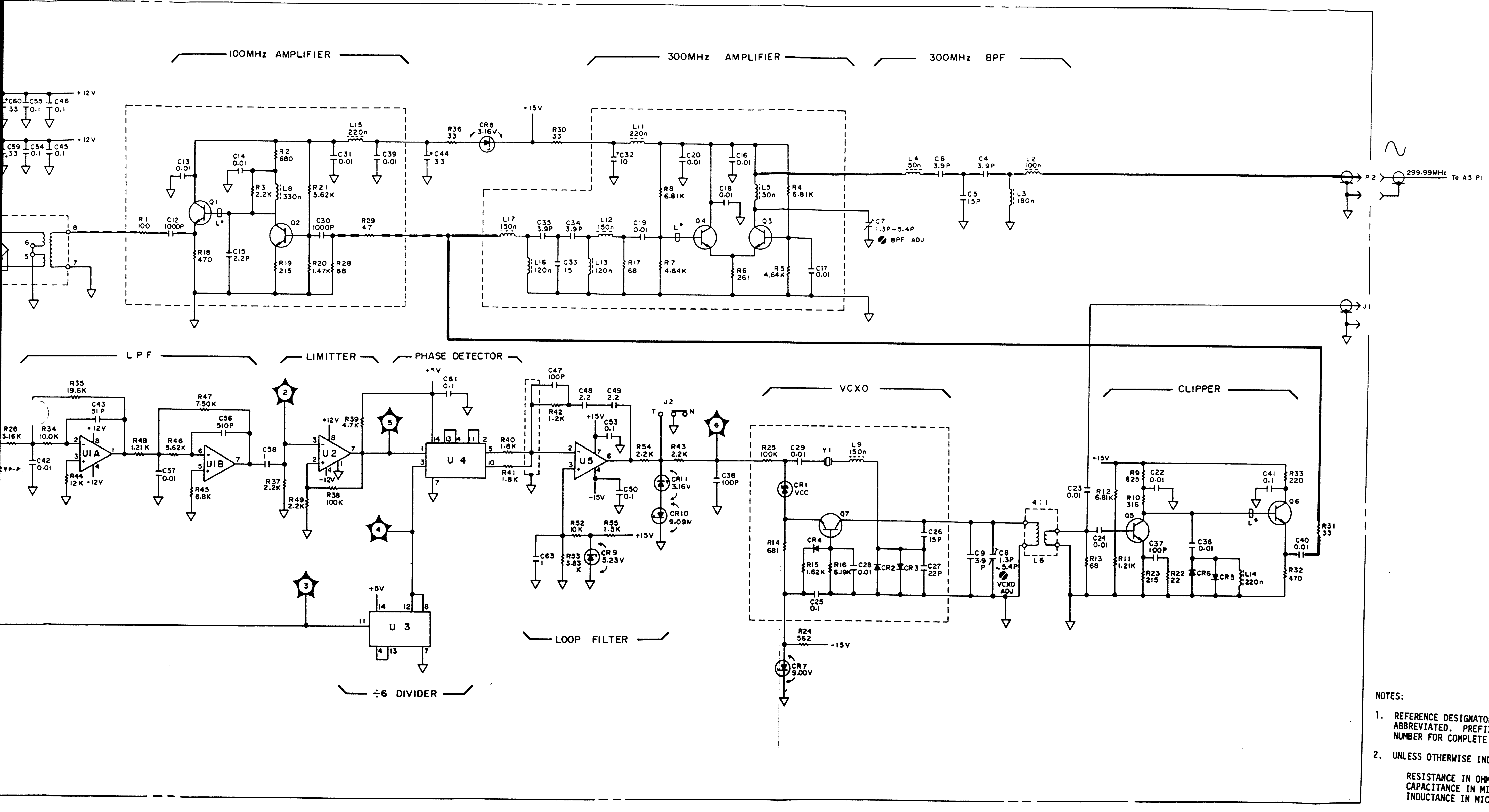


Figure 8-42. A6 Voltage Controlled Crystal Oscillator Board Assembly Component Locations.

## A6 VOLTAGE CONTROLLED CRYSTAL OSCILLATOR (P/N:04193-66506



ROL _D CRYSTAL OSCILLATOR (P/N:04193-66506)



NOTES:

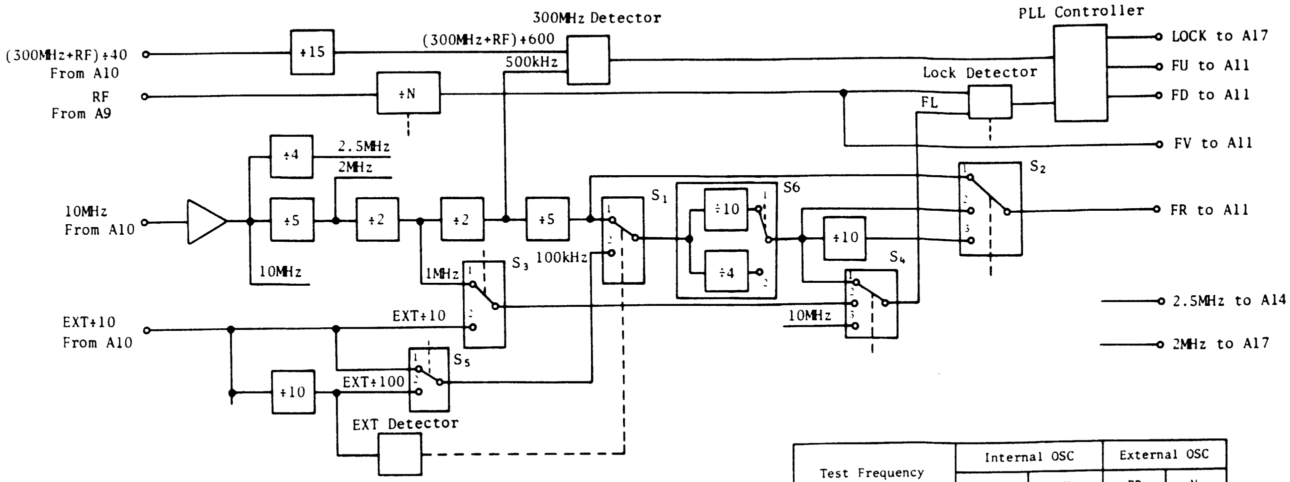
1. REFERENCE DESIGNATORS WITHIN THIS ASSEMBLY ARE ABBREVIATED. PREFIX ABBREVIATION WITH ASSEMBLY NUMBER FOR COMPLETE REFERENCE DESIGNATOR.

2. UNLESS OTHERWISE INDICATED:

RESISTANCE IN OHMS (Ω)
CAPACITANCE IN MICROFARADS (μF)
INDUCTANCE IN MICROHENRIES (μH)

Figure 8-43. A6 Voltage Controlled Crystal Oscillator Board Assembly Schematic Diagram.

## 7 Divider



| FR0 | FR1 | FR |
|---|---|---|
| 0 | x | 1kHz |
| 1 | 0 | 10kHz |
| 1 | 1 | 100kHz |

x: irrelevant

| Test Frequency | Internal OSC | | External OSC | |
|---|---|---|---|---|
| | FR | N | FR | N |
| .400 to 9.999MHz | 1kHz | $\frac{RF}{1kHz}$ | $\frac{RF}{400}$ | 400 |
| 10.00 to 99.99MHz | 10kHz | $\frac{RF}{10kHz}$ | $\frac{RF}{1000}$ | 1000 |
| 100.0 to 110.0MHz | 100kHz | $\frac{RF}{100kHz}$ | $\frac{RF}{1000}$ | 1000 |

A7 Board Block Diagram

Switch Selection for INT OSC.

| Frequency Range | $S_1$ | $S_2$ | $S_3$ | $S_4$ | $S_5$ | $S_6$ | FR | FL |
|---|---|---|---|---|---|---|---|---|
| .400 to 9.999MHz | 1 | 3 | 1 | 1 | 1 | 1 | 1kHz | 10kHz |
| 10.00 to 99.99MHz | 1 | 2 | 1 | 2 | 2 | 1 | 10kHz | 1MHz |
| 100.0 to 110.0MHz | 1 | 1 | 1 | 3 | 2 | 1 | 100kHz | 10MHz |

Switch Selection for EXT OSC.

| Frequency Range | $S_1$ | $S_2$ | $S_3$ | $S_4$ | $S_5$ | $S_6$ | FR | FL |
|---|---|---|---|---|---|---|---|---|
| .400 to 9.999MHz | 2 | 3 | 2 | 1 | 1 | 2 | $\frac{EXT}{400}$ | $\frac{EXT}{40}$ |
| 10.00 to 99.99MHz | 2 | 2 | 2 | 2 | 2 | 1 | $\frac{EXT}{1000}$ | $\frac{EXT}{10}$ |
| 100.0 to 110.0MHz | 2 | 2 | 2 | 2 | 2 | 1 | $\frac{EXT}{1000}$ | $\frac{EXT}{10}$ |

## *A7 Divider Board Theory*

The A7 board controls the frequency of the instrument's test signal source. Major circuits on this board are the ÷N Divider, Osc. Selector, Frequency Selector, Ext. Osc. Detector, 300MHz Detector, Lock Detector, and Time Interval Circuit.

To lock the instrument's test signal source at the frequency displayed on the front-panel or at the frequency of the external oscillator (if connected), FR and FV must be of the same frequency. With no external oscillator connected, FR is maintained constant at 1kHz, 10kHz, or 100kHz, depending on the test frequency range, and FV is determined by the N divisor and the test frequency, RF. The N divisor in this case is determined by the number of counts on the FREQUENCY display. With an external oscillator connected, however, the frequency of FR is equal to 1/400 or 1/1000 of the external oscillator's frequency. The frequency of FV is still determined by the N divisor and the test frequency, but N in this case is either 400 or 1000, depending on the frequency range. The frequency range, with or without an external oscillator, is controlled by the microprocessor and is determined by the FR0 and FR1 frequency range control lines. Refer to the table below for the values of FR, FV, N, FR0, and FR1.

| Test Frequency | Without Ext. Osc. | | | With Ext. Osc | | | FR0 | FR1 |
|---|---|---|---|---|---|---|---|---|
| | FR | FV | N | FR | FV | N | | |
| .400 to 9.999MHz | 1kHz | $\frac{RF}{N}$ | Disp.* Cnts. | $\frac{Ext}{400}$ | $\frac{RF}{N}$ | 400 | X | 0 |
| 10.00 to 99.99MHz | 10kHz | $\frac{RF}{N}$ | Disp.* Cnts. | $\frac{Ext}{1000}$ | $\frac{RF}{N}$ | 1000 | 0 | 1 |
| 100.0 to 110.0MHz | 100kHz | $\frac{RF}{N}$ | Disp.* Cnts. | $\frac{Ext}{1000}$ | $\frac{RF}{N}$ | 1000 | 1 | 1 |

1: TTL HIGH
0: TTL LOW
X: Irrelevant

* Number of counts on the FREQUENCY display.

The ÷N circuit consists of a two modulus (÷10/÷11) prescaler (U5), four programmable decade counters (U23 through U26), and a D flip-flop (U17A). The whole circuit functions as a programmable up-counter, outputting a pulse every N input pulses. The input, TS PLL, is a squared RF (test signal frequency) fed back from the A9 board. The N divisor is determined by the microprocessor and depends on whether or not an external oscillator is connected to the instrument. Refer to the table above. The N divisor actually loaded into the counter is the 4-digit 9's complement of the N values listed in the table. If, for example, N is 400, the value loaded into the counter is 9999-0400, or 9599 (1001, 0101, 1001, 1001).

| U26 | U24 | U23 | U25 |
|---|---|---|---|
| 9 | 9 | 5 | 9 |
| (LSD) | | | (MSD) |

The counter begins with this value and counts up until maximum count (9999) is reached, at which time one pulse is output and U17A resets the entire circuit to the programmed value. The frequency of FV, thus, is TS PLL÷N.

As an example, assume that the test signal source is locked at 500kHz. The N divisor, then, is 500 and the 9's complement of this is 9499. From the above table, FR is 1kHz, and to maintain the locked condition, FV must also be 1kHz. To accomplish this, the prescaler, U5, is initially set to the ÷11 mode and remains so until U26 (LSD of N) reaches maximum count, at which time U26's carry output goes HIGH, setting U5 to the ÷10 mode and stopping U26. The total number of TS PLL pulses counted thus far is

(9-programmed value of U26) x 11

where 9 is the maximum count of U26. Thus, for the example given, no TS PLL pulses have been counted. U5 is now in the ÷10 mode, U26 is disabled (stopped), and U24, U23, and U25 are counting the TS PLL/10 pulses output from U5. When maximum count is reached, one pulse is output (FV) and U17A resets U5 to the ÷11 mode, enables U26, and reloads the N divisor.

Now assume that the FREQUENCY DIAL on the front-panel is rotated until 501kHz is displayed. The microprocessor detects this, and changes the N divisor to 501 (whose 9's complement is 9498). But the frequency of the signal source is still 500kHz, thus FV is 500kHz÷501, or 998Hz. A 2Hz difference now exists between FR (1kHz) and FV. The phase detector on the A11 board detects this difference and slightly charges an integrator, whose output is the VCO control voltage, until the test signal frequency is 501kHz. FV is then 1kHz and the signal source is locked at the new frequency.

U22, U27, U28, and U30 divide down the 10MHz CLK into six signals : 100kHz, 500kHz, 1MHz, 2MHz, 2.5MHz, and 10MHz. The 100kHz signal is used to generate FR; the 500kHz signal is the reference for the 300MHz Detector; the 1MHz and 10MHz signals are used by the Lock Detector; the 2MHz signal (2MHz CLK) is used by the Microproessor; and the 2.5MHz signal (2.5MHz CLK) is used by the integrators on the A14 board.

The Osc. Selector, U20, is a quad 2-line-to-1-line data selector. It is controlled by the EXT OSC DETECTOR, U8B, and selects either the 10MHz CLK or EXT OSC÷10 as the source signal for FR. With no external oscillator connected, pin 5 of U8B is LOW and FR, output from pin 7 of U21, is 1kHz, 10kHz, or 100kHz, depending on the states of FR0 and FR1. When an external oscillator is connected, U8B pin 5 goes HIGH and FR is Ext. Osc/400 or Ext. Osc/1000, again depending on FR0 and FR1.

The ÷4/÷10 Divider, U15, operates in 4 mode when an external oscillator is connected, and in 10 mode otherwise. The Frequency Selector, U21, is a dual 4-line-to-1-line data selector. It is controlled by FR0 and FR1 and outputs to signals : FR and FL (frequency lock). FL is 10kHz, 1MHz, or 10MHz when no external oscillator is connected, or Ext Osc 40 or Ext Osc 10.

The 300MHz Detector contains a phase-frequency detector, U12, and a D-type flip-flop, U27B. It monitors the frequency of the VCO on the A10 board. If the VCO frequency drops below 300.4MHz, the Q output of U27B goes LOW, clearing U3B and, thus, generating $\overline{\text{FU}}$ (frequency up).

The Lock Detector--U3, U4, U11, and related gating--controls the $\overline{FU}$ (frequency up), $\overline{FD}$ (frequency down), and SSRDY (signal source ready) signals. Basically, the circuit compares the FV signal, output from the ÷N circuit, with a signal (from pin 9 of U21) whose frequency is, depending on the test frequency range, 10 or 100 times that of FR. If the frequency of FV is significantly higher or lower than that of FR, the Lock Detector will output the appropriate $\overline{FU}$ or $\overline{FD}$ signal in order to speed up the charge/discharge time of the integrator on the A11 board. If the difference between FR and FV is only slight, $\overline{FU}$ and $\overline{FD}$ are held HIGH and the integrator will charge/discharge at the normal rate. The purpose of the circuit is to reduce the time required to lock the signal source in response to large frequency changes. U4 and U11 are programmable up/down counters. The programmed values are controlled by FR1 and are, thus, signal-source frequency dependent, as shown in the table below :

| Test Frequency (MHz) | U4 Pin | | | | U11 Pin | | | |
|---|---|---|---|---|---|---|---|---|
| | 15 | 1 | 10 | 9 | 15 | 1 | 10 | 9 |
| 0.4 to 9.999 | L | L | L | L | H | H | L | H |
| 10.00 to 110.0 | L | H | H | L | H | L | H | L |

Both counters are initially loaded and both D flip-flops, U3A and U3B, are set up by FV. The counters then begin counting down the pulses from pin 9 of U21 and continue to do so until the next FV pulse. If at the end of this period the content of the counters is greater than 4, the Q output of U3A goes HIGH, causing a short pulse to be output from pin 3 of U2 (dual multivibrator) and generating $\overline{FD}$. If the borrow output of U4 is HIGH at the second FV pulse, the Q output of U3B goes HIGH, causing a short pulse to be output from pin 13 of U2 and generating $\overline{FU}$. The Q output of U3B is also used to clear U3A in order to prevent $\overline{FU}$ and $\overline{FD}$ from existing simultaneously.

The Time Interval Circuit--U2, U17B, and U8A--limits the length of time $\overline{FU}$ or $\overline{FD}$ is active. This prevents the signal source from overshooting the selected test frequency when $\overline{FU}$ or $\overline{FD}$ is active (LOW). Both halves of U2 have an external RC network--R1/C8 and R2/C9--which controls the output pulse width (approximately 70ms). These pulses enable U9A and U9B. U8A and U17B control the SSRDY signal.

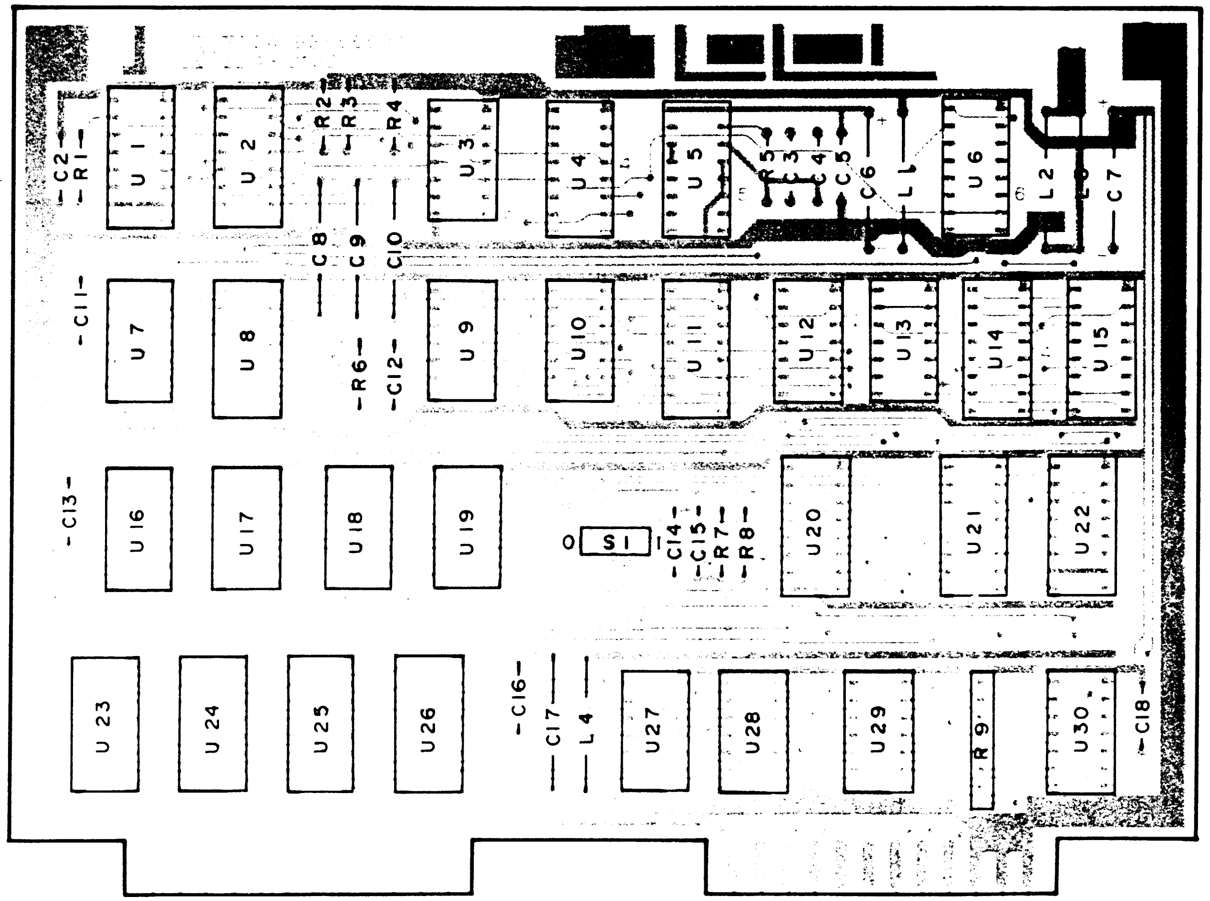
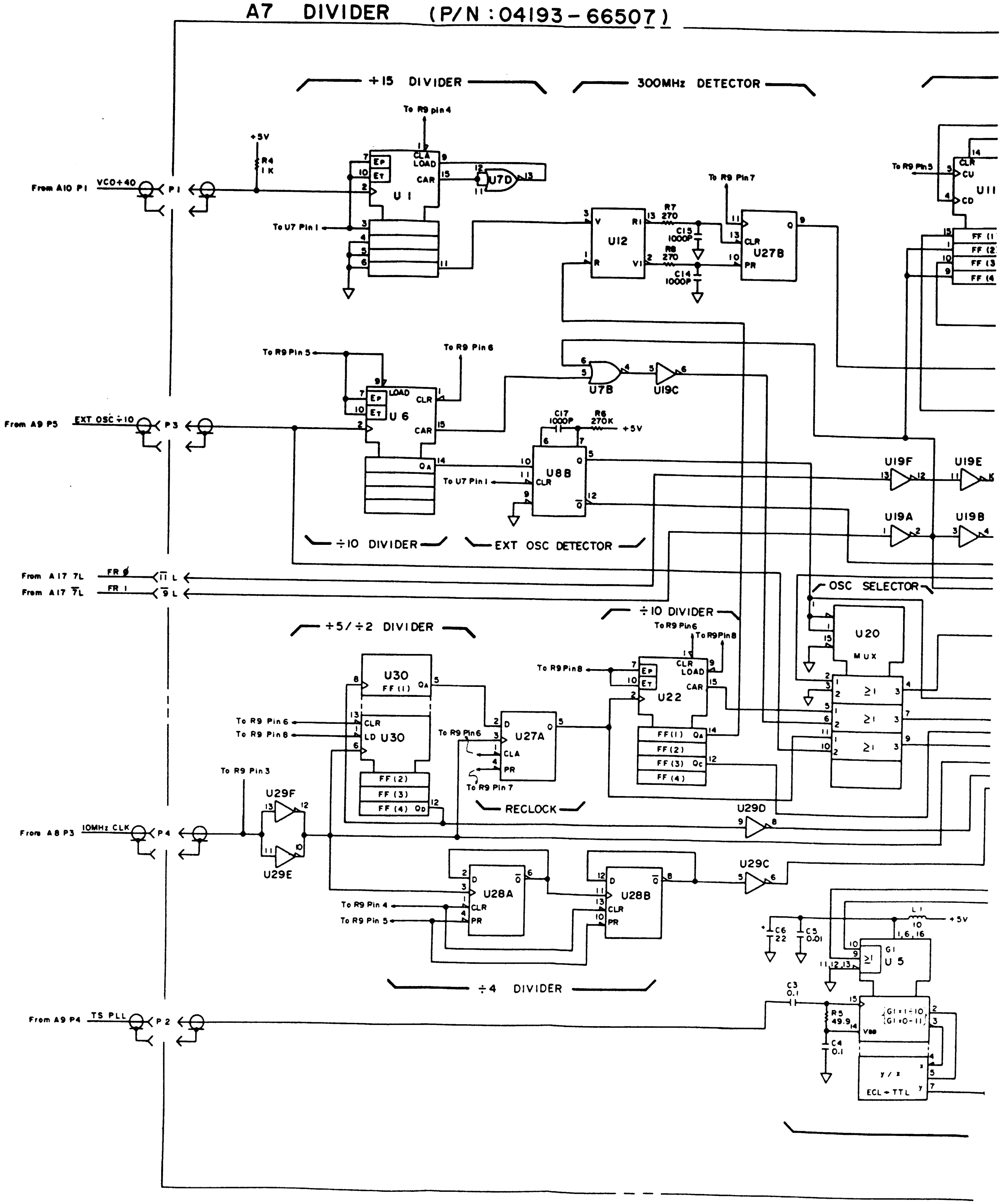
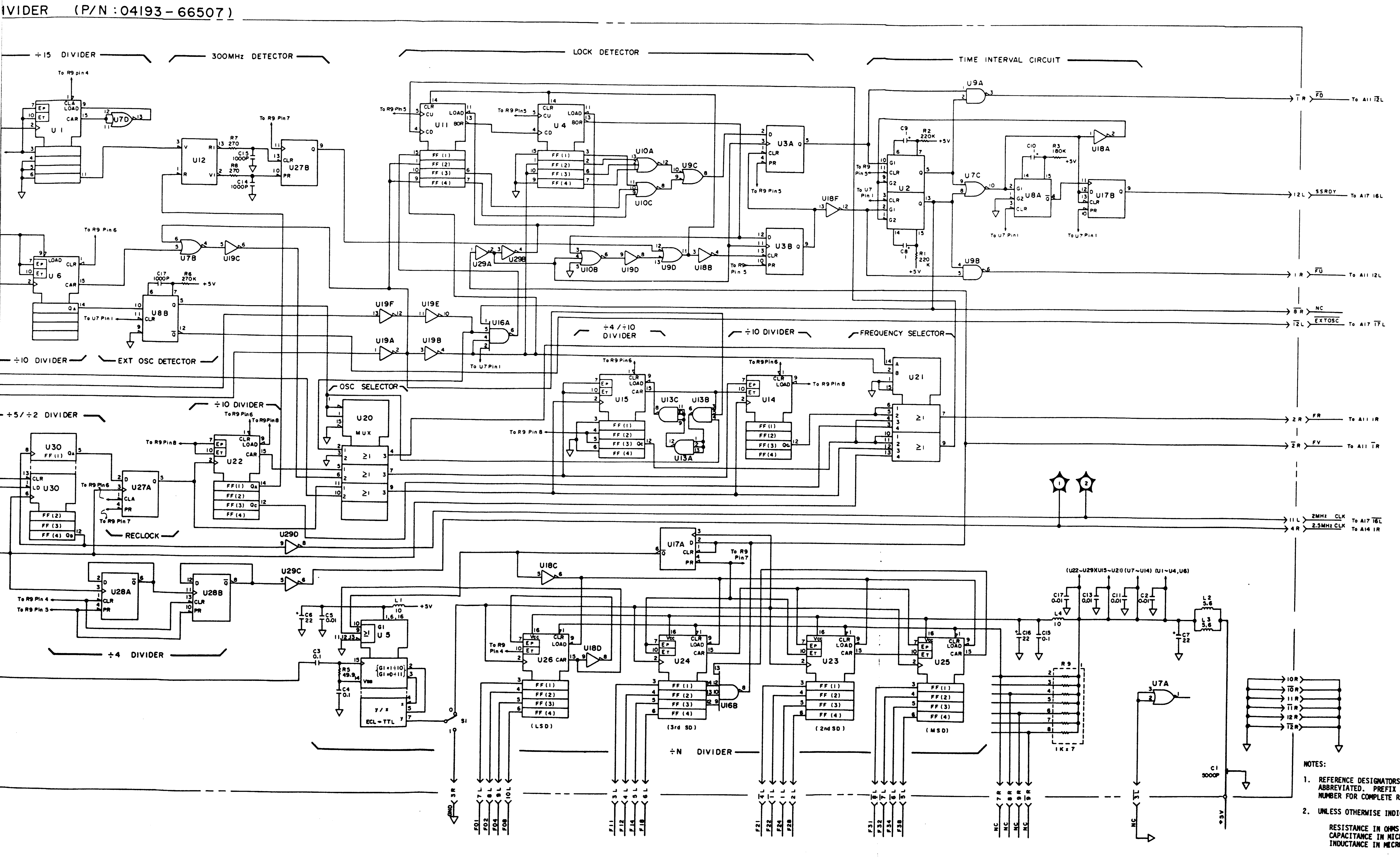


Figure 8-44. A7 Divider Board Assembly Component Locations.





NOTES:

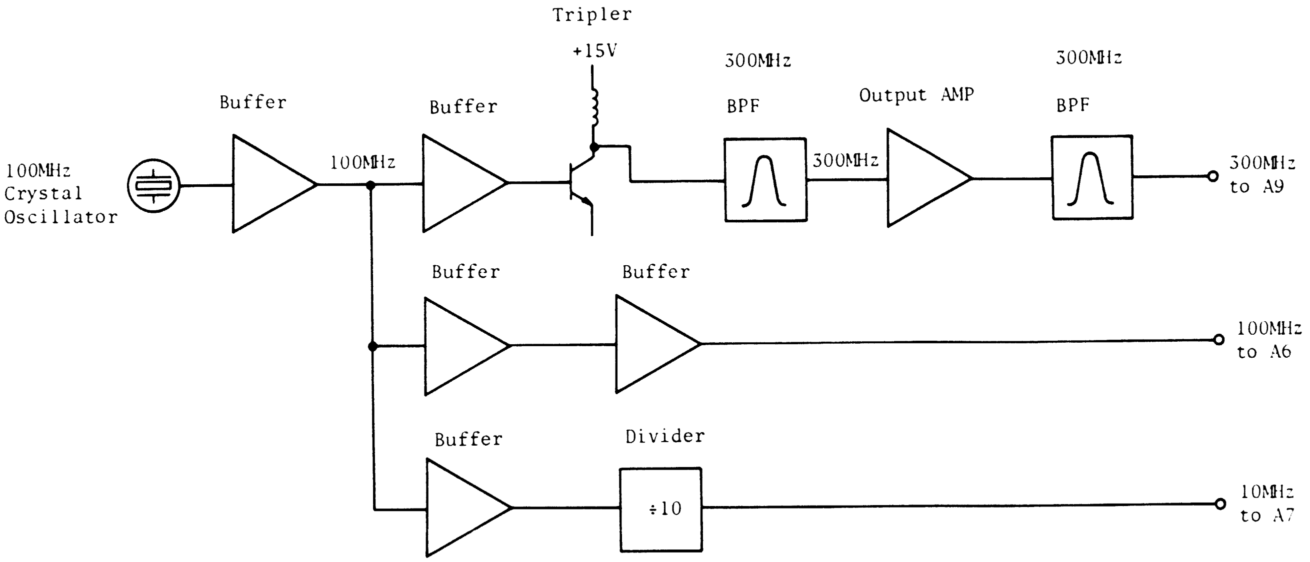
1. REFERENCE DESIGNATORS WITHIN THIS ASSE ABBREVIATED. PREFIX ABBREVIATION WITH NUMBER FOR COMPLETE REFERENCE DESIGNAT

2. UNLESS OTHERWISE INDICATED:

RESISTANCE IN OHMS (Ω)
CAPACITANCE IN MICROFARADS (μF)
INDUCTANCE IN MICROHENRIES (μH)

Figure 8-45. A7 Divider Board Assembly Schematic Diagram.

## A8 Crystal Oscillator



A8 Board Block Diagram

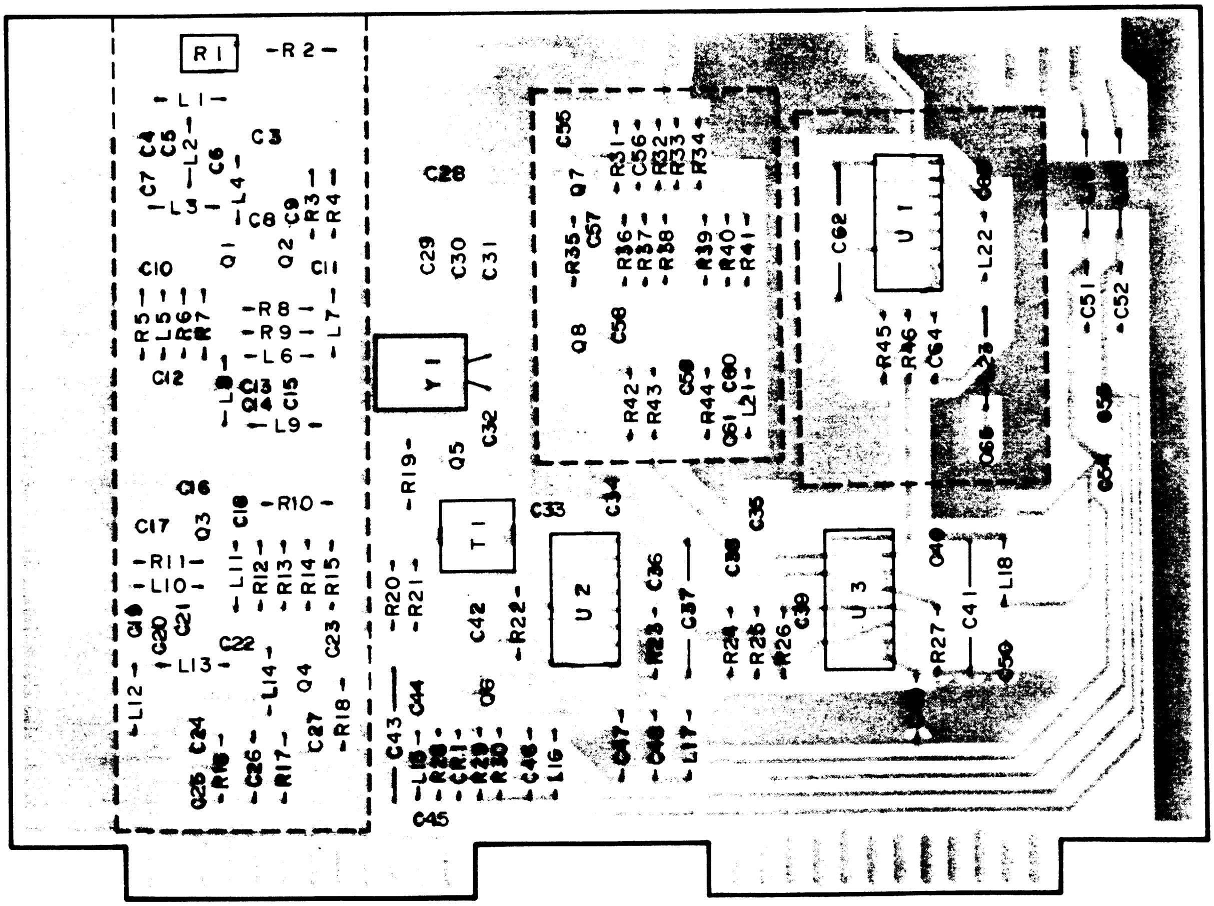
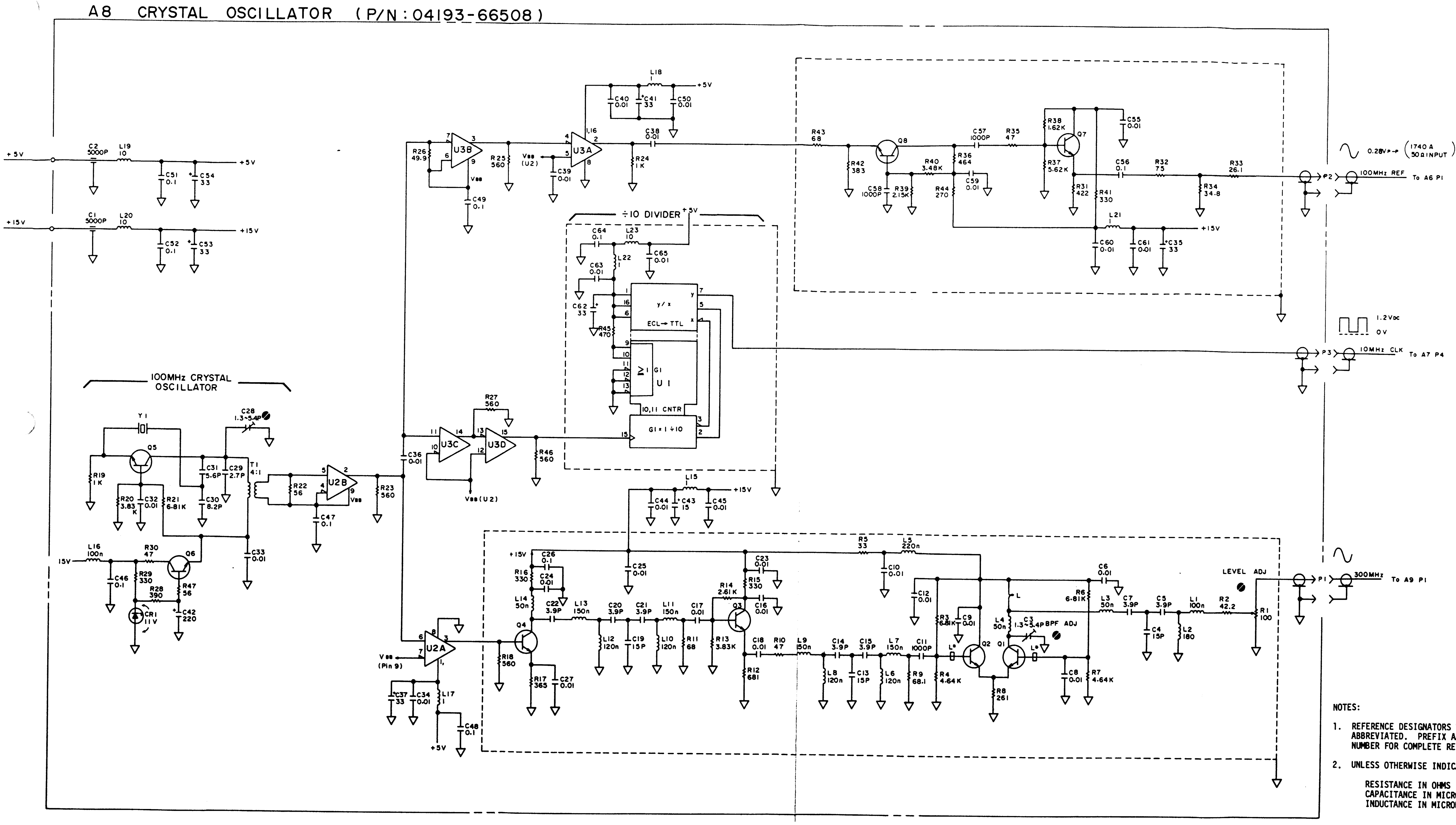


Figure 8-46. A8 Crystal Oscillator Board Assembly Component Locations.



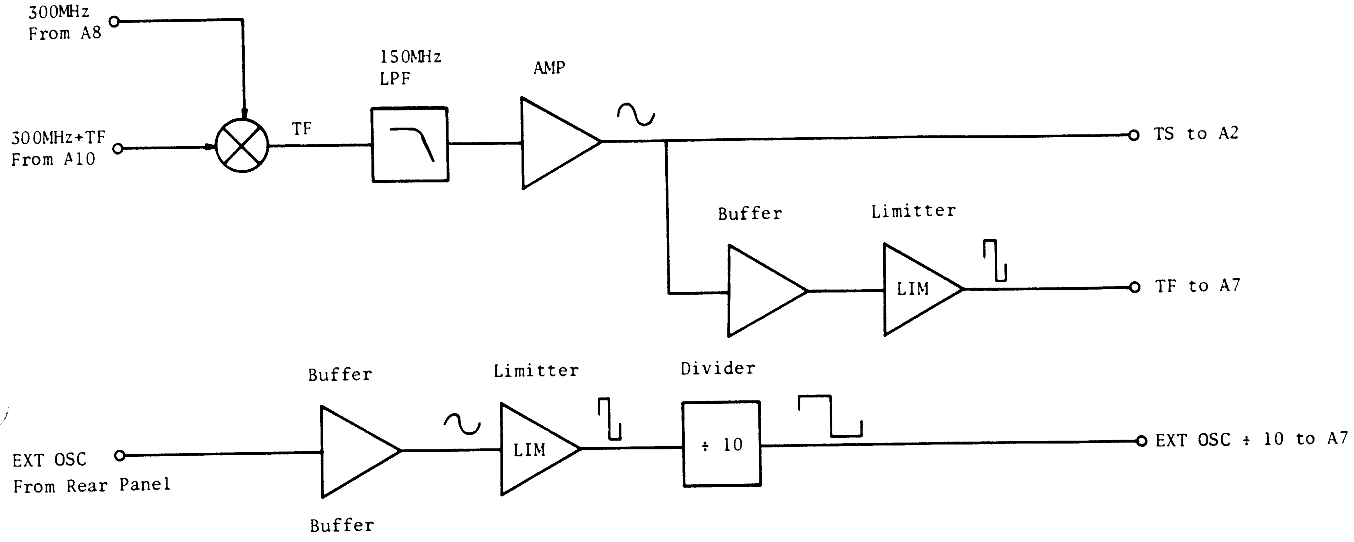
NOTES:

1. REFERENCE DESIGNATORS WITHIN THIS ASSEMBLY ARE ABBREVIATED. PREFIX ABBREVIATION WITH ASSEMBLY NUMBER FOR COMPLETE REFERENCE DESIGNATOR.
2. UNLESS OTHERWISE INDICATED:

   RESISTANCE IN OHMS (Ω)
   CAPACITANCE IN MICROFARADS (µF)
   INDUCTANCE IN MICROHENRIES (µH)

Figure 8-47. A8 Crystal Oscillator Board Assembly Schematic Diagram.

## A9 Mixer



A9 Board Block Diagram

## *A9 Mixer Board Theory*

The A9 board contains a double balanced mixer, 150MHz low-pass filter, output amplifier, two clipping amplifiers, and a ÷10 circuit. It has three functions : (1) synthesize the RF test signal, (2) divide down an incoming signal from an external oscillator, if connected, and (3) square the RF feedback signal.

RF synthesis is accomplished by mixing the 300MHz signal from the A8 board with the 300MHz +RF signal from the A10 board. The mixer output is passed through a 150MHz low-pass filter, leaving only the RF signal. This signal is then amplified by the output amplifier, Q1 and Q2, and output to the A2 board. After amplification it is also clipped by U1 and fed back to the A7 board, where it is used for frequency control.

When an external oscillator is connected to the EXT OSC connector, the incoming signal is first passed through a buffer amplifier, Q7 and Q8, then amplified and clipped by U3, and finally divided down to EXT OSC ÷10 by U2, an ECL-to-TTL counter.

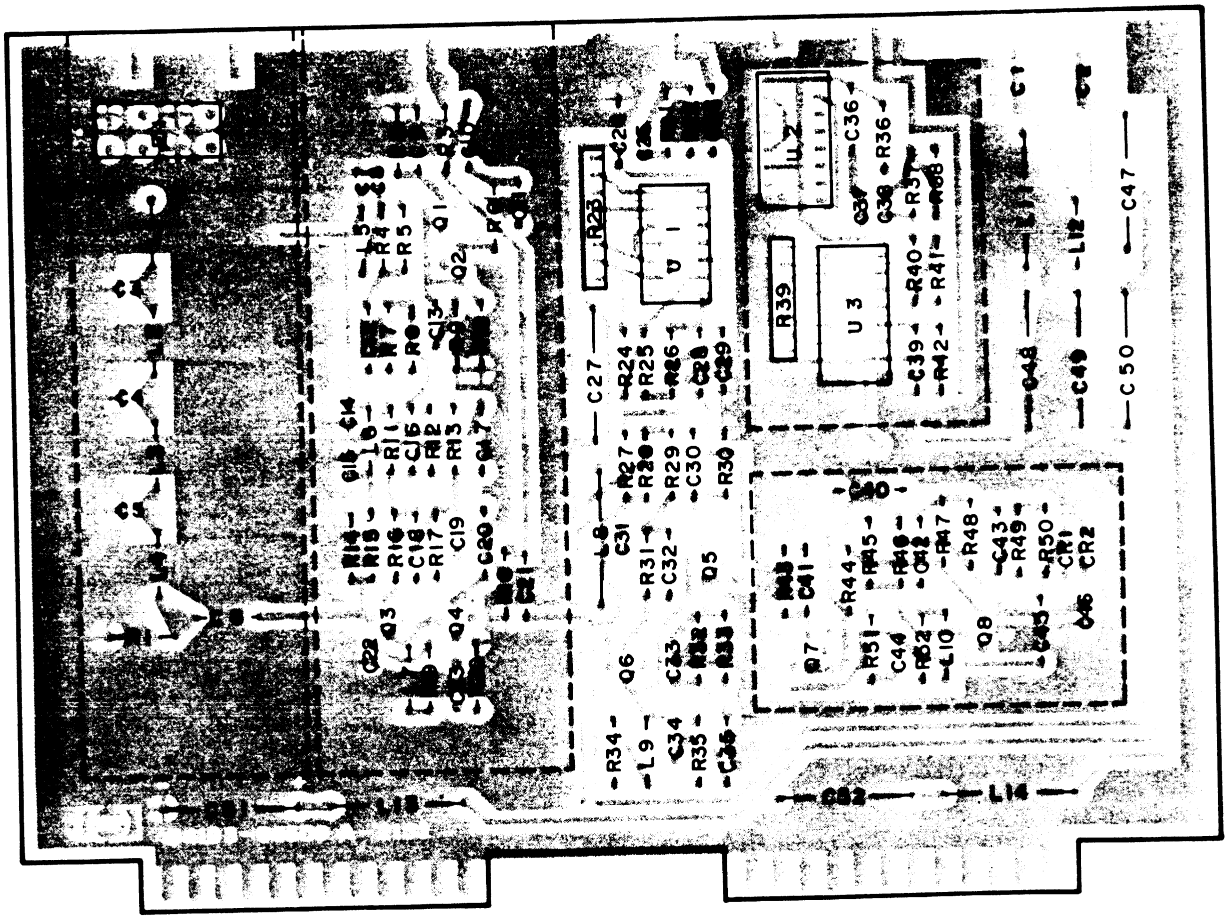
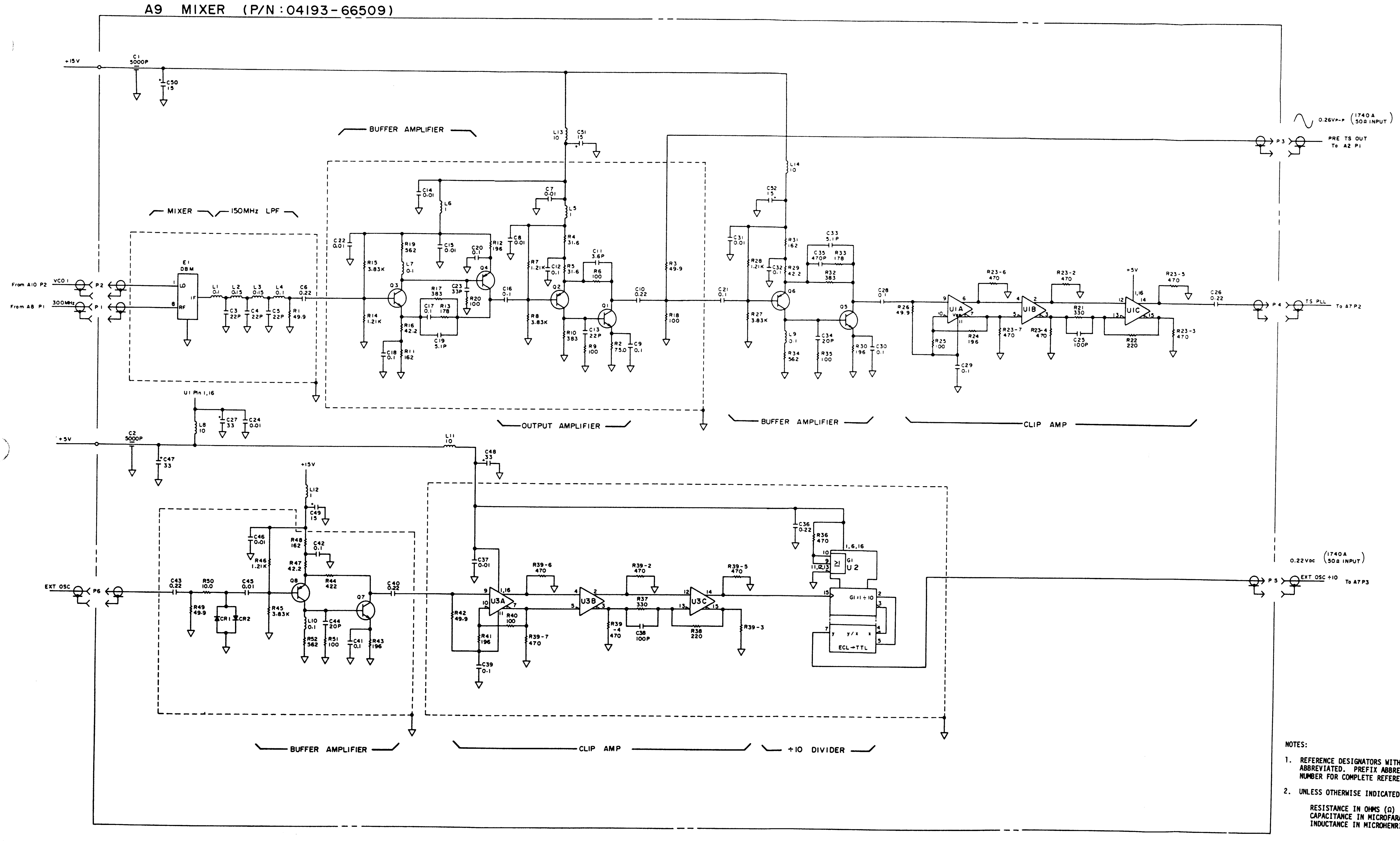


Figure 8-48. A9 Mixer Board Assembly Component Locations.



NOTES:

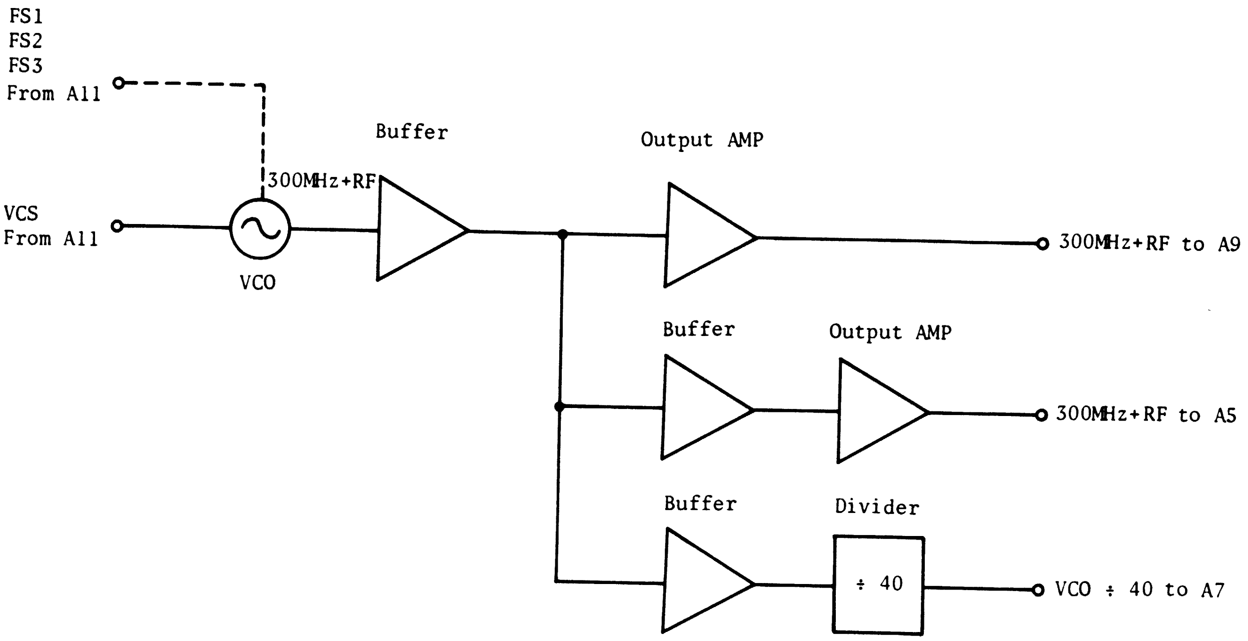
1. REFERENCE DESIGNATORS WITHIN THIS ASSEMBLY ARE ABBREVIATED. PREFIX ABBREVIATION WITH ASSEMBLY NUMBER FOR COMPLETE REFERENCE DESIGNATOR.

2. UNLESS OTHERWISE INDICATED:

RESISTANCE IN OHMS (Ω)
CAPACITANCE IN MICROFARADS (μF)
INDUCTANCE IN MICROHENRIES (μH)

Figure 8-49. A9 Mixer Board Assembly Schematic Diagram.

## A10 Voltage Controlled Oscillator



A10 Board Block Diagram

## *A10 Voltage Controlled Oscillator Board Theory*

The A10 board contains a voltage-controlled oscillator (VCO), buffer amplifier, three output amplifiers, and a ÷40 circuit. It outputs three signals : 300MHz+RF to the A5 board for sampling pulse generation, 300MHz+RF to the A9 board for test frequency synthesis, and (300MHz+RF) ÷40 to the A7 board for PLL control.

The VCO outputs a 300.4MHz to 410MHz signal and is controlled by FS1, FS2, FS3, and VCS from the A11 board. FS1, FS2, and FS3 control the frequency range and each can have a DC voltage of +9V or -23V, depending on the range of the selected test frequency. Refer to the following table :

| FS1 | FS2 | FS3 | Frequency Range |
|---|---|---|---|
| L | L | L | .400 to 9.999MHz |
| H | L | L | 10.00 to 39.99MHz |
| H | H | H | 40.00 to 69.99MHz |
| L | H | H | 70.00 to 110.0MHz |

VCS is output from the integrator on the A11 board and controls the VCO frequency, within the range determined by FS1, FS2, and FS3, by changing the capacitance of CR5 (vari-cap diode). It can have a DC voltage from -2.5V to -10.5V, depending on the selected test frequency. VCS voltages at the minimum and maximum frequencies of each frequency range are listed in the following table :

| Test Frequency (MHz) | VCS Voltage (DC) |
|---|---|
| .4 | -5.5V |
| 9.999 | -7.9V |
| 10 | -2.5V |
| 39.99 | -8.2V |
| 40 | -2.5V |
| 69.99 | -7.2V |
| 70 | -4.0V |
| 110 | -10.5V |

When FS1, FS2, FS3 are each -23V, the three switching dioes—CR2, CR3, and CR4—are reverse biased (off) and the VCO's tank circuit consists of CR5, C69, C70, and the pattern inductance between the collector of Q7 and VCO circuit common. If FS1, for example, is +9V, CR2 will be forward biased and the pattern inductance between the cathode of CR2 and circuit common is effectively removed from the tank circuit. C63, C64, and C65 are large enough to have no effect on the tank circuit's resonance when the corresponding diode—CR2, CR3, and CR4, respectively—is forward biased (on).

The VCO output is resistance coupled to the buffer amplifier, Q5 and Q6, for input to the three output amplifiers.

The ÷40 circuit contains an ECL-to-TTL ÷10 counter, U1, and a dual flip-flop IC, U2, wired for ÷4 operation. The output from the ÷40 circuit, VCO ÷40, is a square wave and is used for PLL control on the A7 board.

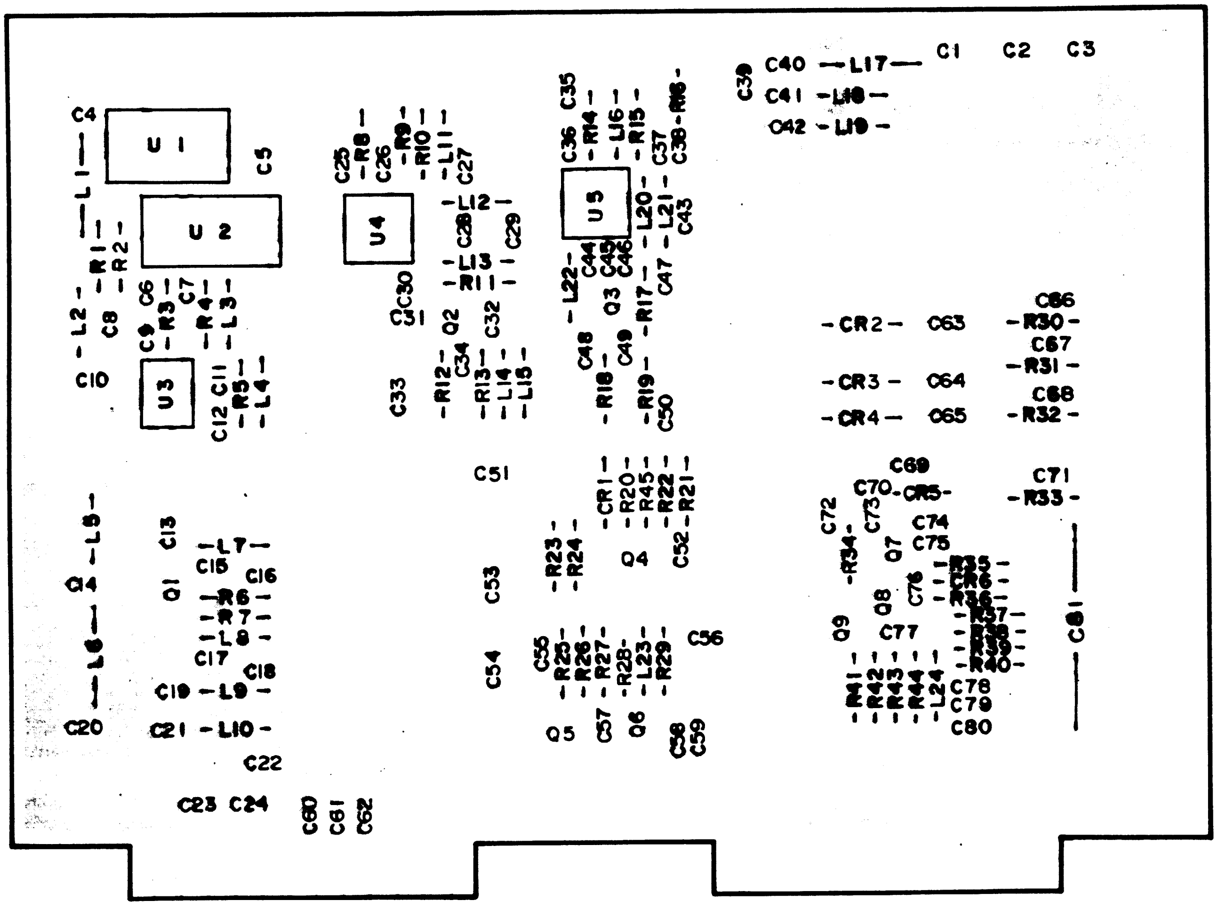
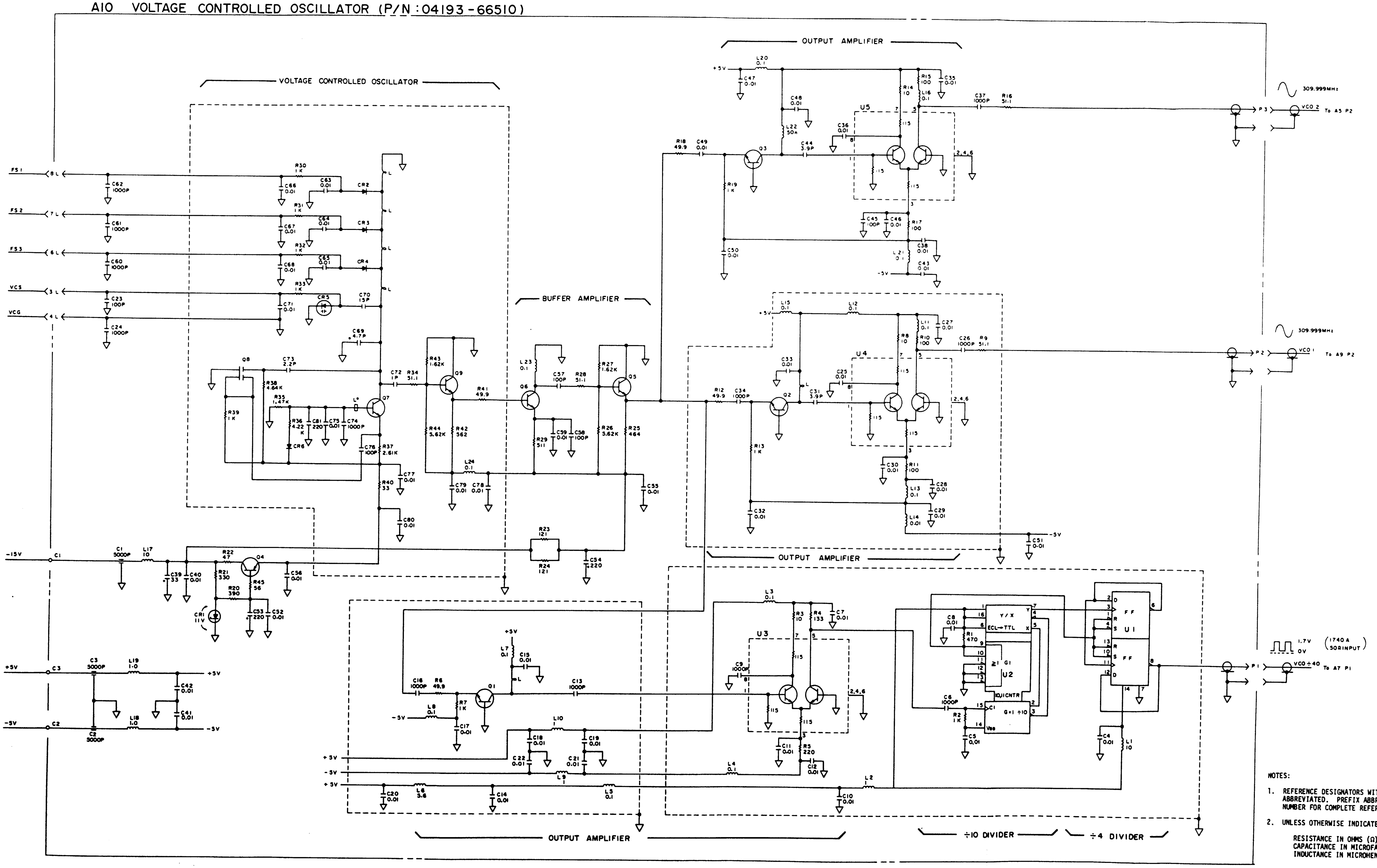


Figure 8-50. A10 Voltage Controlled Oscillator Board Assembly Component Locations.



NOTES:

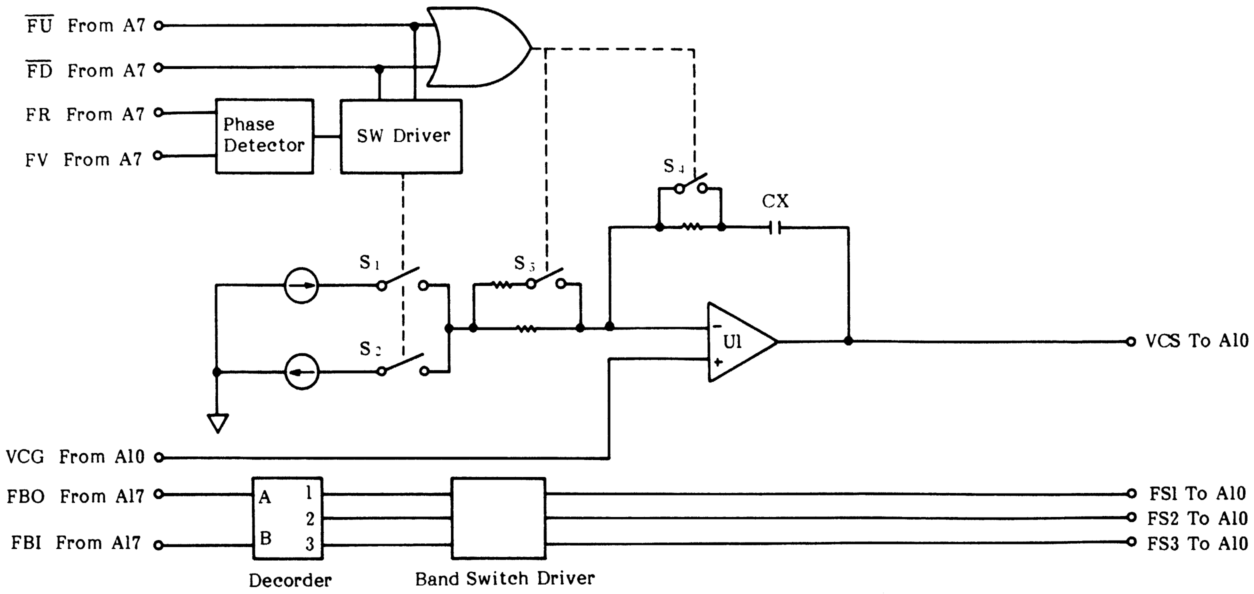
1. REFERENCE DESIGNATORS WITHIN THIS ASSEMBLY ARE ABBREVIATED. PREFIX ABBREVIATION WITH ASSE NUMBER FOR COMPLETE REFERENCE DESIGNATOR.

2. UNLESS OTHERWISE INDICATED:

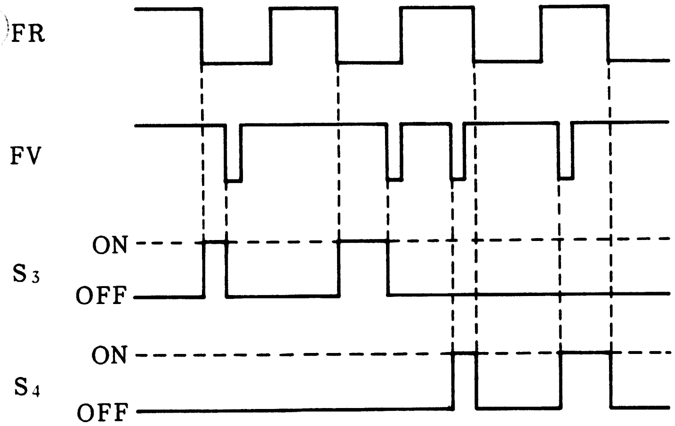
RESISTANCE IN OHMS (Ω)
CAPACITANCE IN MICROFARADS (µF)
INDUCTANCE IN MICROHENRIES (µH)

Figure 8-51. A10 Voltage Controlled Oscillator Board Assembly Schematic Diagram.

## A11 Integrator Amplifier



A11 Board Block Diagram



SW Selections.

| $\overline{FU}$ | $\overline{FD}$ | FR | FV | $S_1$ | $S_2$ | $S_3$ | $S_4$ |
|---|---|---|---|---|---|---|---|
| L | H | x | x | ON | OFF | ON | ON |
| H | L | x | x | OFF | ON | ON | ON |
| H | H | See Figure. | | | | OFF | OFF |
| H | H | | | | | OFF | OFF |

x : irrelevant

FR-FV Relationship in INT OSC.

| Test Frequency Range | FR | FV |
|---|---|---|
| 0.4 - 9.999MHz | 1kHz | $\frac{RF}{N}$ |
| 10.00 - 99.99MHz | 10kHz | |
| 100.0 - 110.0MHz | 100kHz | |

N: 1 - 9999

## *A11 Integrator Amplifier Board Theory*

The A11 board provides the frequency control voltage, VCS, and frequency range control voltages, FS1 through FS3, for the voltage controlled oscillator on the A10 board.

VCS can be from -5.5V to -10.5V and is controlled by FD, FU, FR, and FV. When FR and FV are of the same frequency and in phase, the $\overline{U}$ and $\overline{D}$ outputs of the phase/frequency detector, U9, are both HIGH. The outputs of U6B and U6D, then, are both -5V, opening analog switches U2A and U2B. With both switches open, no charge/discharge voltage from the +5V (Q1) and -5V (Q5) voltage sources is applied to the input of the integrator; thus, VCS remains constant. (Q1 and Q5 limit the charge and discharge voltages to +1V and -1V, respectively.)

When there is a slight frequency difference between FR and FV, U9 will detect this difference and close the appropriate analog switch to allow the integrator to charge to a more negative voltage or discharge to a less negative voltage. As an example, consider the case where the FV frequency is slightly below that of FR. Here the U output of U9 will go LOW, forcing the output of U6B to +5V. Analog switch U2A will then close and the integrator will begin to charge to a more negative voltage (the integrator inverts the input), and will continue to do so until the frequency of FV is equal to that of FR. This is true also for the opposite case, where the frequency of FV is slightly above that of FR. The only difference is that analog switch U2B closes and the integrator is discharged to a less negative voltage by the -5V voltage source.

Up to now, it is assumed that there is little or no difference between the FR and FV frequencies. In both cases, $\overline{FU}$ and $\overline{FD}$ are both HIGH, and as such play no part in charging or discharging the integrator. But when there is a suddenly large difference between the FV and FR frequencies, $\overline{FU}$ or $\overline{FD}$ (never both) come into play. These function in such cases is to shorten the time required to lock the signal source at the new frequency. When either $\overline{FU}$ or $\overline{FD}$ is LOW the output of U6C goes to +5V, reverse biasing CR3 and CR4. With CR3 and CR4 reverse biased, FET switches Q3 and Q4 close, effectively removing R23, R24, and C7 from the circuit and placing R4 in parallel with R5. The RC time constant, which determines the time required to charged/discharge the integrator, is greatly reduced, allowing the integrator to respond more quickly to the frequency difference between FR and FV.

The frequency range control voltages--FS1, FS2, and FS3--are controlled by FB0 and FB1, which are supplied by the microprocessor. U5 and U4 decode FB0 and FB1 for control of transistor switches Q6 through Q11 and U3. The relation between the FB control lines and the FS lines is given in the following table :

| FB0 | FB1 | FS1 | FS2 | FS3 |
|---|---|---|---|---|
| 0 | 0 | L | L | L |
| 1 | 0 | H | L | L |
| 0 | 1 | H | H | L |
| 1 | 1 | L | H | H |

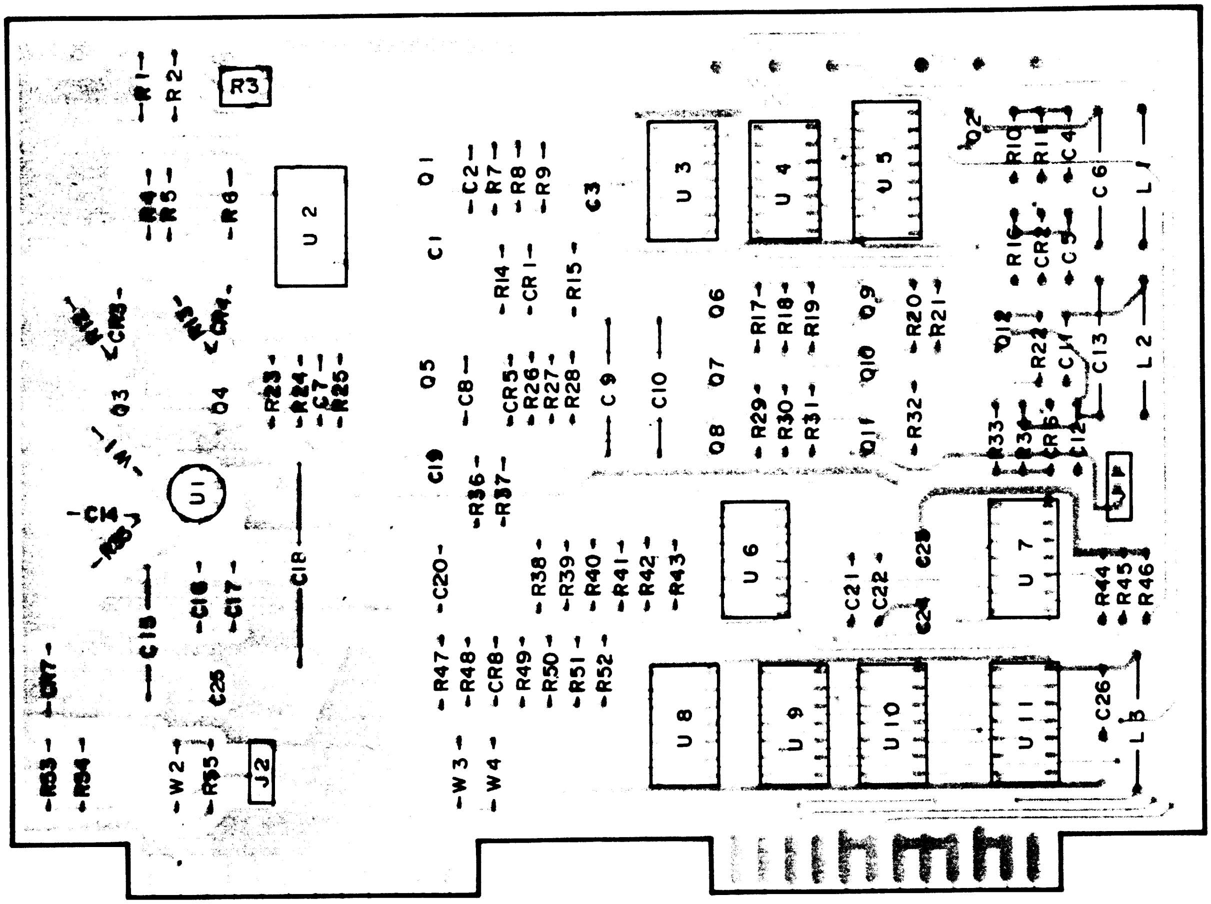
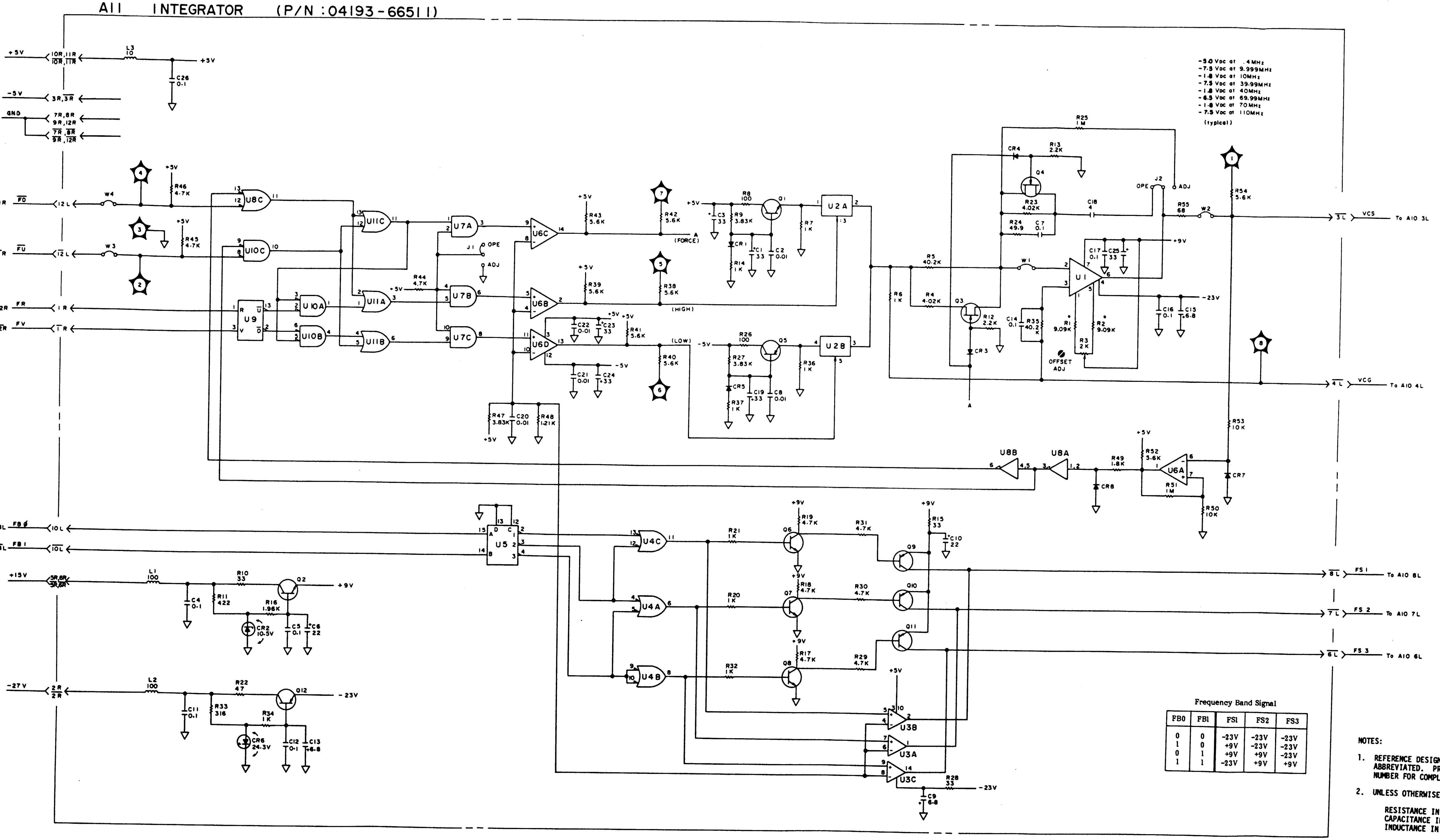


Figure 8-52. All Integrator Amplifier Board Assembly Component Locations.



Frequency Band Signal

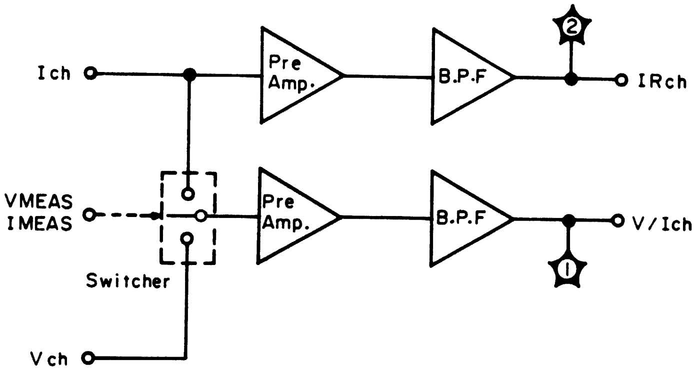
| FB0 | FB1 | FS1 | FS2 | FS3 |
|---|---|---|---|---|
| 0 | 0 | -23V | -23V | -23V |
| 1 | 0 | +9V | -23V | -23V |
| 0 | 1 | +9V | +9V | -23V |
| 1 | 1 | -23V | +9V | +9V |

NOTES:

1. REFERENCE DESIGNATORS WITHIN THIS ASSEMBLY ARE ABBREVIATED. PREFIX ABBREVIATION WITH ASSEMBLY NUMBER FOR COMPLETE REFERENCE DESIGNATOR.
2. UNLESS OTHERWISE INDICATED:

   RESISTANCE IN OHMS (Ω)
   CAPACITANCE IN MICROFARADS (μF)
   INDUCTANCE IN MICROHENRIES (μH)

Figure 8-53. A11 Integrator Amplifier Board Assembly Schematic Diagram.



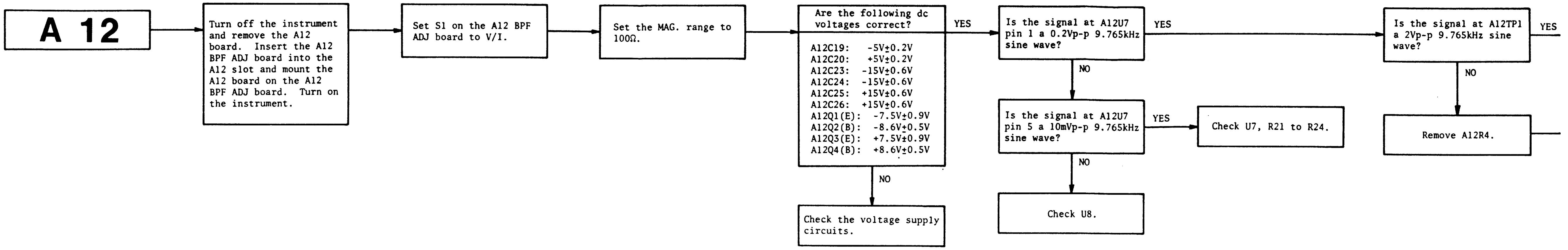
A12 Board Block Diagram

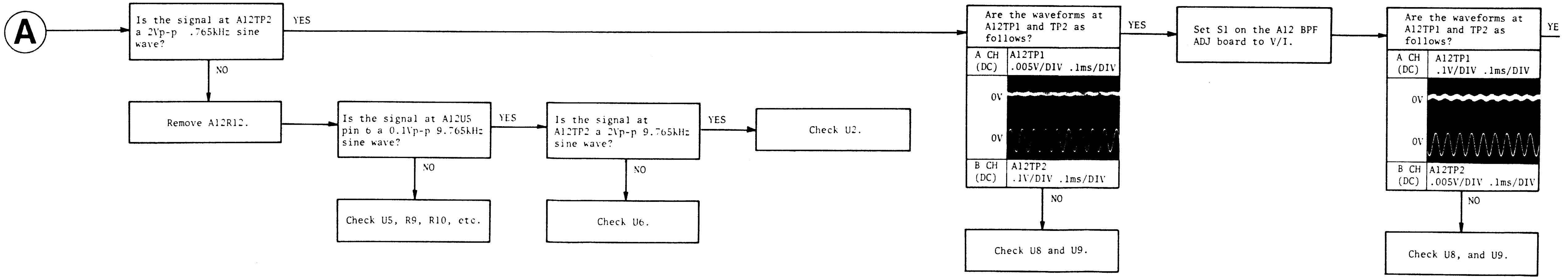
## A12 IF BPF Board Theory

The A12 board contains two identical channels : the I channel and the V/I channel. Each channel contains a preamplifier and a bi-quad band-pass filter.

In the I channel, the ICH signal from the A4 board is constantly fed through the I channel preamplifier and band-pass filter (U2, U5, U6). The signal output from the I channel (IR) is used as the reference for the phase measurement on the A13 board, ALC feedback, and ranging.

In the V/I channel, the ICH signal and the VCH signal (from A3) are alternately fed through the V/I channel preamplifier (U7) and band-pass filter (U1, U3, U4) by switches U8 and U9. The switches are controlled by IMEAS and VMEAS from the A13 board. The signals output from the V/I channel are rectified on the A13 board for measurement by the integrators on the A14 board. It should be noted that the IR and ICH signals output from this board are identical and that the level of each is almost constant. Only the level of the VCH signal changes.


A 12
Turn off the instrument and remove the A12 board. Insert the A12 BPF ADJ board into the A12 slot and mount the A12 board on the A12 BPF ADJ board. Turn on the instrument.
Set S1 on the A12 BPF ADJ board to V/I.
Set the MAG. range to 100Ω.
Are the following dc voltages correct?
A12C19: -5V±0.2V
A12C20: +5V±0.2V
A12C23: -15V±0.6V
A12C24: -15V±0.6V
A12C25: +15V±0.6V
A12C26: +15V±0.6V
A12Q1(E): -7.5V±0.9V
A12Q2(B): -8.6V±0.5V
A12Q3(E): +7.5V±0.9V
A12Q4(B): +8.6V±0.5V
YES
NO
Check the voltage supply circuits.
Is the signal at A12U7 pin 1 a 0.2Vp-p 9.765kHz sine wave?
YES
NO
Is the signal at A12U7 pin 5 a 10mVp-p 9.765kHz sine wave?
YES
NO
Check U7, R21 to R24.
Check U8.
Is the signal at A12TP1 a 2Vp-p 9.765kHz sine wave?
YES
NO
Remove A12R4.


A
Is the signal at A12TP2 a 2Vp-p .765kHz sine wave?
YES
NO
Remove A12R12.
Is the signal at A12U5 pin 6 a 0.1Vp-p 9.765kHz sine wave?
YES
NO
Check U5, R9, R10, etc.
Is the signal at A12TP2 a 2Vp-p 9.765kHz sine wave?
YES
NO
Check U6.
Check U2.
Are the waveforms at A12TP1 and TP2 as follows?
A CH (DC)
A12TP1 .005V/DIV .1ms/DIV
0V
0V
B CH (DC)
A12TP2 .1V/DIV .1ms/DIV
YES
NO
Check U8 and U9.
Set S1 on the A12 BPF ADJ board to V/I.
Are the waveforms at A12TP1 and TP2 as follows?
A CH (DC)
A12TP1 .1V/DIV .1ms/DIV
0V
0V
B CH (DC)
A12TP2 .005V/DIV .1ms/DIV
YE
NO
Check U8, and U9.

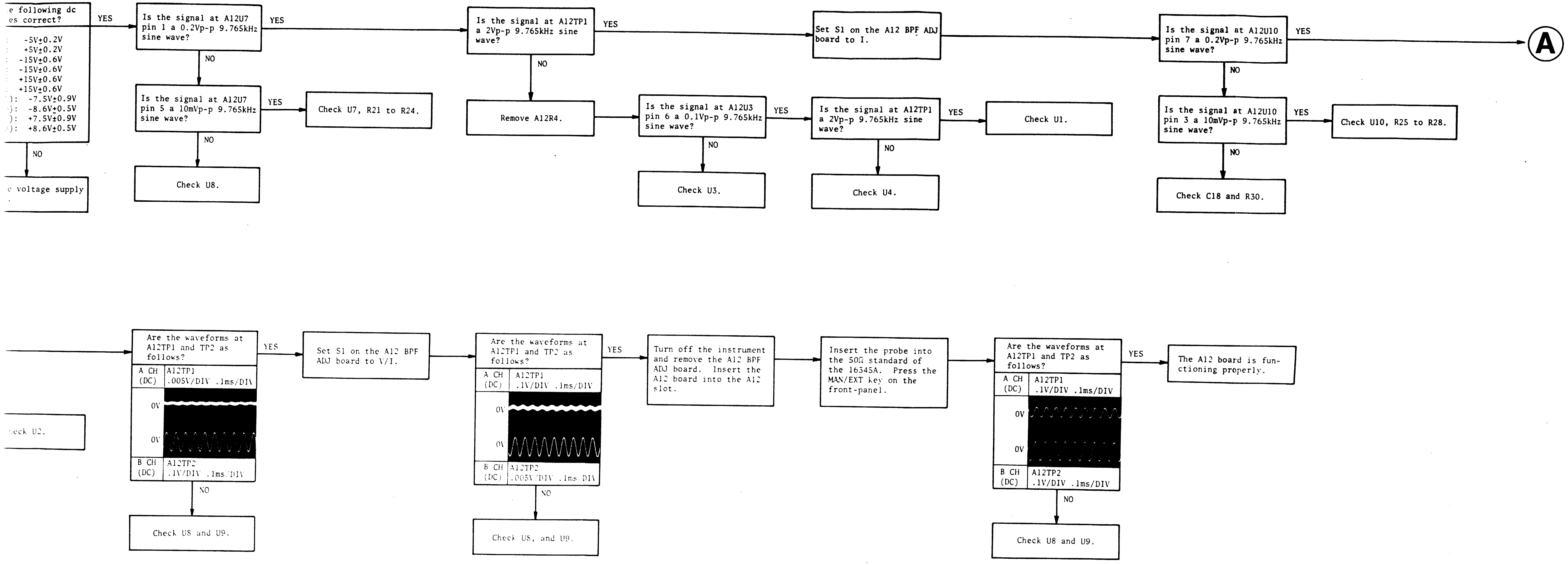


Figure 8-54. A12 Board Troubleshooting Flow Chart.

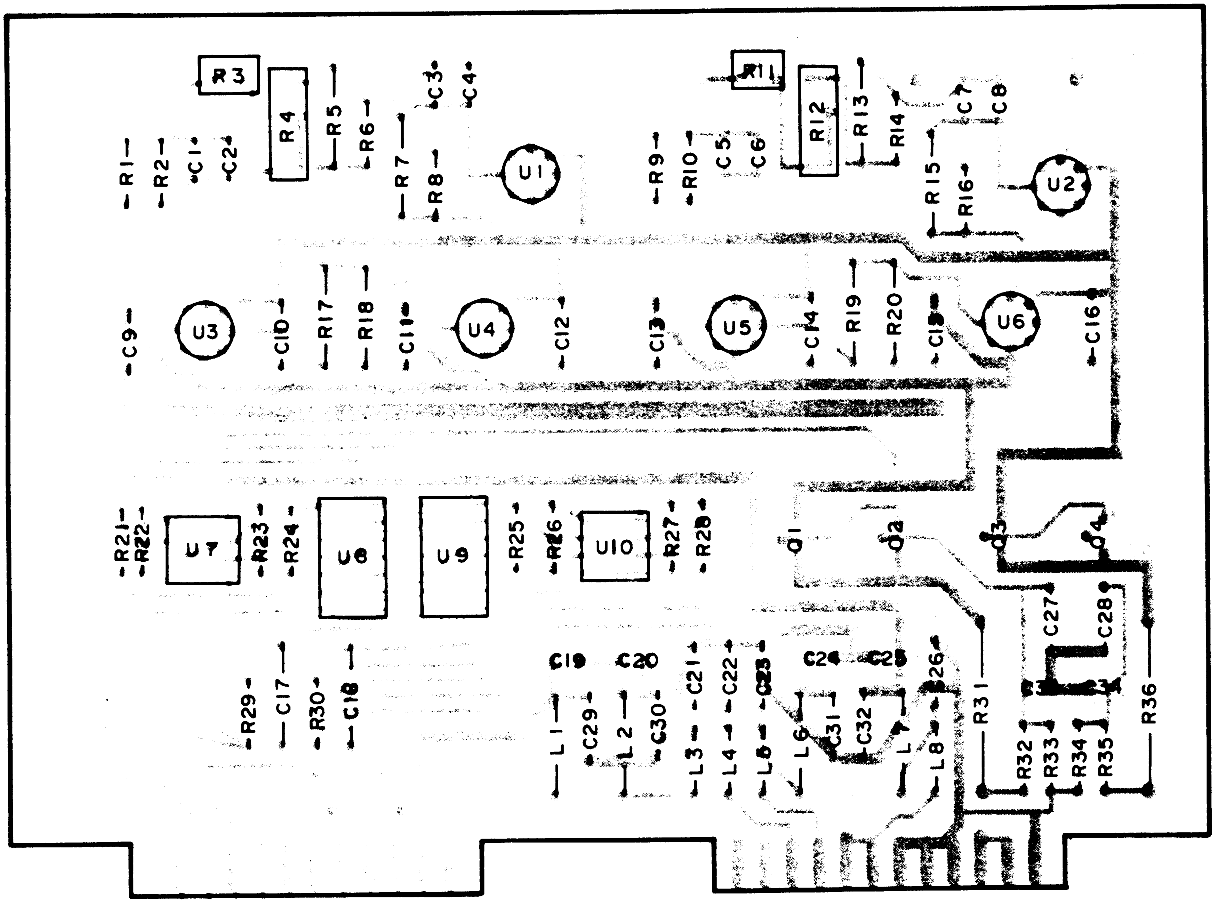
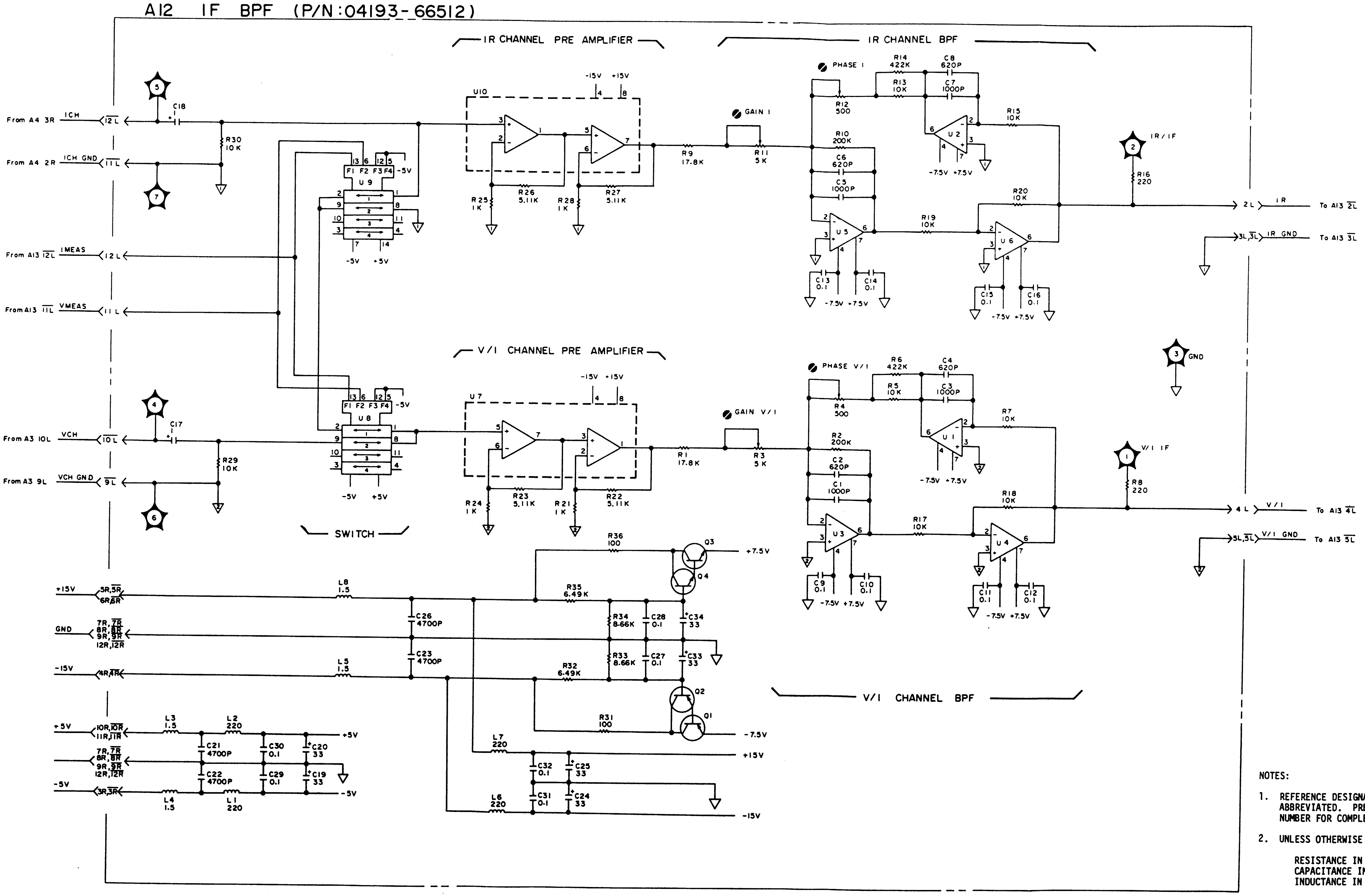


Figure 8-55. A12 IF BPF Board Assembly Component Locations.



NOTES:

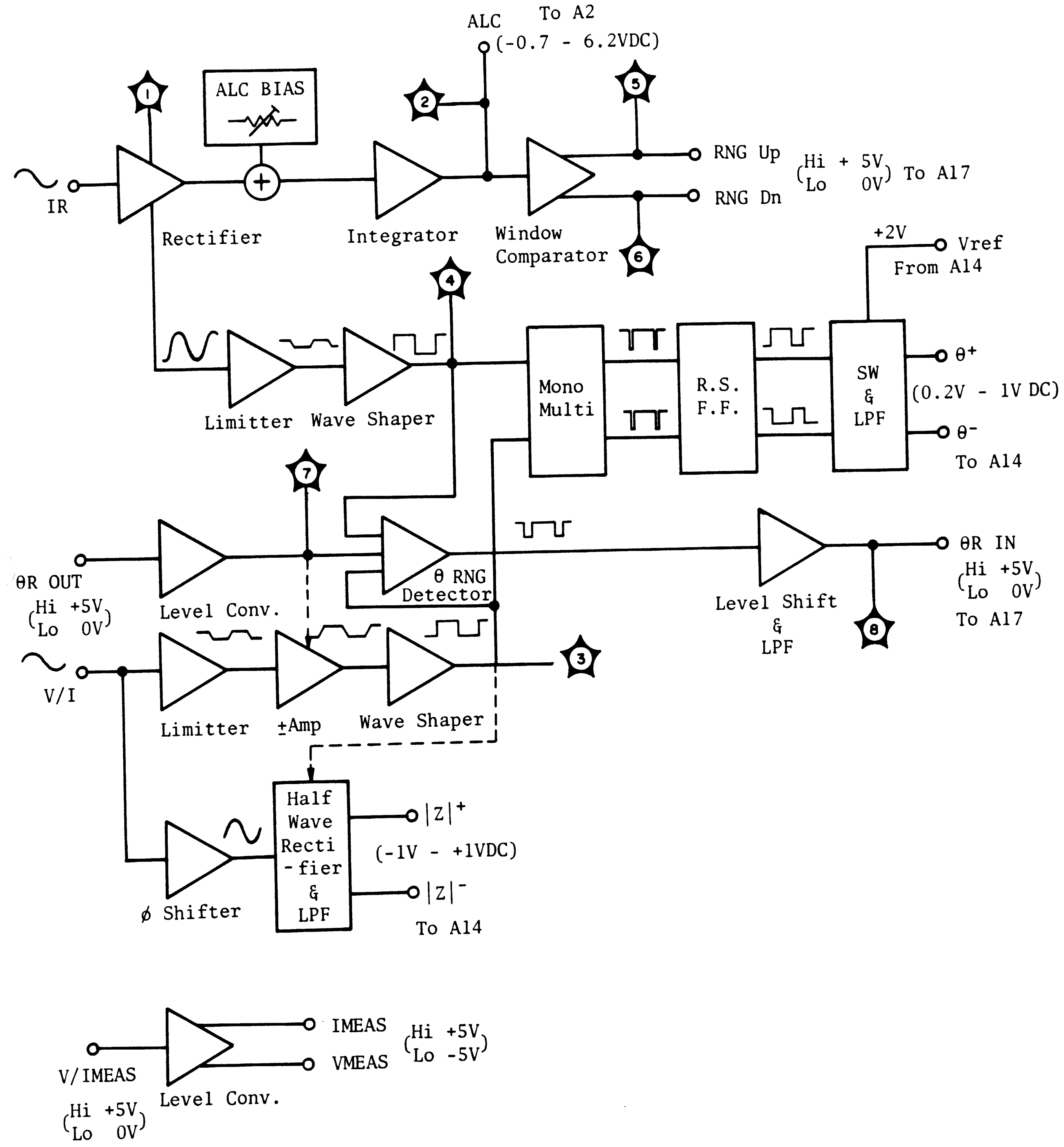
1. REFERENCE DESIGNATORS WITHIN THIS ASSEMBLY ARE ABBREVIATED. PREFIX ABBREVIATION WITH ASSEMBLY NUMBER FOR COMPLETE REFERENCE DESIGNATOR.

2. UNLESS OTHERWISE INDICATED:

   RESISTANCE IN OHMS (Ω)
   CAPACITANCE IN MICROFARADS (μF)
   INDUCTANCE IN MICROHENRIES (μH)

Figure 8-56. A12 IF BPF Board Assembly Schematic Diagram.

A13 Detector



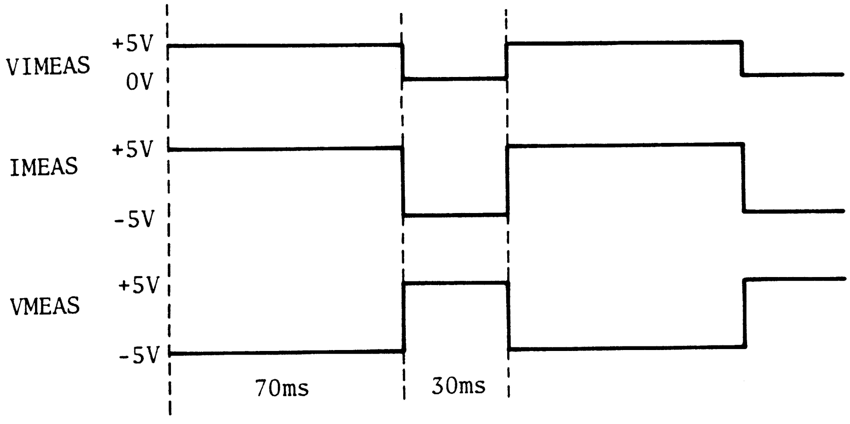
A13 Board Block Diagram

## *A13 Detector Board Theory*

The A13 board provides ALC feedback, magnitude range control, phase range control, phase detection, I channel/V channel switching control signals, and rectification of the V channel and I channel signals.

The IR signal, fed from the A12 board, is used to generate the ALC feedback and RNGUP/RNGDN signals, and is used as the reference for phase detection. To accomplish this, IR is amplified by U1A and then half-wave rectified by CR1. The rectified IR charges the integrator, U1B, and the output is fed back to the A2 board, where it is used to increase or decrease the attenuation of the RF signal. (IR represents the current through the DUT, which must be kept constant for accurate magnitude measurement.) The integrator output is also applied to a window comparator, U5A and U5B, which provides the RNGUP (range-up) and RNGDN (range-down) signals. The unrectified IR (from the output of U1A) is input to a limitter, U2, and then shaped into a 10Vp-p square wave by U9A. This signal is used as the reference signal for phase detection and for phase range detection.

V/I, from the A14 board, is alternately the IF signal (VCH) representing the sampled RF voltage across the DUT and the IF signal (ICH) representing the sampled RF current through the DUT. Switching is performed on the A12 board and is controlled by VMEAS and IMEAS from U3C and U3D, respectively. VMEAS and IMEAS are both 10Vp-p square waves and of the same frequency. The frequency is determined by VIMEAS and depends on whether the instrument is in NORMAL SPEED measurement mode or HIGH SPEED measurement mode. In HIGH SPEED mode VIMEAS has a period of 100 milliseconds. The ON time of VMEAS is approximately 30 milliseconds and that of IMEAS is approximately 70 milliseconds. Refer to the following timing diagram for the relationship between VIMEAS and VMEAS/IMEAS.



When the instrument is set to HOLD, VIMEAS goes LOW and stays LOW until the instrument is manually, externally, or internally triggered. From the above timing diagram, then, VMEAS is ON, allowing only the VCH signal to be sent to the A13 board.

V/I takes two paths on the A13 board. One through U12 and U15 to the A14 board for magnitude measurement, and the other through U13 to the phase range detector and phase detector.

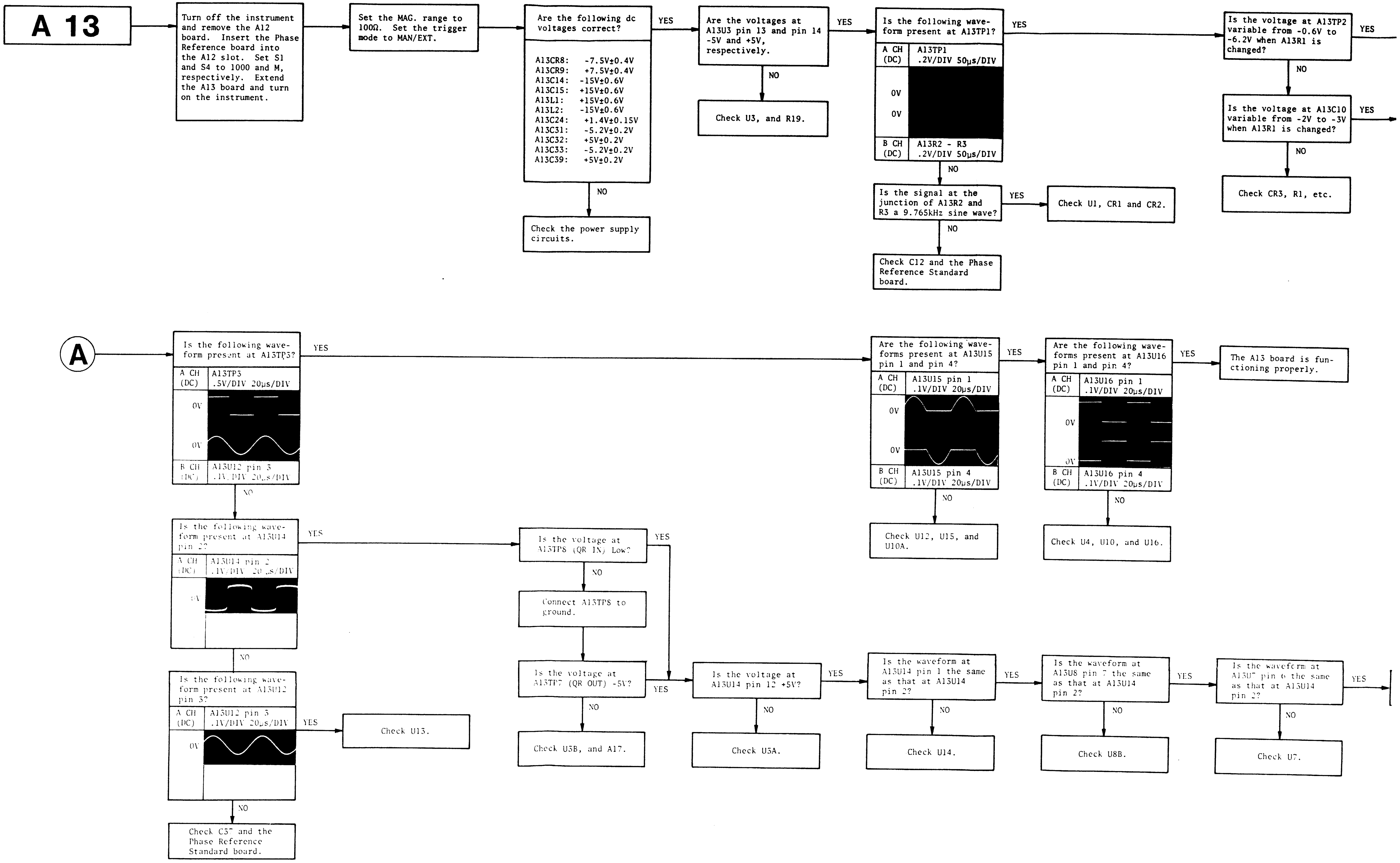
U12 amplifies the incoming V/I signal. It also causes a slight phase shift to negate the phase difference between the rectifier control signals (from U9B) and the rectifier input. This prevents the rectifier from outputting distorted half-wave signals. The rectifier outputs are filtered into DC by R48/C29 and R55/C39, and then input to the magnitude A/D converter on the A14 board.

To extend the range of phase measurements, the 4193A has two phase ranges, 0 ° and 180 °. Phase range selection is automatic and is controlled by the phase range detector, which consists of U11A, U11B, U11C, U5C, and U5D. To insure virtually error free phase measurements, the reference signal, IR, used in phase detection and phase range detection, is identical to the ICH signal of V/I. When IR and V/I arrive at the A13 board there is virtually no phase difference between IR and the ICH signal of V/I. But on the A13 board they take different paths to the phase detector, resulting in a slight phase error, and since the VCH signal of V/I takes the same path as that of ICH, the same phase error will exist between IR and VCH as that between IR and ICH. The instrument first measures the phase of ICH and stores this phase error in the microprocessor. When the phase of VCH is measured, the stored phase error is subtracted from the measured phase before display on the front panel.

The phase range detector compares the V/I signal to the IR signal, and if the phase difference between IR and VCH is greater than ±100 °, the ON period of the square wave output from U5D will be too short for C11 to charge enough to keep the potential at pin 8 of U5C above that at pin 9. In this case, the output of U5C, θRIN, will go HIGH, but only when V/I is VCH. When V/I is ICH, RIN is LOW because there is never more than a slight phase difference between IR and ICH. This means that when the phase difference between IR and VCH is greater ±100 °, θRIN will be a periodic square wave. When θRIN is HIGH, the microprocessor detects it and forces θR HIGH until θRIN goes LOW. Thus, θRIN and θR are identical. θR controls the INVERT/NON INVERT AMPLIFIER—U14, U8A, U8B, and U7.

When the phase is less than ±100 °, V/I passes through U13, U14, U8B, U7, and U9B. The V/I signal at the output of the wave shaper, U9B, is in-phase with the input of the limitter U13. When the phase exceeds ±100 °, however, the VCH signal of V/I will be inverted by U7 because θR will be HIGH, forcing U14 to route the incoming signal through U8A to the inverting input of U7. The ICH signal is never inverted by U7.

The phase detector consists of a dual monostable multivibrator (U4), RS flip-flop (U10B and U10C), and a switch (U16). IR is input to one half of U4, and V/I is input to the other half. The pulse width of each Q output is determined by C3 and C4, and the phase difference between the two outputs determines the pulse width of the flip-flop's output. The flip-flop controls the switch, U16, which, when closed, allows +2VDC to be applied to the two integrating networks, R49/C30 and R56/C40. The outputs from U16 are pulse trains of a constant frequency (IF) but with a duty cycle that depends on the phase of the DUT's impedance. As the duty cycle changes, so does the DC level of PHASE$^+$ and PHASE$^-$. PHASE$^+$ and PHASE$^-$ are sent to the phase A/D converter on the A14 board for measurement.



Turn off the instrument and remove the A12 board. Insert the Phase Reference board into the A12 slot. Set S1 and S4 to 1000 and M, respectively. Extend the A13 board and turn on the instrument.

Set the MAG. range to 100Ω. Set the trigger mode to MAN/EXT.

Are the following dc voltages correct?

A13CR8: -7.5V±0.4V
A13CR9: +7.5V±0.4V
A13C14: -15V±0.6V
A13C15: +15V±0.6V
A13L1: +15V±0.6V
A13L2: -15V±0.6V
A13C24: +1.4V±0.15V
A13C31: -5.2V±0.2V
A13C32: +5V±0.2V
A13C33: -5.2V±0.2V
A13C39: +5V±0.2V

Check the power supply circuits.

Are the voltages at A13U3 pin 13 and pin 14 -5V and +5V, respectively.

Check U3, and R19.

Is the following waveform present at A13TP1?

Is the signal at the junction of A13R2 and R3 a 9.765kHz sine wave?

Check U1, CR1 and CR2.

Check C12 and the Phase Reference Standard board.

Is the voltage at A13TP2 variable from -0.6V to -6.2V when A13R1 is changed?

Is the voltage at A13C10 variable from -2V to -3V when A13R1 is changed?

Check CR3, R1, etc.

Is the following waveform present at A13TP3?

Is the following waveform present at A13U14 pin 2?

Is the following waveform present at A13U12 pin 3?

Check U13.

Check C37 and the Phase Reference Standard board.

Is the voltage at A13TP8 (QR IN) Low?

Connect A13TP8 to ground.

Is the voltage at A13TP7 (QR OUT) -5V?

Check U3B, and A17.

Is the voltage at A13U14 pin 12 +5V?

Check U3A.

Is the waveform at A13U14 pin 1 the same as that at A13U14 pin 2?

Check U14.

Is the waveform at A13U8 pin 7 the same as that at A13U14 pin 2?

Check U8B.

Is the waveform at A13U7 pin 6 the same as that at A13U14 pin 2?

Check U7.

Are the following waveforms present at A13U15 pin 1 and pin 4?

Check U12, U15, and U10A.

Are the following waveforms present at A13U16 pin 1 and pin 4?

Check U4, U10, and U16.

The A13 board is functioning properly.

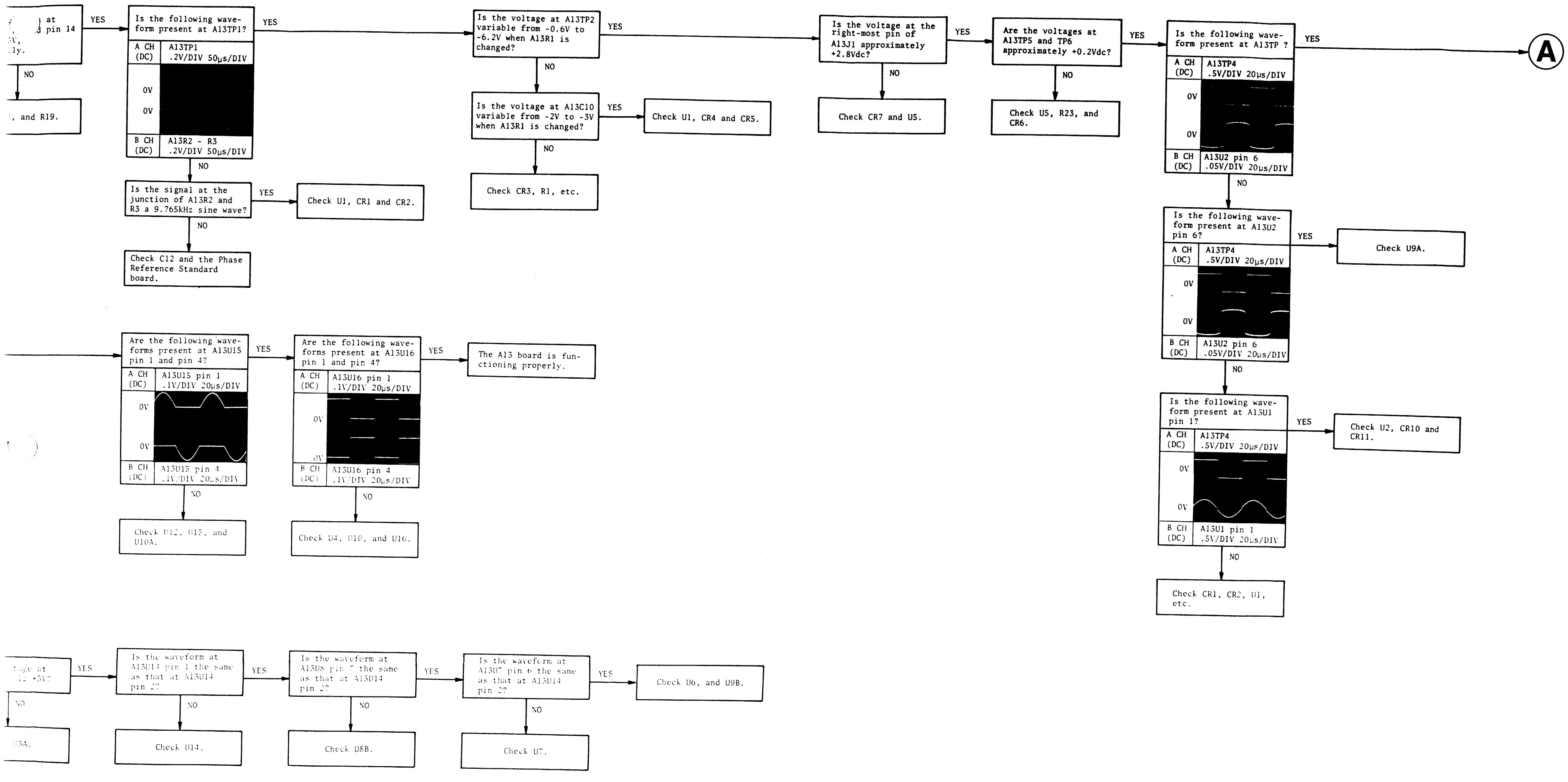


Figure 8-57. A13 Board Troubleshooting Flow Chart.
]

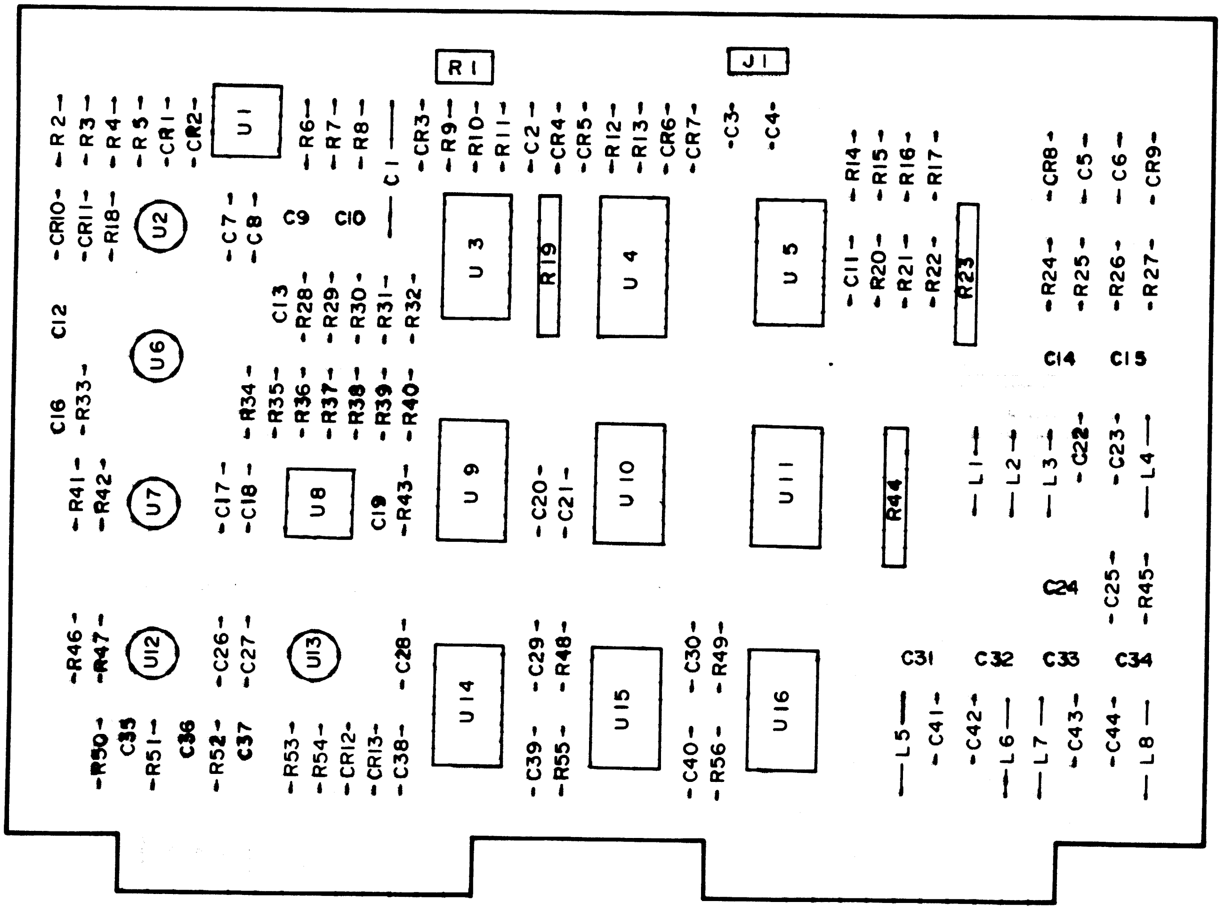
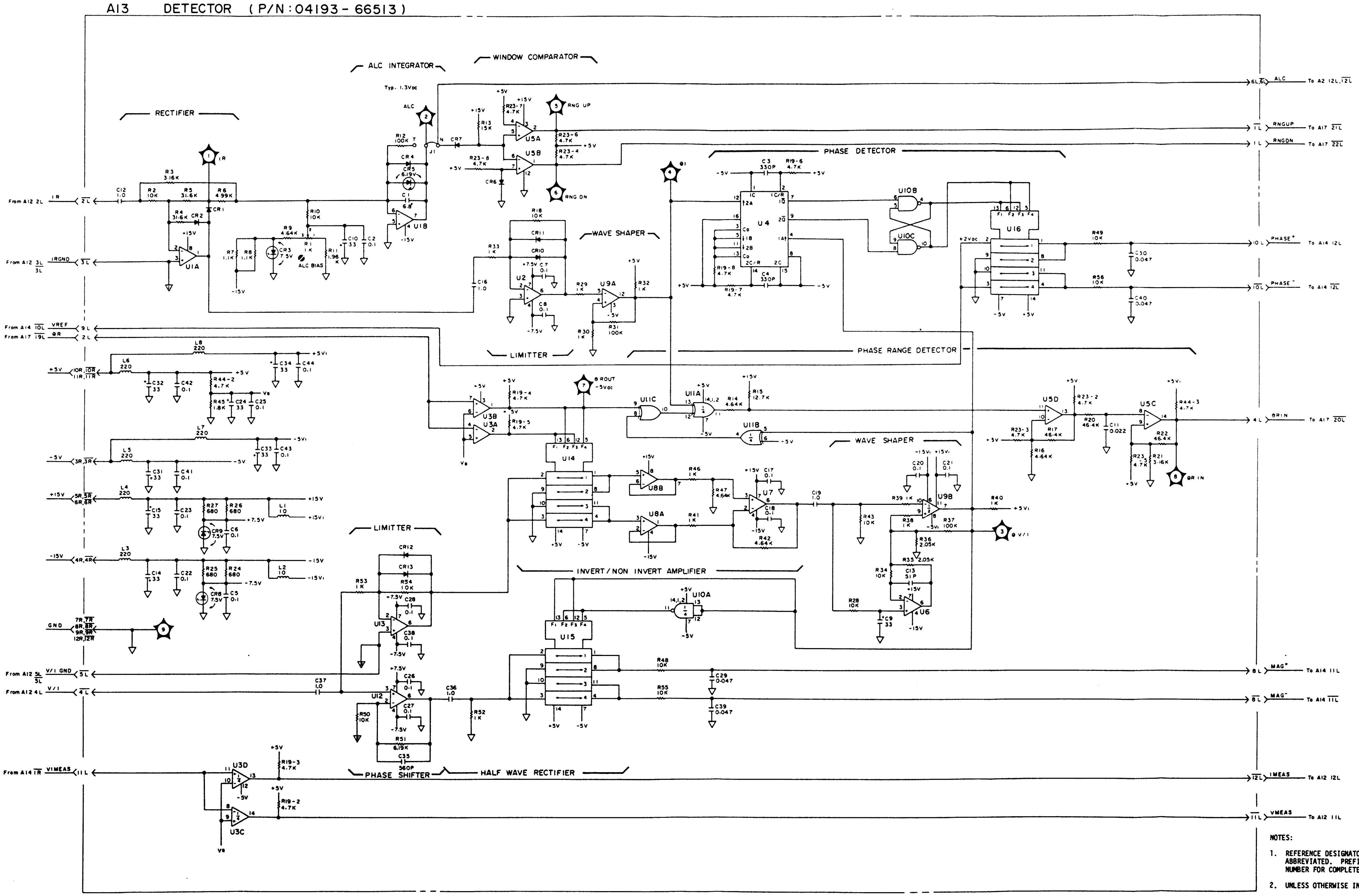


Figure 8-58. A13 Detector Board Assembly Component Locations.



NOTES:

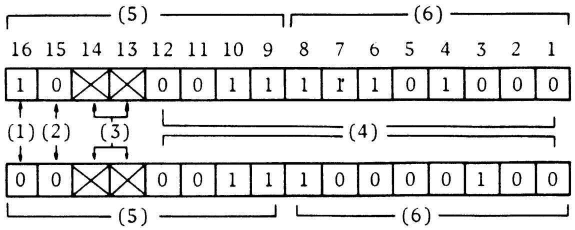
1. REFERENCE DESIGNATORS WITHIN THIS ASSEMBLY ARE ABBREVIATED. PREFIX ABBREVIATION WITH ASSEMBLY NUMBER FOR COMPLETE REFERENCE DESIGNATOR.

2. UNLESS OTHERWISE INDICATED:

   RESISTANCE IN OHMS (Ω)
   CAPACITANCE IN MICROFARADS (μF)
   INDUCTANCE IN MICROHENRIES (μH)

Figure 8-59. A13 Detector Board Assembly Schematic Diagram.

## A14 Analog-to-Digital Converter



| | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Data measured in A14U3: | 1 | 0 | ☒ | ☒ | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | for +1000 counts. |
| Data measured in A14U4: | 0 | 0 | ☒ | ☒ | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | for -900 counts. |

(1): polarity (1 for +, 0 for -).
(2): over range (1 for over range, 0 for not over range).
(3): not used.
(4): measured counts in binary.
(5): high byte.
(6): low byte.

Data Transfer

| $\overline{\text{IOG4}}$ | R/W | AB0 | AB1 | AB2 | IOB7 | IOB6 | IOB5 | IOB4 | IOB3 | IOB2 | IOB1 | IOB0 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L | H | H | L | L | 1 | 0 | ☒ | ☒ | 0 | 0 | 1 | 1 | ..... high byte for A14U3 output. |
| L | H | L | H | L | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | ..... low byte for A14U3 output. |
| L | H | H | H | L | 0 | 0 | ☒ | ☒ | 0 | 0 | 1 | 1 | ..... high byte for A1404 output. |
| L | H | L | L | H | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | ..... low byte for A14U4 output. |

| R/$\overline{\text{W}}$ | $\overline{\text{IOG4}}$ | AB0 | AB1 | AB2 | A14U7 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | pin 15 | pin 14 | pin 13 | pin 12 | pin 11 | pin 10 | pin 9 |
| x | H | x | x | x | H | H | H | H | H | H | H |
| L | x | x | x | x | H | H | H | H | H | H | H |
| H | L | L | L | L | L | H | H | H | H | H | H |
| H | L | H | L | L | H | L | H | H | H | H | H |
| H | L | L | H | L | H | H | L | H | H | H | H |
| H | L | H | H | L | H | H | H | L | H | H | H |
| H | L | L | L | H | H | H | H | H | L | H | H |
| H | L | H | L | H | H | H | H | H | H | L | H |
| H | L | L | H | H | H | H | H | H | H | H | L |

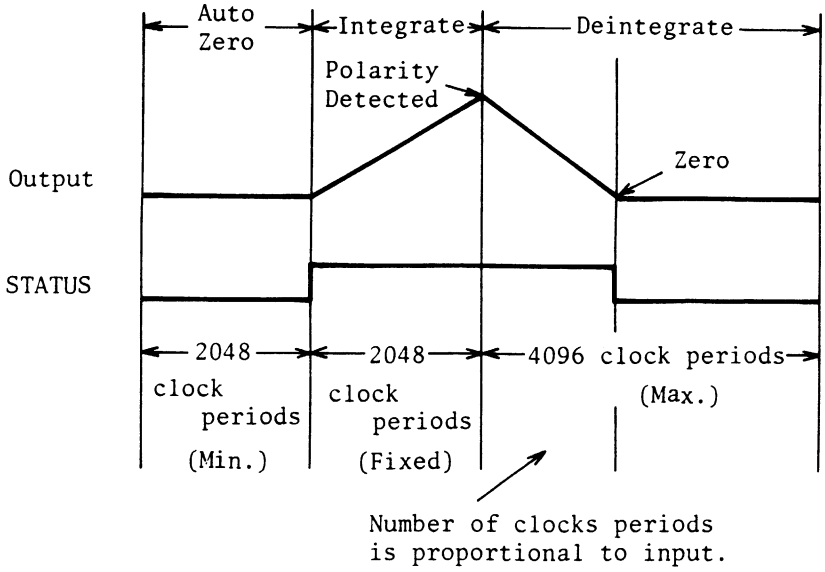
H: high level
L: low level
x: irrelevant

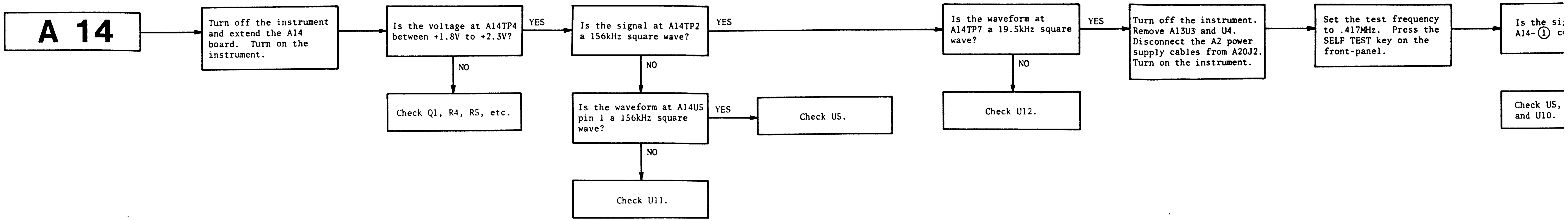
## A14 Analog-to-Digital Converter Board Theory

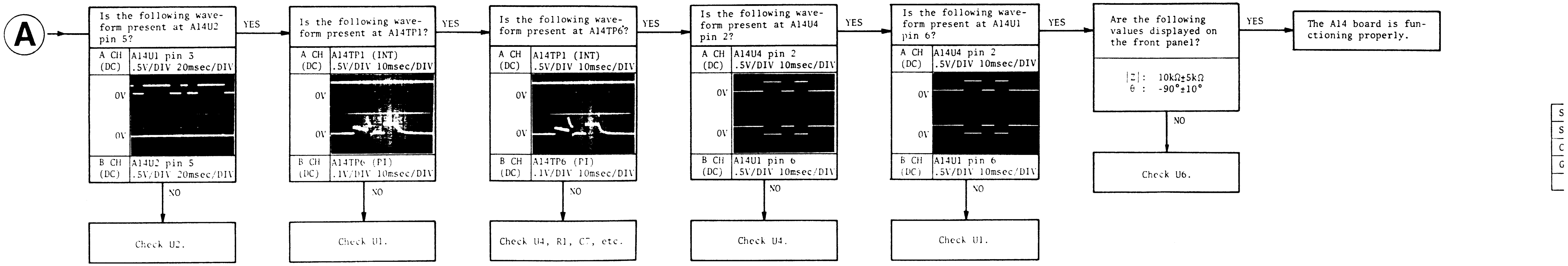
The CLOCK DIVIDER, U11 and U12, outputs a 156kHz clock and a 2IF (19.53kHz) clock. The 156kHz clock is used by the MAGNITUDE and PHASE integrators, and the 2IF clock is used in sampling pulse generation. The CONTROL DECODER, U7, is a 1-of-8 decoder/multiplexer. It controls the overall operation of U3 and U4 and data transfer to the A17 board. When $\overline{\text{IOG4}}$ goes HIGH or R/$\overline{\text{W}}$ goes LOW, all outputs of U7 go HIGH. When $\overline{\text{IOG4}}$ goes LOW and R/$\overline{\text{W}}$ goes HIGH, one of the outputs, determined by AB0, AB1, and AB2, will go LOW. When AB0, AB1, and AB2 are all LOW, U7 pin 15 will be LOW, setting the Q outputs of U9A and U9B HIGH, which signal U3 and U4 to begin integration of the differential voltages MAG$^+$/MAG$^-$ and PHASE$^+$/PHASE$^-$. Also at this time, U7 pins 11, 12, 13, and 14 are HIGH, setting the DATA OUTPUT DRIVER, U6, to the high-Z state and disabling data output from U3 and U4 (LBEN and HBEN of U3 and U4 are held HIGH). At the completion of integration, two things happen : (1) the STATUS outputs of U3 and U4 go LOW and (2) the measured data becomes available at the outputs of U3 and U4. When both STATUS outputs go LOW (they do not go LOW simultaneously), the Q outputs of U2A and U2B will go HIGH, forcing $\overline{\text{ADCINT}}$ LOW. After receiving the $\overline{\text{ADCINT}}$, the microprocessor will begin sequencing the AB0, AB1, and AB2 lines. This resets U9A, U9B, U2A, and U2B, setting U3 and U4 to HOLD and removing the $\overline{\text{ADCINT}}$. U7 then sequentially activates U3 $\overline{\text{HBEN}}$ (high byte enable), U3 $\overline{\text{LBEN}}$ (low byte enable), U4 $\overline{\text{HBEN}}$, and U4 $\overline{\text{LBEN}}$. When the $\overline{\text{HBEN}}$ input of either U3 or U4 is brought LOW, the higher order byte--bits 9 through 12, polarity bit, and overrange bit—of the chip's latch is output onto the 8-bit IO bus; when $\overline{\text{LBEN}}$ is brought LOW, the lower order byte, bits 1 through 8, is output.

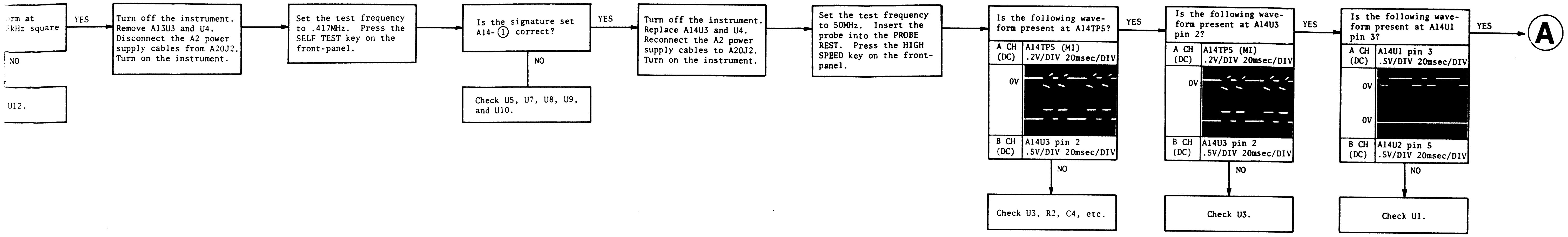
VI MEASURE SELECTOR, U10, outputs a 1Hz TTL square wave (normal speed mode) or 10Hz TTL square wave (HIGH SPEED mode) which controls the channel select switches on the A12 board. When VIMEAS is HIGH (about 30 milliseconds in HIGH SPEED mode), the phase and level of the I channel IF representing the RF current through the DUT are measured; when VIMEAS is LOW (about 70 milliseconds in HIGH SPEED mode), the phase and level of the V channel IF representing the RF voltage across the DUT are measured.

U3 and U4 perform conventional dual-slope integration of the differential voltages present at their INL and INH inputs. The AD conversion rate is determined by the 156kHz clock. Each conversion cycle lasts for 8192 clock periods and each cycle is divided into three phases : auto-zero, integrate, and deintegrate. During auto-zero, the reference capacitors, C1 and C2, are charged by VREF (+2VDC) from the VREF GENERATOR, Q1, and the auto-zero capacitors, C6 and C5, are charged to compensate for various offset voltages on the chips. The auto-zero phase lasts a minimum of 2048 clock periods. During integrate, the differential voltage between INH and INL is integrated for a fixed period of 2048 clock periods. At the end of this phase, polarity is determined. During deintegrate, the integrator is discharged by the previously charged reference capacitor, and the number of clock periods required for the integrator output to return to zero (established in auto-zero) is counted. The input voltage is proportional to the number of clock periods counted. A simplified timing diagram for one complete conversion cycle is shown below :


Auto Zero
Integrate
Deintegrate
Polarity Detected
Zero
Output
STATUS
2048 clock periods (Min.)
2048 clock periods (Fixed)
4096 clock periods (Max.)
Number of clocks periods is proportional to input.


A 14
Turn off the instrument and extend the A14 board. Turn on the instrument.
Is the voltage at A14TP4 between +1.8V to +2.3V?
YES
NO
Check Q1, R4, R5, etc.
Is the signal at A14TP2 a 156kHz square wave?
YES
NO
Is the waveform at A14U5 pin 1 a 156kHz square wave?
YES
Check U5.
NO
Check U11.
Is the waveform at A14TP7 a 19.5kHz square wave?
YES
NO
Check U12.
Turn off the instrument. Remove A13U3 and U4. Disconnect the A2 power supply cables from A20J2. Turn on the instrument.
Set the test frequency to .417MHz. Press the SELF TEST key on the front-panel.
Is the si
A14-① c
Check U5,
and U10.


A
Is the following waveform present at A14U2 pin 5?
A CH (DC) A14U1 pin 3 .5V/DIV 20msec/DIV
0V
0V
B CH (DC) A14U2 pin 5 .5V/DIV 20msec/DIV
YES
NO
Check U2.
Is the following waveform present at A14TP1?
A CH (DC) A14TP1 (INT) .5V/DIV 10msec/DIV
0V
0V
B CH (DC) A14TP6 (PI) .1V/DIV 10msec/DIV
YES
NO
Check U1.
Is the following waveform present at A14TP6?
A CH (DC) A14TP1 (INT) .5V/DIV 10msec/DIV
0V
0V
B CH (DC) A14TP6 (PI) .1V/DIV 10msec/DIV
YES
NO
Check U4, R1, C7, etc.
Is the following waveform present at A14U4 pin 2?
A CH (DC) A14U4 pin 2 .5V/DIV 10msec/DIV
0V
0V
B CH (DC) A14U1 pin 6 .5V/DIV 10msec/DIV
YES
NO
Check U4.
Is the following waveform present at A14U1 pin 6?
A CH (DC) A14U4 pin 2 .5V/DIV 10msec/DIV
0V
0V
B CH (DC) A14U1 pin 6 .5V/DIV 10msec/DIV
YES
NO
Check U1.
Are the following values displayed on the front panel?
|Z|: 10kΩ±5kΩ
θ : -90°±10°
YES
NO
Check U6.
The A14 board is functioning properly.



rm at
kHz square

U12.

Turn off the instrument. Remove A13U3 and U4. Disconnect the A2 power supply cables from A20J2. Turn on the instrument.

Set the test frequency to .417MHz. Press the SELF TEST key on the front-panel.

Is the signature set A14-① correct?

Check U5, U7, U8, U9, and U10.

Turn off the instrument. Replace A14U3 and U4. Reconnect the A2 power supply cables to A20J2. Turn on the instrument.

Set the test frequency to 50MHz. Insert the probe into the PROBE REST. Press the HIGH SPEED key on the front-panel.

Is the following waveform present at A14TP5?

A CH (DC) A14TP5 (MI) .2V/DIV 20msec/DIV

B CH (DC) A14U3 pin 2 .5V/DIV 20msec/DIV

Check U3, R2, C4, etc.

Is the following waveform present at A14U3 pin 2?

A CH (DC) A14TP5 (MI) .2V/DIV 20msec/DIV

B CH (DC) A14U3 pin 2 .5V/DIV 20msec/DIV

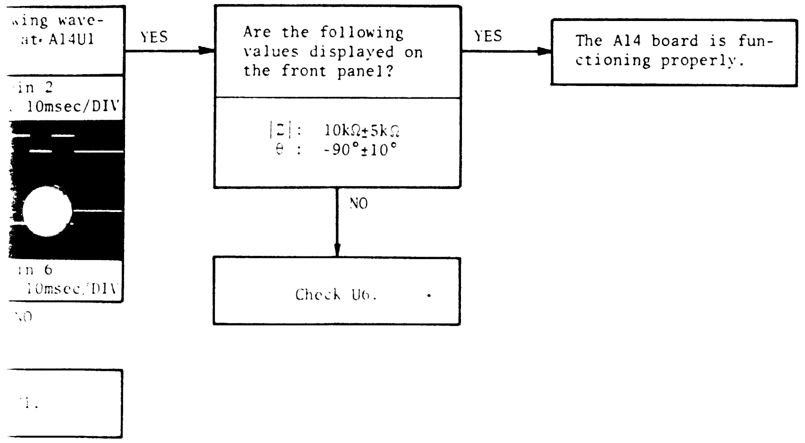
Check U3.

Is the following waveform present at A14U1 pin 3?

A CH (DC) A14U1 pin 3 .5V/DIV 20msec/DIV

B CH (DC) A14U2 pin 5 .5V/DIV 20msec/DIV

Check U1.



ing wave-
at A14U1

in 2
10msec/DIV

in 6
10msec/DIV

1.

Are the following values displayed on the front panel?

|Z|: 10kΩ±5kΩ
θ : -90°±10°

The A14 board is functioning properly.

Check U6.

Signature Set A14 - ①

| | | |
|---|---|---|
| START | A17U23 pin 7 | ▇ ╱ |
| STOP | A17U23 pin 7 | ▂ ╲ |
| CLOCK | A17TP17 | ▂ ╲ |
| GROUND | A17TP19 | |
| +5V | 171A | |

| A14U5 | |
|---|---|
| pin 5 | 5PUU |
| pin 6 | 49P5 |

| A14U7 | |
|---|---|
| pin 9 | APU4 |
| pin 10 | 2AHC |
| pin 11 | AU2A |
| pin 12 | 1112 |
| pin 13 | H614 |
| pin 14 | 36H3 |
| pin 15 | 2P33 |

| A14U8 | |
|---|---|
| pin 6 | 5PUU |

| A14U9 | |
|---|---|
| pin 5 | PU40 |
| pin 9 | PU40 |

| A14U10 | |
|---|---|
| pin 5 | PU2U |

Figure 8-60. A14 Board Troubleshooting Flow Chart.

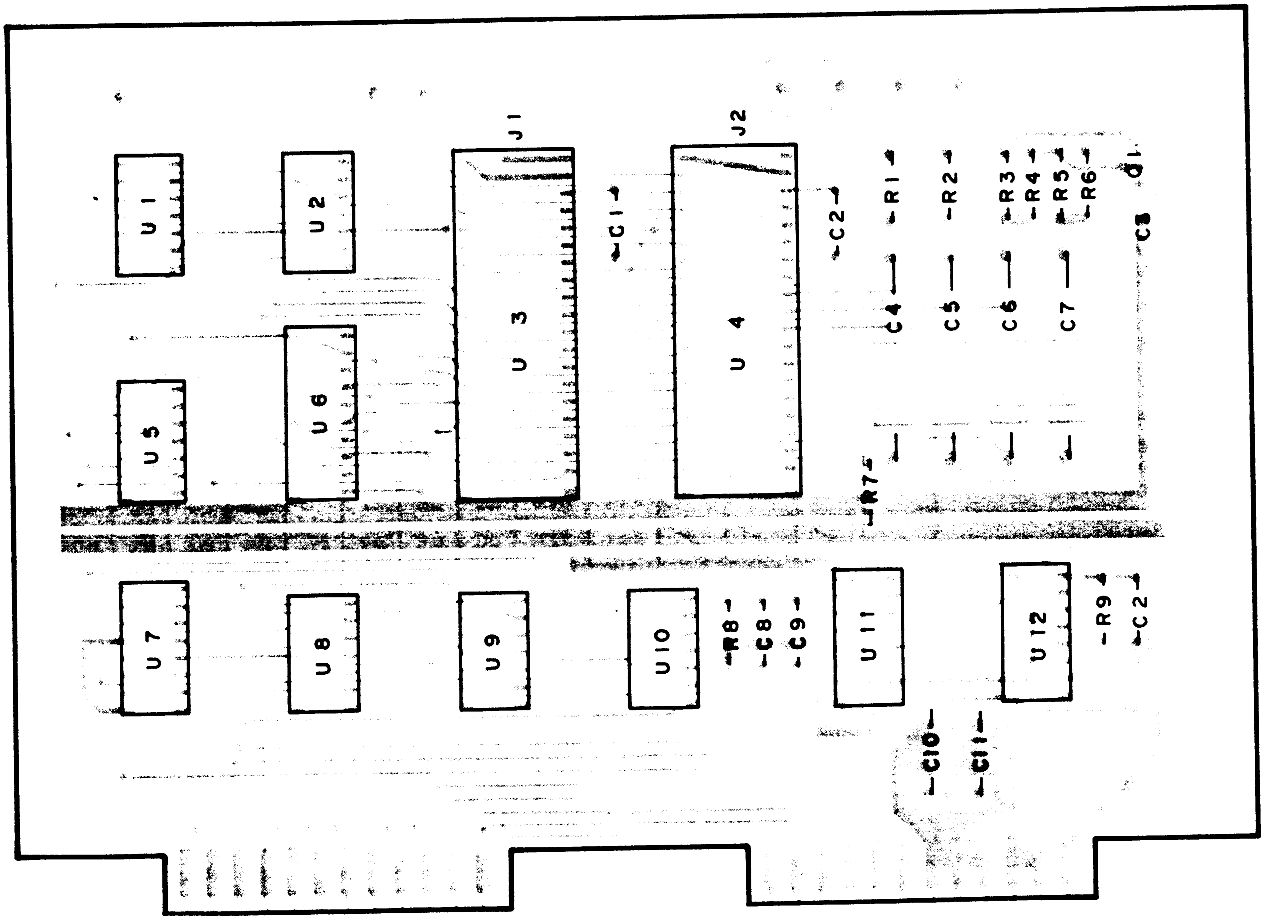
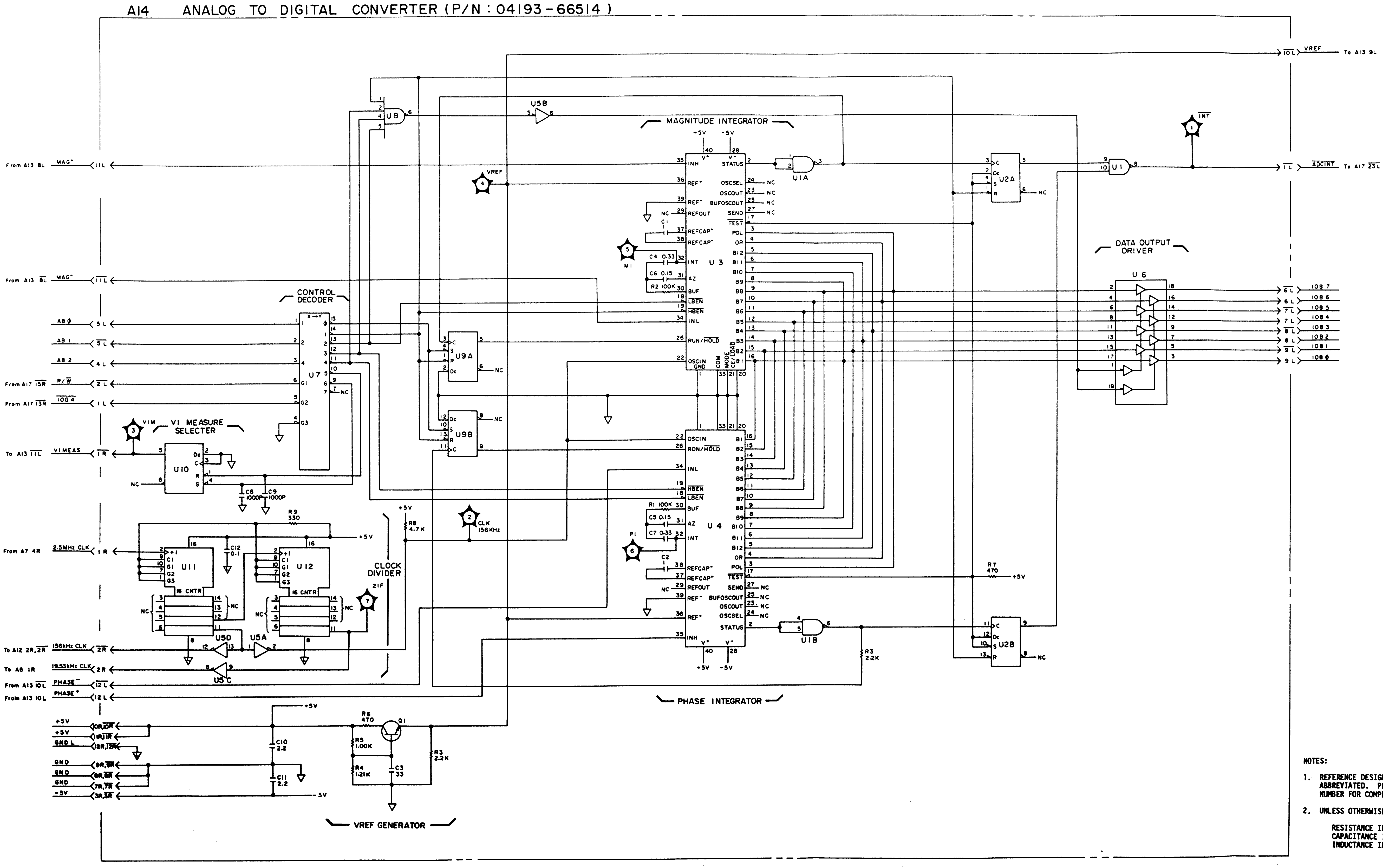


Figure 8-61. A14 Analog-to-Digital Convertor Board Assembly Component Locations.



NOTES:

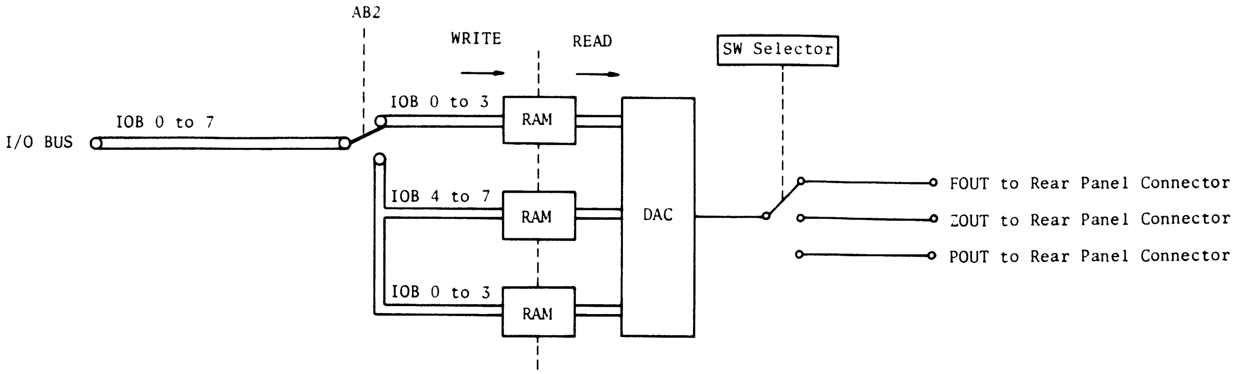
1. REFERENCE DESIGNATORS WITHIN THIS ASSEMBLY ARE ABBREVIATED. PREFIX ABBREVIATION WITH ASSEMBLY NUMBER FOR COMPLETE REFERENCE DESIGNATOR.

2. UNLESS OTHERWISE INDICATED:

RESISTANCE IN OHMS (Ω)
CAPACITANCE IN MICROFARADS (μF)
INDUCTANCE IN MICROHENRIES (μH)

Figure 8-62. A14 Analog-to-Digital Convertor Board Assembly Schematic Diagram.

# A15 Analog Output



A15 Board Block Diagram

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Test Frequency Byte | | | | | F11 | F10 | F9 | F8 | F7 | F6 | F5 | F4 | F3 | F2 | F1 | F0 |
| Impedance Byte | | | | | Z11 | Z10 | Z9 | Z8 | Z7 | Z6 | Z5 | Z4 | Z3 | Z2 | Z1 | Z0 |
| Phase Byte | | | | | P11 | P10 | P9 | P8 | P7 | P6 | P5 | P4 | P3 | P2 | P1 | P0 |

IOB lines

| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| HBF | | | | | F11 | F10 | F9 | F8 |
| LBF | F7 | F6 | F5 | F4 | F3 | F2 | F1 | F0 |
| HBF | | | | | Z11 | Z10 | Z9 | Z8 |
| LBZ | Z7 | Z6 | Z5 | Z4 | Z3 | Z2 | Z1 | Z0 |
| HBP | | | | | P11 | P10 | P9 | P8 |
| LBP | P7 | P6 | P5 | P4 | P3 | P2 | P1 | P0 |

| Data | Read Address* |
|---|---|
| HBF bit 0 to 3 | A15U15A0 |
| LBF bit 4 to 7 | A15U16A0 |
| LBF bit 0 to 3 | A15U17A0 |
| HBZ bit 0 to 3 | A15U15A1 |
| LBZ bit 4 to 7 | A15U16A1 |
| LBZ bit 0 to 3 | A15U17A1 |
| HBP bit 0 to 3 | A15U15A2 |
| LBP bit 4 to 7 | A15U16A2 |
| LBP bit 0 to 3 | A15U17A2 |

*: Read Address A3 is not used.

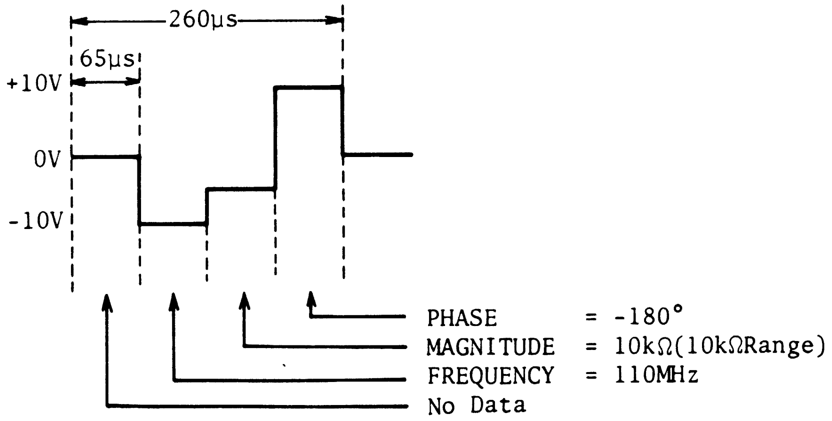
## *A15 Analog Output Board Theory*

The A15 board outputs DC voltages proportional to the magnitude, phase, and frequency values displayed on the front panel when the unit's X-Y RECORDER function is set to ON.

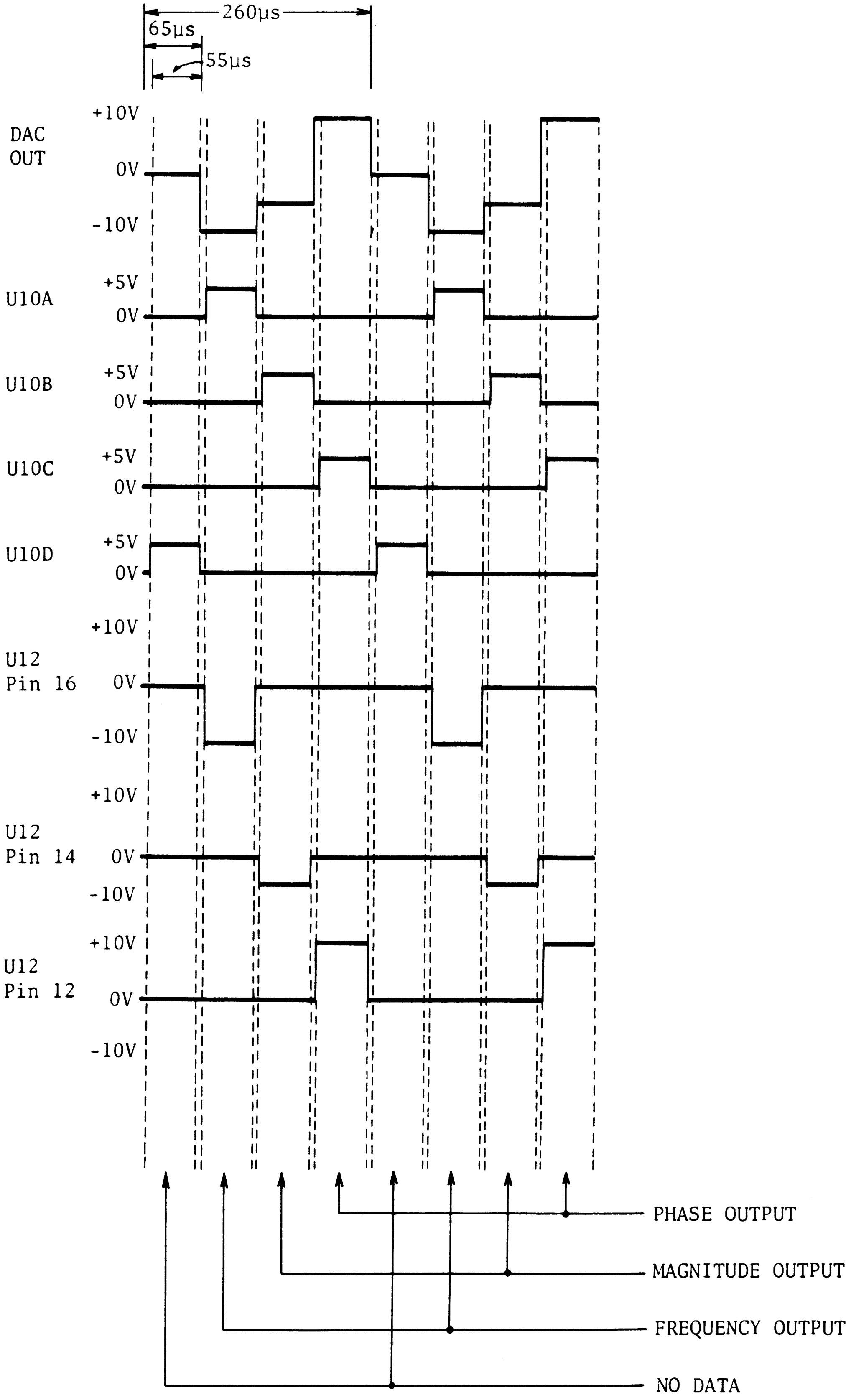
Twelve-bit digital data for each front panel display is sent from the microprocessor via the 8-bit IO bus and is stored in three RAMs, U15, U16 and U17. The low-order byte, bits 1 through 8, is stored in U16 and U17; the high-order byte, bits 9 through 12, is stored in U15. Each RAM is capable of storing four 4-bit words. WRITE addressing for each RAM is controlled by AB0 and AB1. RAM write-enable is controlled by $R/\overline{W}$, $\phi$2, AB2, and IOG7. When U6A pin 6 is LOW the data on lines B0 through B3 of the IO bus is stored in U15 at the address determined by AB0 and AB1. When U6B pin 8 is LOW the data on the IO bus is stored in U16 and U17 at the address determined by AB0 and AB1.

Each RAM is permanently read-enabled (pin 11 grounded), and READ addressing is controlled by the outputs from U3B and U3D, which are produced by dividing down (U1 and U2) the $\phi$2 1MHz clock. The U3B and U3D outputs apply a mod-4 binary count to the READ address inputs of each RAM, allowing the data stored at the selected address to appear at the data outputs of each RAM. The U3B and U3D outputs are also used by the CHANNEL DECODER, U9, to synchronize output channel selection (performed by U12) with the data-read operation. This insures that when phase data, for example, is being read, it is output to the θOUT channel and not to the ZOUT channel or FOUT channel.

The DA converter, U11, continuously converts the 12-bit digital data at its inputs and outputs a proportional DC voltage to the three-channel multiplexor, U12. An example of the DA converter output is shown below :

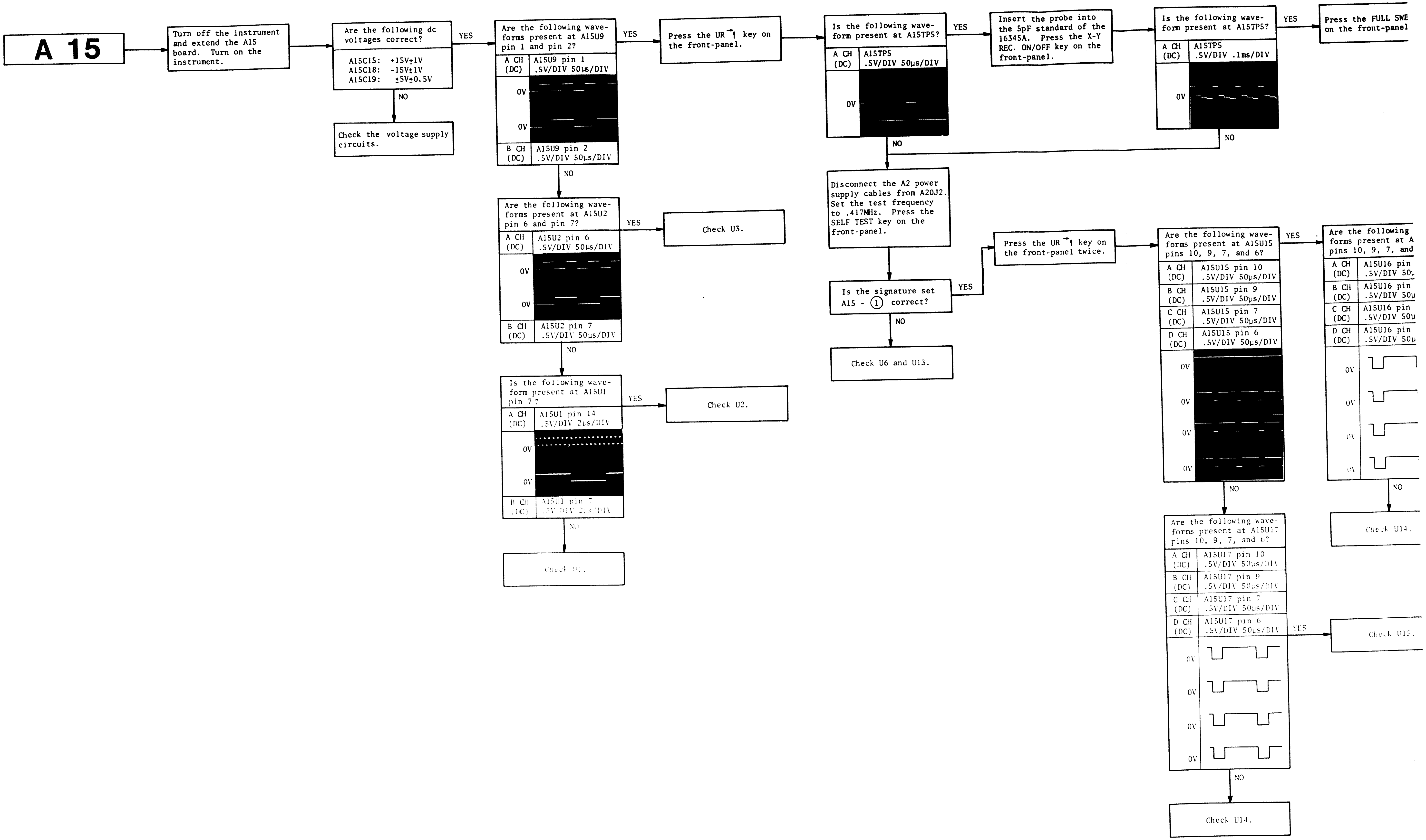


The multiplexor selects the appropriate output channel for the analog voltages, as directed by the CHANNEL DECODER, U9. A timing diagram containing the DAC output, CHANNEL DECODER outputs, and multiplexor outputs is shown below :


260µs
65µs
55µs
DAC OUT
+10V
0V
-10V
U10A
+5V
0V
U10B
+5V
0V
U10C
+5V
0V
U10D
+5V
0V
+10V
U12 Pin 16
0V
-10V
+10V
U12 Pin 14
0V
-10V
+10V
U12 Pin 12
0V
-10V
PHASE OUTPUT
MAGNITUDE OUTPUT
FREQUENCY OUTPUT
NO DATA

Each output channel contains a storage capacitor, buffer amplifier, and variable gain output amplifier. When U10A pin 1 goes HIGH, the multiplexor connects the DA converter output to the frequency channel for approximately 55 microseconds. During this period, the storage capacitor, C7, charges to the DAC output voltage, which, in the case of frequency, is from 0V to -10V. The buffer amplifier provides a high impedance load to prevent C7 from discharging during the 195 microseconds when no DAC voltage is output to the frequency channel. U18A is an inverting variable gain output amplifier and is adjusted so that the voltage at TP6 is one-tenth of the DAC output voltage. The magnitude and phase channels, ZOUT and QOUT, function similarly to the frequency channel, FOUT.

The PEN UP/DOWN CONTROL, U5, provides automatic control of the X-Y recorder's pen. Normally, the Q output, pin 5, of U5 is HIGH (pen up). With the 4193A's X-Y RECORDER function set to ON, PENUP will go LOW (pen down) after the PARTIAL SWEEP START or FULL SWEEP START key is pressed. When the sweep is completed or aborted PENUP will automatically go HIGH.



Turn off the instrument and extend the A15 board. Turn on the instrument.

Are the following dc voltages correct?

A15C15: +15V±1V
A15C18: -15V±1V
A15C19: ±5V±0.5V

Check the voltage supply circuits.

Are the following waveforms present at A15U9 pin 1 and pin 2?

A CH (DC) A15U9 pin 1 .5V/DIV 50us/DIV
B CH (DC) A15U9 pin 2 .5V/DIV 50µs/DIV

Are the following waveforms present at A15U2 pin 6 and pin 7?

A CH (DC) A15U2 pin 6 .5V/DIV 50us/DIV
B CH (DC) A15U2 pin 7 .5V/DIV 50µs/DIV

Check U3.

Is the following waveform present at A15U1 pin 7 ?

A CH (DC) A15U1 pin 14 .5V/DIV 2µs/DIV
B CH (DC) A15U1 pin 7 .5V/DIV 2µs/DIV

Check U2.

Check U1.

Press the UR→↑ key on the front-panel.

Is the following waveform present at A15TP5?

A CH (DC) A15TP5 .5V/DIV 50µs/DIV

Disconnect the A2 power supply cables from A20J2. Set the test frequency to .417MHz. Press the SELF TEST key on the front-panel.

Is the signature set A15 - ① correct?

Check U6 and U13.

Insert the probe into the 5pF standard of the 16345A. Press the X-Y REC. ON/OFF key on the front-panel.

Is the following waveform present at A15TP5?

A CH (DC) A15TP5 .5V/DIV .1ms/DIV

Press the FULL SWE
on the front-panel

Press the UR→↑ key on the front-panel twice.

Are the following waveforms present at A15U15 pins 10, 9, 7, and 6?

A CH (DC) A15U15 pin 10 .5V/DIV 50µs/DIV
B CH (DC) A15U15 pin 9 .5V/DIV 50µs/DIV
C CH (DC) A15U15 pin 7 .5V/DIV 50µs/DIV
D CH (DC) A15U15 pin 6 .5V/DIV 50µs/DIV

Are the following waveforms present at A15U17 pins 10, 9, 7, and 6?

A CH (DC) A15U17 pin 10 .5V/DIV 50µs/DIV
B CH (DC) A15U17 pin 9 .5V/DIV 50µs/DIV
C CH (DC) A15U17 pin 7 .5V/DIV 50µs/DIV
D CH (DC) A15U17 pin 6 .5V/DIV 50µs/DIV

Check U15.

Check U14.

Are the following
forms present at A
pins 10, 9, 7, and

A CH (DC) A15U16 pin .5V/DIV 50µ
B CH (DC) A15U16 pin .5V/DIV 50µ
C CH (DC) A15U16 pin .5V/DIV 50µ
D CH (DC) A15U16 pin .5V/DIV 50µ

Check U14.

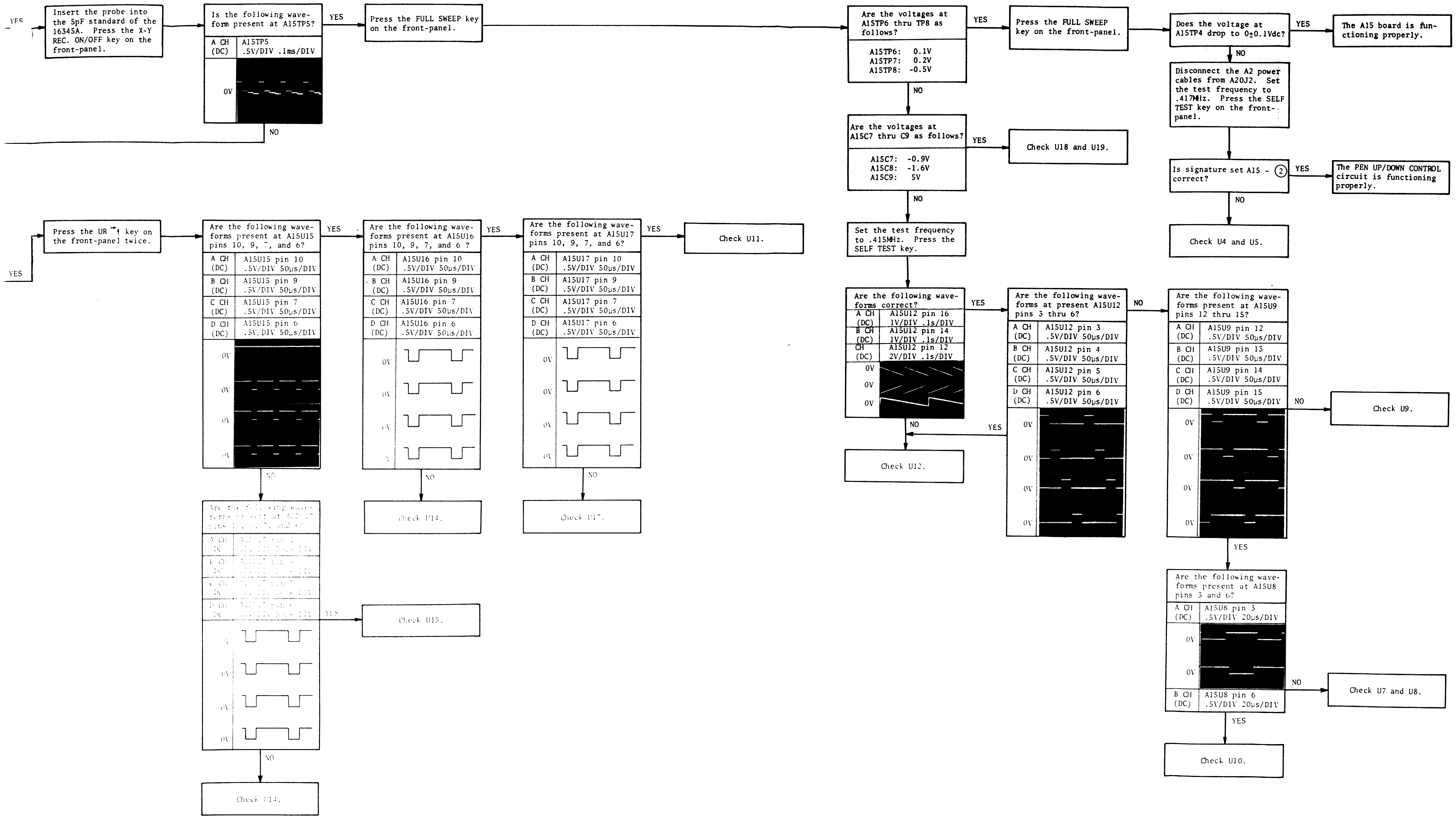


Figure 8-63. A15 Board Troubleshooting Flow Chart.

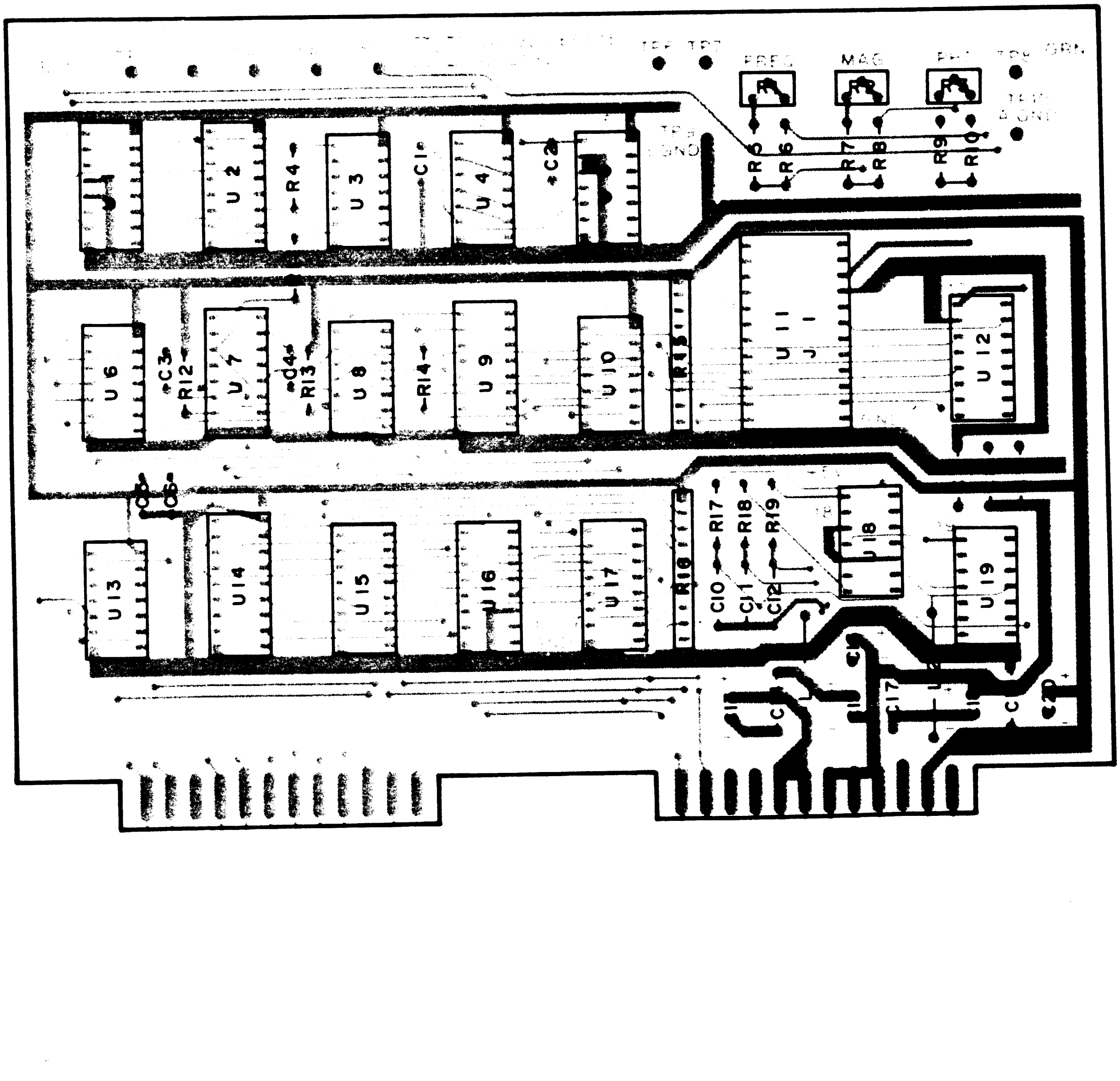
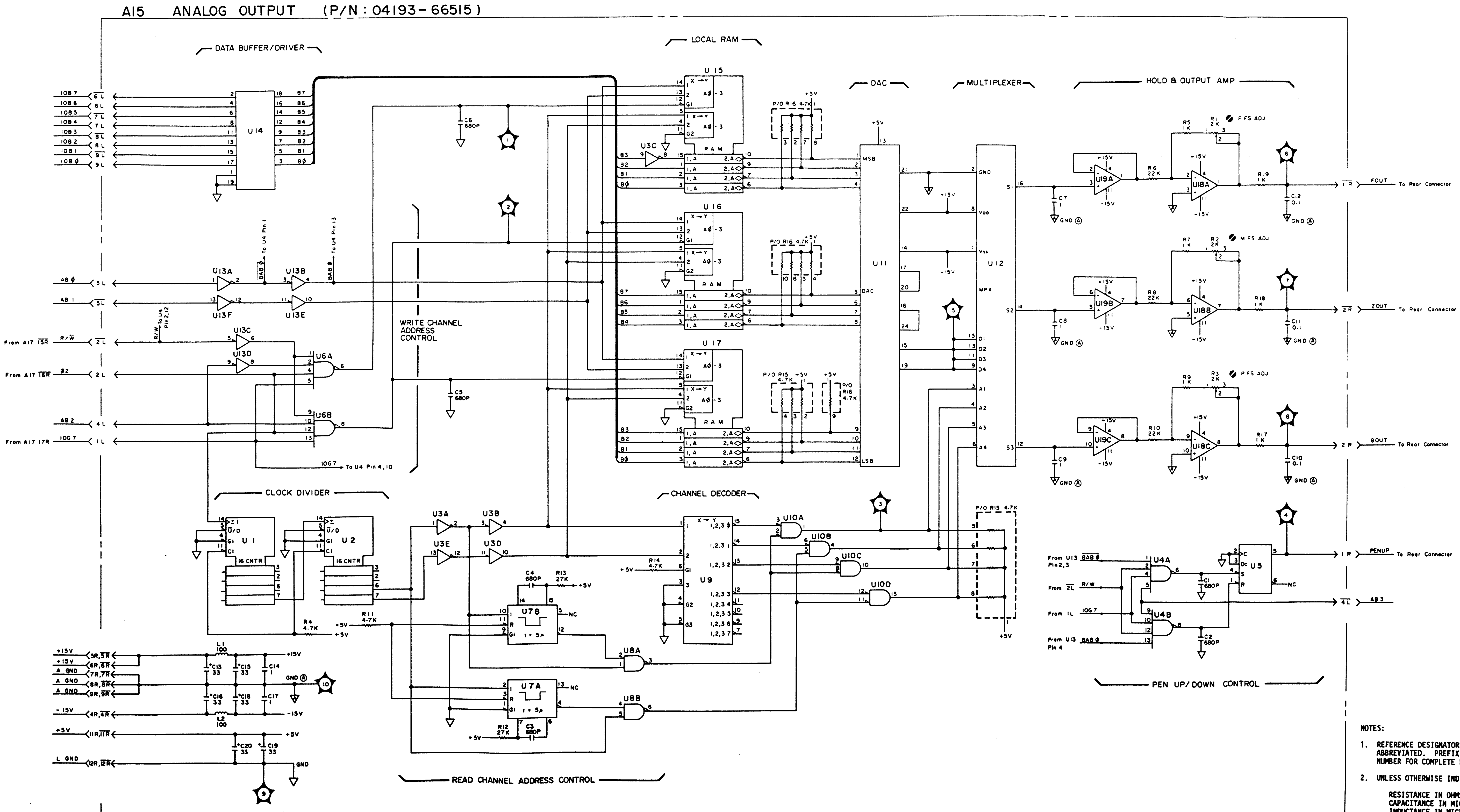


Figure 8-64. A15 Analog Output Board Assembly Component Locations.

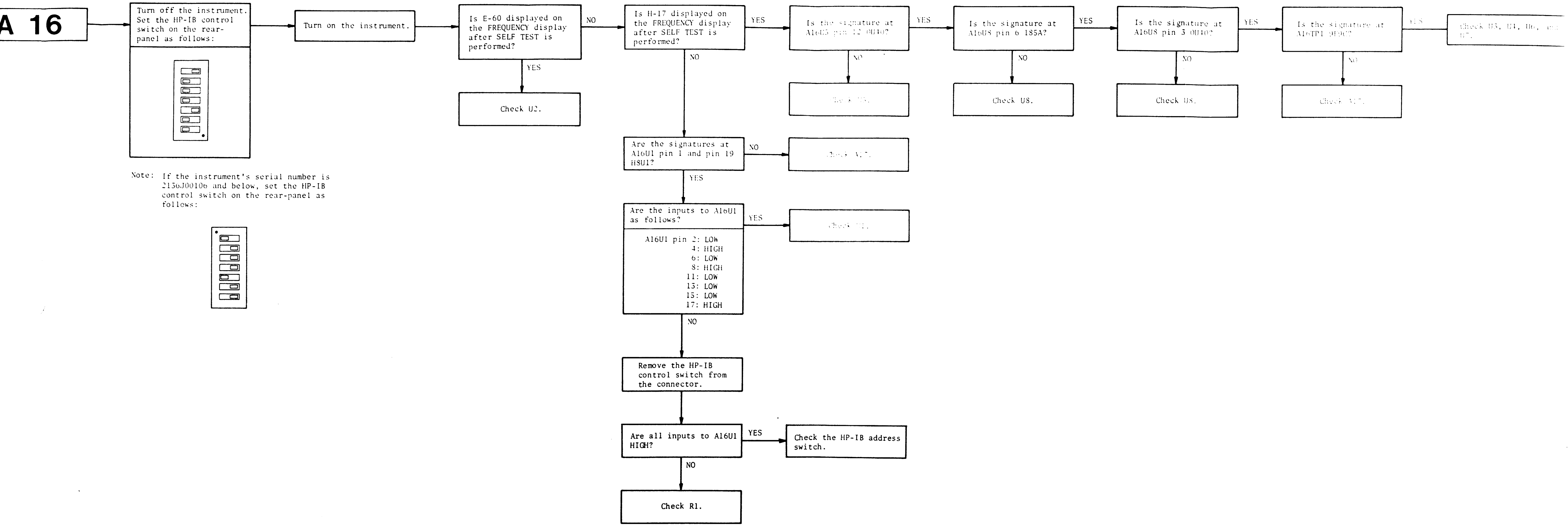


**NOTES:**

1. REFERENCE DESIGNATORS WITHIN THIS ASSEMBLY ARE ABBREVIATED. PREFIX ABBREVIATION WITH ASSEMBLY NUMBER FOR COMPLETE REFERENCE DESIGNATOR.
2. UNLESS OTHERWISE INDICATED:

RESISTANCE IN OHMS (Ω)
CAPACITANCE IN MICROFARADS (μF)
INDUCTANCE IN MICROHENRIES (μH)

**Figure 8-65.** A15 Analog Output Board Assembly Schematic Diagram.



Note: If the instrument's serial number is 2136J00106 and below, set the HP-IB control switch on the rear-panel as follows:

Figure 8-66. A16 Board Troubleshooting Flow Chart.

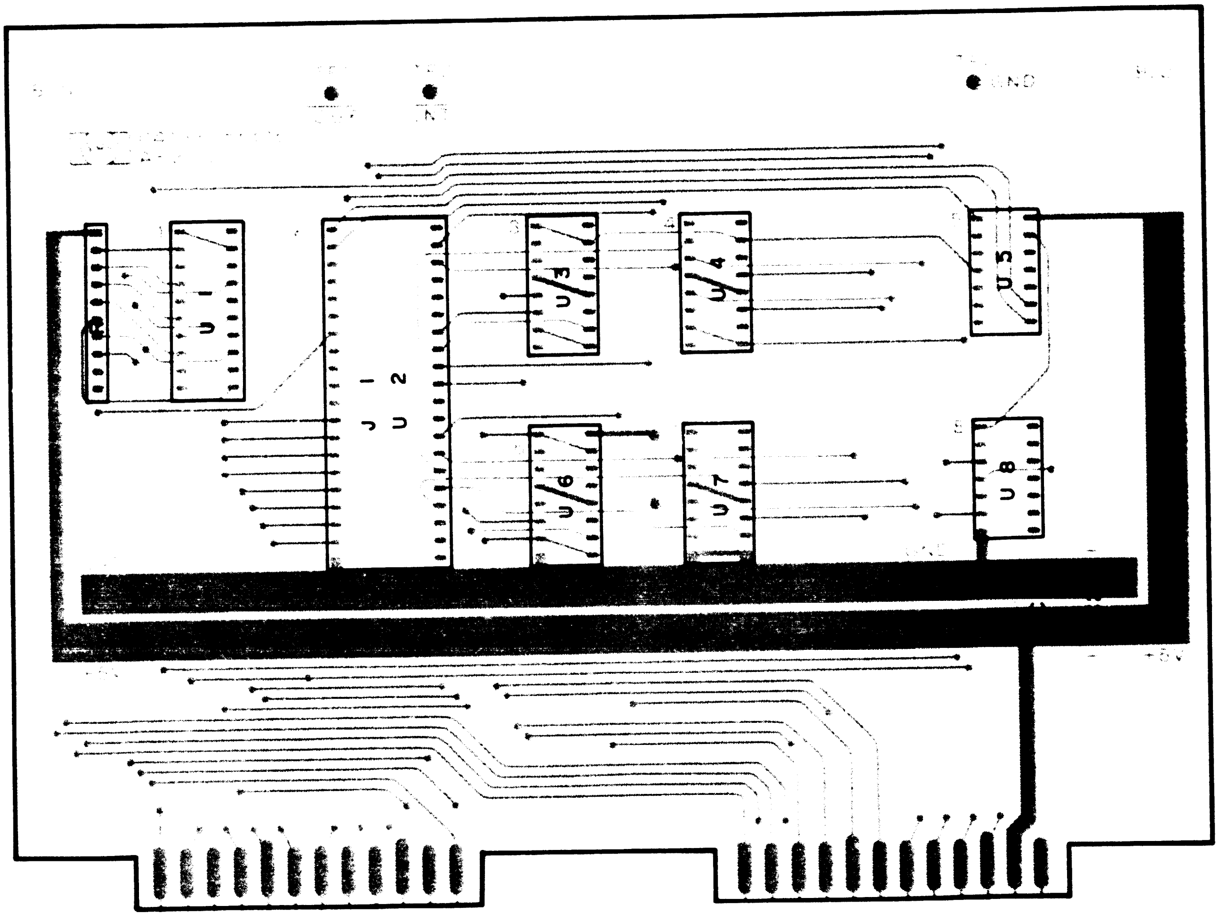
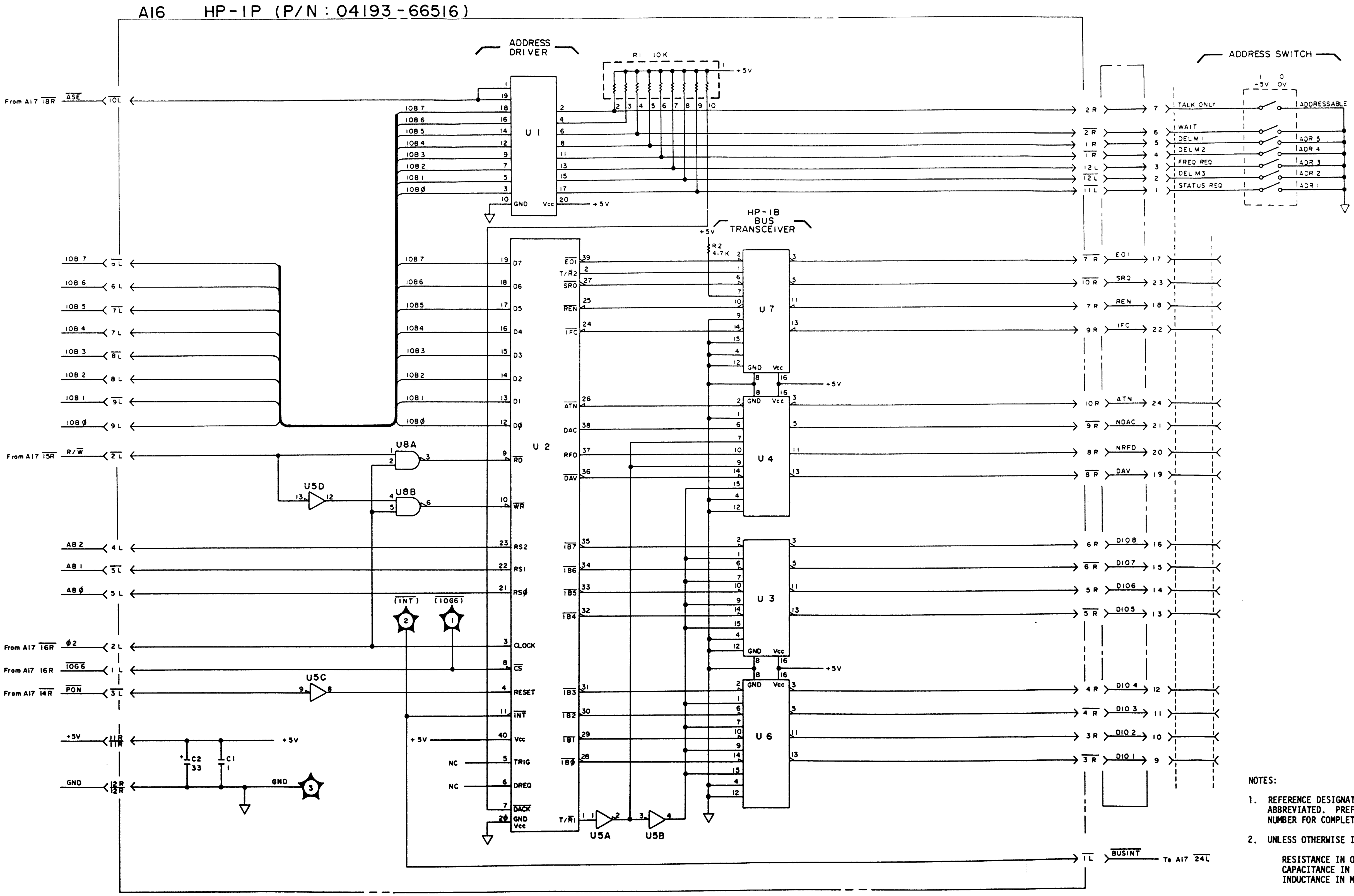


Figure 8-67. A16 HP-IB Board Assembly Component Locations.



NOTES:

1. REFERENCE DESIGNATORS WITHIN THIS ASSEMBLY ARE ABBREVIATED. PREFIX ABBREVIATION WITH ASSEMBLY NUMBER FOR COMPLETE REFERENCE DESIGNATOR.

2. UNLESS OTHERWISE INDICATED:

   RESISTANCE IN OHMS (Ω)
   CAPACITANCE IN MICROFARADS (μF)
   INDUCTANCE IN MICROHENRIES (μH)

**Figure 8-68.** A16 HP-IB Board Assembly Schematic Diagram.

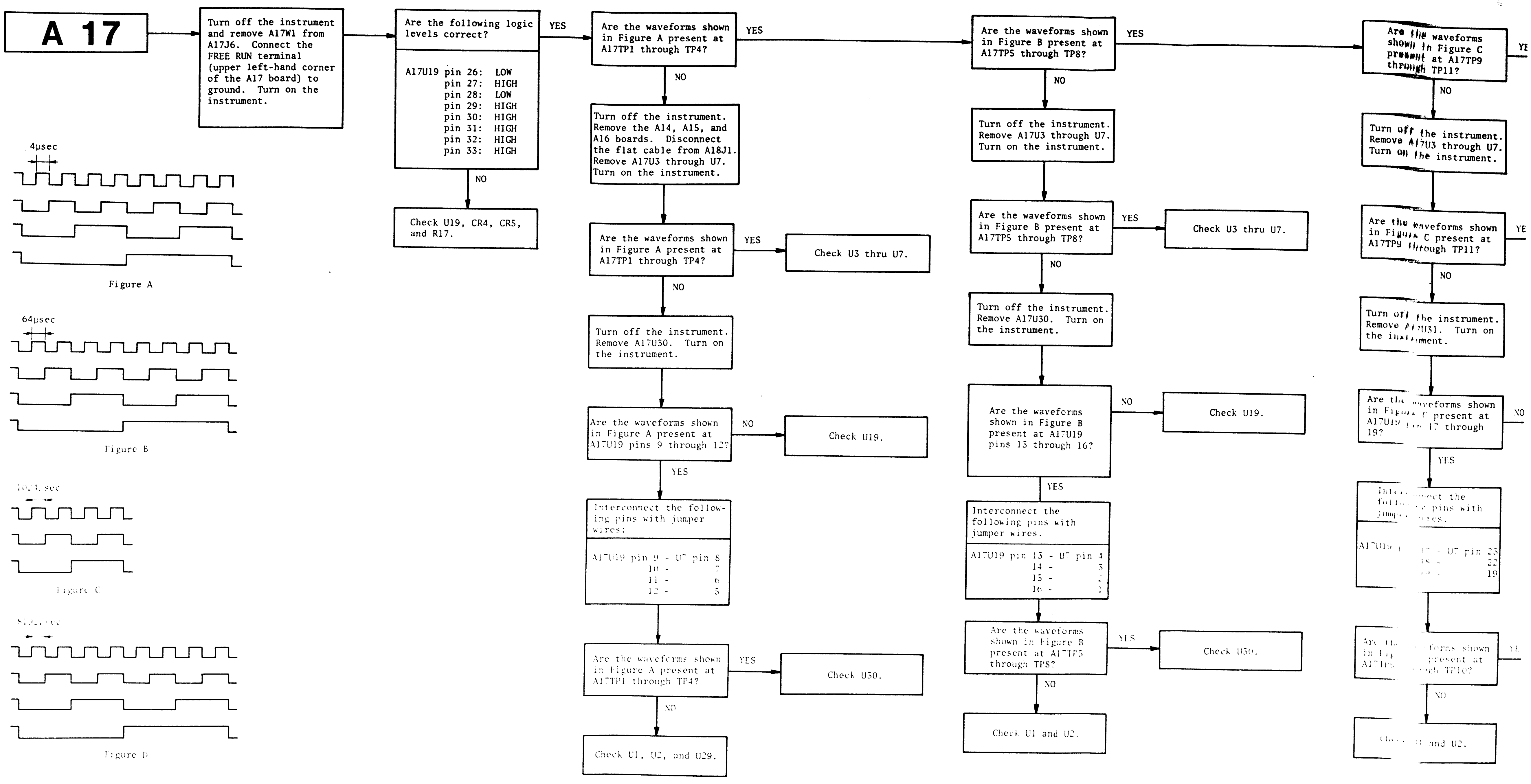


Figure A

Figure B

Figure C

Figure D

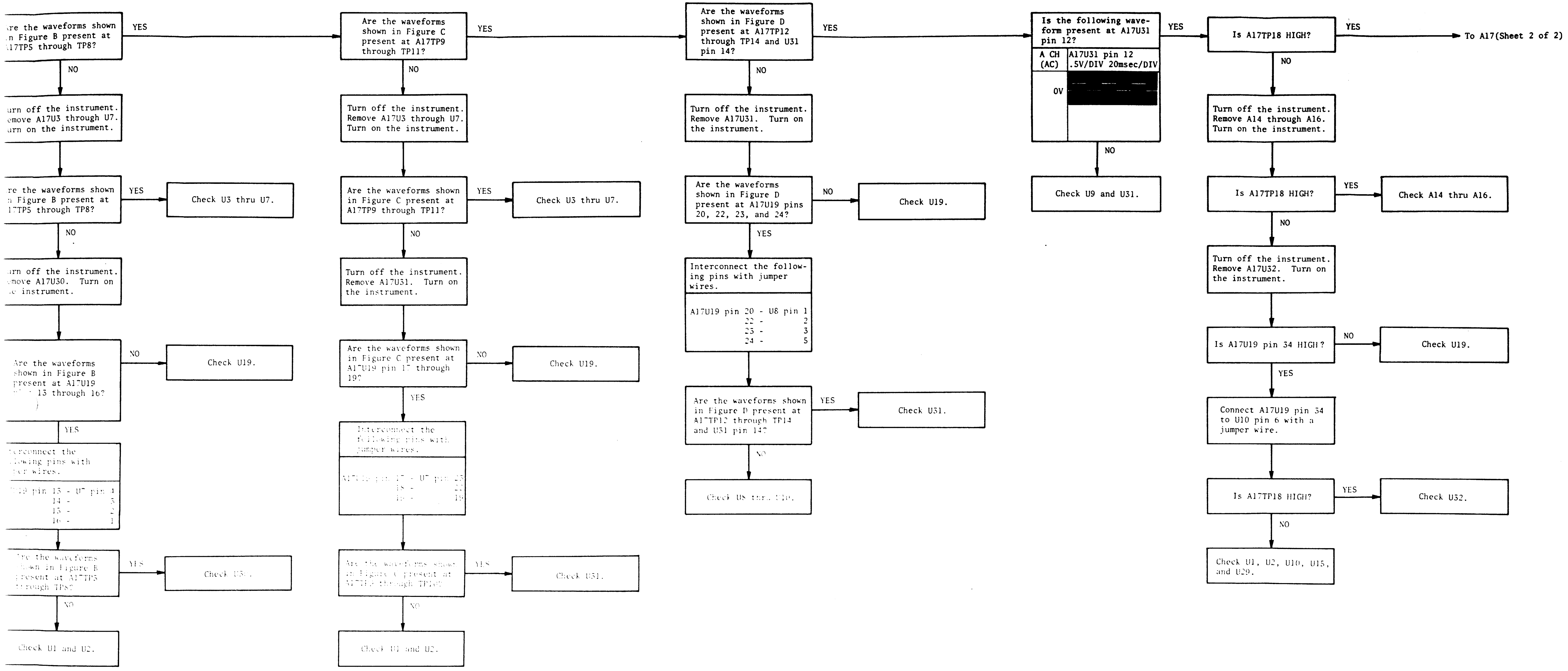
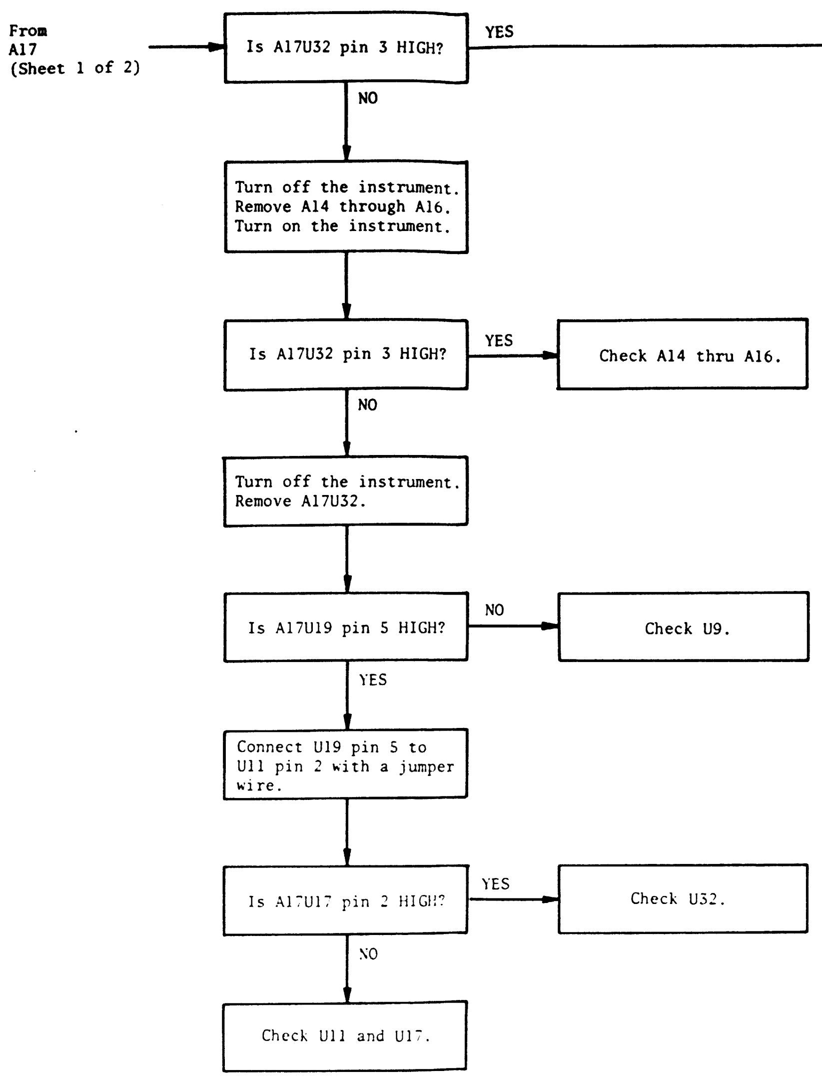
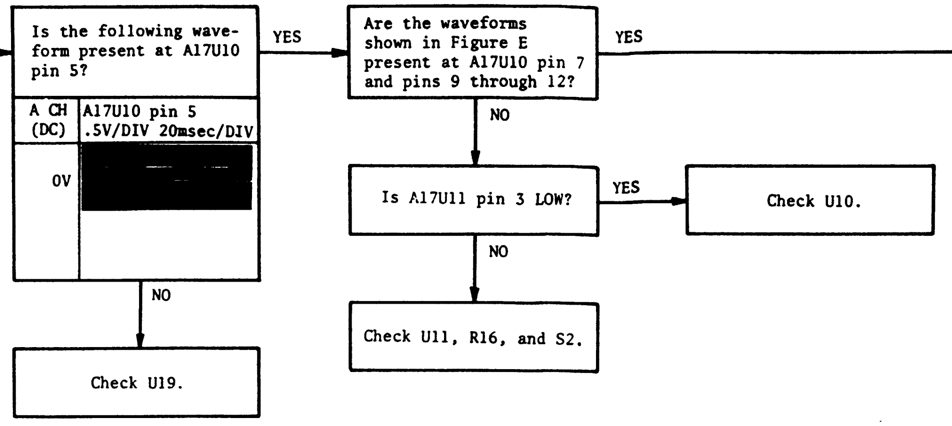
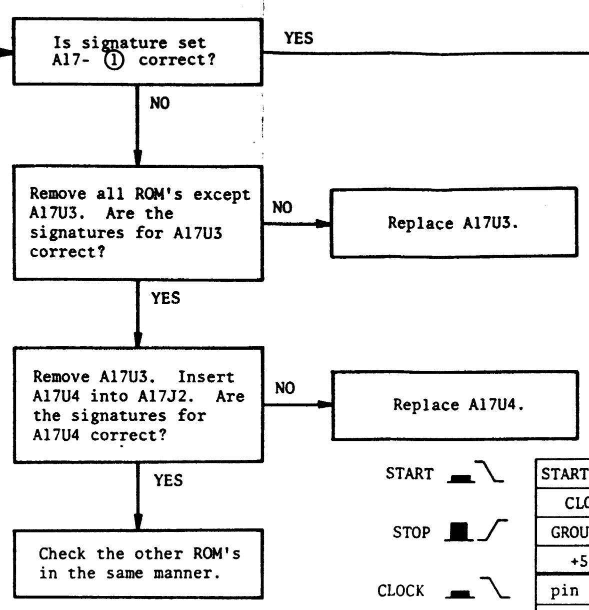
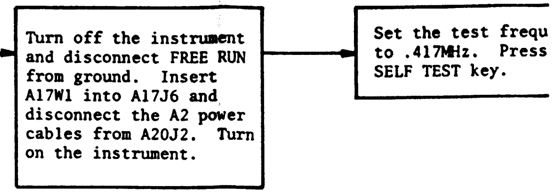


Figure 8-67. A17 Board Troubleshooting Flow Chart (Sheet 1 of 2).









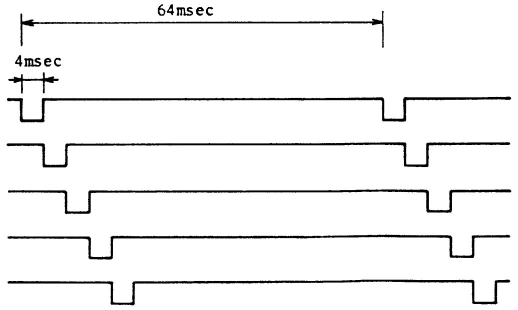


Figure E

Signature Set A17 -①

START ▃╲
STOP █╱
CLOCK ▃╲

| | A17U3 | A17U4 | A17U5 | A17U6 |
|---|---|---|---|---|
| START/STOP | A17U10 pin 12 | A17U10 pin 11 | A17U10 pin 10 | A17U10 pin 9 |
| CLOCK | A17TP17 | A17TP17 | A17TP17 | A17TP17 |
| GROUND | A17TP19 | A17TP19 | A17TP19 | A17TP19 |
| +5V | 826P | 826P | 826P | 826P |
| pin 9 | 380P | 3F32 | 8H0U | P398 |
| pin 10 | A12F | 07H6 | HP23 | A7P5 |
| pin 11 | 0UPP | 66HU | 678P | 982P |
| pin 13 | 32P4 | 0AC8 | HC2A | 22CU |
| pin 14 | 1858 | U323 | 4U25 | 9494 |
| pin 15 | 6PU7 | A4AU | P407 | P9H5 |
| pin 16 | 56HF | 7F8H | 41FH | H9HU |
| pin 17 | CA8U | PF15 | P642 | 8UF0 |

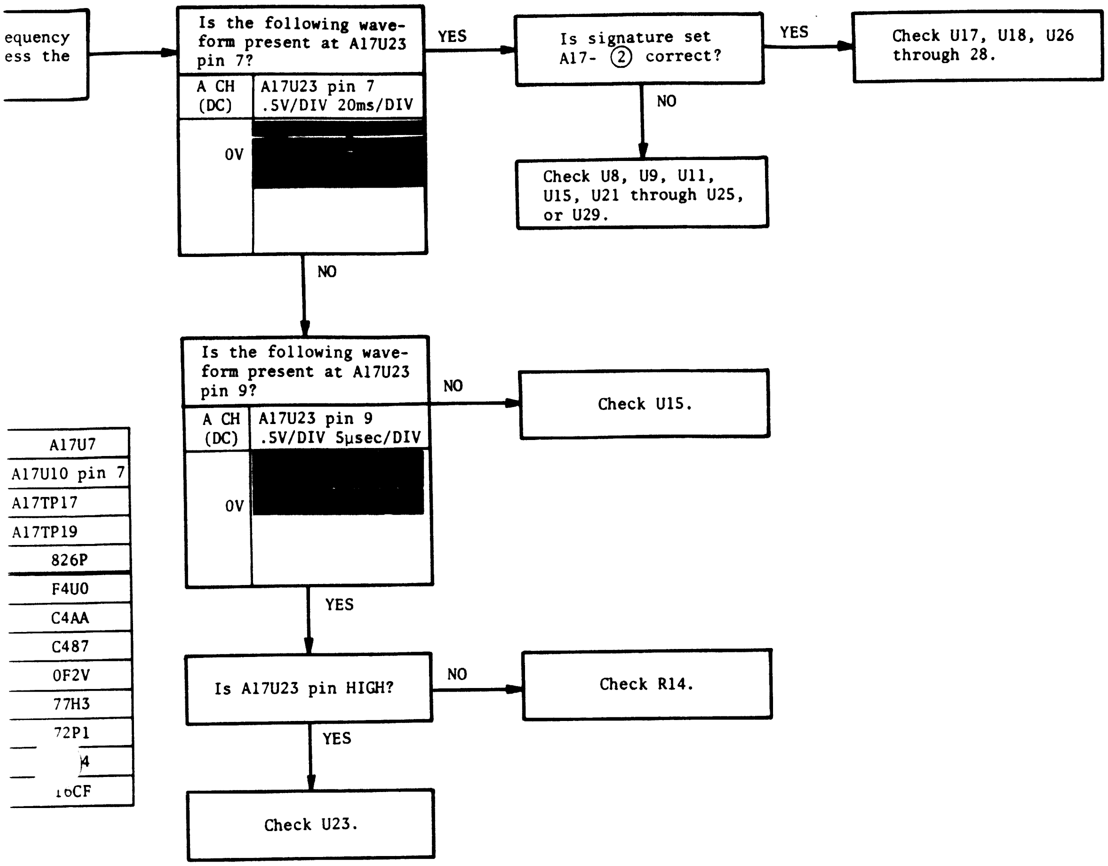
Signature Set A17 -②

| | | |
|---|---|---|
| START | A17U23 pin 7 | █ ╱ |
| STOP | A17U23 pin 7 | ▃ ╲ |
| CLOCK | A17TP17 | ▃ ╲ |
| GROUND | A17TP19 | |
| +5V | 171A | |

| A17U8 | A17U9 | A17U11 | A17U15 | A17U21 |
|---|---|---|---|---|
| pin 7 F47A | pin 2 7A21 | pin 1 171A | pin 11 17CC | pin 2 177A |
| pin 9 9F9C | pin 6 P767 | pin 2 CUCF | pin 12 C602 | pin 5 51H2 |
| pin 10 47U0 | pin 8 C6UU | pin 3 A8A6 | pin 13 0U16 | pin 7 38PU |
| pin 11 U4P3 | pin 10 H360 | pin 8 F4UP | pin 14 1C9H | pin 10 07AH |
| pin 12 8527 | | pin 9 171A | pin 15 3015 | pin 12 741C |
| pin 13 U07H | | pin 10 H3P4 | | pin 15 75AP |
| pin 14 6H3C | | | | |
| pin 15 F4UP | | | | |

Figure 8-69. A17 Board Troubleshooting Flow Chart (Sheet 2 of 2).

A17
SEE INSIDE



| |
|---|
| A17U7 |
| A17U10 pin 7 |
| A17TP17 |
| A17TP19 |
| 826P |
| F4U0 |
| C4AA |
| C487 |
| 0F2V |
| 77H3 |
| 72P1 |
| 4 |
| CF |

| A17U22 | A17U23 | A17U24 | A17U25 | A17U29 |
|---|---|---|---|---|
| pin 2 60U7 | pin 2 1H05 | pin 2 522U | pin 2 38HH | pin 11 6965 |
| pin 5 98CH | pin 5 06C4 | pin 5 7AF9 | pin 5 3763 | pin 12 H8U1 |
| pin 7 5896 | pin 7 171A | pin 6 CAAC | pin 6 43A2 | pin 13 PA78 |
| pin 10 CA49 | pin 10 53P2 | pin 9 1743 | pin 9 35U2 | pin 14 CC51 |
| pin 12 21UU | pin 12 57H9 | pin 12 2815 | pin 12 H1AC | pin 15 9P61 |
| pin 15 F396 | pin 15 849H | pin 15 6AH2 | pin 15 97PU | |
| | | pin 16 F7U7 | pin 16 C617 | |
| | | pin 19 F9U6 | pin 19 F3A6 | |

TROUBLESHOOTING FLOW CHART (Sheet 1 of 2)

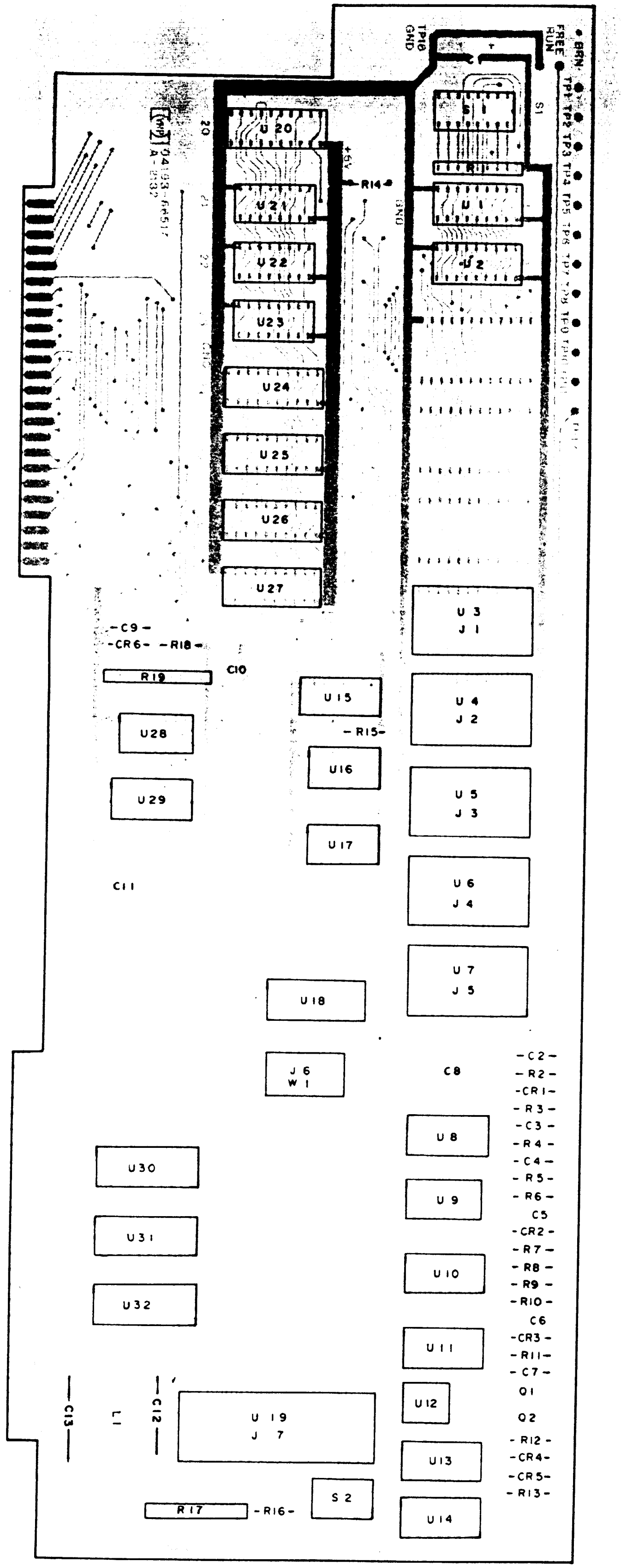
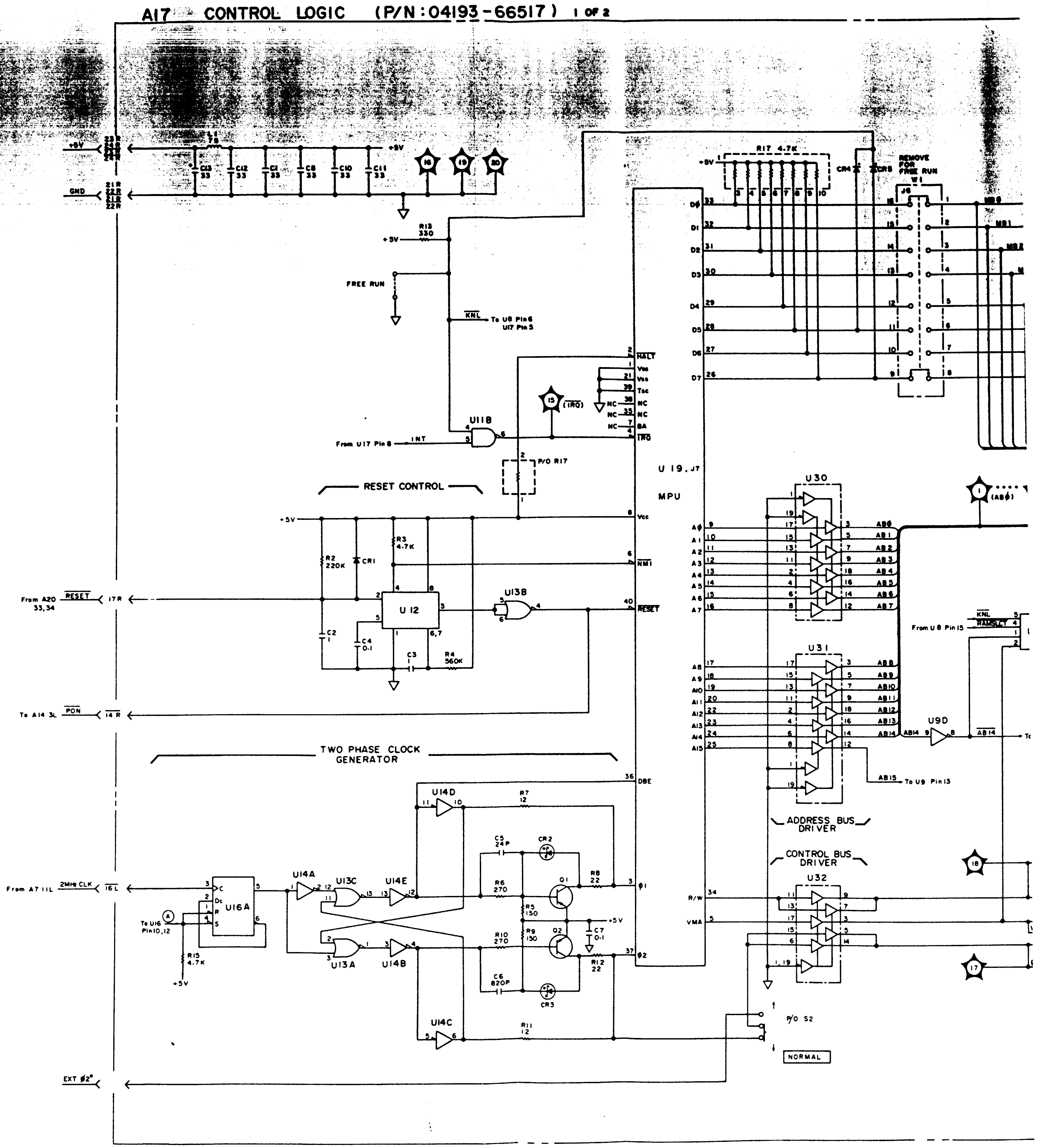
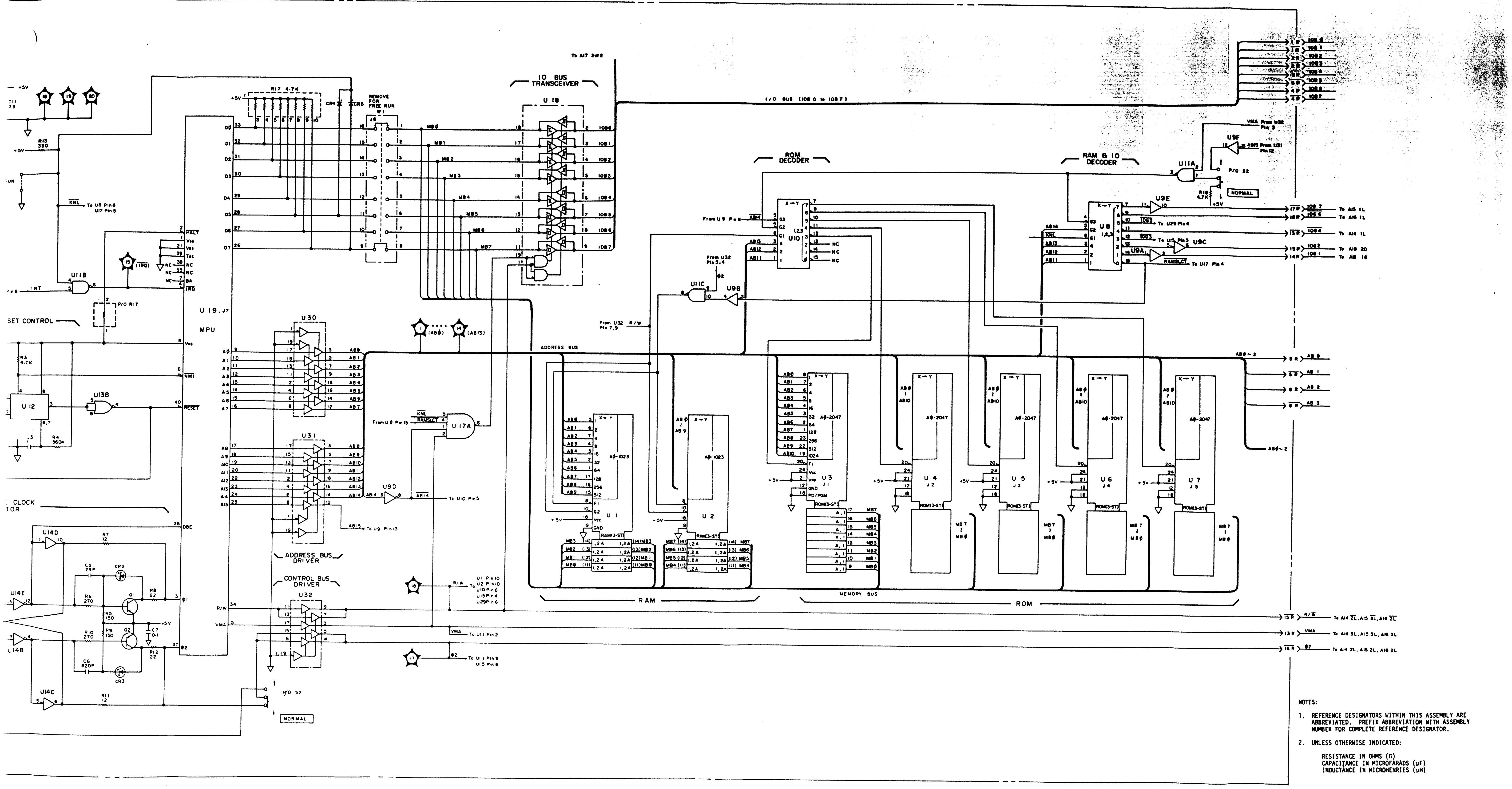


Figure 8-70. A17 Control Logic Board Assembly Component Locations.



(P/N:04193-66517) 1 OF 2



NOTES:

1. REFERENCE DESIGNATORS WITHIN THIS ASSEMBLY ARE ABBREVIATED. PREFIX ABBREVIATION WITH ASSEMBLY NUMBER FOR COMPLETE REFERENCE DESIGNATOR.

2. UNLESS OTHERWISE INDICATED:

   RESISTANCE IN OHMS (Ω)
   CAPACITANCE IN MICROFARADS (μF)
   INDUCTANCE IN MICROHENRIES (μH)

Figure 8-71. A17 Control Logic Board Assembly Schematic Diagram (Sheet 1 of 2).

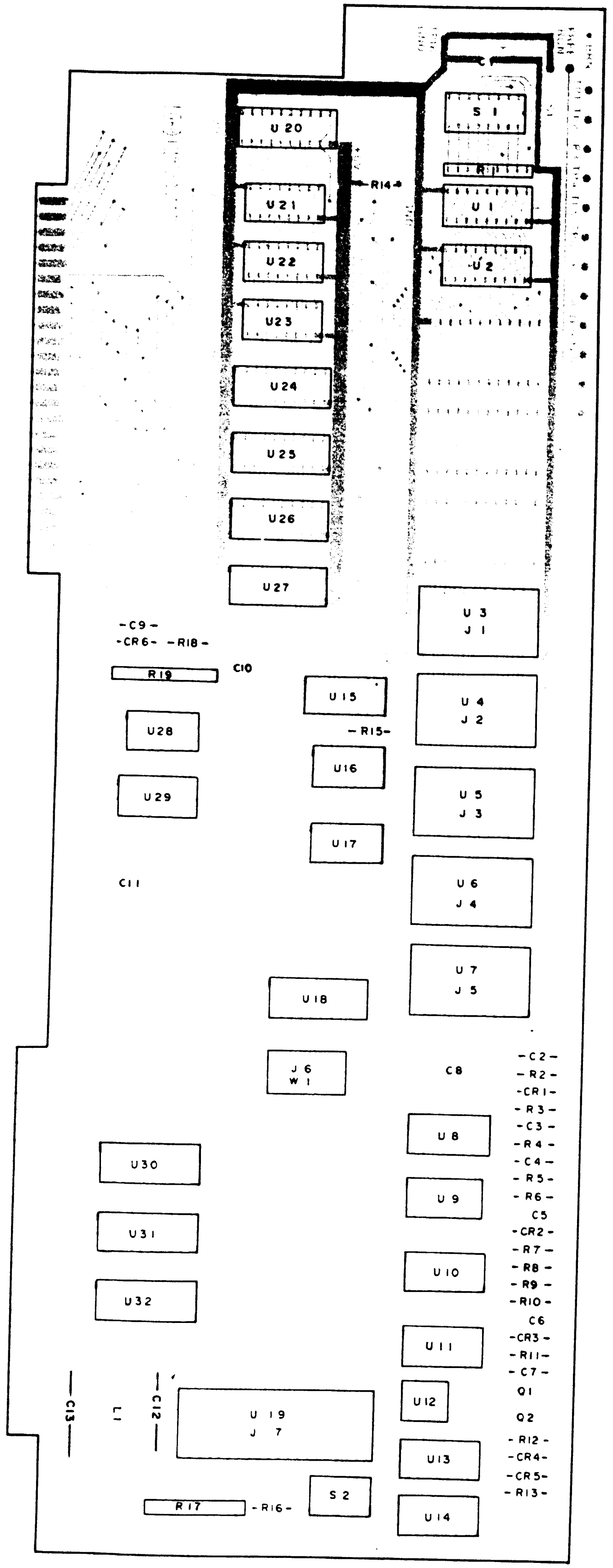
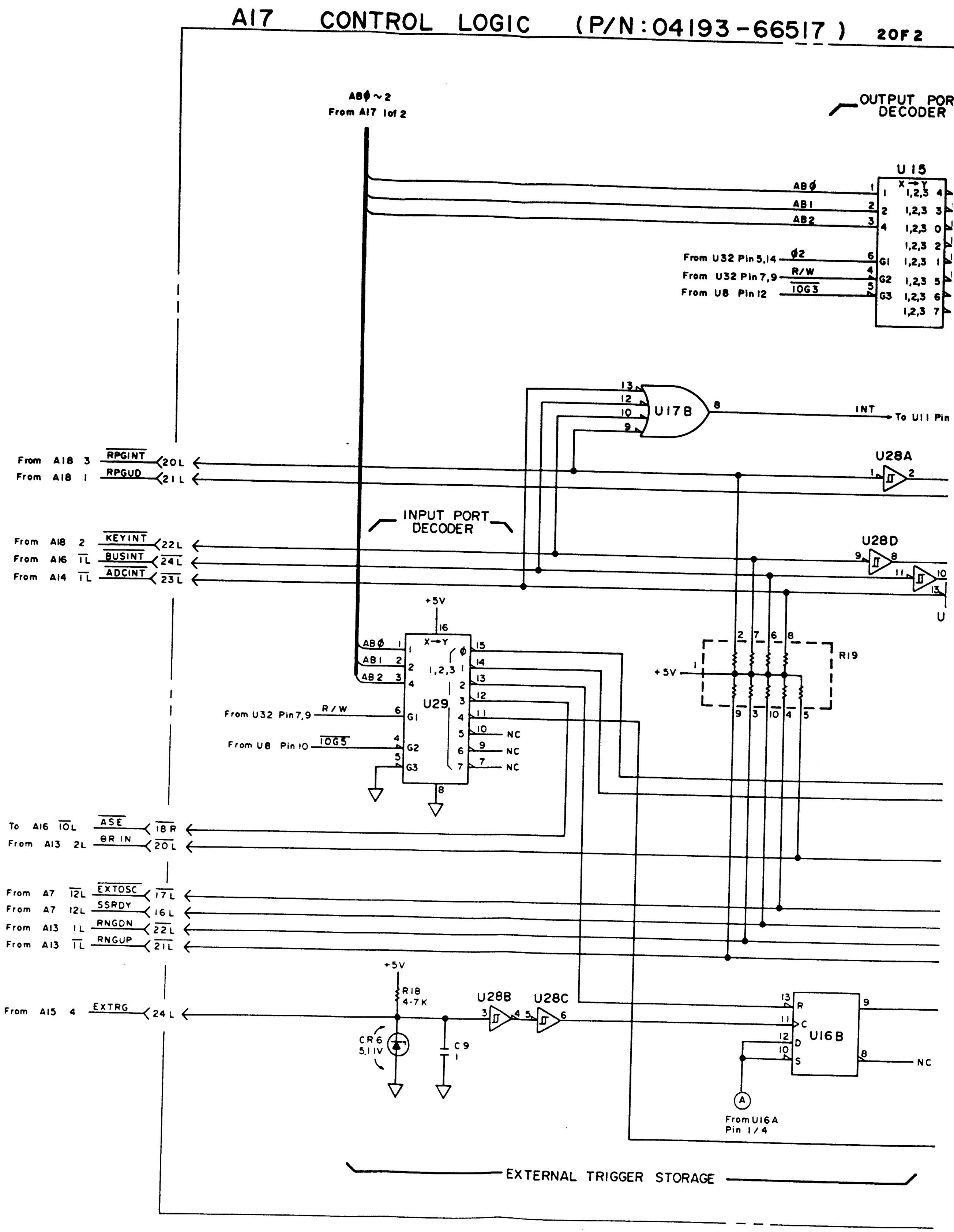
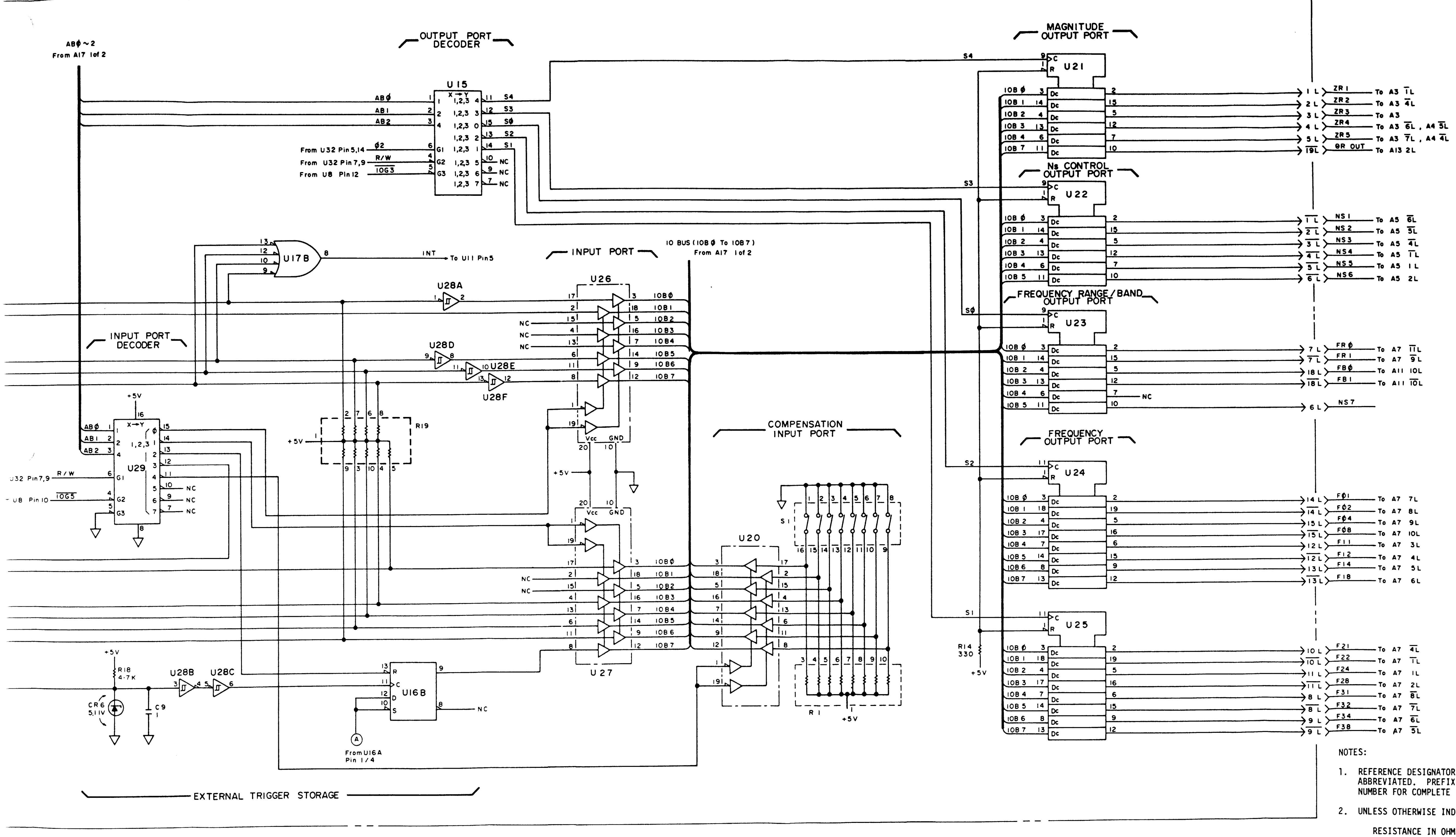


Figure 8-70. A17 Control Logic Board Assembly Component Locations.



# 7 CONTROL LOGIC (P/N:04193-66517) 2OF2



NOTES:

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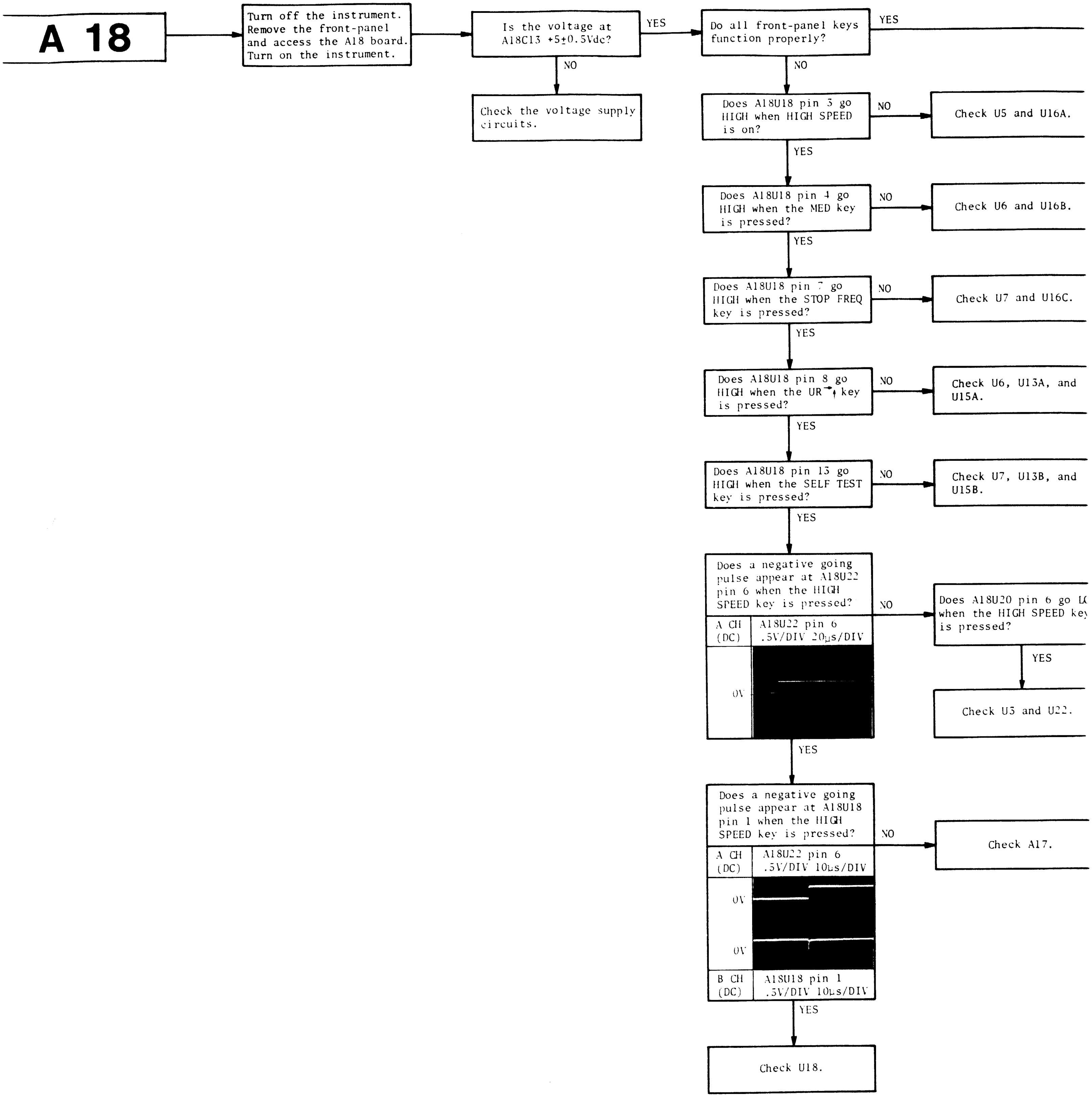
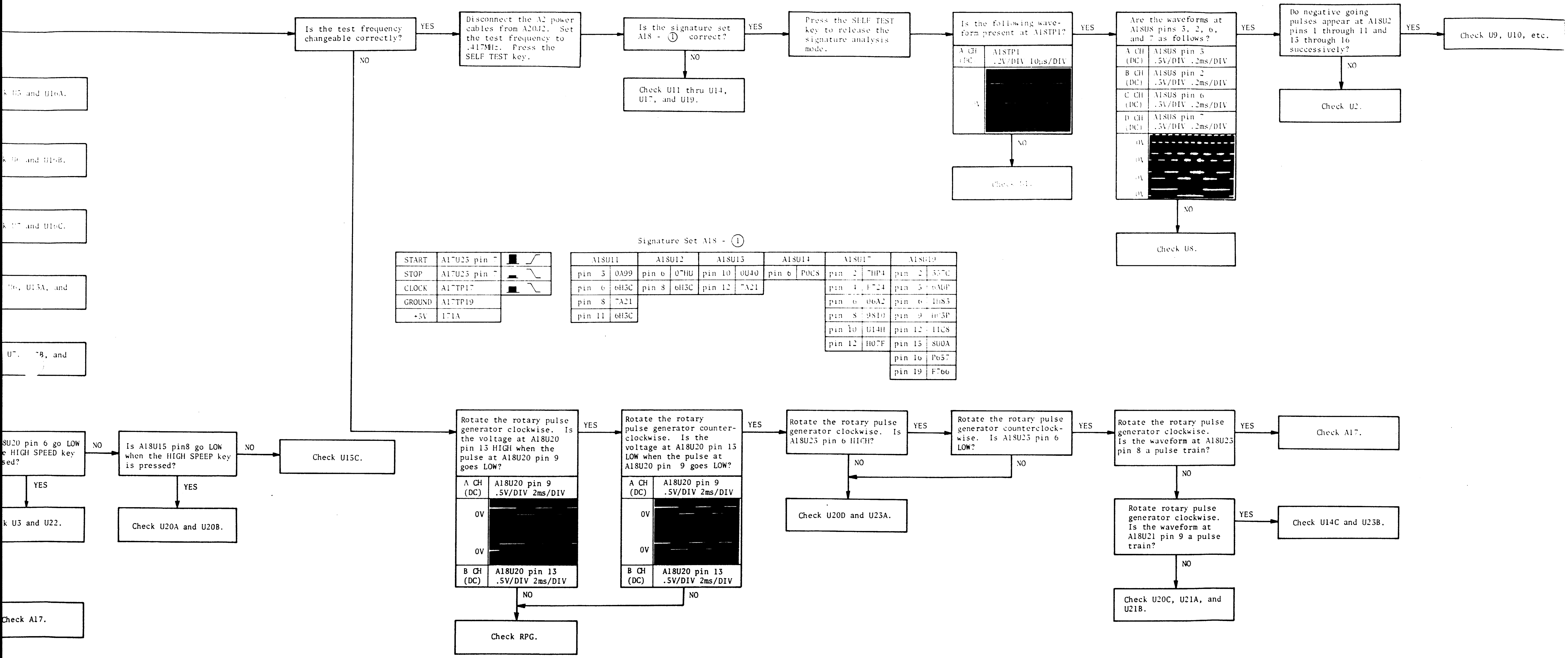
2. UNLESS OTHERWISE INDICATED:

   RESISTANCE IN OHMS (Ω)
   CAPACITANCE IN MICROFARADS (μF)
   INDUCTANCE IN MICROHENRIES (μH)

Figure 8-71. A17 Control Logic Board Assembly Schematic Diagram (Sheet 2 of 2).


A 18
Turn off the instrument. Remove the front-panel and access the A18 board. Turn on the instrument.
Is the voltage at A18C13 +5±0.5Vdc?
YES
NO
Check the voltage supply circuits.
Do all front-panel keys function properly?
YES
NO
Does A18U18 pin 3 go HIGH when HIGH SPEED is on?
NO
Check U5 and U16A.
YES
Does A18U18 pin 4 go HIGH when the MED key is pressed?
NO
Check U6 and U16B.
YES
Does A18U18 pin 7 go HIGH when the STOP FREQ key is pressed?
NO
Check U7 and U16C.
YES
Does A18U18 pin 8 go HIGH when the UR key is pressed?
NO
Check U6, U13A, and U15A.
YES
Does A18U18 pin 13 go HIGH when the SELF TEST key is pressed?
NO
Check U7, U13B, and U15B.
YES
Does a negative going pulse appear at A18U22 pin 6 when the HIGH SPEED key is pressed?
A CH (DC)
A18U22 pin 6 .5V/DIV 20µs/DIV
0V
NO
Does A18U20 pin 6 go L when the HIGH SPEED key is pressed?
YES
Check U3 and U22.
YES
Does a negative going pulse appear at A18U18 pin 1 when the HIGH SPEED key is pressed?
A CH (DC)
A18U22 pin 6 .5V/DIV 10µs/DIV
0V
0V
B CH (DC)
A18U18 pin 1 .5V/DIV 10µs/DIV
NO
Check A17.
YES
Check U18.



Signature Set A18 - ①

| | | |
|---|---|---|
| START | A17U25 pin 7 | ▇ ╱ |
| STOP | A17U25 pin 7 | ▁ ╲ |
| CLOCK | A17TP17 | ▇ ╲ |
| GROUND | A17TP19 | |
| +5V | 171A | |

| A18U11 | | A18U12 | | A18U13 | | A18U14 | | A18U17 | | A18U19 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| pin 3 | 0A99 | pin 6 | 07HU | pin 10 | 0U40 | pin 6 | P0CS | pin 2 | 7HP4 | pin 2 | 337C |
| pin 6 | 6H3C | pin 8 | 6H3C | pin 12 | 7A21 | | | pin 4 | F724 | pin 3 | 6AUP |
| pin 8 | 7A21 | | | | | | | pin 6 | 06A2 | pin 6 | 1H83 |
| pin 11 | 6H3C | | | | | | | pin 8 | 9810 | pin 9 | H03P |
| | | | | | | | | pin 10 | U14H | pin 12 | 11C8 |
| | | | | | | | | pin 12 | H07F | pin 15 | 8U0A |
| | | | | | | | | | | pin 16 | P657 |
| | | | | | | | | | | pin 19 | F766 |

Figure 8-69. A18 Board Troubleshooting Flow Chart.

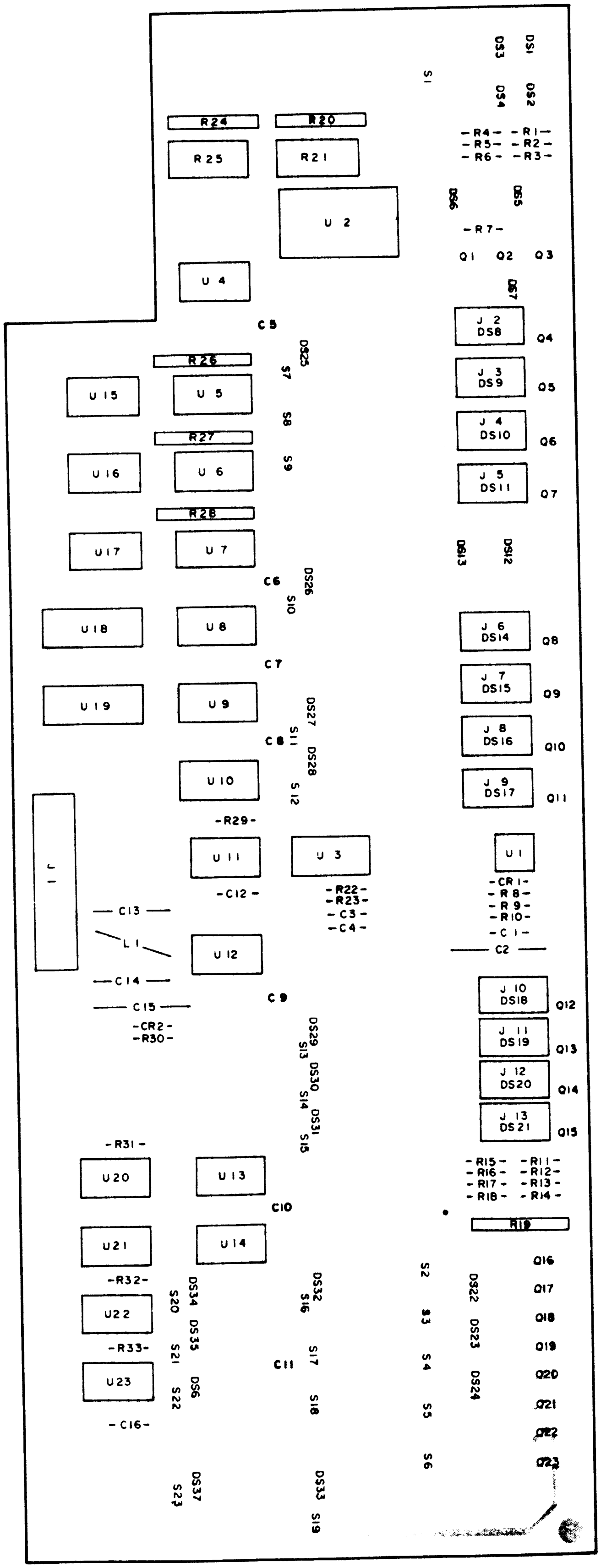
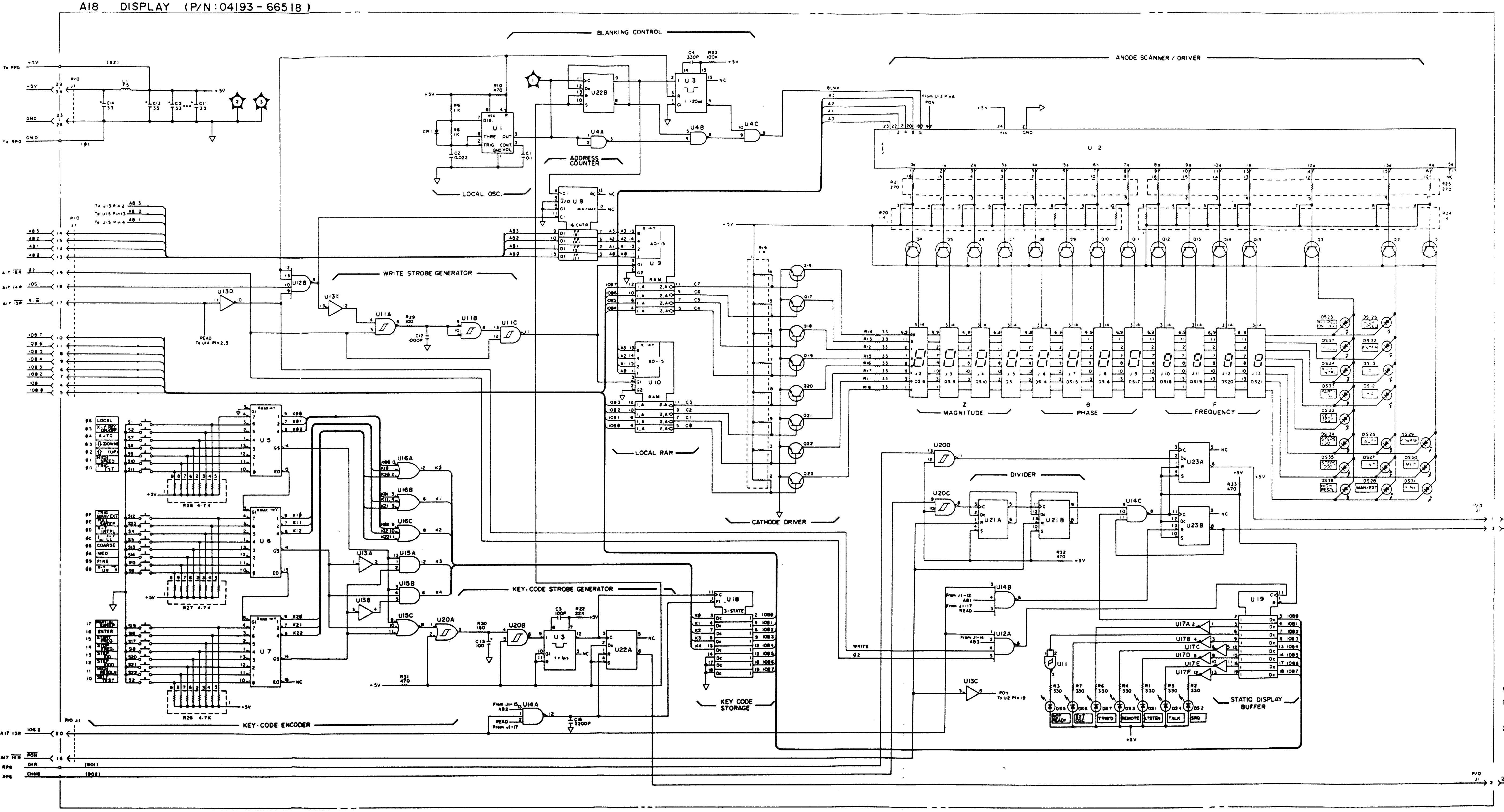


Figure 8-73. A18 Display Board Assembly Component Locations.



NOTES:

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2. UNLESS OTHERWISE INDICATED:

RESISTANCE IN OHMS (Ω)
CAPACITANCE IN MICROFARADS (μF)
INDUCTANCE IN MICROHENRIES (μH)

**Figure 8-74.** A18 Display Board Assembly Schematic D

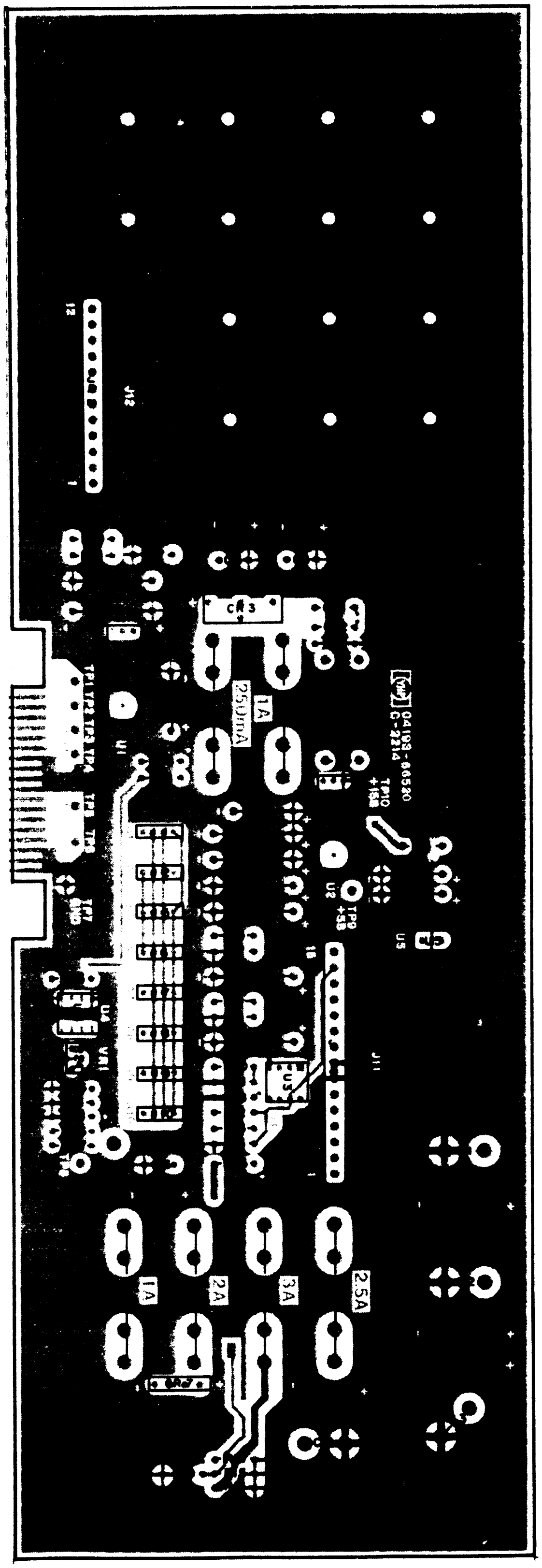
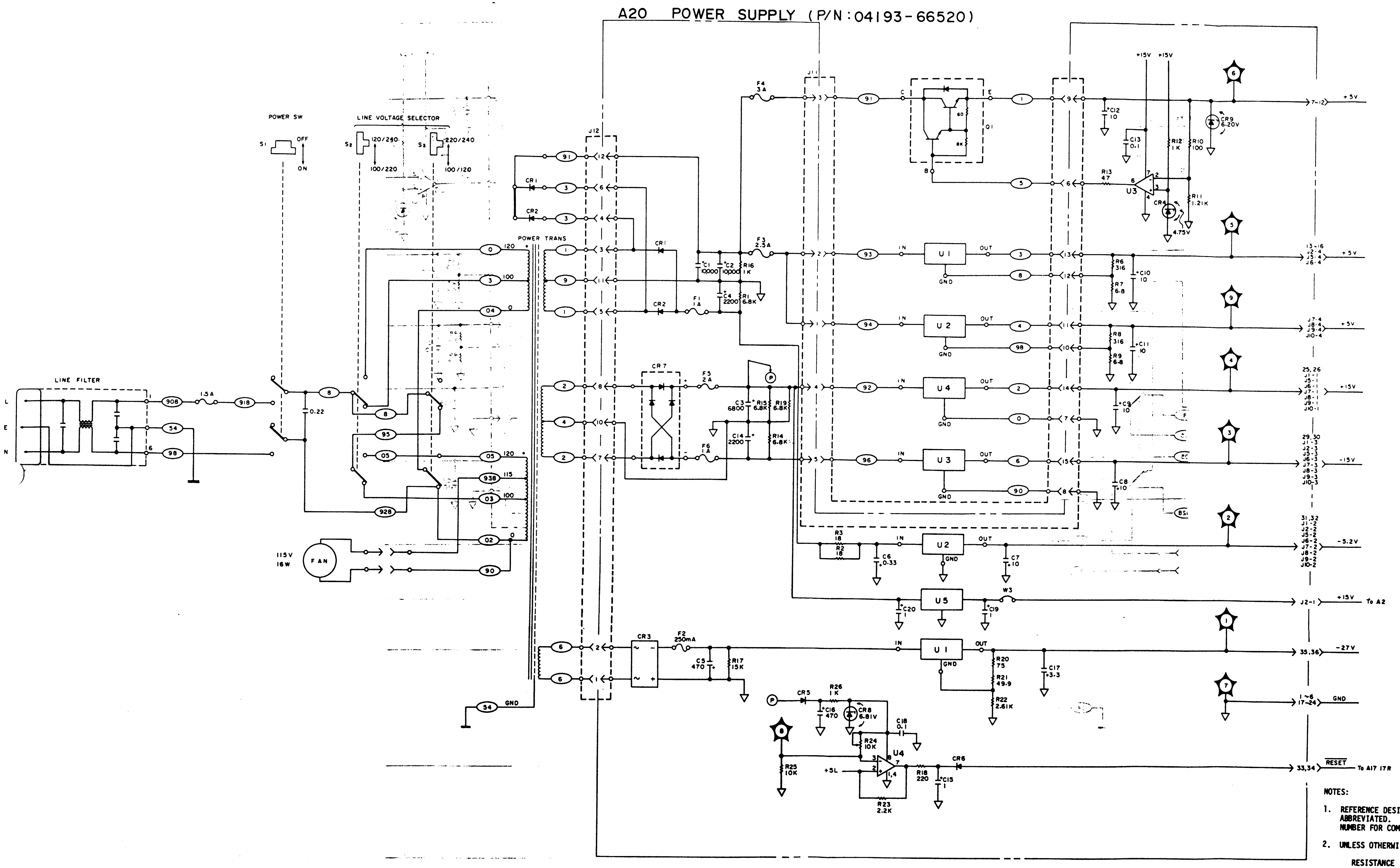


Figure 8-75. A20 Power Supply Board Assembly Component Locations.



NOTES:

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2. UNLESS OTHERWISE INDICATED:

   RESISTANCE IN OHMS (Ω)
   CAPACITANCE IN MICROFARADS (μF)
   INDUCTANCE IN MICROHENRIES (μH)

Figure 8-76. A20 Power Supply Board Assembly Schematic Di