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This manual applies directly to instruments with
serial numbers prefixed 1850J and above.

SERIAL NUMBERS

(Including Options 001, 002, 003, 004 and 101)

MULTI-FREQUENCY LCR METER

MODEL 4274A

SERVICE MANUAL



Section	Title	Page	Section	Title	Page
IV	PERFORMANCE TESTS	4-1	V	A3 Test Signal Level	5-17
4-1	Introduction	4-1	5-29	Monitor Adjuster	5-17
4-3	Equipment Required	4-1	5-30	A1 Range Resistor and A4 Buffer Amp Tracking	5-19
4-5	Test Record	4-1	5-31	A1 Range Resistor Phase	5-21
4-7	Calibration Cycle	4-1	5-32	A21 Internal DC Bias Supply	5-23
4-9	Accuracy Test Considerations	4-2	5-33	A23 Internal DC Bias Supply	5-24
4-9	Accuracy Test Standards	4-4		Adjustment (0 to ±100V)	5-24
4-9	Test Frequency Accuracy Test	4-6			
4-11	Test Signal Level	4-6			
4-13	Self-Operating Test	4-8			
4-15	Capacitance Accuracy Test	4-11			
4-17	Resistance Accuracy Test	4-14			
4-19	Inductance Accuracy Test	4-14			
4-21	Frequency-phase (Confirmation Test)	4-16			
4-23	Accuracy Test	4-18			
4-25	Int DC Bias	4-20			
4-27	HP-IB Interface Test	4-23			
	Supply Test (Option 002)	4-21			
	Supply Test (Option 001)	4-20			
	Int DC Bias	4-18			
	Accuracy Test	4-16			
	Frequency-phase	4-16			
	(Confirmation Test)	4-16			
	Inductance Accuracy Test	4-14			
	Resistance Accuracy Test	4-14			
	Capacitance Accuracy Test	4-11			
	Self-Operating Test	4-8			
	Variable Range Test	4-7			
	Test Signal Level	4-6			
	Test Frequency Accuracy Test	4-6			
	Accuracy Test Standards	4-4			
	Accuracy Test Considerations	4-2			
	Calibration Cycle	4-1			
	Test Record	4-1			
	Equipment Required	4-1			
	Introduction	4-1			
	ADJUSTMENT	5-1			
	Introduction	5-1			
	Safety Requirements	5-1			
	Equipment Required	5-1			
	Factory Selected Components	5-1			
	Adjustment Relationships	5-1			
	Adjustment Locations	5-1			
	Initial Operating Procedure	5-4			
	A11 Power Supply Voltage	5-5			
	Adjustment	5-5			
	A5 ADC DC Reference	5-6			
	Adjustment	5-6			
	A4 Process Amplifier	5-6			
	DC Offset Adjustment	5-6			
	Oscillator Adjustment	5-8			
	A6 Oscillator Adjustment	5-8			
	A3 Power Amplifier Adjustment	5-9			
	A2 90° Phase Adjustment	5-10			
	A2 Modulator Zero Offset	5-11			
	A1 Buffer Amplifier	5-11			
	Adjustment	5-12			
	A2 Modulator Zero Offset	5-12			
	Adjustment	5-13			
	A4 x1, x1/2 and x1/4	5-14			
	Attenuator Adjustment	5-14			
	A4 x1, x1/10 and x1/100	5-15			
	Attenuator Adjustment	5-15			
	ADJUSTMENT	5-1			
	Introduction	5-1			
	Safety Requirements	5-1			
	Equipment Required	5-1			
	Factory Selected Components	5-1			
	Adjustment Relationships	5-1			
	Adjustment Locations	5-1			
	Initial Operating Procedure	5-4			
	A11 Power Supply Voltage	5-5			
	Adjustment	5-5			
	A5 ADC DC Reference	5-6			
	Adjustment	5-6			
	A4 Process Amplifier	5-6			
	DC Offset Adjustment	5-6			
	Oscillator Adjustment	5-8			
	A6 Oscillator Adjustment	5-8			
	A3 Power Amplifier Adjustment	5-9			
	A2 90° Phase Adjustment	5-10			
	A2 Modulator Zero Offset	5-11			
	A1 Buffer Amplifier	5-11			
	Adjustment	5-12			
	A2 Modulator Zero Offset	5-12			
	Adjustment	5-13			
	A4 x1, x1/2 and x1/4	5-14			
	Attenuator Adjustment	5-14			
	A4 x1, x1/10 and x1/100	5-15			
	Attenuator Adjustment	5-15			
	ADJUSTMENT	5-1			
	Introduction	5-1			
	Safety Requirements	5-1			
	Equipment Required	5-1			
	Factory Selected Components	5-1			
	Adjustment Relationships	5-1			
	Adjustment Locations	5-1			
	Initial Operating Procedure	5-4			
	A11 Power Supply Voltage	5-5			
	Adjustment	5-5			
	A5 ADC DC Reference	5-6			
	Adjustment	5-6			
	A4 Process Amplifier	5-6			
	DC Offset Adjustment	5-6			
	Oscillator Adjustment	5-8			
	A6 Oscillator Adjustment	5-8			
	A3 Power Amplifier Adjustment	5-9			
	A2 90° Phase Adjustment	5-10			
	A2 Modulator Zero Offset	5-11			
	A1 Buffer Amplifier	5-11			
	Adjustment	5-12			
	A2 Modulator Zero Offset	5-12			
	Adjustment	5-13			
	A4 x1, x1/2 and x1/4	5-14			
	Attenuator Adjustment	5-14			
	A4 x1, x1/10 and x1/100	5-15			
	Attenuator Adjustment	5-15			
	ADJUSTMENT	5-1			
	Introduction	5-1			
	Safety Requirements	5-1			
	Equipment Required	5-1			
	Factory Selected Components	5-1			
	Adjustment Relationships	5-1			
	Adjustment Locations	5-1			
	Initial Operating Procedure	5-4			
	A11 Power Supply Voltage	5-5			
	Adjustment	5-5			
	A5 ADC DC Reference	5-6			
	Adjustment	5-6			
	A4 Process Amplifier	5-6			
	DC Offset Adjustment	5-6			
	Oscillator Adjustment	5-8			
	A6 Oscillator Adjustment	5-8			
	A3 Power Amplifier Adjustment	5-9			
	A2 90° Phase Adjustment	5-10			
	A2 Modulator Zero Offset	5-11			
	A1 Buffer Amplifier	5-11			
	Adjustment	5-12			
	A2 Modulator Zero Offset	5-12			
	Adjustment	5-13			
	A4 x1, x1/2 and x1/4	5-14			
	Attenuator Adjustment	5-14			
	A4 x1, x1/10 and x1/100	5-15			
	Attenuator Adjustment	5-15			
	ADJUSTMENT	5-1			
	Introduction	5-1			
	Safety Requirements	5-1			
	Equipment Required	5-1			
	Factory Selected Components	5-1			
	Adjustment Relationships	5-1			
	Adjustment Locations	5-1			
	Initial Operating Procedure	5-4			
	A11 Power Supply Voltage	5-5			
	Adjustment	5-5			
	A5 ADC DC Reference	5-6			
	Adjustment	5-6			
	A4 Process Amplifier	5-6			
	DC Offset Adjustment	5-6			
	Oscillator Adjustment	5-8			
	A6 Oscillator Adjustment	5-8			
	A3 Power Amplifier Adjustment	5-9			
	A2 90° Phase Adjustment	5-10			
	A2 Modulator Zero Offset	5-11			
	A1 Buffer Amplifier	5-11			
	Adjustment	5-12			
	A2 Modulator Zero Offset	5-12			
	Adjustment	5-13			
	A4 x1, x1/2 and x1/4	5-14			
	Attenuator Adjustment	5-14			
	A4 x1, x1/10 and x1/100	5-15			
	Attenuator Adjustment	5-15			
	ADJUSTMENT	5-1			
	Introduction	5-1			
	Safety Requirements	5-1			
	Equipment Required	5-1			
	Factory Selected Components	5-1			
	Adjustment Relationships	5-1			
	Adjustment Locations	5-1			
	Initial Operating Procedure	5-4			
	A11 Power Supply Voltage	5-5			
	Adjustment	5-5			
	A5 ADC DC Reference	5-6			
	Adjustment	5-6			
	A4 Process Amplifier	5-6			
	DC Offset Adjustment	5-6			
	Oscillator Adjustment	5-8			
	A6 Oscillator Adjustment	5-8			
	A3 Power Amplifier Adjustment	5-9			
	A2 90° Phase Adjustment	5-10			
	A2 Modulator Zero Offset	5-11			
	A1 Buffer Amplifier	5-11			
	Adjustment	5-12			
	A2 Modulator Zero Offset	5-12			
	Adjustment	5-13			
	A4 x1, x1/2 and x1/4	5-14			
	Attenuator Adjustment	5-14			
	A4 x1, x1/10 and x1/100	5-15			
	Attenuator Adjustment	5-15			
	ADJUSTMENT	5-1			
	Introduction	5-1			
	Safety Requirements	5-1			
	Equipment Required	5-1			
	Factory Selected Components	5-1			
	Adjustment Relationships	5-1			
	Adjustment Locations	5-1			
	Initial Operating Procedure	5-4			
	A11 Power Supply Voltage	5-5			
	Adjustment	5-5			
	A5 ADC DC Reference	5-6			
	Adjustment	5-6			
	A4 Process Amplifier	5-6			
	DC Offset Adjustment	5-6			
	Oscillator Adjustment	5-8			
	A6 Oscillator Adjustment	5-8			
	A3 Power Amplifier Adjustment	5-9			
	A2 90° Phase Adjustment	5-10			
	A2 Modulator Zero Offset	5-11			
	A1 Buffer Amplifier	5-11			
	Adjustment	5-12			
	A2 Modulator Zero Offset	5-12			
	Adjustment	5-13			
	A4 x1, x1/2 and x1/4	5-14			
	Attenuator Adjustment	5-14			
	A4 x1, x1/10 and x1/100	5-15			
	Attenuator Adjustment	5-15			
	ADJUSTMENT	5-1			
	Introduction	5-1			
	Safety Requirements	5-1			
	Equipment Required	5-1			
	Factory Selected Components	5-1			
	Adjustment Relationships	5-1			
	Adjustment Locations	5-1			
	Initial Operating Procedure	5-4			
	A11 Power Supply Voltage	5-5			
	Adjustment	5-5			
	A5 ADC DC Reference	5-6			
	Adjustment	5-6			
	A4 Process Amplifier	5-6			
	DC Offset Adjustment	5-6			
	Oscillator Adjustment	5-8			
	A6 Oscillator Adjustment	5-8			
	A3 Power Amplifier Adjustment	5-9			
	A2 90° Phase Adjustment	5-10			
	A2 Modulator Zero Offset	5-11			
	A1 Buffer Amplifier	5-11			
	Adjustment	5-12			
	A2 Modulator Zero Offset	5-12			
	Adjustment	5-13			
	A4 x1, x1/2 and x1/4	5-14			
	Attenuator Adjustment	5-14			
	A4 x1, x1/10 and x1/100	5-15			
	Attenuator Adjustment	5-15			
	ADJUSTMENT	5-1			
	Introduction	5-1			
	Safety Requirements	5-1			
	Equipment Required	5-1			
	Factory Selected Components	5-1			
	Adjustment Relationships	5-1			
	Adjustment Locations	5-1		</	

8-31.	A3 Power Amplifier Assembly	8-54
	Troubleshooting Tree	8-54
8-32.	A3 Power Amplifier Assembly	8-55
	Component Locations	8-55
8-33.	A3 Power Amplifier Assembly	8-55
	Schematic Diagram	8-55
8-34.	A4 Process Amplifier Assembly	8-56
	Troubleshooting Tree	8-56
8-35.	A4 Process Amplifier Assembly	8-57
	Component Locations	8-57
8-36.	A4 Process Amplifier Assembly	8-57
	Schematic Diagram	8-57
8-37.	A5 A-D Converter Assembly	8-58
	Troubleshooting Tree	8-58
8-38.	A5 A-D Converter Assembly	8-59
	Component Locations	8-59
8-39.	A5 A-D Converter Assembly	8-59
	Schematic Diagram	8-59
8-40.	A6 Oscillator Assembly	8-60
	Troubleshooting Tree	8-60
8-41.	A6 Oscillator Assembly	8-61
	Component Locations	8-61
8-42.	A6 Oscillator Assembly	8-61
	Schematic Diagram	8-61
8-43.	A7 Peripheral Control Assembly	8-63
	Component Locations	8-63
8-44.	A7 Peripheral Control Assembly	8-63
	Schematic Diagram	8-63
8-45.	A8 Display Control Assembly	8-65
	Component Locations	8-65
8-46.	A8 Display Control Assembly	8-65
	Schematic Diagram	8-65
8-47.	A9 MPU Assembly	8-67
	Component Locations	8-67
8-48.	A9 MPU Assembly	8-67
	Schematic Diagram	8-67
8-49.	A10 Display and Key Assembly	8-69
	Component Locations	8-69
8-50.	A10 Display and Key Assembly	8-69
	Schematic Diagram	8-69
8-51.	A11 Power Supply Assembly	8-71
	Component Locations	8-71
8-52.	A11 Power Supply Assembly	8-71
	Schematic Diagram	8-71
8-53.	A21 DC Bias ($\pm 35V$) Assembly	8-73
	Component Locations	8-73
8-54.	A21 DC Bias ($\pm 35V$) Assembly	8-73
	Schematic Diagram	8-73
8-55.	A22 HP-IB Assembly	8-75
	Component Locations	8-75
8-56.	A22 HP-IB Assembly	8-75
	Schematic Diagram	8-75
8-57.	A23 DC Bias ($\pm 100V$) Assembly	8-77
	Component Locations	8-77
8-58.	A23 DC Bias ($\pm 100V$) Assembly	8-79
	Schematic Diagram	8-79

8-1.	Basic Block Diagram	8-2
8-2.	Relationship of DUT Impedance and Source Impedance	8-3
8-3.	A-D Conversion	8-4
8-4.	Concept of Vector Ratio Measurement	8-6
8-5.	Relationship of Range Resistor and Gain Selection	8-10
8-6.	Analog Section Block Diagram	8-13
8-7.	Control Section Block Diagram	8-15
8-8.	Timing Diagram	8-17
8-9.	How to Use Troubleshooting Guide	8-19
8-10.	Signature Analysis Guide	8-24
8-11.	A10 Key and Display Board Disassembly	8-26
8-12.	Schematic Diagram Notes	8-28
8-13.	Adjustment Locations	8-29
8-14.	Assembly Locations	8-30
8-15.	Analog and Digital Sections Isolation Flow	8-31
8-16.	Analog Section Troubleshooting	8-33
8-17.	Digital Section Troubleshooting to Assembly Level	8-35
8-18.	Digital Section Troubleshooting Flow Diagram AL	8-37
8-19.	Digital Section Troubleshooting Flow Diagram BL	8-39
8-20.	Digital Section Troubleshooting Flow Diagram CL	8-41
8-21.	Digital Section Troubleshooting Flow Diagram DL	8-43
8-22.	Digital Section Troubleshooting Flow Diagram EL	8-45
8-23.	Digital Section Troubleshooting Flow Diagram FL	8-47
8-24.	Digital Section Troubleshooting Flow Diagram GL	8-49
8-25.	A1 Range Resistor and Null Detector Assembly	8-50
8-26.	A1 Range Resistor and Null Detector Assembly Troubleshooting Tree	8-51
8-27.	A1 Range Resistor and Null Detector Assembly Component Locations	8-51
8-28.	A2 Modulator Assembly Schematic Diagram	8-51
8-29.	A2 Modulator Assembly Troubleshooting Tree	8-52
8-30.	A2 Modulator Assembly Component Locations	8-53
8-31.	A2 Modulator Assembly Schematic Diagram	8-53

LIST OF ILLUSTRATIONS

Page

Title

Number

Title

Number

Equipment	Critical Specifications	Recommended Model/Note
Capacitance Standards	1pF ±0.03% 10pF ±0.03% 100pF ±0.03% 1000pF ±0.03% Usable frequencies: up to 100K	HP 16381A HP 16382A HP 16383A HP 16384A
Resistance Standards	0.1Ω ±10% 1Ω ±10% 10Ω ±10% 100Ω ±0.03% 1000Ω ±0.03% 10KΩ ±0.03% 100KΩ ±0.03% Usable frequencies: up to 10MHz	HP 16074A Standard Resistor Set
Frequency Counter	Maximum frequency: >10MHz Accuracy: 0.001% (1×10^{-5})	HP 5314A
RF Voltmeter	Voltage range: 1mV to 3V rms f.s. Bandwidth: 10KHz to 10MHz Accuracy: 1%	HP 3400A
DC Voltmeter	Voltage range: 10mV to 100V f.s. Sensitivity: 0.1mV min. Accuracy: 0.05% Input impedance: >10MΩ	HP 3465A/B
Test Cable	BNC to BNC cable	1 ea.
Test Cable	BNC to BNC cable (<10cm) (Replaceable by Open Termination included in HP 16074A).	2 ea.
Bias Controller	(Needed for Option 001 or 002 Internal DC Bias Supply Test).	HP 16023B
Test Fixture	(Needed for Option 001 Internal DC Bias Supply Test).	HP 16047A
Test Leads	(Needed for Option 002 Internal DC Bias Supply Test).	HP 16048A
HP-IB Controller	(Needed for Option 101 HP-IB Interface Test).	HP 9825A/ W 98210A/ W 98213A/ W 98034A
Signature Analyzer		HP 5004A *
Oscilloscope	Bandwidth: 10MHz min Vertical Sensitivity: 5mV/div Horizontal Sweep Rate: 1ms/div	HP 1740A *

*----- is used for troubleshooting.

Table 4-1. Recommended Performance Test Equipment.

**SECTION IV
PERFORMANCE TESTS**

4-1. INTRODUCTION.

Note

4-2. This section provides the check procedures to verify the 4274A specifications listed in Table 1-1. All tests can be performed without access to the interior of the instrument. A simpler operational test is presented in Section III under Self Test (paragraph 3-5). The performance test procedures in this section can also be used to do an incoming inspection of the instrument and to verify whether the instrument meets its specified performance after troubleshooting or making adjustments. If specifications are found to be out of limits, check that controls are properly set, and then proceed to adjustments or troubleshooting.

Note

Allow a 30-minute warm-up and stabilization period before conducting any performance test.

4-3. EQUIPMENT REQUIRED.

4-4. Equipment required for the performance tests is listed in Table 4-1 Recommended Performance Test Equipment. Any equipment whose characteristics equal the critical specifications given in the table may be substituted for the recommended model(s). Accuracy checks in this section use 16380 series standard capacitors (16381A, 16382A, 16383A and 16384A) and the 16074A Standard Resistor Set. These accessory standards have the specifications which satisfy the performance requirements for the accuracy checks and are especially fit for use as 4274A accuracy test standards.

4-5. TEST RECORD. Results of the performance tests may be tabulated on the Test Record at the end of these procedures. The Test Record lists all the tested specifications and their acceptance limits. Test results recorded at incoming inspection can be used for comparison in periodic maintenance and troubleshooting and after repairs or adjustments.

4-7. CALIBRATION CYCLE.

4-8. This instrument requires periodic verification of performance. Depending on the use and environmental conditions, the instrument should be checked with the following performance tests at least once every year. To maximize instrument "up time", the recommended preventive maintenance frequency for the 4274A is twice a year.

Performance Test Table

Accuracy Test Considerations	4-2
Accuracy Test Standards	4-4
Test Frequency Accuracy Test	4-6
Test Signal Level Test	4-7
Self Operating Test	4-8
Capacitance Accuracy Test	4-11
Resistance Accuracy Test	4-14
Inductance Accuracy Test	4-16
Frequency-Phase Accuracy Test	4-18
Opt. 001 Int. DC Bias Test	4-20
Opt. 002 Int. DC Bias Test	4-21
Opt. 101 HP-IB Interface Test	4-23

As discussed above, each measurement parameter is interrelated with the impedance (or admittance) value so the accuracies for each one of its resistive and reactive measurement parameters, e.g. resistance and capacitance from the lowest through the highest test frequencies.

It is important to note that the accuracy is based on arithmetic relationships as are the parameter relationships. This theoretical background is pertinent to the corroboration of the accuracy evaluations which are done by simplified test procedures instead of time-consuming-tests on the 900 (approximately) possible combinations of the fundamental test parameters (measurement parameter, frequency, range, etc.).

Where, C_x is capacitance value of sample,
 f is measurement frequency,
 X_m is measured reactance value of sample.

$$C_x = \frac{1}{2\pi f X_m}$$

The 4274A, in accord with its measurement principles, detects the vector impedance (or its reciprocal value: admittance) of the unknown sample to be tested. The various measurement data provided, with respect to the 13 possible measurement parameters (L, C, R, D, etc.), are arithmetically derived from measured values of the right-angle vector components (resistance and reactance). For example, the capacitance value of a sample is calculated by the following equation relative to the capacitance-to-reactance values:

Theoretical Background of Accuracy Checks.

This paragraph discusses how the 4274A accuracy is tested and verified. As the 4274A has (because of its wider measurement capabilities), to a great extent, expanded the selectable measurement parameters, frequency and range along with high accuracy (as its features), the accuracy check ranges that need to be verified include some critical measuring regions where accuracies are difficult to be directly compared to the specifications by using standards.

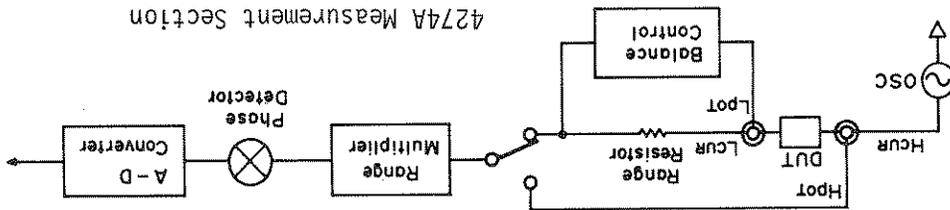
Measurement accuracies are tested by reading the displays when measuring standard capacitors, inductors, resistors and other devices as references whose values are calibrated and certified by transfer of values from national standards. Certain 4274A measurement range capabilities are out of the applicable ranges of the practical standards, so such standards, to satisfy the requirements for checking on all the 4274A ranges, will be unavailable. The method then, is to check accuracies on the specific ranges at which the standards are applicable. Further corroboration for the entire range (to the instrument performance limits) is done by particular tests for evaluating full range accuracy.

Corroboration Check Considerations

The test for measurement accuracy with respect to the vector impedance is made on specific ranges using standards, and on the other ranges by using alternate methods which are (theoretically and experimentally) proven to be practicable for verification of the ranges which otherwise would be uncerifiable because of the limitations of the standards. If the end results of these checks meet all the individual test limits, the instrument should satisfy its specified accuracies across its entire range. Then, how can these methods be explained? Let's look at the performance test articles.

Accuracy test procedures include checks for the following circuit sections:

- 1) Bridge Circuit Range Resistors.
- 2) Range Multiplier.
- 3) Bridge Balance Control.
- 4) Phase Detector.
- 5) A-D (Analog to Digital) Converter.



4274A Measurement Section

CAPACITANCE ACCURACY TEST verifies Range Resistor accuracy for the reactive impedance measurement from the lowest through the highest test frequencies. (Balance Control linearity and normal operations of the Phase Detector and A-D Converter are also verified).

RESISTANCE ACCURACY TEST does its verification in a manner similar to that for the Capacitance Accuracy Test, but for resistive impedance measurements. Thus, accuracies for both reactive and resistive components of the vector impedance are verified.

SELF OPERATING TEST verifies the multiples of the Range Multiplier which extends the measurement ranges. The A-D Converter accuracy is also checked by this combined self-test function which enables automatic check of each one of these circuits.

FREQUENCY-PHASE ACCURACY TEST verifies phase-flatness characteristics (minimum phase shift) of the overall measurement section and Phase Detector phase accuracy from the lowest through the highest test frequencies.

Note

A set of detection phases, each different by 90 degrees, is used in the Phase Detector. If their relative phase angles are exactly 90 degrees, the phase relationships of the detection phases on the vector DUT Voltage (or current) detected have no influence on the resultant accuracy. The accuracy of the right-angle detection phases is verified by both this test and dissipation factor checks associated with the Capacitance Accuracy Test.

The 4274A inductance accuracy is theoretically certified if the capacitance accuracy meets the specifications. Generally, inductors have unwanted parasitic impedances to some extent (that is, coil resistance and distributed capacitance). As these residuals significantly dominate the inductance values at high frequencies, inductance standards useable in RF region (higher than about 100kHz) are substantially unavailable. Inductors with higher inductance values have lower frequency limits.

3) Standard Inductors.

The 0.1 Ω , 1 Ω and 10 Ω resistors are used as the (pure resistance) reference samples in the Frequency-Phase Accuracy Test.

Note

The standard resistors used for accuracy checks should be practically pure resistances and should maintain an extremely low order of residual reactance at frequencies to 100kHz. The HP 16074A Standard Resistor Set, especially designed as standards useable over a broad frequency region, with four terminal pair configurations, is suitable for the accuracy checks. These thin film resistors, which ensure negligible low stray capacitance and less skin effect, provide the standard resistance values of 0.1 Ω , 1 Ω and 10 Ω at $\pm 10\%$ and 100 Ω , 1000 Ω , 10k Ω and 100k Ω at $\pm 0.01\%$ calibration accuracies to 10MHz (1MHz at 100k Ω). Open (OS) and short (SS) terminations which facilitate optimum zero offset adjustment as well as two quasi-inductors for inductance accuracy checks are included in the 16074A.

2) Standard Resistors.

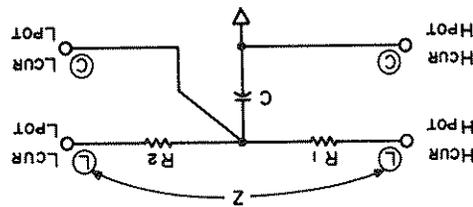
A high capacitance standard, useable in the high frequency region, is unavailable. Here's why:
A 10pF capacitor, for example, has an impedance value of 0.16 Ω at 100kHz. A capacitance standard would have, in addition, residual impedances which could not be neglected when compared to the pure standard capacitor at the higher operating frequency ranges is not practicable.

Note

The HP 16380 series standard capacitors, featuring the four terminal pair configuration, are recommended for use as performance test standards. The four standard capacitors 16381A (1pF), 16382A (10pF), 16383A (100pF) and 16384A (1000pF) are calibrated at 0.01% accuracy (within 0.1% of their nominal capacitance values) at 1kHz. For values at frequencies to 10MHz, an extrapolation of the calibrated values at 1kHz is used (this is based on the careful consideration of their inherent residual parameter values and on the actual test measurement to verify the frequency dependency of the values). Capacitance values at frequencies up to 10MHz are read from the graph given on the data sheet of each standard.

1) Standard Capacitors.

If it is desired to check inductance measurement accuracy on least at one range, a quasi-inductor may be useful as a substitution test sample. The quasi-inductor offers an equivalent inductance (when connected to the 4274A) by a simple network circuit consisting of a capacitor and resistors. A quasi-inductor circuit is shown in the figure below:



$$Z = R_1 + R_2 + j\omega C R_1 R_2$$

The equivalent inductance value is given by the equation:

$$L = C \cdot R_1 \cdot R_2$$

The values of R and C are respectively measured to calculate the equivalent inductance value (prior to the inductance accuracy check). The HP 16074A (quasi-inductors offer the composite inductance values of 100µH and 100mH. Usable frequency ranges for these inductors are given in the table below:

Sample	Usable frequency range	Recommended test frequency
100µH	100kHz to 10MHz	100kHz
100mH	10kHz to 1MHz	10kHz

Note

Component resistors R₁ and R₂ in the quasi circuit may be measured at dc with a high accuracy DMM. These high stability resistors need only be re-calibrated at the recommended calibration period of 6 months. The capacitors should be checked before each test.

GENERAL

The standards should be of the four terminal pair configuration design to provide compatibility with the instrument. This minimizes reduction in reliability of the values due to the effects of the resistors associated with cabling and connections.

- 1) Test limits in above table do not account for reading error contributed by measurement errors in the test equipment.
- 2) If this test fails, the instrument requires troubleshooting.

Note

Frequency setting	Test limits
100Hz	99.99 - 100.01Hz
120Hz	119.99 - 120.01Hz
200Hz	199.98 - 200.02Hz
400Hz	399.96 - 400.04Hz
1.00kHz	999.9 - 1000.1Hz
2.00kHz	1.9998 - 2.0002kHz
4.00kHz	3.9996 - 4.0004kHz
10.0kHz	9.999 - 10.0001kHz
20.0kHz	19.998 - 20.002kHz
40.0kHz	39.996 - 40.004kHz
100kHz	99.99 - 100.01kHz
Opt. Freq.	± 0.01%

Table 4-2. Test Frequency Accuracy Test.

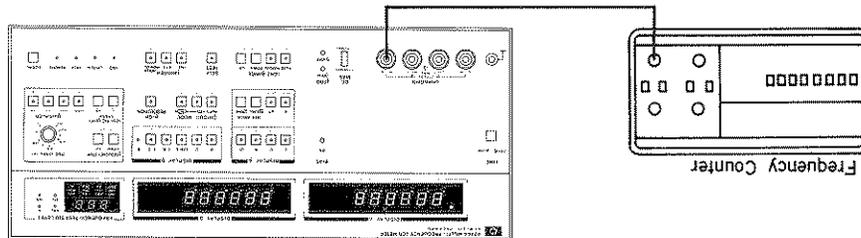
4. Change test frequency setting and read frequency counter display output at each of the 11 spot test frequencies (and any optional frequency). Frequency readouts must be within the test limits given in Table 4-2.
3. Read display output of frequency counter. Frequency readouts must be within 999.9Hz and 1000.1Hz.
2. Set 4274A controls as follows:
 MULTIPLIER X1
 OSC LEVEL fully CW
 Test frequency 1.00kHz
 DC BIAS switch (rear panel) OFF
 Other controls any setting
1. Connect BNC to BNC cable to 4274A UNKNOWN H CUR terminal and to frequency counter input as shown in Figure 4-1.

PROCEDURE:

Frequency Counter HP 5314A.
 Test cable BNC to BNC cable.

EQUIPMENT:

Figure 4-1. Test Frequency Accuracy Test Setup.



4-10. This test verifies that test signal frequencies for 4274A meet the specified frequency accuracy of 0.01%.

4-9. TEST FREQUENCY ACCURACY TEST

PERFORMANCE TESTS



Self test item number (in this case "1" which means the first step) is displayed in DISPLAY A unit indicator as shown below:

Note

3. Press SELF TEST button and then DISPLAY B function D button.
 2. Set test signal frequency to 1.00KHz.
- VERIFY THAT DC BIAS INDICATOR LAMP DOES NOT LIGHT. IF ILLUMINATED, SET REAR PANEL DC BIAS SWITCH TO OFF.

CAUTION

1. Connect L_{CUR} and L_{POT} terminals with a BNC to BNC cable as shown in Figure 4-3. Similarly Connect H_{CUR} and H_{POT} terminals.

PROCEDURE:

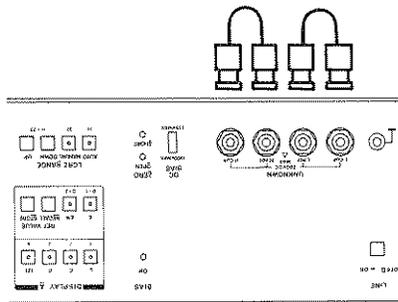
If open (OS) termination of the HP 16074A Standard Resistor set is available, use it instead of BNC to BNC cable.

Note

BNC to BNC cable 10cm long, 2 required.

EQUIPMENT:

Figure 4-3. Self Operating Test Setup.



4-14. The Self-operating Test checks operating conditions of the circuits (Range Multiplier for extending measurement capability to higher and lower ranges; Null Detector for bringing bridge into optimum balance; Buffer Amplifiers for accurately detecting potentials across DUT and range resistor; and Integrator for converting analog measurement quantities into digital) which are especially significant for sustaining the specified accuracies. All the tests on these individual circuits can be accomplished easily and simply with the SELF TEST function. To ascertain that these circuits satisfy the performance requirements for ensuring the specified accuracies, display readouts are compared with severe test limits. Because basic circuit operating conditions related to the accuracy are verified in this test, the instrument should be initially checked with this test for acceptability.

4-13. SELF-OPERATING TEST

PERFORMANCE TESTS

PERFORMANCE TESTS

4. DISPLAY A and DISPLAY B readouts should be within the following test limits:

DISPLAY A ± 160 counts
DISPLAY B ± 160 counts

5. Press DISPLAY B function Q button. Self test item number "2" is displayed.

6. Set test signal level and frequency as follows:

MULTIPLIER x1
OSC LEVEL fully cw
Test frequency 1.00KHz

7. DISPLAY A readout should be within the following test limit:
DISPLAY A -1000.00 ± 160 counts.

8. Change test frequency to 100KHz.

9. DISPLAY B readout should be within the following test limit:
DISPLAY B ± 160 counts.

10. Press DISPLAY B function ESR/G button. Self test item number "3" is displayed.

11. Set test signal in accord with step 6 and repeat test steps 7, 8 and 9 above with respect to the third self-test step.

12. Press DISPLAY B function X/B button. Self test item number "4" is displayed.

13. Set test signal in accord with step 6 and repeat test steps 7, 8 and 9 above with respect to the fourth self-test step.

14. Press DISPLAY B function L/C button. Self test item number "5" is displayed.

15. Set test signal in accord with step 6 and repeat test steps 7, 8 and 9 with respect to the fifth self-test step.

16. Press DISPLAY A Δ button. Self test item number "7" is displayed and MULTIPLIER is automatically set to x 0.1.

17. Set test frequency to 10.0KHz.

18. Display readouts should be within the following test limits:
DISPLAY A ± 160 counts
DISPLAY B ± 160 counts

19. Change test frequency to 100KHz.

20. Display readouts should be within the following test limits:
DISPLAY A ± 500 counts
DISPLAY B ± 500 counts

Note

Self test item 6 does not exist.

Test item	Press button	Control settings			Test Limits	
		MULTIPLIER	OSC LEVEL	Frequency	DISPLAY A	DISPLAY B
1	D	—	—	1.00kHz	.00±160 counts	.00±160 counts
					—	—
2	Q	x1	fully cw	1.00kHz	-1000.00	.00±160 counts
					±160 counts	—
3	ESR/G	x1	fully cw	1.00kHz	-1000.00	.00±160 counts
					±160 counts	—
4	X/B	x1	fully cw	1.00kHz	-1000.00	.00±160 counts
					±160 counts	—
5	L/C	x1	fully cw	1.00kHz	-1000.00	.00±160 counts
					±160 counts	—
7	Δ%	x0.1	fully cw	10.0kHz	.00±160 counts	.00±160 counts
					.00±500 counts	.00±500 counts

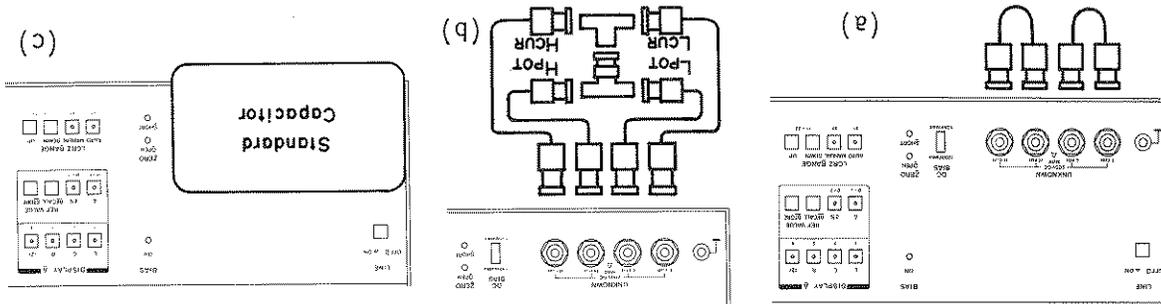
Table 4-4. Self Operating Test Summary.

PERFORMANCE TESTS

- Standard capacitors 1pF : HP 16381A
 10pF : HP 16382A
 100pF : HP 16383A
 1000pF : HP 16384A
- BNC to BNC cable 10cm long, 4 ea. required
- BNC Tee adapter -hp-1250-0781
- hp-1251-0921

EQUIPMENT:

Figure 4-4. Capacitance Accuracy Test Setups.



Check all ranges in parallel (mode) mode. It is sufficient to check any one range in series (mode) mode.

Note

Check for dissipation factor accuracies at the same time as that for capacitance accuracies.

Note

Test on capacitance ranges for test frequencies listed above should be done at three test signal MULTIPLIER settings (x5, x1 and x0.1). OSC LEVEL control is set to its fully cw position.

Tested range. Non-applicable range for recommended capacitance standard.

Range	100Hz	200Hz	400Hz	1KHz	2KHz	4KHz	10KHz	20KHz	40KHz	100KHz
1000fF										
10pF										
100pF										
1000pF										

4-16. This test checks full scale display capacitance measurement accuracies for various combinations of test signal frequency and test signal level. The capacitance accuracy checks are made by connecting a standard capacitor to the instrument and comparing measurement readouts with the calibrated values of the standard to verify that the instrument meets the 4274A accuracy specifications. Accuracies for dissipation factors of nearly zero are also checked in this test. Since fundamental reference elements, (range resistors and detection phases) required for establishing C and D measurement accuracies (and also accuracies of other measurement parameters) are checked by these narrow range tests, almost all ranges, from minimum to maximum, are being verified.

4-15. CAPACITANCE ACCURACY TEST.

PERFORMANCE TESTS

Table 4-5 applies to the tests at three MULTIPLIER settings (x5, x1 and x0.1).

Note

8. Change standard capacitor successively to 10pF, 100pF and 1000pF and verify that the instrument satisfies Table 4-5.
 7. Set test frequency and test signal level MULTIPLIER in accord with Table 4-5. Capacitance and dissipation factor readouts should be within tolerances given in the table.
 6. Disconnect cables and connect 1pF Standard Capacitor direct to UNKNOWN terminals as shown in Figure 4-4 (c).
 5. Press ZERO SHORT button and wait approximately 20 seconds until "short" offset adjustment is completed.
 4. Connect cables and terminal adapters as shown in Figure 4-4 (b). Connect BNC tee adapters to each other.
 3. Press ZERO OPEN button and wait approximately 20 seconds until "open" offset adjustment is completed ("CAL" letters in DISPLAY A disappear).
- VERIFY THAT DC BIAS INDICATOR LAMP DOES NOT LIGHT. IF ILLUMINATED, SET REAR PANEL DC BIAS SWITCH TO OFF.

CAUTION

DISPLAY A function C
 Deviation measurement function off
 LCRZ RANGE AUTO
 DISPLAY B function D
 CIRCUIT MODE AUTO (AUTO) 
 HIGH RESOLUTION on
 SELF TEST off
 TRIGGER INT
 OSC LEVEL fully CW
 MULTIPLIER x5

2. Set 4274A controls as follows:

1. Connect L_{CR} and L_{PR} terminals with a BNC to BNC cable as shown in Figure 4-4 (a). Similarly connect H_{CR} and H_{PR} terminals.

PROCEDURE:

- 1) If short (Ω) and open (∞) terminations of the HP 16074A Standard Resistor Set are available, use them for zero offset adjustment instead of BNC to BNC cables and BNC Tee adapters.
- 2) Use BNC to BNC cables of 10cm long or less. Using a longer cable may affect test results.

Note

PERFORMANCE TESTS

C.V. = Calibrated Value

Test frequency and Multiplier Setting	Standard capacitance: 100pF		Standard capacitance: 1000pF	
	C test limits	D test limits	C test limits	D test limits
100Hz, x5	—	—	—	—
120Hz, (x1)	—	—	—	—
200Hz, x5	—	—	—	—
400Hz, x5	—	—	—	—
1.00kHz, x5	—	—	—	—
2.00kHz, x5	—	—	—	—
4.00kHz, x5	—	—	—	—
10.0kHz, x5	—	—	—	—
20.0kHz, x5	—	—	—	—
40.0kHz, x5	—	—	—	—
100kHz, x5	—	—	—	—

Table 4-5. Capacitance Accuracy Tests (part 2 of 2).

Test frequency and Multiplier Setting	Standard capacitance: 1pF		Standard capacitance: 10pF	
	C test limits	D test limits	C test limits	D test limits
100Hz, x5	—	—	—	—
120Hz, (x1)	—	—	—	—
200Hz, x5	—	—	—	—
400Hz, x5	—	—	—	—
1.00kHz, x5	—	—	—	—
2.00kHz, x5	—	—	—	—
4.00kHz, x5	—	—	—	—
10.0kHz, x5	—	—	—	—
20.0kHz, x5	—	—	—	—
40kHz, x5	—	—	—	—
100kHz, x5	—	—	—	—

Table 4-5. Capacitance Accuracy Tests (part 1 of 2).

PERFORMANCE TESTS

C.V. = Calibrated value of standard resistor

Test Frequency	100Ω	1000Ω	10kΩ	100kΩ
	Test Limits			
All Frequencies	C.V. ±0.13%	C.V. ±4.0%	C.V. ±4%	C.V. ±400%

Table 4-6. Resistance Accuracy Tests.

1. Table 4-6 applies to tests at three MULTIPLIER settings (x5, x1 and x0.1).
 2. Measurement CIRCUIT MODE is automatically set to  mode on 100Ω range and to  mode on other ranges.
- Note
2. Connect 100Ω standard resistor direct to UNKNOWN terminals as shown in Figure 4-5.
 3. Set test frequency and test signal level MULTIPLIER in accord with Table 4-6. Resistance readouts should be within tolerances given in the table.
 4. Change standard resistor successively to 1000Ω, 10kΩ and 100kΩ and verify that the instrument satisfies Table 4-6.
- If Capacitance Accuracy Test (paragraph 4-15) has not been performed before doing this test, perform zero offset adjustment in accord with Capacitance Accuracy Test steps 1, 3, 4 and 5.

Note

VERIFY THAT DC BIAS INDICATOR LAMP DOES NOT LIGHT. IF ILLUMINATED, SET REAR PANEL DC BIAS SWITCH TO OFF.

CAUTION

SELF TEST off
 TRIGGER INT
 OSC LEVEL fully cw
 MULTIPLIER x5

PERFORMANCE TESTS

If Capacitance Accuracy Test (paragraph 4-15) has not been performed before doing this test, perform a zero offset adjustment in accord with Capacitance Accuracy Test steps 1, 3, 4 and 5.

Note

VERIFY THAT DC BIAS INDICATOR LAMP DOES NOT LIGHT. IF ILLUMINATED, SET REAR PANEL DC BIAS SWITCH TO OFF.

CAUTION

- DISPLAY A function L
- Deviation measurement function off
- LCRZ RANGE AUTO
- CIRCUIT MODE on
- HIGH RESOLUTION on
- SELF TEST off
- TRIGGER INT
- OSC LEVEL fully cw
- MULTIPLIER x5

1. Set 4274A controls as follows:

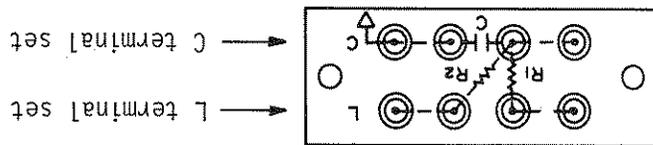
PROCEDURE:

Quasi-inductor, 100mH from HP 16074A Standard Resistor Set.

EQUIPMENT:

Internal connection configuration }
[is shown in the figure.

Figure 4-6. HP 16074A Quasi-inductor.



This confirmation test does not necessarily have to be done.

Note

4-20. Inductance accuracy is verified if the instrument meets both capacitance and resistance accuracy test limits. If it is desired to confirm the inductance accuracy on at least at one range, perform the following test:

4-19. INDUCTANCE ACCURACY TEST (Confirmation Test).

PERFORMANCE TESTS

2. Connect the "L" terminals of the 100mH quasi-inductor directly to the 4274A UNKNOWN terminals. See Figure 4-6.
3. Set the test signal frequency to 10kHz.
4. Inductance display readout should be within $\pm 0.4\text{mH}$ of the calibrated inductance value.
5. Change test signal frequency to 100kHz.
6. Inductance display readout should be within $\pm 0.4\text{mH}$ of the calibrated inductance value.

PERFORMANCE TESTS

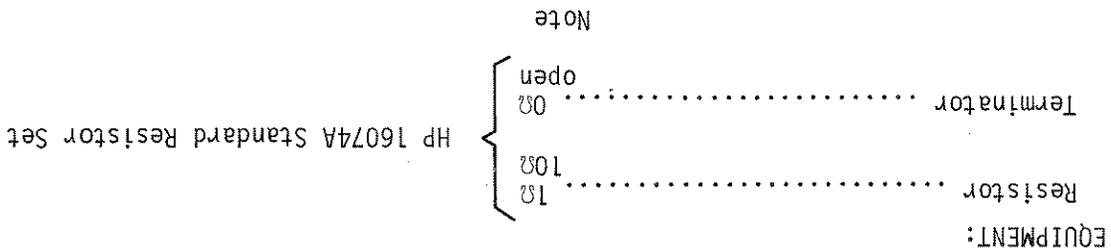
DISPLAY A function R
 Deviation measurement function off
 LCRZ RANGE AUTO
 DISPLAY B function X
 CIRCUIT MODE AUTO
 HIGH RESOLUTION on
 SELF TEST off
 INT off
 OSC LEVEL fully cw
 MULTIPLIER x5

2. Set 4274A controls as follows:

1. Connect open terminator direct to UNKNOWN terminals as shown in Figure 4-5.

PROCEDURE:

The resistors used as references in this test have been designed to maintain extremely low order (residual) reactance at frequencies to 10MHz. 0Ω and open terminators are specially matched to these two resistors in order to ensure an optimum zero offset adjustment.



The test should be done at three test signal MULTIPLIER settings (x5, x1 and x0.1). OSC LEVEL control is set to its fully cw position.

Note

R range	Test frequency
1000mΩ	100Hz to 100kHz
10Ω	100Hz to 100kHz

Frequency-Phase Accuracy Check Ranges

4-22. This test checks phase accuracies to ascertain accurate detection of the vector impedance components which are the source of the arithmetic measurement data. The frequency-phase accuracy test is made by connecting a resistor with extremely low reactive elements and by reading reactance display values (almost zero) to verify that the impedance of the DUT is being accurately detected with respect to the right-angle vector components.

4-21. FREQUENCY-PHASE ACCURACY TEST

PERFORMANCE TESTS

100Hz to 100KHz	0±1.50mΩ	0±0.0130Ω
Test frequencies	1000mΩ	10Ω
	Reactance test limits	

Table 4-7. Frequency-Phase Accuracy Tests.

Table 4-7 applies to tests at three MULTIPLIER settings (x5, x1 and x0.1).

Note

8. Connect 10Ω test resistor in place of 1Ω resistor and verify that Table 4-7 is satisfied.
7. Set test frequency and test signal level MULTIPLIER in accord with Table 4-7. Reactance display readouts should be within tolerances given in the table.
6. Disconnect 0Ω terminator and connect 1Ω test resistor direct to UNKNOWN terminals.
5. Press ZERO SHORT button and wait approximately 20 seconds until "short offset adjustment is completed."
4. Disconnect open terminator and connect 0Ω terminator direct to UNKNOWN terminals.
3. Press ZERO OPEN button and wait approximately 20 seconds until "open offset adjustment is completed ("CAL" letters in DISPLAY A disappear). SET REAR PANEL DC BIAS SWITCH TO OFF.

CAUTION

VERIFY THAT DC BIAS INDICATOR LAMP DOES NOT LIGHT. IF ILLUMINATED,

PERFORMANCE TESTS

1. Set a new bias voltage value into the three digit thumbwheel switch of the 16023B.
2. Press 16023B ENTER button (this actuates the 4274A to read the new value).

To change bias voltage:

Note

3. Set rear panel DC BIAS switch to INT $\pm 35V/100V$ ($<.1\mu F$) position.
4. Connect an appropriate pair of wire leads between dc voltmeter input and 16047A Test Fixture (see Figure 4-7).
5. Set dc bias voltage into 16023B DC Bias Controller in accord with Table 4-8. DC voltmeter readouts should be identical with the bias setting voltages within tolerances given in the table.

BEFORE OPERATING DC BIAS SWITCH, VERIFY THAT DC BIAS VOLTAGE HAS BEEN SET TO ZERO VOLTS.

CAUTION

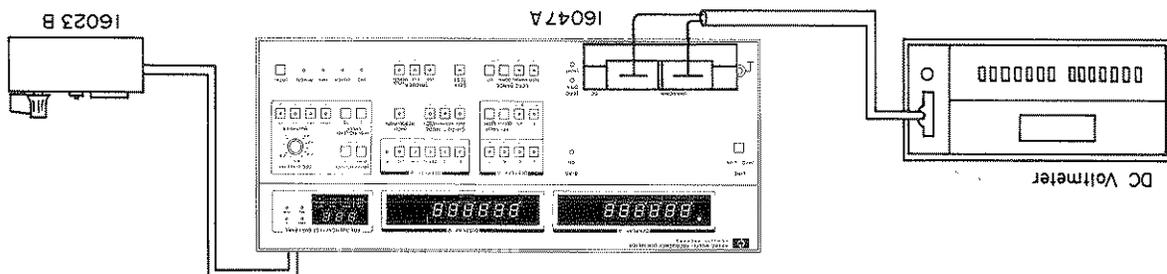
1. Set 4274A front panel DC BIAS switch to $\pm 35V$ MAX position. Attach 16047A Test Fixture to UNKNOWN terminals.
2. Connect 16023B DC Bias Controller to rear panel INT DC BIAS CONTROL connector.

PROCEDURE:

- HP 3465A/B DC Voltmeter
- HP 16047A Test Fixture
- HP 16023B Bias Controller

EQUIPMENT:

Figure 4-7. Option 001 Int DC Bias Supply Test Setup.

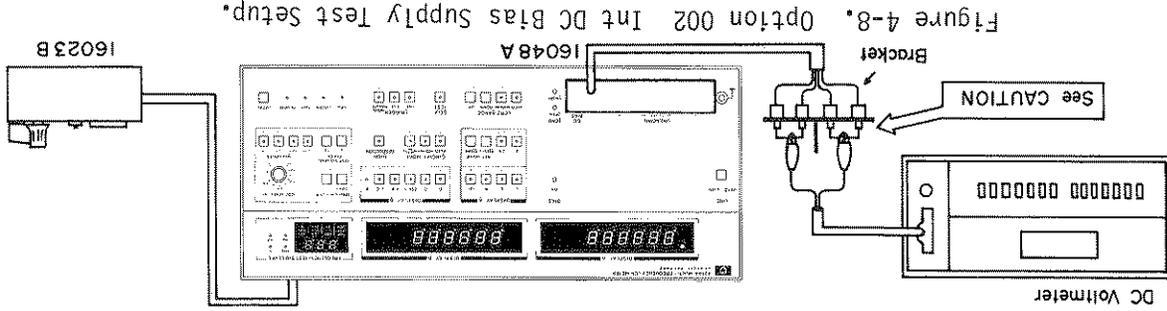


4-24. This test verifies that the Option 001 Internal DC BIAS Supply applies the specified bias voltages to the device under test.

4-23. INT DC BIAS SUPPLY TEST (OPTION 001)

PERFORMANCE TESTS

EQUIPMENT:
 DC Voltmeter HP 3465A/B
 Test Leads HP 16048A
 Bias Controller HP 16023B



4-26. This test verifies that the Option 002 Internal DC Bias Supply applies the specified bias voltages to the device under test.

4-25. INT DC BIAS SUPPLY TEST (OPTION 002)

Where, Z_i is voltmeter input impedance (in $k\Omega$).

$$E_m = E_{\text{bias}} \times \frac{30 + Z_i}{Z_i} \text{ (V)}$$

When dc bias voltage is measured at rear panel INT DC BIAS MONITOR connector, voltmeter readout will be somewhat lower than the actual (applied) voltage because of monitor output impedance (30k Ω). Measured voltage value E_m is:

Note

DC Bias Setting	Tolerance	DC Bias Setting	Tolerance
.000V	-.0020 - .0020V	.100V	.200
.001	-.0010 - .0030	.200	.300
.002	.0000 - .0040	.300	.2035
.003	.0010 - .0050	.400	.3960 - .4040
.004	.0020 - .0060	.500	.4955 - .5045
.005	.0030 - .0070	.600	.5950 - .6050
.006	.0040 - .0080	.700	.6945 - .7055
.007	.0050 - .0090	.800	.7940 - .8060
.008	.0060 - .0100	.900	.8935 - .9065
.009	.0070 - .0110	1.00	.9910 - 1.009
.010	.0080 - .0120	2.00	1.986 - 2.014
.020	.0179 - .0221	3.00	2.982 - 3.018
.030	.0279 - .0321	4.00	3.977 - 4.023
.040	.0378 - .0422	5.00	4.972 - 5.028
.050	.0478 - .0522	6.00	5.967 - 6.033
.060	.0577 - .0623	7.00	6.962 - 7.038
.070	.0677 - .0723	8.00	7.958 - 8.042
.080	.0776 - .0824	9.00	8.953 - 9.047
.090	.0876 - .0924	10.0	9.930 - 10.07
		20.0	19.88 - 20.12
		30.0	29.82 - 30.16

Table 4-8. DC Bias Voltage Test Limits.

PERFORMANCE TESTS

When dc bias voltage is measured at rear panel INT DC BIAS MONITOR connector, voltmeter readout will be somewhat lower than the actual bias voltage. Refer to note in Paragraph 4-24.

Note

DC Bias Setting	Tolerance	DC Bias Setting	Tolerance
00.0V	-0.040 - 0.040V	05.0V	05.0V
00.1	0.058 - 0.142	06.0	06.0
00.2	0.156 - 0.244	07.0	07.0
00.3	0.254 - 0.346	08.0	08.0
00.4	0.352 - 0.448	09.0	09.0
00.5	0.450 - 0.550	10.0	10.0
00.6	0.548 - 0.652	20.0	20.0
00.7	0.646 - 0.754	30.0	30.0
00.8	0.744 - 0.856	40.0	40.0
00.9	0.842 - 0.958	50.0	50.0
01.0	0.940 - 1.060	60.0	60.0
02.0	1.920 - 2.08	70.0	70.0
03.0	2.90 - 3.10	80.0	80.0
04.0	3.88 - 4.12	90.0	90.0
		88.18 - 91.82	
		78.38 - 81.62	
		68.58 - 71.42	
		58.77 - 61.23	
		48.97 - 51.03	
		39.17 - 40.83	
		29.37 - 30.63	
		19.56 - 20.44	
		9.76 - 10.24	
		8.78 - 9.22	
		7.80 - 8.20	
		6.82 - 7.18	
		5.84 - 6.16	
		4.86 - 5.14V	

Table 4-9. DC Bias Voltage Test Limits.

1. Set a new bias voltage value into the three digit thumbwheel switch of the 16023B.
2. Press 16023B ENTER button (this actuates the 4274A to read the new value).

To change bias voltage:

Note

5. Set dc bias voltage into 16023B DC Bias Controller switch in accord with Table 4-9. DC Voltmeter readouts should be identical with the bias setting voltages within tolerances given in the table.

DO NOT TOUCH BNC CONNECTOR CENTER PIN WHERE A LIVE VOLTAGE MAY EXIST.

CAUTION

4. Connect 16048A Test Leads to dc voltmeter input (see Figure 4-8).
 3. Set rear panel DC BIAS switch to INT $\pm 35V/100V$ ($\leq 1\mu F$) position.
- BEFORE OPERATING DC BIAS SWITCH, VERIFY THAT DC BIAS VOLTAGE HAS BEEN SET TO ZERO VOLTS.

CAUTION

2. Connect 16023B DC BIAS Controller to rear panel INT DC BIAS CONTROL connector.
1. Set 4274A front panel DC BIAS switch to $\pm 200V$ MAX position. Connect 16048A Test Leads to UNKNOWN terminals.

PROCEDURE:

PERFORMANCE TESTS

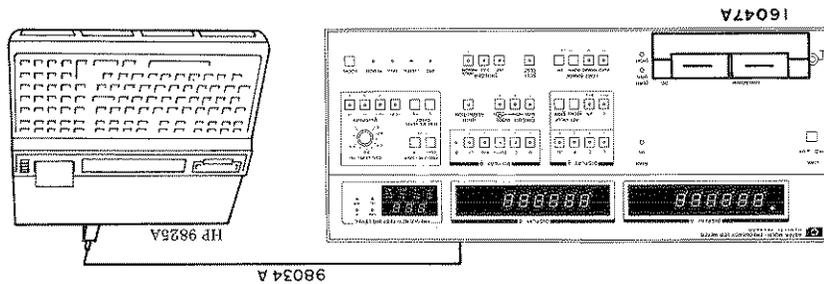
1. Turn power switches of both the 4274A and 9825A to OFF.
2. Connect 98034A Interface Card with cable between 9825A I/O slot and 4274A rear panel HP-IB connector as shown in Figure 4-9.
3. Install required ROM blocks in 9825A ROM slots.
4. Set 98034A Select Code Switch dial to select code 7 (using a screwdriver).
5. Remove 4274A top cover.
6. Set 4274A A2251 HP-IB Control Switch to following settings:
 bit 1~5 : 10001 (17 in binary code)
 bit 6 : 0
 bit 7 : 0
7. Replace top cover.
8. Connect 16047A Test Fixture to 4274A UNKNOWN terminals.
9. Turn 4274A and 9825A ON.
10. Set 4274A controls as follows:
 OSC LEVEL 1
 16047A Test Fixture Open
 Other Controls Initial control settings.
11. Load test program as shown on Pages 4-24 through 4-27 in calculator.
12. Execute the program.
13. Check that 4274A display, 9825A display, and printed data are in accord with Controller Instructions and Operator Responses for each test program.
14. Perform steps 10 thru 13 with respect to individual test programs and verify that 4274A and 9825A correctly communicates through the HP-IB interface.

PROCEDURE:

Sample capacitor (1000pF~1000µF)

- EQUIPMENT:
- Calculator
 - ROM
 - Interface Card with cable
 - HP 9825A
 - HP 98210A, 98213A
 - HP 98034A

Figure 4-9. HP-IB Interface Test Setup.



4-28. This test verifies that the HP-IB circuitry has the capabilities listed in Table 3-10) to correctly communicate between external HP-IB devices and the 4274A through the interface bus cable.

4-27. HP-IB INTERFACE TEST

PERFORMANCE TESTS

- (25) Disables talk address by listen address.
- (23) Disables listen address by talk address.
- (17) Returns to the status of Step 14.
- (15) Causes 4274A to revert to manual control for future parameter modifications (REN remains at "1").
- (14) Prevents the device operator from switching the unit to manual control.
- (12) Sets REN to "1". Switches 4274A to remote operation.
- (10) Sets REN to "0". Removes all device lockout mode and causes all voices (Interface Select Code 7) from local lockout to revert to local.
- (8) Sets IFC (Interface Clear) line of 9825A (independent of the device currently in control) and stops all communication.
- (6) Addresses 9825A to talk and 4274A to listen.
- (5) Sets REN (Remote Enable) line of the bus line to "1". Switches selected devices (Interface Select Code 7) to remote operation allowing parameters and device characteristics to be controlled by data message.
- (3) Clears 4274A SRO Status Byte.

```

0: "REMOTE/LOCAL TEST";
1: DIM AS I
2: 0-A
3: GOS (717)-B
4: PRT "REMOTE/LOCAL TEST";SPC 3
5: REM 7
6: WRT 717,"T1";ENT "LISTEN= 1 ,TALK= 0 ,REMOTE= 1",AS
7: IF AS="n",I+A
8: C11 7;ENT "LISTEN= 0 ,TALK= 0 ,REMOTE= 1",AS
9: IF AS="n",I+A
10: ICL 7;ENT "LISTEN= 0 ,TALK= 0 ,REMOTE= 0 " ,AS
11: IF AS="n",I+A
12: REM 717;ENT "REMOTE=0",AS
13: IF AS="n",I+A
14: ILO 7
15: ICL 717;ENT "REMOTE=1",AS
16: IF AS="n",I+A
17: WRT 717,"T1";ENT "LISTEN= 1 ,TALK= 0 ,REMOTE= 1 " ,AS
18: IF AS="n",I+A
19: IF A=1;PRT "REMOTE/LOCAL TEST
20: PRT "REMOTE/LOCAL TEST
21: 0-A
22: PRT "LISTEN/TALK TEST";SPC 3
23: RED 717,A,B;ENT "LISTEN= 0 ,TALK= 1 ,REMOTE= 1 " ,AS
24: IF AS="n",I+A
25: WRT 717,"T1";ENT "LISTEN= 1 ,TALK= 0 ,REMOTE= 1 " ,AS
26: IF AS="n",I+A
27: IF A=1;PRT "LISTEN/TALK TEST
28: PRT "LISTEN/TALK TEST
29: PRT "END";SPC 3
30: C11 7
31: ICL 7
32: END
*32472
    
```

[PROGRAMMING]

- (1) Remote/Local Capability.
- (2) Local Lockout.
- (3) Talk Address Disabled by Listen Address.
- (4) Listen Address Disabled by Talk Address.

This test verifies that 4274A Opt. 101 has the following capabilities:

[PURPOSE]

TEST PROGRAM 1

PERFORMANCE TESTS

Controller Instructions		Displays	Printout	Operator Response
Connect a capacitor to 16047A		TALKER TEST		
DATA OUTPUT TEST				
Connect a capacitor (1000pF to 16047A Test Fixture, Press "CONTINUE")				
2.74300e-09				
5.00000e-04				

(Continued)

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

```

0: "TALKER TEST";
1: prt "TALKER TEST";spc 3
2: dsp "Connect a capacitor to 16047A.";:stp
3: prt "DATA OUTPUT TEST"
4: dim a$[50],b$[50],c$[50],d$[50],e$[50],f$[1]
5: rds(717)+c
6: lcl 7
7: ltr 5
8: rem 7
9: cll 7
10: clr 717
11: wrt 717,"TR"
12: red 717,"A,B"
13: prt a,b;spc 2
14: ent "Is output data true ? (Y or N)";:f$[1]
15: if f$="n";prt "DATA OUTPUT TEST"
16: if f$="n";prt "DATA OUTPUT TEST"
17: prt "COMPLETE DATA OUTPUT TEST"
18: wrt 717,"E"
19: red 717,"A$"
20: prt a$;spc 2
21: ent "Is output data true ? (Y or N)";:f$[1]
22: if f$="n";prt "COMPLETE DATA OUTPUT TEST"
23: prt "COMPLETE DATA OUTPUT TEST"
24: prt "DEVICE TRIGGER TEST"
25: ltr 717
26: red 717,"B$"
27: prt b$;spc 2
28: ent "Is output data true ? (Y or N)";:f$[1]
29: if f$="n";prt "DEVICE TRIGGER TEST"
30: prt "DEVICE TRIGGER TEST"
31: prt "REFERENCE VALUE TEST"
32: wrt 717,"ST"
33: wrt 717,"RE"
34: red 717,"C$"
35: prt c$;spc 2
36: ent "Is output data true ? (Y or N)";:f$[1]
37: if f$="n";prt "REFERENCE VALUE TEST"
38: prt "REFERENCE VALUE TEST"
39: prt "TEST SIG LEVEL CHECK TEST"
40: wrt 717,"LV"
41: red 717,"B$"
42: prt b$;spc 1
43: wrt 717,"LA"
44: red 717,"E$"
45: prt e$;spc 2
46: ent "Is output data true ? (Y or N)";:f$[1]
47: if f$="n";prt "TEST SIG LEVEL CHECK TEST"
48: prt "TEST SIG LEVEL CHECK TEST"
49: prt "END";:spc 3
50: end
*9606

```

(25) Causes 4274A to simultaneously initiate a device-dependent action.

[PROGRAMMING]

- (2) Device Trigger.
- (1) Talker.

This test verifies that 4274A Opt. 101 has following capabilities:

[PURPOSE]

TEST PROGRAM 3

PERFORMANCE TESTS

Controller Instructions		Displays	Printout	Operator Response
		Is output data true? (y or n)		If outputted data and values of DISPLAY A and B are same, press "Y", CONTINUE ". If not, press "N", CONTINUE ".
	DATA OUTPUT TEST PASS DATA OUTPUT TEST FAIL			
	COMPLETE DATA OU TPUT TEST			
	PLNC+0.27440E-0 8,ND+0.00040E+00			
	COMPLETE DATA OU TPUT TEST PASS COMPLETE DATA OU TPUT TEST FAIL	Is output data true? (y or n)		If outputted data is true, press "Y", CONTINUE ". (see paragraph 3-82). If not, press "N", CONTINUE ".
	DEVICE TRIGGER T EST			
	PLNC+0.27430E-0 8,ND+0.00030E+00			
	DEVICE TRIGGER T EST PASS DEVICE TRIGGER T EST FAIL	Is output data true? (y or n)		If outputted data is true, press "Y", CONTINUE ". (see paragraph 3-82). If not, press "N", CONTINUE ".
	REFERENCE VALUE TEST			
	REFERENCE VALUE TEST PASS REFERENCE VALUE TEST FAIL	Is output data true? (y or n)		If outputted data is true, press "Y", CONTINUE ". (see paragraph 3-84). If not, press "N", CONTINUE ".
	TEST SIG LEVEL C HECK TEST			
	NV+1.03E+00 NA+0.17E-04			
	TEST SIG LEVEL C HECK TEST PASS TEST SIG LEVEL C HECK TEST FAIL	Is output data true? (y or n)		If outputted data is true, press "Y", CONTINUE ". (see paragraph 3-86). If not, press "N", CONTINUE ".
	END			

Table 4-12. Controller Instructions and Operator Responses for Test Program 3 (Cont'd).

PERFORMANCE TESTS

PERFORMANCE TESTS

TEST PROGRAM 4

[PURPOSE]

This test program verifies that 4274A Opt. 101 has following capabilities:

(1) Service Request.

(2) Serial Port.

[PROGRAMMING]

```

01: prt "SRQ TEST";spc 3
02: fxd 0
03: onl 7,"SRQ"
04: rem 7
05: cll 7
06: cll 717
07: rds(717)+A
08: 0+A;prt "DATA READY";wrt 717,"113E";gsh "LOOP"
09: 0+A;prt "SELF TEST -PASS";wrt 717,"1081";gsh "LOOP"
10: 0+A;prt "SELF TEST -FAIL";wrt 717,"A1";gsh "LOOP"
11: 0+A;prt "ZERO TEST -PASS";wrt 717,"S020";gsh "LOOP"
12: 0+A;prt "ZERO OFFSET -FAIL(Err1)";wrt 717,"ZS";gsh "LOOP"
13: 0+A;prt "Err5";wrt 717,"11";wait 9000
14: wrt 717,"ST";gsh "LOOP"
15: 0+A;prt "SYNTAX ERROR";wrt 717,"A5";gsh "LOOP"
16: prt "END";spc 3
17: end
18: "LOOP";eir 7,128
19: if bit(0,A)=1;prt A;spc 3;ret
20: if bit(1,A)=1;prt A;spc 3;ret
21: if bit(2,A)=1;prt A;spc 3;ret
22: if bit(3,A)=1;prt A;spc 3;ret
23: gco "LOOP"
24: "SRQ";rds(717)+A
25: if bit(6,A)=1;jmp 2
26: prt "OTHER DEVICE SRQ";spc 3
27: "INRT";eir 7,128
28: iret
*13153

```

(3) Designates label (SRQ) for service routing to be performed when an interrupt is set by a device on select code 7 bus line.

(18) Labels loop. Enables Service Request to be sent from device on select code 7 Bus Line. Checks status of SRQ line on the bus line. Again enables acceptance of SRQ from device because SRQ is disabled when Status Byte signal transfer is completed.

(27) After service subroutine is completed, return to the step that follows step 7, 8 or 9 (as appropriate) to main programming sequence.

Operator Response	Controller Instructions (Printout)
	SRQ TEST
Outputted SRQ Status Byte data should be 65 (= 01000001).	DATA READY
	65
Outputted SRQ Status Byte data should be 68 (= 01000100).	SELF TEST -PASS
	68
Outputted SRQ Status Byte data should be 76 (= 01001100).	SELF TEST -FAIL
	76
Outputted SRQ Status Byte data should be 68 (= 01000100).	ZERO OFFSET -PASS
	68
Outputted SRQ Status Byte data should be 76 (= 01001100).	ZERO OFFSET -FAIL
	76
Outputted SRQ Status Byte data should be 72 (= 01001000).	ZERO OFFSET -PASS
	72
Outputted SRQ Status Byte data should be 66 (= 01000010).	ZERO OFFSET -FAIL
	66
	SYNTAX ERROR
	66
	END

Table 4-13. Controller Instructions and Operator Responses for Test Program 4.

PERFORMANCE TESTS



R

W



R

W



Paragraph Number	TEST	Results	
		Minimum	Actual Maximum
4-13	SELF OPERATING TEST (Continued) STEP 5. DISPLAY A. 1KHZ DISPLAY B. 100KHZ Step 7. DISPLAY A. 10KHZ DISPLAY B. 100KHZ DISPLAY A. 100KHZ DISPLAY B. 100KHZ	998.40 -1.60 -1.60 -1.60 -5.00 -5.00	1001.60 1.60 1.60 1.60 5.00 5.00
4-15	CAPACITANCE ACCURACY TEST 1000FF Range. MULTIPLIER: x5 Capacity. PRL 40KHZ SER 100KHZ Opt. freq. () 1000FF Range. MULTIPLIER: x1 Capacity. PRL 40KHZ SER 100KHZ Opt. freq. () Dissipation. PRL 40KHZ 100KHZ Opt. freq. () Capacity. PRL 40KHZ 100KHZ Opt. freq. () Dissipation. PRL 40KHZ 100KHZ Opt. freq. () 1000FF Range. MULTIPLIER: x0.1 Capacity. PRL 40KHZ 100KHZ Opt. freq. () Dissipation. PRL 40KHZ 100KHZ Opt. freq. () Capacity. PRL 40KHZ 100KHZ Opt. freq. () Dissipation. PRL 40KHZ 100KHZ Opt. freq. () 10PF Range. MULTIPLIER: x5 Capacity. PRL 4KHZ 10KHZ 20KHZ 40KHZ 100KHZ	C V -4.6FF C V -4.3FF C V -4.3FF 0 -.00230 0 -.00170 0 -.00230 C V -10.0FF C V -7.0FF 0 -.00320 0 -.00260 C V -64.0FF C V -34.0FF 0 -.01220 0 -.01160 C V -.016PF C V -.013PF C V -.012PF C V -.037PF C V -.034PF	C V +4.6FF C V +4.3FF C V +4.3FF 0 +.00230 0 +.00170 0 +.00230 C V +10.0FF C V +7.0FF 0 +.00320 0 +.00260 C V +64.0FF C V +34.0FF 0 +.01220 0 +.01160 C V +.016PF C V +.013PF C V +.012PF C V +.037PF C V +.034PF

*C V = Calibrated Value

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*C V = Calibrated Value

Paragraph Number	TEST	Minimum	Actual	Maximum
4-15	CAPACITANCE ACCURACY TEST (continued)	C V -.016pF	_____	C V +.016pF
	Dissipation, PRL 4KHZ 10KHZ 20KHZ 40KHZ 100KHZ SER Opt. freq. ()	0 -.00120 0 -.00090 0 -.00075 0 -.00230 0 -.00170 0 -.00120	_____	0 +.00120 0 +.00090 0 +.00075 0 +.00230 0 +.00170 0 +.00120
	10PF Range, MULTIPLIER: X1	C V -.070pF	_____	C V +.070pF
	Capacitance, PRL 4KHZ 10KHZ 20KHZ 40KHZ 100KHZ Opt. freq. ()	C V -.040pF C V -.030pF C V -.037pF C V -.034pF	_____	C V +.040pF C V +.030pF C V +.037pF C V +.034pF
	Dissipation, PRL 4KHZ 10KHZ 20KHZ 40KHZ 100KHZ Opt. freq. ()	0 -.00210 0 -.00180 0 -.00165 0 -.00230 0 -.00170	_____	0 +.00210 0 +.00180 0 +.00165 0 +.00230 0 +.00170
	10PF Range, MULTIPLIER: X0.1	C V -.610pF	_____	C V +.610pF
	Capacitance, PRL 4KHZ 10KHZ 20KHZ 40KHZ 100KHZ Opt. freq. ()	C V -.310pF C V -.310pF C V -.091pF C V -.061pF	_____	C V +.310pF C V +.310pF C V +.091pF C V +.061pF
	Dissipation, PRL 4KHZ 10KHZ 20KHZ 40KHZ 100KHZ Opt. freq. ()	0 -.0110 0 -.01080 0 -.01065 0 -.00320 0 -.00260	_____	0 +.0110 0 +.01080 0 +.01065 0 +.00320 0 +.00260
	100PF Range, MULTIPLIER: X5	C V -.16pF	_____	C V +.16pF
	Capacitance, PRL 400HZ 1KHZ 2KHZ 4KHZ 10KHZ	C V -.16pF C V -.13pF C V -.12pF C V -.16pF C V -.13pF	_____	C V +.16pF C V +.13pF C V +.12pF C V +.16pF C V +.13pF

Results

*C V = Calibrated Value

Paragraph Number	TEST	Minimum	Actual	Maximum
4-13	SELF OPERATING TEST (Continued)	998.40		1001.60
	STEP 5. DISPLAY A. 1KHZ DISPLAY B. 100KHZ	-1.60		1.60
	STEP 7. DISPLAY A. 10KHZ DISPLAY B. 100KHZ	-1.60		1.60
	DISP A. 100KHZ DISP B. 5.00	-5.00		5.00
4-15	CAPACITANCE ACCURACY TEST			
	1000FF Range. MULTIPLIER: x5	C V -4.8FF		C V +4.8FF
	Capacitance. PRL 30KHZ	C V -4.5FF		C V +4.5FF
	Opt. freq. () 100KHZ	C V -4.3FF		C V +4.3FF
	SER 30KHZ	C V -4.8FF		C V +4.8FF
	Opt. freq. () 30KHZ	0 - .00130		0 + .00130
	Dissipation. PRL 30KHZ	0 - .00230		0 + .00230
	Opt. freq. () 100KHZ	0 - .00170		0 + .00170
	SER 30KHZ	0 - .00130		0 + .00130
	Opt. freq. () 30KHZ	0 - .00220		0 + .00220
	Dissipation. PRL 30KHZ	0 - .00320		0 + .00320
	Opt. freq. () 100KHZ	0 - .00260		0 + .00260
	Capacitance. PRL 30KHZ	C V -84.0FF		C V +84.0FF
	Opt. freq. () 50KHZ	C V -54.0FF		C V +54.0FF
	1000FF Range. MULTIPLIER: x0.1	C V -34.0FF		C V +34.0FF
	Capacitance. PRL 30KHZ	C V -84.0FF		C V +84.0FF
	Opt. freq. () 100KHZ	C V -34.0FF		C V +34.0FF
	Dissipation. PRL 30KHZ	0 - .01120		0 + .01120
	Opt. freq. () 50KHZ	0 - .01220		0 + .01220
	10PF Range. MULTIPLIER: x5	0 - .01160		0 + .01160
	Capacitance. PRL 3KHZ	C V - .018PF		C V + .018PF
	5KHZ	C V - .015PF		C V + .015PF
	10KHZ	C V - .013PF		C V + .013PF
	30KHZ	C V - .038PF		C V + .038PF
	50KHZ	C V - .035PF		C V + .035PF

Results

TEST

Paragraph Number

SELF OPERATING TEST (Continued)

1001.60

1.60

1.60

1.60

5.00

5.00

Maximum

Actual

Minimum

Maximum

*C V = Calibrated Value

Paragraph Number	TEST	Minimum	Actual	Maximum
4-15	CAPACITANCE ACCURACY TEST (continued)	C V -.034pF C V -.018pF	_____	C V +.034pF C V +.018pF
	Opt. freq. () SER 100KHz 3KHz	0 -.00160 0 -.00170 0 -.00230 0 -.00130 0 -.00090 0 -.00120 0 +.00160	_____	0 +.00160 0 +.00170 0 +.00230 0 +.00130 0 +.00090 0 +.00120 0 +.00160
	Dissipation, PRL 3KHz 5KHz 10KHz 30KHz 50KHz 100KHz	0 -.00160 0 -.00120 0 -.00090 0 -.00130 0 -.00230 0 -.00170	_____	0 +.00160 0 +.00120 0 +.00090 0 +.00130 0 +.00230 0 +.00170
	Opt. freq. () Capacitance, PRL 3KHz 5KHz 10KHz 30KHz 50KHz 100KHz	C V -.080pF C V -.060pF C V -.040pF C V -.110pF C V -.080pF C V -.034pF	_____	C V +.080pF C V +.060pF C V +.040pF C V +.110pF C V +.080pF C V +.034pF
	Opt. freq. () Dissipation, PRL 3KHz 5KHz 10KHz 30KHz 50KHz 100KHz	0 -.00160 0 -.00210 0 -.00180 0 -.00130 0 -.00230 0 -.00170	_____	0 +.00160 0 +.00210 0 +.00180 0 +.00130 0 +.00230 0 +.00170
	Opt. freq. () Capacitance, PRL 3KHz 5KHz 10KHz 30KHz 50KHz 100KHz	C V -.810pF C V -.510pF C V -.310pF C V -.830pF C V -.530pF C V -.061pF	_____	C V +.810pF C V +.510pF C V +.310pF C V +.830pF C V +.530pF C V +.061pF
	Opt. freq. () Dissipation, PRL 3KHz 5KHz 10KHz 30KHz 50KHz 100KHz	0 -.01150 0 -.01110 0 -.01080 0 -.00220 0 -.00320 0 -.00260	_____	0 +.01150 0 +.01110 0 +.01080 0 +.00220 0 +.00320 0 +.00260
	Opt. freq. () Capacitance, PRL 300Hz 500Hz 1KHz 3KHz 5KHz	C V -.18pF C V -.15pF C V -.13pF C V -.18pF C V -.15pF	_____	C V +.18pF C V +.15pF C V +.13pF C V +.18pF C V +.15pF
	Opt. freq. () Dissipation, PRL 300Hz 500Hz 1KHz 3KHz 5KHz	C V -.18pF C V -.15pF C V -.13pF C V -.18pF C V -.15pF	_____	C V +.18pF C V +.15pF C V +.13pF C V +.18pF C V +.15pF

Results

Paragraph Number	TEST	Results	
		Minimum	Actual Maximum
4-23	INT DC BIAS SUPPLY TEST (OPTION 001 ONLY) (continued)	19.88V 29.82V	20.12V 30.16V
4-25	INT DC BIAS SUPPLY TEST (OPTION 002 ONLY)	-0.040V 0.156V 0.450V 0.940V 1.920V 4.86V 9.76V 19.56V 48.97V 88.18V	0.040V 0.244V 0.550V 1.060V 2.08V 5.14V 10.24V 20.44V 51.03V 91.82V



5-14. ADJUSTMENT LOCATIONS.
5-15. For reference, an illustration of over-
all adjustment locations is given in Figure
8-13. The locations of individual board as-
semblies are shown in board assembly compo-
nent location illustrations included with
each fold-out service sheet.

5-12. ADJUSTMENT RELATIONSHIPS.
5-13. The adjustment procedures, beginning
with paragraph 5-18, should be performed in
step sequence as they are interactive. Neg-
lecting or changing procedures may make it
impossible to obtain best 4274A performance.
Table 5-3 shows necessary adjustment proce-
dures to be used after repair to the instru-
ment.

5-11. Adjustable components, with reference
designators are listed in Table 5-1. The
table gives the name of the control to be ad-
justed and the purpose of its adjustment.

5-9. FACTORY SELECTED COMPONENTS.
5-10. Factory selected components can be re-
cognized by an asterisk adjacent to the re-
ference designator on the schematic diagrams
in Section VIII (nominal value is shown).
Table 5-2 lists all factory selected com-
ponents with their nominal value ranges and
their influence on instrument performance.

5-7. EQUIPMENT REQUIRED.
5-8. The equipment needed to adjust the Mod-
el 4274A is listed in Table 4-1 (page 4-0).
This equipment should always be calibrated
to satisfy its own specifications and those
of the required characteristics. If the re-
commended model is not available, any instru-
ment that has specifications equal to or
better than required specifications may be
substituted.

ADJUSTMENTS DESCRIBED HEREIN ARE PER-
FORMED WITH POWER SUPPLIED TO THE IN-
STRUMENT AFTER PROTECTIVE COVERS HAVE
BEEN REMOVED. ENERGY EXISTING AT
MANY POINTS MAY, IF CONTACTED, RESULT
IN PERSONAL INJURY.

WARNING

SECTION V
ADJUSTMENT

5-5. The opening of covers for removal of
parts, except those to which access can be
gained by hand, is likely to expose live
parts.
5-6. Capacitors inside instrument may still
be charged even if instrument has been dis-
connected from its source of supply.

ANY INTERRUPTION OF THE PROTECTIVE
(GROUNDED) CONDUCTOR (INSIDE OR OUT-
SIDE OF THE INSTRUMENT) OR DISCONNEC-
TION OF THE PROTECTIVE EARTH TERMINAL
IS LIKELY TO MAKE THE INSTRUMENT DAN-
GEROUS. INTENTIONAL INTERRUPTION IS
PROHIBITED.

WARNING

5-3. SAFETY REQUIREMENTS.
5-4. Although the instrument has been de-
signed in accordance with international safe-
ty standards, this manual contains informa-
tion, cautions and warnings which must be
followed to ensure safe operation and to keep
the instrument in safe condition. Adjust-
ments described in this section should be
performed only by qualified service personnel.

Before proceeding to any adjustment,
allow a warm up time of more than 30
minutes to stabilize operating condi-
tions.

Note

5-2. This section provides the information
needed to adjust the 4274A to its specifica-
tions (listed in Table 1-1). The prime pur-
pose of adjustment is to return the instru-
ment to its peak operating capabilities after
repairs have been made. Adjustment proce-
dures can also be periodically performed to
maintain top notch performance. Recommended
adjustment cycle for the 4274A is once every
six months. All adjustable components refer-
red to in individual adjustments are sum-
marized in Table 5-1 and these locations can
be identified in Section VIII. If proper
performance cannot be achieved after adjust-
ment procedure has been performed, refer to
Section VIII Troubleshooting Procedures.

5-1. INTRODUCTION.

Paragraph	Reference Designator	Name of Control	Purpose
5-18	A1R3	STANDARD REFERENCE VOLTAGE	To set output of reference voltage to ± 5.00 volts.
5-19	A5R3	DC REF	To minimize residual input to integrator and to optimize zero detection.
5-20	A4R1(ADJ4) A4R5(ADJ2) A4R8(ADJ3)	DC OFFSET	To minimize residual DC offset voltage in process amplifier to maximize measurement accuracy.
5-21	A6R3	OSCILLATOR	To obtain appropriate oscillation without any visible distortion or clipping.
5-22	A3R1	POWER AMPLIFIER	To set appropriate amplitude and to ensure that a clean sinusoidal signal is present at UNKNOWN terminals.
5-23	A2R43	90° PHASE SHIFT	To set an accurate 90° phase shift for 90° phase detector to achieve optimum bridge balance.
5-24	A2R1 A2R8	ZERO OFFSET	To eliminate residual offset in phase tracking amplifier (preadjustment).
5-25	A1R1 A1C2	OFFSET	To minimize residual offset in buffer amplifier at all frequencies.
5-26	A2R1 A2R8	ZERO OFFSET	To eliminate residual offset from both phase detector 0° and 90° integrators.
5-27	A4R10(ADJ7) A4C6(ADJ10) A4C7(ADJ9) A4R11(ADJ8)	ATTENUATOR AND GAIN	To set accurate amplifier gains and attenuations for $x1$, $x1/2$ and $x1/4$ amplifiers to maximize measurement accuracy.
5-28	A4R6(ADJ11) A4C4(ADJ14) A4C5(ADJ13) A4R7(ADJ12)	ATTENUATOR AND GAIN	To set accurate amplifier gains and attenuations for $x1$, $x1/10$ and $x1/100$ amplifier to maximize measurement accuracy.
5-29	A3R16	OSC LEVEL MONITOR	To establish a precise indication for test signal level monitoring.
5-30	A1R21(100K Ω) A1R18(10K Ω) A1R15(1K Ω) A1R12(100 Ω) A1R8(10 Ω) A4R1(ADJ4) A4C3(ADJ5)	RANGE RESISTOR & BUFFER AMP GAIN	To establish precise range resistor resistance to maximize measurement accuracy on each range at 1.00 kHz and to set appropriate gain in range resistor buffer amplifier at 100kHz.
5-31	A1C11(100K Ω) A1C10(10K Ω) A1C9(1K Ω) A1C7(10 Ω)	RANGE RESISTOR PHASE	To minimize residual phase offset that especially occurs at higher frequencies in the range resistor of bridge circuit to maximize measurement accuracy for all frequencies.

Table 5-1. Adjustable Components.

Assembly Repaired or Replaced	A1 04274-66501 (NULL DET & RANGE RESISTOR)	Para. 5-25	Para. 5-31
Required Adjustment	A2 04274-66502 (MODULATOR)	Para. 5-23	Para. 5-31
	A3 04274-66503 (POWER AMP)	Para. 5-22	Para. 5-31
	A4 04274-66504 (PROCESS AMP)	Para. 5-20	Para. 5-31
	A5 04274-66505 (A/D CONVERTER)	Para. 5-19	Para. 5-31
	A6 04274-66506 (OSCILLATOR)	Para. 5-21	Para. 5-31
	A7 04274-66507 (PERIPHERAL CONTROL)	None	None
	A8 04274-66508 (DISPLAY & KEY CONTROL)	None	None
	A9 04274-66513 (MPU)	None	None
	A10 04274-66520 (DISPLAY & KEY)	None	None
	A11 04274-66511 (POWER SUPPLY)	Para. 5-18	Para. 5-32
	A21 04274-66521 (OPT. 001 DC BIAS)	Para. 5-32	Para. 5-32
	A22 04274-66522 (OPT. 101 HP1B)	None	None
	A23 04274-66523 (OPT. 002 DC BIAS)	Para. 5-33	Para. 5-33

Table 5-3. Adjustments Requirement.

HP P/N: 0683-0565 R: FXD 5.6Ω HP P/N: 0683-1005 R: FXD 10Ω	HP P/N: 0683-0275 R: FXD 2.7Ω HP P/N: 0683-0565 R: FXD 5.6Ω	HP P/N: 0160-2203 C: FXD 91pF HP P/N: 0160-2205 C: FXD 120pF HP P/N: 0140-0196 C: FXD 150pF HP P/N: 0140-0197 C: FXD 180pF HP P/N: 0160-0134 C: FXD 220pF HP P/N: 0140-0199 C: FXD 240pF HP P/N: 0140-0210 C: FXD 270pF HP P/N: 0160-2207 C: FXD 300pF HP P/N: 0160-2208 C: FXD 330pF	Maximizes attenuator accuracy of x1/2 amplifier. If unadjustable with only A4ADJ7 (A4R10), add 10Ω resistor (refer to paragraph 5-27).	Maximizes attenuator accuracy of x1/4 amplifier. If unadjustable with only A4ADJ8 (A4R11), add 5.6Ω resistor (refer to paragraph 5-27).	Minimizes residual input to integrator. If offset value is positive, use capacitor. Changing capacitance value of A5C10 by 30pF causes approximately a 1 count change on Display A.
---	--	---	--	---	---

Table 5-2. Factory Selected Components (sheet 2 of 2).

TO INSURE PERSONAL SAFETY FROM POSSIBLE ELECTRICAL SHOCK HAZARDS AND RESULTANT INJURY, USE INSULATED ADJUSTMENT TOOL.

- WARNING
- Loosen the retaining screw at rear of top cover.
 - Pull top cover towards the rear and lift off.
- Remove top cover as follows:

WHEN TOP COVER IS REMOVED, LIVE PARTS ARE EXPOSED.

WARNING

TOP COVER REMOVAL

Confirm that instrument power line selector switches are set for local power line voltage. Program Memory Test described on page 3-1 and the SELF TEST procedure in Figure 3-0 on page 3-0 should be completely performed and successfully passed before progressing to adjustment procedure.

FUNDAMENTAL OPERATING CHECKS facilitates a thoroughgoing adjustment): the adjustment controls (this procedure the following to locate and to gain access to 5-17. Preparatory to adjusting the 4274A, do

e. Remove dual banana-to-alligator cable and 3465B from 4274A.

TEST POINT	DVM TOLERANCES
A11TP17 (+5V)	4.90 - 5.10
A11TP10 (-5V)	-4.90 - -5.10
A11TP1 (+12V)	11.76 - 12.24
A11TP5 (-12V)	-11.76 - -12.24

listed below:

- d. After adjustment of STANDARD VOLTAGE REFERENCE control, check that other DC voltages at TP1, TP5, TP10 and TP17 are within values
- c. Adjust A11R3 STANDARD VOLTAGE REFERENCE to +5 volts ± 0.01 volts.
- b. Connect voltmeter plus input to A11TP9 and minus input to 4274A chassis with dual banana-to-alligator clip cable. See Figure 5-1.

FUNCTION V
RANGE 20V

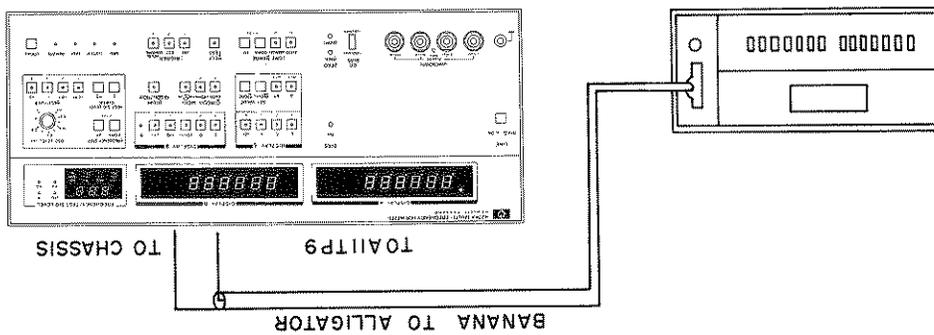
a. Set 3465B controls as follows:

PROCEDURE:

DIGITAL VOLTMETER HP 3465B

EQUIPMENT:

Figure 5-1. A11 Power Supply Voltage Adjustment.



This adjustment sets the power supply voltages for the 4274A internal circuits. Although there are 4 power voltages (+5V, -5V, +12V and -12V), only one control, the STANDARD REFERENCE VOLTAGE adjustment to plus 5 volts is necessary. Other voltages (-5V, +12V and -12V), are automatically controlled to their appropriate values by the STANDARD VOLTAGE ADJUSTMENT.

PURPOSE:

5-18. A11 POWER SUPPLY VOLTAGE ADJUSTMENT.

ADJUSTMENTS

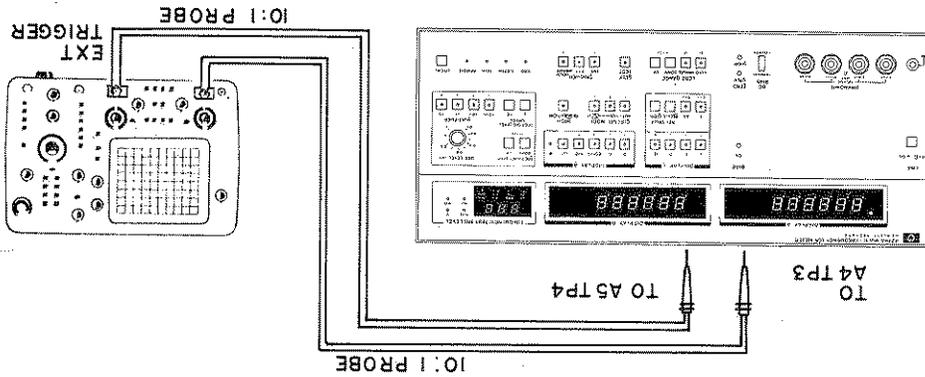
VOLTS/DIV01V/div (USE 10:1 probe)
 TIME/DIV 5ms/div
 INPUT DC
 TRIGGER EXT
 SWEEP NORMAL

a. Set 1740A controls as follows:

PROCEDURE:

EQUIPMENT: OSCILLOSCOPE HP 1740A

Figure 5-2. A4 Process Amplifier DC Offset Adjustment.

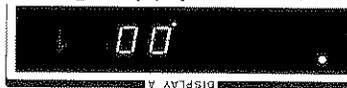


To minimize residual DC offset voltage in process amplifier.

PURPOSE:

5-20. A4 PROCESS AMPLIFIER DC OFFSET ADJUSTMENT.

- d. Adjust DC REF ADJ A5R3 until display count is -10 ± 5 counts on Display B.
- c. Check that display counts are within ± 5 counts. No adjustable component.



- b. Press, in order, **SELF TEST** and **D** keys and check that the figure "1" is displayed on Display A unit indicator. See figure below.
- a. Connect nothing to 4274A UNKNOWN terminals.

PROCEDURE:

None.

EQUIPMENT:

To minimize residual input to integrator and to obtain optimum zero detection.

PURPOSE:

5-19. A5 ADC DC REFERENCE ADJUSTMENT.

ADJUSTMENTS

ADJUSTMENTS

- b. Remove the three miniature connector cables from A4 board.
- c. Press 4274A **SELF TEST** key and **Δ** key so that the figure "6" appears on unit indicator of Display A.
- d. Connect a 10:1 divider probe between 4274A A4TP3 and chassis. See Figure 5-2.
- e. Connect a 10:1 divider probe between A5TP4 and chassis for EXT TRIGGER input of 1740A. See Figure 5-2.

- f. Adjust A4ADJ1 (A4R5) to flatten and balance square waves ① and ② as shown Figure 5-4 from the waveforms as shown in Figure 5-3.

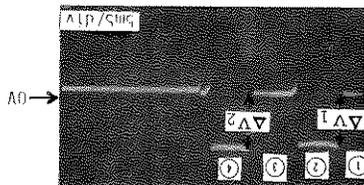


Figure 5-3. Waveforms before Adjustment.

- g. Change 1740A V/DIV setting as appropriate while adjusting for minimum balance ($\Delta V1$).

- h. In like manner, adjust A4ADJ2 (A4R55) for square waves ③ and ④. The balances ($\Delta V1, \Delta V2$) should be within $\pm 100mV$ as shown in Figure 5-4.

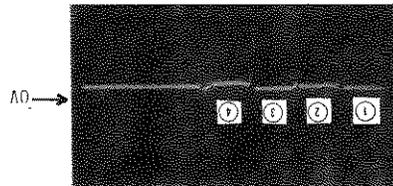


Figure 5-4. Waveforms after Adjustments with A4ADJ1 and A4ADJ2.

- i. Adjust A4ADJ3 (A4R8) until the top of the four (4) square waves is within 0 volts $\pm 30mV$.

- j. The waveforms after typical adjustments of A4ADJ1, A4ADJ2 and A4ADJ3 should be as shown as in Figure 5-5.

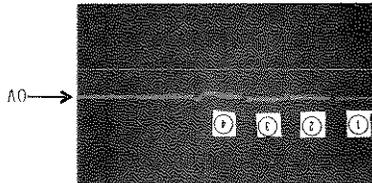


Figure 5-5. Waveforms Typically Adjusted.

- k. Replace the three miniature connector cables on A4 board.

VERIFY THAT DC BIAS INDICATOR DOES NOT LIGHT.
IF ILLUMINATED, SET REAR PANEL DC BIAS SW TO
OFF!

CAUTION

SELF TEST OFF
OTHER CONTROLS Any Settings

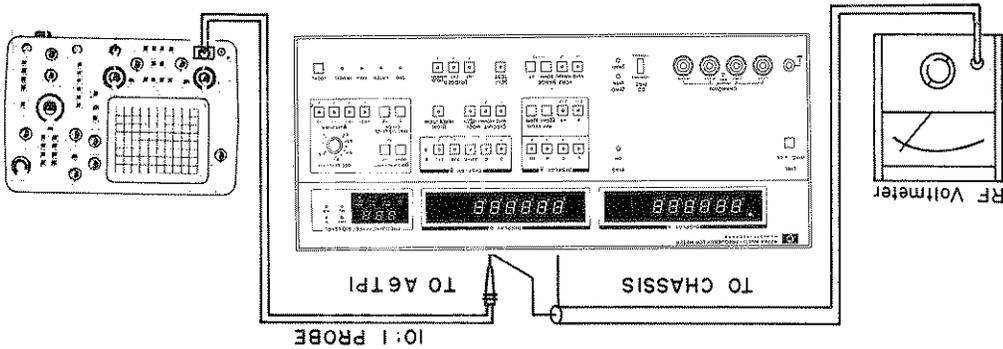
a. Set 4274A controls as follows.

PROCEDURE:

OSCILLOSCOPE HP 1740A
DVM HP 3400A

EQUIPMENT:

Figure 5-6. A6 Oscillator Adjustment.



To obtain an appropriate oscillation without any visible distortion.

PURPOSE:

5-21. A6 OSCILLATOR ADJUSTMENT.

If these adjustments still can not be performed after installing jumper wires instead of 4.64k Ω resistor as listed in above table, proceed to Section VIII A4 troubleshooting.

Note

Component	Jumper Wire (k Ω)			
	A4R12 (4.64k Ω)	A4R13 (4.64k Ω)	A4R54 (4.64k Ω)	A4R63 (4.64k Ω)
$\Delta V1 < -100mV$	$\Delta V1 > +100mV$	$\Delta V2 < -100mV$	$\Delta V2 > +100mV$	

If these adjustments can not be made to specified limit, change values of A4R12, A4R13, A4R54 and A4R63 in accordance with table below:

Note

ADJUSTMENTS

MULTIPLIER X1
 OSC LEVEL CM
 SELF TEST OFF
 OTHER CONTROLS Any Settings

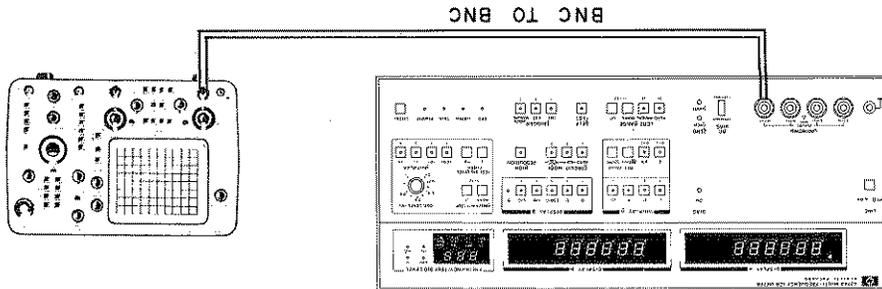
a. Set 4274A controls as follows:

PROCEDURE:

OSCILLOSCOPE HP 1740A

EQUIPMENT:

Figure 5-7. A3 Power Amplifier Adjustment.



To set appropriate amplitude and to ensure that a clean sinusoidal signal is present at 4274A UNKNOWN terminals.

PURPOSE:

5-22. A3 POWER AMPLIFIER ADJUSTMENT.

- h. Observe that peak-to-peak values of displayed waveform are within 1.2V P-P to 1.6V P-P for all test frequencies.
- g. Adjust A6R3 until 3400A reading is 500mVrms.
- f. Connect voltmeter plus input to A6T1 and minus input to 4274A chassis with BNC-to-alligator clip cable.
- e. Set 4274A FREQUENCY to 1.00kHz.

If any distortion or clipping appears, proceed to Section VIII A6 Troubleshooting.

Note

- d. Observe displayed waveform at all test frequencies of 4274A and check that these waveforms do not have any visible distortion.
- c. Connect 10:1 probe to A6T1 and ground lead to 4274A chassis as shown in Figure 5-6.

V/DIV 0.02V/div (USE 10:1 probe)
 INPUT AC
 SWEEP NORMAL
 TRIGGER INT

b. Set oscilloscope controls as follows:

ADJUSTMENTS

VOLT/DIV A CHAN. 0.02V/div (Use 10:1 probe)
B CHAN. 0.02V/div (Use 10:1 probe)
SWEEP AUTO A VS B

- d. Set oscilloscope 1740A controls as follows:
 - c. Set 4274A test frequency to 1kHz.
- Two 5060-4953 22 Pin Extender Boards can be substituted if 5060-4025 are not available.

Note

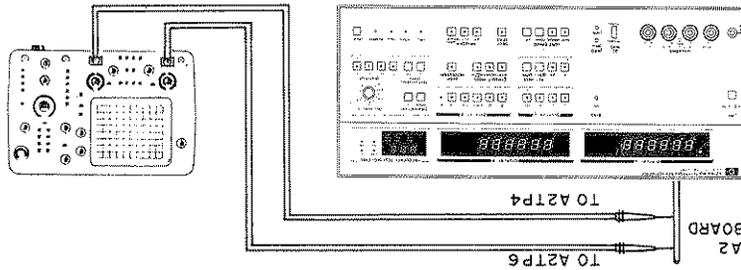
- a. Remove A2 MODULATOR board from 4274A.
- b. Install extender board (HP P/N: 5060-4025) in A2 slot and install A2 board in extender.

PROCEDURE:

OSCILLOSCOPE HP 1740A

EQUIPMENT:

Figure 5-8. A2 90° Phase Adjustment.



To set any accurate 90° phase shift for 90° phase detector to achieve optimum bridge balance.

PURPOSE:

5-23. A2 90° PHASE ADJUSTMENT.

- e. Remove BNC-to-BNC cable and oscilloscope from 4274A.

Proceed to Section VIII A3 troubleshooting if unable to perform appropriate adjustment with A3R1.

Note

- d. Adjust A3R1 to obtain clean sinusoidal waveform.
- c. Observe that waveforms displayed on oscilloscope for all frequencies from 100Hz to 100kHz are of constant amplitude without any distortion or clipping.
- b. Connect 1740A input to 4274A H cur BNC connector of UNKNOWN terminals with BNC-to-BNC cable as in Figure 5-7.

ADJUSTMENTS

ADJUSTMENTS

PROCEDURE:

- a. Press 4274A [SELF TEST] and [Δ%] keys (in that order) and check that a figure "7" appears on unit indicator of Display A. See figure below.



- b. Set 4274A test frequency to 10kHz and OSC LEVEL to full CW position.

- c. Connect BNC-to-BNC cable between H cur and L pot connectors and another BNC-to-BNC cable between L cur and L pot connectors of 4274A unknown terminals as shown Figure 5-10.

- d. Alternately adjust A2R1 and A2R8 until display counts are within ±10 counts for both Display A and Display B. The adjustments of A2R1 and A2R8 are interactive for both displays. Therefore, do the adjustment bit-by-bit.

- e. Change 4274A test frequency to 100kHz and that check display counts are within 0±120 counts for Display A and Display B.

- f. Readjust A2R1 and A2R8 so that display counts are within 0±120 counts.

- g. Change 4274A test frequency from 100kHz thru 100Hz and that check display counts are within 0±120 counts for all frequencies.

- h. Remove both BNC-to-BNC cables from 4274A.

5-25. A1 BUFFER AMPLIFIER ADJUSTMENT.

PURPOSE:

To minimize residual offset in buffer amplifier.

EQUIPMENT:

BNC-to-BNC cable 10cm long

- d. Alternately adjust AZR1 and AZR8 until both display counts are within $.00 \pm 10$ counts for both Display A and Display B.



- c. Press 4274A [V] key and check that a figure "7" appears on unit indicator of Display A. See figure below.
- b. Connect BNC-to-BNC cables between H cur and L pot connectors and between L cur and L pot connectors.

```

FREQUENCY ..... 100KHZ
MULTIPLIER ..... X1
VERNIER ..... full CW
SELF TEST ..... ON
OTHER CONTROLS ..... Any Settings

```

- a. Set 4274A controls as follows:

PROCEDURE:

Use Open (os) terminator of 16074A standard Resistor Set if it's available.

Note

Open terminator (os) BNC-to-BNC cable (10cm long, 2ea required)

EQUIPMENT:

To eliminate residual offset from both Phase Detector 0° and 90° integrators.

PURPOSE:

5-26. A2 MODULATOR ZERO OFFSET ADJUSTMENT.

- g. Remove BNC-to-BNC cable from 4274A.
- f. Adjust A1C2 until display count is within $.00 \pm 300$ counts for Display A.
- e. Change 4274A test frequency to 100kHz.
- Proceed to Section VIII A1 troubleshooting if display counts are not within $.00 \pm 500$ counts.

Note

- d. Adjust A1R1 until display counts are within $.00 \pm 500$ counts on Display A.
- c. Connect terminals Hcur and Lpot together for a few seconds and then remove the cable from Lpot and connect it to Hpot.



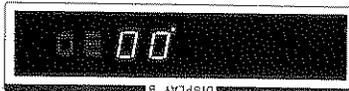
- b. Check that a figure "8" appears on unit indicator of Display A. Set 4274A test frequency to 1kHz. See figure below.
- a. Confirm that 4274A Self Test function is activated and press **REFERENCE VALUE RECALL** key.

PROCEDURE:

ADJUSTMENTS

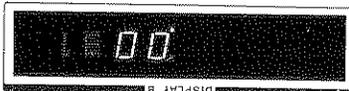
ADJUSTMENTS

e. Press 4274A **STORE** key and press **RANGE UP** or **DOWN** keys until figure a "30" appears on unit indicator of Display B. See figure below.



f. Check that display counts are within ± 15 counts for both Display A and Display B. Proceed to Section VIII A4 and A5 troubleshooting if step f cannot be performed.

g. Change 4274A LEVEL MULTIPLIER to x5 and press **RANGE UP** or **DOWN** key until a figure "31" appears on unit indicator of Display B. See figure below.



h. Check that display counts are within ± 15 counts for both Display A and Display B.

Note

Proceed to Section VIII A4 troubleshooting if stop h cannot be performed.

i. Change 4274A test frequency to 10kHz and press 4274A **Δ%** key.

j. Check that a figure "7" appears on unit indicator of Display A.



k. Alternately adjust A2R1 and A2R8 until display counts are within ± 15 counts for both Display A and Display B.

5-27. A4 x1, x1/2 AND x1/4 ATTENUATER ADJUSTMENT.

PURPOSE:

To set accurate Amplifier gains and attenuations for x1, x1/2 and x1/4 Amplifiers.

EQUIPMENT:

Open termination (os) BNC-to-BNC cable (10cm long, 2ea required)

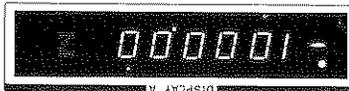
PROCEDURE:

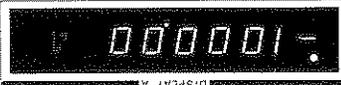
a. Set 4274A controls as follows:

FREQUENCY 1KHZ
 SELF TEST ON
 OTHER CONTROLS Any Settings

b. Connect both BNC-to-BNC cables to 4274A UNKNOWN terminals as in 5-26 step b.

c. Press 4274A **0** key and check that a figure "2" appears on unit indicator of Display A. See figure below.





b. Press 4274A [X/B] key and check that a figure "4" appears on unit indicator of Display A. See figure below.

FREQUENCY 1KHZ
SELF TEST ON
Condition of UNKNOWN terminals is same as for 5-26 step b.

a. Set 4274A controls as follows:

PROCEDURE:

Open termination (os) BNC-to-BNC cable (10cm long, sea required)

EQUIPMENT:

To set accurate amplifier gains and attenuations for x1, x1/10 and x1/100 Amplifiers.

PURPOSE:

5-28. A4 x1, x1/10 and x1/100 ATTENUATOR ADJUSTMENT.

To facilitate easier adjustment, Table 5-6 Adjustment Summary can be used.

Note

If step f is unadjustable with A4ADJ10 (A4C6), refer to Table 5-2 Factory Selected Components on page 5-4. If step h is unadjustable with A4ADJ9 (A4C7), go to A4 troubleshooting tree.

Note

k. Leave both BNC-to-BNC cables connected to 4274A UNKNOWN terminals.

j. Adjust A4ADJ8 (A4R11) until display counts are within -1000.00±20 counts for Display A.

i. Change 4274A test frequency to 1kHz.

h. Adjust A4ADJ9 (A4C7) until display counts are within .00±20 counts for Display B.



g. Press 4274A [ESR/G] key and check that a figure "3" appears on unit indicator of Display A.

f. Adjust A4ADJ10 (A4C6) until display counts are within .00±20 counts for Display B.

e. Change 4274A test frequency to 100kHz.

d. Adjust A4ADJ7 (A4R10) until display count is within -1000.00±20 counts.

ADJUSTMENTS

ADJUSTMENTS

c. Adjust A4ADJ11 (A4R6) until display counts are within -1000.00 ± 20 counts for Display A.

d. Change 4274A test frequency to 100kHz.

e. Adjust A4ADJ14 (A4C4) until display counts are within $.00 \pm 20$ counts for Display B.

f. Press 4274A [L/C] key and check that a figure "5" appears on unit indicator of Display A. See figure below.



g. Adjust A4ADJ13 (A4C5) until display counts are within $.00 \pm 20$ counts for Display B.

h. Change 4274A test frequency to 1kHz.

i. Adjust A4ADJ12 (A4R7) until display counts are within -1000.00 ± 20 counts for Display A.

Note

If any steps are unadjustable, refer to Table 5-2 Factory Selected Components on page 5-4.

j. Remove both BNC-to-BNC cables from 4274A.

Note

To facilitate easier adjustment, Table 5-5 Adjustment Summary can be used.

Table 5-4. 1-1/2-1/4 ATTENUATOR ADJUSTMENTS.

ITEM NUMBER	PRESS \rightarrow KEY	FREQUENCY	ADJUSTABLE COMPONENTS	DISPLAY A	DISPLAY B
2	[Q]	1.00kHz	A4ADJ7	-1000.00 ± 20	$.00 \pm 20$
3	[ESR/G]	1.00kHz	A4ADJ8 A4ADJ9	-1000.00 ± 20	$.00 \pm 20$

Table 5-5. 1-1/10-1/100 ATTENUATOR ADJUSTMENTS.

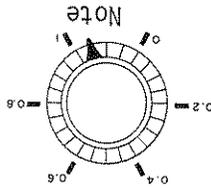
4	[X/B]	1.00kHz	A4ADJ11 A4ADJ14	-1000.00 ± 20	$.00 \pm 20$
5	[L/C]	1.00kHz	A4ADJ12 A4ADJ13	-1000.00 ± 20	$.00 \pm 20$

- g. Change OSC LEVEL CM to 1 and adjust A3R1 until 5.00Vrms is displayed.
- f. Change OSC LEVEL CM to 0.1 and adjust A3R16 until the display value is 1/10 of the display value noted in step e.
- e. Read and note the displayed value of test signal level white key is being pressed.
- d. Press 4274A TEST SIGNAL LEVEL CHECK key and check that lamp changes from kHz to V.
- c. Connect 16047A to 4274A UNKNOWN terminals as shown Figure 5-11.

b. Set 4274A controls as follows:

FREQUENCY	..... 1.00KHZ
OSC LEVEL	..... 1 (exactly)
MULTIPLIER	..... X5
SELF TEST	..... OFF
OTHER CONTROLS	..... Any Settings

If necessary, loosen the two knob lock screws and reset knob.



- a. Rotate OSC LEVEL Vernier fully CW and check that marker pointer of Vernier knob points to a position approximately 10 degrees above the 1 scale reading as shown in figure below.

PROCEDURE:

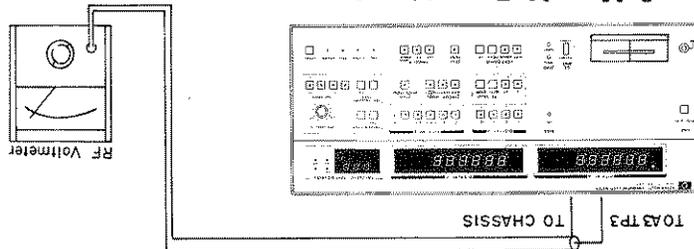
Use open terminator (os) of 16074A Resistor Standard Set if available.

Note

RF VOLTMETER HP 3400A
 TEST FIXTURE HP 16047A

EQUIPMENT:

Figure 5-11. A3 Test Signal Level Monitor Adjustment.



To establish a precise indication of test signal level when and are pressed.

PURPOSE:

5-29. A3 TEST SIGNAL LEVEL MONITOR ADJUSTMENT.

ADJUSTMENTS

- o. Display should be within 100mA±5mA.
 - n. Press 4274A TEST SIGNAL CHECK [mA] key and check that lamp [mA] is lit.
- Use Short (0Ω) termination of 16074A Standard Resistor Set if available.

Note

- m. Connect 16047A to 4274A UNKNOWN terminals and connect shorting bar between High and Low Contacts of 16047A.

FREQUENCY	..... 1KHZ
OSC LEVEL	..... 1
MULTIPLIER	..... X5
SELF TEST	..... OFF
OTHER CONTROLS	..... Any Settings

- 1. Change 4274A controls as follows:

No adjustments or factory selected components are in the 4274A for frequency accuracy. Proceed to Section VIII A6 troubleshooting if Paragraph 4-9 TEST FREQUENCY ACCURACY TEST can not be made as listed in Table 4-2.

Note

4274A SETTING	OSC LEVEL	.009	.090	.90	1.00	3.00	4.50
	DISPLAY						
VOLTMETER READING LIMITS	UPPER	10mV	920mV	920mV	1.02V	3.06V	4.62V
	LOWER	8mV	880mV	880mV	980mV	2.94V	4.40V
MULTIPLIER	MULTIPLIER	X.01	X.1	X1	X5		

Table 5-7. Signal level limits that appear at UNKNOWN Terminals.

SETTING	OSC LEVEL	1	1	1	1	0.6	0.2
	DISPLAY	.011	.110	1.10	5.10	3.80	1.60
LIMITS	UPPER	.009	.090	.90	4.90	2.20	0.40
	LOWER						
MULTIPLIER	MULTIPLIER	X.01	X.1	X1	X5		

Table 5-6. Display Limits for OSC Level Monitor.

- i. Check respective display values for other combinations of MULTIPLIER settings and vernier positions as listed in Table 5-6.
- j. Connect voltmeter plus input to A3TP-3 and minus input to 4274A chassis with dual banana-to-alligator clip cable. See Figure 5-11.
- k. Check that voltmeter readings are within the lower and upper limits for their respective settings as listed in Table 5-7.
- h. Repeat steps e through g as necessary.

ADJUSTMENTS

d. Connect 100kΩ resistor to 4274A UNKNOWN terminals as shown Figure 5-12 and adjust (100kΩ) A1R21 until display counts are 10.0000μS±20 counts for Display A.

The adjustment limits given in steps d through k are for ideal standard resistors; that is, standard resistors whose values are exactly 100Ω, 1kΩ, 10kΩ and 100kΩ, respectively. THEY CANNOT BE USED AS THE ADJUSTMENT LIMITS FOR AN ACTUAL ADJUSTMENT. Actual adjustment limits depend on the calibrated value of the standard resistor used in each step of the adjustment. Use the reciprocal of the standard resistor's calibrated value as the adjustment limit. For example, if the calibrated value of the 100kΩ resistor is 100.02kΩ, the adjustment limit used in step d should be 9.9980μS±20 counts.

Note



b. Press 4274A REFERENCE VALUE STORE key and check that a figure "μS" appears on unit indicator of Display A. See figure below.
 c. Press RANGE UP or DOWN key until the figure "50" appears on unit indicator of Display B. See figure below.

SELF TEST ON
 FREQUENCY 1KHZ
 OSC LEVEL FULL CM
 MULTIPLIER X1

a. Set 4274A controls as follows:

PROCEDURE:

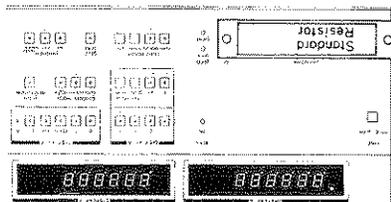
Use 100Ω to 100kΩ resistors from 16074A Standard Resistor Set if available.

Note

STANDARD RESISTOR 100kΩ±0.03%
 10kΩ±0.03%
 1kΩ±0.03%
 100Ω±0.03%
 Usable frequencies: (up to 100kHz)
 16074A Standard Resistor Set

EQUIPMENT:

Figure 5-12. A1 Range Resistor and A4 Buffer AMP Tracking Adjustment.



To establish precise Range Resistor Resistance (which directly affects the accuracies of all functions).

PURPOSE:

5-30. A1 RANGE RESISTOR and A4 BUFFER AMP TRACKING ADJUSTMENT.

ADJUSTMENTS

If step p is unadjustable with A4ADJ5 (A4C3), refer to Table 5-2 (Factory Adjust Components). To facilitate easier adjustment, Table 5-8 Adjustment Summary can be used.

Note

- q. Remove 100Ω Standard Resistor from 4274A UNKNOWN terminals.
- p. Adjust A4ADJ5 (A4C3) until display counts are within .020±20 counts for Display B.
- o. Adjust A4ADJ4 A4R1 until display counts are 100.000±20 counts for Display A.



- n. Press 4274A RANGE UP or DOWN keys until the figures "0" and "20", respectively, appear on Display A and Display B.
- m. Change 4274A OSC LEVEL MULTIPLIER setting to x1 and FREQUENCY setting to 100kHz.
- l. Adjust (10Ω) A1R8 until display counts are 10.0000±20 counts for Display A.



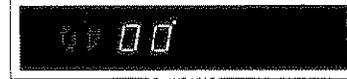
- k. Change 4274A OSC LEVEL MULTIPLIER setting to x5 key so that the figure "11" appears on the annunciator of Display B.
- j. Remove 1kΩ Standard Resistor and connect the 100Ω Resistor Standard to 4274A and adjust (100Ω) A1R12 until display counts are 10.0000±20 counts. The 100Ω Resistor Standard should now be left on the 4274A UNKNOWN terminals.



- i. Press 4274A RANGE UP or DOWN key until the figure "20" appears on unit indicator of Display B.
- h. Remove 10kΩ Standard Resistor and connect 1kΩ Standard Resistor to 4274A UNKNOWN terminals and adjust (1kΩ) A1R15 until display counts are 1000.000±20 counts for Display A.



- g. Press 4274A RANGE UP or DOWN key until the figure "30" appears on unit indicator of Display B. See figure below.
- f. Remove 100kΩ and connect 10kΩ Standard Resistor to 4274A and adjust (10kΩ) A1R18 until display counts are 100.000±20 counts for Display A.



- e. Press 4274A RANGE UP or DOWN key until the figure "40" appears on unit indicator of Display B. See figure below.

ADJUSTMENTS



- b. Press 4274A STORE key and RANGE UP or DOWN keys until the figure "50" appears on unit indicator of Display B. See figure below.
- a. Set 4274A controls as follows:
- SELF TEST ON
 - FREQUENCY 100KHZ
 - OSC LEVEL full CM
 - MULTIPLIER x1
 - OTHER CONTROLS Any Settings

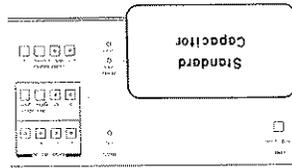
PROCEDURE:

STANDARD CAPACITORS
 1pF: HP 16381A
 10pF: HP 16382A
 100pF: HP 16383A
 1000pF: HP 16384A

(Useable frequencies: up to 100KHz)

EQUIPMENT:

Figure 5-13. A1 Range Resistor Phase Adjustment.



To minimize residual phase offset that especially occurs at high frequencies in Range Resistor of bridge circuit.

PURPOSE:

5-31. A1 RANGE RESISTOR PHASE ADJUSTMENT.

A4ADJ4 Display A 100.000Ω±20 (C.R.V.Ω±20)	A4ADJ5 Display B 20±20
---	------------------------------------

Table 5-8 (b). Adjustment Summary (of steps m thru q).

C.R.V. calibrated resistance value

Display-B Unit Indication	Press+Key	Resistor Standard	Adjustable Component(s)	Display-A (Nominal)	Display-A (Actual)
50	RANGE UP DOWN	100kΩ	100kΩ (A1R21)	10.000μs±20	$\frac{C.R.V.}{1}$ s±20
40	RANGE UP DOWN	10kΩ	10kΩ (A1R18)	100.000μs±20	$\frac{C.R.V.}{1}$ s±20
30	RANGE UP DOWN	1kΩ	1kΩ (A1R15)	1000.00μs±20	$\frac{C.R.V.}{1}$ s±20
20	RANGE UP DOWN	100Ω	100Ω (A1R12)	10.000μs±20	$\frac{C.R.V.}{1}$ s±20
11	MULTIPLIER [X5]	100Ω	10Ω (A1R 8)	10.000Ω±20	$\frac{C.R.V.}{10}$ Ω±20

Table 5-8(a). Adjustment Summary (of step a thru e).

ADJUSTMENTS

Item Number	Standard	Adjust	Display	Count Limits
50	10pF	100kΩ (A1C11)	A	$.0000\mu\text{s} \pm 4\%$
40	100pF	10kΩ (A1C10)	A	$.0001\mu\text{s} \pm 3\%$
30	1000pF	1kΩ (A1C9)		$.001\mu\text{s} \pm 3\%$
11	100Ω	10Ω (A1C7)	B	$.020 \pm 20$

Table 5-9. Adjustment Summary.

To facilitate easier adjustment, Table 5-9 Adjustment Summary can be used.

Note

If only A1C7 (10Ω) in step 1 is unadjustable, refer to Table 5-2 (Factory Adjust Components).

Note

1. Adjust A1C7 (10Ω) until display counts are within $.020 \pm 20$ counts for Display B.



k. Change Multiplier to x5 and press 4274A RANGE **UP** or **DOWN** key until the figure "0" and "1", respectively, appear on unit indicators for Display A and Display B.

j. Remove 1000pF Capacitor Standard (16384A) from 4274A and connect 100Ω Standard Resistor to 4274A UNKNOWN terminals.

i. Adjust A1C9 (1kΩ) until display counts are within $.001\mu\text{s} \pm 3\%$ counts for Display A.



h. Press 4274A RANGE **UP** or **DOWN** key until the figure "30" appears on unit indicator of Display B. See figure below.

g. Remove 100pF Standard Capacitor (16383A) from 4274A and connect 1000pF Standard Capacitor (16384A) to 4274A UNKNOWN terminals.

f. Adjust A1C10 (10kΩ) until display counts are within $.0001\mu\text{s} \pm 3\%$ counts for Display A.



e. Press 4274A RANGE **UP** or **DOWN** key until the figure "40" appears on unit indicator of Display B. See figure below.

d. Remove 10pF Standard Capacitor (16382A) from 4274A and connect 100pF Capacitor Standard (16383A) to 4274A UNKNOWN terminals.

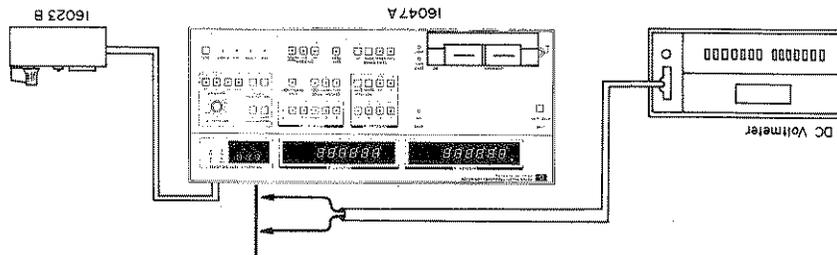
c. Connect 10pF Standard Capacitor (16382A) to 4274A as shown in Figure 5-13 and adjust A1C11 (100kΩ) until display counts are within $.0000\mu\text{s} \pm 4\%$ counts for Display A.

ADJUSTMENTS

5-32. A21 INTERNAL DC BIAS SUPPLY ADJUSTMENT (0 to $\pm 35V$).

PURPOSE:

To set internal DC voltage and the gain of DAC and Amplifier so that accurate DC bias voltages can be applied to the sample when controlled with 16023B BIAS CONTROLLER.



EQUIPMENT: Adjustment (0 to $\pm 35V$).

- BIAS CONTROLLER HP 16023B
- DIGITAL VOLTMETER HP 3465B

PROCEDURE:

a. Set 4274A controls as follows.

- DC BIAS SWITCH $\pm 35V$ MAX
- Display A C
- TRIGGER Manual
- MULTIPLIER $\times .01$
- OSC LEVEL Full CM
- OTHER CONTROLS Any Settings
- DC BIAS SELECTOR SW INT 35V/100V ($C < .1\mu F$)

- b. Set 16023B DC Bias Controller thumbwheel switch to 0.00 and connect its 24 pin mate connector to BIAS CONTROL connector on the rear panel of the 4274A. See Figure 5-14.
- c. Remove A21 board and install board extender in A21 slot and install A21 board in extender.

CAUTION

Before removing A21 board, DC Bias connector board must be pulled out toward the rear panel by loosening its two screws.

d. Set 3465B controls as follows:

- FUNCTION V
- RANGE 200V

- e. Connect 3465B plus input to the negative lead of A21C19 ($-42V$) and minus input to the positive lead of A21C19 (GND ∇) with dual banana to alligator clip cable.
- f. Adjust A21R83 so the 3465B reads $-42V \pm 0.1V$ and check that the voltage across A21C18 is within $\pm 42V \pm 1.0V$.

Note

Change 3465B Range control to the appropriate setting for the adjustments that follow.

ADJUSTMENTS

Before removing A23 board, DC Bias connector board must be pulled out toward rear panel by loosening its two screws.

Note

- c. Remove A23 board and install board extender in A23 slot and install A23 board in extender.
- b. Set 16023B DC Bias Controller thumbwheel switch to .000 and connect its 24 pin male connector to Bias Controller connector on the rear panel of 4274A. Refer to Figure 5-14 except for the difference in test pins and board number.

DC BIAS SWITCH ±200V MAX
 TRIGGER Manual
 DISPLAY A C
 OSC LEVEL full CCM
 OTHER CONTROLS Any Settings
 DC BIAS SELECTOR SW INT 35V/100V (<.1µF)
 (REAR PANEL)

- a. Set 4274A controls as follows:

PROCEDURE:

Same as in Para. 5-32.

PURPOSE and EQUIPMENT:

5-33. A23 INTERNAL DC BIAS SUPPLY ADJUSTMENT (0 to ±100V).

Although the variable resistor A21R48 is mounted on the A21 board, it is a "factory only" adjustable component and is not field adjustable.

Note

- p. Remove dual banana to alligator clip cable, 3465B and 16023B from 4274A.
- o. Adjust A21R13 until the 3465B reads -9V±.002V.
- n. Change 16023B thumbwheel switch setting to -9.00Vx1 and press ENTER button.
- m. Adjust A21R8 until the 3465B reads 0V±0.1mV.
- l. Remove 3465B plus input from A21TP3 and connect to TP2.
- k. Adjust A21R11 until the 3465B reads 0V±0.1mV.
- j. Change 16023B thumbwheel switch setting to +.00Vx1 and press ENTER button.
- i. Adjust A21R12 until the 3465B reads 0V±0.1mV.
- h. Connect 3465B plus input to A21TP3 and minus input to x/A 16R connector pin (GND[⊕]).
- g. Change 16023B thumbwheel switch setting to -.00Vx1 and press ENTER button.

ADJUSTMENTS

ADJUSTMENTS

d. Set 3465B controls as follows:

FUNCTION V
RANGE 200V

e. Connect 3465B plus input to the negative lead of A23C26 and minus input to the positive lead of A23C26 with dual banana to alligator clip cable.

f. Adjust A23R55 until the 3465B reads $-42V \pm 0.1V$.

Note

Change 3465B Range Control to the appropriate setting for the adjustments that follow.

g. Connect 3465B plus input to the A23TP2 and minus input to the x/A 16R connector pin (GND Δ).

h. Set 16023B thumbwheel switch control to $-0.00V \times 1$ and press ENTER button.

i. Adjust A23R11 until the 3465B reads $0V \pm 0.1mV$.

j. Change 16023B thumbwheel switch setting to $+0.00 \times 1$ and press ENTER button.

k. Adjust A23R10 until the 3465B reads $0 \pm 0.1mV$.

l. Connect 3465B plus input to A23TP1 and minus input to the x/A 16R connector pin.

m. Change 16023B thumbwheel switch setting to $-0.00V \times 1$ and press ENTER button.

n. Adjust A23R8 until the 3465B reads $0V \pm 2mV$.

o. Change 16023B thumbwheel switch setting to $-9.00V \times 1$ and press ENTER button.

p. Adjust A23R9 until the 3465B reads $-90V \pm 40mV$.

q. Remove dual banana to alligator clip cable, 3465B and 16023B from 4277A.



MFR NO.	MANUFACTURER	ADDRESS	ZIP CODE
00633	AKTIEBOLAGET RIFA	BROMMA	SE
00000	ANY SATISFACTORY SUPPLIER		
01121	ALLEN-BRADLEY CO	MILWAUKEE	WI
01295	TEXAS INSTR INC SEMICONDUCTOR DIV	DALLAS	TX
01928	RCA CORP SOLID STATE DIV	SOMERVILLE	NJ
02111	SPECTROL ELECTRONICS CORP	CITY OF IND	CA
02114	FERROXCORBE CORP	SAUGERTIES	NY
03888	KDI PYROFILM CORP	WHIPPANY	NJ
04713	MOTOROLA SEMICONDUCTOR PRODUCTS	PHOENIX	AZ
07263	FAIRCHILD SEMICONDUCTOR DIV	MOUNTAIN VIEW	CA
12954	SIEMENS CORP COMPONENTS GROUP	SCOTTSDALE	AZ
18324	SIGNETICS CORP		
19701	NEPCO/ELECTRA CORP	SUNNYSVALE	CA
24046	TRANSISTRON ELECTRONIC CORP	MAKERFIELD	MA
24355	ANALOG DEVICES INC	NORWOOD	MA
24546	CORNING GLASS WORKS (BRADFORD)	BRADFORD	PA
27014	NATIONAL SEMICONDUCTOR CORP	SANTA CLARA	CA
27167	CORNING GLASS WORKS (WILMINGTON)	WILMINGTON	NC
28480	HEWLETT-PACKARD CO CORPORATE HQ	PALO ALTO	CA
30983	NEPCO/ELECTRA CORP	SAN DIEGO	CA
32293	INTERFIL INC	CUPERINO	CA
32997	BOURNS INC TRIMPOT PROD DIV	RIVERSIDE	CA
34649	INTEL CORP	MOUNTAIN VIEW	CA
52763	STETTNER-TRUSH INC	CAZENOVIA	NY
56289	SPRAGUE ELECTRIC CO	NORTH ADAMS	MA
72136	ELECTRO MOTIVE CORP SUB IEC	WILLIAMANTIC	CT
73138	BECKMAN INSTRUMENTS INC HELIPOT DIV	FULLERTON	CA
75915	LITTELFUSE INC	DES PLAINES	IL

Table 6-2. Manufacturers Code List.

- 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.
- 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.
- 6-13. 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.
- 6-12. DIRECT MAIL ORDER SYSTEM.
- the Recommended Spares List are based on failure reports, 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.

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

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

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1	04274-66501	8	NULL DETECTOR & RANGE REGISTER BD, A99Y.	28480	04274-66501
A1C1	0180-1077	5	CAPACITOR-FXD 220UF +50-10% 16VDC	28480	0180-1077
A1C2	0121-0105	4	CAPACITOR-V TRMR-CER 9-35PF 200V PC-MTG	52763	0180-1077
A1C3	0180-1077	7	CAPACITOR-FXD 220UF +50-10% 6.3VDC	28480	0180-1077
A1C4	0180-1077	5	CAPACITOR-FXD 220UF +50-10% 16VDC	28480	0180-1077
A1C5	0180-1079	7	CAPACITOR-FXD 220UF +30-10% 6.3VDC	28480	0180-1079
A1C6	0180-1079	7	CAPACITOR-FXD 220UF +30-10% 6.3VDC	28480	0180-1079
A1C7	0160-4835	1	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A1C8	0160-4835	1	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A1C9	0160-4835	1	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A1C10	0121-0036	7	CAPACITOR-V TRMR-CER 9-35PF 350V PC-MTG	52763	0121-0036
A1C11	0121-0036	7	CAPACITOR-V TRMR-CER 9-35PF 350V PC-MTG	52763	0121-0036
A1C12	0160-4832	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	0160-4832
A1C13	0180-1077	5	CAPACITOR-FXD 220UF +50-10% 16VDC	28480	0180-1077
A1C14	0180-1077	5	CAPACITOR-FXD 220UF +50-10% 16VDC	28480	0180-1077
A1C15	0160-4835	1	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A1C16	0160-4835	1	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A1C17	0160-4835	1	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A1C18	0160-4835	1	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A1C19	0160-4835	1	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A1C20	0180-1077	11	CAPACITOR-FXD 220UF +50-10% 16VDC	28480	0180-1077
A1C21	0180-1049	5	CAPACITOR-FXD 470UF +50-10% 16VDC	28480	0180-1049
A1C22	0160-4835	1	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A1C23	0160-4835	1	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A1C24	0140-0199	1	CAPACITOR-FXD 240PF +5X 300VDC MICA	72136	DM15F241J0300WV1CR
A1C25	0180-1085	5	CAPACITOR-FXD 4.7UF +20% 16VDC	28480	0180-1085
A1C26	0160-2208	4	CAPACITOR-FXD 100PF +5X 300VDC MICA	28480	0160-2208
A1C27	0160-2257	3	CAPACITOR-FXD 10PF +5X 500VDC CER 0+60	28480	0160-2257
A1C28	0160-2257	3	CAPACITOR-FXD 10PF +5X 500VDC CER 0+60	28480	0160-2257
A1C29	0160-4835	1	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A1C30	0160-4835	1	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A1C31	0160-4835	1	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A1C32	0160-4835	1	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A1C33	0140-0199	1	CAPACITOR-FXD 240PF +5X 300VDC MICA	72136	DM15F241J0300WV1CR
A1C34	0180-1085	5	CAPACITOR-FXD 4.7UF +20% 16VDC	28480	0180-1085
A1C35	0180-1085	5	CAPACITOR-FXD 4.7UF +20% 16VDC	28480	0180-1085
A1C36	0180-1085	5	CAPACITOR-FXD 4.7UF +20% 16VDC	28480	0180-1085
A1C37	0180-1077	5	CAPACITOR-FXD 220UF +50-10% 16VDC	28480	0180-1077
A1C38	0180-1077	5	CAPACITOR-FXD 220UF +50-10% 16VDC	28480	0180-1077
A1C39	0140-0196	1	CAPACITOR-FXD 150PF +5X 300VDC MICA	72136	DM15F151J0300WV1CR
A1C40	0160-2222	2	CAPACITOR-FXD 150PF +5X 300VDC MICA	28480	0160-2222
A1C41	0160-4031	4	CAPACITOR-FXD .012UF +10% 200VDC POLYE	28480	0160-4031
A1C42	0160-4832	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	0160-4832
A1C43	0160-4832	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	0160-4832
A1C44	0160-4832	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	0160-4832
A1C45	0160-4835	1	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A1C46	0160-4835	1	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A1C47	0160-2055	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	0160-2055
A1C48	0160-2055	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	0160-2055
A1C49	0160-4835	1	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A1C50	0160-4835	1	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A1C51	0160-4835	1	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A1C52	0160-4835	1	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A1C53	0160-4835	1	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A1C54	0160-4835	1	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A1C55	0160-4835	1	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A1C56	0180-1085	5	CAPACITOR-FXD 4.7UF +20% 16VDC	28480	0180-1085
A1C57	0180-1085	5	CAPACITOR-FXD 4.7UF +20% 16VDC	28480	0180-1085
A1C58	0180-1083	6	CAPACITOR-FXD 33UF -10+75% 25WVDC TA	56289	0180-1083
A1C59	0180-1083	6	CAPACITOR-FXD 33UF -10+75% 25WVDC TA	56289	0180-1083
A1C60	0160-1049	1	CAPACITOR-FXD 470UF +50-10% 16VDC	28480	0160-1049
A1C61	0180-1049	1	CAPACITOR-FXD 470UF +50-10% 16VDC	28480	0180-1049
A1C62	0180-1085	5	CAPACITOR-FXD 4.7UF +20% 16VDC	28480	0180-1085
A1C63	0160-4835	1	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A1C64	0160-4835	1	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A1C65	0180-1085	5	CAPACITOR-FXD 4.7UF +20% 16VDC	28480	0180-1085
A1C66	0180-1085	5	CAPACITOR-FXD 4.7UF +20% 16VDC	28480	0180-1085
A1C67	0180-1049	1	CAPACITOR-FXD 470UF +50-10% 16VDC	28480	0180-1049
A1C68	0180-1085	5	CAPACITOR-FXD 4.7UF +20% 16VDC	28480	0180-1085
A1C69	0180-1085	5	CAPACITOR-FXD 4.7UF +20% 16VDC	28480	0180-1085
A1C70	0160-2141	6	CAPACITOR-FXD 3.3UF +10% 50VDC TA	56289	0160-2141
A1C71	0180-1086	6	CAPACITOR-FXD 33UF +50-30% 16VDC	28480	0180-1086
A1C72	0180-1086	6	CAPACITOR-FXD 33UF +50-30% 16VDC	28480	0180-1086
A1C73	0180-1086	6	CAPACITOR-FXD 33UF +50-30% 16VDC	28480	0180-1086
A1C74	0180-1086	6	CAPACITOR-FXD 33UF +50-30% 16VDC	28480	0180-1086
A1C75	0180-1086	6	CAPACITOR-FXD 33UF +50-30% 16VDC	28480	0180-1086
A1C76	0180-1086	6	CAPACITOR-FXD 33UF +50-30% 16VDC	28480	0180-1086
A1C77	0180-1086	6	CAPACITOR-FXD 33UF +50-30% 16VDC	28480	0180-1086
A1C78	0180-1086	6	CAPACITOR-FXD 33UF +50-30% 16VDC	28480	0180-1086
A1C79	0180-1086	6	CAPACITOR-FXD 33UF +50-30% 16VDC	28480	0180-1086
A1C80	0180-1086	6	CAPACITOR-FXD 33UF +50-30% 16VDC	28480	0180-1086
A1C81	0180-1086	6	CAPACITOR-FXD 33UF +50-30% 16VDC	28480	0180-1086
A1C82	0180-1086	6	CAPACITOR-FXD 33UF +50-30% 16VDC	28480	0180-1086
A1C83	0180-1086	6	CAPACITOR-FXD 33UF +50-30% 16VDC	28480	0180-1086
A1C84	0180-1086	6	CAPACITOR-FXD 33UF +50-30% 16VDC	28480	0180-1086
A1C85	0180-1086	6	CAPACITOR-FXD 33UF +50-30% 16VDC	28480	0180-1086
A1C86	0180-1086	6	CAPACITOR-FXD 33UF +50-30% 16VDC	28480	0180-1086
A1C87	0180-1086	6	CAPACITOR-FXD 33UF +50-30% 16VDC	28480	0180-1086
A1C88	0180-1086	6	CAPACITOR-FXD 33UF +50-30% 16VDC	28480	0180-1086
A1C89	0180-1086	6	CAPACITOR-FXD 33UF +50-30% 16VDC	28480	0180-1086
A1C90	0180-1086	6	CAPACITOR-FXD 33UF +50-30% 16VDC	28480	0180-1086
A1C91	0180-1086	6	CAPACITOR-FXD 33UF +50-30% 16VDC	28480	0180-1086
A1C92	0180-1086	6	CAPACITOR-FXD 33UF +50-30% 16VDC	28480	0180-1086
A1C93	0180-1086	6	CAPACITOR-FXD 33UF +50-30% 16VDC	28480	0180-1086
A1C94	0180-1086	6	CAPACITOR-FXD 33UF +50-30% 16VDC	28480	0180-1086
A1C95	0180-1086	6	CAPACITOR-FXD 33UF +50-30% 16VDC	28480	0180-1086
A1C96	0180-1086	6	CAPACITOR-FXD 33UF +50-30% 16VDC	28480	0180-1086
A1C97	0180-1086	6	CAPACITOR-FXD 33UF +50-30% 16VDC	28480	0180-1086
A1C98	0180-1086	6	CAPACITOR-FXD 33UF +50-30% 16VDC	28480	0180-1086
A1C99	0180-1086	6	CAPACITOR-FXD 33UF +50-30% 16VDC	28480	0180-1086
A1C00	0180-1086	6	CAPACITOR-FXD 33UF +50-30% 16VDC	28480	0180-1086

Table 6-3. Replaceable Parts

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

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1R1	2100-2574	3	RESISTOR-TMR 500 10X C SIDE-ADJ 1-TRN	0121	E15X501
A1R2	0757-0394	0	RESISTOR 51.1 1% .125W F TC=+100	24546	C4-1/B-10=51R1F
A1R3	0698-4433	0	RESISTOR 2.26K 1% .125W F TC=+100	24546	C4-1/B-10=2261F
A1R4	0757-0280	3	RESISTOR 1K 1% .125W F TC=+100	24546	C4-1/B-10=1001F
A1R5	0693-7515	4	RESISTOR 750 5% .25W FC TC=400/+600	01121	CB7515
A1R6	0693-7515	4	RESISTOR 750 5% .25W FC TC=400/+600	01121	CB7515
A1R7	0757-0442	9	RESISTOR 10K 1% .125W F TC=+100	24546	C4-1/B-10=1002F
A1R8	2100-3273	1	RESISTOR-TMR 2K 10X C SIDE-ADJ 1-TRN	24480	2100-3273
A1R9	0757-0418	1	RESISTOR 619 1% .125W F TC=+100	24546	C4-1/B-10=619R#
A1R10	0698-2337	9	RESISTOR 20.2 +.5% .5W	24480	0698-2337
A1R11	0698-2337	2	RESISTOR 20.2 +.5% .5W	24480	0698-2337
A1R12	2100-3274	2	RESISTOR 20.2 +.5% .5W	24480	0698-2337
A1R13	0757-0440	7	RESISTOR 7.5K 1% .125W F TC=+100	24546	C4-1/B-10=7501F
A1R14	0698-2316	4	RESISTOR-FXD MET FLW 101.3 OHM 0.1% 1/8	24480	2100-3426
A1R15	2100-3426	4	RESISTOR-TMR 20 10X C SIDE-ADJ 1-TRN	24480	2100-3426
A1R16	0757-0394	0	RESISTOR 51.1 1% .125W F TC=+100	24546	C4-1/B-10=51R1F
A1R17	0698-2338	0	RESISTOR-FXD 950 +/-1% .125W	24480	0698-2338
A1R18	2100-3350	5	RESISTOR-TMR 200 10X C SIDE-ADJ 1-TRN	24480	2100-3350
A1R19	0757-0416	7	RESISTOR 511 1% .125W F TC=+100	24546	C4-1/B-10=511R#
A1R20	0698-2339	1	RESISTOR-FXD 10.5K +/-1% .125W	24480	0698-2339
A1R21	2100-3273	1	RESISTOR-TMR 2K 10X C SIDE-ADJ 1-TRN	24480	2100-3273
A1R22	0698-3154	4	RESISTOR 4.22K 1% .125W F TC=+100	24546	C4-1/B-10=4221F
A1R23	0698-2340	4	RESISTOR-FXD 95K +/-1% .125W	24480	0698-2340
A1R24	0757-0346	2	RESISTOR 10 1% .125W F TC=+100	24546	C4-1/B-10=10R#
A1R25	0693-4725	2	RESISTOR 4.7K 5% .25W FC TC=400/+700	01121	CB4725
A1R26	0693-4725	2	RESISTOR 4.7K 5% .25W FC TC=400/+700	01121	CB4725
A1R27	0693-4725	2	RESISTOR 4.7K 5% .25W FC TC=400/+700	01121	CB4725
A1R28	0693-4725	2	RESISTOR 4.7K 5% .25W FC TC=400/+700	01121	CB4725
A1R29	0693-4725	2	RESISTOR 4.7K 5% .25W FC TC=400/+700	01121	CB4725
A1R30	0693-4725	2	RESISTOR 4.7K 5% .25W FC TC=400/+700	01121	CB4725
A1R31	0757-0346	0	RESISTOR 10 1% .125W F TC=+100	24546	C4-1/B-10=10R#
A1R32	0757-0401	2	RESISTOR 100 1% .125W F TC=+100	24546	C4-1/B-10=1001F
A1R33	0757-0280	3	RESISTOR 1K 1% .125W F TC=+100	24546	C4-1/B-10=1001F
A1R34	0757-0442	3	RESISTOR 1K 1% .125W F TC=+100	24546	C4-1/B-10=1001F
A1R35	0757-0442	6	RESISTOR 100K 1% .125W F TC=+100	24546	C4-1/B-10=1003F
A1R36	0693-1035	1	RESISTOR 10K 5% .25W FC TC=400/+700	01121	CB1035
A1R37	0693-1035	1	RESISTOR 10K 5% .25W FC TC=400/+700	01121	CB1035
A1R38	0693-1035	1	RESISTOR 10K 5% .25W FC TC=400/+700	01121	CB1035
A1R39	0693-1035	1	RESISTOR 10K 5% .25W FC TC=400/+700	01121	CB1035
A1R40	0757-0280	3	RESISTOR 1K 1% .125W F TC=+100	24546	C4-1/B-10=1001F
A1R41	0693-4715	0	RESISTOR 470 5% .25W FC TC=400/+600	01121	CB4715
A1R42	2100-1768	9	RESISTOR-TMR 500 10X C TOP-ADJ 1-TRN	01121	CB4715
A1R43	0698-0084	9	RESISTOR 2.15K 1% .125W F TC=+100	24546	C4-1/B-10=2151F
A1R44	0698-0084	9	RESISTOR 2.15K 1% .125W F TC=+100	24546	C4-1/B-10=2151F
A1R45	0698-0083	8	RESISTOR 1.96K 1% .125W F TC=+100	24546	C4-1/B-10=1961F
A1R46	0757-0446	1	RESISTOR 61.9K 1% .125W F TC=+100	24546	C4-1/B-10=6192F
A1R47	0698-0083	8	RESISTOR 1.96K 1% .125W F TC=+100	24546	C4-1/B-10=1961F
A1R48	0693-4725	2	RESISTOR 4.7K 5% .25W FC TC=400/+700	01121	CB4725
A1R49	0693-1515	2	RESISTOR 150 5% .25W FC TC=400/+600	01121	CB1515
A1R50	0693-4705	8	RESISTOR 47 5% .25W FC TC=400/+500	01121	CB4705
A1R51	0693-4725	2	RESISTOR 4.7K 5% .25W FC TC=400/+700	01121	CB4725
A1R52	0693-1005	5	RESISTOR 10 5% .25W FC TC=400/+500	01121	CB1005
A1R53	0693-1005	5	RESISTOR 10 5% .25W FC TC=400/+500	01121	CB1005
A1R54	0693-4705	8	RESISTOR 47 5% .25W FC TC=400/+500	01121	CB4705
A1R55	0693-2205	9	RESISTOR 22 5% .25W FC TC=400/+500	01121	CB2205
A1R56	0693-2205	9	RESISTOR 22 5% .25W FC TC=400/+500	01121	CB2205
A1R57	0757-0280	1	RESISTOR 1K 1% .125W F TC=+100	24546	C4-1/B-10=1001F
A1R58	0693-1035	1	RESISTOR 10K 5% .25W FC TC=400/+700	01121	CB1035
A1R59	0693-1035	1	RESISTOR 10K 5% .25W FC TC=400/+700	01121	CB1035
A1R60	0693-2235	5	RESISTOR 22K 5% .25W FC TC=400/+600	01121	CB2235
A1R61	0693-2235	5	RESISTOR 22K 5% .25W FC TC=400/+600	01121	CB2235
A1R62	0693-2235	5	RESISTOR 22K 5% .25W FC TC=400/+600	01121	CB2235
A1R63	0693-2235	5	RESISTOR 22K 5% .25W FC TC=400/+600	01121	CB2235
A1R64	0698-3440	1	RESISTOR 10K 5% .25W FC TC=400/+700	01121	CB1035
A1R65	0698-3440	3	RESISTOR 196 1% .125W F TC=+100	24546	C4-1/B-10=196R#
A1R66	2100-2216	1	RESISTOR-TMR 5K 10X C TOP-ADJ 1-TRN	73136	62PR500
A1R67	0757-0279	0	RESISTOR 3.16K 1% .125W F TC=+100	24546	C4-1/B-10=3161F
A1R68	0698-4455	5	RESISTOR 536 1% .125W F TC=+100	24546	C4-1/B-10=536R#
A1R69	0757-0290	6	RESISTOR 6.19K 1% .125W F TC=+100	19701	MF401/B-10=6191F
A1R70	0693-4715	0	RESISTOR 470 5% .25W FC TC=400/+600	01121	CB4715
A1R71	0693-1035	1	RESISTOR 10K 5% .25W FC TC=400/+700	01121	CB1035
A1R72	0693-1035	1	RESISTOR 10K 5% .25W FC TC=400/+700	01121	CB1035
A1R73	0693-1035	1	RESISTOR 10K 5% .25W FC TC=400/+700	01121	CB1035
A1R74	0693-1035	1	RESISTOR 10K 5% .25W FC TC=400/+700	01121	CB1035
A1R75	0698-3154	0	RESISTOR 4.22K 1% .125W F TC=+100	24546	C4-1/B-10=4221F

Table 6-3. Replaceable Parts (cont'd).

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

Reference Designation	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
A1R76	0757-0280	3			RESISTOR 1K 1% .125W F TC0+/-100		25496 C4-1/B-10-1001-F
A1R77	0757-0410	7			RESISTOR 511 1% .125W F TC0+/-100		25496 C4-1/B-10-511R-F
A1R78	0757-0410	7			RESISTOR 511 1% .125W F TC0+/-100		25496 C4-1/B-10-511R-F
A1R79	0698-3450	9			RESISTOR 42.2K 1% .125W F TC0+/-100		25496 C4-1/B-10-4222-F
A1R80	0693-2225	3			RESISTOR 2.2K 5% .25W FC TC=400/+700		01121 C82225
A1R81	0693-3335	8			RESISTOR 33K 5% .25W FC TC=400/+800		01121 C83335
A1R82	0757-0442	9			RESISTOR 10K 1% .125W F TC0+/-100		25496 C4-1/B-10-1002-F
A1R83	0757-0442	9			RESISTOR 10K 1% .125W F TC0+/-100		25496 C4-1/B-10-1002-F
A1R84	0757-0272	0			RESISTOR 3.16K 1% .125W F TC0+/-100		25496 C4-1/B-10-3161-F
A1R85	0693-1005	5			RESISTOR 10 5% .25W FC TC=400/+500		01121 C81005
A1R86	0693-1005	5			RESISTOR 10 5% .25W FC TC=400/+500		01121 C81005
A1R87	0757-0442	9			RESISTOR 10K 1% .125W F TC0+/-100		25496 C4-1/B-10-1002-F
A1R88	0757-0410	7			RESISTOR 511 1% .125W F TC0+/-100		25496 C4-1/B-10-511R-F
A1R89	0757-0410	7			RESISTOR 511 1% .125W F TC0+/-100		25496 C4-1/B-10-511R-F
A1R90	0693-4725	2			RESISTOR 4.7K 5% .25W FC TC=400/+700		01121 C84725
A1R91	0693-1005	5			RESISTOR 10 5% .25W FC TC=400/+500		01121 C81005
A1R92	0693-1005	5			RESISTOR 10 5% .25W FC TC=400/+500		01121 C81005
A1R93	0693-4725	2			RESISTOR 4.7K 5% .25W FC TC=400/+700		01121 C84725
A1R94	0693-4705	8			RESISTOR 47 5% .25W FC TC=400/+500		01121 C84705
A1R95	0693-1015	7			RESISTOR 100 5% .25W FC TC=400/+500		01121 C81015
A1R96	0693-1015	7			RESISTOR 100 5% .25W FC TC=400/+500		01121 C81015
A1R97	0698-4705	0			RESISTOR 47 5% .25W FC TC=400/+500		01121 C84705
A1R98	0698-3345	0			RESISTOR 20.5K 1% .125W F TC0+/-100		25496 C4-1/B-10-2052-F
A1R99	0757-0274	5			RESISTOR 1.21K 1% .125W F TC0+/-100		25496 C4-1/B-10-1213-F
A1R100	0757-0274	5			RESISTOR 1.21K 1% .125W F TC0+/-100		25496 C4-1/B-10-1213-F
A1R101	0757-0274	5			RESISTOR 1.21K 1% .125W F TC0+/-100		25496 C4-1/B-10-1213-F
A1R102	0757-0274	5			RESISTOR 1.21K 1% .125W F TC0+/-100		25496 C4-1/B-10-1213-F
A1R103	0698-3345	0			RESISTOR 20.5K 1% .125W F TC0+/-100		25496 C4-1/B-10-2052-F
A1R104	1810-0205	7			NETWORK-RES 8-PIN-8PC		25496 Z084472
A1R150	0698-3155	1			RESISTOR 4.94K 1% .125W F TC0+/-100		25496 C4-1/B-10-4941-F
A1R151	0693-1025	9			RESISTOR 1K 5% .25W FC TC=400/+600		01121 C81025
A1T1	9100-0874	9			TRANSFORMER-SIGNAL		25480 9100-0874
A1T2	9100-0876	3			TRANSFORMER-SIGNAL		25480 9100-0876
A1U1	1826-0357	3			OP AMP WB 10-99		27014 LF357H
A1U2	5080-3069	7			IC LF356H SEL		27014 LF356H
A1U3	5080-3069	7			IC LF356H SEL		27014 LF356H
A1U4	1826-0319	7			OP AMP BIFET 10-99		27014 LF356H
A1U5	1826-0138	8			COMPARTOR GP QUAD 14-DIP-P		04713 LM339P
A1U6	1826-0319	7			OP AMP BIFET 10-99		27014 LF356H
A1U7	1826-0081	0			OP AMP WB 10-99		27014 LM318H
A1U8	1820-0203	6			OP AMP GP 10-99		01928 CA741C1
A2	04274-66502	9			MODULATOR BOARD ASSEMBLY		28480 04274-66502
A2C1	0160-4835	8			CAPACITOR-FXD 2.2UF +/-10% 20VDC TA		56289 150D225X9020A2
A2C2	0160-4835	5			CAPACITOR-FXD .1UF +/-10% 50VDC CER		28480 0160-1603
A2C3	0160-4835	5			CAPACITOR-FXD .1UF +/-10% 50VDC CER		28480 0160-1603
A2C4	0160-4835	5			CAPACITOR-FXD .1UF +/-10% 50VDC CER		28480 0160-1603
A2C5	0160-4835	5			CAPACITOR-FXD .1UF +/-10% 50VDC CER		28480 0160-1603
A2C6	0160-4835	5			CAPACITOR-FXD .1UF +/-10% 50VDC CER		28480 0160-1603
A2C7	0160-4835	5			CAPACITOR-FXD .1UF +/-10% 50VDC CER		28480 0160-1603
A2C8	0160-4835	5			CAPACITOR-FXD .1UF +/-10% 50VDC CER		28480 0160-1603
A2C9	0160-4835	5			CAPACITOR-FXD .1UF +/-10% 50VDC CER		28480 0160-1603
A2C10	0160-4835	5			CAPACITOR-FXD .1UF +/-10% 50VDC CER		28480 0160-1603
A2C11	0160-1603	7			CAPACITOR-FXD 220PF +/-50-10% 16VDC		28480 0160-1061
A2C12	0160-4835	3			CAPACITOR-FXD .1UF +/-10% 20VDC TA		56289 150D106X9020B2
A2C13	0160-4835	5			CAPACITOR-FXD .1UF +/-10% 50VDC CER		28480 0160-2940
A2C14	0160-4835	5			CAPACITOR-FXD .1UF +/-10% 50VDC CER		28480 0160-2940
A2C15	0160-4835	5			CAPACITOR-FXD .1UF +/-10% 50VDC CER		28480 0160-2940
A2C16	0160-2940	1			CAPACITOR-FXD 470PF +/-5% 300VDC MICA		28480 0160-2940
A2C17	0160-4835	5			CAPACITOR-FXD .1UF +/-10% 50VDC CER		28480 0160-2940
A2C18	0160-4835	5			CAPACITOR-FXD .1UF +/-10% 50VDC CER		28480 0160-2940
A2C19	0160-0134	1			CAPACITOR-FXD 220PF +/-5% 300VDC MICA		28480 0160-0134
A2C20	0160-1603	1			CIFXD MY 1 UF 10X 100VDCM		28480 0160-1603
A2C21	0160-4835	5			CAPACITOR-FXD .1UF +/-10% 50VDC CER		28480 0160-1603
A2C22	0160-1603	1			CIFXD MY 1 UF 10X 100VDCM		28480 0160-1603
A2C23	0160-4835	5			CAPACITOR-FXD .1UF +/-10% 50VDC CER		28480 0160-1603
A2C24	0160-4835	5			CAPACITOR-FXD .1UF +/-10% 50VDC CER		28480 0160-1603
A2C25	0160-4835	5			CAPACITOR-FXD .1UF +/-10% 50VDC CER		28480 0160-1603
A2C26	0160-4835	5			CAPACITOR-FXD .1UF +/-10% 50VDC CER		28480 0160-1603

Table 6-3. Replaceable Parts (Cont'd).

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

Reference	Designation	HP Part Number	D	C	Qty	Description	Mfr Code	Mfr Part Number
A2C30	A2C31	0160-1685	9	5	1	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-1685
A2C31	A2C32	0160-0970	6	3	1	CAPACITOR-FXD .47UF +10% 80VDC POLYE	28480	0160-0970
A2C31	A2C33	0160-0166	6	3	1	CAPACITOR-FXD .068UF +10% 200VDC POLYE	28480	0160-0166
A2C31	A2C34	0160-0159	3	1	1	CAPACITOR-FXD 6800PF +10% 200VDC POLYE	28480	0160-0159
A2C35	A2C35	0160-0153	6	6	1	CAPACITOR-FXD 1000PF +10% 200VDC POLYE	28480	0160-0153
A2C36	A2C36	0160-0374	3	3	1	CAPACITOR-FXD 10UF +10% 20VDC TA	56289	150D106X9020B2
A2C37	A2C37	0160-0374	3	3	1	CAPACITOR-FXD 10UF +10% 20VDC TA	56289	150D106X9020B2
A2C38	A2C38	0160-1061	7	7	1	CAPACITOR-FXD 220UF +50-10% 16VDC	28480	0160-1061
A2C39	A2C39	0160-1061	7	7	1	CAPACITOR-FXD 220UF +50-10% 16VDC	28480	0160-1061
A2C40	A2C40	0160-4835	5	5	1	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A2C41	A2C41	0160-4835	5	5	1	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A2C42	A2C42	0160-2306	3	3	1	CAPACITOR-FXD 27PF +5% 300VDC MICA	28480	0160-2306
A2C43	A2C43	0160-0197	2	2	12	CAPACITOR-FXD 2.2UF +10% 20VDC TA	56289	150D225X9020A2
A2C44	A2C44	0160-0127	2	2	12	CAPACITOR-FXD 1UF +20% 25VDC CER	28480	0160-0127
A2C45	A2C45	0160-0127	2	2	12	CAPACITOR-FXD 1UF +20% 25VDC CER	28480	0160-0127
A2C46	A2C46	0160-0197	8	8	1	CAPACITOR-FXD 2.2UF +10% 20VDC TA	56289	150D225X9020A2
A2C47	A2C47	0160-0127	2	2	12	CAPACITOR-FXD 1UF +20% 25VDC CER	28480	0160-0127
A2C48	A2C48	0160-0127	2	2	12	CAPACITOR-FXD 1UF +20% 25VDC CER	28480	0160-0127
A2C49	A2C49	0160-4835	5	5	1	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A2C50	A2C50	0160-4835	5	5	1	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A2C51	A2C51	0160-0374	3	3	2	CAPACITOR-FXD 10UF +10% 20VDC TA	56289	150D106X9020B2
A2C52	A2C52	0160-0229	7	7	2	CAPACITOR-FXD 33UF +10% 10VDC TA	56289	150D336X9010B2
A2CR1	A2CR1	1901-0040	1	1	1	DIODE-ZNR 3.16V 5% 00-7 PDR 4M TC=-.064X	28480	1901-0040
A2CR2	A2CR2	1902-3036	3	3	1	DIODE-ZNR 3.16V 5% 00-7 PDR 4M TC=-.064X	28480	1902-3036
A2CR3	A2CR3	1902-3036	3	3	1	DIODE-ZNR 3.16V 5% 00-7 PDR 4M TC=-.064X	28480	1902-3036
A2CR4	A2CR4	1902-3036	3	3	1	DIODE-ZNR 3.16V 5% 00-7 PDR 4M TC=-.064X	28480	1902-3036
A2CR5	A2CR5	1902-3036	3	3	1	DIODE-ZNR 3.16V 5% 00-7 PDR 4M TC=-.064X	28480	1902-3036
A2CR25 ~ 28	A2CR25 ~ 28	1901-0040	1	1	1	DIODE-SM1TCHING	28480	1901-0040
A2R1	A2R1	2100-3161	6	2	2	RESISTOR-TMR 20K 10% C SIDE-ADJ 17-TRN	02111	43P203
A2R2	A2R2	0683-4725	2	2	21	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A2R3	A2R3	0683-3325	2	2	21	RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A2R4	A2R4	0751-0288	1	1	6	RESISTOR 9.09K 1% .125W F TC=0+100	19701	MFA1/B=10-9091-F
A2R5	A2R5	0683-4705	8	8	6	RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A2R6	A2R6	0683-2225	3	3	3	RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A2R7	A2R7	0683-4705	8	8	3	RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A2R8	A2R8	2100-3161	2	2	2	RESISTOR-TMR 20K 10% C SIDE-ADJ 17-TRN	02111	43P203
A2R9	A2R9	0683-4725	2	2	2	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A2R10	A2R10	0683-3325	6	6	2	RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A2R11	A2R11	0751-0270	1	8	1	RESISTOR 9.09K 1% .125W F TC=0+100	19701	MFA1/B=10-9091-F
A2R12	A2R12	0683-4705	8	8	1	RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A2R13	A2R13	0683-2225	3	3	1	RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A2R14	A2R14	0683-4705	8	8	1	RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A2R15	A2R15	0683-1035	1	1	9	RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A2R16	A2R16	0683-1025	9	9	9	RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A2R17	A2R17	0683-4725	4	4	9	RESISTOR 47K 5% .25W FC TC=-400/+800	01121	CB4725
A2R18	A2R18	0683-4725	4	4	9	RESISTOR 47K 5% .25W FC TC=-400/+800	01121	CB4725
A2R19	A2R19	0751-0288	1	1	2	RESISTOR 9.09K 1% .125W F TC=0+100	19701	MFA1/B=10-9091-F
A2R20	A2R20	0683-4725	2	2	2	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A2R21	A2R21	0683-4725	2	2	6	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A2R22	A2R22	0683-1825	7	7	6	RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A2R23	A2R23	0683-4725	2	2	6	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A2R24	A2R24	0683-3325	6	6	2	RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A2R26	A2R26	0683-8473	0	0	2	RESISTOR 3.358K 0.1% .1M F TC=0+100	24546	CB3325
A2R27	A2R27	0683-3315	4	4	2	RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315
A2R28	A2R28	0683-8473	0	0	2	RESISTOR 3.358K 0.1% .1M F TC=0+100	24546	CB3325
A2R29	A2R29	0683-6943	3	3	9	RESISTOR 20K 0.1% .125W F TC=0+100	24546	CB3325
A2R30	A2R30	0683-6943	3	3	9	RESISTOR 20K 0.1% .125W F TC=0+100	24546	CB3325
A2R31	A2R31	0683-7842	8	8	8	RESISTOR 26.1K 0.1% .125W F TC=0+100	24546	CB3325
A2R32	A2R32	0683-3325	6	6	8	RESISTOR 3.358K 0.1% .1M F TC=0+100	24546	CB3325
A2R33	A2R33	0683-3325	6	6	8	RESISTOR 3.358K 0.1% .1M F TC=0+100	24546	CB3325
A2R34	A2R34	0683-3315	4	4	8	RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315

Table 6-3. Replaceable Parts (Cont'd).

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

Reference Designation	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
AZR36	0663-8473	0			RESISTOR 3.368K 0.1% 125W F TC=+100	24546	24546
AZR37	0663-6943	3			RESISTOR 20K 0.1% 125W F TC=+100	24546	24546
AZR38	0663-6943	3			RESISTOR 20K 0.1% 125W F TC=+100	24546	24546
AZR39	0698-7842	6			RESISTOR 26.1K 0.1% 125W F TC=+100	24546	24546
AZR40	0698-7842	6			RESISTOR 26.1K 0.1% 125W F TC=+100	24546	24546
AZR41	0663-1015	7			RESISTOR 100 5% .25W FC TC=+400/+500	01121	CB1015
AZR42	0663-1015	7			RESISTOR 100 5% .25W FC TC=+400/+500	01121	CB1015
AZR43	2100-3852	6		2	RESISTOR-RMR 1K 10% C SIDE-ADJ 1TRN	24480	CB1015
AZR44	0757-0439	4			RESISTOR 6.01K 1% .125W F TC=+100	24546	CB1015
AZR45	0757-0279	4			RESISTOR 3.16K 1% .125W F TC=+100	24546	CB1015
AZR46	0663-3325	6			RESISTOR 3.3K 5% .25W FC TC=+400/+500	01121	CB3325
AZR47	0663-4705	8			RESISTOR 47 5% .25W FC TC=+400/+500	01121	CB4705
AZR48	0663-2225	3			RESISTOR 2.2K 5% .25W FC TC=+400/+700	01121	CB2225
AZR49	0663-1035	1			RESISTOR 10K 5% .25W FC TC=+400/+700	01121	CB1035
AZR50	0663-1035	1			RESISTOR 10K 5% .25W FC TC=+400/+700	01121	CB1035
AZR51	0663-1035	1			RESISTOR 10K 5% .25W FC TC=+400/+700	01121	CB1035
AZR52	0663-1035	1			RESISTOR 10K 5% .25W FC TC=+400/+700	01121	CB1035
AZR53	0663-1035	1			RESISTOR 10K 5% .25W FC TC=+400/+700	01121	CB1035
AZR54	0663-1035	5			RESISTOR 10K 5% .25W FC TC=+400/+700	01121	CB1035
AZR55	0663-1035	1			RESISTOR 10K 5% .25W FC TC=+400/+700	01121	CB1035
AZR56	0663-1035	1			RESISTOR 10K 5% .25W FC TC=+400/+700	01121	CB1035
AZR57	0663-1035	1			RESISTOR 10K 5% .25W FC TC=+400/+700	01121	CB1035
AZR58	0663-1035	1			RESISTOR 10K 5% .25W FC TC=+400/+700	01121	CB1035
AZR59	0663-1055	5			RESISTOR 1M 5% .25W FC TC=+800/+900	01121	CB1055
AZR60	1990-0404	8		1	LEADABLE LUMINIZING 300UCD 1F=50MA=MAX	24480	50B2-4480
AZR61	0663-3325	6			RESISTOR 3.3K 5% .25W FC TC=+400/+500	01121	CB3325
AZR62	0663-4725	8			RESISTOR 47K 5% .25W FC TC=+400/+700	01121	CB4725
AZR63	0663-4725	2		2	RESISTOR 47K 5% .25W FC TC=+400/+700	01121	CB4725
AZR64	0663-4725	2			RESISTOR 47K 5% .25W FC TC=+400/+700	01121	CB4725
AZR65	0757-0280	3			RESISTOR 1K 1% .125W F TC=+100	24546	CB1015
AZR66	0663-4725	2			RESISTOR 47K 5% .25W FC TC=+400/+700	01121	CB4725
AZR67	0663-2225	5			RESISTOR 2.2K 5% .25W FC TC=+400/+800	01121	CB2225
AZR68	0663-2225	5			RESISTOR 2.2K 5% .25W FC TC=+400/+800	01121	CB2225
AZR69	0663-2225	5			RESISTOR 2.2K 5% .25W FC TC=+400/+800	01121	CB2225
AZR70	0663-2225	5			RESISTOR 2.2K 5% .25W FC TC=+400/+800	01121	CB2225
AZR71	0663-3325	6			RESISTOR 3.3K 5% .25W FC TC=+400/+800	01121	CB3325
AZR72	0663-2225	5			RESISTOR 2.2K 5% .25W FC TC=+400/+800	01121	CB2225
AZR73	0663-2225	3			RESISTOR 2.2K 5% .25W FC TC=+400/+700	01121	CB2225
AZR74	0757-0288	1			RESISTOR 9.09K 1% .125W F TC=+100	17701	M421/6-10-9091-F
AZR75	0663-4725	2			RESISTOR 47K 5% .25W FC TC=+400/+700	01121	CB4725
AZR76	0663-4725	2			RESISTOR 47K 5% .25W FC TC=+400/+700	01121	CB4725
AZR77	0663-4725	2			RESISTOR 47K 5% .25W FC TC=+400/+700	01121	CB4725
AZR78	0663-2225	3			RESISTOR 2.2K 5% .25W FC TC=+400/+700	01121	CB2225
AZR79	0663-4725	2			RESISTOR 47K 5% .25W FC TC=+400/+700	01121	CB4725
AZR80	0663-4725	2			RESISTOR 47K 5% .25W FC TC=+400/+700	01121	CB4725
AZR81	0663-2225	3			RESISTOR 2.2K 5% .25W FC TC=+400/+700	01121	CB2225
AZR82	0663-4725	2			RESISTOR 47K 5% .25W FC TC=+400/+700	01121	CB4725
AZR83	0663-4725	2			RESISTOR 47K 5% .25W FC TC=+400/+700	01121	CB4725
AZR84	0663-2225	3			RESISTOR 2.2K 5% .25W FC TC=+400/+700	01121	CB2225
AZR85	0663-4725	2			RESISTOR 47K 5% .25W FC TC=+400/+700	01121	CB4725
AZR86	0663-4725	2			RESISTOR 47K 5% .25W FC TC=+400/+700	01121	CB4725
AZR87	0757-0442	9		1	RESISTOR 10K 1% .125W F TC=+100	24546	CB1015
AZR88	0757-0442	9		1.5	RESISTOR 12.1K 1% .125W F TC=+100	24546	CB1015
AZR89	0663-1835	9			RESISTOR 18K 5% .25W FC TC=+400/+800	01121	CB1835
AZR90	0663-1835	9			RESISTOR 18K 5% .25W FC TC=+400/+800	01121	CB1835
AZR91	0663-1835	9			RESISTOR 18K 5% .25W FC TC=+400/+800	01121	CB1835
AZR92	0663-4725	2			RESISTOR 47K 5% .25W FC TC=+400/+700	01121	CB4725
AZR93	0663-3325	6			RESISTOR 3.3K 5% .25W FC TC=+400/+700	01121	CB3325
AZR94	0663-4725	2			RESISTOR 47K 5% .25W FC TC=+400/+700	01121	CB4725
AZR95	0663-4725	2			RESISTOR 47K 5% .25W FC TC=+400/+700	01121	CB4725
AZR96	0663-1025	6			RESISTOR 1K 5% .25W FC TC=+400/+600	01121	CB1025
AZR97	0663-3325	6			RESISTOR 3.3K 5% .25W FC TC=+400/+700	01121	CB3325
AZR98	0663-4705	8			RESISTOR 47 5% .25W FC TC=+400/+500	01121	CB4705
AZR99	0663-4705	8			RESISTOR 47 5% .25W FC TC=+400/+500	01121	CB4705
AZR100	0663-3325	6			RESISTOR 3.3K 5% .25W FC TC=+400/+700	01121	CB3325
AZR101	0663-0084	9			RESISTOR 2.15K 1% .125W F TC=+100	24546	CB1015
AZR102	0663-1025	9			RESISTOR 1K 5% .25W FC TC=+400/+600	01121	CB1025
AZR103	0663-3325	6			RESISTOR 3.3K 5% .25W FC TC=+400/+700	01121	CB3325
AZR104	0663-4705	8			RESISTOR 47 5% .25W FC TC=+400/+500	01121	CB4705
AZR105	0663-4705	8			RESISTOR 47 5% .25W FC TC=+400/+500	01121	CB4705
AZR106	0663-3325	6			RESISTOR 3.3K 5% .25W FC TC=+400/+700	01121	CB3325
AZR107	0663-0084	9			RESISTOR 2.15K 1% .125W F TC=+100	24546	CB1015
AZR108	0663-4725	2			RESISTOR 47K 5% .25W FC TC=+400/+700	01121	CB4725
AZR109	0663-4725	2			RESISTOR 47K 5% .25W FC TC=+400/+700	01121	CB4725

Table 6-3. Replaceable Parts (Cont'd).

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

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A2R10	0757-0442	9	RESISTOR 10K 1% .125W F TC0+/-100	24546	CA=1/8-10-1002-F
A2R11	0757-0288	1	RESISTOR 9.09K 1% .125W F TC0+/-100	19701	MFA41/8-10-9991-F
A2R12	0683-1025	9	RESISTOR 1K 5% .25W FC TC=400/+600	01121	CB1025
A2R13	0683-1025	9	RESISTOR 1K 5% .25W FC TC=400/+600	01121	CB1025
A2R14	0683-1025	9	RESISTOR 1K 5% .25W FC TC=400/+600	01121	CB1025
A2R15	0683-0335	2	RESISTOR 3.3 5% .25W FC TC=400/+500	01121	CB3305
A2R16	0683-0335	2	RESISTOR 3.3 5% .25W FC TC=400/+500	01121	CB3305
A2R17	0698-3160	8	RESISTOR 31.6K 1% .125W F TC0+/-100	24546	CA=1/8-10-3162-F
A2R18	0698-3160	8	RESISTOR 31.6K 1% .125W F TC0+/-100	24546	CA=1/8-10-3162-F
A21	9100-0875	0	TRANSFORMER-SIGNAL	2480	9100-0875
A2U1	1826-0139	9	OP AMP GP DUAL 8-DIP-P	01928	CA14566
A2U2	1826-0427	6	MODULATOR 10-100	04713	MCI4966
A2U3	5080-3056	7	IC, LINER	2480	5080-3056
A2U4	5080-3056	7	IC, LINER	2480	5080-3056
A2U5	1826-0061	0	OP AMP WB 10-99	27014	LM318H
A2U6	1826-0222	1	OP AMP GP QUAD 14-DIP-P	07263	UA4136PC
A2U7	1826-0222	1	OP AMP GP QUAD 14-DIP-P	07263	UA4136PC
A2U9	1826-0138	6	COMPARATOR GP QUAD 14-DIP-P	04713	MLM339P
A2U9	1826-0081	7	IC OP AMP WB 10-99 PKG	27014	LM339P
A2U10	1826-0427	6	MODULATOR 10-100	04713	MCI4966
A2U11	1826-0427	6	MODULATOR 10-100	04713	MCI4966
A2U12	1826-0139	9	OP AMP GP DUAL 8-DIP-P	01928	CA14566
A2	04274-26502	5	PC BOARD, BLANK	2480	04274-26502
A3	04274-66503	0	POWER AMPLIFIER BOARD ASSEMBLY	2480	04274-66503
A3C1	0180-1078	6	CAPACITOR, FXD 330 UF 6.3VDC AL	2480	0180-1078
A3C2	0180-1085	5	CAPACITOR, FXD 4.7 UF 16VDC TA	2480	0180-1085
A3C3	0180-1085	5	CAPACITOR, FXD 4.7 UF 16VDC TA	2480	0180-1085
A3C4	0180-1085	5	CAPACITOR, FXD 4.7 UF 16VDC TA	2480	0180-1085
A3C5	0180-1085	5	CAPACITOR, FXD 4.7 UF 16VDC TA	2480	0180-1085
A3C6	0180-1078	6	CAPACITOR, FXD 330 UF 6.3VDC AL	2480	0180-1078
A3C7	0180-1077	5	CAPACITOR, FXD 220 UF 16 VDC AL	2480	0180-1077
A3C8	0180-1077	5	CAPACITOR, FXD 220 UF 16 VDC AL	2480	0180-1077
A3C9	0180-1077	5	CAPACITOR, FXD 220 UF 16 VDC AL	2480	0180-1077
A3C10	0180-1085	5	CAPACITOR, FXD 4.7 UF 16VDC TA	2480	0180-1085
A3C11	0180-4835	1	CAPACITOR-FXD .1UF +10% 50VDC CER	2480	0180-4835
A3C12	0180-4835	1	CAPACITOR-FXD .1UF +10% 50VDC CER	2480	0180-4835
A3C13	0180-1085	5	CAPACITOR, FXD 4.7 UF 16VDC TA	2480	0180-1085
A3C14	0180-0228	6	CAPACITOR-FXD 22UF+10% 15VDC TA	2480	0180-0228
A3C15	0180-0228	6	CAPACITOR-FXD 22UF+10% 15VDC TA	2480	0180-0228
A3C16	0180-1078	6	CAPACITOR, FXD 330 UF 6.3VDC AL	2480	0180-1078
A3C17	0180-1077	5	CAPACITOR, FXD 220 UF 16 VDC AL	2480	0180-1077
A3C18	0180-1077	5	CAPACITOR, FXD 220 UF 16 VDC AL	2480	0180-1077
A3C19	0180-1085	5	CAPACITOR, FXD 4.7 UF 16VDC TA	2480	0180-1085
A3C20	0180-0652	1	CAPACITOR-FXD .05UF +20% 400VDC CER	2480	0180-0652
A3C21	0180-1085	5	CAPACITOR, FXD 4.7 UF 16VDC TA	2480	0180-1085
A3C22	0180-1078	6	CAPACITOR, FXD 330 UF 6.3VDC AL	2480	0180-1078
A3C23	0180-1085	5	CAPACITOR, FXD 4.7 UF 16VDC TA	2480	0180-1085
A3C24	0180-0127	2	CAPACITOR-FXD .1UF +20% 25VDC CER	2480	0180-0127
A3C25	0180-1085	5	CAPACITOR, FXD 4.7 UF 16VDC TA	2480	0180-1085
A3C26	0180-1985	5	CAPACITOR, FXD 4.7 UF 16VDC TA	2480	0180-1985
A3C27	0180-2141	6	CAPACITOR-FXD 3.3UF+10% 50VDC TA	2480	0180-2141
A3C28	0180-4835	1	CAPACITOR-FXD .1UF +10% 50VDC CER	2480	0180-4835
A3C29	0180-4835	1	CAPACITOR-FXD .1UF +10% 50VDC CER	2480	0180-4835
A3C30	0180-4835	1	CAPACITOR-FXD .1UF +10% 50VDC CER	2480	0180-4835
A3C31	0180-4835	1	CAPACITOR-FXD .1UF +10% 50VDC CER	2480	0180-4835
A3C32	0180-4835	1	CAPACITOR-FXD .1UF +10% 50VDC CER	2480	0180-4835
A3C33	0180-1085	5	CAPACITOR, FXD 4.7 UF 16VDC TA	2480	0180-1085
A3C34	0180-1085	5	CAPACITOR, FXD 4.7 UF 16VDC TA	2480	0180-1085
A3C35	0180-0228	6	CAPACITOR-FXD 22UF+10% 15VDC TA	2480	0180-0228
A3C36	0180-0228	6	CAPACITOR-FXD 22UF+10% 15VDC TA	2480	0180-0228
A3C37	0180-1077	5	CAPACITOR, FXD 220 UF 16 VDC AL	2480	0180-1077
A3C38	0180-1049	1	CAPACITOR, FXD 470 UF 16VDC TA	2480	0180-1049
A3C39	0180-1049	1	CAPACITOR, FXD 470 UF 16VDC TA	2480	0180-1049
A3C40	0180-1077	5	CAPACITOR, FXD 220 UF 16 VDC AL	2480	0180-1077
A3C41	0180-1077	5	CAPACITOR, FXD 220 UF 16 VDC AL	2480	0180-1077
A3C42	0180-1085	5	CAPACITOR, FXD 4.7 UF 16VDC TA	2480	0180-1085
A3C43	0180-1085	5	CAPACITOR, FXD 4.7 UF 16VDC TA	2480	0180-1085
A3C44	0180-1085	5	CAPACITOR, FXD 4.7 UF 16VDC TA	2480	0180-1085
A3C45	0180-1085	5	CAPACITOR, FXD 4.7 UF 16VDC TA	2480	0180-1085

Table 6-3. Replaceable Parts (Cont'd).

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

Reference	HP Part Number	D	Qty	Description	Mfr Code	Mfr Part Number
A3R26	0663-1035	1	5	RESISTOR 10K 5% .25W FC TC=400/+700	01121	CR1035
A3R27	0663-1005	5	5	RESISTOR 10 5% .25W FC TC=400/+500	01121	CR1005
A3R28	0757-0276	7	5	RESISTOR 61.9 1% .125W F TC=0/+100	24546	CR1005
A3R29	0698-3155	1	7	RESISTOR 4.7 5% .25W FC TC=400/+500	01121	CR1005
A3R30	0698-3155	1	7	RESISTOR 4.7 5% .25W FC TC=400/+500	01121	CR1005
A3R31	0663-4705	6	1	RESISTOR 47 5% .25W FC TC=400/+500	01121	CR4705
A3R32	0698-3154	0	0	RESISTOR 4.22K 1% .125W F TC=0/+100	24546	CR4705
A3R33	0663-4705	0	0	RESISTOR 47 5% .25W FC TC=400/+500	01121	CR4705
A3R34	0663-4705	0	0	RESISTOR 47 5% .25W FC TC=400/+500	01121	CR4705
A3R35	0663-4705	0	0	RESISTOR 47 5% .25W FC TC=400/+500	01121	CR4705
A3R36	0663-4705	0	0	RESISTOR 47 5% .25W FC TC=400/+500	01121	CR4705
A3R37	0663-4705	0	0	RESISTOR 47 5% .25W FC TC=400/+500	01121	CR4705
A3R38	0663-4705	0	0	RESISTOR 47 5% .25W FC TC=400/+500	01121	CR4705
A3R39	0663-4705	0	0	RESISTOR 47 5% .25W FC TC=400/+500	01121	CR4705
A3R40	0663-4705	0	0	RESISTOR 47 5% .25W FC TC=400/+500	01121	CR4705
A3R41	0698-3397	7	7	RESISTOR 42.2 1% .5W F TC=0/+100	24480	CR4705
A3R42	0683-1535	3	3	RESISTOR 15K 5% .25W FC TC=400/+800	01121	CR4705
A3R43	0683-1535	3	3	RESISTOR 15K 5% .25W FC TC=400/+800	01121	CR4705
A3R44	0757-0458	7	7	RESISTOR 51.1K 1% .125W F TC=0/+100	24546	CR4705
A3R45	0663-1045	3	3	RESISTOR 100K 5% .25W FC TC=400/+800	01121	CR4705
A3R46	0757-0274	1	5	RESISTOR 1.21K 1% .125W F TC=0/+100	24546	CR4705
A3R47	0757-0442	3	3	RESISTOR 10K 5% .25W FC TC=400/+800	01121	CR4705
A3R48	0663-1035	1	1	RESISTOR 10K 5% .25W FC TC=400/+700	01121	CR4705
A3R49	0663-1035	1	1	RESISTOR 10K 5% .25W FC TC=400/+700	01121	CR4705
A3R50	0698-3495	0	0	RESISTOR 866 1% .125W F TC=0/+100	24546	CR4705
A3R51	0663-3335	3	3	RESISTOR 33K 5% .25W FC TC=400/+800	01121	CR4705
A3R52	0663-2225	3	3	RESISTOR 2.2K 5% .25W FC TC=400/+700	01121	CR4705
A3R53	0663-1005	5	5	RESISTOR 10 5% .25W FC TC=400/+500	01121	CR4705
A3R54	0757-0403	2	2	RESISTOR 121 1% .125W F TC=0/+100	24546	CR4705
A3R55	0757-0403	2	2	RESISTOR 121 1% .125W F TC=0/+100	24546	CR4705
A3R56	0757-0279	0	0	RESISTOR 3.16K 1% .125W F TC=0/+100	24546	CR4705
A3R57	0757-0442	1	1	RESISTOR 10K 5% .25W FC TC=400/+800	01121	CR4705
A3R58	0663-1035	1	1	RESISTOR 10K 5% .25W FC TC=400/+700	01121	CR4705
A3R59	0698-4308	0	0	RESISTOR 16.9K 1% .125W F TC=0/+100	24546	CR4705
A3R60	0698-4125	7	7	RESISTOR 933 1% .125W F TC=0/+100	24546	CR4705
A3R61	0757-0399	5	5	RESISTOR 82.5 1% .125W F TC=0/+100	24546	CR4705
A3R62	0757-0441	0	0	RESISTOR 8.25K 1% .125W F TC=0/+100	24546	CR4705
A3R63	0698-3136	0	0	RESISTOR 17.8K 1% .125W F TC=0/+100	24546	CR4705
A3R64	0698-3135	1	1	RESISTOR 4.64K 1% .125W F TC=0/+100	24546	CR4705
A3R65	0698-4469	2	2	RESISTOR 1.15K 1% .125W F TC=0/+100	24546	CR4705
A3R66	0663-1035	1	1	RESISTOR 10K 5% .25W FC TC=400/+700	01121	CR4705
A3R67	0663-1035	1	1	RESISTOR 10K 5% .25W FC TC=400/+700	01121	CR4705
A3R68	0663-1035	1	1	RESISTOR 10K 5% .25W FC TC=400/+700	01121	CR4705
A3R69	0663-1035	1	1	RESISTOR 10K 5% .25W FC TC=400/+700	01121	CR4705
A3R70	0663-1005	5	5	RESISTOR 10 5% .25W FC TC=400/+500	01121	CR4705
A3R71	0663-1005	7	7	RESISTOR 10 5% .25W FC TC=400/+500	01121	CR4705
A3R72	0757-0276	5	5	RESISTOR 61.9 1% .125W F TC=0/+100	24546	CR4705
A3R73	0698-3155	0	0	RESISTOR 4.44K 1% .125W F TC=0/+100	24546	CR4705
A3R74	0698-3154	0	0	RESISTOR 4.22K 1% .125W F TC=0/+100	24546	CR4705
A3R75	0757-0276	7	7	RESISTOR 61.9 1% .125W F TC=0/+100	24546	CR4705
A3R76	0698-3154	0	0	RESISTOR 4.22K 1% .125W F TC=0/+100	24546	CR4705
A3R77	0757-0316	0	0	RESISTOR 4.22 1% .125W F TC=0/+100	24546	CR4705
A3R78	0663-4705	0	0	RESISTOR 47 5% .25W FC TC=400/+500	01121	CR4705
A3R79	0663-4705	1	1	RESISTOR 47 5% .25W FC TC=400/+500	01121	CR4705
A3R80	0663-4705	1	1	RESISTOR 47 5% .25W FC TC=400/+500	01121	CR4705
A3R81	0663-4705	6	6	RESISTOR 47 5% .25W FC TC=400/+500	01121	CR4705
A3R82	0698-3344	7	7	RESISTOR 50K +/-1% .125W F TC=0/+100	24480	CR4705
A3R83	0698-3344	7	7	RESISTOR 50K +/-1% .125W F TC=0/+100	24480	CR4705
A3R84	0663-1515	2	2	RESISTOR 100 1% .125W F TC=0/+100	24546	CR4705
A3R85	0757-0401	0	0	RESISTOR 100 1% .125W F TC=0/+100	24546	CR4705
A3R86	0757-0280	3	3	RESISTOR 1K 1% .125W F TC=0/+100	24546	CR4705
A3R87	0663-2235	5	5	RESISTOR 22K 5% .25W FC TC=400/+800	01121	CR4705
A3R88	0663-2235	5	5	RESISTOR 22K 5% .25W FC TC=400/+800	01121	CR4705
A3R89	1810-0205	7	7	NETWORK=RES 8-PIN-SIP, 1-PIN-8PC6	01121	CR4705
A3R90	1810-0205	7	7	NETWORK=RES 8-PIN-SIP, 1-PIN-8PC6	01121	CR4705
A3R91	1810-0205	6	6	NETWORK=RES 16-PIN-DIP, 1-PIN-8PC6	01121	CR4705
A3R92	0663-5625	3	3	RESISTOR 5.6K 5% .25W FC TC=400/+700	01121	CR4705
A3R93	0663-5625	3	3	RESISTOR 5.6K 5% .25W FC TC=400/+700	01121	CR4705
A3R94	0663-1505	1	1	RESISTOR 15 5% .25W FC TC=400/+500	01121	CR4705
A3R95	0757-0401	0	0	RESISTOR 100 1% .125W F TC=0/+100	24546	CR4705
A3R96	0757-0280	3	3	RESISTOR 1K 1% .125W F TC=0/+100	24546	CR4705
A3R97	0663-2235	5	5	RESISTOR 22K 5% .25W FC TC=400/+800	01121	CR4705
A3R98	0663-2235	5	5	RESISTOR 22K 5% .25W FC TC=400/+800	01121	CR4705
A3R99	1810-0205	7	7	NETWORK=RES 8-PIN-SIP, 1-PIN-8PC6	01121	CR4705
A3R00	1810-0205	7	7	NETWORK=RES 8-PIN-SIP, 1-PIN-8PC6	01121	CR4705
A3U01	1826-0081	0	0	OP AMP WB 10-99	27014	LM318H
A3U02	1826-0081	0	0	OP AMP WB 10-99	27014	LM318H
A3U03	1826-0081	0	0	OP AMP WB 10-99	27014	LM318H
A3U04	1826-0081	0	0	OP AMP WB 10-99	27014	LM318H
A3U05	1826-0138	0	0	COMPARATOR GP QUAD 14-DIP-P	04713	LM339P
A3I01	9100-0855	6	6	TRANSFORMER, PULSE	24480	9100-0855
A3I02	9100-0872	7	7	TRANSFORMER, SIGNAL	24480	9100-0872
A3I03	9100-0873	0	0	TRANSFORMER, PULSE	24480	9100-0873
A3I04	9100-0855	7	7	TRANSFORMER, SIGNAL	24480	9100-0855
A3I05	9100-0872	7	7	TRANSFORMER, SIGNAL	24480	9100-0872
A3I06	9100-0855	6	6	TRANSFORMER, PULSE	24480	9100-0855

Table 6-3. Replaceable Parts (Cont'd).

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

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A3U6	1826-0138	8	COMPARATOR GP QUAD 14-DIP-P	04713	MLM339P
A3U7	1826-0138	6	COMPARATOR GP QUAD 14-DIP-P	04713	MLM339P
A3U8	1820-1730	6	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	6N74LS273N
A3U9	1820-1730	6	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	6N74LS273N
A3U0	1820-1730	6	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	6N74LS273N
A4	04274-66504	1	PROCESS AMPLIFIER BOARD ASSEMBLY	28480	04274-66504
A4A	04274-26503	6	PC BOARD, BLANK	28480	04274-26503
A4B					
A4C	0160-1241	3	CAPACITOR, FXD 0.047 UF 10% 500VDC CER	28480	0160-1241
A4D	0160-4835	3	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A4E	0160-2265	3	CAPACITOR-FXD 22PF +5% 500VDC CER 0+-30	28480	0160-2265
A4F	0160-1085	5	CAPACITOR, FXD 4.7 UF 16VDC TA	28480	0160-1085
A4G	0160-2208	5	CAPACITOR-FXD 330PF +5% 300VDC MICA	28480	0160-2208
A4H	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A4I	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A4J	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A4K	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A4L	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A4M	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A4N	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A4O	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A4P	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A4Q	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A4R	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A4S	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A4T	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A4U	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A4V	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A4W	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A4X	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A4Y	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A4Z	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A50	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A51	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A52	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A53	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A54	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A55	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A56	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A57	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A58	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A59	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A60	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A61	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A62	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A63	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A64	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A65	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A66	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A67	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A68	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A69	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A70	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A71	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A72	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A73	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A74	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A75	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A76	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A77	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A78	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A79	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A80	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A81	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A82	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A83	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A84	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A85	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A86	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A87	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A88	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A89	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A90	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A91	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A92	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A93	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A94	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A95	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A96	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A97	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A98	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A99	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A00	0160-4835	5	CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835

Table 6-3. Replaceable Parts (Cont'd).

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

Reference	Designation	HP Part Number	D	C	Qty	Description	Mfr Code	Mfr Part Number
AAR50		0757-0442	9	0	1	RESISTOR 10K 1% .125W F TC=0+/-100	24546	C441/B-10-1002-F
AAR51		0757-0446	6	0	1	RESISTOR 100K 1% .125W F TC=0+/-100	24546	C441/B-10-1003-F
AAR52		0757-0448	3	0	1	RESISTOR 909K 1% .125W F TC=0+/-100	24546	C441/B-10-2612-F
AAR53		0698-3155	3	0	1	RESISTOR 26.1K 1% .125W F TC=0+/-100	24546	C441/B-10-2612-F
AAR54		0698-3155	1	0	1	RESISTOR 4.64K 1% .125W F TC=0+/-100	24546	C441/B-10-4641-F
AAR55		2100-3353	8	0	1	RESISTOR-TMR 20K 1% C 3IDEADJ 1-TRN	32997	3306X-446-203
AAR56		0683-3355	8	0	1	RESISTOR 33K 5% .25W F TC=400/+800	01121	CB3335
AAR57		0683-1035	1	0	1	RESISTOR 10K 5% .25W F TC=400/+700	01121	CB1035
AAR58		0683-1045	3	0	1	RESISTOR 100K 5% .25W F TC=400/+800	01121	CB1045
AAR59		0683-1035	1	0	1	RESISTOR 10K 5% .25W F TC=400/+700	01121	CB1035
AAR60		0698-4467	0	0	1	RESISTOR 1.05K 1% .125W F TC=0+/-100	24546	C441/B-10-1051-F
AAR61		0757-0417	8	0	1	RESISTOR 562 1% .125W F TC=0+/-100	24546	C441/B-10-562H-F
AAR62		0757-0433	8	0	1	RESISTOR 3.32K 1% .125W F TC=0+/-100	24546	C441/B-10-3321-F
AAR63		0698-3155	1	0	1	RESISTOR 4.64K 1% .125W F TC=0+/-100	24546	C441/B-10-4641-F
AAR64		0698-3155	1	0	1	RESISTOR 4.64K 1% .125W F TC=0+/-100	24546	C441/B-10-4641-F
AAR65		1610-0207	9	0	3	NETWORK-RES 8-PIN-8IP 1-PIN-8PCG	01121	208A223
AAR66		1610-0207	9	0	3	NETWORK-RES 8-PIN-8IP 1-PIN-8PCG	01121	208A223
AAR67		1610-0207	9	0	3	NETWORK-RES 8-PIN-8IP 1-PIN-8PCG	01121	208A223
AAR68		0683-1045	3	0	1	RESISTOR 100K 5% .25W F TC=400/+800	01121	CB1045
AAR69		0683-1035	1	0	1	RESISTOR 10K 5% .25W F TC=400/+700	01121	CB1035
AAR70		0698-3152	8	0	1	RESISTOR 3.48K 1% .125W F TC=0+/-100	24546	C441/B-10-3481-F
AAR71		0683-2245	7	0	1	RESISTOR 220K 5% .25W F TC=800/+900	01121	CB2245
AAR72		0683-2245	7	0	1	RESISTOR 220K 5% .25W F TC=800/+900	01121	CB2245
AAR73		0683-2245	7	0	1	RESISTOR 220K 5% .25W F TC=800/+900	01121	CB2245
AAR74		0683-2245	7	0	1	RESISTOR 220K 5% .25W F TC=800/+900	01121	CB2245
AAR75		0757-0402	4	0	1	RESISTOR 511K 1% .125W F TC=0+/-100	24546	C441/B-10-5110-F
AAR76		0698-3132	4	0	1	RESISTOR 261 1% .125W F TC=0+/-100	24546	C441/B-10-2610-F
AAR77		0757-0280	3	0	1	RESISTOR 1K 1% .125W F TC=0+/-100	24546	C441/B-10-1001-F
AAR78		0683-1035	7	0	1	RESISTOR 100 5% .25W F TC=400/+500	01121	CB1035
AAR79		0683-1035	7	0	1	RESISTOR 100 5% .25W F TC=400/+500	01121	CB1035
AAR80		0757-1094	9	0	1	RESISTOR 1.47K 1% .125W F TC=0+/-100	24546	C441/B-10-1471-F
AAR81		0683-4725	2	2	2	RESISTOR 4.7K 5% .25W F TC=400/+700	01121	CB4725
AAR82		0683-4725	2	2	2	RESISTOR 4.7K 5% .25W F TC=400/+700	01121	CB4725
AAR83		0683-4725	2	2	2	RESISTOR 4.7K 5% .25W F TC=400/+700	01121	CB4725
AAR84		0683-4725	2	2	2	RESISTOR 4.7K 5% .25W F TC=400/+700	01121	CB4725
AAR85		0757-0443	0	0	1	RESISTOR 11K 1% .125W F TC=0+/-100	24546	C441/B-10-1102-F
AAR86		0757-0440	7	0	1	RESISTOR 7.5K 1% .125W F TC=0+/-100	24546	C441/B-10-7501-F
AAR87		0698-0033	7	0	1	RESISTOR 1.96K 1% .125W F TC=0+/-100	24546	C441/B-10-1961-F
AAR88		0683-1084	9	0	1	RESISTOR 2.15K 1% .125W F TC=0+/-100	24546	C441/B-10-2151-F
AAR89		0683-1015	7	0	1	RESISTOR 100 5% .25W F TC=400/+500	01121	CB1015
AAR90		0683-1015	7	0	1	RESISTOR 100 5% .25W F TC=400/+500	01121	CB1015
AAR91		9100-0878	3	0	1	TRANSFORMER, SIGNAL	28480	9100-0878
AAR92		9100-0855	6	0	1	TRANSFORMER, PULSE	28480	9100-0855
AAR93		9100-0878	3	0	1	TRANSFORMER, SIGNAL	28480	9100-0878
AAR94		9100-0855	6	0	1	TRANSFORMER, PULSE	28480	9100-0855
AAR95		9100-0878	3	0	1	TRANSFORMER, SIGNAL	28480	9100-0878
AAR96		9100-0855	6	0	1	TRANSFORMER, PULSE	28480	9100-0855
AAR97		9100-0878	3	0	1	TRANSFORMER, SIGNAL	28480	9100-0878
AAR98		9100-0855	6	0	1	TRANSFORMER, PULSE	28480	9100-0855
AAR99		9100-0878	3	0	1	TRANSFORMER, SIGNAL	28480	9100-0878
AAR00		9100-0855	6	0	1	TRANSFORMER, PULSE	28480	9100-0855
AAR01		9100-0878	3	0	1	TRANSFORMER, SIGNAL	28480	9100-0878
AAR02		1826-0081	3	0	0	OP AMP WB 10-99	27014	LM318H
AAR03		1826-0081	0	0	0	OP AMP WB 10-99	27014	LM318H
AAR04		1826-0319	0	0	0	IC OP AMP LOW-BIAS-H-IMPD 10-99 PKG	27014	LM318H
AAR05		5080-3069	0	0	0	IC LF356H SEL	27014	LM318H
AAR06		1826-0081	0	0	0	OP AMP WB 10-99	27014	LM318H
AAR07		5080-3069	7	0	0	OP AMP WB 10-99	27014	LM318H
AAR08		5080-3066	3	0	0	IC-LIN SELECTED	27014	LM318H
AAR09		1826-0138	8	0	0	COMPARATOR GP QUAD 14-DIP	04713	MLM339P
AAR10		1826-0138	8	0	0	COMPARATOR GP QUAD 14-DIP	04713	MLM339P
AAR11		1826-0138	8	0	0	COMPARATOR GP QUAD 14-DIP	04713	MLM339P
AAR12		1826-0138	8	0	0	COMPARATOR GP QUAD 14-DIP	04713	MLM339P
AAR13		1826-0138	8	0	0	COMPARATOR GP QUAD 14-DIP	04713	MLM339P
AAR14		1826-0346	0	0	0	OP AMP GP DUAL 8-DIP	27014	LM358N
AAR15		04274-26504	7	0	0	PC BOARD, BLANK	28480	04274-26504
AAR16		04274-66505	2	0	0	A/D CONVERTER BOARD ASSEMBLY	28480	04274-66505
AAR17		0160-4835	5	0	0	CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
AAR18		0160-4835	5	0	0	CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
AAR19		0160-4835	5	0	0	CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
AAR20		0160-4835	5	0	0	CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
AAR21		0160-4835	5	0	0	CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
AAR22		0160-4835	5	0	0	CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
AAR23		0160-4835	5	0	0	CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
AAR24		0160-4835	5	0	0	CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
AAR25		0160-4835	5	0	0	CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
AAR26		0160-0153	4	0	0	CAPACITOR-FXD 1000PF +-10% 200VDC POLYE	28480	0160-0153
AAR27		0160-4835	5	0	0	CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
AAR28		0160-4835	5	0	0	CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
AAR29		0160-4835	5	0	0	CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
AAR30		0160-1674	1	0	0	CAPACITOR .33UF +-5% 200VDC	28480	0160-1674
AAR31		0160-0134	1	0	0	CAPACITOR-FXD 220PF +-5% 300VDC MICA	28480	0160-0134

Table 6-3. Replaceable Parts (Cont'd).

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

Reference Designation	HP Part Number	D	C	Qty	Description	Mfr Code	Mfr Part Number
ASR16	0698-0064			9	RESISTOR 2.15K 1% .125W F TCR0+100	24546	C4-1/B-10-2151-F
ASR17	0698-3268			7	RESISTOR 11.5K 1% .125W F TCR0+100	24546	C4-1/B-10-1152-F
ASR18	0698-3268			7	RESISTOR 11.5K 1% .125W F TCR0+100	24546	C4-1/B-10-1152-F
ASR19	0757-0428			9	RESISTOR 10K 1% .125W F TCR0+100	24546	C4-1/B-10-1002-F
ASR20	0698-3153			8	RESISTOR 17.8K 1% .125W F TCR0+100	24546	C4-1/B-10-1782-F
ASR21	0698-3155			1	RESISTOR 4.64K 1% .125W F TCR0+100	24546	C4-1/B-10-4641-F
ASR22	0757-0465			3	RESISTOR 100K 1% .125W F TCR0+100	24546	C4-1/B-10-1001-F
ASR23	0757-0465			3	RESISTOR 100K 1% .125W F TCR0+100	24546	C4-1/B-10-1003-F
ASR24	0698-3155			1	RESISTOR 4.64K 1% .125W F TCR0+100	24546	C4-1/B-10-4641-F
ASR25	0757-0279			7	RESISTOR 3.16K0 +-1% .125W FILM	24546	C4-1/B-10-3161-F
ASR26	0757-0279			7	RESISTOR 3.16K0 +-1% .125W FILM	24546	C4-1/B-10-3161-F
ASR27	0757-0279			7	RESISTOR 3.16K0 +-1% .125W FILM	24546	C4-1/B-10-3161-F
ASR28	0757-0279			7	RESISTOR 3.16K0 +-1% .125W FILM	24546	C4-1/B-10-3161-F
ASR29	0757-0279			7	RESISTOR 3.16K0 +-1% .125W FILM	24546	C4-1/B-10-3161-F
ASR30	0757-0279			7	RESISTOR 3.16K0 +-1% .125W FILM	24546	C4-1/B-10-3161-F
ASR31	0698-3155			1	RESISTOR 4.64K 1% .125W F TCR0+100	24546	C4-1/B-10-4641-F
ASR32	0698-3155			1	RESISTOR 4.64K 1% .125W F TCR0+100	24546	C4-1/B-10-4641-F
ASR33	0698-3153			9	RESISTOR 3.83K 1% .125W F TCR0+100	24546	C4-1/B-10-3831-F
ASR34	0698-3153			9	RESISTOR 3.83K 1% .125W F TCR0+100	24546	C4-1/B-10-3831-F
ASR35	0698-3153			9	RESISTOR 3.83K 1% .125W F TCR0+100	24546	C4-1/B-10-3831-F
ASR36	0698-3153			9	RESISTOR 3.83K 1% .125W F TCR0+100	24546	C4-1/B-10-3831-F
ASR37	0698-3153			9	RESISTOR 3.83K 1% .125W F TCR0+100	24546	C4-1/B-10-3831-F
ASR38	0698-3153			9	RESISTOR 3.83K 1% .125W F TCR0+100	24546	C4-1/B-10-3831-F
ASR39	0698-3245			0	RESISTOR 29.8K +-1% .1W	24546	0698-2345
ASR40	0698-3245			9	RESISTOR 42.2K +-1% .1W	24546	0698-2345
ASR41	0698-2345			9	RESISTOR 42.2K +-1% .1W	24546	0698-2345
ASR42	0698-2345			9	RESISTOR 42.2K +-1% .1W	24546	0698-2345
ASR43	0757-0276			2	RESISTOR 61.90 +-1% .125W FILM	24546	0698-6360
ASR44	0698-6360			6	RESISTOR 10K 1% .125W F TCR0+25	24546	0698-6360
ASR45	0698-6360			6	RESISTOR 10K 1% .125W F TCR0+25	24546	0698-6360
ASR46	0698-3160			6	RESISTOR 31.6K 1% .125W F TCR0+100	24546	C4-1/B-10-3162-F
ASR47	0698-3160			6	RESISTOR 31.6K 1% .125W F TCR0+100	24546	C4-1/B-10-3162-F
ASR48	0698-3156			2	RESISTOR 14.7K 1% .125W F TCR0+100	24546	C4-1/B-10-1472-F
ASR49	0757-0123			3	RESISTOR 34.8K 1% .125W F TCR0+100	24546	0757-0123
ASR50	0757-0401			0	RESISTOR 100 1% .125W F TCR0+100	24546	C4-1/B-10-101-F
ASR51	0698-3155			1	RESISTOR 4.64K 1% .125W F TCR0+100	24546	C4-1/B-10-4641-F
ASR52	0698-3155			1	RESISTOR 4.64K 1% .125W F TCR0+100	24546	C4-1/B-10-4641-F
ASR53	0757-0465			6	RESISTOR 100K 1% .125W F TCR0+100	24546	C4-1/B-10-1003-F
ASR54	0757-0465			6	RESISTOR 100K 1% .125W F TCR0+100	24546	C4-1/B-10-1003-F
ASR55	0757-0199			3	RESISTOR 21.5K 1% .125W F TCR0+100	24546	C4-1/B-10-2152-F
ASR56	0698-3155			1	RESISTOR 4.64K 1% .125W F TCR0+100	24546	C4-1/B-10-4641-F
ASU1	1820-0203			6	OP AMP GP 10-99	01295	CAT4CT
ASU2	1820-0035			4	OP AMP LOW-DRIFT 10-99	01295	LM308AM
ASU3	1820-0203			6	OP AMP GP 10-99	01295	CAT4CT
ASU4	5080-3069			7	IC LP356H SEL	27014	LM318M
ASU5	1820-0081			0	OP AMP WB 10-99	27014	LM318M
ASU6	1820-1112			8	IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74N
ASU7	1820-1112			8	IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74N
ASU8	1820-0081			0	OP AMP WB 10-99	27014	LM318M
ASU9	5080-3069			0	IC LP356H SEL	27014	LM318M
ASU10	1820-0138			8	COMPARATOR GP DUAD 14-DIP-P	04713	LM1339P
ASU11	1820-1195			7	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS15N
ASU12	1820-0210			7	COMPARATOR MS 14-DIP-P	27014	LM641N
ASU13	1820-1210			7	IC GATE TTL LS AND-OR-INV DUAL 2-INP	01295	SN74LS51N
ASU14	1820-1210			7	IC GATE TTL LS AND-OR-INV DUAL 2-INP	01295	SN74LS51N
ASU15	1820-1199			1	IC INV TTL LS HEX 1-INP	01295	SN74LS04N
ASU16	1820-1730			6	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS273N
ASU17	1820-1730			6	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS273N
ASU18	1820-1730			6	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS273N
ASU19	1820-1112			6	IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74N
ASU20	1820-1432			5	IC CNTR TTL LS BIN SYNCHRO POS-EDGE-TRIG	01295	SN74LS163AN
ASW1	8159-0005			0	WIRE 22AWG W PVC 1X22 R0C	28480	8159-0005
					AS MISCELLANEOUS PARTS	28480	04274-26505
					PC BOARD, BLANK	28480	04274-26505
46	04274-66506			3	OSCILLATOR BOARD ASSEMBLY	28480	04274-66506
46C1	0180-1735			2	CAPACITOR-FXD .22UF+10% 35VDC 1A	56289	150D224X9035A2
46C2	0180-1735			2	CAPACITOR-FXD .22UF+10% 35VDC 1A	56289	150D224X9035A2
46C3	0180-0127			2	CAPACITOR-FXD 1UF +20% 25VDC CER	28480	0180-0127
46C4	0180-2209			5	CAPACITOR-FXD 360PF +5% 30VDC MICA	28480	0180-2209
46C5	0180-1085			5	CAPACITOR, FXD 4.7 UF 16VDC 1A	28480	0180-1085

Table 6-3. Replaceable Parts (Cont'd).

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

Reference	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A6C6	0160-1704	5	CAPACITOR-FXD 47UF+10% 6VDC TA	28480	150D476X9006B2
A6C7	0160-0127	2	CAPACITOR-FXD 1UF +20% 25VDC CER	28480	0160-0127
A6C8	0160-0127	2	CAPACITOR-FXD 1UF +20% 25VDC CER	28480	0160-0127
A6C9	0160-0127	2	CAPACITOR-FXD 1UF +20% 25VDC CER	28480	0160-0127
A6C10	0160-0127	2	CAPACITOR-FXD 1UF +20% 25VDC CER	28480	0160-0127
A6C11	0160-0153	6	CAPACITOR-FXD .033UF +10% 200VDC POLYE	28480	0160-0153
A6C12	0160-0155	6	CAPACITOR-FXD .033UF +10% 200VDC POLYE	28480	0160-0155
A6C13	0160-2209	5	CAPACITOR-FXD 360PF +5% 300VDC MICA	28480	0160-2209
A6C14	0160-4832	5	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	0160-4832
A6C15	0160-4832	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	0160-4832
A6C16	0160-2219	7	CAPACITOR-FXD 1100PF +5% 300VDC MICA	28480	0160-2219
A6C17	0160-0161	4	CAPACITOR-FXD .01UF +10% 200VDC POLYE	28480	0160-0161
A6C18	0160-0168	1	CAPACITOR-FXD .1UF +10% 200VDC POLYE	28480	0160-0168
A6C19	0160-1055	5	CAPACITOR, FXD 100 UF 25VDCM TA	28480	0160-1055
A6C20	0160-1050	4	CAPACITOR, FXD 100 UF 25VDCM TA	28480	0160-1050
A6C21	0160-2940	1	CAPACITOR-FXD 470PF +5% 300VDC MICA	28480	0160-2940
A6C22	0160-0134	1	CAPACITOR-FXD 220PF +5% 300VDC MICA	28480	0160-0134
A6C23	0160-0134	1	CAPACITOR-FXD 220PF +5% 300VDC MICA	28480	0160-0134
A6C24	0160-0134	1	CAPACITOR-FXD 220PF +5% 300VDC MICA	28480	0160-0134
A6C25	0160-0374	1	CAPACITOR-FXD 10UF+10% 20VDC TA	56289	150D106X9020B2
A6C26	0160-4832	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	0160-4832
A6C27	0160-4832	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	0160-4832
A6C28	0160-4832	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	0160-4832
A6C29	0160-4832	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	0160-4832
A6C30	0160-3901	6	CAPACITOR-FXD 2.2UF +20% 25VDC CER	28480	0160-3901
A6C31	0160-4832	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	0160-4832
A6C32	0160-4832	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	0160-4832
A6C33	0160-0134	1	CAPACITOR-FXD 220PF +5% 300VDC MICA	28480	0160-0134
A6C34	0160-0374	1	CAPACITOR-FXD 10UF+10% 20VDC TA	56289	150D106X9020B2
A6C35	0160-0374	1	CAPACITOR-FXD 10UF+10% 20VDC TA	56289	150D106X9020B2
A6C36	0160-4832	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	0160-4832
A6C37	0160-4832	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	0160-4832
A6C38	0160-4832	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	0160-4832
A6C39	0160-0168	9	CAPACITOR-FXD 0.1UF +10% 200VDC POLYE	28480	0160-0168
A6C40	0160-0163	5	CAPACITOR-FXD 0.01UF +10% 200VDC POLYE	28480	0160-0163
A6C41	0160-0163	5	CAPACITOR-FXD 0.01UF +10% 200VDC POLYE	28480	0160-0163
A6C42	0160-4832	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	0160-4832
A6C43	0160-4832	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	0160-4832
A6C44	0160-4832	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	0160-4832
A6C45	0160-4832	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	0160-4832
A6C46	0160-0163	6	CAPACITOR-FXD .033UF +10% 200VDC POLYE	28480	0160-0163
A6C47	0160-0155	6	CAPACITOR-FXD .033UF +10% 200VDC POLYE	28480	0160-0155
A6C48	0160-2209	5	CAPACITOR-FXD 360PF +5% 300VDC MICA	28480	0160-2209
A6C49	0160-4832	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	0160-4832
A6C50	0160-4832	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	0160-4832
A6C51	0160-0161	7	CAPACITOR-FXD 1100PF +5% 300VDC MICA	28480	0160-0161
A6C52	0160-0161	7	CAPACITOR-FXD 1100PF +5% 300VDC MICA	28480	0160-0161
A6C53	0160-0168	3	CAPACITOR-FXD .1UF +10% 200VDC POLYE	28480	0160-0168
A6C54	0160-0374	3	CAPACITOR-FXD 10UF+10% 20VDC TA	56289	150D106X9020B2
A6C55	0160-4832	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	0160-4832
A6C56	0160-4832	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	0160-4832
A6C57	0160-0374	9	CAPACITOR-FXD 10UF+10% 20VDC TA	56289	150D106X9020B2
A6C58	0160-4832	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	0160-4832
A6C59	0160-2266	5	CAPACITOR-FXD 24PF +.5% CER 500VDC	28480	0160-2266
A6C60	1990-0104	5	PHOTOCELL LAMP	28480	1990-0104
A6C61	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C62	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C63	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C64	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C65	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C66	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C67	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C68	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C69	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C70	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C71	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C72	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C73	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C74	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C75	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C76	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C77	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C78	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C79	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C80	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C81	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C82	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C83	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C84	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C85	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C86	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C87	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C88	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C89	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C90	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C91	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C92	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C93	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C94	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C95	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C96	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C97	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C98	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C99	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6C100	1901-0040	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040

Table 6-3. Replaceable Parts (Cont'd).

Reference	Designation	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
A9C11		0160-2307	4			CAPACITOR-FXD .01UF +10% 30VDC MICA	28480	0160-2307
A9C12		0180-2205	7			CAPACITOR-FXD .33UF +10% 35VDC	56289	150D105X9035A2
A9C13		0180-2291	3			CAPACITOR-FXD .1UF +10% 35VDC TA	56289	150D105X9035A2
A9C14		0160-4832	9			CAPACITOR-FXD .01UF +10% 100VDC CER	28480	0160-4832
A9C15		0160-4832	9			CAPACITOR-FXD .01UF +10% 100VDC CER	28480	0160-4832
A9C16		0160-4832	9			CAPACITOR-FXD .01UF +10% 100VDC CER	28480	0160-4832
A9C17		0160-4832	9			CAPACITOR-FXD .01UF +10% 100VDC CER	28480	0160-4832
A9C18		0160-4832	9			CAPACITOR-FXD .01UF +10% 100VDC CER	28480	0160-4832
A9C19		0160-4832	9			CAPACITOR-FXD .01UF +10% 100VDC CER	28480	0160-4832
A9C20		0160-4832	9			CAPACITOR-FXD .01UF +10% 100VDC CER	28480	0160-4832
A9C21		0160-4835	5			CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A9C22		0160-4835	5			CAPACITOR-FXD .1UF +10% 50VDC CER	28480	0160-4835
A9C23		0160-4832	9			CAPACITOR-FXD .01UF +10% 100VDC CER	28480	0160-4832
A9C24		0160-4832	9			CAPACITOR-FXD .01UF +10% 100VDC CER	28480	0160-4832
A9C25		0160-4832	9			CAPACITOR-FXD .01UF +10% 100VDC CER	28480	0160-4832
A9C26		0160-2208	4			CAPACITOR-FXD .330PF +5% 30VDC MICA	28480	0160-2208
A9C81		1901-0518	6			DIPD-SCHOTKY	28480	1901-0518
A9C82		1901-0518	6			DIPD-SCHOTKY	28480	1901-0518
A9C83		1901-0016	2			DIPD-GERMANIUM 60V 60MA D0-7	28480	1901-0016
A9C84		1901-0025	2			DIPD-GEN PNP 100V 200MA D0-7	28480	1901-0025
A9C85		1901-0040	1			DIPD-SMITHING 10V 50MA ZNS D0-35	28480	1901-0040
A9J12		1200-0664	1			SOCKET-IC 40-CONT	28480	
A9L1		9100-1788	6			CHOKER WIDE BAND ZMAX660 OHMS 180 MHZ	02114	VK200 20/48
A9L2		9100-3139	5			COIL 75UH 15% SDX.075L6-NOM	28480	9100-3139
A9Q1		1553-0015	7	2		TRANSISTOR PNP 51 PD=200MW FT=500MHZ	28480	1553-0015
A9Q2		1553-0015	7	2		TRANSISTOR PNP 51 PD=200MW FT=500MHZ	28480	1553-0015
A9Q3		1553-0405	8	3		TRANSISTOR PNP PD=700MW FT=850MHZ	28480	1553-0405
A9R1		0663-1035	8	1		RESISTOR 10K 5% .25W FC TC=400/+500	01121	0663-1035
A9R2		0663-1035	8	1		RESISTOR 10K 5% .25W FC TC=400/+500	01121	0663-1035
A9R3		0663-1035	8	1		RESISTOR 10K 5% .25W FC TC=400/+500	01121	0663-1035
A9R4		0663-1035	8	1		RESISTOR 10K 5% .25W FC TC=400/+500	01121	0663-1035
A9R5		0663-1035	8	1		RESISTOR 10K 5% .25W FC TC=400/+500	01121	0663-1035
A9R6		0663-1035	8	1		RESISTOR 10K 5% .25W FC TC=400/+500	01121	0663-1035
A9R7		0663-1035	8	1		RESISTOR 10K 5% .25W FC TC=400/+500	01121	0663-1035
A9R8		0663-1035	8	1		RESISTOR 10K 5% .25W FC TC=400/+500	01121	0663-1035
A9R9		0663-1035	8	1		RESISTOR 10K 5% .25W FC TC=400/+500	01121	0663-1035
A9R10		0663-1515	2	2		RESISTOR 150 5% .25W FC TC=400/+600	01121	0663-1515
A9R11		1810-0269	3	3		NETWORK-RES 9-PIN-SIP .1-PIN-SPCG	28480	1810-0269
A9R12		0663-1035	9	3		RESISTOR 1K 5% .25W FC TC=400/+600	01121	0663-1035
A9R13		0663-1035	9	3		RESISTOR 1K 5% .25W FC TC=400/+600	01121	0663-1035
A9R14		0663-1035	9	3		RESISTOR 1K 5% .25W FC TC=400/+600	01121	0663-1035
A9R15		0663-1035	9	3		RESISTOR 1K 5% .25W FC TC=400/+600	01121	0663-1035
A9R16		0663-1035	9	3		RESISTOR 1K 5% .25W FC TC=400/+600	01121	0663-1035
A9R17		0663-1035	9	3		RESISTOR 1K 5% .25W FC TC=400/+600	01121	0663-1035
A9R18		0663-1035	9	3		RESISTOR 1K 5% .25W FC TC=400/+600	01121	0663-1035
A9R19		0663-1035	9	3		RESISTOR 1K 5% .25W FC TC=400/+600	01121	0663-1035
A9R20		0663-1035	9	3		RESISTOR 1K 5% .25W FC TC=400/+600	01121	0663-1035
A9R21		0663-1035	9	3		RESISTOR 1K 5% .25W FC TC=400/+600	01121	0663-1035
A9R22		0663-4745	6	6		RESISTOR 470K 5% .25W FC TC=800/+900	01121	0663-4745
A9R23		0663-1035	7	1		RESISTOR 10K 5% .25W FC TC=400/+500	01121	0663-1035
A9R24		0663-1035	7	1		RESISTOR 10K 5% .25W FC TC=400/+500	01121	0663-1035
A9R25		0663-1035	7	1		RESISTOR 10K 5% .25W FC TC=400/+500	01121	0663-1035
A9R26		1810-0269	1	1		NETWORK-RES 9-PIN-SIP .1-PIN-SPCG	28480	1810-0269
A9R27		1810-0269	1	1		NETWORK-RES 9-PIN-SIP .1-PIN-SPCG	28480	1810-0269
A9R28		0698-3158	4	2		RESISTOR 23.7K 1% .125W F TC=0/+100	01121	0698-3158
A9R29		0757-0442	4	2		RESISTOR 10K 1% .125W F TC=0/+100	01121	0757-0442
A9R30		0698-3158	4	2		RESISTOR 23.7K 1% .125W F TC=0/+100	01121	0698-3158
A9R31		0663-4726	3	3		RESISTOR 4.7K 5% .25W TC=400/+700	01121	0663-4726
A9R32		3101-1973	7	2		SWITCH, SLIDE 7-14-NS	28480	3101-1973
A9U1		1818-1134	7	1		IC, MASK-ROM	28480	
A9U3		1818-1136	7	1		IC, MASK-ROM	28480	
A9U5		1818-1136	9	1		IC, MASK-ROM	28480	
A9U7		1818-1137	1	1		IC, MASK-ROM	28480	
A9U10		1818-1548	3	3		IC, MASK-ROM	28480	
A9U12		1818-0436	4	2		IC CMOS 4K RAM 81AT 450-NS 3-S	28480	
A9U13		1818-1750	4	2		IC CMOS 4K RAM 81AT 450-NS 3-S	28480	
A9U14		1818-1750	7	7		IC CMOS 4K RAM 81AT 450-NS 3-S	28480	
A9U15		1818-1750	7	7		IC CMOS 4K RAM 81AT 450-NS 3-S	28480	
A9U16		1820-1216	3	3		IC DCR T1L LS 3-10-E-LINE 3-INP	01295	1820-1216
A9U17		1820-2024	3	3		IC DCR T1L LS 3-10-E-LINE 3-INP	01295	1820-2024
A9U18		1820-1484	3	3		IC MICRO CMOS 8-BIT	04713	1820-1484
A9U19		1820-1484	5	5		IC GATE T1L LS NOR QUAD 2-INP	01295	1820-1484
A9U20		1820-0683	6	6		IC INV T1L S HEX 1-INP	01295	1820-0683
A9U21		1820-1197	6	6		IC GATE T1L LS NAND QUAD 2-INP	01295	1820-1197
A9U22		1820-1216	9	3		IC DCR T1L LS 3-10-E-LINE 3-INP	01295	1820-1216

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

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

Reference Designation	HP Part Number	D Qty	Description	Mfr Code	Mfr Part Number
A923	1820-1491	6	IC BFR TTL LS NON-INV HEX 1-INP	01295	9N74LS37AN
A925	1820-0408	5	8-dip	32293	1CL8212CA
A926	1820-0661	9	IC GATE TTL OR QUAD 2-INP	01295	9N74J2N
A927	1820-1197	9	IC GATE TTL LS NAND QUAD 2-INP	01295	9N74LS00N
A928	1820-1216	3	IC OCOR TTL LS 3-10-B=LINE 3-INP	01295	9N74LS138N
A929	1820-2024	3	IC DRIVER TTL LS LINE DRIVER OCTL	01295	9N74LS244N
A930	1906-0075	2	DIPD-ARRAY 40V 400MA	28480	1906-0075
A931	1820-1994	2	IC DRIVER TTL LS LINE DRIVER OCTL	01295	9N74LS243N
A932	1820-1994	4	IC DRIVER TTL LS LINE DRIVER OCTL	01295	9N74LS243N
A933	1820-1491	6	IC BFR TTL LS NON-INV HEX 1-INP	01295	9N74LS37AN
A934	1820-1199	1	IC INV TTL LS HEX 1-INP	01295	9N74LS04N
A935	1820-0180	0	IC TIMER TTL MONO/AS1BL	04713	MC1455P1
A9M1	8159-0005	0	WIRE 22AWG W PVC 1X22 80C	28480	8159-0005
A9M2	8159-0005	0	WIRE 22AWG W PVC 1X22 80C	28480	8159-0005
A9M3	8159-0005	0	WIRE 22AWG W PVC 1X22 80C	28480	8159-0005
A9M4	8159-0005	0	WIRE 22AWG W PVC 1X22 80C	28480	8159-0005
A9M5	8159-0005	0	WIRE 22AWG W PVC 1X22 80C	28480	8159-0005
A9M6	8159-0005	0	WIRE 22AWG W PVC 1X22 80C	28480	8159-0005
A10C1	0160-4832	6	CAPACITOR-FXD 22UF+10% 15VDC 1A	56289	150D226X9015B2
A10C2	0160-4832	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	
A10C3	0160-4832	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	
A10C4	0160-4832	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	
A10C5	0160-4832	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	
A10C6	0160-4832	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	
A10C7	0160-4832	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	
A10C8	0160-4832	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	
A10C9	0160-4832	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	
A10C10	0160-4832	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	
A10C11	0160-4832	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	
A10C12	0160-4832	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	
A10C13	0160-4832	9	CAPACITOR-FXD .01UF +10% 100VDC CER	28480	
A10D81	1990-0486	35	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4884
A10D82	1990-0540	3	DISPLA-NUM-SEG 1=CHAR ,43-H	28480	5082-7650
A10D83	1990-0540	3	DISPLA-NUM-SEG 1=CHAR ,43-H	28480	5082-7650
A10D84	1990-0540	3	DISPLA-NUM-SEG 1=CHAR ,43-H	28480	5082-7650
A10D85	1990-0540	3	DISPLA-NUM-SEG 1=CHAR ,43-H	28480	5082-7650
A10D86	1990-0540	3	DISPLA-NUM-SEG 1=CHAR ,43-H	28480	5082-7650
A10D87	1990-0540	3	DISPLA-NUM-SEG 1=CHAR ,43-H	28480	5082-7650
A10D88	1990-0617	5	DISPLA-NUM-SEG 1=CHAR ,3-H	28480	5082-7650
A10D89	1990-0617	5	DISPLA-NUM-SEG 1=CHAR ,3-H	28480	5082-7650
A10D90	1990-0617	5	DISPLA-NUM-SEG 1=CHAR ,3-H	28480	5082-7650
A10D91	1990-0617	5	DISPLA-NUM-SEG 1=CHAR ,3-H	28480	5082-7650
A10D92	1990-0617	5	DISPLA-NUM-SEG 1=CHAR ,3-H	28480	5082-7650
A10D93	1990-0617	5	DISPLA-NUM-SEG 1=CHAR ,3-H	28480	5082-7650
A10D94	1990-0617	5	DISPLA-NUM-SEG 1=CHAR ,3-H	28480	5082-7650
A10D95	1990-0617	5	DISPLA-NUM-SEG 1=CHAR ,3-H	28480	5082-7650
A10D96	1990-0617	5	DISPLA-NUM-SEG 1=CHAR ,3-H	28480	5082-7650
A10D97	1990-0617	5	DISPLA-NUM-SEG 1=CHAR ,3-H	28480	5082-7650
A10D98	1990-0617	5	DISPLA-NUM-SEG 1=CHAR ,3-H	28480	5082-7650
A10D99	1990-0617	5	DISPLA-NUM-SEG 1=CHAR ,3-H	28480	5082-7650
A10D100	1990-0617	5	DISPLA-NUM-SEG 1=CHAR ,3-H	28480	5082-7650
A10D81	1990-0486	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4884
A10D82	1990-0486	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4884
A10D83	1990-0486	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4884
A10D84	1990-0486	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4884
A10D85	1990-0486	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4884
A10D86	1990-0486	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4884
A10D87	1990-0486	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4884
A10D88	1990-0486	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4884
A10D89	1990-0486	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4884
A10D90	1990-0486	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4884
A10D91	1990-0486	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4884
A10D92	1990-0486	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4884
A10D93	1990-0486	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4884
A10D94	1990-0486	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4884
A10D95	1990-0486	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4884
A10D96	1990-0486	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4884
A10D97	1990-0486	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4884
A10D98	1990-0486	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4884
A10D99	1990-0486	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4884
A10D100	1990-0486	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4884
A10D81	1990-0434	4	DISPLA-NUM-SEG 1=CHAR ,3-H	28480	5082-7730, CAT B-E
A10D82	1990-0434	4	DISPLA-NUM-SEG 1=CHAR ,3-H	28480	5082-7730, CAT B-E
A10D83	1990-0434	4	DISPLA-NUM-SEG 1=CHAR ,3-H	28480	5082-7730, CAT B-E
A10D84	1990-0434	4	DISPLA-NUM-SEG 1=CHAR ,3-H	28480	5082-7730, CAT B-E
A10D85	1990-0434	4	DISPLA-NUM-SEG 1=CHAR ,3-H	28480	5082-7730, CAT B-E
A10D86	1990-0434	4	DISPLA-NUM-SEG 1=CHAR ,3-H	28480	5082-7730, CAT B-E
A10D87	1990-0434	4	DISPLA-NUM-SEG 1=CHAR ,3-H	28480	5082-7730, CAT B-E
A10D88	1990-0434	4	DISPLA-NUM-SEG 1=CHAR ,3-H	28480	5082-7730, CAT B-E
A10D89	1990-0434	4	DISPLA-NUM-SEG 1=CHAR ,3-H	28480	5082-7730, CAT B-E
A10D90	1990-0434	4	DISPLA-NUM-SEG 1=CHAR ,3-H	28480	5082-7730, CAT B-E
A10D91	1990-0434	4	DISPLA-NUM-SEG 1=CHAR ,3-H	28480	5082-7730, CAT B-E
A10D92	1990-0434	4	DISPLA-NUM-SEG 1=CHAR ,3-H	28480	5082-7730, CAT B-E
A10D93	1990-0434	4	DISPLA-NUM-SEG 1=CHAR ,3-H	28480	5082-7730, CAT B-E
A10D94	1990-0434	4	DISPLA-NUM-SEG 1=CHAR ,3-H	28480	5082-7730, CAT B-E
A10D95	1990-0434	4	DISPLA-NUM-SEG 1=CHAR ,3-H	28480	5082-7730, CAT B-E
A10D96	1990-0434	4	DISPLA-NUM-SEG 1=CHAR ,3-H	28480	5082-7730, CAT B-E
A10D97	1990-0434	4	DISPLA-NUM-SEG 1=CHAR ,3-H	28480	5082-7730, CAT B-E
A10D98	1990-0434	4	DISPLA-NUM-SEG 1=CHAR ,3-H	28480	5082-7730, CAT B-E
A10D99	1990-0434	4	DISPLA-NUM-SEG 1=CHAR ,3-H	28480	5082-7730, CAT B-E
A10D100	1990-0434	4	DISPLA-NUM-SEG 1=CHAR ,3-H	28480	5082-7730, CAT B-E
A10D81	1990-0665	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4664
A10D82	1990-0665	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4664
A10D83	1990-0665	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4664
A10D84	1990-0665	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4664
A10D85	1990-0665	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4664
A10D86	1990-0665	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4664
A10D87	1990-0665	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4664
A10D88	1990-0665	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4664
A10D89	1990-0665	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4664
A10D90	1990-0665	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4664
A10D91	1990-0665	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4664
A10D92	1990-0665	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4664
A10D93	1990-0665	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4664
A10D94	1990-0665	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4664
A10D95	1990-0665	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4664
A10D96	1990-0665	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4664
A10D97	1990-0665	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4664
A10D98	1990-0665	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4664
A10D99	1990-0665	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4664
A10D100	1990-0665	6	LED-VISIBLE LUM-INTEGRIMCD IF=20MA-MAX	28480	5082-4664

Table 6-3. Replaceable Parts (Cont'd).

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

Reference Designation	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
A10B36	1990-0665	6	6	6	LED-VISIBLE LUM-INTEGRATED IF=20MA-MAX	28480	5041-0318
A10B37	1990-0665	6	6	6	LED-VISIBLE LUM-INTEGRATED IF=20MA-MAX	28480	5041-0318
A10B38	1990-0665	6	6	6	LED-VISIBLE LUM-INTEGRATED IF=20MA-MAX	28480	5041-0318
A10B39	1990-0665	6	6	6	LED-VISIBLE LUM-INTEGRATED IF=20MA-MAX	28480	5041-0318
A10B40	1990-0665	6	6	6	LED-VISIBLE LUM-INTEGRATED IF=20MA-MAX	28480	5041-0318
A10B41	1990-0665	6	6	6	LED-VISIBLE LUM-INTEGRATED IF=20MA-MAX	28480	5041-0318
A10B42	1990-0665	6	6	6	LED-VISIBLE LUM-INTEGRATED IF=20MA-MAX	28480	5041-0318
A10B43	1990-0665	6	6	6	LED-VISIBLE LUM-INTEGRATED IF=20MA-MAX	28480	5041-0318
A10B44	1990-0665	6	6	6	LED-VISIBLE LUM-INTEGRATED IF=20MA-MAX	28480	5041-0318
A10B45	1990-0665	6	6	6	LED-VISIBLE LUM-INTEGRATED IF=20MA-MAX	28480	5041-0318
A10B46	1990-0665	6	6	6	LED-VISIBLE LUM-INTEGRATED IF=20MA-MAX	28480	5041-0318
A10B47	1990-0665	6	6	6	LED-VISIBLE LUM-INTEGRATED IF=20MA-MAX	28480	5041-0318
A10B48	1990-0665	6	6	6	LED-VISIBLE LUM-INTEGRATED IF=20MA-MAX	28480	5041-0318
A10B49	1990-0665	6	6	6	LED-VISIBLE LUM-INTEGRATED IF=20MA-MAX	28480	5041-0318
A10B50	1990-0665	6	6	6	LED-VISIBLE LUM-INTEGRATED IF=20MA-MAX	28480	5041-0318
A10B51	1990-0665	6	6	6	LED-VISIBLE LUM-INTEGRATED IF=20MA-MAX	28480	5041-0318
A10B52	1990-0665	6	6	6	LED-VISIBLE LUM-INTEGRATED IF=20MA-MAX	28480	5041-0318
A10B53	1990-0665	6	6	6	LED-VISIBLE LUM-INTEGRATED IF=20MA-MAX	28480	5041-0318
A10B54	1990-0665	6	6	6	LED-VISIBLE LUM-INTEGRATED IF=20MA-MAX	28480	5041-0318
A10B55	1990-0665	6	6	6	LED-VISIBLE LUM-INTEGRATED IF=20MA-MAX	28480	5041-0318
A10J2	1200-0638	9	9	9	SOCKET-IC 14-CONT DIP-SLDR	28480	5041-0309
A10J3	1200-0638	9	9	9	SOCKET-IC 14-CONT DIP-SLDR	28480	5041-0309
A10J4	1200-0638	9	9	9	SOCKET-IC 14-CONT DIP-SLDR	28480	5041-0309
A10J5	1200-0638	9	9	9	SOCKET-IC 14-CONT DIP-SLDR	28480	5041-0309
A10J6	1200-0638	9	9	9	SOCKET-IC 14-CONT DIP-SLDR	28480	5041-0309
A10J7	1200-0638	9	9	9	SOCKET-IC 14-CONT DIP-SLDR	28480	5041-0309
A10J8	1200-0424	9	9	9	SOCKET-ELEC (MISC ITEM)	28480	5041-0351
A10J9	1200-0424	9	9	9	14-PIN SOCKET FOR DS8, 9, 16, AND 17	28480	5041-0351
A10J10	1200-0638	9	9	9	SOCKET-IC 14-CONT DIP-SLDR	28480	5041-0309
A10J11	1200-0638	9	9	9	SOCKET-IC 14-CONT DIP-SLDR	28480	5041-0309
A10J12	1200-0638	9	9	9	SOCKET-IC 14-CONT DIP-SLDR	28480	5041-0309
A10J13	1200-0638	9	9	9	SOCKET-IC 14-CONT DIP-SLDR	28480	5041-0309
A10J14	1200-0638	9	9	9	SOCKET-IC 14-CONT DIP-SLDR	28480	5041-0309
A10J15	1200-0638	9	9	9	SOCKET-IC 14-CONT DIP-SLDR	28480	5041-0309
A10J16	1200-0424	9	9	9	SOCKET-ELEC (MISC ITEM)	28480	5041-0351
A10J17	1200-0424	9	9	9	SOCKET-ELEC (MISC ITEM)	28480	5041-0351
A10J18	1200-0508	0	0	0	SOCKET-IC 14-CONT DIP-SLDR	28480	5041-0318
A10J19	1200-0508	0	0	0	SOCKET FOR DS18 THROUGH DS20	28480	5041-0318
A10K1	5041-0252	7	7	7	KEY CAP	28480	5041-0318
A10K6	5041-0252	7	7	7	KEY CAP	28480	5041-0318
A10K7	5041-0252	7	7	7	KEY CAP	28480	5041-0318
A10K8	5041-0252	7	7	7	KEY CAP	28480	5041-0318
A10K9	5041-0252	7	7	7	KEY CAP	28480	5041-0318
A10K10	5041-0309	5	5	5	KEY CAP	28480	5041-0309
A10K11	5041-0309	5	5	5	KEY CAP	28480	5041-0309
A10K12	5041-0318	6	6	6	*LK CAP- PTY GRAY	28480	5041-0318
A10K13	5041-0318	6	6	6	*LK CAP- PTY GRAY	28480	5041-0318
A10K14	5041-0309	5	5	5	KEY CAP	28480	5041-0309
A10K15	5041-0309	5	5	5	KEY CAP	28480	5041-0309
A10K16	5041-0318	6	6	6	*LK CAP- PTY GRAY	28480	5041-0318
A10K17	5041-0318	6	6	6	*LK CAP- PTY GRAY	28480	5041-0318
A10K18	5041-0318	6	6	6	*LK CAP- PTY GRAY	28480	5041-0318
A10K19	5041-0318	6	6	6	*LK CAP- PTY GRAY	28480	5041-0318
A10K20	5041-0309	5	5	5	KEY CAP	28480	5041-0309
A10K21	5041-0309	5	5	5	KEY CAP	28480	5041-0309
A10K22	5041-0318	6	6	6	*LK CAP- PTY GRAY	28480	5041-0318
A10K23	5041-0318	6	6	6	*LK CAP- PTY GRAY	28480	5041-0318
A10K24	5041-0318	6	6	6	*LK CAP- PTY GRAY	28480	5041-0318
A10K25	5041-0318	6	6	6	*LK CAP- PTY GRAY	28480	5041-0318
A10K30	5041-0318	6	6	6	*LK CAP- PTY GRAY	28480	5041-0318
A10K31	5041-0318	6	6	6	*LK CAP- PTY GRAY	28480	5041-0318
A10K32	5041-0309	5	5	5	KEY CAP	28480	5041-0309
A10K33	5041-0309	5	5	5	KEY CAP	28480	5041-0309
A10K34	5041-0309	5	5	5	KEY CAP	28480	5041-0309
A10K35	5041-0318	6	6	6	*LK CAP- PTY GRAY	28480	5041-0318
A10K36	5041-0318	6	6	6	*LK CAP- PTY GRAY	28480	5041-0318
A10K37	5041-0318	6	6	6	*LK CAP- PTY GRAY	28480	5041-0318
A10K38	5041-0354	6	6	6	KEY-Q-SMOKE GRAY	28480	5041-0354

Table 6-3. Replaceable Parts (Cont'd).

Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A10F1	0757-0400	9	RESISTOR 90.9 1% .125W F TC=+100	24546	C4=1/8=10=90R9-F
A10F2	0757-0400	9	RESISTOR 90.9 1% .125W F TC=+100	24546	C4=1/8=10=90R9-F
A10F3	0757-0400	9	RESISTOR 90.9 1% .125W F TC=+100	24546	C4=1/8=10=90R9-F
A10F4	0757-0400	9	RESISTOR 90.9 1% .125W F TC=+100	24546	C4=1/8=10=90R9-F
A10F5	1810-0203	7	NETWRK-RES 8-PIN-SIP, 1-PIN-SPC	01121	C4=1/8=10=90R9-F
A10F6	1810-0203	7	NETWRK-RES 8-PIN-SIP, 1-PIN-SPC	01121	C4=1/8=10=90R9-F
A10F7	0693-3447	9	RESISTOR 422 1% .125W F TC=+100	24546	C4=1/8=10=90R9-F
A10F8	0757-0400	9	RESISTOR 90.9 1% .125W F TC=+100	24546	C4=1/8=10=90R9-F
A10F9	0757-0400	9	RESISTOR 90.9 1% .125W F TC=+100	24546	C4=1/8=10=90R9-F
A10F10	0757-0400	9	RESISTOR 90.9 1% .125W F TC=+100	24546	C4=1/8=10=90R9-F
A10F11	0757-0400	9	RESISTOR 90.9 1% .125W F TC=+100	24546	C4=1/8=10=90R9-F
A10F12	0663-1215	9	RESISTOR 120 5% .25W FC TC=+400/+600	01121	CB1215
A10F13	0663-1215	9	RESISTOR 120 5% .25W FC TC=+400/+600	01121	CB1215
A10F14	0663-1215	9	RESISTOR 120 5% .25W FC TC=+400/+600	01121	CB1215
A10F15	0663-1215	9	RESISTOR 120 5% .25W FC TC=+400/+600	01121	CB1215
A10F16	0663-1215	9	RESISTOR 120 5% .25W FC TC=+400/+600	01121	CB1215
A10F17	0663-1215	9	RESISTOR 120 5% .25W FC TC=+400/+600	01121	CB1215
A10F18	0663-1215	9	RESISTOR 120 5% .25W FC TC=+400/+600	01121	CB1215
A10F19	0663-1215	9	RESISTOR 120 5% .25W FC TC=+400/+600	01121	CB1215
A10F20	0663-1215	9	RESISTOR 120 5% .25W FC TC=+400/+600	01121	CB1215
A10F21	0663-1215	9	RESISTOR 120 5% .25W FC TC=+400/+600	01121	CB1215
A10F22	0663-1215	9	RESISTOR 120 5% .25W FC TC=+400/+600	01121	CB1215
A10F23	0663-1215	9	RESISTOR 120 5% .25W FC TC=+400/+600	01121	CB1215
A10F24	0663-1215	9	RESISTOR 120 5% .25W FC TC=+400/+600	01121	CB1215
A10F25	0663-1215	9	RESISTOR 120 5% .25W FC TC=+400/+600	01121	CB1215
A10F26	0663-1215	9	RESISTOR 120 5% .25W FC TC=+400/+600	01121	CB1215
A10F27	0663-1215	9	RESISTOR 120 5% .25W FC TC=+400/+600	01121	CB1215
A10F28	2100-1174	1	RESISTOR, VAR 2K 10%	24546	C4=1/8=10=90R9-F
A10F29	0757-0400	9	RESISTOR 90.9 1% .125W F TC=+100	24546	C4=1/8=10=90R9-F
A10F30	0757-0400	9	RESISTOR 90.9 1% .125W F TC=+100	24546	C4=1/8=10=90R9-F
A10F31	0757-0400	9	RESISTOR 90.9 1% .125W F TC=+100	24546	C4=1/8=10=90R9-F
A10F32	0757-0400	9	RESISTOR 90.9 1% .125W F TC=+100	24546	C4=1/8=10=90R9-F
A10F33	0757-0400	9	RESISTOR 90.9 1% .125W F TC=+100	24546	C4=1/8=10=90R9-F
A10F34	0757-0400	9	RESISTOR 90.9 1% .125W F TC=+100	24546	C4=1/8=10=90R9-F
A10F35	0757-0400	9	RESISTOR 90.9 1% .125W F TC=+100	24546	C4=1/8=10=90R9-F
A10S1-	5060-9436	7	PUSHBUTTON SWITCH P.C. MOUNT	24546	5060-9436
A10S27	3101-2046	7	SWITCH, SLIDE DPDT-NS	24546	3101-2046
A10S28	3101-1074	9	SWITCH, PUSHBUTTON SPST NO	24546	3101-1074
A10S29	3101-1074	9	SWITCH, PUSHBUTTON SPST NO	24546	3101-1074
A10S30-	3101-2046	7	SWITCH, SLIDE DPDT-NS	24546	3101-2046
A10S38	5060-9436	7	PUSHBUTTON SWITCH P.C. MOUNT	24546	5060-9436
A10U1	1858-0038	4	TRANSISTOR ARRAY	24546	1858-0038
A10U2	1858-0038	4	TRANSISTOR ARRAY	24546	1858-0038
A10U3	1858-0038	4	TRANSISTOR ARRAY	24546	1858-0038
A10U4	1858-0038	4	TRANSISTOR ARRAY	24546	1858-0038
A10U5	1858-0038	4	TRANSISTOR ARRAY	24546	1858-0038
A10U6	1820-0666	7	IC BFR TTL NON-INV HEX 1-INP	01295	8N7407N
A10U7	1820-0666	7	IC BFR TTL NON-INV HEX 1-INP	01295	8N7407N
A10U8	1820-0495	8	IC DCOR TTL 4-TO-16-LINE 4-INP	01295	8N74154N
A10U9	1820-0495	8	IC DCOR TTL 4-TO-16-LINE 4-INP	01295	8N74154N
A10W1	04274-61621	3	WIRING ASSEMBLY	24546	04274-61621
A10W1	0360-1706	9	CABLE TRANSITION	24546	0360-1706
A11	04274-26510	5	PC BOARD, BLANK	24546	04274-26510
A11	04274-66551	0	POWER SUPPLY BOARD ASSEMBLY	24546	04274-66551
A11C1	0180-1073	1	CAPACITOR-FXD 2200UF +30-10% 16VDC	24546	0180-1073
A11C2	0180-1071	9	CAPACITOR-FXD 1500UF +30-10% 16VDC	24546	0180-1071
A11C3	0180-1072	0	CAPACITOR-FXD 1000UF +30-10% 25VDC	24546	0180-1072
A11C4	0180-1072	0	CAPACITOR-FXD 1000UF +30-10% 25VDC	24546	0180-1072
A11C5	0180-1074	2	CAPACITOR-FXD 470UF +50-10% 100VDC	24546	0180-1074
A11C6	0180-1074	2	CAPACITOR-FXD 470UF +50-10% 100VDC	24546	0180-1074
A11C7	0180-1076	4	CAPACITOR-FXD 470UF +50-10% 35VDC	24546	0180-1076
A11C8	0180-1076	4	CAPACITOR-FXD 470UF +50-10% 35VDC	24546	0180-1076
A11C9	0180-1076	4	CAPACITOR-FXD 470UF +50-10% 35VDC	24546	0180-1076
A11C10	0180-1076	4	CAPACITOR-FXD 470UF +50-10% 35VDC	24546	0180-1076
A11C11	0180-1076	4	CAPACITOR-FXD 470UF +50-10% 35VDC	24546	0180-1076
A11C12	0180-1051	5	CAPACITOR-FXD 100 UF 16V M	24546	0180-1051
A11C13	0180-1076	4	CAPACITOR-FXD 470UF +50-10% 35VDC	24546	0180-1076
A11C14	0180-1075	3	CAPACITOR-FXD 2200UF +30-10% 16VDC	24546	0180-1075
A11C15	0180-1075	3	CAPACITOR-FXD 2200UF +30-10% 16VDC	24546	0180-1075

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

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

Reference	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A16	1251-0292	5	DC BIAS CONNECTOR BOARD ASSEMBLY	28480	04274-66516
A16	1251-0292	5	PC BOARD, BLANK	28480	04274-26515
A17			NOT ASSIGNED		
A18			NOT ASSIGNED		
A19			NOT ASSIGNED		
A20			NOT ASSIGNED		
A21	04274-66521	2	DC BIAS(+/-35V) BOARD ASSEMBLY (OPTION 001 ONLY)	28480	04274-66521
A21C1	0160-2204	0	CAPACITOR-FXD 100PF +/-5% 300VDC MICA	28480	0160-2204
A21C2	0160-2242	6	CAPACITOR-FXD 2uPF +/-25PF 500VDC CER	28480	0160-2242
A21C3	0160-2257	3	CAPACITOR-FXD 10PF +/-5% 500VDC CER 0+40	28480	0160-2257
A21C4	0160-4832	9	CAPACITOR-FXD .01UF +/-10% 100VDC CER	28480	0160-4832
A21C5	0160-2261	8	CAPACITOR-FXD .01UF +/-10% 100VDC CER 0+30	28480	0160-2261
A21C6	0140-0191	9	CAPACITOR-FXD 56PF +/-5% 300VDC MICA	28480	0140-0191
A21C7	0180-1081	1	CAPACITOR, FXD 47 UF 50 VDC AL	28480	0180-1081
A21C8	0180-1081	1	CAPACITOR, FXD 47 UF 50 VDC AL	28480	0180-1081
A21C9	0180-1081	1	CAPACITOR, FXD 47 UF 50 VDC AL	28480	0180-1081
A21C10	0160-4832	4	CAPACITOR-FXD .01UF +/-10% 100VDC CER	28480	0160-4832
A21C11	0180-1050	4	CAPACITOR, FXD 100 UF 25VDC	28480	0180-1050
A21C12	0180-1050	4	CAPACITOR, FXD 100 UF 25VDC	28480	0180-1050
A21C13	0160-4832	7	CAPACITOR-FXD .01UF +/-10% 100VDC CER	28480	0160-4832
A21C14	0160-0659	4	CAPACITOR-FXD 1uF +/-10% 50VDC POLYE	28480	0160-0659
A21C15	0180-1050	4	CAPACITOR, FXD 100 UF 25VDC	28480	0180-1050
A21C16	0180-1050	4	CAPACITOR, FXD 100 UF 25VDC	28480	0180-1050
A21C17	0180-1081	1	CAPACITOR, FXD 47 UF 50 VDC AL	28480	0180-1081
A21C18	0180-1081	1	CAPACITOR, FXD 47 UF 50 VDC AL	28480	0180-1081
A21C19	0180-1081	1	CAPACITOR, FXD 47 UF 50 VDC AL	28480	0180-1081
A21C20	0160-4832	2	CAPACITOR-FXD .01UF +/-10% 100VDC CER	28480	0160-4832
A21C21	0180-1050	4	CAPACITOR, FXD 100 UF 25VDC	28480	0180-1050
A21C22	0180-1050	4	CAPACITOR, FXD 100 UF 25VDC	28480	0180-1050
A21C23	0180-1081	1	CAPACITOR, FXD 47 UF 50 VDC AL	28480	0180-1081
A21C24	0180-1050	4	CAPACITOR, FXD 100 UF 25VDC	28480	0180-1050
A21C25	0180-1050	4	CAPACITOR, FXD 100 UF 25VDC	28480	0180-1050
A21C26	0160-4832	9	CAPACITOR-FXD .01UF +/-10% 100VDC CER	28480	0160-4832
A21C27	0180-2951	6	CAPACITOR-FXD 33UF+-20% 16VDC AL	28480	0180-2951
A21C28	0180-2951	6	CAPACITOR-FXD 33UF+-20% 16VDC AL	28480	0180-2951
A21C29	0180-2951	6	CAPACITOR-FXD 33UF+-20% 16VDC AL	28480	0180-2951
A21C30	0180-1082	2	CAPACITOR, FXD 10 UF 100VDC AL	28480	0180-1082
A21C31	1902-3234	3	DIODE-ZNR 19.6V 5% DO-7 PDM+4M TC+0.73X	28480	1902-3234
A21C32	1902-3234	3	DIODE-ZNR 19.6V 5% DO-7 PDM+4M TC+0.73X	28480	1902-3234
A21C33	1902-3234	3	DIODE-ZNR 19.6V 5% DO-7 PDM+4M TC+0.73X	28480	1902-3234
A21C34	1902-3234	3	DIODE-ZNR 19.6V 5% DO-7 PDM+4M TC+0.73X	28480	1902-3234
A21C35	1901-0033	2	DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A21C36	1901-0033	2	DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A21C37	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C38	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C39	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C40	1901-0033	2	DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A21C41	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C42	1902-1259	6	DIODE-ZNR 1N5378 20V 5% PDM5M IR=500MA	28480	1902-1259
A21C43	1902-1259	6	DIODE-ZNR 1N5378 20V 5% PDM5M IR=500MA	28480	1902-1259
A21C44	1902-1259	6	DIODE-ZNR 1N5378 20V 5% PDM5M IR=500MA	28480	1902-1259
A21C45	1902-1259	6	DIODE-ZNR 1N5378 20V 5% PDM5M IR=500MA	28480	1902-1259
A21C46	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C47	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C48	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C49	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C50	1901-0033	2	DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A21C51	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C52	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C53	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C54	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C55	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C56	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C57	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C58	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C59	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C60	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C61	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C62	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C63	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C64	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C65	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C66	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C67	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C68	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C69	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C70	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C71	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C72	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C73	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C74	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C75	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C76	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C77	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C78	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C79	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C80	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C81	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C82	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C83	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C84	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C85	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C86	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C87	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C88	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C89	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C90	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C91	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C92	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C93	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C94	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C95	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C96	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C97	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C98	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C99	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21C100	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025

Table 6-3. Replaceable Parts (Cont'd).

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

Reference Designation	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
A21F40	0663-5625	3		3	RESISTOR 5.6K 5% .25W FC TC=400+/700	01121	C85625
A21F41	0663-5625	3		3	RESISTOR 5.6K 5% .25W FC TC=400+/700	01121	C85625
A21F42	0663-5625	3		3	RESISTOR 5.6K 5% .25W FC TC=400+/700	01121	C85625
A21F44	0663-1235	3		3	RESISTOR 12K 5% .25W FC TC=400+/800	01121	C81235
A21F45	0663-1235	3		3	RESISTOR 12K 5% .25W FC TC=400+/800	01121	C81235
A21F46	0663-1235	3		3	RESISTOR 12K 5% .25W FC TC=400+/800	01121	C81235
A21F47	0663-3335	3		3	RESISTOR 33K 5% .25W FC TC=400+/800	01121	C83335
A21F48	0663-1835	3		3	RESISTOR 18K 5% .25W FC TC=400+/800	01121	C81835
A21F49	0663-4735	4		4	RESISTOR 47K 5% .25W FC TC=400+/800	01121	C84735
A21F50	0663-4735	4		4	RESISTOR 47K 5% .25W FC TC=400+/800	01121	C84735
A21F51	0663-4735	4		4	RESISTOR 47K 5% .25W FC TC=400+/800	01121	C84735
A21F52	0663-1835	3		3	RESISTOR 18K 5% .25W FC TC=400+/800	01121	C81835
A21F53	0663-1835	3		3	RESISTOR 18K 5% .25W FC TC=400+/800	01121	C81835
A21F54	0663-1505	0		0	RESISTOR 15 5% .25W FC TC=400+/500	01121	C81505
A21F55	0663-3335	3		3	RESISTOR 33K 5% .25W FC TC=400+/800	01121	C83335
A21F56	0663-5605	3		3	RESISTOR 56 5% .25W FC TC=400+/500	01121	C85605
A21F57	0663-4750	9		9	RESISTOR 47.5K 1% .125W F TC=0+/100	24546	C4-1/B-10-4222-F
A21F58	0663-4750	9		9	RESISTOR 47.5K 1% .125W F TC=0+/100	24546	C4-1/B-10-4222-F
A21F59	0663-4735	4		4	RESISTOR 47K 5% .25W FC TC=400+/800	01121	C84735
A21F60	0663-1225	1		1	RESISTOR 1.2K 5% .25W FC TC=400+/700	01121	C81225
A21F61	0663-1235	3		3	RESISTOR 12K 5% .25W FC TC=400+/800	01121	C81235
A21F62	0663-1235	3		3	RESISTOR 12K 5% .25W FC TC=400+/800	01121	C81235
A21F63	0663-1225	1		1	RESISTOR 1.2K 5% .25W FC TC=400+/700	01121	C81225
A21F64	0663-3335	3		3	RESISTOR 33K 5% .25W FC TC=400+/800	01121	C83335
A21F65	0663-5615	1		1	RESISTOR 560 5% .25W FC TC=400+/500	01121	C85615
A21F66	0663-4735	4		4	RESISTOR 47.5K 1% .125W F TC=0+/100	24546	C4-1/B-10-4222-F
A21F67	0663-4735	4		4	RESISTOR 47.5K 1% .125W F TC=0+/100	24546	C4-1/B-10-4222-F
A21F68	0663-4735	4		4	RESISTOR 47.5K 1% .125W F TC=0+/100	24546	C4-1/B-10-4222-F
A21F69	0663-1055	3		3	RESISTOR 1M 5% .25W FC TC=600+/900	24546	C4-1/B-10-4222-F
A21F70	0663-1835	9		9	RESISTOR 18K 5% .25W FC TC=400+/800	01121	C81835
A21F71	0663-1505	0		0	RESISTOR 15 5% .25W FC TC=400+/500	01121	C81505
A21F72	0663-3335	3		3	RESISTOR 33K 5% .25W FC TC=400+/800	01121	C83335
A21F73	0663-5605	3		3	RESISTOR 56 5% .25W FC TC=400+/500	01121	C85605
A21F74	0663-4725	2		2	RESISTOR 47K 5% .25W FC TC=400+/700	01121	C84725
A21F75	0663-4735	4		4	RESISTOR 47K 5% .25W FC TC=400+/800	01121	C84735
A21F76	0663-4735	4		4	RESISTOR 47K 5% .25W FC TC=400+/800	01121	C84735
A21F77	0663-1225	1		1	RESISTOR 1.2K 5% .25W FC TC=400+/700	01121	C81225
A21F78	0663-1235	3		3	RESISTOR 12K 5% .25W FC TC=400+/800	01121	C81235
A21F79	0663-1835	9		9	RESISTOR 18K 5% .25W FC TC=400+/800	01121	C81835
A21F80	0663-1225	1		1	RESISTOR 1.2K 5% .25W FC TC=400+/700	01121	C81225
A21F81	0663-5605	3		3	RESISTOR 56 5% .25W FC TC=400+/500	01121	C85605
A21F82	1810-0269	3		3	NETWORK-RES 9-PIN-SIP	24546	C4-1/B-10-4222-F
A21F83	1810-0269	3		3	NETWORK-RES 9-PIN-SIP	24546	C4-1/B-10-4222-F
A21F84	1810-0269	3		3	NETWORK-RES 9-PIN-SIP	24546	C4-1/B-10-4222-F
A21F85	1810-0269	3		3	NETWORK-RES 9-PIN-SIP	24546	C4-1/B-10-4222-F
A21F86	0663-5625	3		3	RESISTOR 5.6K 5% .25W FC TC=400+/700	01121	C85625
A21F87	0663-5625	3		3	RESISTOR 5.6K 5% .25W FC TC=400+/700	01121	C85625
A21F88	0663-5625	3		3	RESISTOR 5.6K 5% .25W FC TC=400+/700	01121	C85625
A21F89	0663-5625	3		3	RESISTOR 5.6K 5% .25W FC TC=400+/700	01121	C85625
A21F90	0663-5625	3		3	RESISTOR 5.6K 5% .25W FC TC=400+/700	01121	C85625
A21U10	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U11	1820-1481	4		4	IC PIA NMS0	04713	MC68211
A21U12	1820-2024	3		3	IC DRIVER TTL LS LINE DRVR OCTL	01295	SN74LS244N
A21U13	1820-2024	3		3	IC DRIVER TTL LS LINE DRVR OCTL	01295	SN74LS244N
A21U14	1820-1856	7		7	OP AMP BIFET 10-99	27014	LF356H
A21U15	1820-1730	6		6	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS273N
A21U16	1820-1730	6		6	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS273N
A21U17	1820-1730	6		6	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS273N
A21U18	1820-1730	6		6	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS273N
A21U19	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U20	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U21	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U22	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U23	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U24	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U25	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U26	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U27	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U28	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U29	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U30	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U31	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U32	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U33	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U34	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U35	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U36	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U37	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U38	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U39	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U40	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U41	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U42	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U43	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U44	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U45	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U46	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U47	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U48	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U49	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U50	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U51	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U52	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U53	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U54	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U55	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U56	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U57	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U58	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U59	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U60	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U61	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U62	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U63	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U64	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U65	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U66	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U67	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U68	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U69	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U70	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U71	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U72	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U73	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U74	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U75	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U76	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U77	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U78	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U79	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U80	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U81	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC
A21U82	1820-1197	9		9	IC GATE TTL LS NAND QUAD 2-INP	07263	U44136FC

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

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A22L1	9100-1139	5	COIL 75UH 15% .5DX, 875LG-NOM	28480	9100-1139
A22L2	9100-1788	5	CHOKER-WIDE BAND 2Mkx680 OHMS 180 MHZ	02114	AK800 20/46
A22L3	1820-2269	3	NETWORKERS 9-PIN-SIP 1-PIN-SIP	28480	1810-0269
A22L4	1820-1873	6	IC 8FR TTL LS INV OCTL 2-INP	27014	DM61L886N
A22L5	1820-2104	9	IC GATE TTL LS NAND DUAL 4-INP	01295	8N74L820N
A22L6	1820-2113	1	IC MICROPROCESSORS NMOS	04713	MC6800L
A22L7	1820-1199	1	IC INV TTL LS HEX 1-INP	01295	8N74L804N
A22L8	1820-2058	3	IC MISC TTL 9 QUAD	28480	1820-2058
A22L9	1820-2058	3	IC MISC TTL 9 QUAD	28480	1820-2058
A22L10	1820-2058	3	IC MISC TTL 9 QUAD	28480	1820-2058
A22M1	8159-0005	0	WIRE 22AWG W PVC 1X22 80C	28480	8159-0005
A22M2	8159-0005	0	WIRE 22AWG W PVC 1X22 80C	28480	8159-0005
A23	04274-66523	4	DC BIAS (+/-100V) BOARD ASSEMBLY	28480	04274-66523
A23C1	04274-26522	9	A22 MISCELLANEOUS PARTS	28480	04274-26522
A23C2	04274-26522	9	PC BOARD, BLANK	28480	04274-26522
A23C3	0140-0210	2	CAPACITOR-FXD 270PF +/-5% 30VDC MICA	72136	DM15F27J0300MVICR
A23C4	0160-4832	9	CAPACITOR-FXD .01UF +/-10% 100VDC CER	28480	
A23C5	0160-1050	4	CAPACITOR-FXD 100UF +/-10% 25VDC CER	28480	
A23C6	0160-4832	9	CAPACITOR-FXD .01UF +/-10% 100VDC CER	28480	
A23C7	0160-0127	2	CAPACITOR-FXD 1UF +/-20% 25VDC CER	28480	0160-0127
A23C8	0160-4832	9	CAPACITOR-FXD .01UF +/-10% 100VDC CER	28480	
A23C9	0160-1080	0	CAPACITOR-FXD 4.7UF +/-100-10% 160VDC	28480	0160-1080
A23C10	0160-1080	0	CAPACITOR-FXD 4.7UF +/-100-10% 160VDC	28480	0160-1080
A23C11	0160-1082	2	CAPACITOR-FXD 10UF +/-50-10% 100VDC	28480	0160-1082
A23C12	0160-1082	2	CAPACITOR-FXD 10UF +/-50-10% 100VDC	28480	0160-1082
A23C13	0160-4832	9	CAPACITOR-FXD .01UF +/-10% 100VDC CER	28480	
A23C14	0160-4832	9	CAPACITOR-FXD .01UF +/-10% 100VDC CER	28480	
A23C15	0160-1050	4	CAPACITOR-FXD 100UF +/-10% 25VDC	28480	0160-1050
A23C16	0170-0066	9	CAPACITOR-FXD .027UF +/-10% 200VDC POLY	28480	0170-0066
A23C17	0160-3456	9	CAPACITOR-FXD 1000PF +/-10% 1KVDC CER	28480	0160-3456
A23C18	0160-3456	9	CAPACITOR-FXD 1000PF +/-10% 1KVDC CER	28480	0160-3456
A23C19	0160-3456	9	CAPACITOR-FXD 1000PF +/-10% 1KVDC CER	28480	0160-3456
A23C20	0160-3456	9	CAPACITOR-FXD 1000PF +/-10% 1KVDC CER	28480	0160-3456
A23C21	0160-1050	4	CAPACITOR-FXD 100UF +/-50-10% 25VDC	28480	0160-1050
A23C22	0160-1050	4	CAPACITOR-FXD 100UF +/-50-10% 25VDC	28480	0160-1050
A23C23	0160-1081	1	CAPACITOR-FXD 47UF +/-50-10% 50VDC	28480	0160-1081
A23C24	0160-1081	1	CAPACITOR-FXD 47UF +/-50-10% 50VDC	28480	0160-1081
A23C25	0160-1081	1	CAPACITOR-FXD 47UF +/-50-10% 50VDC	28480	0160-1081
A23C26	0160-1081	1	CAPACITOR-FXD 47UF +/-50-10% 50VDC	28480	0160-1081
A23C27	0160-1082	2	CAPACITOR-FXD 10UF +/-50-10% 100VDC	28480	0160-1082
A23C28	0160-1082	2	CAPACITOR-FXD 10UF +/-50-10% 100VDC	28480	0160-1082
A23C29	0160-1050	4	CAPACITOR-FXD 100UF +/-50-10% 25VDC	28480	0160-1050
A23C30	0160-4832	9	CAPACITOR-FXD .01UF +/-10% 100VDC CER	28480	
A23C31	0160-1081	1	CAPACITOR-FXD 47UF +/-50-10% 50VDC	28480	0160-1081
A23C32	0160-1050	4	CAPACITOR-FXD 100UF +/-50-10% 25VDC	28480	0160-1050
A23C33	0160-1050	4	CAPACITOR-FXD 100UF +/-50-10% 25VDC	28480	0160-1050
A23C34	0160-4832	9	CAPACITOR-FXD .01UF +/-10% 100VDC CER	28480	
A23C35	0160-2951	6	CAPACITOR-FXD 33UF +/-20% 16VDC AL	28480	0160-2951
A23C36	0160-2951	6	CAPACITOR-FXD 33UF +/-20% 16VDC AL	28480	0160-2951
A23C37	0160-2951	6	CAPACITOR-FXD 33UF +/-20% 16VDC AL	28480	0160-2951
A23C81	1902-3385	5	DIOIDE-ZNR 69.8V 2K DO-7 PDM,WM TCR+0.19%	28480	1902-3385
A23C82	1902-3385	5	DIOIDE-ZNR 69.8V 2K DO-7 PDM,WM TCR+0.19%	28480	1902-3385
A23C83	1902-3385	5	DIOIDE-ZNR 69.8V 2K DO-7 PDM,WM TCR+0.19%	28480	1902-3385
A23C84	1902-3385	5	DIOIDE-ZNR 69.8V 2K DO-7 PDM,WM TCR+0.19%	28480	1902-3385
A23C85	1901-0025	2	DIOIDE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A23C86	1901-0025	2	DIOIDE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A23C87	1901-0025	2	DIOIDE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A23C88	1901-0033	2	DIOIDE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A23C89	1901-0033	2	DIOIDE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A23C90	1901-0033	2	DIOIDE-GEN PRP 180V 200MA DO-7	28480	1901-0033

Table 6-3. Replaceable Parts (Cont'd).

Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A23C11	1901-0033	2	DIODE-GEN PRP 180V 200MA D0-7	28480	1901-0033
A23C12	1901-0025	2	DIODE-GEN PRP 100V 200MA D0-7	28480	1901-0025
A23C13	1901-0025	2	DIODE-GEN PRP 100V 200MA D0-7	28480	1901-0025
A23C14	1901-0025	2	DIODE-GEN PRP 100V 200MA D0-7	28480	1901-0025
A23C15	1902-3122	8	DIODE-ZNR 6.55V 2X D0-7 PWR 4W TCR+ .038X	28480	1902-3122
A23J1	1200-0607	8	SOCKET-IC 16-CONT DIP DIP-SLDR	28480	
A23J2	1200-0607	8	SOCKET-IC 16-CONT DIP DIP-SLDR	28480	
A23J3	1200-0654	1	SOCKET-IC 40-CONT	28480	
A23J4	1200-0541	1	SOCKET-IC 24-CONT DIP DIP-SLDR	28480	
A23L1	9140-0137	1	COIL-MLD 1MH 5X 0660 .19DX .44LG-NOM	28480	9140-0137
A23L2	9140-0137	1	COIL-MLD 1MH 5X 0660 .19DX .44LG-NOM	28480	9140-0137
A23L3	9140-0137	1	COIL-MLD 1MH 5X 0660 .19DX .44LG-NOM	28480	9140-0137
A23L4	9140-0137	1	COIL-MLD 1MH 5X 0660 .19DX .44LG-NOM	28480	9140-0137
A23L5	9140-0137	1	COIL-MLD 1MH 5X 0660 .19DX .44LG-NOM	28480	9140-0137
A23L6	9140-0137	1	COIL-MLD 1MH 5X 0660 .19DX .44LG-NOM	28480	9140-0137
A23L7	9100-0168	1	COIL-MLD 5.6UH 10X 0645 .155DX .375LG-NOM	28480	9100-0168
A23L8	9100-0168	1	COIL-MLD 5.6UH 10X 0645 .155DX .375LG-NOM	28480	9100-0168
A23L9	9100-0139	5	COIL 75UH 15X .05DX .875LG-NOM	28480	9100-0139
A23O1	1853-0414	0	TRANSISTOR PNP 2N6423 3I 10-66 PD35M	04713	2N6423
A23O2	1854-0324	3	TRANSISTOR NPN 2N3739 3I 10-66 PD20M	04713	2N3739
A23O3	1854-0474	3	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O4	1853-0060	6	TRANSISTOR PNP 8I PD330MM FT30MHZ	04713	2N4920
A23O5	1853-0060	6	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O6	1854-0347	6	TRANSISTOR NPN 2N4923 3I PD30M FT3MHZ	04713	2N4923
A23O7	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O8	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O9	1854-0071	3	TRANSISTOR NPN 8I 10-39 PD1M FT130MHZ	28480	1854-0071
A23O10	1854-0071	3	TRANSISTOR NPN 8I 10-39 PD1M FT130MHZ	28480	1854-0071
A23O11	1853-0060	6	TRANSISTOR PNP 8I PD330MM FT30MHZ	04713	2N4920
A23O12	1854-0347	6	TRANSISTOR NPN 2N4923 3I PD30M FT3MHZ	04713	2N4923
A23O13	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O14	1853-0060	6	TRANSISTOR PNP 8I PD330MM FT30MHZ	04713	2N4920
A23O15	1853-0060	6	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O16	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O17	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O18	1853-0060	6	TRANSISTOR PNP 8I PD330MM FT30MHZ	04713	2N4920
A23O19	1853-0060	6	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O20	1853-0060	6	TRANSISTOR PNP 8I PD330MM FT30MHZ	04713	2N4920
A23O21	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O22	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O23	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O24	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O25	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O26	1853-0060	6	TRANSISTOR PNP 8I PD330MM FT30MHZ	04713	2N4920
A23O27	1853-0060	6	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O28	1853-0060	6	TRANSISTOR PNP 8I PD330MM FT30MHZ	04713	2N4920
A23O29	1853-0060	6	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O30	1853-0060	6	TRANSISTOR PNP 8I PD330MM FT30MHZ	04713	2N4920
A23O31	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O32	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O33	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O34	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O35	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O36	1855-0111	8	TRANSISTOR J-FET N-CHAN 5I	28480	1855-0111
A23O37	1853-0204	6	TRANSISTOR PNP 2N4920 3I PD30M FT3MHZ	04713	2N4920
A23O38	1853-0037	6	TRANSISTOR PNP 8I 10-39 PD1M FT130MHZ	28480	1853-0037
A23O39	1853-0037	6	TRANSISTOR PNP 8I 10-39 PD1M FT130MHZ	28480	1853-0037
A23O40	1854-0071	3	TRANSISTOR NPN 8I 10-39 PD1M FT130MHZ	28480	1854-0071
A23O41	1854-0071	3	TRANSISTOR NPN 8I 10-39 PD1M FT130MHZ	28480	1854-0071
A23O42	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O43	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O44	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O45	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O46	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O47	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O48	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O49	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O50	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O51	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O52	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O53	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O54	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O55	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O56	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O57	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O58	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O59	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O60	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O61	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O62	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O63	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O64	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O65	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O66	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O67	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O68	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O69	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O70	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O71	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O72	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O73	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O74	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O75	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O76	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O77	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O78	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O79	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O80	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O81	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O82	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O83	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O84	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O85	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O86	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O87	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O88	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O89	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O90	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O91	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O92	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O93	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O94	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O95	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O96	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O97	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O98	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O99	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23O100	1854-0474	4	TRANSISTOR NPN 8I PD310MM FT100MHZ	04713	2N5551
A23R1	0683-5625	3	RESISTOR 5.6K 5X .25W FC TCR=400/+700	01121	CB5625
A23R2	0683-3335	6	RESISTOR 3.3K 5X .25W FC TCR=400/+700	01121	CB3335
A23R3	0683-3335	6	RESISTOR 3.3K 5X .25W FC TCR=400/+700	01121	CB3335
A23R4	0683-1335	9	RESISTOR 1.6K 5X .25W FC TCR=400/+800	01121	CB1335
A23R5	0683-1335	9	RESISTOR 1.6K 5X .25W FC TCR=400/+800	01121	CB1335
A23R6	0698-3450	9	RESISTOR 42.2K 1X .125W F TCR0+/-100	24546	CA1/B-10-4222-F
A23R7	0698-4486	3	RESISTOR 22K 5X .25W FC TCR=400/+800	24546	CA1/B-10-2492-F
A23R8	0683-4735	4	RESISTOR 47K 5X .25W FC TCR=400/+800	01121	CB4735
A23R9	0683-1225	3	RESISTOR 1.2K 5X .25W FC TCR=400/+700	01121	CB1225
A23R10	0683-1225	3	RESISTOR 1.2K 5X .25W FC TCR=400/+700	01121	CB1225
A23R11	0683-1525	4	RESISTOR 1.5K 5X .25W FC TCR=400/+700	01121	CB1525
A23R12	0683-1525	4	RESISTOR 1.5K 5X .25W FC TCR=400/+700	01121	CB1525
A23R13	0683-4735	4	RESISTOR 47K 5X .25W FC TCR=400/+800	01121	CB4735
A23R14	0683-1335	9	RESISTOR 1.6K 5X .25W FC TCR=400/+800	01121	CB1335
A23R15	0683-1335	9	RESISTOR 1.6K 5X .25W FC TCR=400/+800	01121	CB1335
A23R16	0698-3450	9	RESISTOR 42.2K 1X .125W F TCR0+/-100	24546	CA1/B-10-4222-F
A23R17	0698-4486	3	RESISTOR 22K 5X .25W FC TCR=400/+800	24546	CA1/B-10-2492-F
A23R18	0683-4735	4	RESISTOR 47K 5X .25W FC TCR=400/+800	01121	CB4735

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

Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
41	04274-61601	9	CABLE ASSEMBLY, INPUT(LC) (3) CM	28480	04274-61601
42	04274-61602	1	CABLE ASSEMBLY, INPUT(LP) (3) CM	28480	04274-61602
43	04274-61603	1	CABLE ASSEMBLY, INPUT(LC) (4) CM	28480	04274-61603
44	04274-61604	2	CABLE ASSEMBLY, INPUT (HP) (3) CM	28480	04274-61604
45	04274-61605	3	CABLE ASSEMBLY, INPUT(A) THRU (A3)(3) CM	28480	04274-61605
46	04274-61606	4	CABLE ASSEMBLY, INPUT(A) THRU (A4)(4) CM	28480	04274-61606
47	04274-61607	5	CABLE ASSEMBLY, INPUT(A) THRU (A4)(4) CM	28480	04274-61607
X41	2110-0565	9	FUSEHOLDER CAP 12A MAX FOR UL	28480	2110-0565
X41	2110-0565	9	FUSEHOLDER CAP 12A MAX FOR UL	28480	2110-0565
1	5040-7219	2	FRONT CAP	28480	5040-7219
2	5040-9805	4	HANDLE	28480	5040-9805
3	5040-9843	1	SIDE COVER	28480	5040-9843
4	5040-7220	1	REAR CAP	28480	5040-7220
5	5040-0172	1	SCREEN-MACH 10-32, 375-IN-LG 100 DEG	28480	5040-0172
6	3101-2216	3	SWITCH-PB OPDT ALING 44 250VAC	28480	3101-2216
7	0570-0368	2	SCREEN	28480	0570-0368
8	2190-0225	2	WASHER	28480	2190-0225
9	1200-0080	3	INSULATOR-DIO ALUMINUM HD-ANODZ	28480	1200-0080
10	3050-0226	2	WASHER-FL MILC NO. 10 203-IN-ID	28480	3050-0226
11	2740-0003	5	NUT-HEX-W/LKRN 10-32-THD, 125-IN-LK	00000	ORDER BY DESCRIPTION
12	1901-0046	1	DIODE-PWR RECT 100V 12A 00-4	04713	MR121
13	9100-0870	5	TRANSFORMER	28480	9100-0870
14	1250-0018	2	CONTACT-RF CONNECTOR SER M FEMALE+.093	28480	1250-0018
15	5040-0345	7	INSULATORCONNECTOR	28480	5040-0345
16	0624-0260	8	SCREEN-TPG 6-20, 5-IN-LG PAN-HD-PHL STL	00000	ORDER BY DESCRIPTION
17	2190-0020	8	WASHER-LK HLCL NO. 5, 128-IN-ID	28480	2190-0020
18	0740-0833	9	INSULATOR-XSTR NYLON BLACK	28480	0740-0833
19	0624-0248	2	SCREEN-TPG 8-12, 75-IN-LG HEX WSM-HD STL	28480	0624-0248
20	0370-2994	0	KNOB	28480	0370-2994
21	2510-0045	0	SCREEN-MACH 8-32, 375-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
22	0360-0270	0	TERMINAL-GLDR LUG LK-M16 FOR-#10-SCR	28480	0360-0270
23	3100-1205	6	SWITCH-ROTARY	28480	3100-1205
24	0360-1190	5	TERMINAL-GLDR LUG PL-M16 FOR-#3/8-SCR	28480	0360-1190
25	2950-0001	8	NUT-HEX-DRL-CHAM 3/8-32-THD, .094-IN-LK	00000	ORDER BY DESCRIPTION
26	5020-8806	9	REAR FRAME	28480	5020-8806
27	5060-9836	1	TOP COVER	28480	5060-9836
28	04274-00617	1	PLATE	28480	04274-00617
29	04274-00602	2	PLATE SHIELD	28480	04274-00602
30	5040-7202	9	TKIM, TOP	28480	5040-7202
31	5020-8805	8	FRONT FRAME	28480	5020-8805
32	04274-25002	2	WINDOW (FRG)	28480	04274-25002
33	0370-1097	2	KNOB	28480	0370-1097
34	04274-00203	9	FRONT PANEL (YHP)	28480	04274-00203
35	04274-25001	1	WINDOW DISP, A,B	28480	04274-25001
36	7120-1254	1	NAMEPLATE, 312-IN-WD, 54-IN-LG AL	28480	7120-1254
37	7120-0478	9	TRADE MARK (YHP)	28480	7120-0478
38	04274-50024	4	INSULATOR	28480	04274-50024
39	2950-0035	8	NUT-HEX-DRL-CHAM 15/32-32-THD	00000	ORDER BY DESCRIPTION
40	1250-0252	6	BINDING POST ASSY SGL THD-STUD	28480	1250-0252
41	1510-0038	8	CONNECTOR-RF BNC FEM SGL-HOLE-RR 50-OHM	28480	1510-0038
42	04271-50025	5	INSULATOR	28480	04271-50025
43	5041-0564	4	KEY CAP	28480	5041-0564
44	1460-1345	5	TILT STAND SST	28480	1460-1345
45	5040-7201	6	FOOT(STANDARD)	28480	5040-7201
46	5020-8838	7	STRIUT	28480	5020-8838
47	04274-40001	9	ROD (POWER SWITCH)	28480	04274-40001
48	04274-01202	0	ANGLE (POWER SWITCH)	28480	04274-01202
49	04274-40002	0	GUIDE (ANGLE)	28480	04274-40002
50	04274-00618	1	PLATE, SHIELD	28480	04274-00618
51	5060-9848	5	BOTTOM COVER	28480	5060-9848
53	04274-00205	1	SBR PANEL	28480	04274-00205
54	04274-60203	1	REAR PANEL	28480	04274-60203

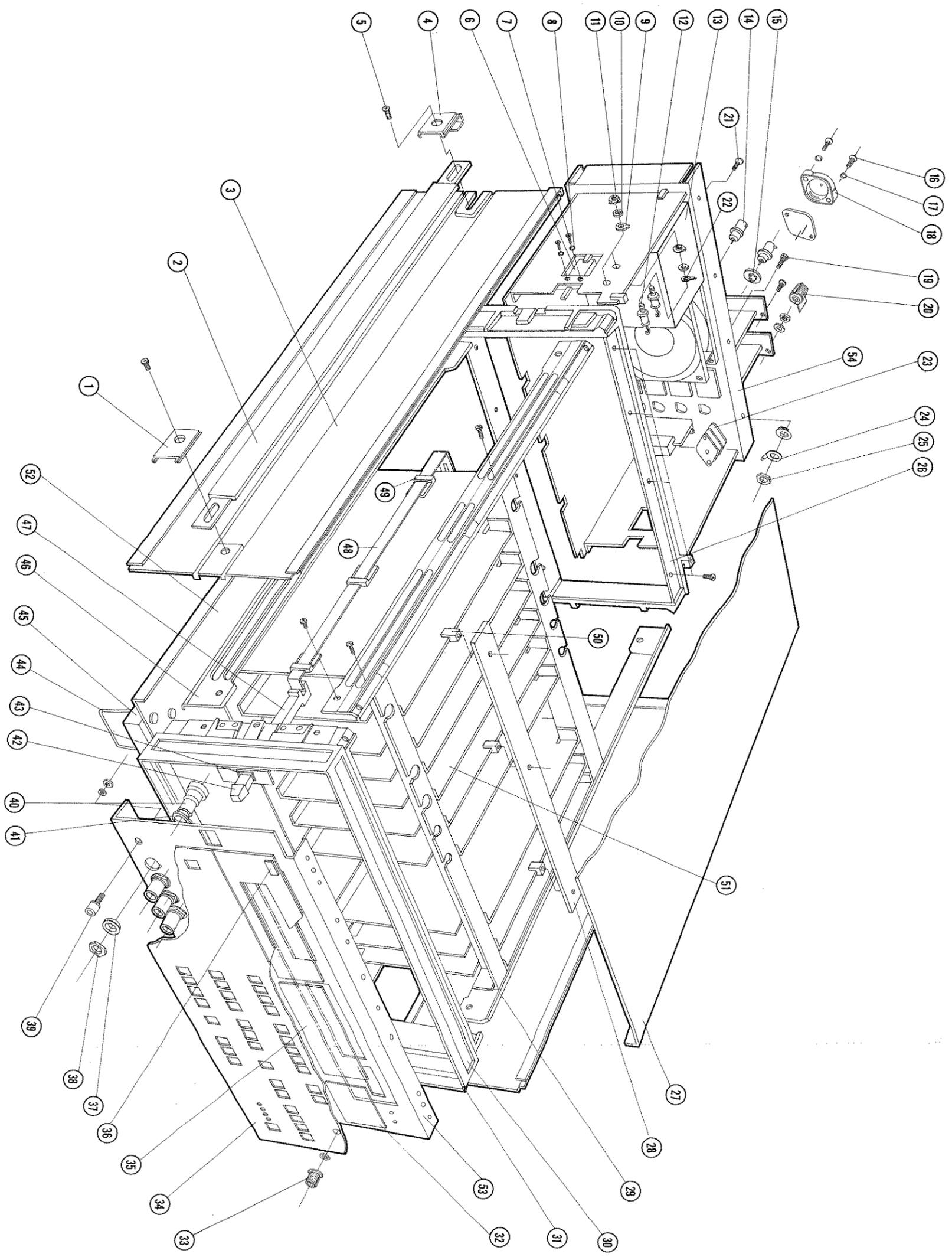


FIGURE 6-1. CABINET PARTS

SECTION VIII 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 other instruments with lower serial prefixes.

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 sequence listed. Table 7-2 gives a manual changes 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 Numbers.

Serial Prefix or Number	Make Manual Changes
1850J00160 and below	A,B,C,D,F,H,I
1850J00235 and below	B,C,D,F,H,I
1850J00385 and below	C,D,F,H,I
1850J00669 and below	D,F,H,I
2019J00670 to 2019J00740	E,F,H,I
2019J00760 and below	F,H,I
2019J00761 to 2031J00850	G,H,I
2031J01000 and below	H,I,J
2031J01115 and below	I,J
2031J00851 to 2031J01210	J,L
2031J01211 to 2147J01224	K,L
2019J00741 to 2147J01660	L

Table 7-2. Summary of Changes by Assembly (Sheet 1 of 2).

CHANGE		A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
A			C42 C43				C70 U4			U1 U5	
B											
C			CR25 CR26 CR27 CR28								
D											
E											
F										U1 to U10 U7 to W10	
G										Q3 R26 to R31 U14, U15	
H										U10	
I			C43								
J										CR3 R26 to R31	
K										CR3 R26 to R31	
L											

CHANGE										A11	A12	A15	A16	A21	A22	A23				
Assembly																				
A																				
B																				
C																				
D										C18,F8 F9,R23 R24										
E										XA1L to XA9R, XA11L, XA11R XA21L to XA21R										
F																				
G																				
H																				
I																				
J																				
K																				
L										F8 F9 R23 R24										

Table 7-2. Summary of Changes by Assembly (Sheet 2 of 2).

CHANGE A

Page 6-12, Table 6-3. Replaceable Parts: Delete A4C42 and A4C43.

Page 6-12, Figures 8-35. A4 Process Amplifier Assembly Component Locations and Figure 8-36. A4 Process Amplifier Assembly Schematic Diagram: Delete A4C42 and A4C43 from both figures.

CHANGE B

Page 6-17, Table 6-3. Replaceable Parts: Delete the following part:

A6C70 0160-2266 CAPACITOR-FXD 24pF

Page 6-19, Table 6-3. Replaceable Parts: Change the part number and description for A6U4 to read:

A6U4 1826-0319 OP AMP BIFET T0-99

Page 6-22, Table 6-3. Replaceable Parts, A9U1 and U5: Change the part number for A9U1 and U5 to read:

A9U1 04274-85021
A9U5 04274-85015

NOTE

These instruments below were installed with 04274-85031 and 04274-85025.

1850J-00208

00211

00213

00215

00216

00217

00218

00219

00221

00222

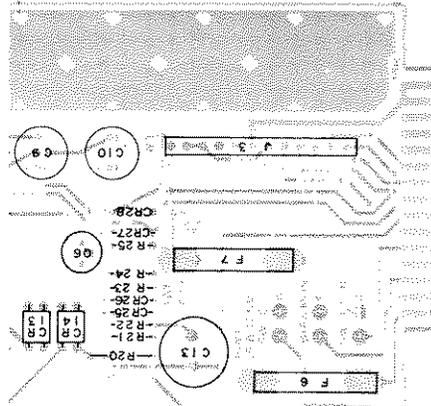
00231

04274-85021 (old U1) cannot be used with 04274-85025 (new U5). Also, 04274-85015 (old U5) cannot be utilized with 04274-85031 (new U1).

CHANGE C

Page 6-7, Table 6-3. Replaceable Parts: Delete the following parts:

A2CR25 to 28 1901-0040 DIODE-SWITCHING



Partially change the figure as follows:

Page 8-71, Figure 8-51. A11 Power Supply Assembly Component Locations: Delete C18.

A11R23 0683-0475 RESISTOR 4.7 5% .25W FC TC = -400/+500
A11R24

Add the following parts:

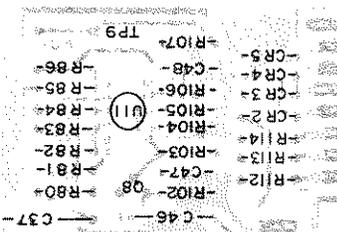
Delete A11 F8 and F9.

Delete A11C18.

Pages 6-26 and 6-27, Table 6-3. Replaceable Parts:

CHANGE D

Figure 8-29. A2 Component Locations.



Partially change the diagram as follows:

Page 8-53, Figure 8-29. A3 Component Locations:

The A11 board with P/N 04274-66511 and that with P/N 04274-66551 use different 15 pin connectors. The same is also true for A12 boards: 04274-66512 and 04274-66552.

NOTE

XA1L to 9R 1251-1887
XA11L and 11R 1251-4189
XA21L to 22R 1251-1887

Change the part number for A12XA1L to 22R to read:

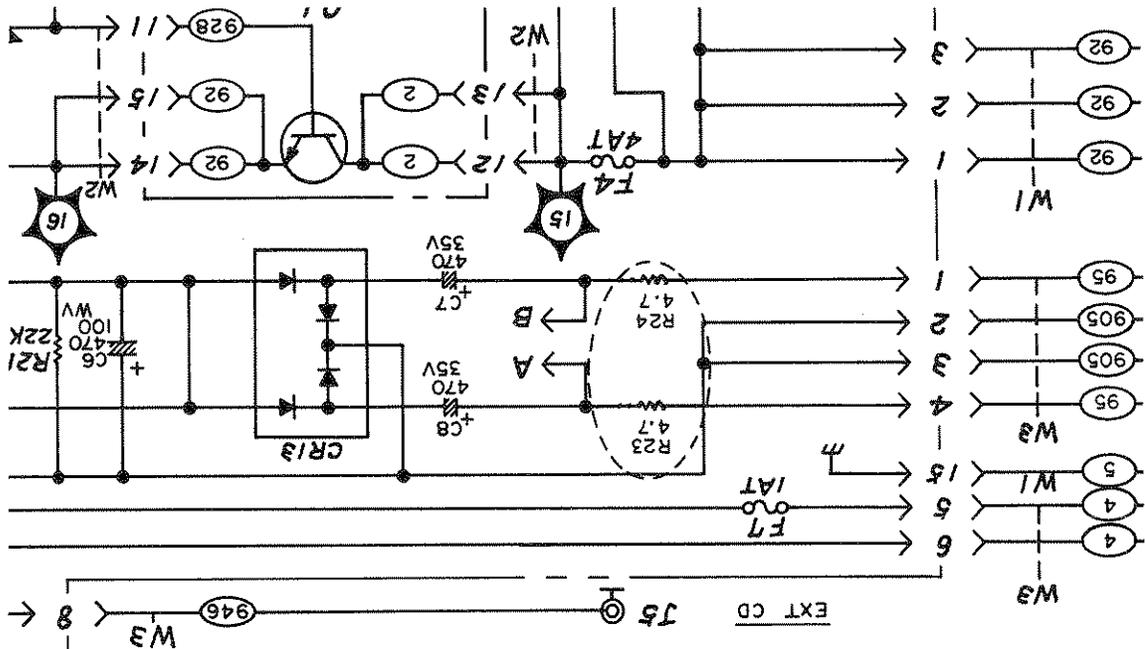
04274-66512

Page 6-27, Table 6-3. Replaceable Parts: Change the part number for A12 Mother Board Ass'y to read:

04274-66511

Page 6-25, Table 6-3. Replaceable Parts, A11: Change the part number for A11 Power Supply Board Ass'y to read:

CHANGE E



Partially change the figure as follows:

Page 8-71, Figure 8-52. A11 Power Supply Assembly Schematic Diagram: Delete C18.

Page 8-39, Signature Connections for DSA1 and DSA-12 through DSA-17:
Change the table as follows:

Signature Connections for DSA-1 and DSA-12 thru DSA-21.

DSA NO	START	STOP	CLOCK	A9 DSA-SM
DSA-1	A9T1-13	A9T1-13	A9T1-13	A9T1-7
RAM				
DATA BUS				

Signature Connections Window (+5V) : APC4

DSA NO	START	STOP	CLOCK	A9 DSA-SM
DSA-12	A9U27-11	A9U16-5	A9T1-6	A9T1-6
NOP				
(U7~U8)				

Signature Connections Window (+5V) : 755U

DSA NO	START	STOP	CLOCK	A9 DSA-SM
DSA-13	A9U22-9	A9U10-20	A9T1-6	A9T1-6
NOP				
(U10)				

Signature Connections Window (+5V) : 826P

DSA NO	START	STOP	CLOCK	A9 DSA-SM
DSA-14	A9U16-9	A9U16-7	A9T1-6	A9T1-6
NOP				
(U1,2)				

Signature Connections Window (+5V) : P254

DSA NO	START	STOP	CLOCK	A9 DSA-SM
DSA-15	A9U16-11	A9U16-10	A9T1-6	A9T1-6
NOP				
(U3,4)				

Signature Connections Window (+5V) : P254

DSA NO	START	STOP	CLOCK	A9 DSA-SM
DSA-16	A9U16-13	A9U16-12	A9T1-6	A9T1-6
NOP				
(U5,6)				

Signature Connections Window (+5V) : P254

DSA NO	START	STOP	CLOCK	A9 DSA-SM
DSA-17	A9U16-15	A9U16-14	A9T1-6	A9T1-6
NOP				
(U7,8)				

Signature Connections Window (+5V) : P254

DSA NO	START	STOP	CLOCK	A9 DSA-SM
DSA-18	A9U16-9	A9U16-7	A9T1-6	A9T1-6
NOP				
(U1)				

Signature Connections Window (+5V) : 826P

DSA NO	START	STOP	CLOCK	A9 DSA-SM
DSA-19	A9U16-11	A9U16-10	A9T1-6	A9T1-6
NOP				
(U3)				

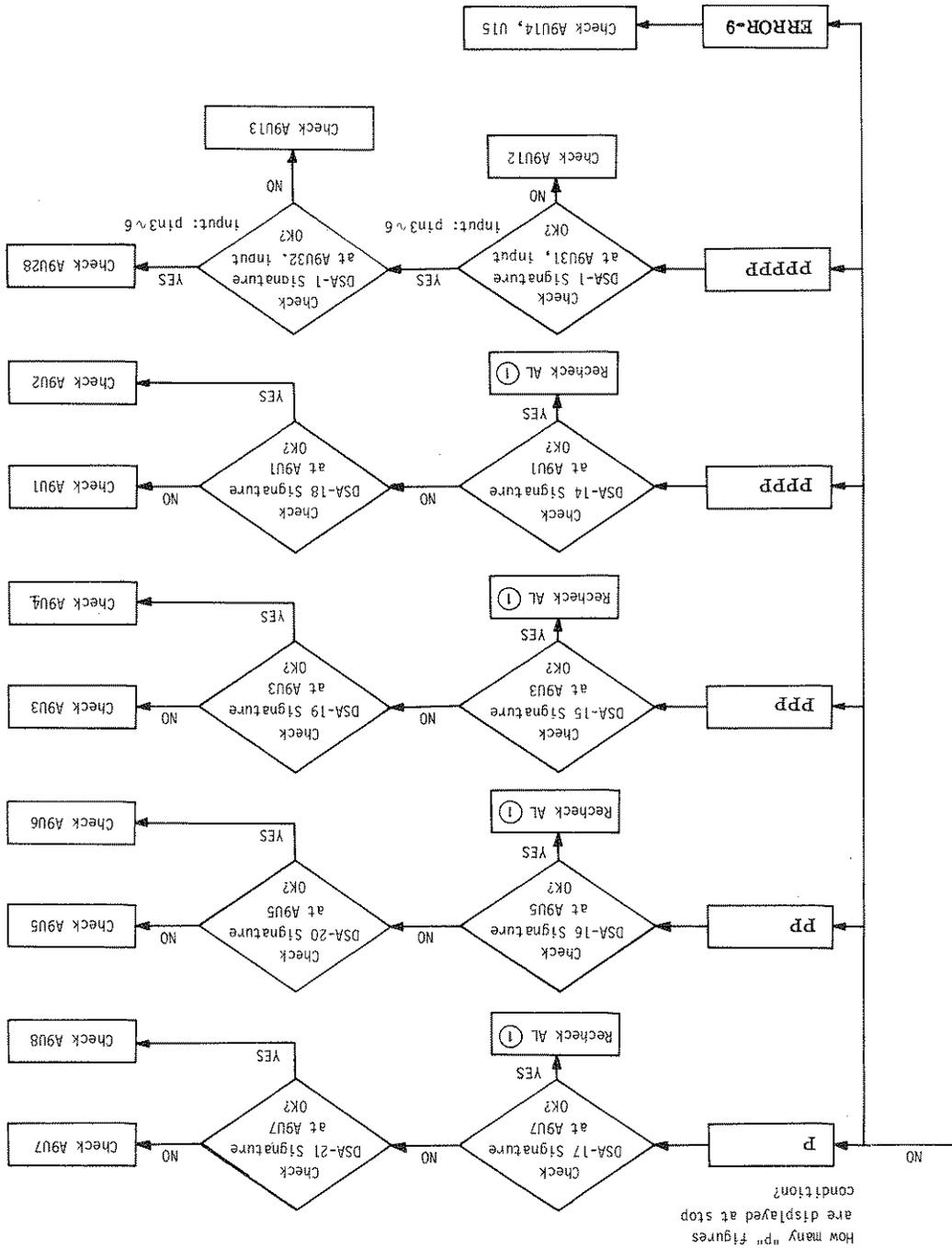
Signature Connections Window (+5V) : 826P

DSA NO	START	STOP	CLOCK	A9 DSA-SM
DSA-20	A9U16-13	A9U16-12	A9T1-6	A9T1-6
NOP				
(U5)				

Signature Connections Window (+5V) : 826P

DSA NO	START	STOP	CLOCK	A9 DSA-SM
DSA-21	A9U16-15	A9U16-14	A9T1-6	A9T1-6
NOP				
(U7)				

Signature Connections Window (+5V) : 826P



Page 8-39, Figure 8-19, Digital Section Troubleshooting Flow Diagram BL. Partially change the flow diagram as follows:

How many "p" figures are displayed at stop condition?

Figure 8-33. Digital Section Troubleshooting Flow Diagram BL.

Page 8-66, Signature Connections tables:
 Change the tables for DSA-12, DSA-14, DSA-15, DSA-16 and DSA-17 as follows:

Signature Connections Window (+5V) : 755U

DSA NO	START	STOP	CLOCK	A9 DSA-SW
DSA-12	A9U27-11	A9U16-5	A9Tp-6	A9 DSA-SW
NOP				
(U1~U8)				

Signature Connections Window (+5V) : 254P

DSA NO	START	STOP	CLOCK	A9 DSA-SW
DSA-14	A9U16-9	A9U16-7	A9Tp-6	A9 DSA-SW
NOP				
(U1,2)				

Signature Connections Window (+5V) : 254P

DSA NO	START	STOP	CLOCK	A9 DSA-SW
DSA-15	A9U16-11	A9U16-10	A9Tp-6	A9 DSA-SW
NOP				
(U3,4)				

Signature Connections Window (+5V) : 254P

DSA NO	START	STOP	CLOCK	A9 DSA-SW
DSA-16	A9U16-13	A9U16-12	A9Tp-6	A9 DSA-SW
NOP				
(U5,6)				

Signature Connections Window (+5V) : 254P

DSA NO	START	STOP	CLOCK	A9 DSA-SW
DSA-17	A9U16-15	A9U16-14	A9Tp-6	A9 DSA-SW
NOP				
(U7,8)				

Add the following tables for DSA-18, DSA-19, DSA-20 and DSA-21:

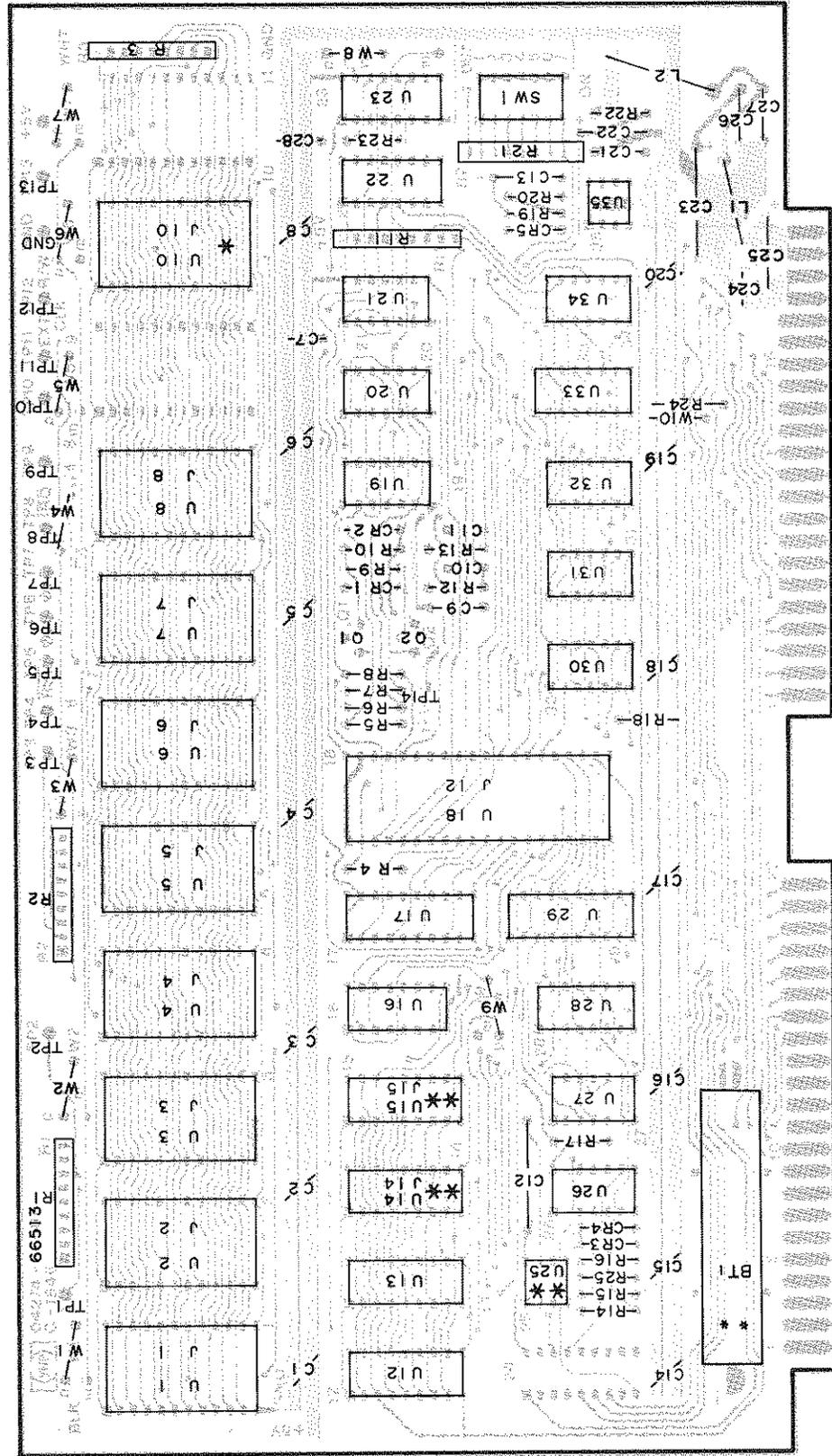
DSA NO	START	STOP	CLOCK	A9 DSA-SW	Window (+5V) : 826P
DSA-18	A9U16-9	A9U16-7	A9TP-6	A9 DSA-SW	
NOP					
(U1)					

DSA NO	START	STOP	CLOCK	A9 DSA-SW	Window (+5V) : 826P
DSA-19	A9U16-11	A9U16-10	A9TP-6	A9 DSA-SW	
NOP					
(U3)					

DSA NO	START	STOP	CLOCK	A9 DSA-SW	Window (+5V) : 826P
DSA-20	A9U16-13	A9U16-12	A9TP-6	A9 DSA-SW	
NOP					
(U5)					

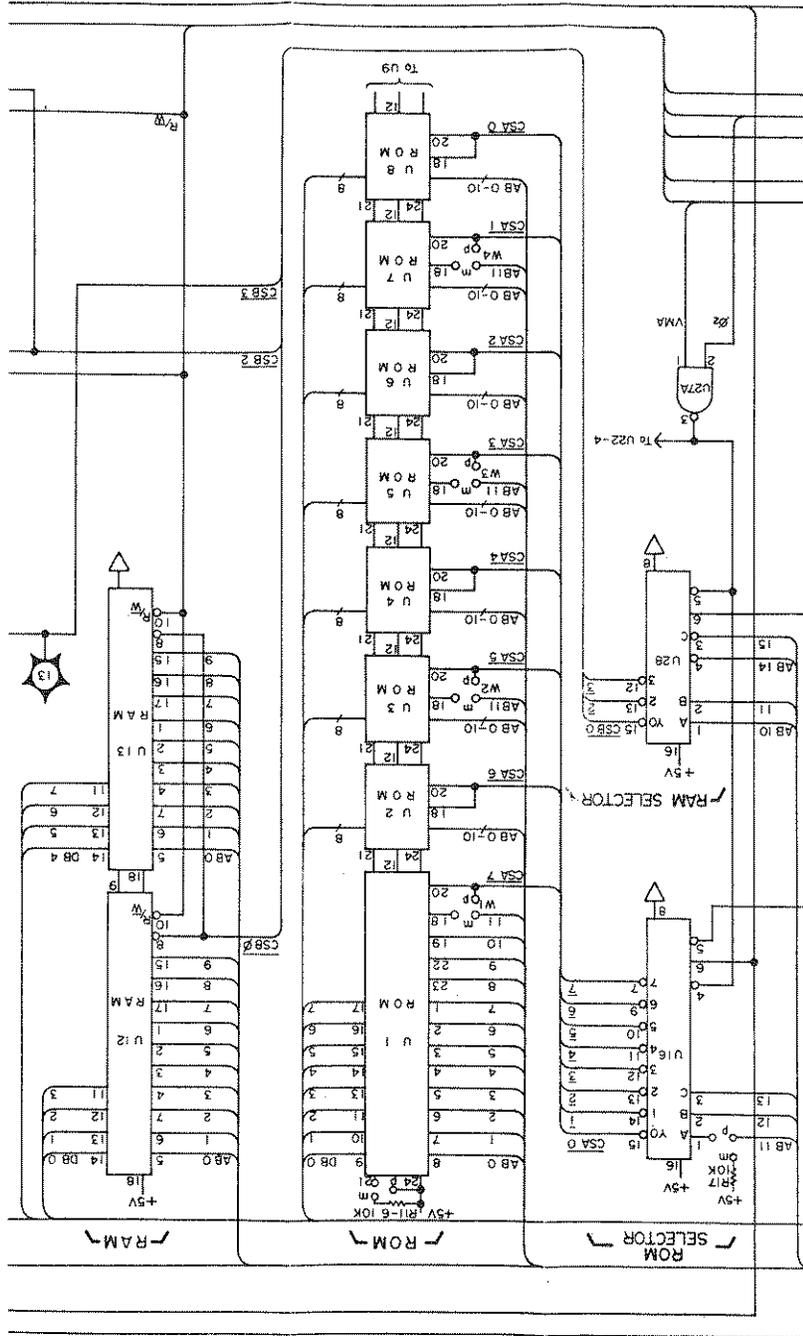
DSA NO	START	STOP	CLOCK	A9 DSA-SW	Window (+5V) : 826P
DSA-21	A9U16-15	A9U16-14	A9TP-6	A9 DSA-SW	
NOP					
(U7)					

Figure 8-47. A9 Component Locations.



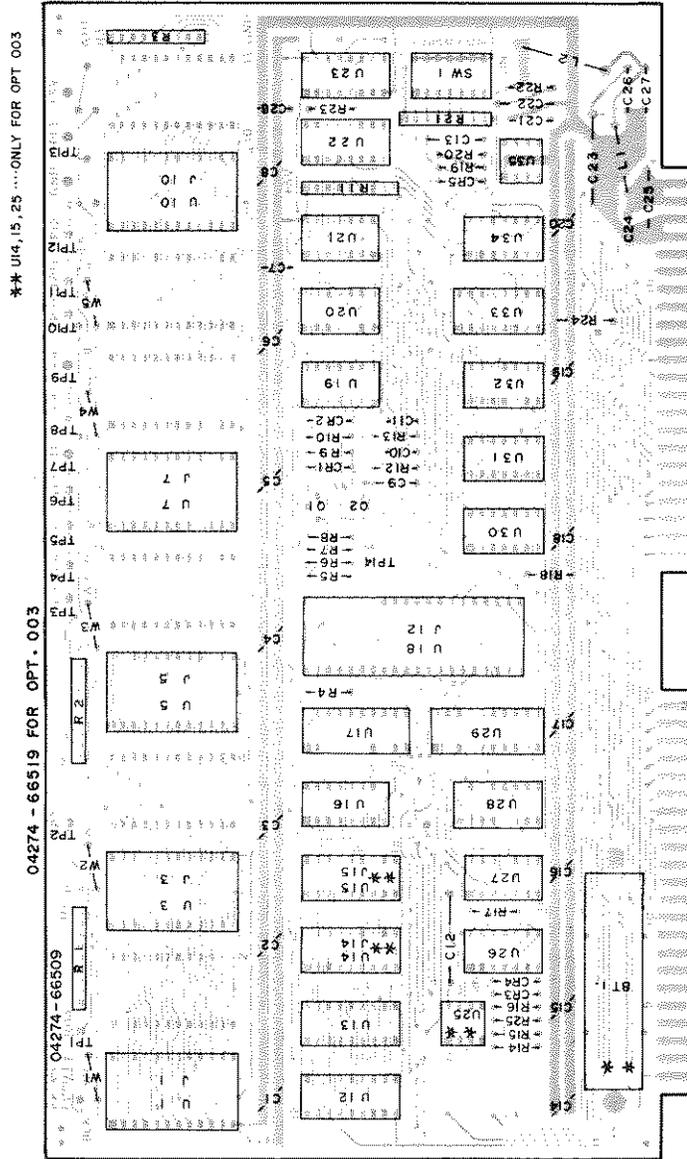
** U10... ONLY FOR OPT 101
 ** U14,15,25,BT1, ... ONLY FOR OPT 003
 *

Page 8-67, Figure 8-47. A9 Component Locations: Partially change the diagram as follows:



Page 8-67, Figure 8-48, A9 MPU Assembly Schematic Diagram: Change the diagram as follows:

Figure 8-47. A9 MPU Assembly Component Locations.



Page 8-67, Figure 8-47. A9MPU Assembly Component Locations: Change the figure as follows:

01818-0796

Change the part number for A9U14 and U15 to read:

Delete A9Q3 and A9R26 through A9R31.

04274-66509 ... MPU BOARD ASSEMBLY (STANDARD)
04274-66519 ... MPU BOARD ASSEMBLY (FOR OPT. 003 ONLY)
FOR OPT. 003 USE U14, U15, U25 and BT1

Page 6-21 and 22, Table 6-3. Replaceable Parts: Change the part number and description for A9 to read:

CHANGE 6

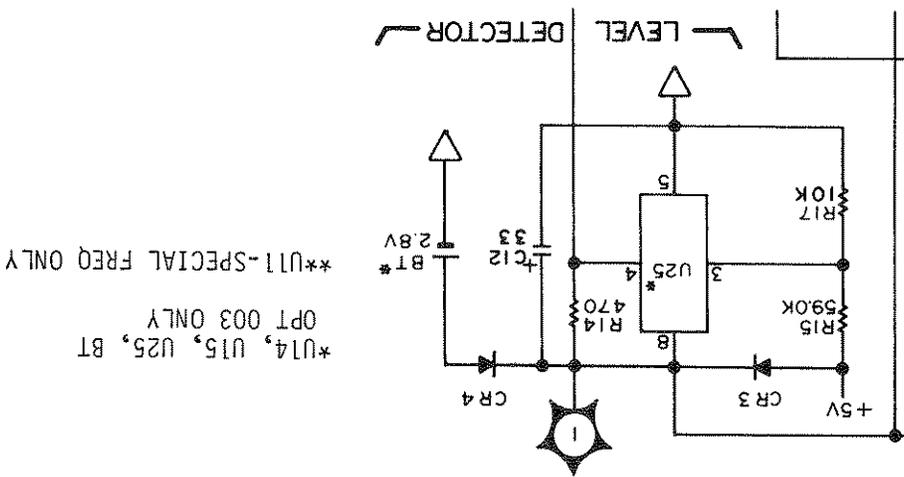
DSA-13
A9U10
826P
UUPA
HAUH
A63F
3094
565C
501H
39A1
F454

Page 8-38 and 8-66, signature table:
Change the DSA-13 to read:

1818-1139

Page 6-22, Table 6-3. Replaceable Parts:
Change the part number for A9U10 to read:

CHANGE H



Page 8-67, Figure 8-48. A9 MPU Assembly Schematic Diagram:
Change the part number shown at the upper left in the figure to
04274-66509 (04274-66519 FOR OPT. 003)
Partially change the figure as follows:

Page 8-67, Figure 8-47. A9 MPU Assembly Component Locations:
Change the figure as follows:

Change A9R31 to A9R26.

Delete A9CR3 and A9R31 to A9R26.

04274-66519 ... MPU BOARD ASSEMBLY (FOR OPT. 003 ONLY)
FOR OPT. 003 USE U14, U15, U25 and BTL

04274-66509 ... MPU BOARD ASSEMBLY (STANDARD)

Pages 6-21 and 6-22, Table 6-3. Replaceable Parts:
Change the part number and description for A9 to read:

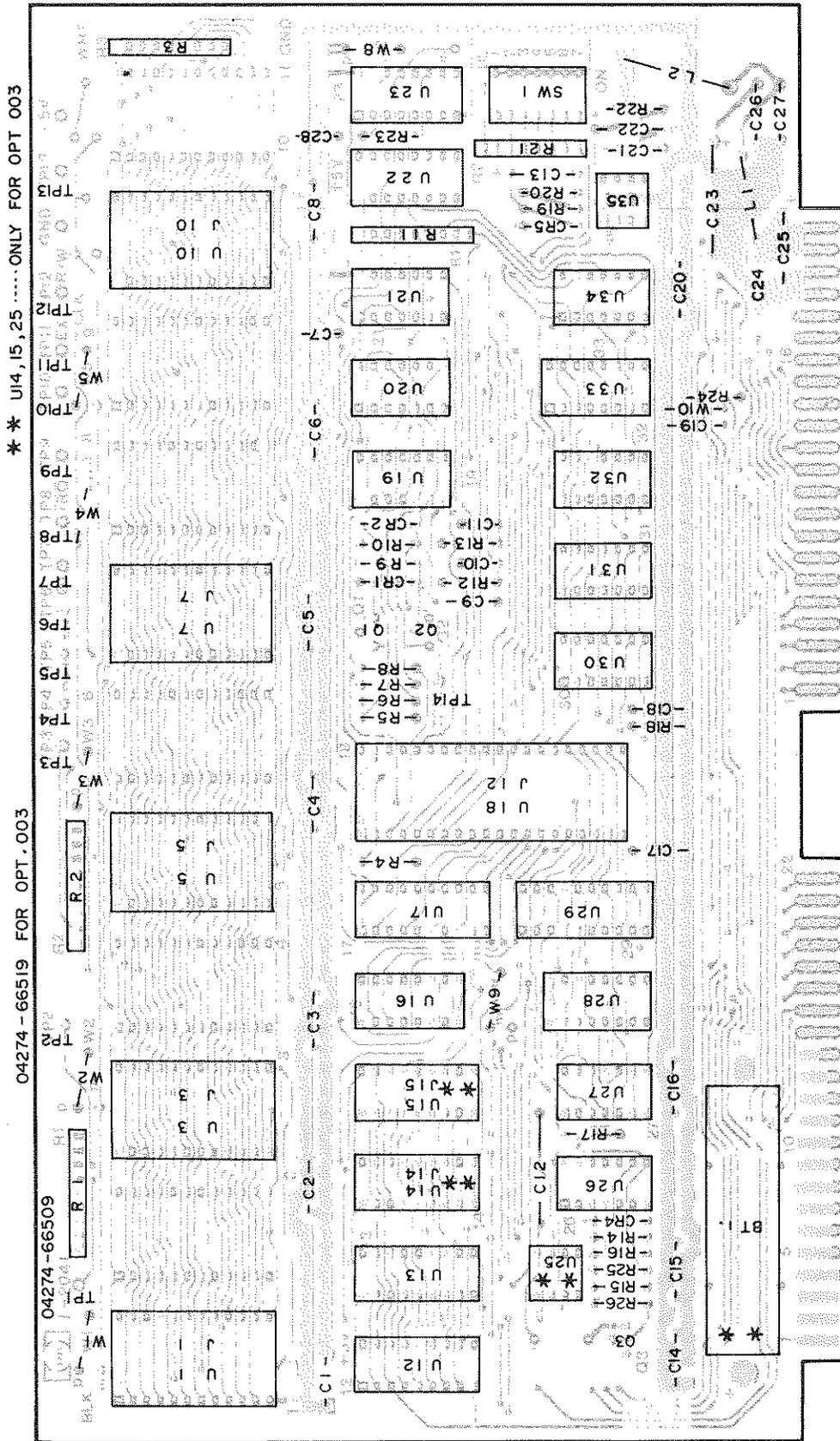
CHANGE J

Page 8-57, Figure 8-35, A4 Process Amplifier Assembly Component Locations
and Figure 8-36, A4 Process Amplifier Assembly Schematic Diagram:
Delete A4C43 from both figures.

Page 6-12, Table 6-3, Replaceable Parts:
Delete A4C43.

CHANGE I

Figure 8-67. A9 MPU Assembly Component Locations.



* * U1,4,15,25 ONLY FOR OPT 003

04274 - 66519 FOR OPT .003

04274 - 66509

Page 8-67, Figure 8-47, A9 MPU Assembly Component Locations:
Change the figure as follows:

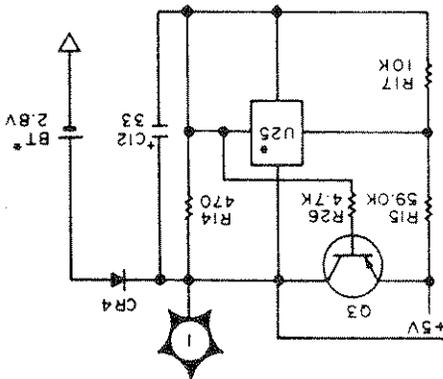
Change A9R31 to A9R26.

Delete A9CR3 and A926 through A9R30.

Pages 6-21, 6-22, Table 6-3, Replaceable Parts:
Change the part number for A9 to 04274-66519.

CHANGE K
(2031J01211 to 2147J001224)

Figure 8-48. A9 MPU Assembly Schematic Diagram.



Page 8-67, Figure 8-48. A9 MPU Assembly Schematic Diagram:
Change the part number shown at the upper left in the figure to
04274-66509 (04274-66519 FOR OPT. 003).
Partially change the figure as follows:

Figure 8-47. A9 MPU Assembly Component Locations.

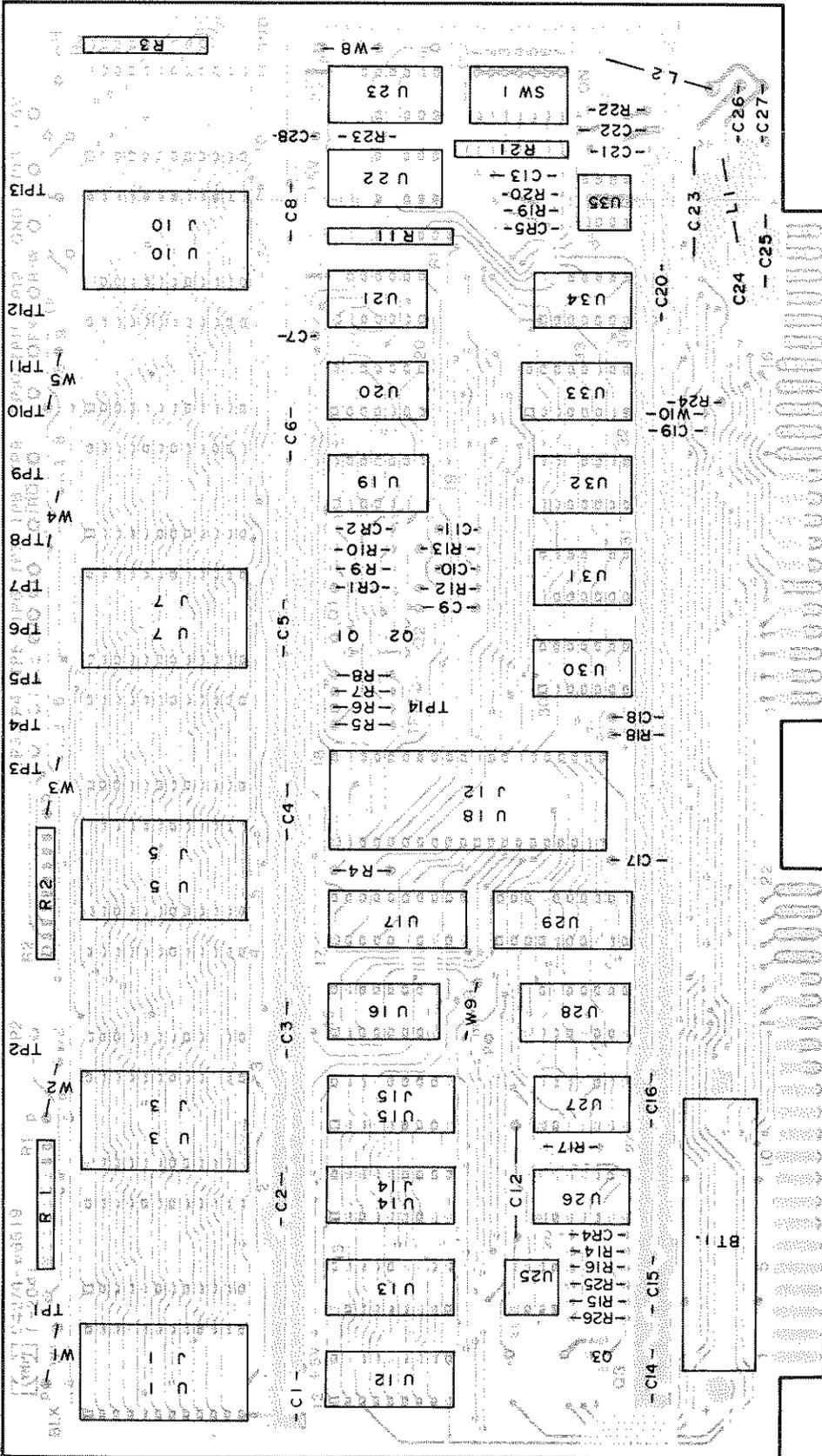
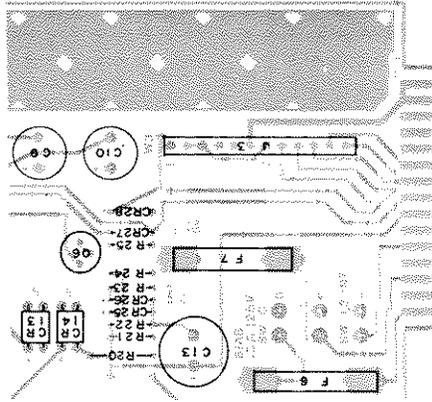


Figure 8-64. A9 MPU Assembly Schematic Diagram.



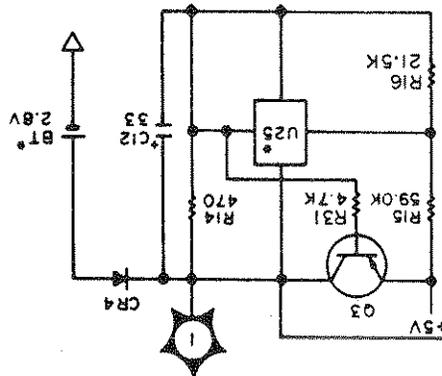
Page 8-71, Figure 8-51, A11 Power Supply Assembly Component Locations: Partially change the figure as follows:

A11R23 0683-0475 RESISTOR 4.7 5% .25W FC TC = -400/+500
A11R24

Add the following parts:

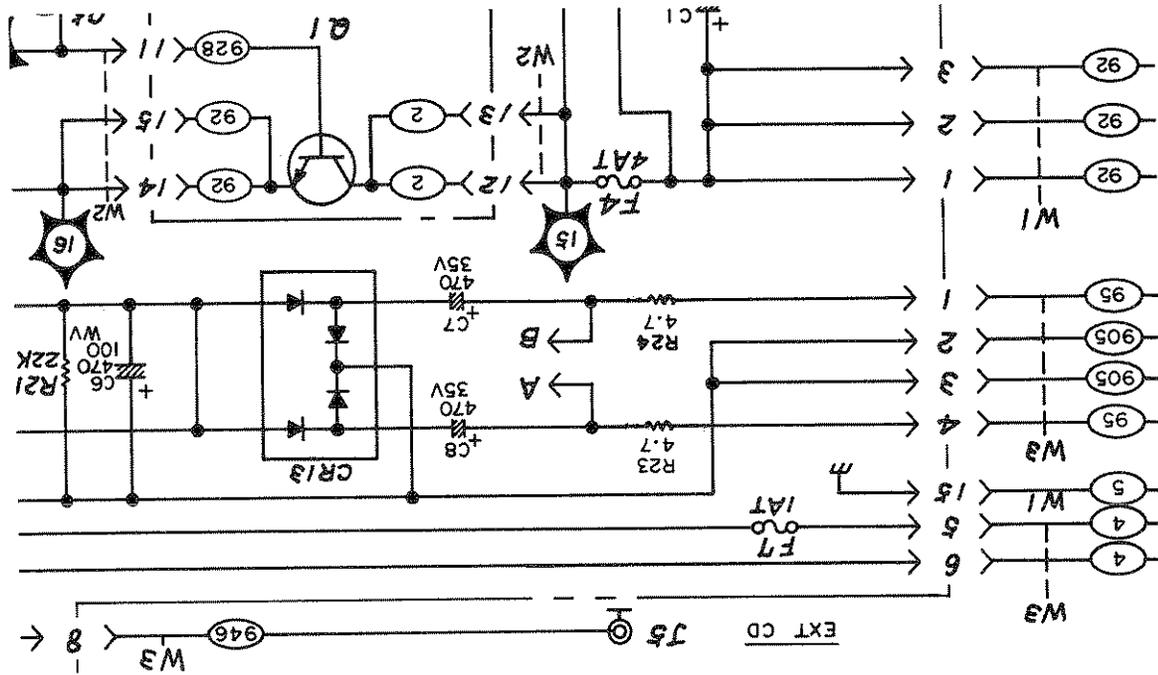
Pages 6-26 and 6-27, Table 6-3. Replaceable Parts: Delete A11F8 and F9.

CHANGE L



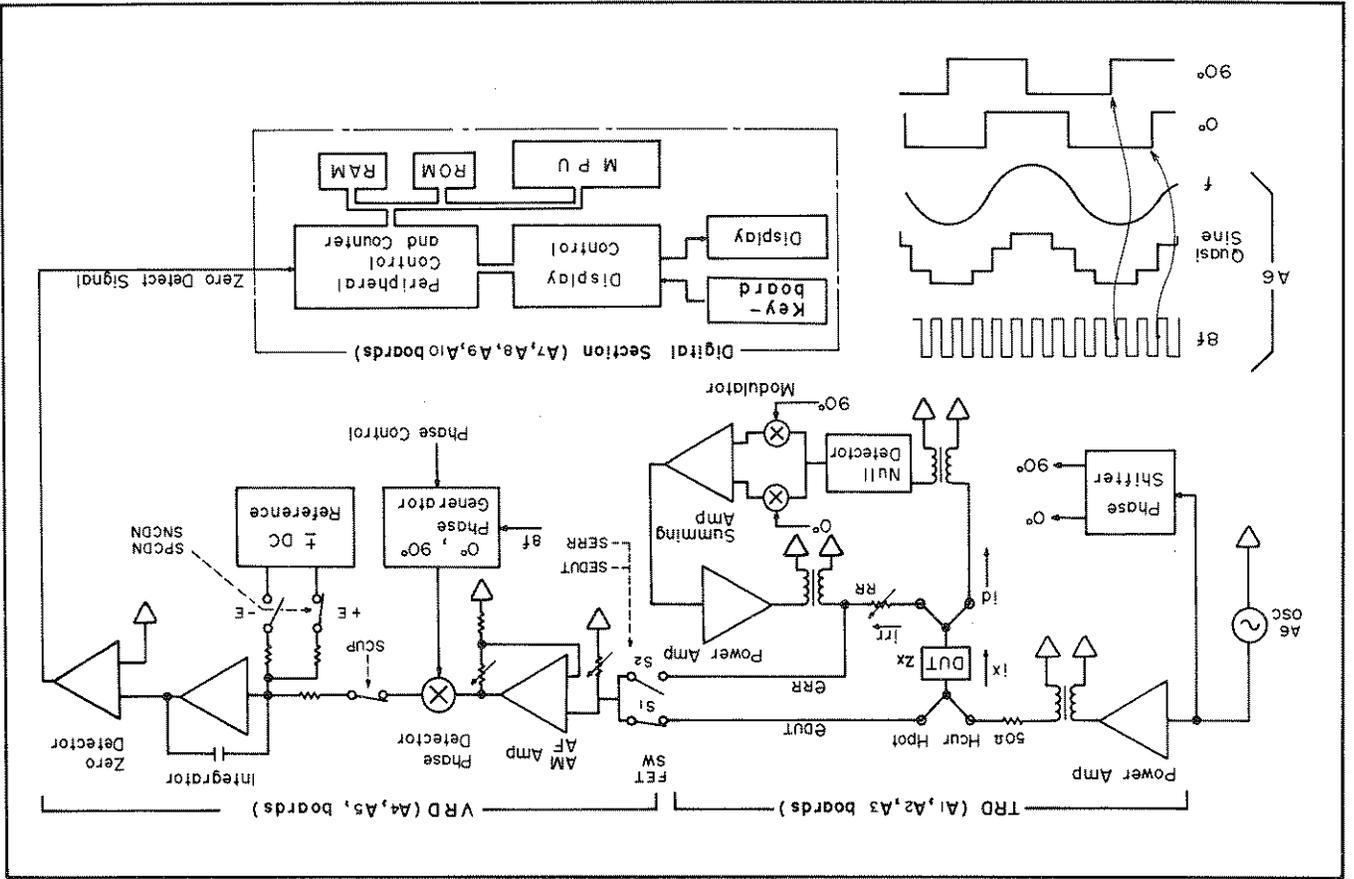
Partially change the figure as follows:

Page 8-67, Figure 8-48, A9 MPU Assembly Schematic Diagram: Change the part number shown at the upper left of the figure to 04274-66519.



Page 8-71, Figure 8-52. All Power Supply Assembly Component Locations: Partially change the figure as follows:

Figure 8-1. Basic Block Diagram.



These detected signals are applied to the integrator and converted to digital signals for displaying on a counter employing the popular dual slope technique used in Digital Voltmeters.

The control section has a microprocessor as its CPU (central processor unit) and the various software needed for controlling the digital and analog circuits are memorized in a ROM (Read Only Memory).

8-13. TRANSDUCER (TRD).
 8-14. The TRD is composed of three board assemblies A1: Range Resistor and Null Detector; A2: Modulator assembly and A3: Power amplifier assembly. Its function and purposes are to apply a consistent test signal to the DUT and to transfer its voltage drop (ϵ_{DUT}) to VRD section as well as to cause the same current (as DUT current) to flow through the internal range resistor and in like manner, to transfer the range resistor voltage drop (ϵ_{RR}) to the VRD section.

8-11. BASIC THEORY.

8-12. The HP Model 4274A is comprised of three major circuit sections: the TRD (Transducer), VRD (Vector Ratio Detector) and the microprocessor-centered control blocks as shown in Figure 8-1.

The TRD, mainly consists of the bridge circuit and forms the four terminal pair measurement configuration. A multifrequency signal from the oscillator flows through the DUT (Device Under Test) connected to the unknown terminal and the internal range resistor. When the currents flowing in both the DUT and the RR (range resistor) are mutually equal (bridge section is balanced), the ϵ_{DUT} and ϵ_{RR} factors are transferred to the VRD section.

The VRD alternately receives ϵ_{DUT} and ϵ_{RR} , amplifies (or attenuates) and detects the real (0° part) and the imaginary (90° part) components for respective ϵ_{DUT} and ϵ_{RR} by circuitry synchronously controlled from a control section.

When the bridge is balanced ($i_x = i_r$) bridge section principles are described in paragraph 8-15):

$$Z_x = \frac{e_{DUT}}{e_{RR/RR}} = RR \cdot \frac{e_{RR}}{e_{DUT}}$$

For ranges of 100Ω and higher, the admittance measurement can be represented by the following formulas:

$$e_{DUT} = i_x \cdot \frac{Y_x}{1} \quad Y_x = \frac{e_{DUT}}{i_x}$$

$$e_{RR} = i_r \cdot \frac{Y_R}{1} \quad i_r = e_{RR} \cdot Y_R$$

$$= e_{RR} \cdot \frac{1}{RR}$$

$$Y_x = \frac{e_{DUT}}{i_x} = \frac{e_{DUT}}{e_{RR} \cdot Y_R} = \frac{e_{DUT}}{e_{RR}} \cdot \frac{1}{RR}$$

These two measurement concepts cover the wide measurement range functions for capacitance, inductance, resistance and impedance.

The test signal with its level appropriately controlled by the A3 power amplifier, is applied to the DUT. For impedance range measurement techniques, the constant current (i_x) flows through the DUT and its voltage drop (e_{DUT}) depends on the impedance of the DUT. For the admittance range measurement, the constant voltage (V_x) is applied to the DUT. Thus e_{DUT} is constant and e_{RR} depends on the impedance of the DUT.

8-15. Bridge section. The term showing that the bridge section is balanced is quite simple: Here the current (i_x) flowing through the DUT is equal to the current (i_r) flowing through the range resistor.

When the bridge section is unbalanced, an unbalanced current (i_d) is generated and flows into the Lpot terminal. i_d is converted into an unbalanced voltage which is passed to a 0° phase detector for detecting DC voltage proportional to the unbalanced voltage. These DC voltages charge an integrator and their outputs, respectively, modulate the AC signal of both phase components, real (0°) and imaginary (90°). The (0° and 90°)

Power amplifier (A3) receives a 100Hz to 100kHz test signal at a constant level (programmably formed and automatically level controlled in the A6 oscillator). For the various DUT measurements at the desired test levels, the power amplifier attenuates or amplifies the test signal and presents a signal at 1mVrms to 5Vrms to the DUT. The output impedance of the power amplifier is approximately 50Ω so the test signal is always offered through a 50Ω output impedance. Since this 50Ω impedance is constant regardless of the DUT connected to the unknown terminals, a theoretically constant current flows through the DUT on DUT ranges whose impedance is less than 50Ω. On the other hand, a constant voltage is applied to DUT's on ranges whose DUT impedances are greater than 50Ω. See curves in figure 8-2.

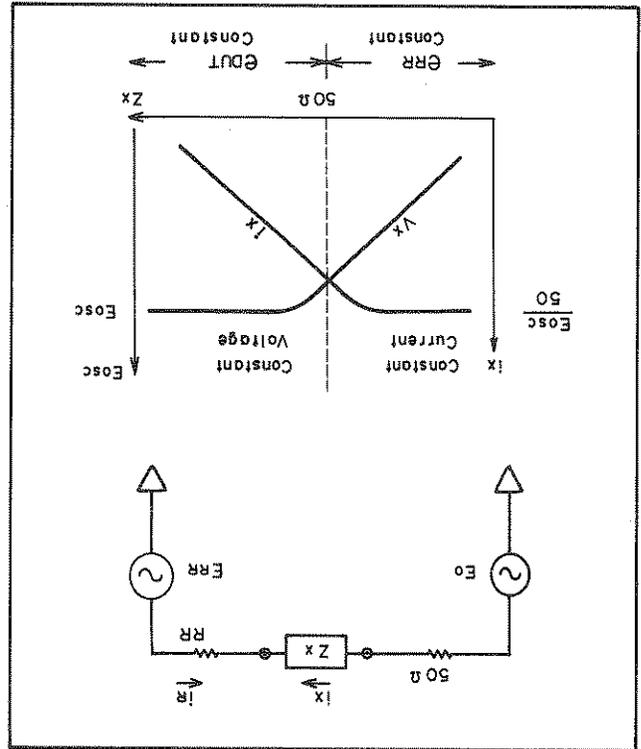


Figure 8-2. Relationship of DUT Impedance and Source Impedance.

For practical measurements, the boundary of the impedance and admittance measurement range is between the 100 and 1000 ranges. For ranges of 100Ω and less, an impedance measurement may be represented by the following formula:

$$e_{DUT} = i_x \cdot Z_x \quad Z_x = \frac{e_{DUT}}{i_x}$$

$$e_{RR} = i_r \cdot R_R \quad i_r = \frac{e_{RR}}{R_R}$$

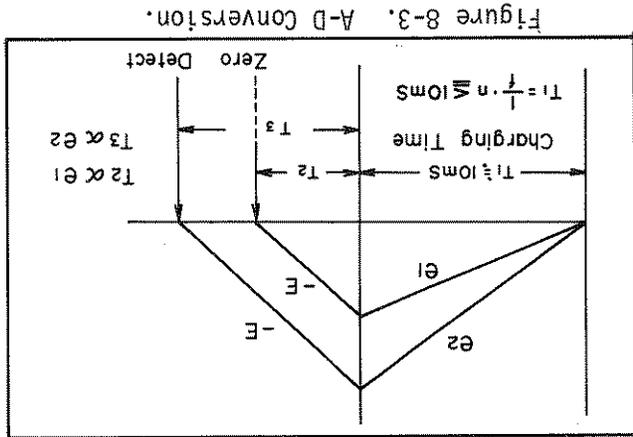


Figure 8-3. A-D Conversion.

EDUT and ER are chopped and converted to rectangular components whose magnitudes are proportional to the real (0°) and the imaginary (90°) parts of both EDUT and ER by the phase detector. Thus, four components (0° part of EDUT, 0° part of ER, 90° part of EDUT and 90° part of ER) are detected by the phase detector circuit. The individual phase components are serially integrated for about 10ms and discharged by the dual slope A-D converter (an integrator with plus/minus DC reference voltage sources) to obtain time periods which are exactly proportional to the amplitudes of each of the four components as shown in figure 8-3.

8-18. VOLTAGE RATIO DETECTOR. The VRD section receives EDUT and ER information from the TRD section. These two voltages are periodically passed to the AM/AF amplifier through the buffer amplifier and FET switches (S1 and S2) which are operated by control signals (SEDUT and SERR) sent from A5 Latch. EDUT and ER are attenuated or amplified by the AM/AF amplifier to an appropriate amplitude and fed to the phase detector. The Phase Detector is sequentially switched by square waves whose phase shifts are respectively 0° and 90° as referenced to the test signal.

1. Convert two AC voltages (EDUT and ER) detected by the TRD to real (0°) and imaginary (90°) vector components, respectively. To output four (4) components to the A-D converter in which the dual slope technique is employed and to transfer the equivalent time data information to the digital section.

2. The VRD section receives EDUT and ER information sent to the measurement section (VRD) and the instrument is ready to measure and count.

8-17. Bridge Balance Response Time. The response time for balancing the bridge is typically less than 25ms and less than 10ms at 400Hz and higher test frequencies. Response time is affected by the loop gain (k) and the phase shift (θ) in the bridge circuitry. Consequently, if the current flowing through the DUT is momentarily changed, a resultant unbalanced voltage (Ed) is generated (and it no longer equals zero volts).

As described in paragraph 8-15, the balancing procedure operates to bring Ed towards 0 volts. Ed variations can be represented by the following formula:

$$Ed \propto e^{-k(\cos \theta) t}$$

k: loop gain
θ: phase shift between modulator output (I-V converter) and phase detector

8-16. Range Resistor and Gain Selections. There is a complex relationship in the 4274A between the range resistor used and the range of the respective function (L, C, and R). In addition, the frequency range must be known to determine the range resistor to be used. These relationships are summarized in Table 8-A of Figure 8-5.

This balancing continues until the unbalance current reaches zero. While the bridge is in unbalanced condition, an UNBAL signal is continuously sent to the control section to announce that the measurement is not ready to be displayed. The bridge section is balanced by switching range resistors, selecting the appropriate measurement range, and by controlling the attenuation and gain. When the bridge is balanced EDUT and ER are alteredly sent to the measurement section (VRD) and the instrument is ready to measure and count.

8-19. The VRD (Vector Ratio Detector) is composed of two board assemblies: A4 Process amplifier and A5 A-D converter assembly. Principal functions of this section are to:

1. Convert two AC voltages (EDUT and ER) detected by the TRD to real (0°) and imaginary (90°) vector components, respectively. To output four (4) components to the A-D converter in which the dual slope technique is employed and to transfer the equivalent time data information to the digital section.

2. The VRD section receives EDUT and ER information from the TRD section. These two voltages are periodically passed to the AM/AF amplifier through the buffer amplifier and FET switches (S1 and S2) which are operated by control signals (SEDUT and SERR) sent from A5 Latch. EDUT and ER are attenuated or amplified by the AM/AF amplifier to an appropriate amplitude and fed to the phase detector. The Phase Detector is sequentially switched by square waves whose phase shifts are respectively 0° and 90° as referenced to the test signal.

When a control key is depressed, a key input detector in the display control identifies the new key data and sends it to the peripheral control board (A7) via the data bus. The PIA sends an interrupt signal to the MPU asking it to provide up-dated instructions. The MPU recognizes the new address and fetches the necessary program from the addressed ROM, sends new data to display section and new instructions to both the analog latches and the digital boards. Display control (A8) converts the measurement data signals from MPU to display component signals which are coded such that the corresponding numeric figures are displayed on the 7 segment LED displays. The measurement data is momentarily stored in a memory in this section and sent to the matrix drive of each display on display board (A10).

8-22. The peripheral control includes a peripheral interface adapter (PIA) which provides a universal means for interfacing peripheral equipment to the MPU through two 8 bit bidirectional peripheral data buses. Its function is programmed by the MPU. The PIA has four (4) control lines and no external logic is required to communicate with other peripherals. This capability is useful for interfacing with the HP-IB compatible interface (option 101) or with the DC bias control boards (options 001 or 002). The data from the MPU is translated into the various control signals which set the FET switches in the analog section for measuring the desired signal under the appropriate conditions. This board also includes the counter which counts the internal 10MHz clock pulses for the period transferred from the A-D converter (A5).

All the functions set at the front panel keyboard are decoded in the display control board. All keyboard switches are assigned individual addresses to facilitate recognizing and setting the chosen function.

8-21. The analog section of the 4274A is controlled by a microprocessor (MPU)-centered control section which governs the various sequences required to perform the desired measurement and the self diagnostic tests. Range control, selection of the measurement mode, timing and processing of the VRD section, and the complex management of the matrix for appropriate gain selections, and the numerical computation for displaying the measurement results are manipulated through the peripheral interface adapter (PIA) by the MPU which is used for control and computation purposes. These controls are done by interrupting the MPU and address to the memory which stores the necessary management instructions for both the analog and the digital sections. The 16 bit address bus allows the MPU to address up to 64k memory locations. The data bus is 8 bits wide and is bidirectional for reading and writing the desired data to and from the MPU.

8-20. CONTROL SECTION

This time data is transferred to the data counter in the digital section. Internal clock pulses are counted for these durations (which are proportional to the respective components) and a vector ratio is calculated by arithmetical manipulation in the digital section for each of the functions controlled from the front panel (display-A and display-B).

Figure 8-4. Concept of Vector Ratio Measurement (Sheet 1 of 4).

Thus, the real and imaginary components of the DUT can be calculated by the above equations once the values V_1 , V_2 , V_3 and V_4 have been determined. The real parts (V_1 , V_2) of E_1 and E_2 are first measured and then the imaginary parts (V_3 , V_4) are next measured in the VRD section. To enable constant production of the values V_1 thru V_4 , the A-D converter continuously transfers the required four (4) pieces of time data information to the digital section.

$$Y = \frac{V_1 V_2 + V_3 V_4}{V_1 V_4 - V_2 V_3} \dots \dots \dots (6)$$

$$X = \frac{V_1 V_2 + V_3 V_4}{V_1 V_4 - V_2 V_3} \dots \dots \dots (5)$$

$$X + jY = \frac{V_2 + jV_4}{V_1 + jV_3} = \frac{V_1 V_2 + V_3 V_4 + j(V_1 V_4 - V_2 V_3)}{V_1^2 + V_3^2} \dots \dots (4)$$

$$\frac{E_2}{E_1} = X + jY \dots \dots \dots (3)$$

Since the value of RR is known, the ratio of E_1 and E_2 ($\frac{E_1}{E_2}$ or $\frac{E_2}{E_1}$) can be used to calculate the unknown value of the DUT in admittance or impedance measurements. As RR is a constant value for one measurement cycle, $\frac{E_1}{E_2}$ can be represented as:

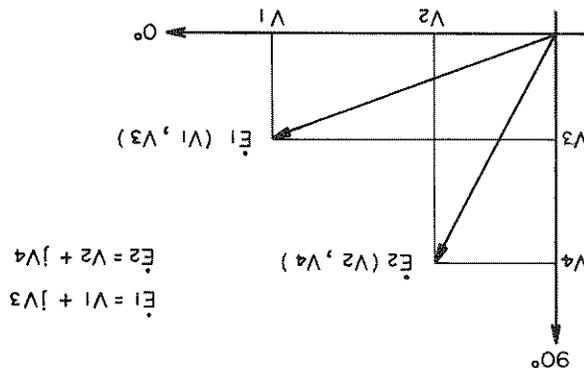
$$Z_x = \frac{E_2}{E_1} \cdot RR \quad \text{or} \quad Y_x = \frac{E_1}{E_2} \cdot RR \dots \dots \dots (2)$$

(Where RR is the Range Resistance).

The desired impedances or admittances are given by the following equations:

$$E_1 = V_1 + jV_3 \quad E_2 = V_2 + jV_4 \dots \dots \dots (1)$$

For the explanation of this technique, E_1 and E_2 are used instead of E_{DUT} and E_{RR} . E_1 is divided into V_1 (0° component) and V_3 (90° component) by the 0° and 90° gates of the phase detector. In like manner, E_2 is divided into V_2 (0° component) and V_4 (90° component). Thus E_1 and E_2 can be represented by the formulas:



Concept of Vector Voltage Ratio Measurement:

Figure 8-4. Concept of Vector Ratio Measurement (Sheet 2 of 4).

The digital section arithmetically calculates the result of the above equations by fetching and using the time data (T1 thru T4) from its memory as necessary.

$$Y = \frac{T1 \cdot T4 - T2 \cdot T3}{T1^2 + T3^2} \dots \dots \dots (9)$$

$$X = \frac{T1 \cdot T2 + T3 \cdot T4}{T1^2 + T3^2} \dots \dots \dots (8)$$

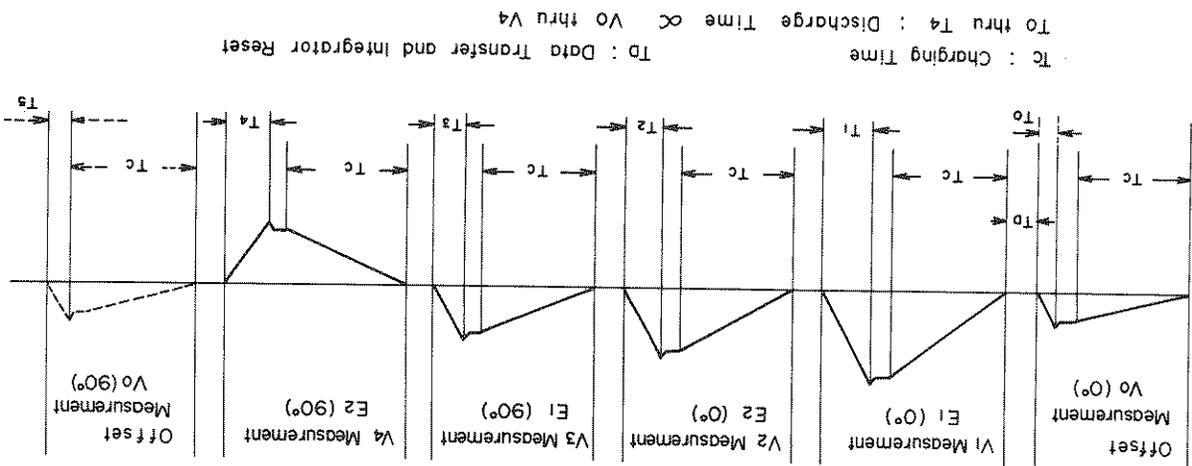
Consequently, equations (5) and (6) can be rearranged to produce:

K·T.C·E is a constant value for one measurement cycle.

Note: K = (Amplifier gain) x (Efficiency of phase detector) x (Integration Constant).

$$\left. \begin{aligned} V1 &= K \cdot T.C \cdot E \cdot T1 \\ V2 &= K \cdot T.C \cdot E \cdot T2 \\ V3 &= K \cdot T.C \cdot E \cdot T3 \\ V4 &= K \cdot T.C \cdot E \cdot T4 \end{aligned} \right\} \dots \dots \dots (7)$$

The digital section accepts the time data and stores it in its memory. It now resets the control logic for the next conversion cycle (V2 conversion to T2). Again, and in like manner, four components (V1 thru V4) are translated into time data (T1 thru T4) and serially transferred to the digital section. Since these four (4) pieces of time data (T1 thru T4) are exactly proportional to the amplitude of the four components (V1 thru V4), V1 thru V4 can be given by the following equations:



The real part (V1) of E1 is detected in the phase detector in the following manner: the integrator is charged during time Tc (about 10 msec). Just after minus DC reference voltage towards zero volts is discharged by either the plus or crossed. As soon as the discharge crosses the DC zero volt level, a zero comparator sends a pulse indicating completion of the discharge cycle and simultaneously transfers the time data (T1: discharging time) to the digital section.

Figure 8-4. Concept of Vector Ratio Measurement (Sheet 3 of 4).

Consequently, a voltage ratio with a magnitude of ten (10) times can be obtained. Also, three (3) attenuations (1/1, 1/2 and 1/4) are established in the AF amplifier of the VRD section to compensate for the frequency characteristics (W or W/L) of one decade frequency range (i.e.: 250Hz thru 2.5KHz) when capacitors or inductors are measured. These actions improve the signal-to-noise (S/N) ratio.

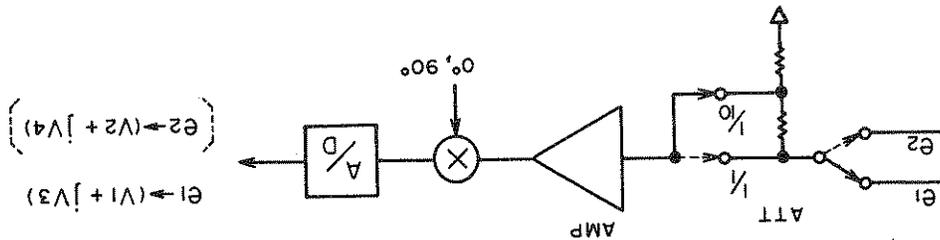
$$X = 10 \cdot \frac{I_1 \cdot I_2 + I_3 \cdot I_4}{I_1 \cdot I_2 + I_3 \cdot I_4} \quad Y = 10 \cdot \frac{I_1 \cdot I_4 - I_2 \cdot I_3}{I_1 \cdot I_4 - I_2 \cdot I_3} \dots (14)$$

Therefore,

$$V_2 = K \cdot T_C \cdot E \cdot T_1 \quad V_4 = K \cdot T_C \cdot E \cdot T_4 \dots (13)$$

$$\frac{V_1}{V_3} = K \cdot T_C \cdot E \cdot T_1 \quad \frac{V_1}{V_3} = K \cdot T_C \cdot E \cdot T_3 \dots (12)$$

To measure the θ_1 signal, the attenuator is switched to its 1/10 position enabling the measurement of V_1 and V_3 . On the next measurement cycle (to measure θ_2) the attenuator is switched to its 1/1 (through) position and V_2 and V_4 are measured. See above figure.



VRD Multiplier:
 AM amplifier includes accurate attenuators (1/1, 1/10 and 1/100) in the VRD section as shown in Figure 8-A so the measurable ranges can be expanded (in addition to the five ranges determined by the five range resistors in the TRD section).

$$Y = \frac{(T_1 - T_0)(T_4 - T_0) - (T_2 - T_0)(T_3 - T_0)}{(T_1 - T_0)(T_4 - T_0) + (T_3 - T_0)(T_2 - T_0)} \dots (11)$$

$$X = \frac{(T_1 - T_0)(T_2 - T_0) + (T_3 - T_0)(T_4 - T_0)}{(T_1 - T_0)(T_4 - T_0) - (T_2 - T_0)(T_3 - T_0)} \dots (10)$$

However, since it is substantially known that T_0 is equal to T_5 at frequencies lower than 10KHz, X and Y can be given by the following equations:

In an actual measurement cycle, two additional measurements are made to compensate for any residual offset existing in the circuits behind the phase detector. To accomplish this compensation, 0° and 90° components of the offset magnitude (V_0) are respectively measured to obtain the proportional times (T_0 and T_5) (on the condition with that the input of the phase detector is shorted). To T_5 , respectively, subtracted from both T_1 , T_2 and T_5 is, respectively, subtracted from both T_3 and T_4 .

AC signals of known amplitude (10 mVrms), and of the same frequency as the test frequency, are measured instead of θ_{RR} , and their absolute values compared and calculated by the following equations:

$$\frac{\theta_{DUT}}{\theta_{OSC}} = X + jY \dots \dots \dots (15)$$

$$|\theta_{DUT}| = \sqrt{X^2 + Y^2} \cdot |\theta_{OSC}| \dots \dots \dots (16)$$

To calculate the current through the DUT, the following equations are used:

$$\theta_{RR} = jX \cdot RR \dots \dots \dots (17)$$

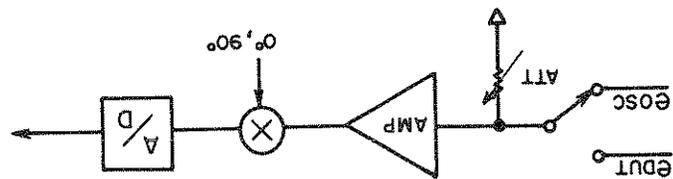
θ_{RR} is the absolute value resulting from:

$$|\theta_{RR}| = \sqrt{X^2 + Y^2} |\theta_{OSC}| \dots \dots \dots (18)$$

Hence,

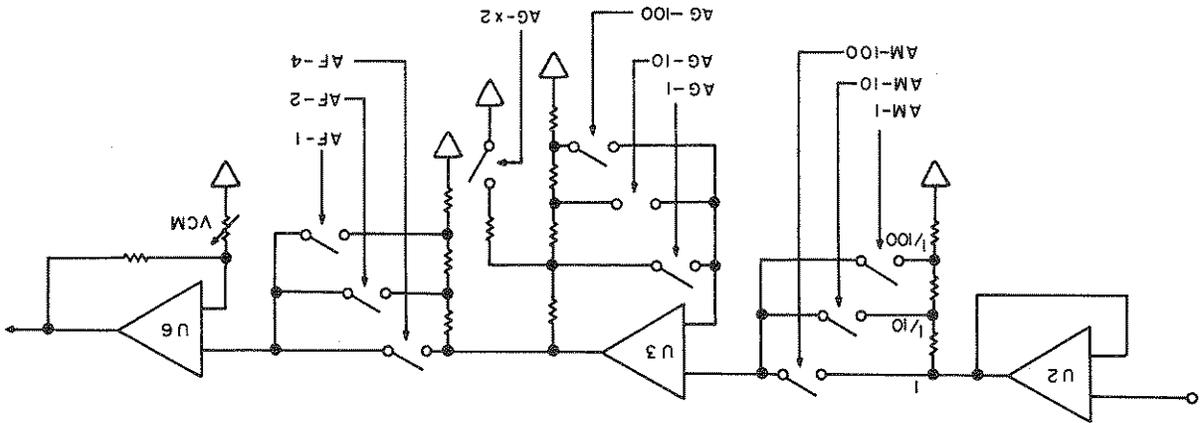
$$jX = \frac{\theta_{RR}}{\theta_{OSC}} = \frac{RR}{|\theta_{OSC}|} \cdot \sqrt{X^2 + Y^2} \dots \dots \dots (19)$$

The VRD section is designed so that the voltages applied to the DUT can be measured. For this measurement, a similar vector voltage ratio measurement technique is employed. See figure below.



Test Level Measurement:

Figure 8-5. Relationship of Range Resistor and Gain Selection. (Sheet 1 of 2)



To determine the range resistor employed, use the table. For example, if the 100nF range is selected with a test frequency of 1.0kHz, follow the frequency (250Hz - 2.5kHz) line to the 100nF range (Y-4) column and go the bottom of the table where the range resistors are listed to find 100Ω (OSC MULTIPLIER: x5) and 1kΩ (OSC MULTIPLIER: except for x5).

It is theoretically possible to equip the instrument with 9 separate range resistors. However, it's substantially difficult to use them while maintaining both precise resistance accuracy and negligible phase shift over a wide frequency range. Therefore, the other four (virtually eight) ranges are arithmetically constructed by a combination of amplifier gains (AM: x1, AM: x10, AM: x100, AG: x1, AG: 2, AG: 10, AG: 20 and AG: 100).

Table 8-A can be used to determine which range resistor is being used under a given set of conditions. There are five (5) range resistors which differ decade step and are so accurate. As described in paragraph 3-14 on page 3-10, the 9 basic ranges (Z1 - Z4, Y1 - Y5) cover 13 virtual ranges depending on the values of the measured parameters and the test frequencies set. In Table 8-A, Z indicates the ranges on which impedance measurements are performed and Y indicates the ranges on which admittance measurements are performed.

RANGE RESISTOR and GAIN SELECTIONS.

Therefore, Table 8-A can be used to roughly isolate an inappropriate range resistor selection or whose value has shifted from original design value. AM and AG are unique abbreviations for describing the gain condition of AM Amplifier in the A4 Process Amplifier. AM means amplifier multiplier, and in effect, represents the condition of the attenuator (1, 1/10 or 1/100) in the amplifier. To indicate which attenuator is activated, AM x 1, AM x 10 or AM x 100 should be translated as follows: AM x 1 indicates that the 1/100 attenuator is activated and operates with the amplifier, AM x 100 indicates that 1/1 attenuator is activated, etc.

To achieve the appropriate gain required for various DUT's, the AM amplifier is controlled in five degrees of AG (amplifier gain: x1, x2, x10, x20 and x100). The unit here is not dB. In an actual measurement, the five range resistors, three of the ten decade step attenuators and the five operational gains are combined as required to produce an appropriate measurements.

Figure 8-5. Relationship of Range Resistor and Gain Selection. (Sheet 2 of 2)

FUNCTION	TEST FREQUENCY	L, C, R, |Z| RANGE																								
		100Hz ~ 250Hz	250Hz ~ 2.5kHz	2.5kHz ~ 25kHz	25kHz ~ 100kHz	100Hz ~ 999Hz	100μH ~ 10mH	1000μH ~ 10mH	100μH ~ 10mH	1000μH ~ 10mH	100μH ~ 10mH															
INDUCTANCE L	RESISTANCE R, |Z| IMPEDANCE	RANGE RESISTOR USED																								
		x 5	x 0.1	x 1	x 0.1	x 1	x 0.1	x 1	x 0.1	x 1	x 5															
CAPACITANCE C	100Hz ~ 250Hz	100mF	10mF	1000μF	100μF	1000μF	100μF	1000μF	100μF	1000μF	100μF	1000μF	100μF	1000μF	100μF	1000μF	100μF	1000μF	100μF	1000μF	100μF	1000μF				
	250Hz ~ 2.5kHz	10mF	1000μF	100μF	1000μF	100μF	1000μF	100μF	1000μF	100μF	1000μF	100μF	1000μF	100μF	1000μF	100μF	1000μF	100μF	1000μF	100μF	1000μF	100μF	1000μF			
	2.5kHz ~ 25kHz	1000μF	100μF	1000μF	100μF	1000μF	100μF	1000μF	100μF	1000μF	100μF	1000μF	100μF	1000μF	100μF	1000μF	100μF	1000μF	100μF	1000μF	100μF	1000μF	100μF	1000μF		
	25kHz ~ 100kHz	100μF	10μF	1000μF	100μF	1000μF	100μF	1000μF	100μF	1000μF	100μF	1000μF	100μF	1000μF	100μF	1000μF	100μF	1000μF	100μF	1000μF	100μF	1000μF	100μF	1000μF		
L	100Hz ~ 999Hz	1000μH	100μH	1000μH	100μH	1000μH	100μH	1000μH	100μH	1000μH	100μH	1000μH	100μH	1000μH	100μH	1000μH	100μH	1000μH	100μH	1000μH	100μH	1000μH	100μH	1000μH		
	1kHz ~ 9.99kHz	10μH	1000μH	100μH	1000μH	100μH	1000μH	100μH	1000μH	100μH	1000μH	100μH	1000μH	100μH	1000μH	100μH	1000μH	100μH	1000μH	100μH	1000μH	100μH	1000μH	100μH	1000μH	
	10kHz ~ 99.9kHz	1000mH	100mH	1000mH	100mH	1000mH	100mH	1000mH	100mH	1000mH	100mH	1000mH	100mH	1000mH	100mH	1000mH	100mH	1000mH	100mH	1000mH	100mH	1000mH	100mH	1000mH	100mH	1000mH
	100kHz ~ 100kHz	100mΩ	1000mΩ	100mΩ	1000mΩ	100mΩ	1000mΩ	100mΩ	1000mΩ	100mΩ	1000mΩ	100mΩ	1000mΩ	100mΩ	1000mΩ	100mΩ	1000mΩ	100mΩ	1000mΩ	100mΩ	1000mΩ	100mΩ	1000mΩ	100mΩ	1000mΩ	
Combination of RR, AM gain (attenuation) and AG (amplifier gain).	x 5	RR(Ω)	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10		
		AM	x 100	x 10	x 1	x 1	x 1/10	x 10	x 10	x 10	x 10	x 10	x 10	x 10	x 10	x 10	x 10	x 10	x 10	x 10	x 10	x 10	x 10	x 10	x 10	
		AG	20	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
	x 1	RR(Ω)	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	
		AM	x 100	x 10	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	
		AG	100	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	
	x 0.1	RR(Ω)	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	
		AM	x 10	x 10	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	
		AG	100	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	
	x 0.01	RR(Ω)	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	
		AM	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	
		AG	100	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	

Table 8-A. Range Resistor and Gain Matrix.

8-27. A2 Modulator
 The Modulator circuit receives the same test signal (OSC) applied to the A3 board and produces a 90° phase shifted signal at the output of the 90° phase shifter (U1, U2 and U5). Thus there are two signals (sine waves) whose amplitudes are the same and their phase difference is 90°. The unbalance voltage (E_{nuo}) transferred from A1 (Null Detector) is applied to both phase detectors (0° and 90°). The two signals are respectively applied to the 0° (U4) and 90° (U3) phase detectors through non-inverting tracking amplifier (U6 and U7) phase reference signals and also sent to the 0° and 90° modulators (U11 and U10). The unbalance voltage (E_{nuo}) is defined and detected as the 0° and 90° factors and respectively converted to proportionate DC voltages in both the 0° and 90° integrators. These two DC voltages control the attenuate both AC signals from the input and amplifier (Q6). The output waveform at Q6 emitter is the composite (quasi-sine) of three squarewaves as illustrated in Figure 8-1. The quasi-sine wave is filtered by double low pass filters to form a clean sine wave and the output sine wave is automatically controlled by an ALC circuit (U1, U3 and U4) which converts its AC amplitude to a DC level. This DC level is fed back to a photocell for providing the desired, consistent test signal levels.

8-28. A1 Range Resistor and Null Detector.
 While the bridge section is being balanced, two currents (I_{rr}, I_{id}) flow into the A1 board from the LCR and LPT terminals of the UNKNOWN terminal. During the bridge unbalance time (I_x = I_{rr}), I_{id} flows into the Null Detector (U3 and Q12 thru Q16) and this current is converted to a proportional voltage signal. There are two main signal paths on the A1 board. And its two main functions are to detect the unbalance voltage and to deliver this voltage to the Modulator so that unbalance current (I_{id}) becomes zero ampere (I_x = I_{rr}) and to feed an ERK signal to A4 process amplifier input. Circuit gain amplitude between the Null Detector and the Unbalance Detector is controlled so as to be consistent with the control signal from the digital section. The unbalance current (I_{id}) applied to Null Detector (U3 and Q12 thru Q16) is converted to a proportional unbalance voltage whose amplitude is calculated by the product of I_x and the feedback resistor. The unbalance voltage is filtered and amplified in two amplifier stages (U6 and U7) and sent to both the unbalance detector and to the A2 Modulator.

8-26. A3 Power Amplifier
 This board has two similarly designed amplifier paths: one to control the test signals to an appropriate amplitude across the unknown device (DUT) and another for receiving and feeding the unbalance voltages (E_{MOD}) detected at A2 output back to the range resistors in the bridge section loop. In the DUT path, the test signal level is amplified in a vernier amplifier (Q1 and U1) whose gain is initially set by the OSC LEVEL control. This output signal is attenuated by the control signals (TLM and TLL) and amplified by 2 in a power amplifier (U2 and Q5 thru Q7) in accordance with the front panel MULTIPLIER settings (X0.01 thru X5). In the RR (range resistor) path, the unbalance voltage (E_{mod}) is amplified by a vernier amplifier (Q9 and U3) whose gain is exactly the same as vernier amplifier (Q1 and U1) in the path. This amplified E_{mod} is attenuated in accordance with the OSC MULTIPLIER setting and again amplified with a power amplifier (U4 and Q15 thru Q18), then fed to the range resistor on the A1 board so that the current flowing through the range resistor (I_{rr}) becomes exactly the same as the current flowing through the unknown device (I_x).

8-25. A6 Oscillator
 The 9.6MHz crystal oscillator is designed to provide a wide range of test frequencies in either a 1-2-4 or 1-3-5 step frequency sequence. The basic frequency (9.6MHz) is the L.C.M (Least Common Multiple) that is 8 times any of the 11 test frequencies. The 8f (8 times test frequency) that is produced (9.6MHz) is divided by a programmable divider (U13 thru U15 and U17 thru U19) to generate the desired test frequency and transferred to a quasi-sine wave generator which is composed of dividers (U7, U9 and U10) and a summing amplifier (Q6). The output waveform at Q6 emitter is the composite (quasi-sine) of three squarewaves as illustrated in Figure 8-1. The quasi-sine wave is filtered by double low pass filters to form a clean sine wave and the output sine wave is automatically controlled by an ALC circuit (U1, U3 and U4) which converts its AC amplitude to a DC level. This DC level is fed back to a photocell for providing the desired, consistent test signal levels.

8-24 Analog Block Diagram.
 Figure 8-6 is a detailed block diagram of the 4274A analog section. The construction of this diagram is based on the actual printed circuit board assembly. It is useful for board level troubleshooting.

8-23 BLOCK DIAGRAM DISCUSSION

8-31. CONTROL SECTION

8-32. A9 MPU Board
MPU board contains the microprocessor, 18K x 8 bit static memory (nine) (9) x 2K x 8 bit ROM -- one is used for HP-IB option) and the 1024 x 8 bit static memory (2 x 512 x 8 bit RAM). This assembly controls the initial display self-diagnostic test, initial control settings, measurement mode, zero offset cancellation, self diagnostic test and other functions. It also performs numerical computations for displaying measurement data on the front panel. To accomplish this control and to do the numerical computations, nine ROMs are provided for the microprocessor and they are identified with assigned addresses. The ROM's are used to store the various management instructions which include:

- a. VRD processing control for L, C, R and other measurements.
- b. VRD processing control for self diagnostic test.
- c. Key control.
- d. Display control.
- e. Utility program.
- f. Mathematics pack.
- g. Computation program.
- h. Main program.
- i. Table and DC bias control.
- j. HP-IB control.

The Microprocessor fetches the appropriate control program in accordance with front panel control settings and outputs the desired measurement results as well as doing a self-diagnostic test evaluation. Both measurement and diagnostic test results are displayed on the front panel displays.

8-33. A8 Display Control, A10 Display and Key board.
This board controls the key information set at the front panel and houses the data ma-

trix for the seven (7) segment numeric displays. When a given panel key is depressed, the information is sent to interrupt decoder (U14) through KY 4-6 lines. Key decoder sends the KIPIPT signal to A7 peripheral control board and simultaneously stops key scan counter (U15). New key information is sent to the MPU through the bus lines (PDA0-6). The MPU addresses new address to execute any new function set at the front panel and transmits the necessary key information to A10 multiplexer for turning appropriate key LED's on. Measurement result data computed on the MPU board are transferred to three groups of display RAMs (U4-U6 and U10-U12) through 8 bus lines (PDB 0-PDB7). These data are momentarily stored in the appropriate RAM in synchronization with WE1 thru WE3 in accordance with the addresses of the numerical data and the display-B. These RAM outputs, respectively, control the cathode driver (U1-U3) to activate the three groups of display LED's.

8-34. Peripheral Control Board
The peripheral control board includes the peripheral interface adapter (PIA), the 1MHz clock generator, the timing control section and the data counter. The PIA (U17) provides a universal means for interfacing peripheral equipment to the MPU through two 8 bit bidirectional peripheral data buses. Its function is programmed by the MPU. The PIA has four (4) control lines and no external logic is required to communicate with other peripherals. The MPU addresses the PIA to enable the circuits associated with the PIA to act in accordance with the instructions sent through the 8 bit data bus. The PIA includes two data banks which are selected by the MPU. Two data output buses are identified as peripheral A (PA) and peripheral B (PB). PA data are sent to two multiplexers (U30 and U31) and decoded to 24 bit control signals (19 lines are virtually used). These signals mainly manage the gain control for the TRD and VRD sections. Other PB data are sent to the logic control (U11) which produces the timing pulses for the timing detector (U6, U21) and the data counter (U12 and U25) which counts the internal clock pulses during the period that is proportional to the time data from the A-D converter.

As long as an unbalance voltage signal (ed) appears at the output of U7, the unbalance detector (U8) amplifies this UNBAL signal and sends it to the digital section to announce that the bridge is not yet balanced. The other path on A1 is comprised of range resistors (10 Ω thru 100k Ω) and a buffer amplifier (U1). The voltage (ERR) across the range resistor as applied by the relay matrix is transferred to the input of the process amplifier (A4). There is a complex relationship between the selected range resistor, the function, test frequency and test signal level as selected on front panel. These relationships are shown in figure 8-5 Buffer amplifier (U1) is provided to compensate for the voltage drops which residually appear between the DUT and the range resistor.

8-29. A4 Process Amplifier
The process amplifier board receives two main signals (EDUT and ERR) and two subordinate (ELPH and EOSC1) signals. EDUT and ERR are periodicaly passed through FET switches (S1 and S2) which are activated by control signals (SEDUT and SERR). EDUT is transferred to an AM amplifier (U2) while SEDUT (Select EDUT) closes switch S1 and ERR is transferred- red white SERR (Select e Range Resistor) closes switch S2. Both signals are respectively attenuated or amplified by the AM(U2) and AF(U6) amplifiers in accordance with the combinations of AM, AG and AF originally matrixed to provide the appropriate gains (vector ratio). This manipulation of various combinations is the artifice for extending the measurement ranges (13 ranges) from the basic group of five (5) range resistors. For combination details, refer to figure 8-5. An explanation of each amplifier is given in figure 8-5. Level vernier amplifier (U6 and Q19 thru Q22) sets the signal amplitude which appears at the output of the A4 board when the test signal level is set to a lower value.

Q19 thru Q22 successively conduct to improve the gain as the VCM (Voltage Control Middle) level is decreased at the front panel. ELPH is transferred from A1 to A4 to compensate for the residual offset present at the HPOT terminal when the unknown terminal is shorted. Another subordinate signal, EOSC is the reference for the test signal level measurement for doing equivalent vector ratio calculation. Switch S3 is closed by the SLVL (Select Level) signal in virtual device measurements. Switch S3 is closed by the SLVL (Select Level) signal while the SCUP (Start Change-up) is being transferred from the latch (which is controlled by the digital section) and the integrator (U4) is charged for a period of about 10ms. After this charging cycle, the slope amplifier (U5) drives the zero comparator (I2) to detect the polarity and switch S2 or S3 is closed by the SPCDM (Start Positive Charge Down) or the SNCNDN (Start Negative Charge Down) circuitry depending on the polarity discrimination of the integrator voltage. The integrator discharges until the discharge crosses the zero (0) volts level. When the discharge reaches zero volts, a zero detect signal is sent to the digital section. The time period between the start of discharge and the zero crossing point is proportional to the real part of EDUT. In like manner, the real part of ERR, the imaginary part of EDUT and the imaginary part of ERR are serially detected and converted into digital data.

8-30. A5 A-D Converter
The EDUT signal is transferred from A4 process amplifier to the phase detector (U8, U9 and Q1 thru Q8) and its real (0 $^\circ$) part is detected and filtered. The detected signal is passed through switch S1 while the SCUP (Start Change-up) is being transferred from the latch (which is controlled by the digital section) and the integrator (U4) is charged for a period of about 10ms. After this charging cycle, the slope amplifier (U5) drives the zero comparator (I2) to detect the polarity and switch S2 or S3 is closed by the SPCDM (Start Positive Charge Down) or the SNCNDN (Start Negative Charge Down) circuitry depending on the polarity discrimination of the integrator voltage. The integrator discharges until the discharge crosses the zero (0) volts level. When the discharge reaches zero volts, a zero detect signal is sent to the digital section. The time period between the start of discharge and the zero crossing point is proportional to the real part of EDUT. In like manner, the real part of ERR, the imaginary part of EDUT and the imaginary part of ERR are serially detected and converted into digital data.

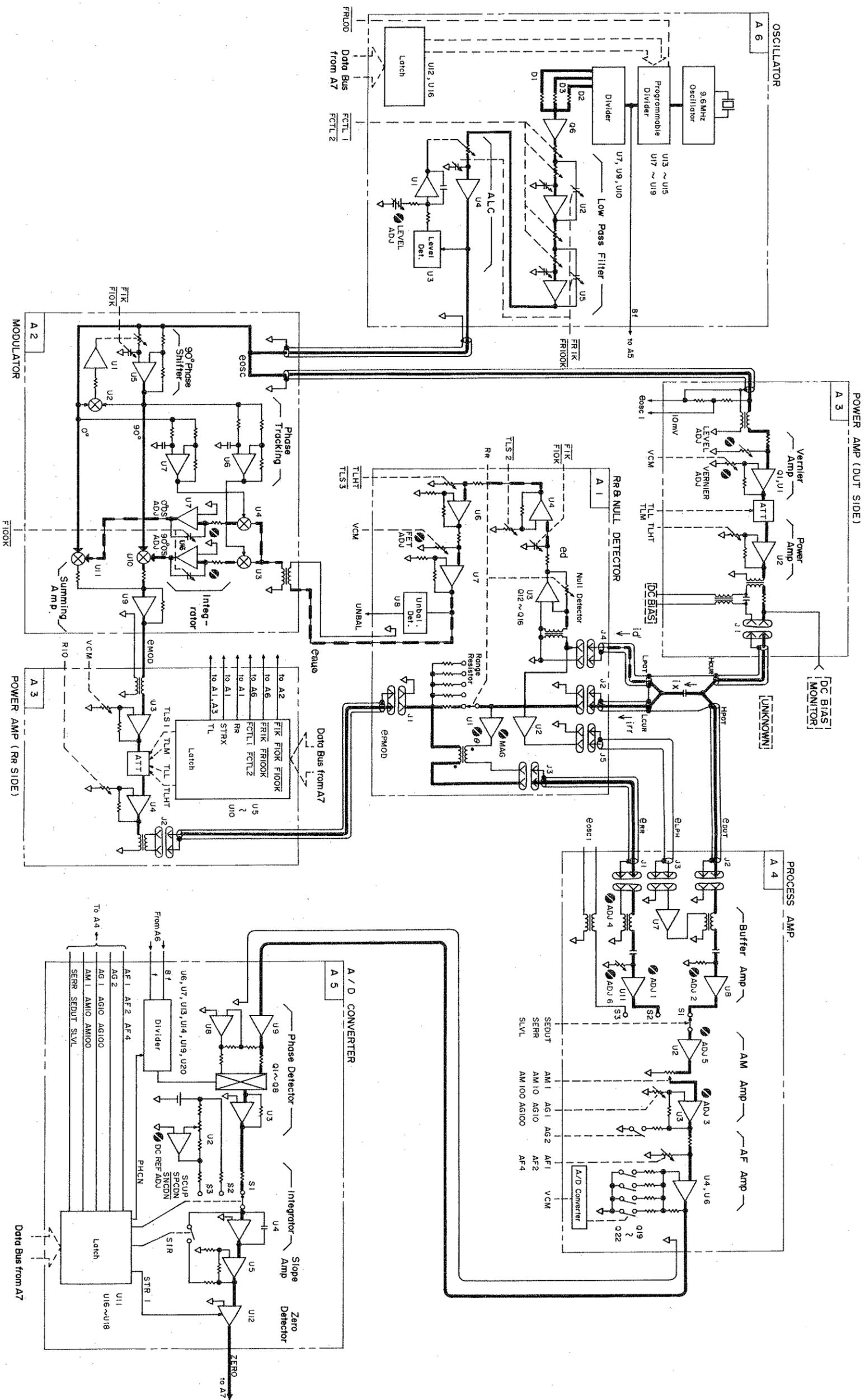


Figure 8-6

FIGURE 8-6. ANALOG SECTION BLOCK DIAGRAM

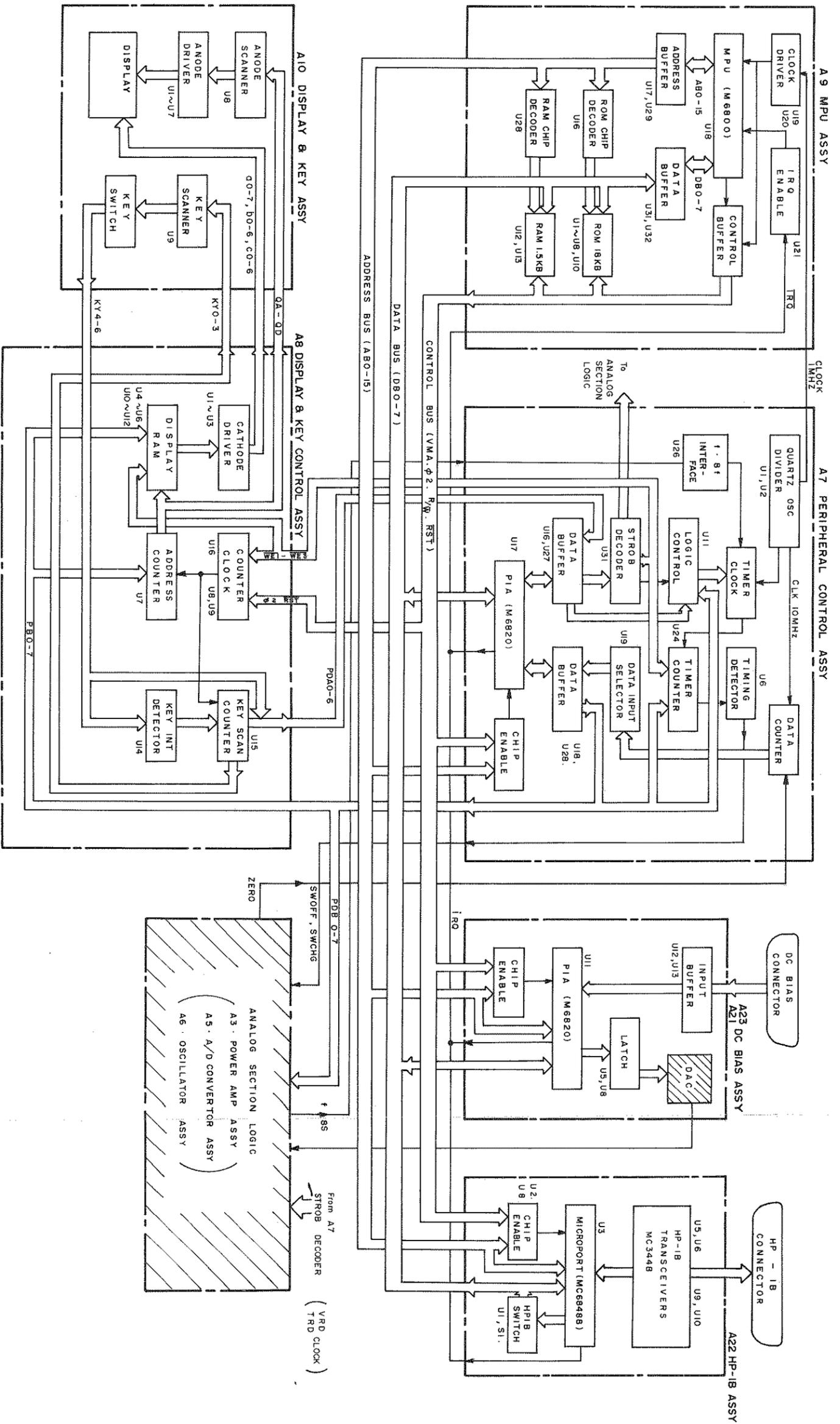


FIGURE 8-7. Control Section Block Diagram

8-35. TIMING DIAGRAM DISCUSSION

8-36. As described in Table 8-1, five measurement cycles are repeated to do the vector ratio calculation of an unknown device to produce a measurement result. This paragraph describes the timing sequence of the five fundamental component A-D conversions: VRD clocks (VRDCLK) 1 thru 4 are decoded by the STROB clock decoder in A7 which receives the data from the MPU. When the power is switched on, the MPU is initialized and fetches the programmed data for A9U1 that manages the VRD sections. VRDCLK1 mainly generates the control signals which determine the measured components ($0^\circ \times \text{EDUT}$, $0^\circ \times \text{ERR}$, $90^\circ \times \text{EDUT}$ and $90^\circ \times \text{ERR}$) and the states of the A-D converter by synchronizing the data from the MPU. EDUT is measured while SEDUT (Select EDUT) is high and ERR is measured while SERR (Select ERR) is high for the admittance measurement. This relationship changes when an impedance measurement is being done. SLVL (Select Oscillator Level) is set high instead of SERR for measuring the voltage across the unknown device while the V key on the front panel is being depressed.

The ADC integrator is reset on the first cycle, to be ready for A-D conversion, while SIR is high. STCUP goes high on the positive edge of STCUP so as to be ready and the input signal charges the integrator for 10 milliseconds. A polarity check (PLCHK of VRV4) is done during the next $500\mu\text{S}$ (approximately) so that charging is in the proper direction. A small charge for the next $400\mu\text{S}$ (approximately) is done while SPCDN is high (charge down phase 1). This small charge is necessary so that an accurate measurement can be made when the input signal value is small. As the charge voltage is positive, the processor signals that integrator should be discharged in a negative direction (SNCDN). The integrator starts discharging on the positive edge of SNCDN until its DC level crosses zero volts (charge down phase 2). ZRCMP (Zero Compare) goes low when the discharge reaches zero volts and the timing-end detector is reset (SMOFF) to low and SNCDN is set high to stop the discharge phase and to, simultaneously,

set SIR high. The time data for this discharge phase (charge down phase 2) is transferred to the processor for storing in the static memory during the period of Data Transfer. In like manner, AD conversion for 0 components of EDUT and ERR is accomplished and PHCH (VRDCLK 3) is set high to detect 90° components in the phase detector. The timing sequence of VRDCLK1 and VRDCLK4 are inseparably related to repeat same processing of charge and discharge cycle for next component measurement to serially send time data to digital section.

VRDCLK2 and VRDCLK3 clocks are provided to generate the control signals which mainly determine the appropriate gain in the matrix that is determined by the test frequency measurement range, function and OSC MULTIPLIER. This timing diagram shows the timing states for an admittance measurement. EDUT (0° and 90°) are amplified by AM1 during the time that AM1 is set high and ERR (0° and 90°) are amplified by AM10 during the time that AM10 is set high so to obtain a ten times ($\times 10$) voltage ratio. Also, EDUT (0° and 90°) are amplified by AF1 when AF1 is set high and ERR (0° and 90°) is amplified by AF2 when AF2 is set high.

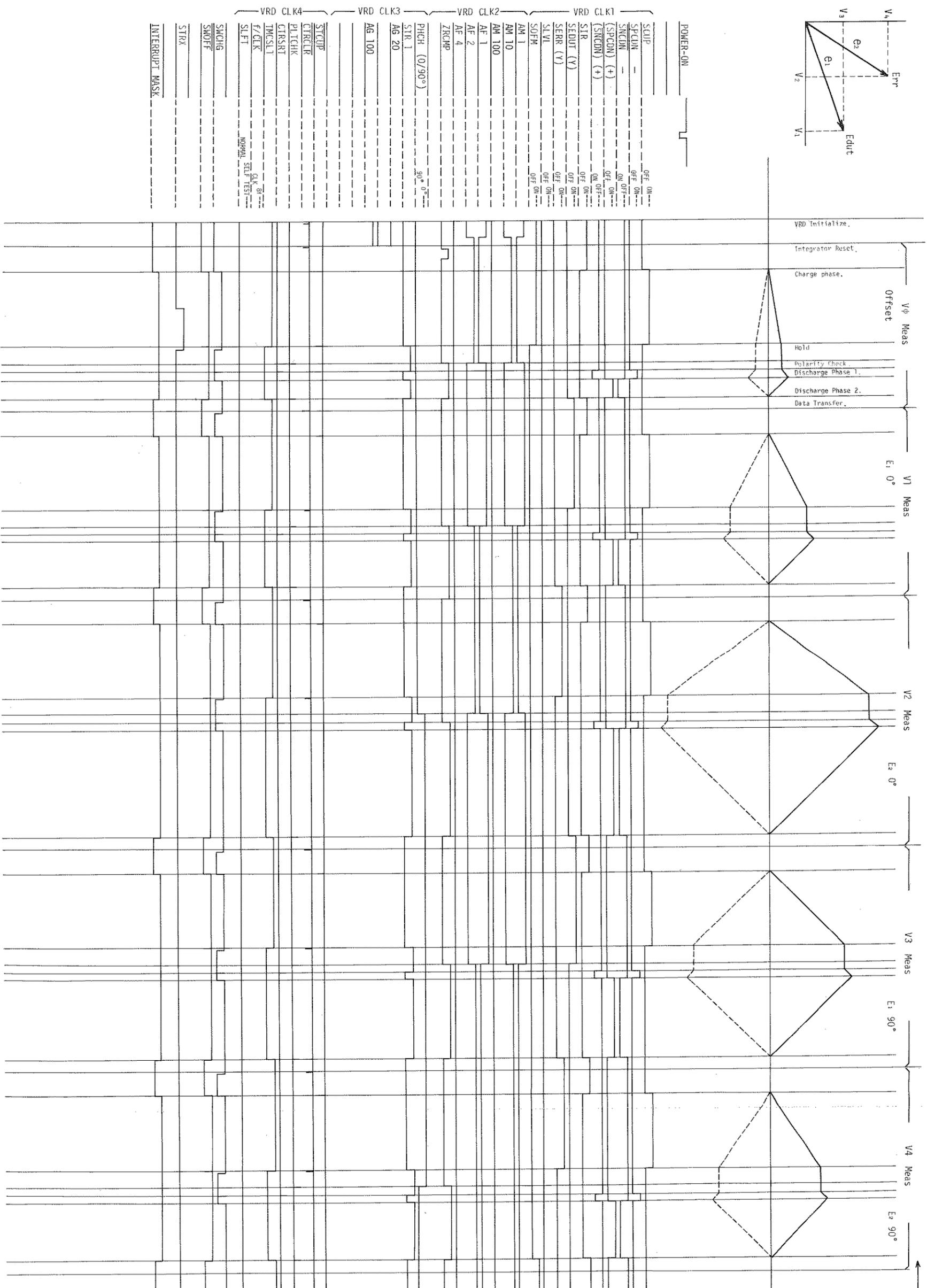
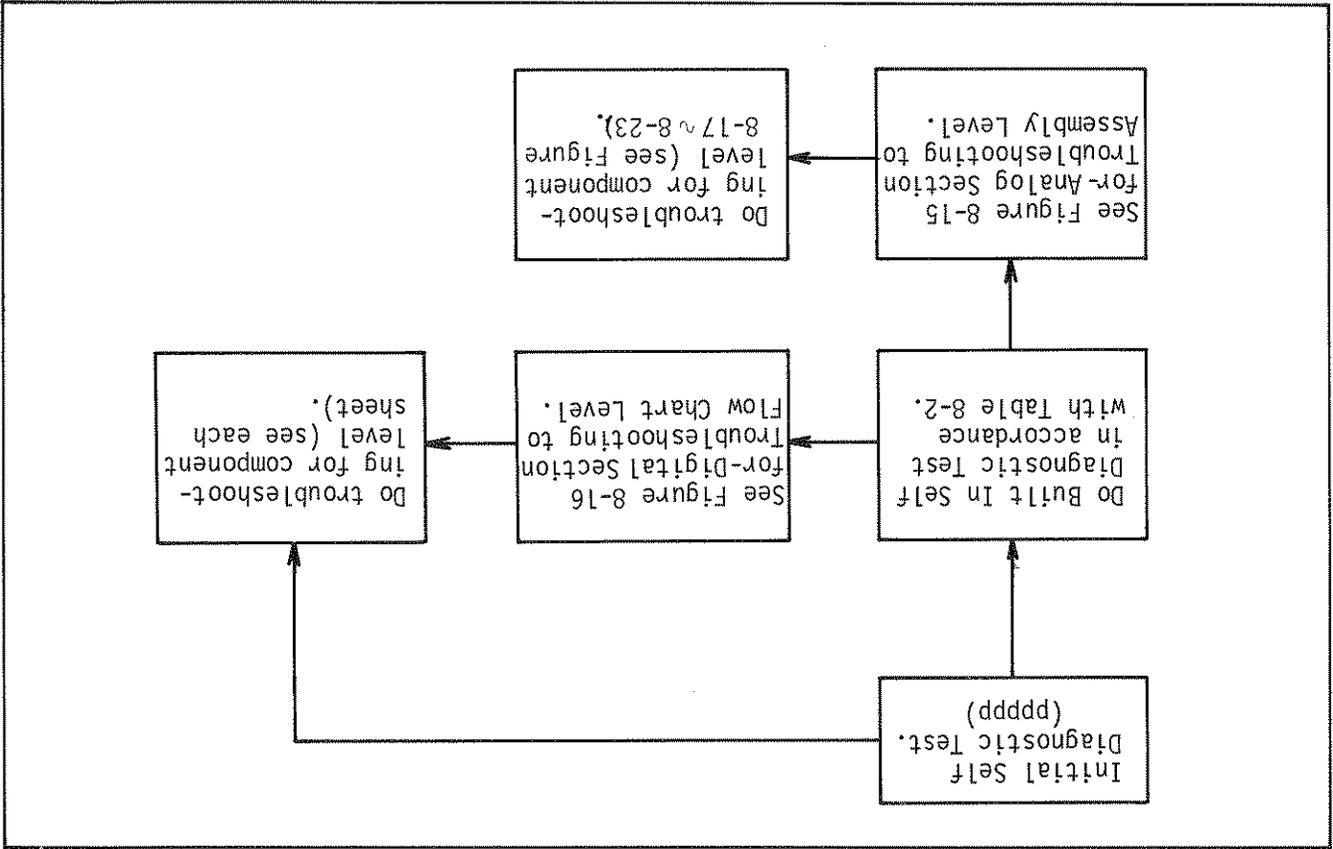


FIGURE 8-8. Timing Diagram

Table 8-1. Mnemonic Information.

Mnemonic	Description	Mnemonic	Description
AB	Address Bus	PDA	Peripheral Data A
AF	Amplifier for Frequency	PDB	Peripheral Data B
AF1	Amplifier Frequency 1. (AF Attenuator: 1/4)	<u>PRST</u>	Preset
AF4	Amplifier Frequency 4. (AF Attenuator: 1/1)	<u>RST</u>	Reset
AG	Amplifier Gain	<u>R/W</u>	Read Write
AG1	Amplifier Gain x1	R10	Range Resistor 10 Ω
AG100	Amplifier Gain x100	R100K	Range Resistor 100K Ω
AM	Amplifier Multiplier	SCUP	Start Charge Up
AM1	Amplifier Multiplier x1 (Attenuator: 1/100)	SEDUT	Select Device Under Test Voltage
AM100	Amplifier Multiplier x100 (Attenuator: 1/1)	SERR	Select Range Resistor Voltage
BCLK	Blanking Clock	SLVL	Select OSC Level
CBLNG	Cable Length SW on	SIR	Set Integrator Reset
CSA	Chip Select A	SNCNDN	Start Negative Charge Down
CSB	Chip Select B	SPCDN	Start Positive Charge Down
DB	Data Bus	<u>STADLD</u>	Start Address Load
DBE	Data Bus Enable	STRX	Strobe X
DCHON	DC Bias High ($\pm 100V$) on	<u>STPSCN</u>	Stop Scan
<u>DSBL</u>	Disable	SMCHG	Switching
<u>EXTCD</u>	External Clock Drive	SWOFF	Switch Off
<u>ELPH</u>	Low Potential Compensate High Potential	TLHT	Test Level Highest
<u>EMOD</u>	Modulated Signal	TLL	Test Level Low
<u>EMODG</u>	Modulated Signal Ground	TLM	Test Level Middle
<u>ENUO</u>	Null Detector Out Signal	TLS	Test Level Small
<u>ENUOG</u>	Null Detector Out Ground	TRDCLK	Transducer Clock
<u>EOSC</u>	Reference Signal	<u>TRON</u>	Turn On
FCTL	Filter Control	VCH	Voltage Control High
FRCLK	Frequency Clock	VCI	Voltage Control In Phase
FRL0D	Frequency Load	VCL	Voltage Control Low
FROPT	Frequency Option Select	VCM	Voltage Control Middle
IRQ	Interrupt Request	VCQ	Voltage Control Quadrature
<u>KYIPF</u>	Key Input	VMA	Valid Memory Address
<u>NMI</u>	Non Maskable Interrupt	VRDCLK	Vector Ratio Detector Clock
		<u>WE</u>	Write Enable
		ZERO	Zero Detect Pulse
		ϕ	Clock

Figure 8-9. How to Use Troubleshooting Guides.



WHENEVER IT IS LIKELY THAT THE PROTECTION PROVIDED BY THE FUSES HAS BEEN IMPAIRED, THE INSTRUMENT MUST BE MADE IN OPERATION. RATING AND MUST BE SECURED AGAINST ANY UNINTENDED OPERATION.

IF, AFTERWARDS, ANY ADJUSTMENT, MAINTENANCE OR REPAIR OF THE OPENED APPARATUS UNDER VOLTAGE IS REQUIRED, IT SHALL BE CARRIED OUT ONLY BY A SKILLED PERSON WHO IS AWARE OF THE HAZARD INVOLVED.

WARNING

8-39. Follow the troubleshooting procedure in Figure 8-9 which provides specific instructions for isolating the Analog and Digital section from each other.

FOR WHICH THE APPARATUS MUST BE OPENED. MAINTENANCE AND REPAIR ARE PERFORMED PARTS REPLACEMENT OR MAINTENANCE SOURCES BEFORE ANY ADJUSTMENT, CONNECTED FROM ALL VOLTAGE THE APPARATUS SHALL BE DIS-

CAUTION

8-37. TROUBLESHOOTING.

8-38. Figure 8-9 "How to Use Troubleshooting Guides" is helpful when starting to troubleshoot the 4274A. As the analog boards include the latches which are controlled through bus lines by the MPU, the signature analysis technique is useful for analog board troubleshooting. The sequence of the digital section troubleshooting depends upon the program routine and it is difficult to provide individual flow diagrams. All thru GL all contain digital section troubleshooting aids.

THE OPENING OF COVERS OR REMOVAL OF PARTS, EXCEPT THOSE TO WHICH ACCESS CAN BE GAINED BY HAND, IS LIKELY TO EXPOSE LIVE PARTS; IN ADDITION, ACCESSIBLE TERMINALS MAY ALSO BE LIVE.

CAUTION

CAPACITORS INSIDE THE INSTRUMENT MAY STILL BE CHARGED EVEN IF THE INSTRUMENT HAS BEEN DISCONNECTED FROM ALL VOLTAGE SOURCES.

BE SURE THAT ONLY FUSES OF 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.

The above simple isolation tests for ROM and RAM faults can be performed except that faults in the bus line because it is interrupted or abnormally affected (or perhaps the ROM in which the self test instruction is programmed is defective).

If these tests are satisfactorily performed, advance to self test open and short test on the assumption that the digital section is operating normally (for at least its major functions).

8-40. Troubleshooting Analog Section to Assembly Level. Follow the troubleshooting procedure in Figure 8-15 Analog Section Troubleshooting Guide to isolate an analog fault to a board assembly. Troubleshooting to component level is covered in the service sheet for each assembly.

8-41. Digital Section Troubleshooting Figure 8-16 is helpful in speeding the troubleshooting. The signals circulate through the bus line and the flow diagrams are given in accordance with the main instructions of the 4274A for efficient problem isolation. The signature analysis technique is a most helpful method for following the component isolation flows AL thru GL (A Logic flow thru G Logic flow). Except for the HP 5004A Signature Analyzer, no additional boards or equipment are necessary.

8-42. Initial Self Diagnostic Tests Just after SW-ON. ROM and RAM test:

BLANK A9U10
p A9U7,8
pp A9U5,6
ppp A9U3,4
pppp A9U1,2
ppppp ... READ WRITE TEST ERROR ... A9U12, 13

8-43. Built-in Self Test. The 4274A has the capability for automaticaly performing a brief self-diagnostic routine for the heart of the logic control circuits (microprocessor, ROM and RAM). This diagnostic procedure is started automatically and is completed just after switching power to ON. Its completion can be recognized by the "p" figures that sequentially appear (up to five(5) in left to right direction) on display A. The meaning of the display condition, if the instrument doesn't arrive and stop at initial control settings as described in Paragraph 3-19 of page 3-17, indicate the problem location for roughly isolating the malfunction.

The display counts for op-01 thru op-05 can be read when the sequential test is stopped by depressing SELF-TEST and D thru L/C keys of display A function. A manual self-diagnosis of the main functions of the analog section and major control capabilities of the control section can be progressively observed by pressing the self-test key on the front panel. As described in Section V, some steps can be utilized to do adjustments. Simplified explanations of what is tested and what is possibly defective is described in Table 8-2.

Error Message	Display	Test Content Implemented.	Tested Circuits	Meaning of Error Message
<p>OP 01</p>	<p>A MPU functions to open A5Q12 and to close A5Q11 to establish the DC 0 volts at pin-3 of A5U9. This DC voltage is measured by two methods (using the +DC and -DC reference voltages) and are added to display.</p>	<p>B The CPU operates to open A5Q9, thus isolating the PHASE DETECTOR. In this condition, the +DC reference voltage (+6.3V) charges the integrator and discharges on the -DC reference voltage. During the next sequence, the -DC reference voltage charges the integrator and discharges it on the +DC reference voltage. These two measured values are mathematically added together in the digital section to display nearly zero on display - B.</p>	<p>A5 1) This error message means that both integrator and comparator have a time delay that cannot be neglected. 2) Or the integrator isn't operate normally or ±DC reference voltages aren't correct.</p>	<p>AM/AF amplifier This error message means either of the AF attenuators (X1 and X1/2) of the AF amplifier aren't adjusted for correct attenuation accuracy. Error messages op-02~op-05 appear when the measurement result described at left is not within 1000.00±160 counts on display-A.</p>
<p>OP 02</p>	<p>A This test compares the two measured values of the EDUT signal via two different attenuator paths and calculates the ratio: path 1. Combination of X1 AM and X1 AF attenuators. path 2. Combination of X1 AM and X1/2 AF attenuators. Since EDUT is constant, the path 1 measured value is twice the value of the path 2 measured value. For easier reading at high resolution, the results in path 2 are multiplied by two and their ratio calculated in the digital section for displaying nearly 1000.00 on display-A. (Decimal point location is not controlled).</p>	<p>B The combined residual phase offsets of various attenuators including the AM (1, 1/10, 1/100) attenuator and the AF (1, 1/2, 1/4) attenuator are measured and displayed on display-B.</p>	<p>A3 A4 This error message means AM or AF amplifier has a residual offset that cannot be neglected. Error messages op-02~op-05 appear when a residual offset value is not within .00±160 counts on display-B.</p>	

Table 8-2. Built-in Self Test Function (Sheet 1 of 3).

Error Message	Display	Test Content Implemented.	Tested Circuits	Meaning of Error Message
OP 03	A B	This test repeats equivalent measurement, calculation and display as outlined for op-02 for following combination of AF and AM attenuators: path 1: Combination through (1) AM and 1/2 AF attenuators. path 2: Combination through (1) AM and 1/4 AF attenuators.	A3 A4	This error message means that either the AF attenuators (x1/2) and x1/4 of AF amplifier aren't being properly controlled or aren't adjusted for proper attenuation accuracy.
OP 04	A B	This test repeats equivalent measurement, calculation and display as outlined for op-02 for following combination of AF and AM attenuators: path 1: Combination of 1/10 AM plus 1/1 AF attenuators. path 2: Combination of 1/1 AM and 1/4 AF attenuators.	A3 A4	This error message means that either the AM attenuator (1/10) and/or the AF attenuator (1/4) aren't being controlled properly or aren't adjusted for proper attenuation accuracy.
OP 05	A B	This test repeats equivalent measurement, calculation and display as outlined for op-02 for following combination of AM and AF attenuators: path 1: Combination of 1/10 AM and 1/4 AF attenuators. path 2: Combination of 1/100 AM plus 1/1 AF attenuators.	A3 A4	This error message means that either the combination of the 1/10 AM and 1/4 AF attenuators and/or combination of 1/100 AM (through 1/1 AF attenuators) aren't being controlled properly or aren't adjusted for proper attenuation accuracy.
OP 07	A B	Offset is measured against minimum of I/V converter and amplifier on A1 board. Consequently, any offset here is significant when measured against the main signal and can be displayed with high resolution.	A1 A2	Total offset measurement of A1 and A2. This error message means that total offset in A1 thru A2 assemblies is excessive (for maintaining accurate bridge balance).
OP 10	C	Oscillator and power amplifier check.	A3	Error message op-10, op-11, op-12 or op-13 appear, if measured voltage values are not within ±20% of proper voltages. OSC LEVEL has to be set to its fully cw positions.
OP 11	C	1Vrms measurement	A6	
OP 12	C	0.1Vrms measurement	A6	
OP 13	C	0.01Vrms measurement	A6	
OP 14	1MΩ Range	Admittance measurement of open (OS) unknown condition at selected frequency with X1 MULTIPLIER setting for respective range of function	A1 A4	This error message means that appropriate resistor range isn't selected, or the resistance value of resistor is abnormal. This error message means that has shifted to an abnormal value.
OP 15	100KΩ Range		A1 A4	

Table 8-2. Built-in Self Test Function (Sheet 2 of 3).

Meaning of Error Message	Tested Circuits	Test Content Implemented.	Error Message
This error message means that appropriate resistor range isn't selected, or the resistance value of respective range resistor has shifted to an abnormal value.	A1	Admittance measurement of open (OS) unknown condition at selected frequency with X1 MULTIPLIER setting for respective range of function.	OP 1A
	A4	Admittance measurement of open (OS) unknown condition at selected frequency with X1 MULTIPLIER setting.	OP 1B
	A1	Admittance measurement of open (OS) unknown condition at selected frequency with X5 MULTIPLIER setting.	OP 1B
	A4	Admittance measurement of open (OS) unknown condition at selected frequency with X1 MULTIPLIER setting.	OP 19
	A1	Admittance measurement of open (OS) unknown condition at selected frequency with X0.01 MULTIPLIER setting.	OP 20
	A4	Admittance measurement of open (OS) unknown condition at selected frequency with X0.01 MULTIPLIER setting.	OP 20
Same operating test is repeated except for test signal level. If open tests 14 thru 17 are passed and one of the 18 to 20 tests fails, the OSC LEVEL control isn't being satisfactorily performed.	A1	Impedance measurement of unknown in a shorted condition on the 100Ω range with sequential change of MULTIPLIER setting (x.5, x.1, x.1 and x.01).	SH 21 SH 22 SH 23
	A3	Current that flows through shorted DUT is 100mA since OSC level is +5Vrms and OSC output impedance is nearly 50Ω. This current also flows through range resistor and voltage drop is measured and compared with the test limits calculated in logic section.	SH 24
	A4	Same measurements and calculations are implemented at OSC level settings of 1Vrms with range resistor on 100Ω range.	SH 25
This error message can mean any of the following: 1. OSC level is less than 80% of required value of 5Vrms. 2. Bridge cannot be balanced. 3. Appropriate gain controls of AM AMP and AG AMP aren't being performed. (AG AMP: x20, AM AMP: x100)	A1	Current that flows through shorted DUT is 100mA since OSC level is +5Vrms and OSC output impedance is nearly 50Ω. This current also flows through range resistor and voltage drop is measured and compared with the test limits calculated in logic section.	SH 24
	A3	Same measurements and calculations are implemented at OSC level settings of 1Vrms with range resistor on 100Ω range.	SH 25
	A4	Sequential current measurements are done for shorted (0Ω) unknown for 100Ω, 1kΩ and 10kΩ range resistors.	SH 26
This error message means that the range resistor 100Ω, 1kΩ or 10kΩ value is inappropriate (if short tests 24 and 26 are satisfactory).	A1	This error message means that the range resistor 100Ω, 1kΩ or 10kΩ value is inappropriate (if short tests 24 and 26 are satisfactory).	SH 27
	A1	This error message can mean any of the following: 1. OSC level is less than 80% of required value of 1Vrms. 2. 100Ω range resistor has shifted to an abnormal value or appropriate control for range resistor isn't being performed. 3. Appropriate gain controls of AM AMP and AG AMP aren't being performed. (AG AMP: X1, AM AMP: x1)	SH 28

Table 8-2. Built-in Self Test Function (Sheet 3 of 3).

Figure 8-10. Signature Analysis Guide (Sheet 1 of 2).

An active digital hand-held logic tracer coupled with an active pod (with four miniature clip connection leads) is sufficient for detecting the test signal and for development of the signature on the Signature Analyzer display. The active probe has access to the desired node in the circuit being tested and transfers this input data to the analyzer. The four input leads of the test cable active pod connect the gate signals --- START, STOP and CLOCK --- from the instrument being tested to the analyzer. The remaining lead is connected to instrument GND. The START signal is an open "window" (measurement gate) signal which causes the signature analyzer to prepare for receiving data via the active probe. The STOP signal causes the window to close. The CLOCK is taken from the time base of the instrument and permits receiving input data and gate signals in synchronization. Polarity of the gate signal active (enable) edges (positive or negative) can be selected by the front panel controls of the signature analyzer. Probing points and connection locations of START, STOP and CLOCK leads are designated on the troubleshooting flow diagrams.

SIGNATURE ANALYZER TECHNIQUE.

For doing signature analysis, a DSA (Data Stream Analysis) switch is provided on the A9 (MPU) board of the 4274A. No additional test board is required. There are twenty-one (21) kinds of DSA for performing signature troubleshooting and they are identified by the abbreviated names of DSA-1 thru DSA-21. These names are denoted around the signature pattern in the respective schematic and troubleshooting trees for setting the signature analyzer and the 4274A for appropriate control settings, window setting, DSA switch position of A9 board and other necessary conditions of the 4274A.

Signature Analysis for the 4274A.

The advantage of troubleshooting based on "Signature Analysis" is accuracy and ease in finding failures. It is generally difficult to search for an error by means of observing waveforms on an oscilloscope for the reason that bit trains in a digital circuit seem to be much the same whichever is observed. Specifically, to find the errors in a stream of large bit size (or word length) data takes much time and requires the use of an instrument such as a logic state analyzer. Hewlett-Packard has proposed a method called "Signature Analysis" which recognizes the bit pattern measured in a 4 digit hexa decimal code (signature) for running an easy diagnostic test program. With the Signature Analyzer (HP 5004A), the signatures are displayed in a readable 4 digit-figure set of alphanumeric figures (0 1 2 3 4 5 6 7 8 9 A C F H P U). Signature analysis is based on the usual signal tracing method followed in troubleshooting an analog circuit. According to signature analysis, devices in a digital circuit are checked with the signal analyzer by comparing signal input and output signatures to and from each device for the "correct" signature denoted in the service manual signature map. If a signature is not identical, the troubleshooter need only trace the bit train in the opposite direction of the signal flow and, when a device is noted which generates an erratic signature despite a correct input, the component may be regarded as faulty.

Digital Section Troubleshooting Using Signature Analyzer.

Figure 8-10. Signature Analysis Guide (Sheet 2 of 2).

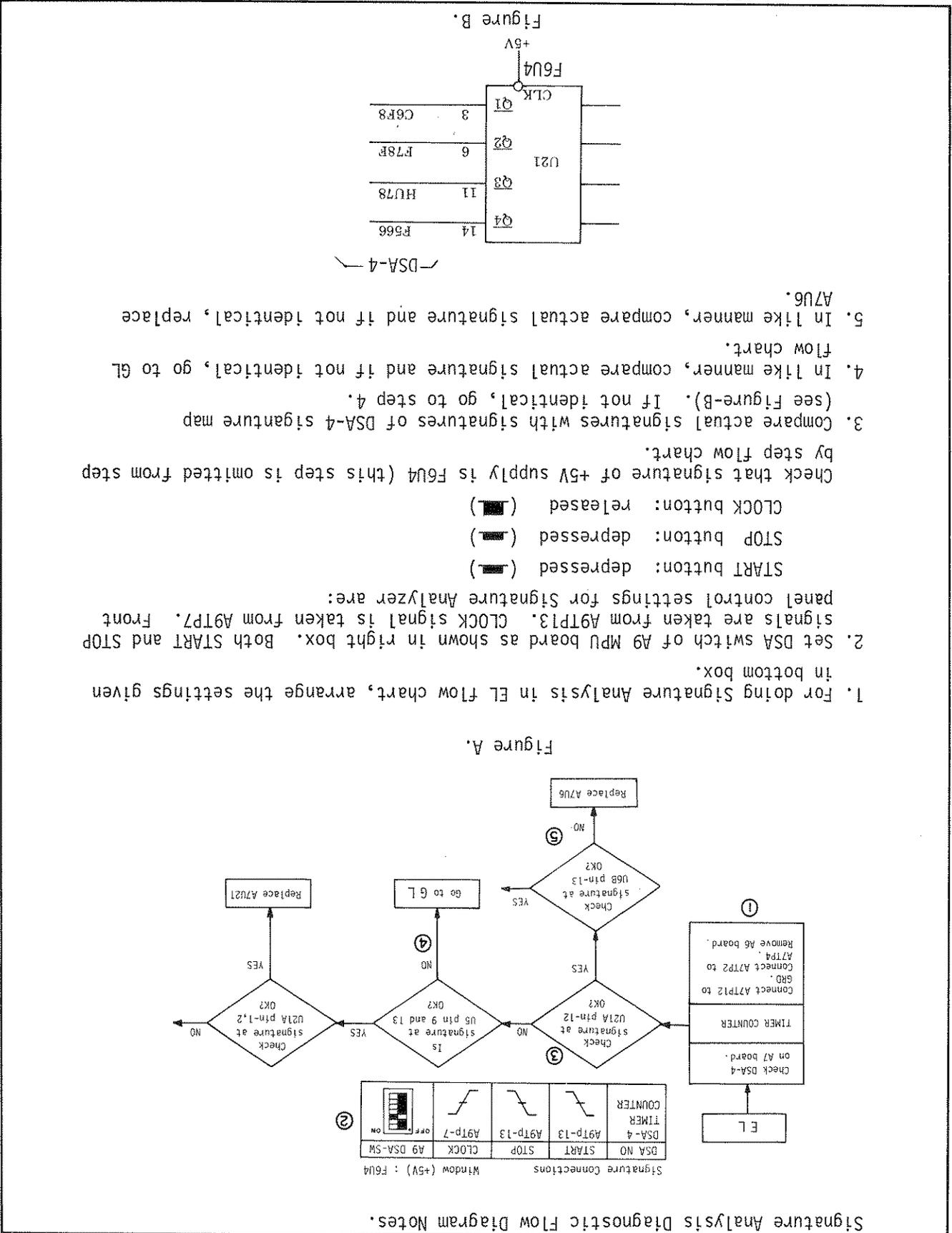
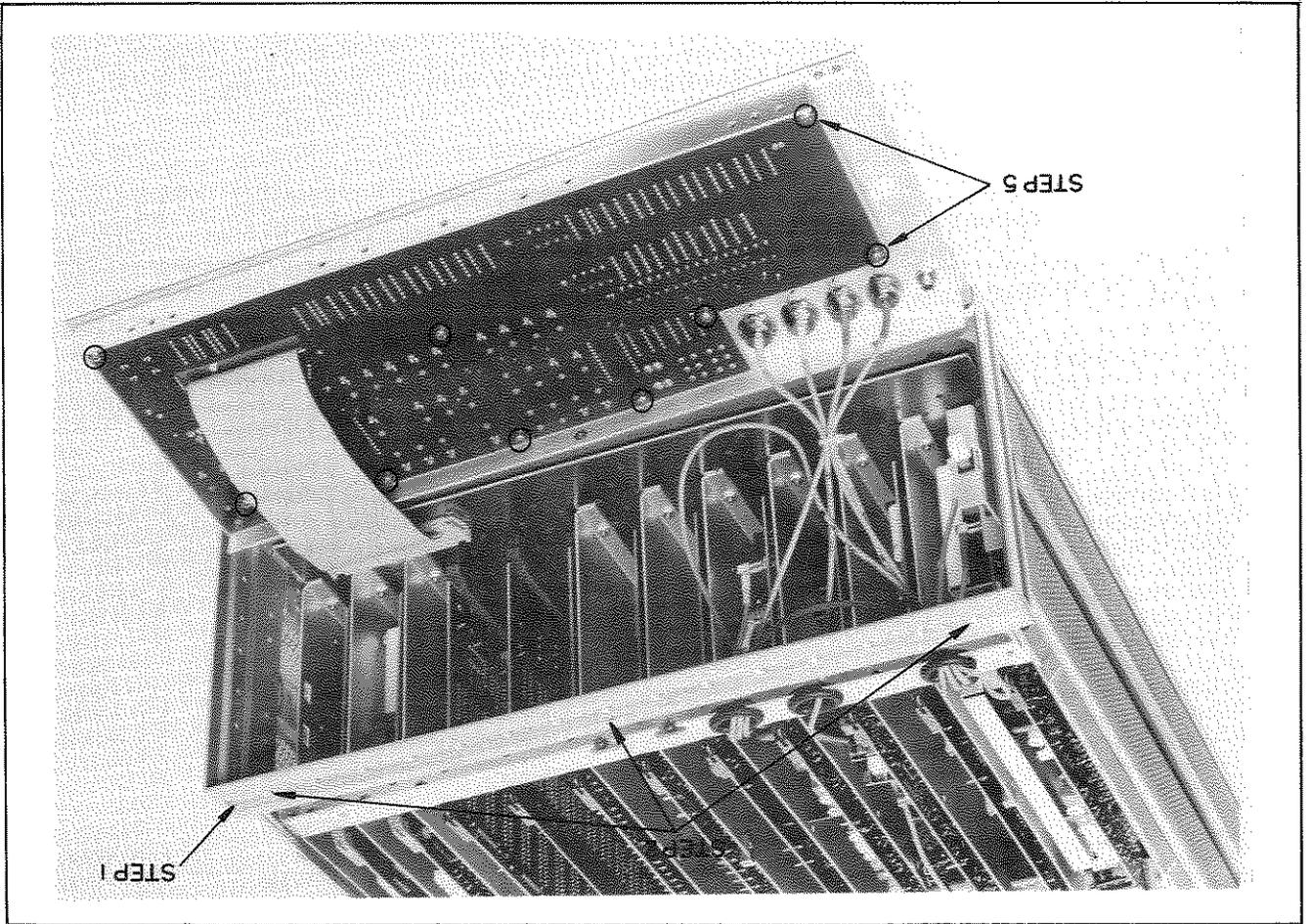


Figure 8-11. A10 Display and Key Board Disassembly.



3. Remove the two foot assemblies and three screws from bottom of front frame.
4. Press front panel assembly forward (from inside) without adding strong stress to the cable assemblies which are connected between front panel and main body.
5. Remove the nine (9) screws from A10 board assembly and the now accessible associated parts around the front panel and the A10 board assembly.

1. Carefully remove trim strip from top of front frame (without bending trim strip).
 2. Remove the three screws from top of front frame.
- To replace the parts mounted on A10 board assembly, the front panel has to be removed from the front frame of the 4274A. The procedure is as follows:
- 8-44. Disassembly of A10 (Display and Key) Board

8-45. PRODUCT SAFETY CHECKS.

WARNING

WHENEVER IT APPEARS LIKELY THAT SAFETY PROTECTIVE PROVISIONS HAVE BEEN IMPAIRED, THE APPARATUS SHALL BE MADE INOPERATIVE AND BE SECURED AGAINST ANY UNINTENDED OPERATION. THE PROTECTION IS LIKELY TO BE COMPROMISED IF, FOR EXAMPLE:

--- THE APPARATUS SHOWS VISIBLE DAMAGE.

--- THE INSTRUMENT FAILS TO PERFORM THE INTENDED MEASUREMENT.

--- THE UNIT HAS UNDERGONE PROLONGED STORAGE UNDER UNFAVORABLE CONDITIONS.

--- THE INSTRUMENT HAS SUFFERED SEVERE TRANSPORT STRESS.

8-46. The following five checks are recommended to verify the product safety of the 4274A LCR Meter (these checks may also be done to check for product safety after troubleshooting and repair). When such checks are needed, perform the following.

1. Visually inspect interior of instrument for any signs of abnormal internal heat such as discolored printed circuit boards or components, damaged insulation, or evidence of arcing. Determine and remedy cause of any such condition.

2. Using a suitable ohmmeter, check resistance from instrument enclosure to ground pin on power cord plug. The reading must be less than 0.5 ohm. Flex the power cord while making this measurement to determine whether intermittent discontinuities exist.

3. Check GROUND terminal on front panel using procedure (2).

- 4. Disconnect instrument from power source. Turn power switch to on. Check resistance from instrument enclosure to line and neutral (tied together). The minimum acceptable resistance is two megohms. Replace any component which fails or causes a failure.
- 5. Check line fuse to verify that a correctly rated fuse is installed.

Figure 8-12. Schematic Diagram Notes.

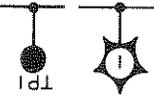
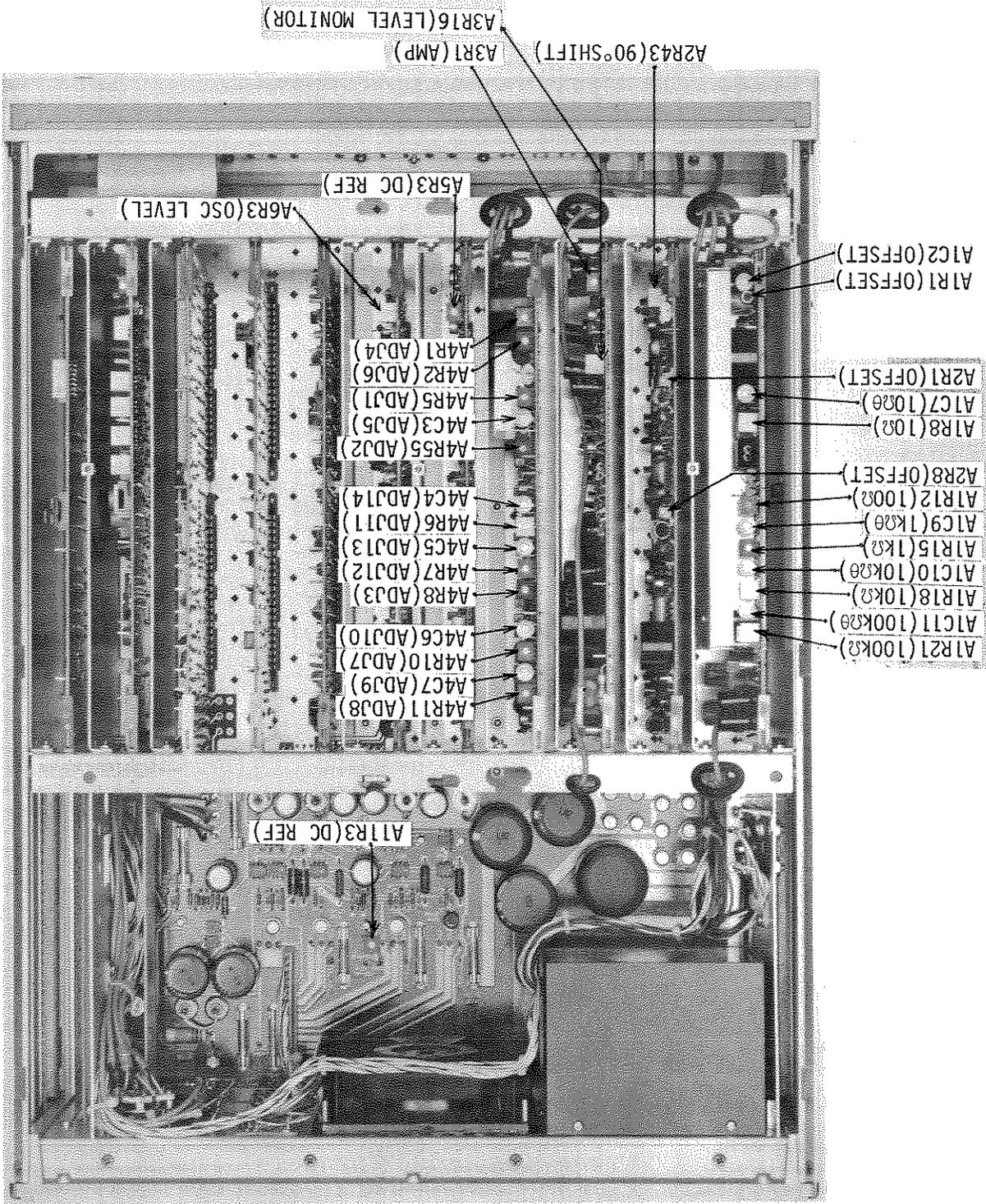
Part of.		Encloses front panel designations.
Knob control.		Encloses rear panel designations.
Screwdriver adjustment.		Circuit assembly borderline.
Asterisk denotes a factory selected value. Value shown is typical (part many be omitted).	*	Heavy line indicates main signal path.
Heavy dashed line indicates 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 the earth.		Indicates conducting connection to chassis or frame.
Indicates circuit common connection.		

Figure 8-13. Adjustment Location.



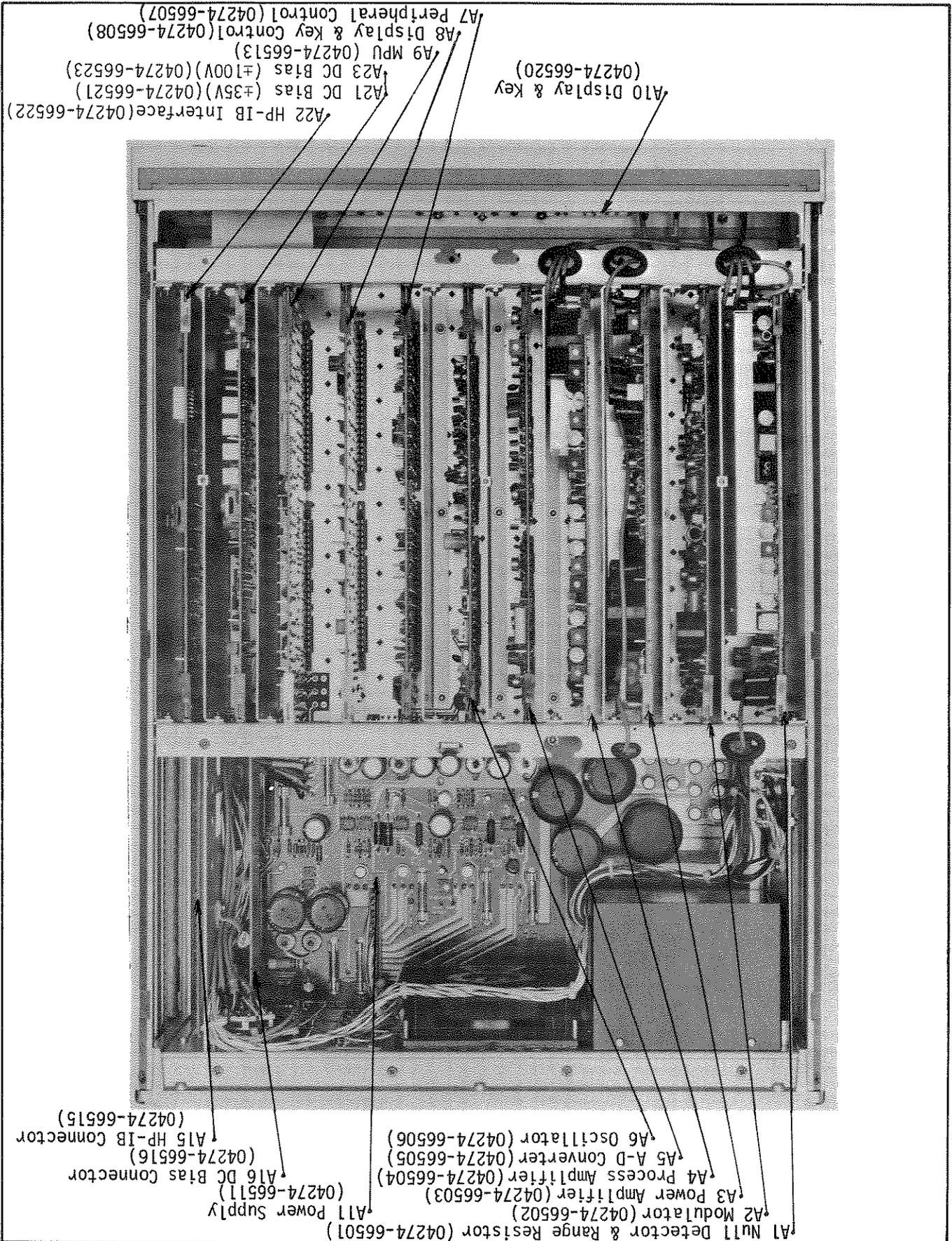
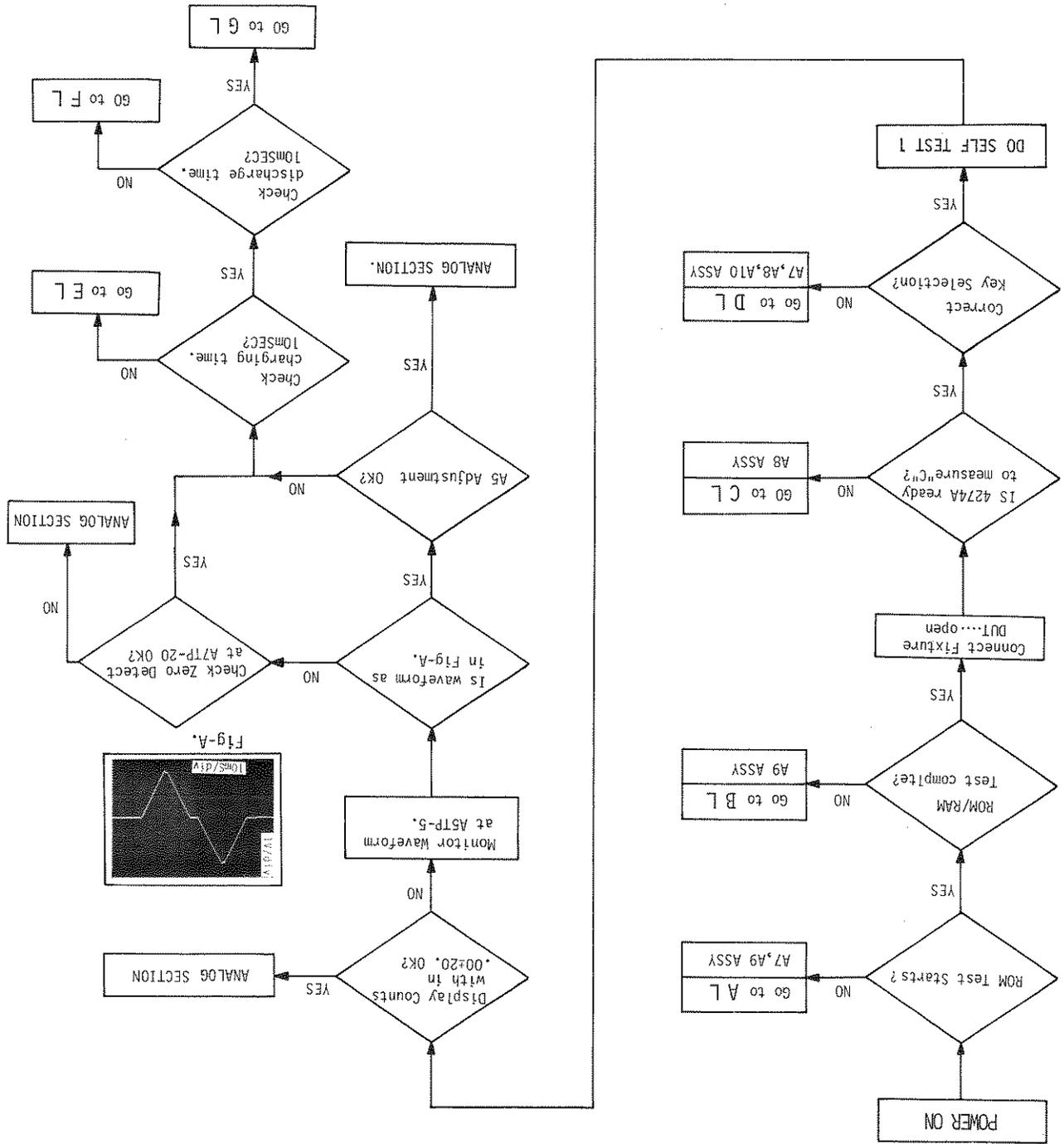
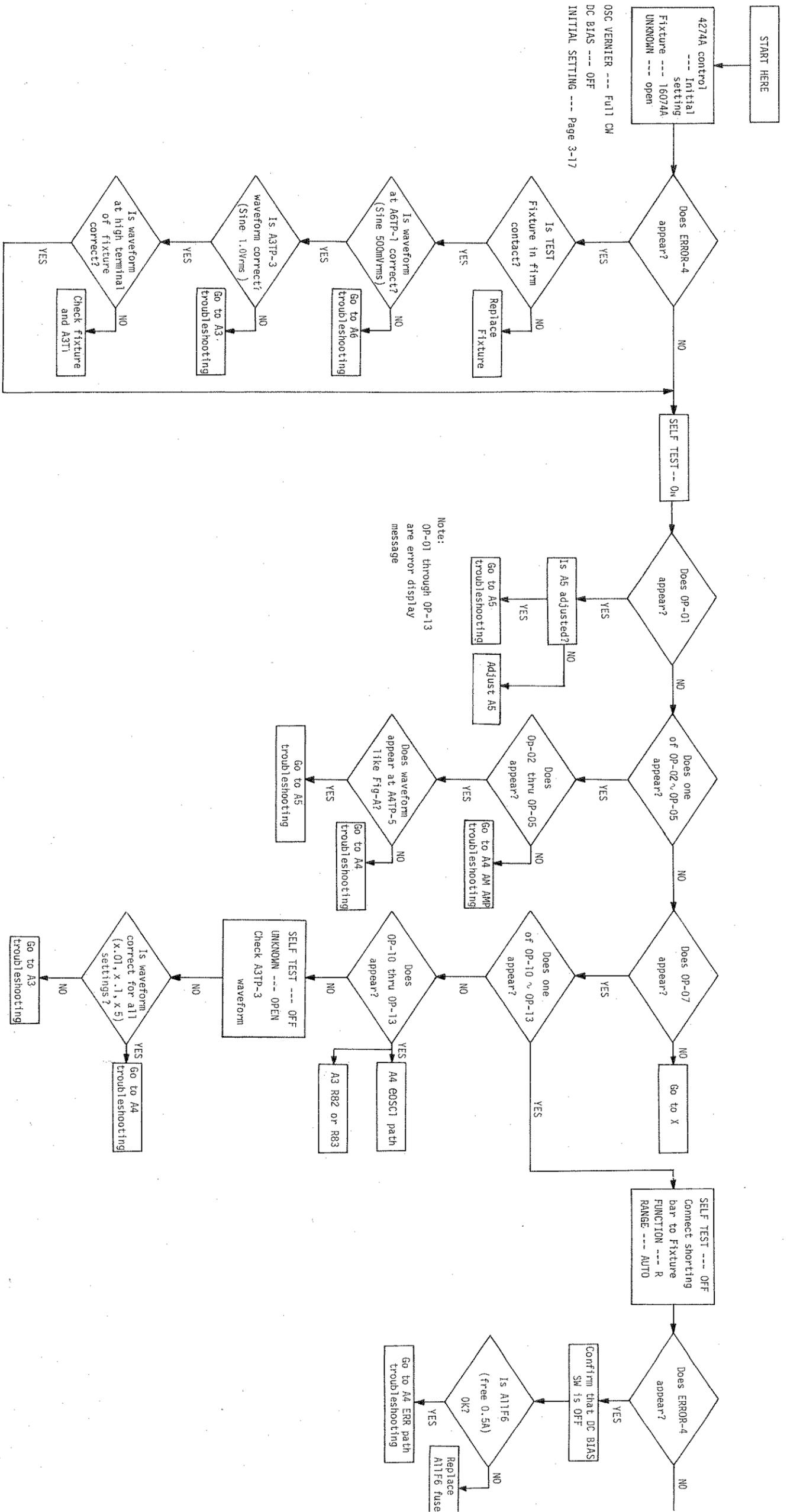


Figure 8-14. Assembly Location.

FIGURE 8-15, ANALOG AND DIGITAL SECTIONS ISOLATION FLOW.







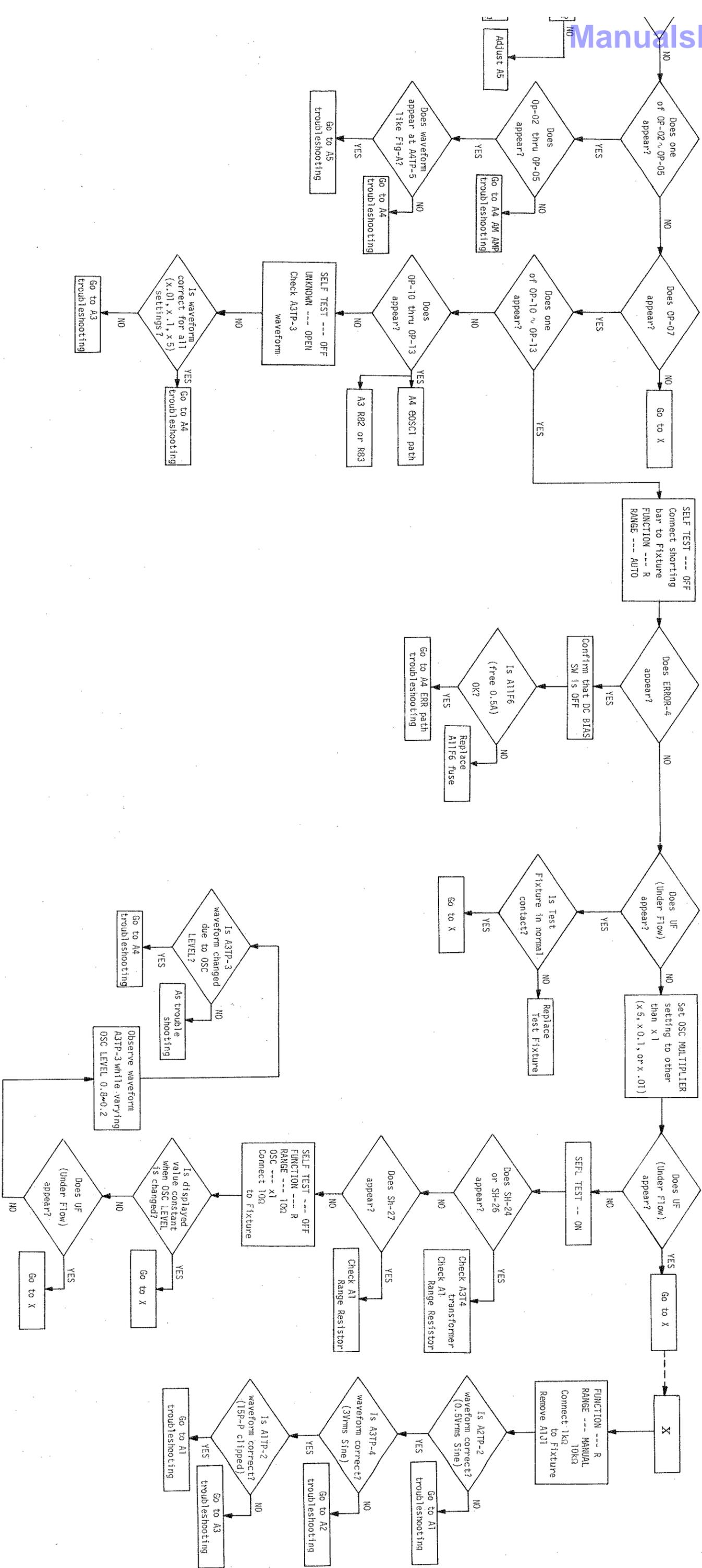
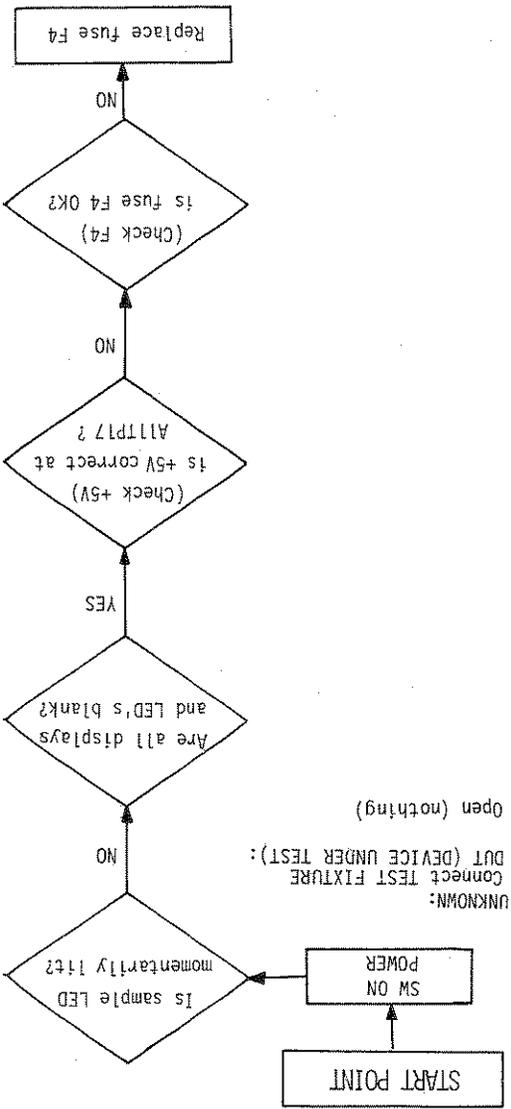


Figure 8-16

FIGURE 8-16. ANALOG SECTION TROUBLE SHOOTING TO ASSEMBLY LEVEL.



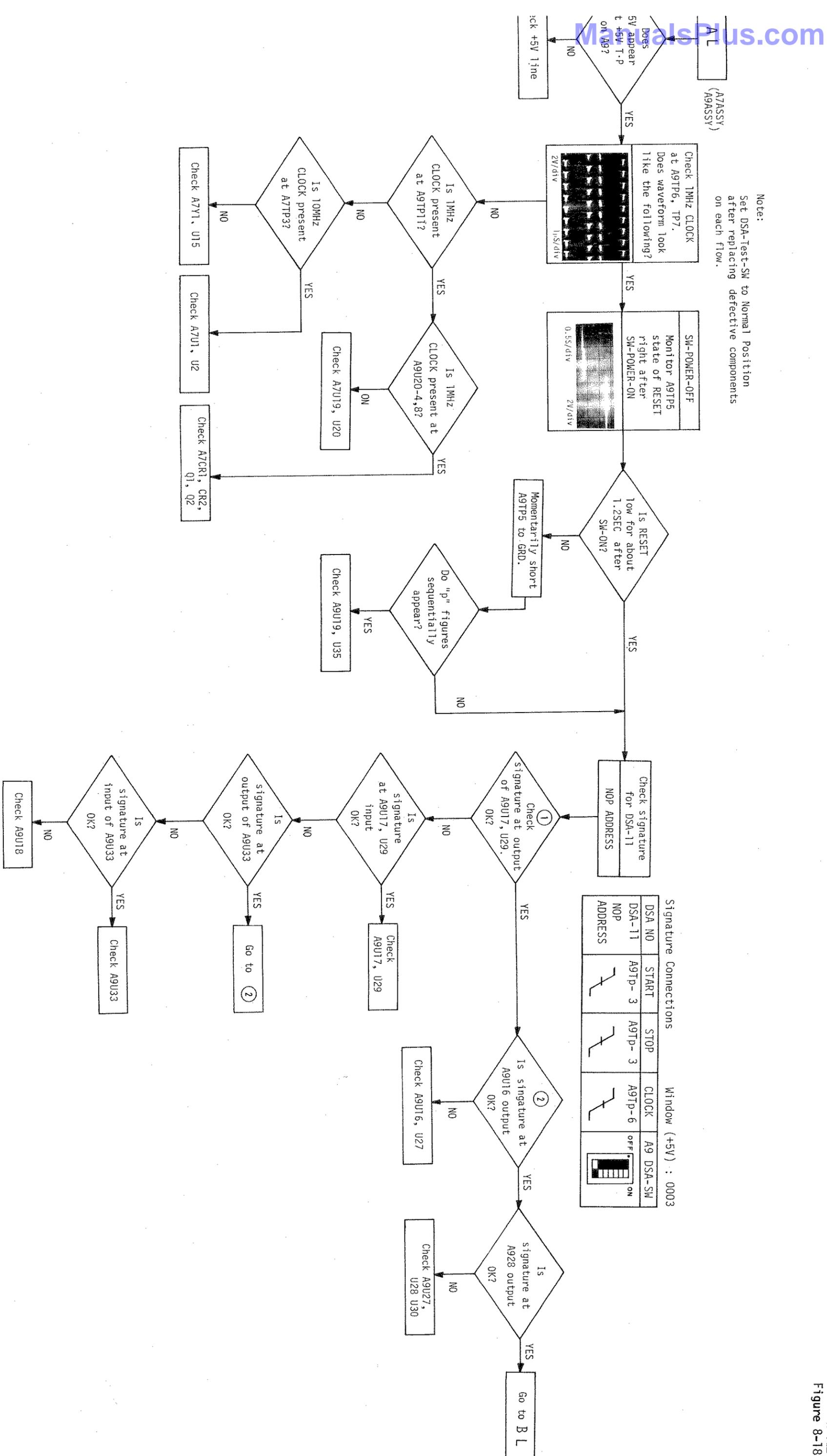


FIGURE 8-18, DIGITAL SECTION TROUBLE SHOOTING FLOW DIAGRAM AL, 8-37

Signature Connections for DSA-1 and DSA-12 thru DSA-21.

Signature Connections Window (+5V) : APC4

DSA NO	START	STOP	CLOCK	A9 DSA-SW
DSA-1	A9Tp-13	A9Tp-13	A9Tp-7	OFF ON
RAM				
DATA BUS				

Signature Connections Window (+5V) : 755U

DSA NO	START	STOP	CLOCK	A9 DSA-SW
DSA-12	A9U27-11	A9U16-5	A9Tp-6	OFF ON
NOP	(U7~U7)			

Signature Connections Window (+5V) : 826P

DSA NO	START	STOP	CLOCK	A9 DSA-SW
DSA-13	A9U22-9	A9U10-20	A9Tp-6	OFF ON
NOP	(U10)			

Signature Connections Window (+5V) : P254

DSA NO	START	STOP	CLOCK	A9 DSA-SW
DSA-14	A9U16-10	A9U16-7	A9Tp-6	OFF ON
NOP	(U1)			

Signature Connections Window (+5V) : P254

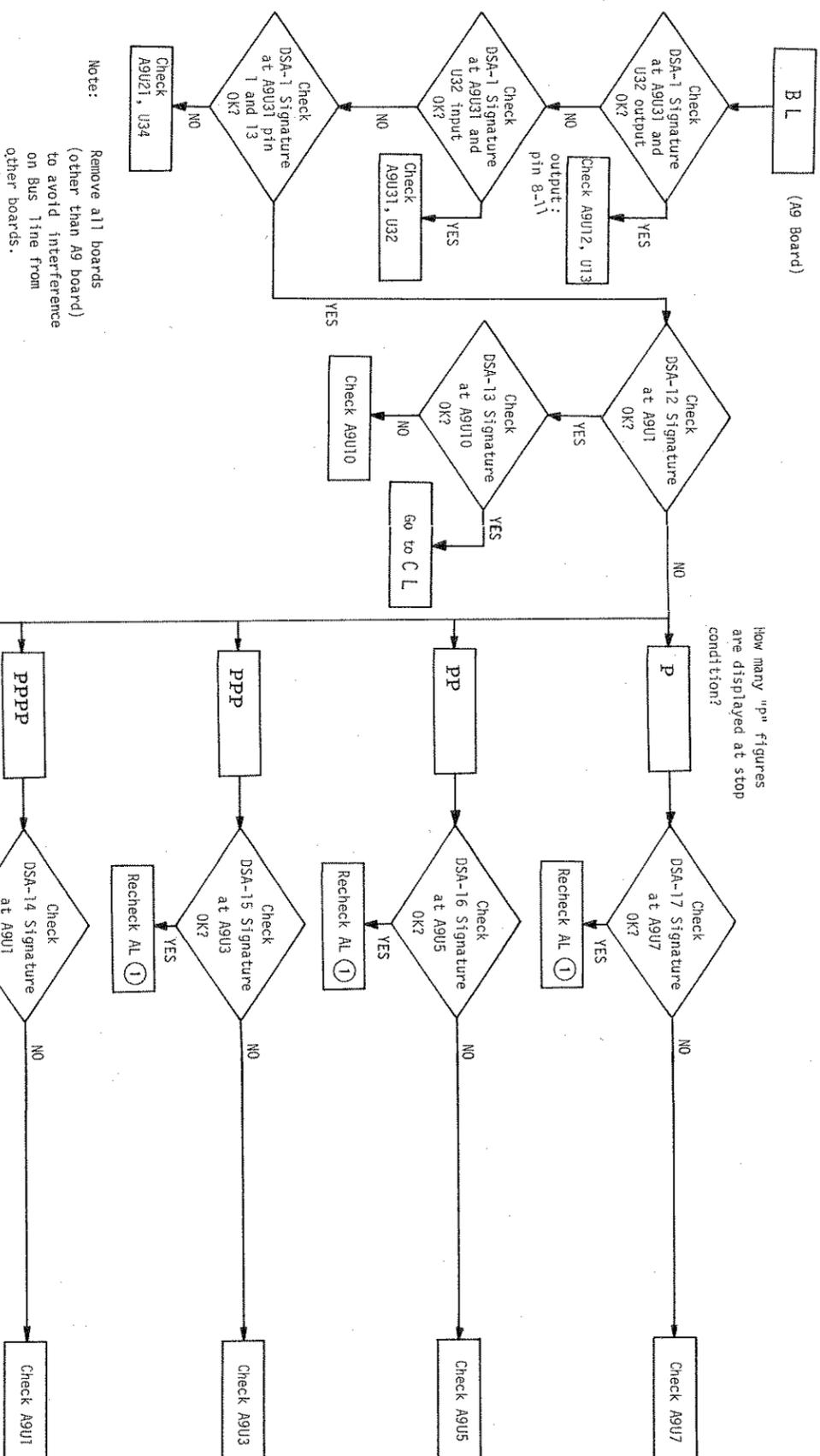
DSA NO	START	STOP	CLOCK	A9 DSA-SW
DSA-15	A9U16-10	A9U16-7	A9Tp-6	OFF ON
NOP	(U3)			

Signature Connections Window (+5V) : P254

DSA NO	START	STOP	CLOCK	A9 DSA-SW
DSA-16	A9U16-12	A9U16-10	A9Tp-6	OFF ON
NOP	(U5)			

Signature Connections Window (+5V) : P254

DSA NO	START	STOP	CLOCK	A9 DSA-SW
DSA-17	A9U16-14	A9U16-12	A9Tp-6	OFF ON
NOP	(U7)			



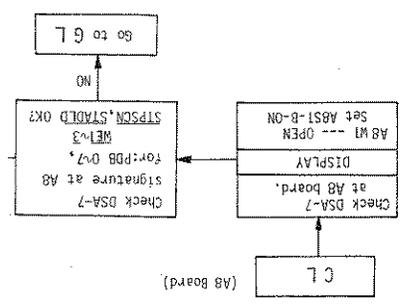
How many "p" figures are displayed at stop condition?

FIGURE 8-12

FIGURE 8-19, DIGITAL SECTION TROUBLE SHOOTING FLOW DIAGRAM BL.

Signature Connections Window (+5V):

DSA NO	START	STOP	CLOCK	A9 DSA
DSA-7	A9TP-13	A9TP-13	A9TP-7	
DISPLAY				



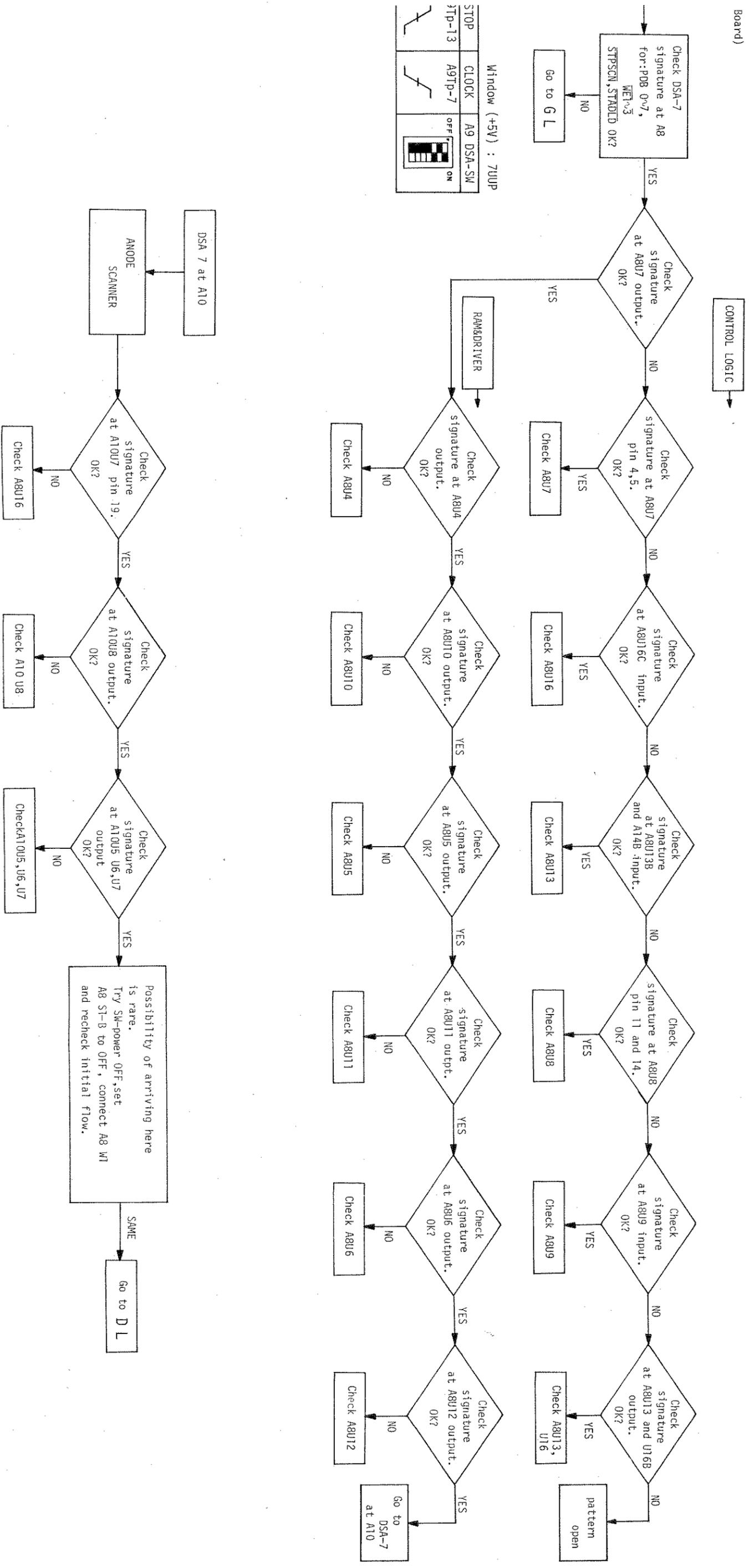


FIGURE 8-20. DIGITAL SECTION TROUBLE SHOOTING FLOW DIAGRAM CL.

Signature Connections Window (+5V) : FGU4

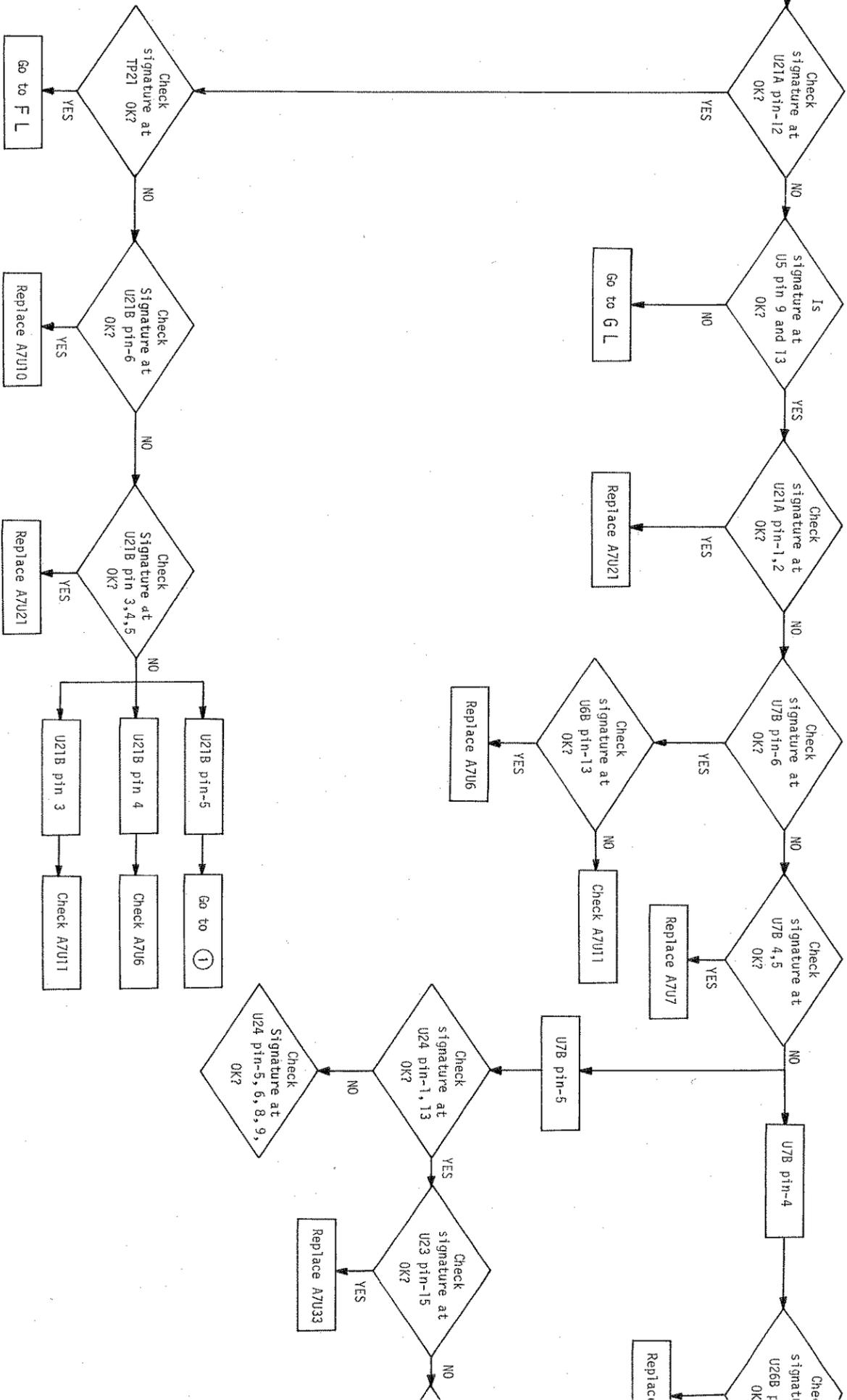
DSA NO	START	STOP	CLOCK	A9 DSA-SW
DSA-4 TIMER COUNTER	A9Tp-13 <input checked="" type="checkbox"/>	A9Tp-13 <input checked="" type="checkbox"/>	A9Tp-7 <input checked="" type="checkbox"/>	OFF <input type="checkbox"/> ON <input type="checkbox"/>

EL

Check DSA-4 on A7 board.

TIMER COUNTER

Connect A7Tp12 to GRD.
Connect A7Tp2 to A7Tp4.
Remove A6 board.



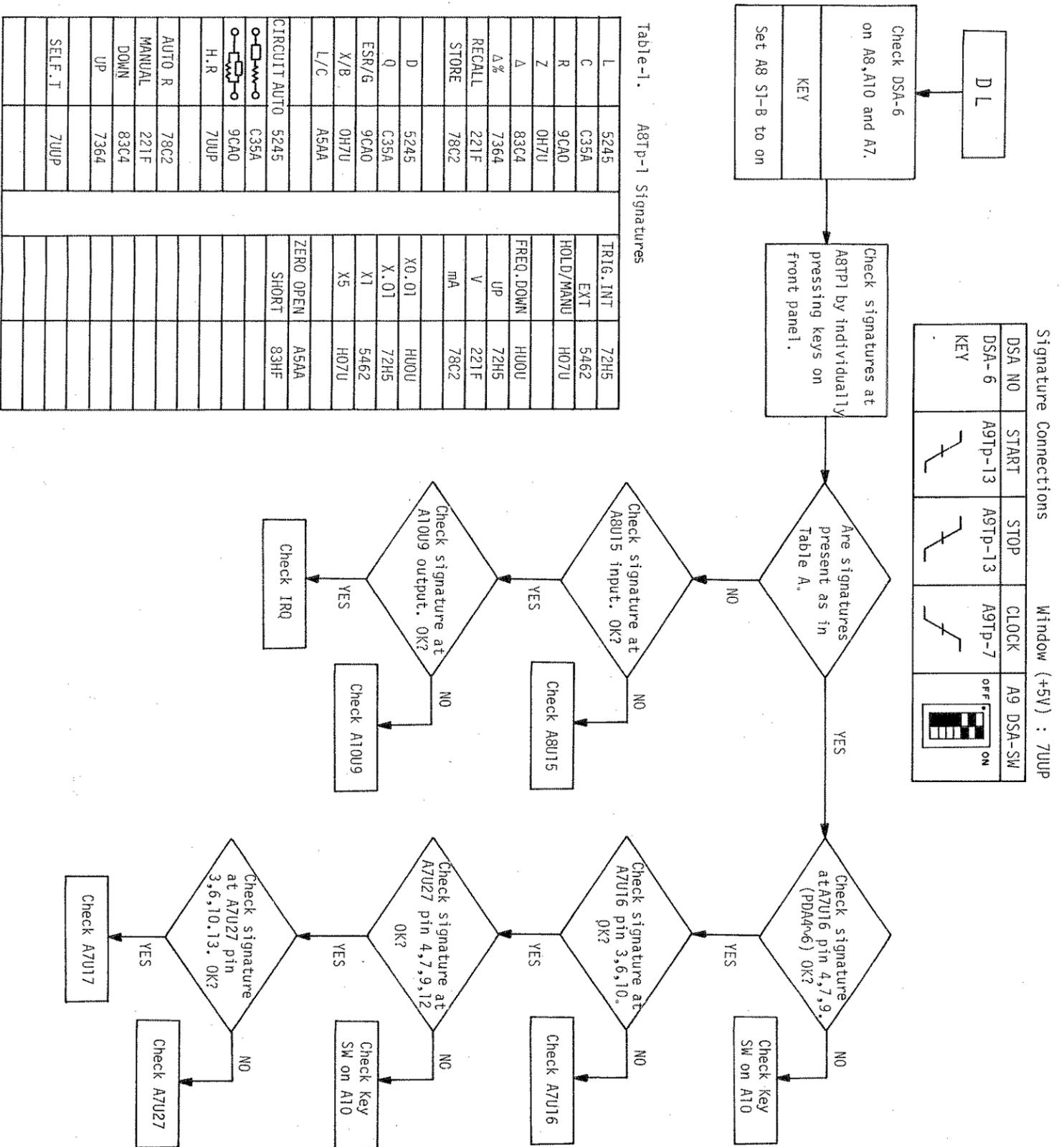


Table 2. A10U9 Signatures

pin	Key	signature	pin	Key	signature
1	SELF TEST	0000	9	STORE	074F
2	L	ZHCC	10	Δ	UF4A
3	C	FFA4	11	Δ%	0F9A
4	R	P45P	14	0.01	A0U1
5	Z	7281	15	0.1	0H2C
6	L/C	HA54	16	1	2C9F
7	SHORT	UF22	17	5	AU81
8	RECALL	SHP2			

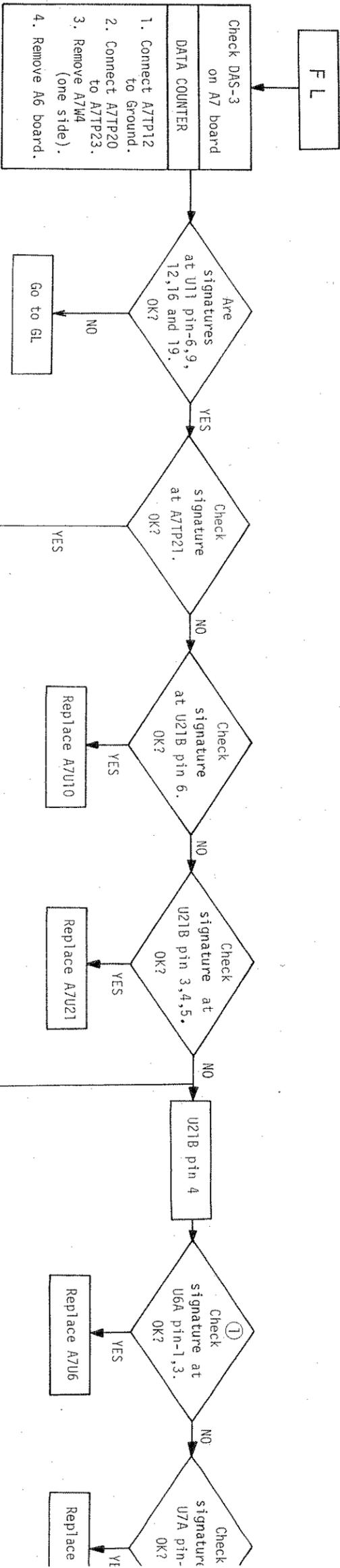
Table 3. A7U16,U27 Signatures

SIGNAL	TEST PIN	SIGNATURE	TEST PIN	SIGNATURE
PDA 0	U27-4	P48F	U27-3	7686
1	-7	7CAA	-6	H68U
2	-9	1067	-10	7FUF
3	-12	C704	-13	PP7U
4	U16-4	0000	U16-3	PP7U
5	-7	0000	-6	PP7U
6	-9	0000	-10	PP7U

Table-1. A8Tp-1 Signatures

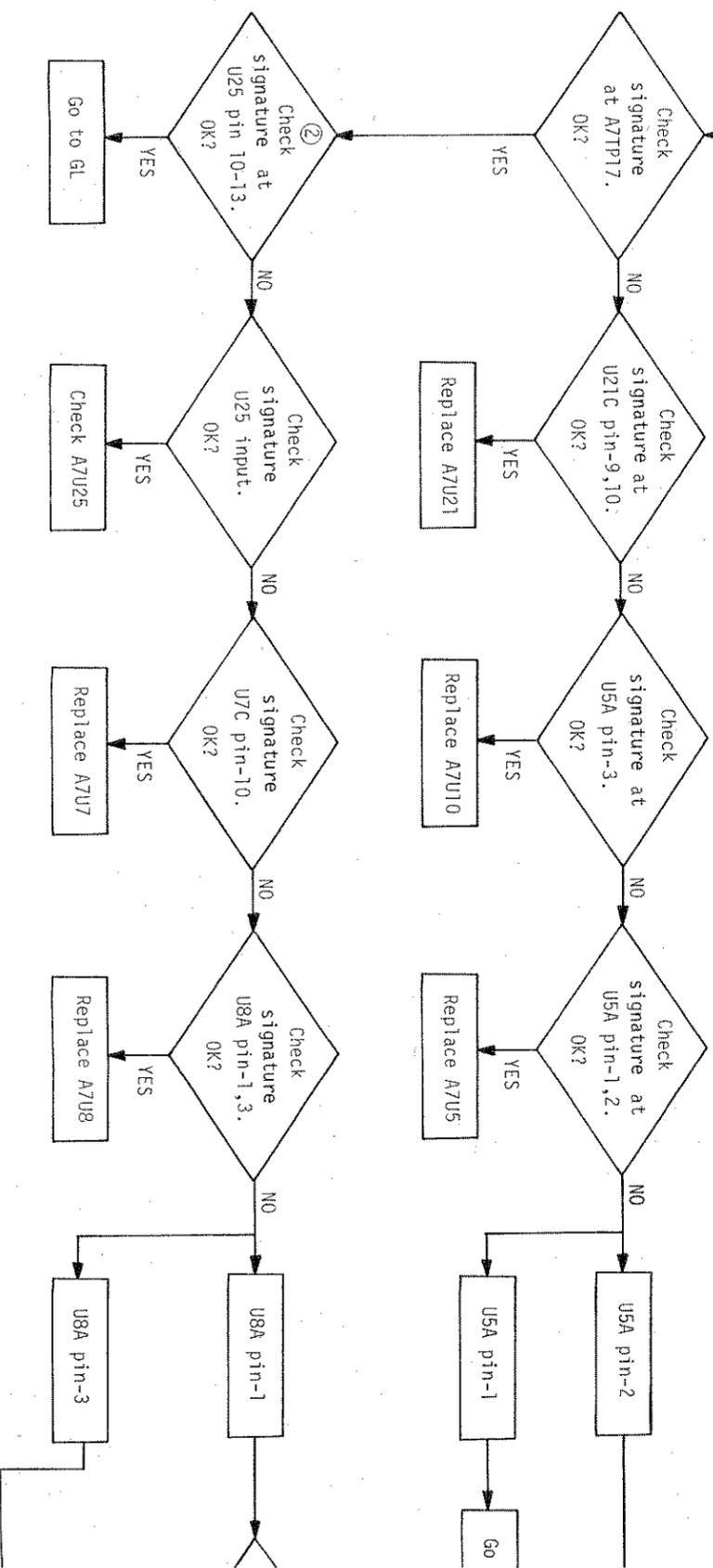
Key	Signature	Key	Signature
L	5245	TRIG. INT	72H5
C	C35A	EXT	5462
R	9CA0	HOLD/MANU	H07U
Z	0H7U		
Δ	83C4	FREQ. DOWN	HU0U
Δ%	7364	UP	72H5
RECALL	221F	V	221F
STORE	78C2	mA	78C2
D	5245	X0.01	HU0U
0	C35A	X.01	72H5
ESR/G	9CA0	X1	5462
X/B	0H7U	X5	H07U
L/C	A5AA	ZERO OPEN	A5AA
		SHORT	83HF
CIRCUIT AUTO	5245		
	C35A		
	9CA0		
H.R	7UUP		
AUTO R	78C2		
MANUAL	221F		
DOWN	83C4		
UP	7364		
SELF.T	7UUP		

FIGURE 8-21. DIGITAL SECTION TROUBLE SHOOTING FLOW DIAGRAM DL.



Signature Connections Window (+5V) : HIUH

DSA NO	START	STOP	CLOCK	A9 DSA-SW
DSA- 3	A9Tp-13	A9Tp-13	A9Tp-7	OFF ON



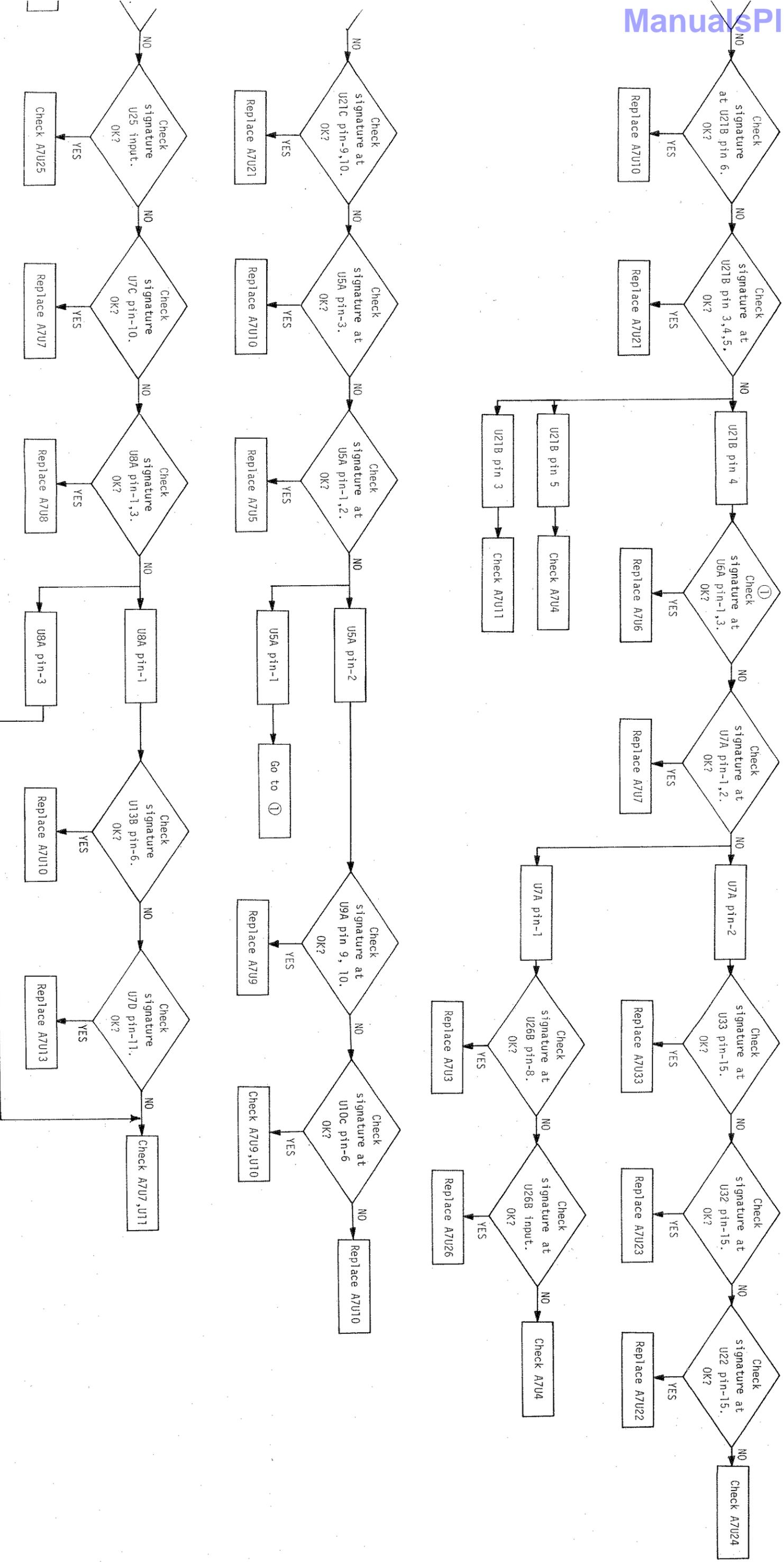


Figure 8-23

FIGURE 8-23. DIGITAL SECTION TROUBLE SHOOTING FLOW DIAGRAM FL. 8-47

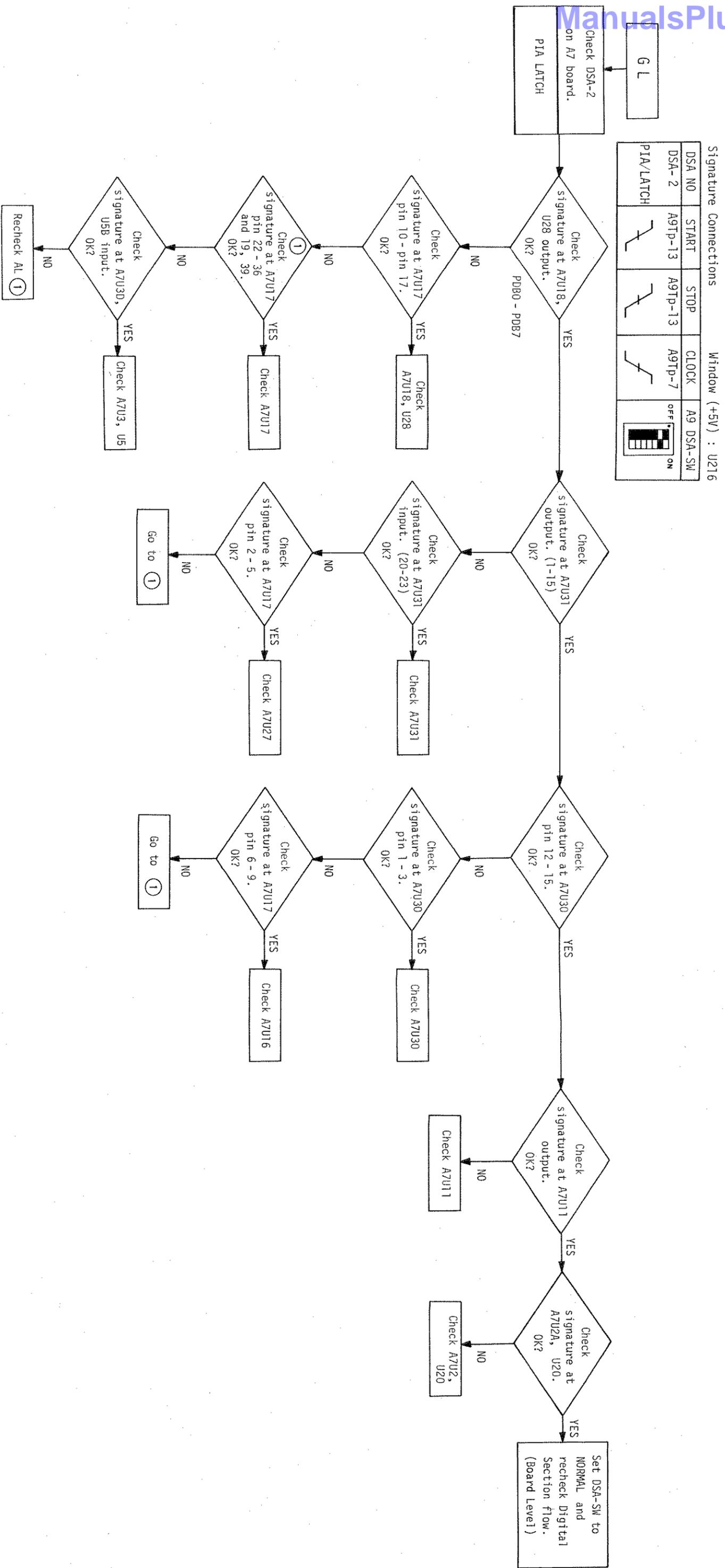


FIGURE 8-24. DIGITAL SECTION TROUBLE SHOOTING FLOW DIAGRAM GL. 8-49

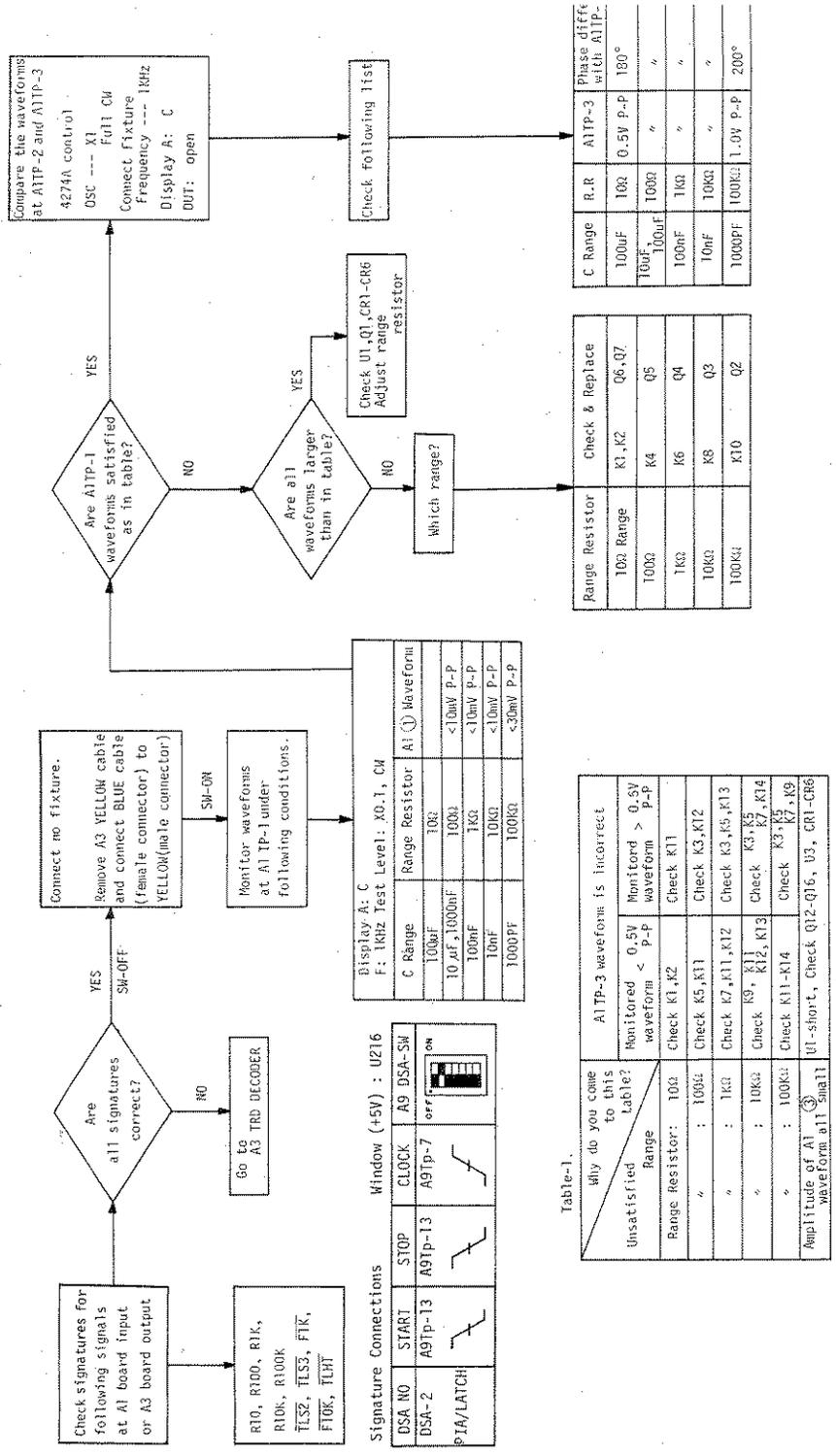


FIGURE 8-25. A1 RANGE RESISTOR AND NULL DETECTOR ASSEMBLY TROUBLESHOOTING TREE.

← G1 TROUBLESHOOTING TREE UNDER FOLD

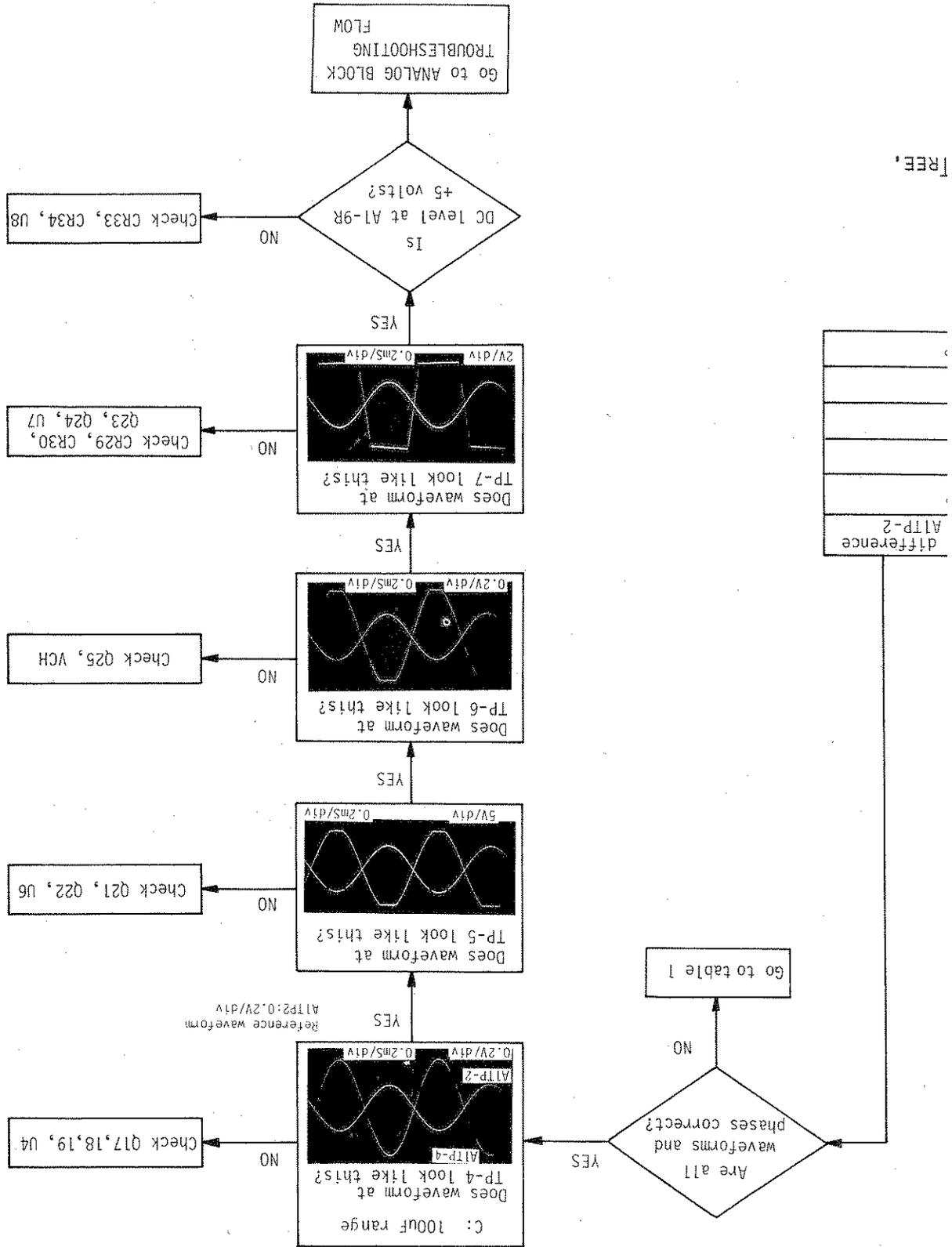
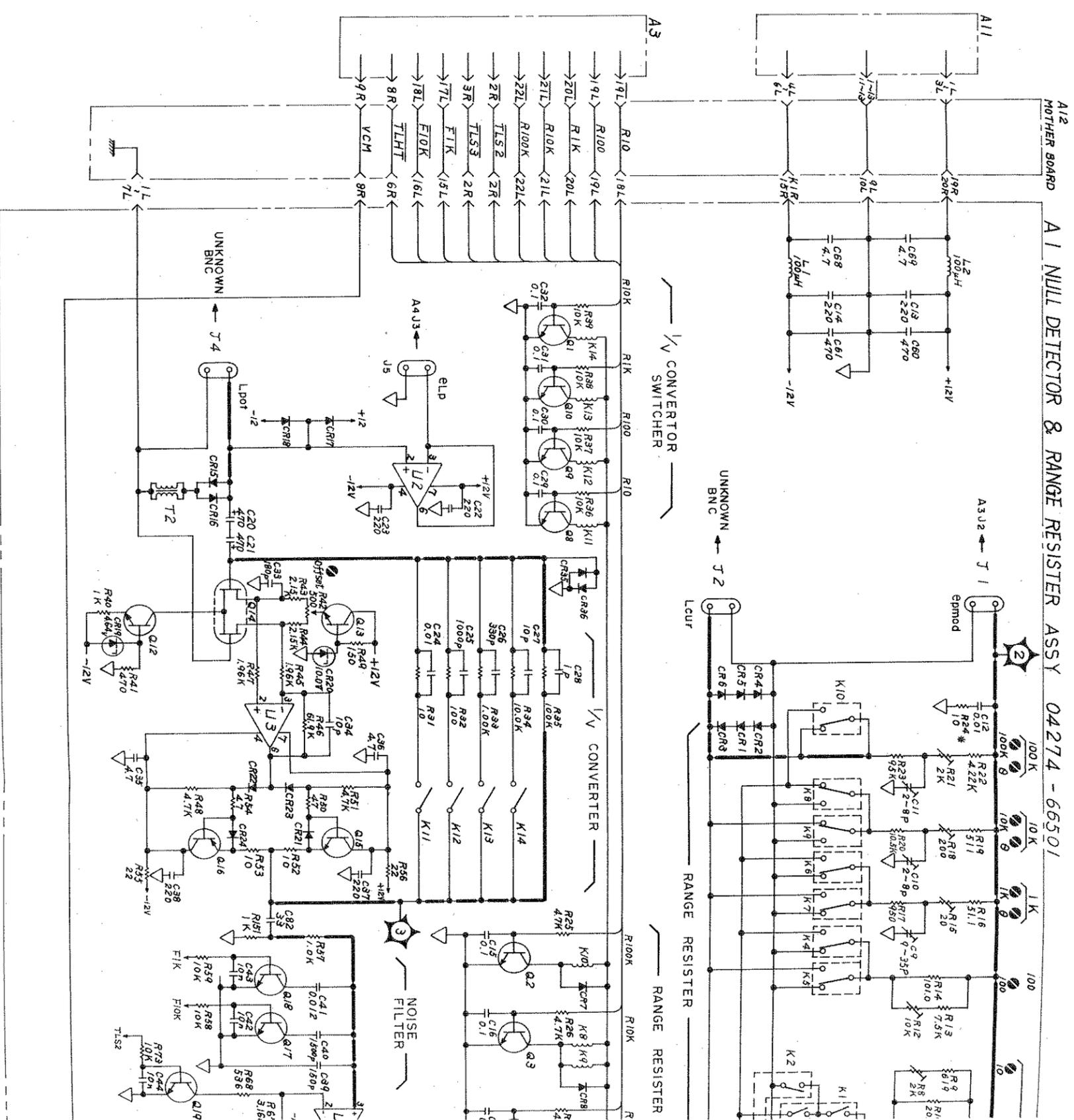
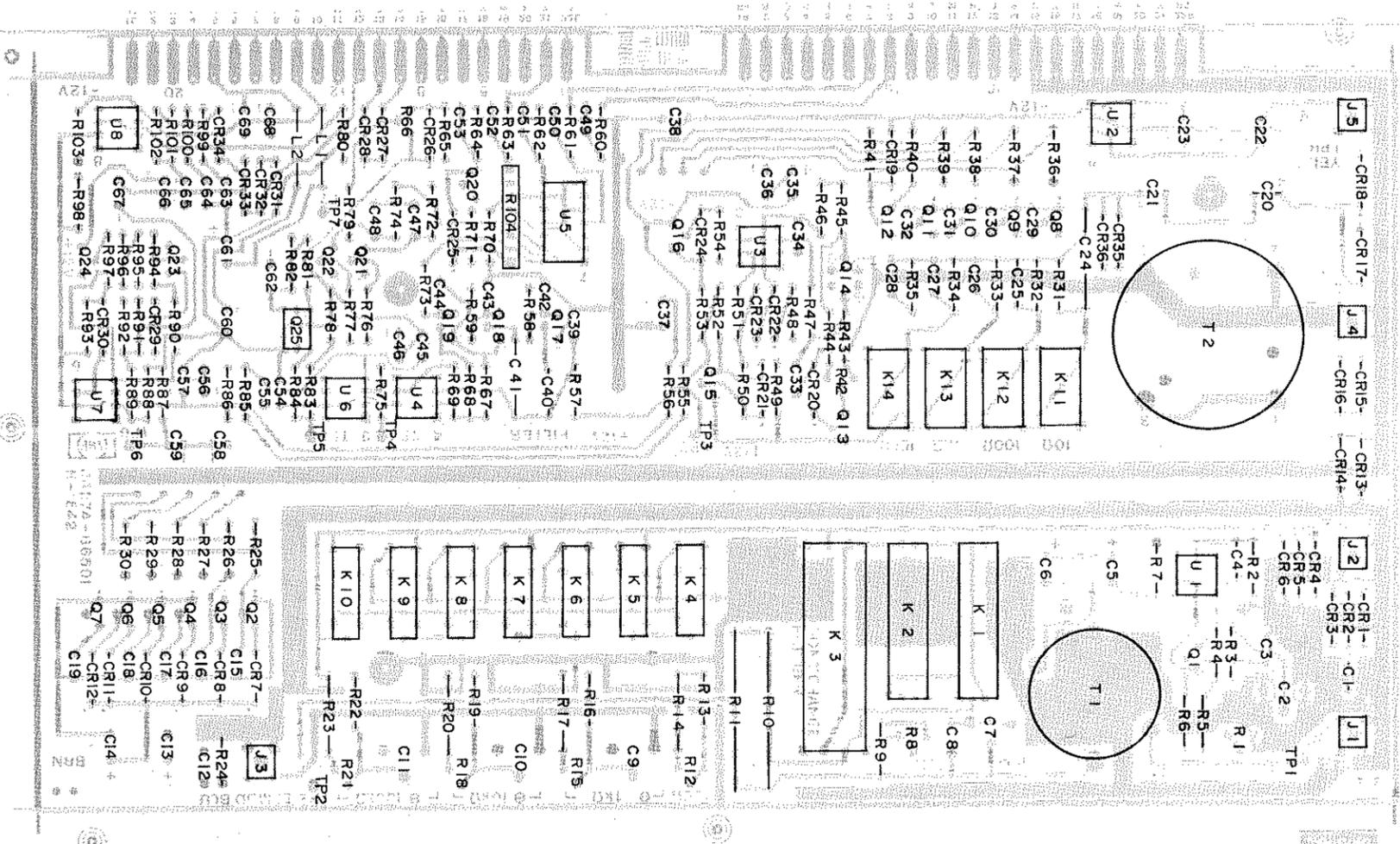
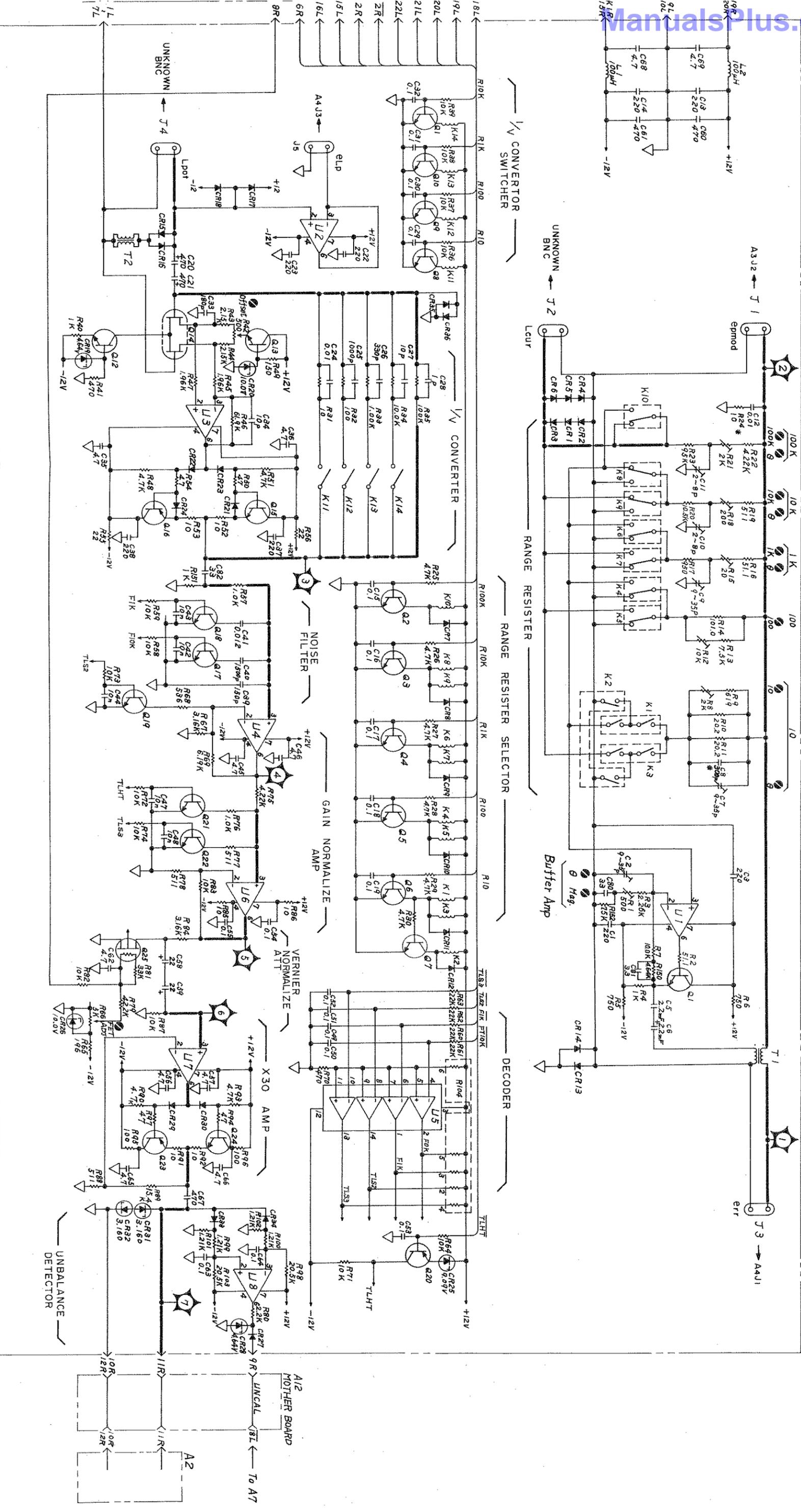


FIGURE 8-26. A1 RANGE RESISTOR AND NULL DETECTOR ASSEMBLY COMPONENT LOCATION.





FIGURES 8-20 AND 8-21

FIGURE 8-27, AI RANGE RESISTOR AND NULL DETECTOR ASSEMBLY SCHEMATIC DIAGRAM, 8-51

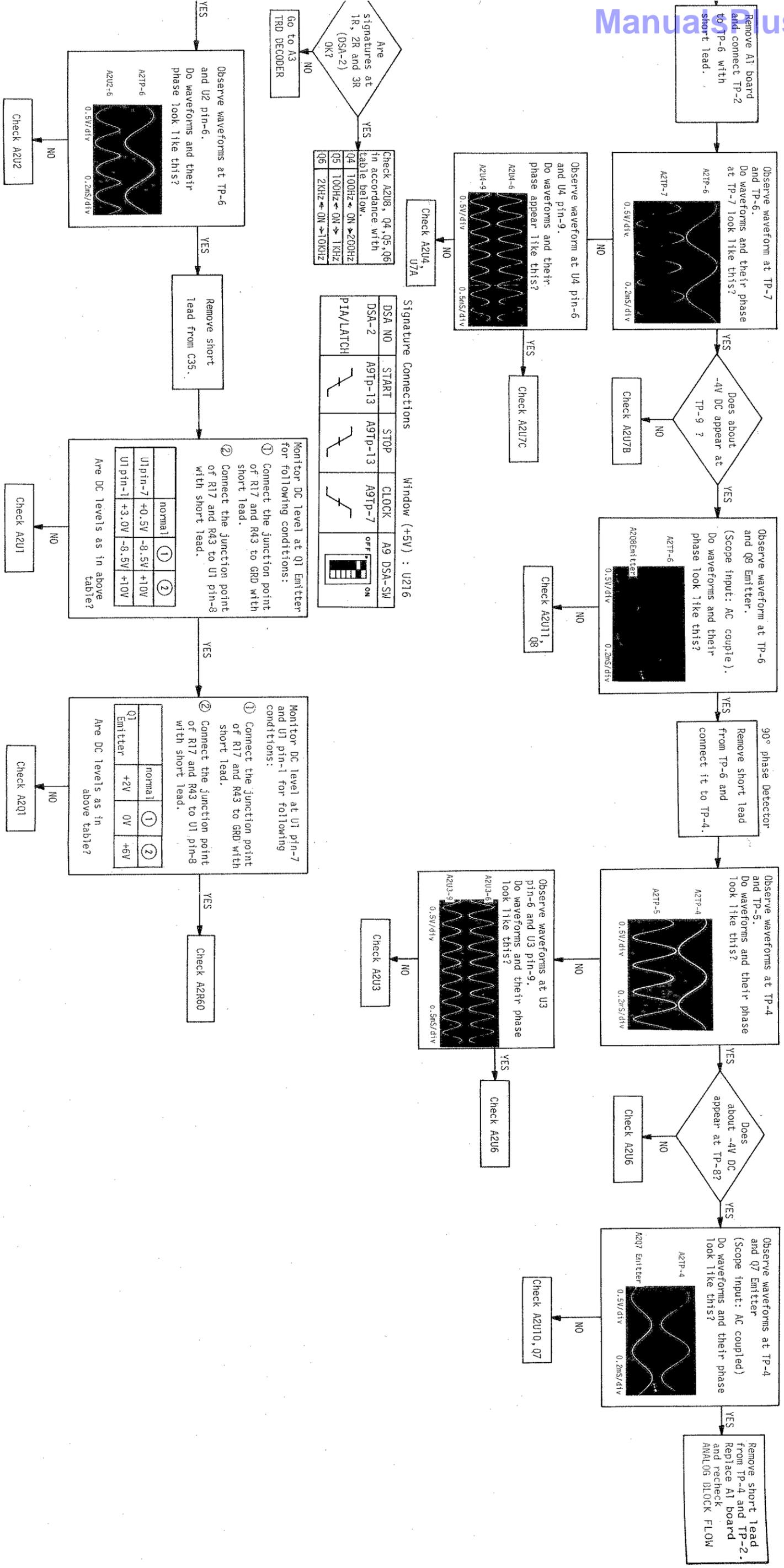


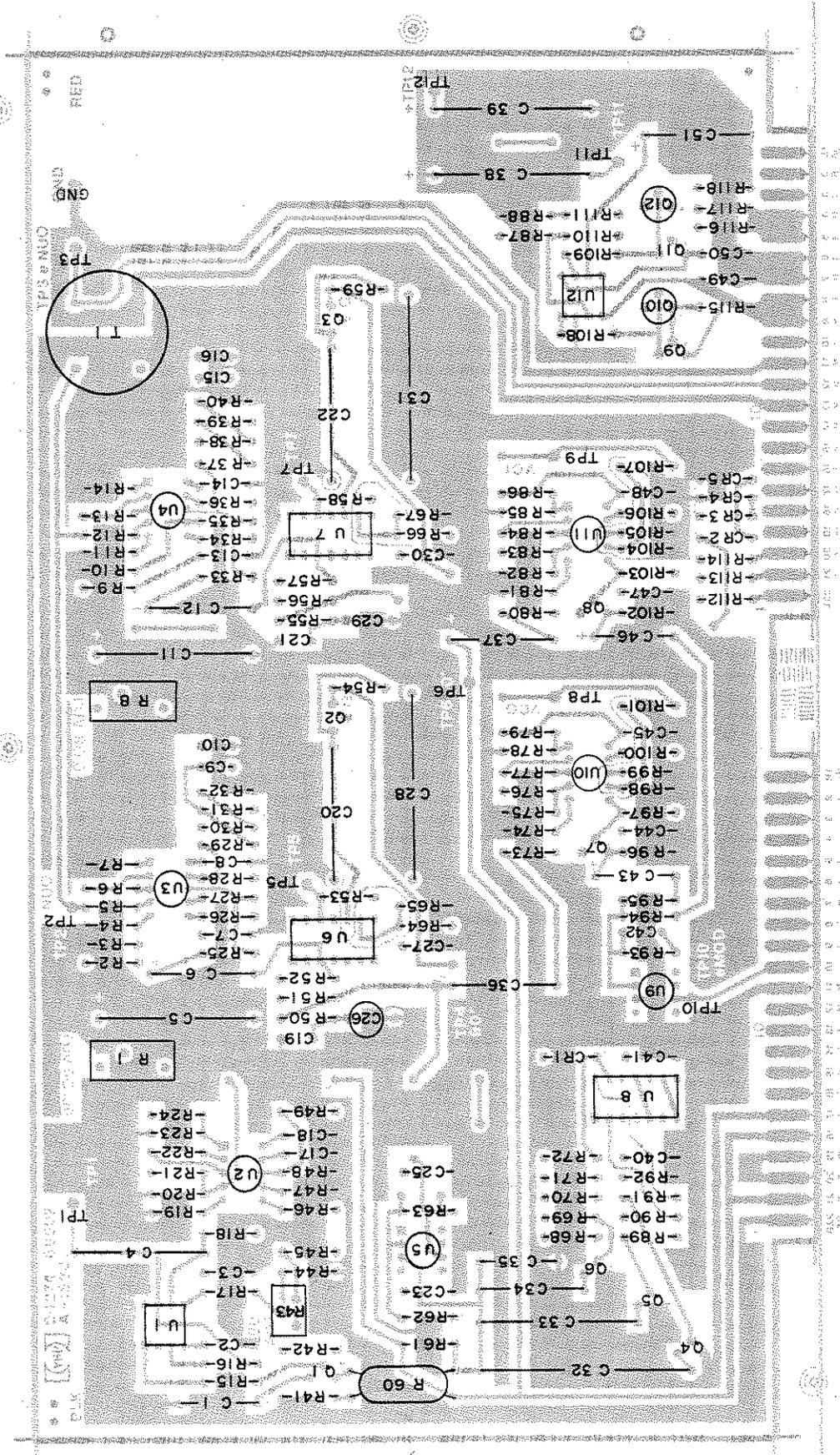
FIGURE 8-28. A2 MODULATOR ASSEMBLY TROUBLESHOOTING TREE.

AI Range Resistor and Null Detector
Service Sheet

8-51

8-52

FIGURE 8-29. A2 MODULATOR ASSEMBLY COMPONENT LOCATIONS.



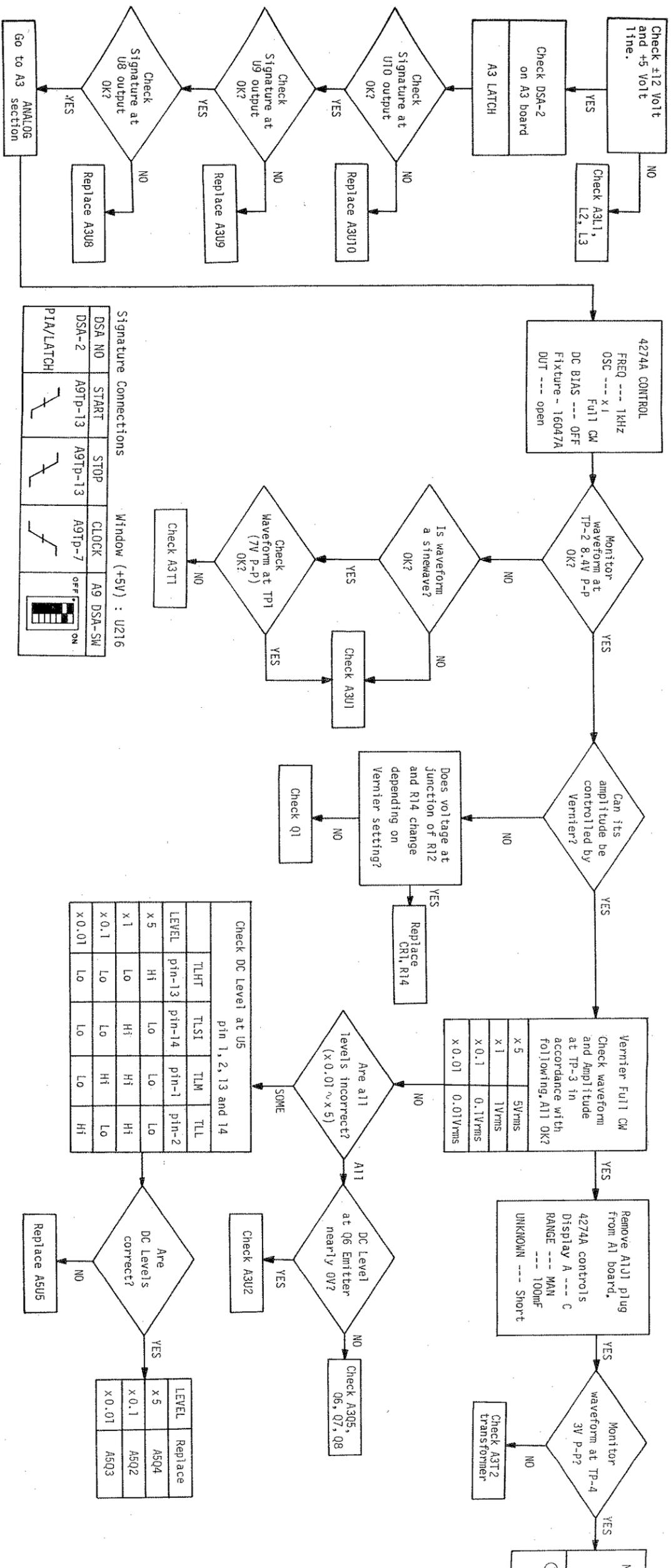
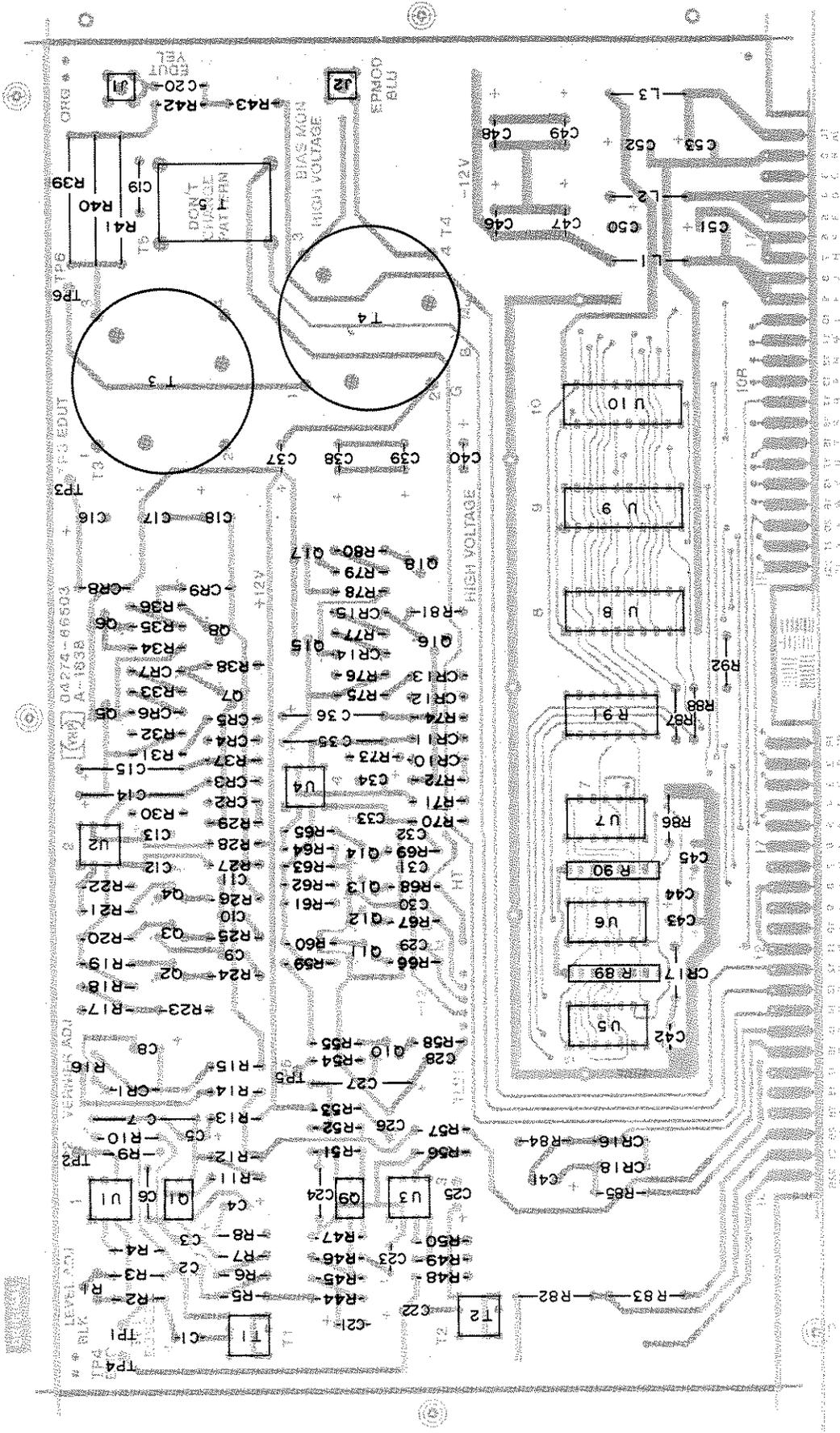


FIGURE 8-31. A3 POWER AMPLIFIER ASSEMBLY TROUBLESHOOTING TREE.

→ A2 Modulator Service Sheet

FIGURE 8-32. A3 POWER AMPLIFIER ASSEMBLY COMPONENT LOCATIONS.



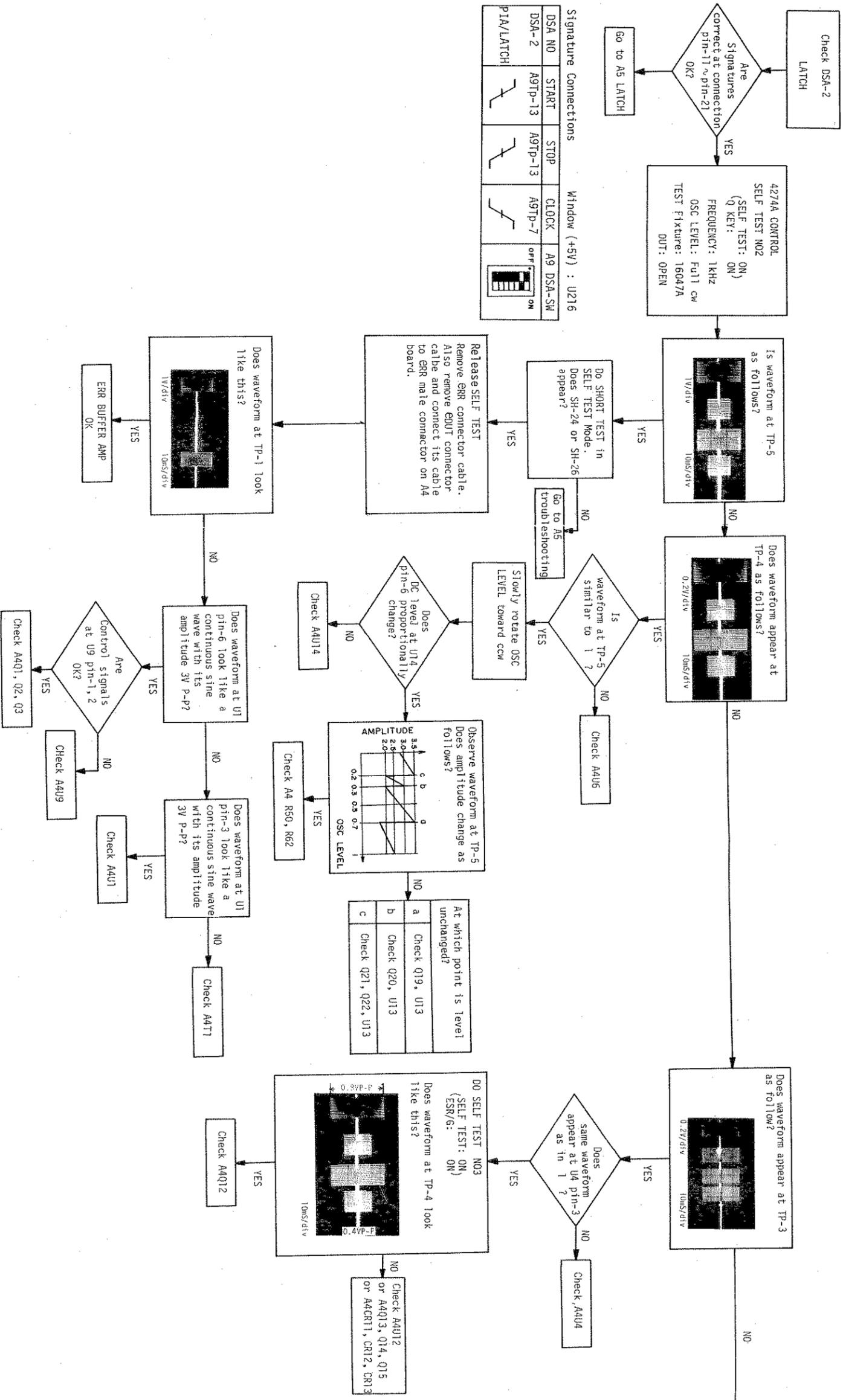
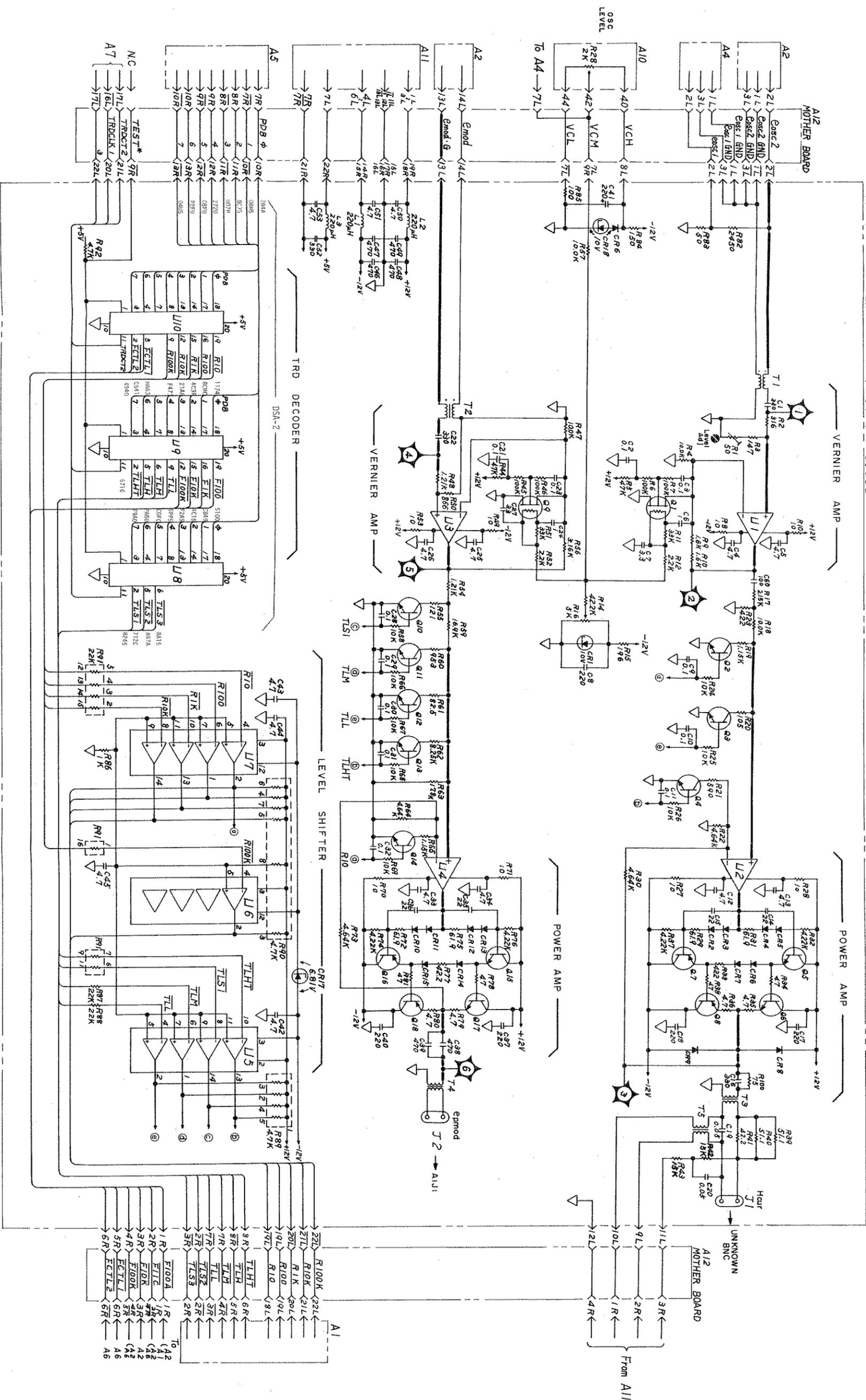


FIGURE 8-34. A4 PROCESS AMPLIFIER ASSEMBLY TROUBLESHOOTING TREE

← A3 Power Amplifier Service Sheet

A3 POWER AMPLIFIER ASSY 04274-66503



Figures 8-32 and 8-33

Figure 8-33, A3 POWER AMPLIFIER ASSEMBLY SCHEMATIC DIAGRAM.

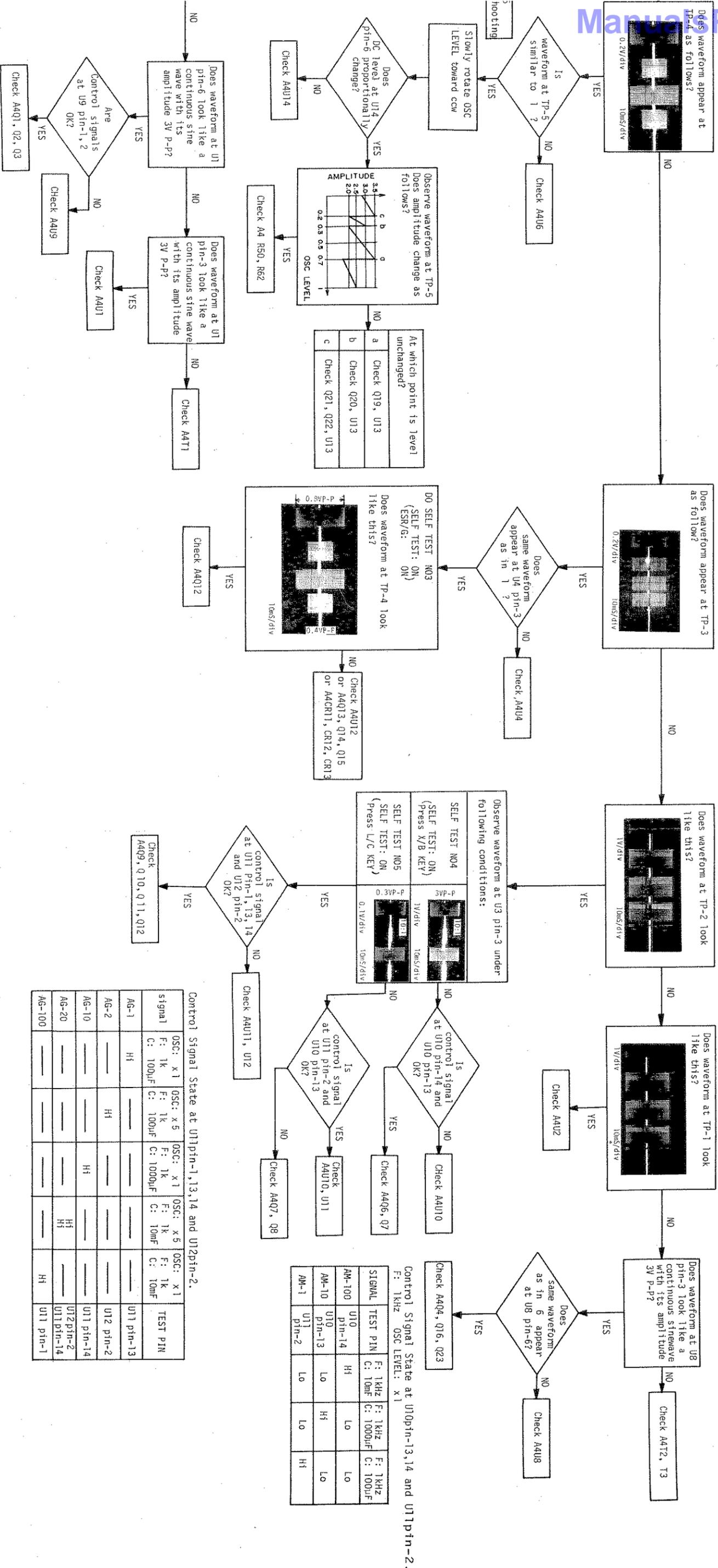


FIGURE 8-34. A4 PROCESS AMPLIFIER ASSEMBLY TROUBLESHOOTING TREE.

A3 Power Amplifier Service Sheet

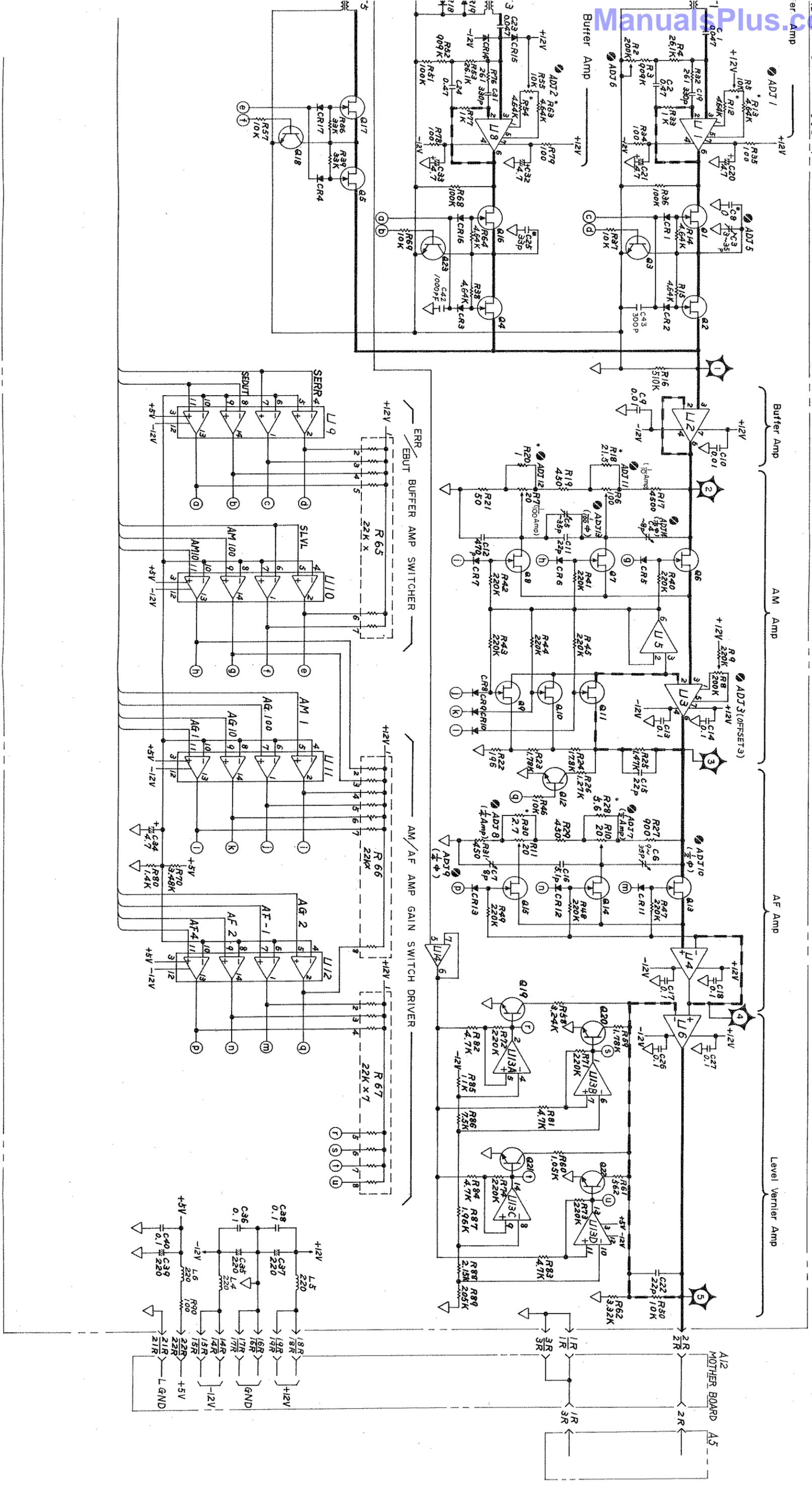
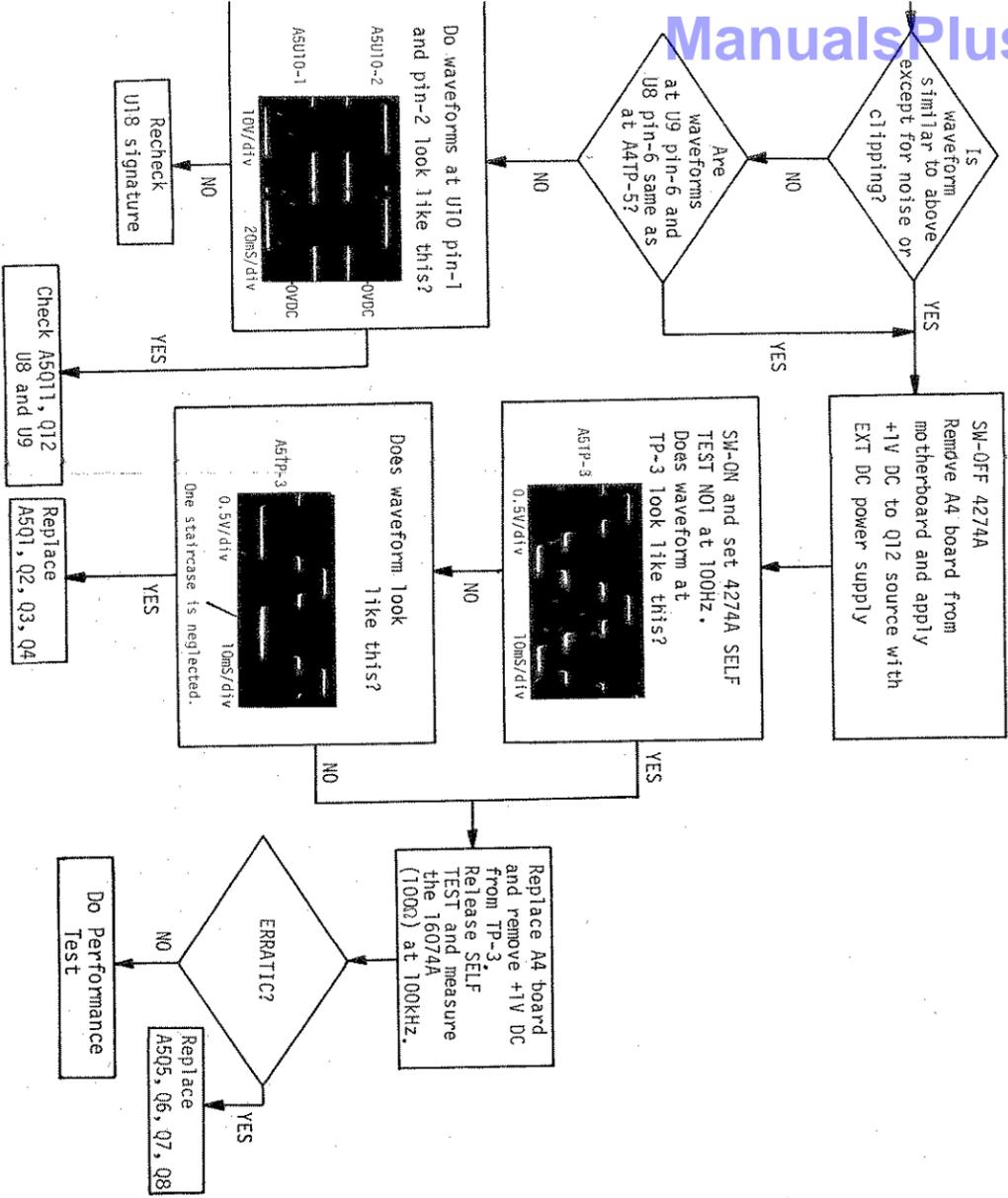
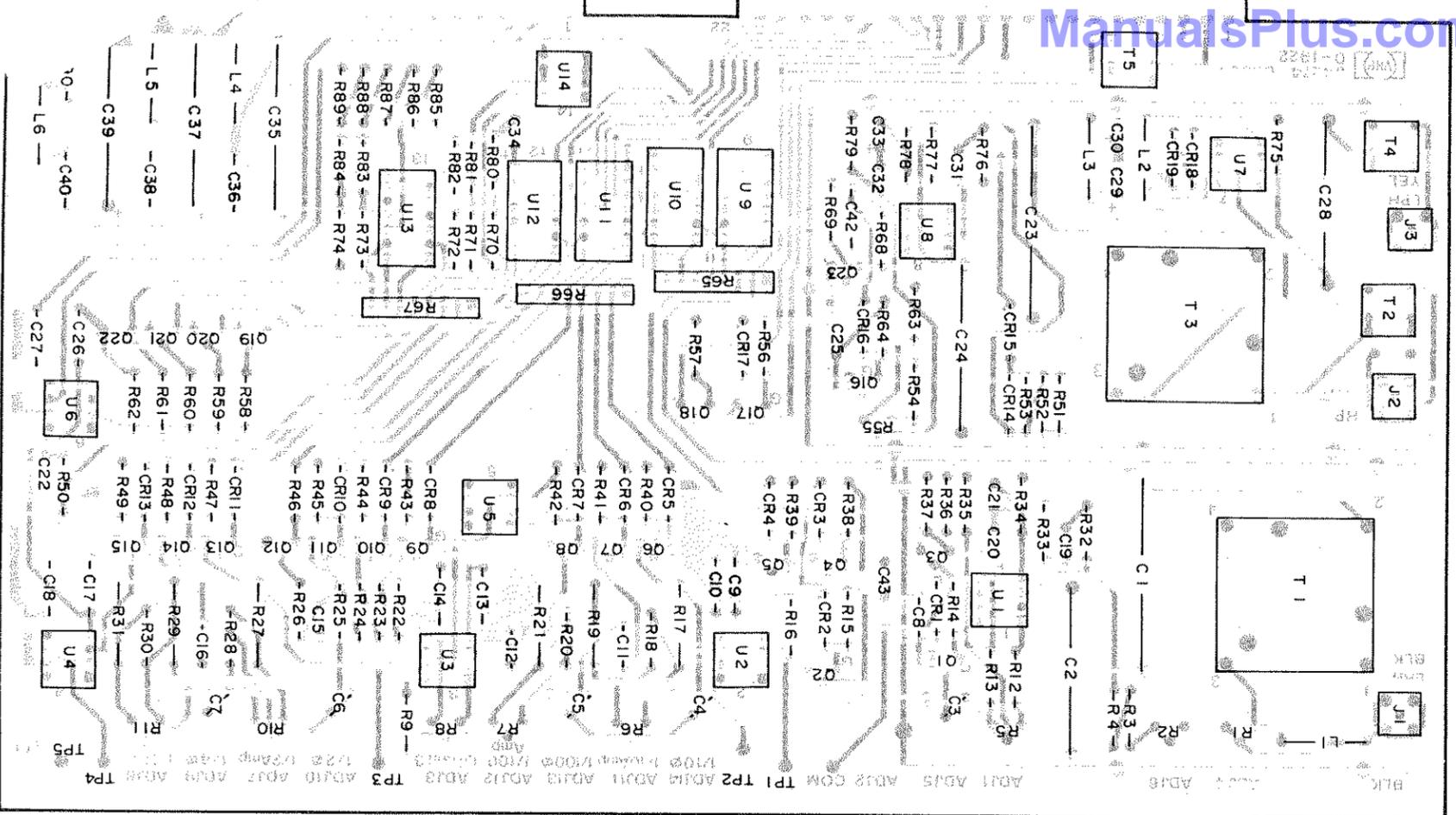


Figure 8-35 and 8-36

FIGURE 8-36. A4 PROCESS AMPLIFIER ASSEMBLY SCHEMATIC DIAGRAM.

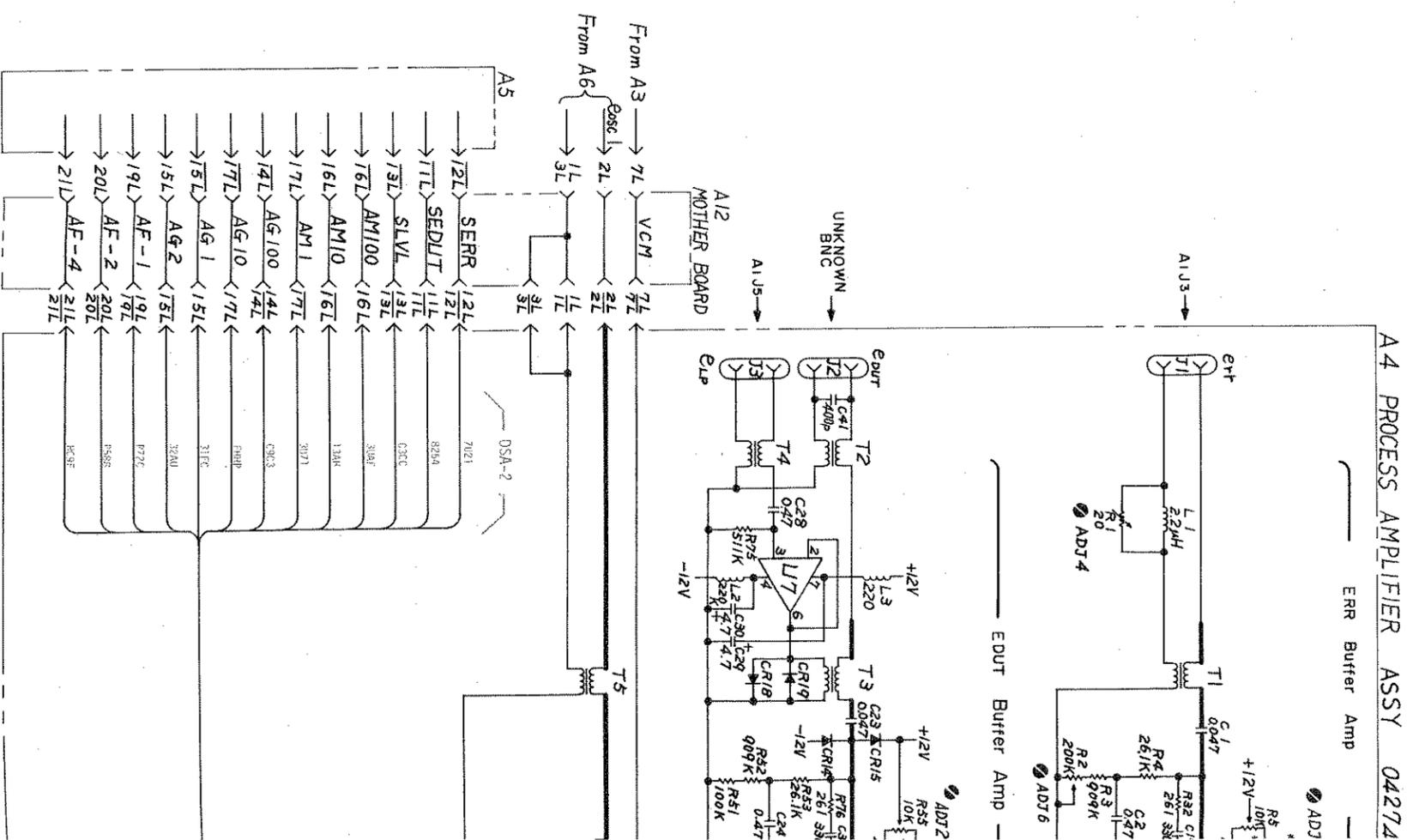


→ A4 Process Amplifier Service Sheet



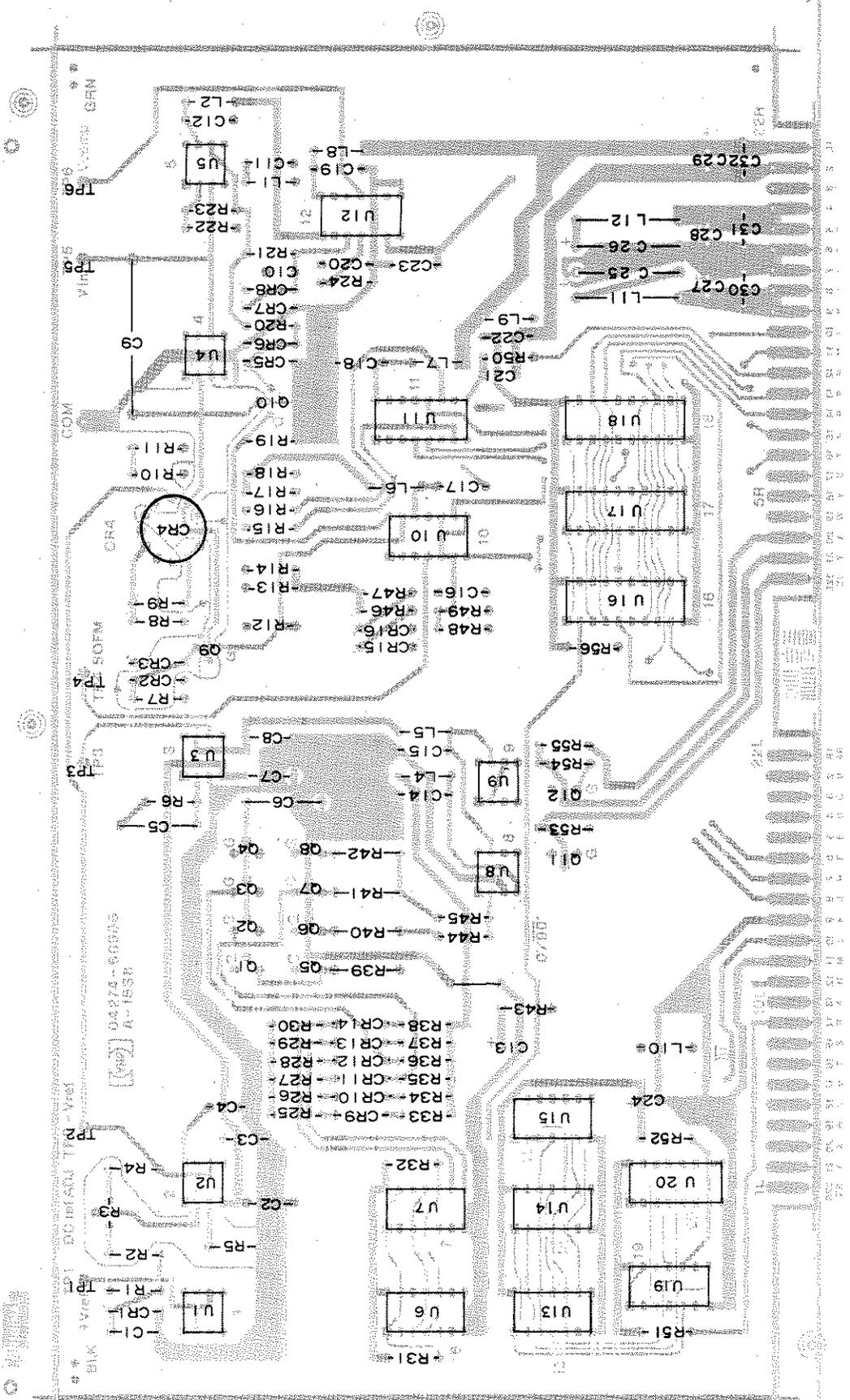
8-35. A4 PROCESS AMPLIFIER ASSEMBLY COMPONENT LOCATIONS.

FUNCTION	TEST FREQUENCY	L, C, R, |Z| RANGE									
		Z-1	Z-2	Z-3	Z-4	Y-5	Y-4	Y-3	Y-2	Y-1	
CAPACITANCE C	100Hz ~ 250Hz	100mF	10mF	1000µF	100µF	10µF	1000nF	100nF	10nF	1000pF	100pF
	250Hz ~ 2.5kHz	10mF	1000µF	100µF	10µF	1000nF	100nF	10nF	1000pF	100pF	10pF
INDUCTANCE L	25kHz ~ 100kHz	100µF	10µF	1000nF	100nF	10nF	1000pF	100pF	10pF	1000fF	100fF
	100Hz ~ 999Hz	100µH	1000µH	10mH	100mH	1000mH	10H	100H	1000H	10KH	100KH
R, |Z| RESISTANCE IMPEDANCE	1kHz ~ 9.99kHz	10µH	100µH	1000µH	10mH	100mH	1000mH	10H	100H	1000H	10KH
	10kHz ~ 99.9kHz	1000mH	10H	100µH	1000µH	10mH	100mH	1000mH	10H	100H	1000H
RANGE RESISTOR USED	100Hz ~ 100kHz	100mΩ	1000mΩ	10Ω	100Ω	1kΩ	10kΩ	100kΩ	1000kΩ	10MΩ	100MΩ
		x 5	10Ω	10Ω	10Ω	10Ω	10Ω	10Ω	10Ω	10Ω	10Ω
COMBINATION OF RR, AM GAIN (attenuation) and AG (amplifier gain).	x 5	RR(Ω)	10	10	10	10	10	10	10	10	10
	x 0.1	AM	x 100	x 10	x 1	x 1/10	x 10	x 10	x 10	x 10	x 10
	x 0.01	AG	20	2	2	2	2	2	2	2	2
		RR(Ω)	10	10	10	100	100	1k	10k	100k	100k
	AM	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 1	x 10	
	AG	100	100	10	10	10	10	10	10	100	



A4 PROCESS AMPLIFIER ASSY 04274

FIGURE 8-38, A5 A-D CONVERTER ASSEMBLY COMPONENT LOCATIONS



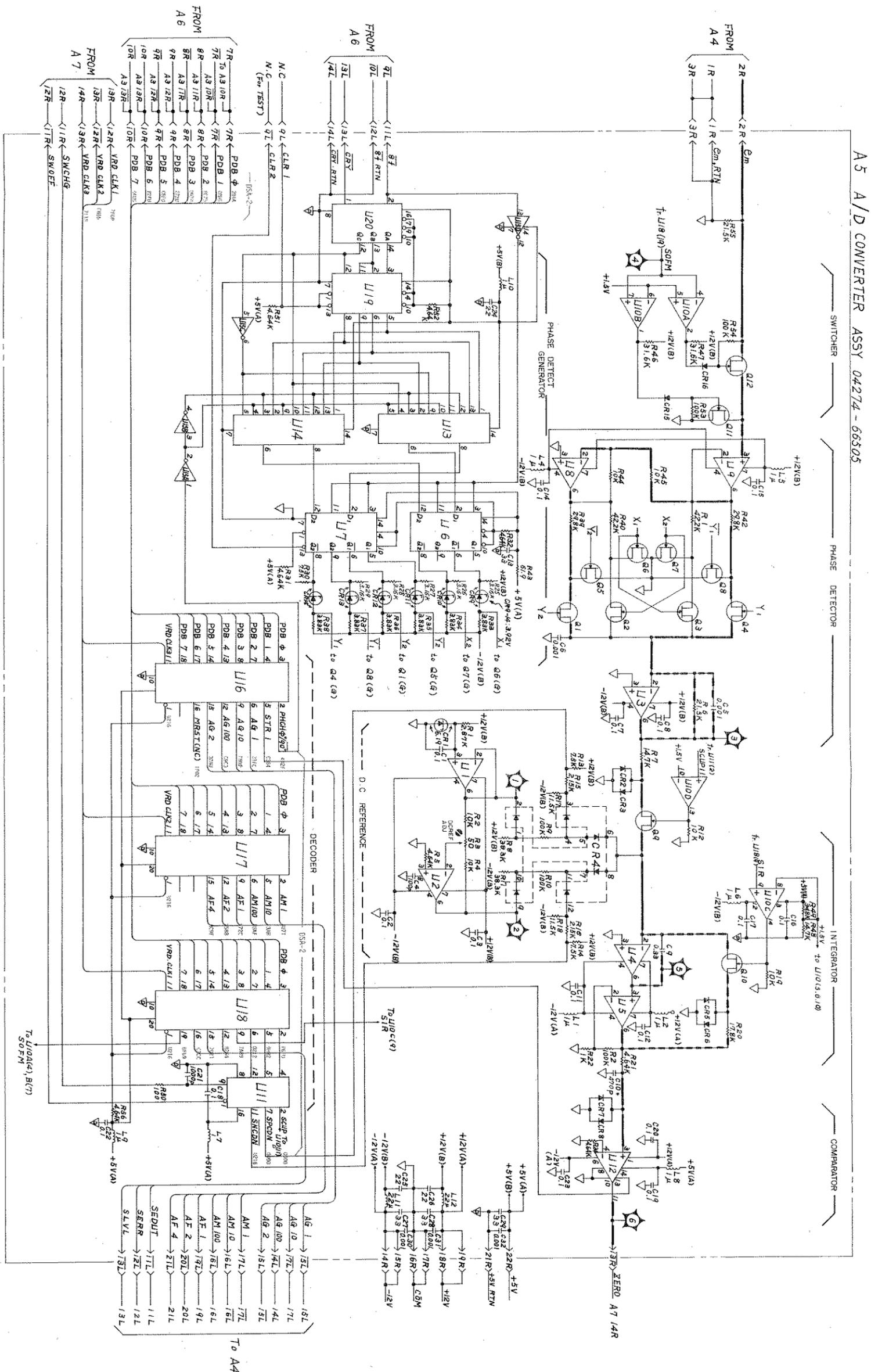
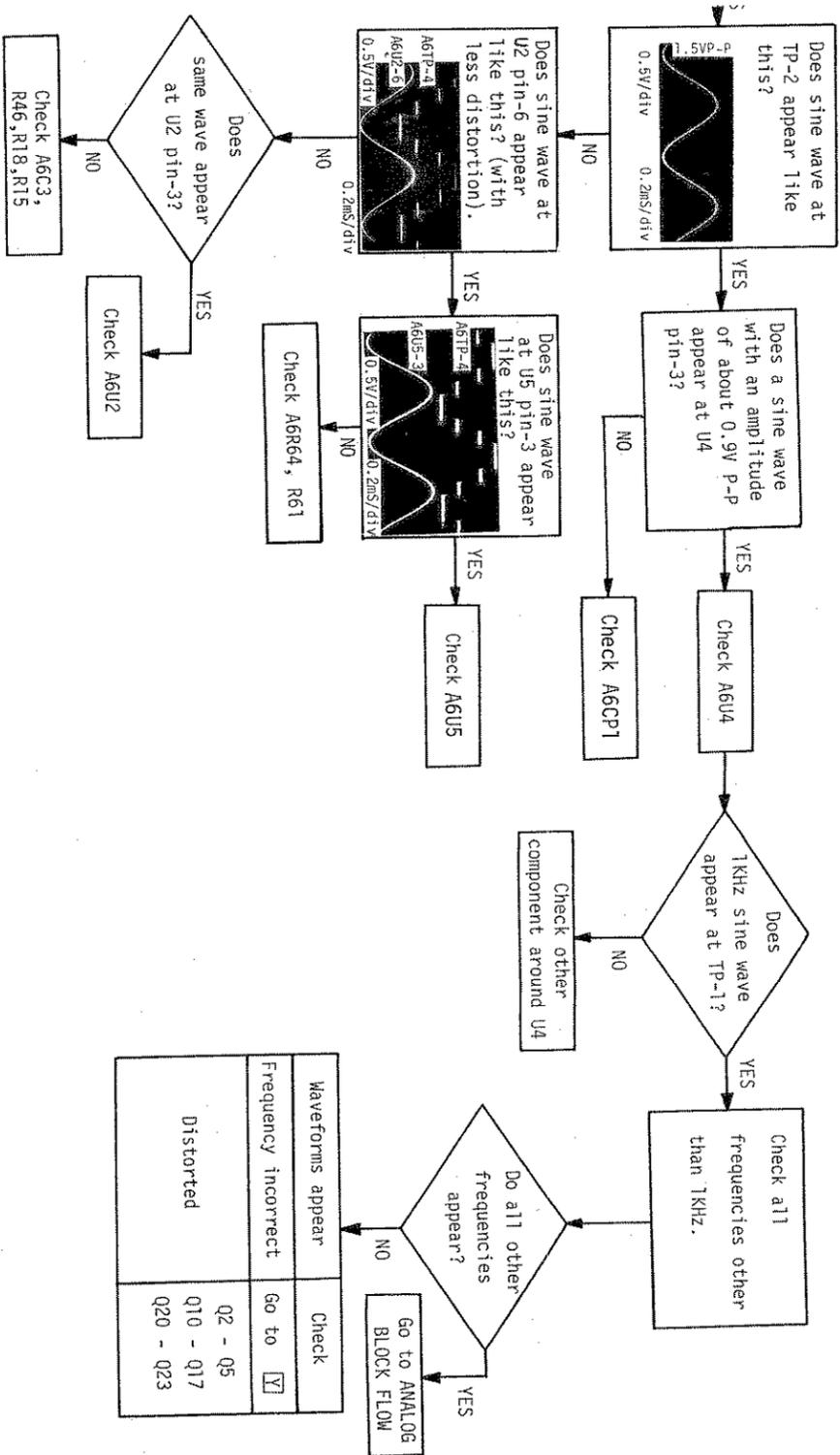


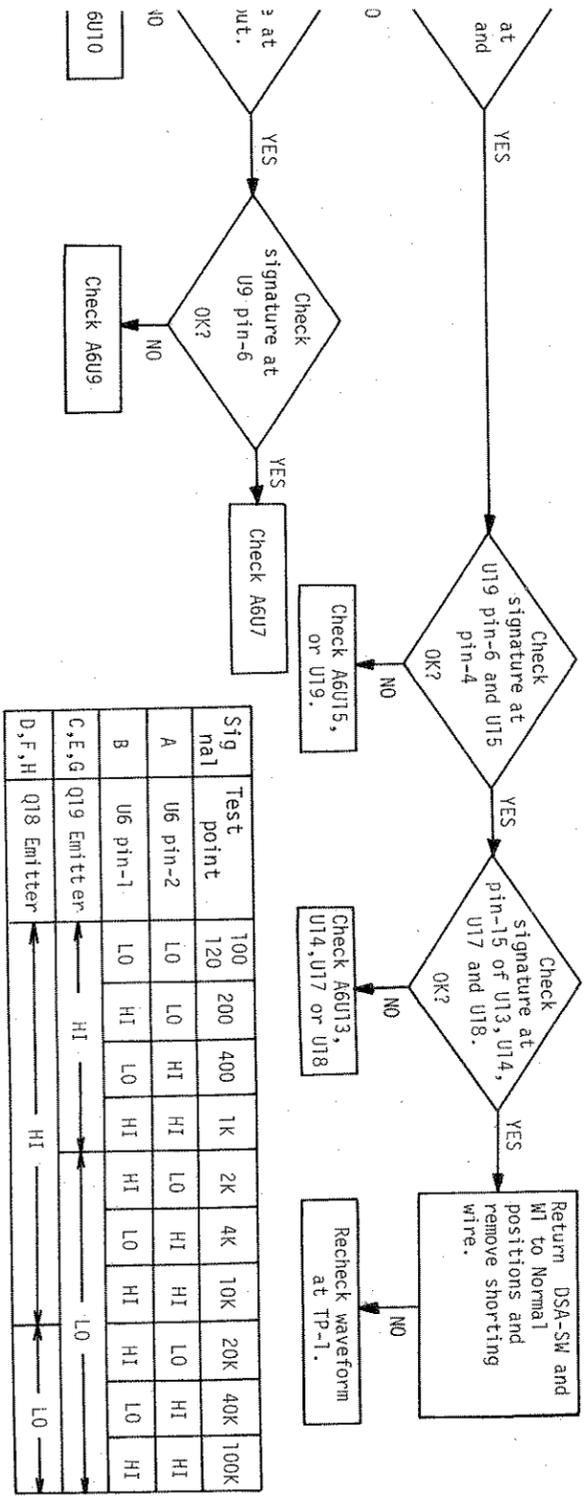
FIGURE 8-39. A5 A-D CONVERTER ASSEMBLY SCHEMATIC DIAGRAM. 8-59



Signature Connections Window (+5V) : F3PC

DSA NO	START	STOP	CLOCK	A9 DSA-SW
DSA-5	A9Tp-13	A9Tp-13	A9Tp-7	OFF
FREQUENCY				ON

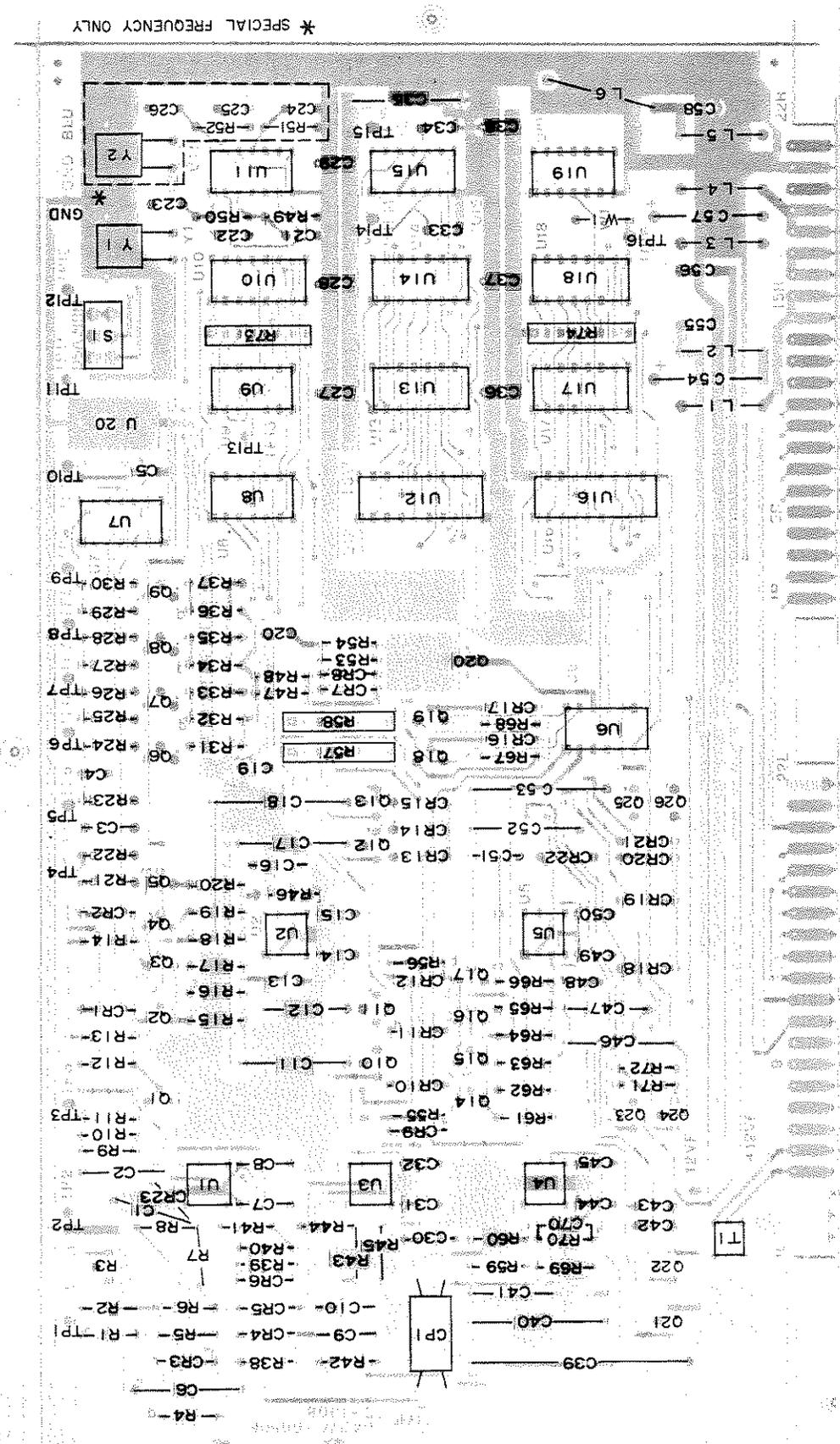
Other Setting:
Set A6S1 switch to DSA.
Disconnect one side of A6W1.
Connect A7TP23 to A6TP16 with shorting clip.



Signal	Test point	100	200	400	1K	2K	4K	10K	20K	40K	100K
A	U6 pin-2	LO	LO	LO	HI	HI	LO	HI	LO	HI	HI
B	U6 pin-1	LO	HI	LO	HI	HI	LO	HI	LO	HI	HI
C, E, G	Q19 Emitter	HI									
D, F, H	Q18 Emitter	LO									

ASSEMBLY TROUBLESHOOTING TREE.

FIGURE 8-41. A6 OSCILLATOR ASSEMBLY COMPONENT LOCATIONS.



* SPECIAL FREQUENCY ONLY

Other Settings:
 Remove A6 ASSY.
 Connect TP12 to GRD with shorting clip.
 Connect A7TP2 to A7TP4 with shorting clip.

DSA NO	DSA-4	TIMER COUNTER
START	A9Tp-13	
STOP	A9Tp-13	
CLOCK	A9Tp-7	
A9 DSA-SM		

Signature Connections Window (+5V) : 8C0A

Other Setting:
 Remove A6 ASSY.
 Connect TP12 to GRD with shorting clip.
 Connect TP20 to TP23 with shorting clip.
 Remove A7M4 one side.

DSA NO	DSA-3	
START	A9Tp-13	
STOP	A9Tp-13	
CLOCK	A9Tp-7	
A9 DSA-SM		

Signature Connections Window (+5V) : H1UH

DSA NO	DSA-2	PIA/LATCH
START	A9Tp-13	
STOP	A9Tp-13	
CLOCK	A9Tp-7	
A9 DSA-SM		

Signature Connections Window (+5V) : U216

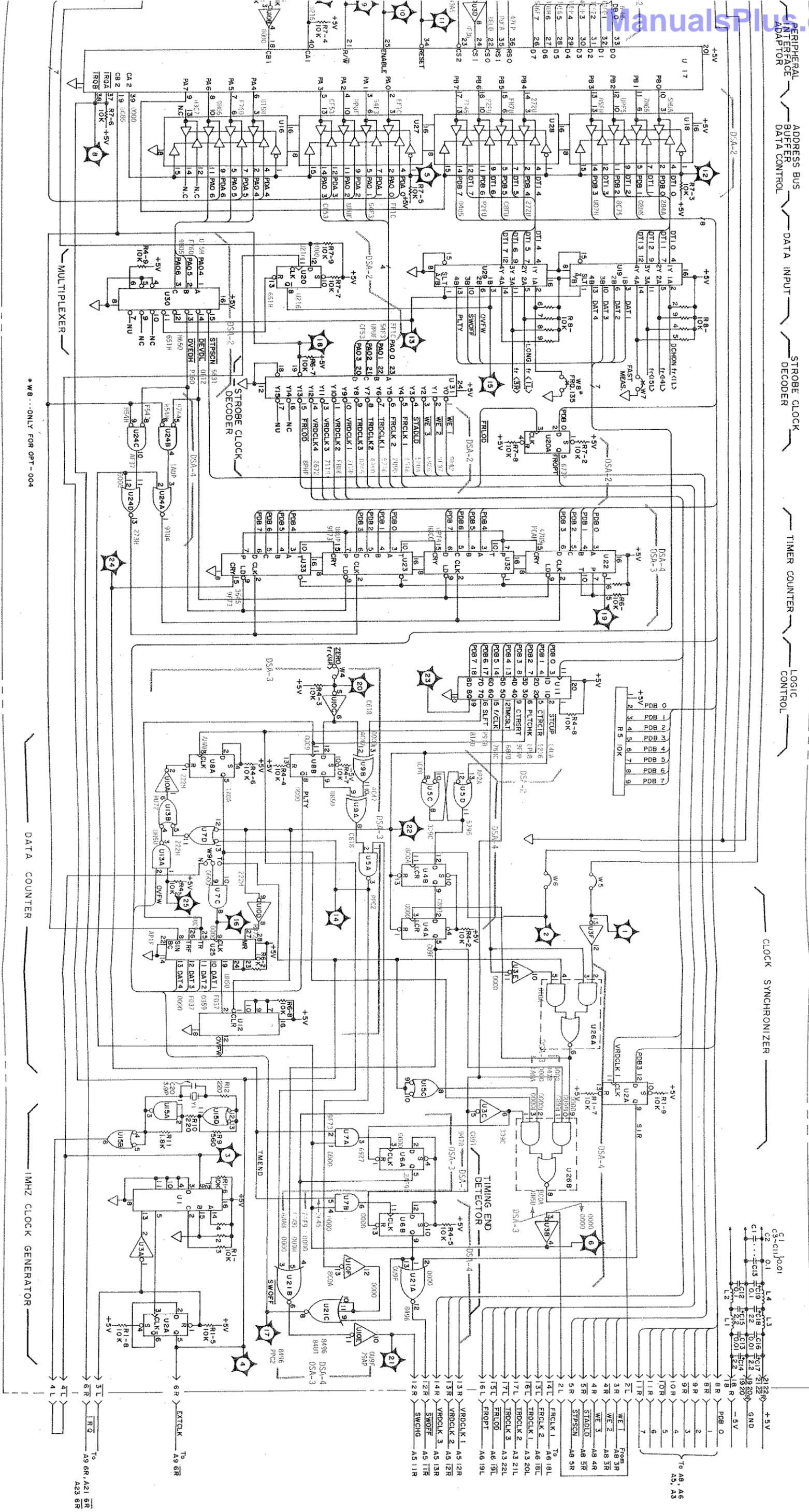
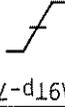


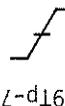
FIGURE 8-44. A7 PERIPHERAL CONTROL ASSEMBLY SCHEMATIC DIAGRAM.

Signature Connections Window (+5V) : 7UUP

DSA NO	START	STOP	CLOCK	A9 DSA-SM
DSA-7	A9Tp-13	A9Tp-13	A9Tp-7	
DISPLAY	A9Tp-13	A9Tp-13	A9Tp-7	

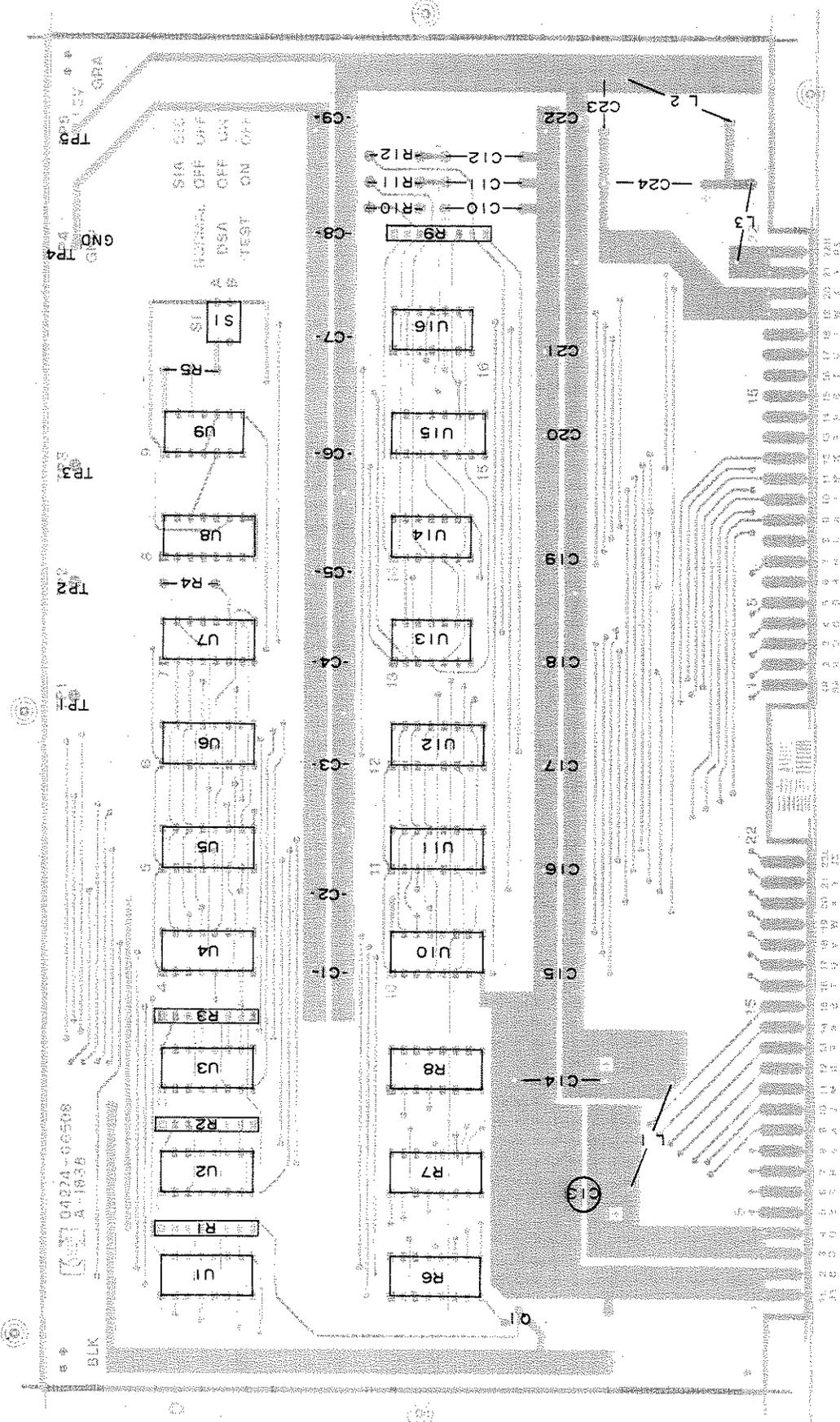
Other Settings:
Set A8S1-B switch to ON.
Disconnect one side of A8M1.

Signature Connections Window (+5V) : 7UUP

DSA NO	START	STOP	CLOCK	A9 DSA-SM
DSA-6	A9Tp-13	A9Tp-13	A9Tp-7	
KEY	A9Tp-13	A9Tp-13	A9Tp-7	

Other settings:
Set A8S1-B switch to ON.
Observe respective signatures at A8TP1
for every key on front panel (push in turn).

FIGURE 8-45. A8 DISPLAY CONTROL ASSEMBLY COMPONENT LOCATIONS.



This table can be used to check signatures at A9U1 thru A9U10 ROM's. Signature test point is established at input of Data Buffer (pins 8 thru 6 of A9U31 and A9U32) instead of the respective ROM outputs (A9U1 thru A9U10). This signature list can be used for units with its serial number suffixes of -00761 and above.

For other instruments whose serial number suffixes are earlier than 00761, check that unstable signature display appears or that output states of these ROM's pull up and pull down. If you find above states active in earlier instruments, the program contents in these ROM may be alive.

TEST PIN NO SIGNAL NAME	DSA NAME		A9U1 A9U7	A9U1	A9U3	A9U5	A9U7	A9U10
	ROM NO.	TEST POINT						
WINDOW(+5V)	U1	pin-24	755U	P254	P254	P254	P254	826P
DB0	U31	pin-3	5A83	42P2	7994	264C	H3AF	1H62
DB1		pin-4	FCCP	9949	307F	08CA	86P3	FOAP
DB2		pin-5	17C6	8UH8	HPF4	9FBF	7HPC	4A69
DB3		pin-6	283P	P909	379A	CP1U	5H2H	2UFA
DB4	U32	pin-3	H6F2	8FU9	2U43	5H23	5A01	54F9
DB5		pin-4	5A48	F854	5410	U899	H1F5	F63A
DB6		pin-5	73F2	6PF8	69HH	89PP	775H	9208
DB7		pin-6	7AHA	052P	0P76	FP5F	8PC7	F15P

Signature Connections Window (+5V): CCC3

DSA NO	START	STOP	CLOCK	A9 DSA-SW
DSA-10	A9Tp-13	A9Tp-13	A9Tp-7	OFF ON
IRQ				

Signature Connections Window (+5V): P254

DSA NO	START	STOP	CLOCK	A9 DSA-SW
DSA-14	A9U16-10	A9U16-7	A9Tp-6	OFF ON
DSA-14	NOP (U1)			

Signature Connections Window (+5V): 0003

DSA NO	START	STOP	CLOCK	A9 DSA-SW
DSA-11	A9Tp-3	A9Tp-3	A9Tp-6	OFF ON
NOP ADDRESS				

Signature Connections Window (+5V): P254

DSA NO	START	STOP	CLOCK	A9 DSA-SW
DSA-15	A9U16-10	A9U16-7	A9Tp-6	OFF ON
DSA-15	NOP (U3)			

Signature Connections Window (+5V): 755U

DSA NO	START	STOP	CLOCK	A9 DSA-SW
DSA-12	A9U27-11	A9U16-5	A9Tp-6	OFF ON
NOP (U1, U3, U5, U7)				

Signature Connections Window (+5V): P254

DSA NO	START	STOP	CLOCK	A9 DSA-SW
DSA-16	A9U16-12	A9U16-10	A9Tp-6	OFF ON
DSA-16	NOP (U5)			

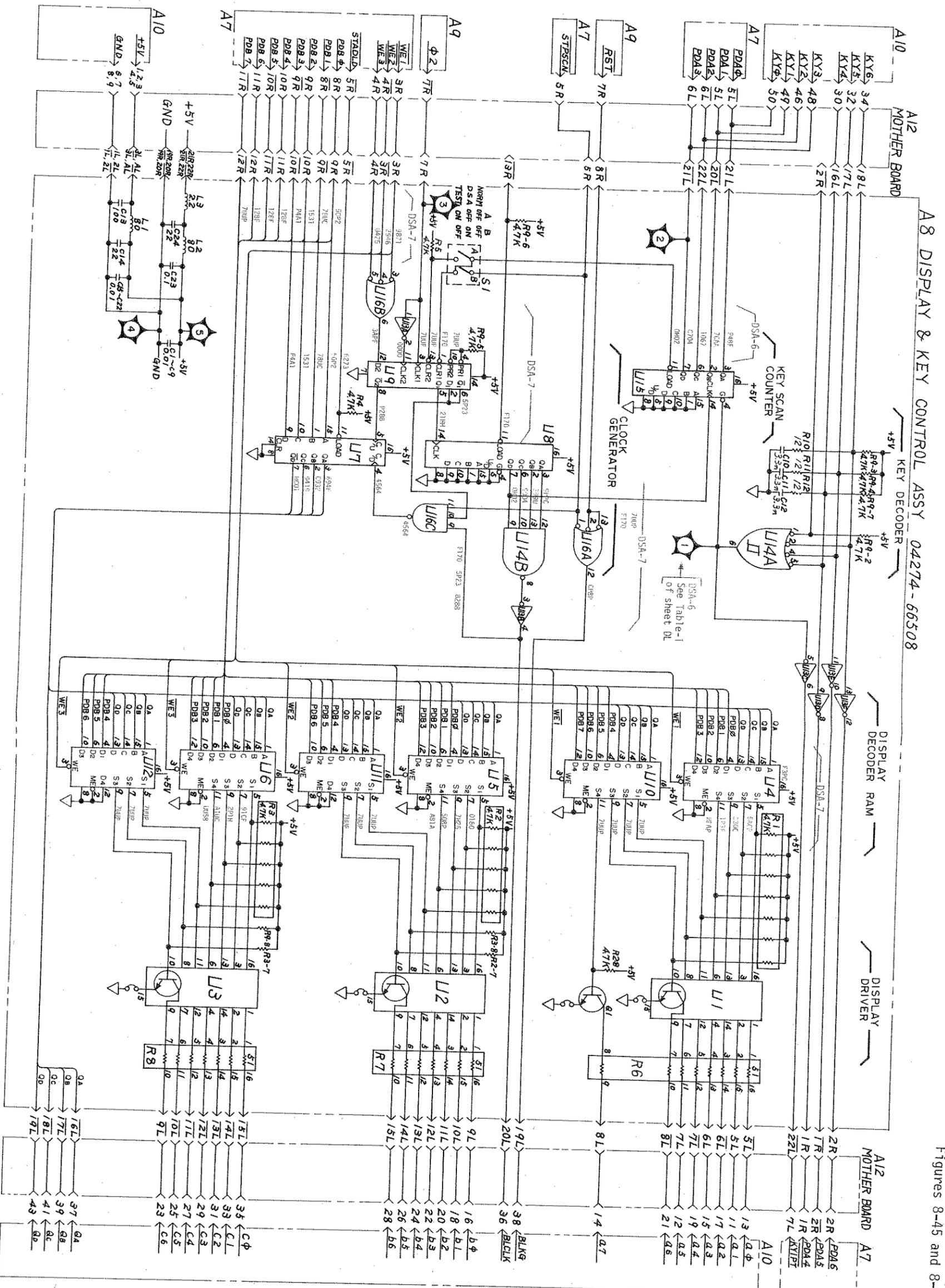
Signature Connections Window (+5V): 826P

DSA NO	START	STOP	CLOCK	A9 DSA-SW
DSA-13	A9U22-9	A9U10-20	A9Tp-6	OFF ON
NOP (U10)				

Signature Connections Window (+5V): P254

DSA NO	START	STOP	CLOCK	A9 DSA-SW
DSA-17	A9U16-14	A9U16-12	A9Tp-6	OFF ON
DSA-17	NOP (U7)			

→ A8 Display Control Service Sheet



Section VIII
Figures 8-45 and 8-46

Figure 8-46. A8 Display Control Assembly Schematic Diagram.

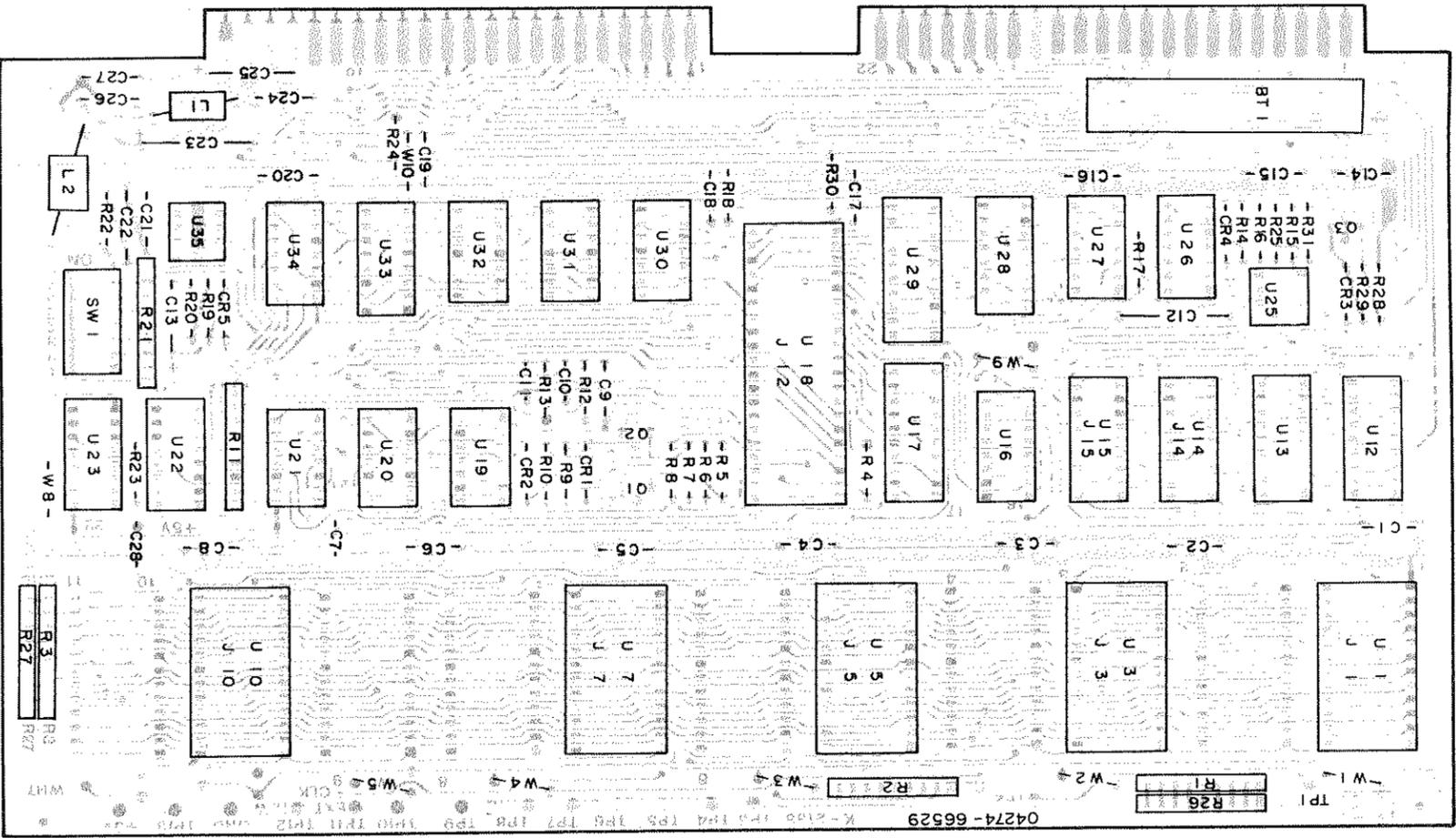
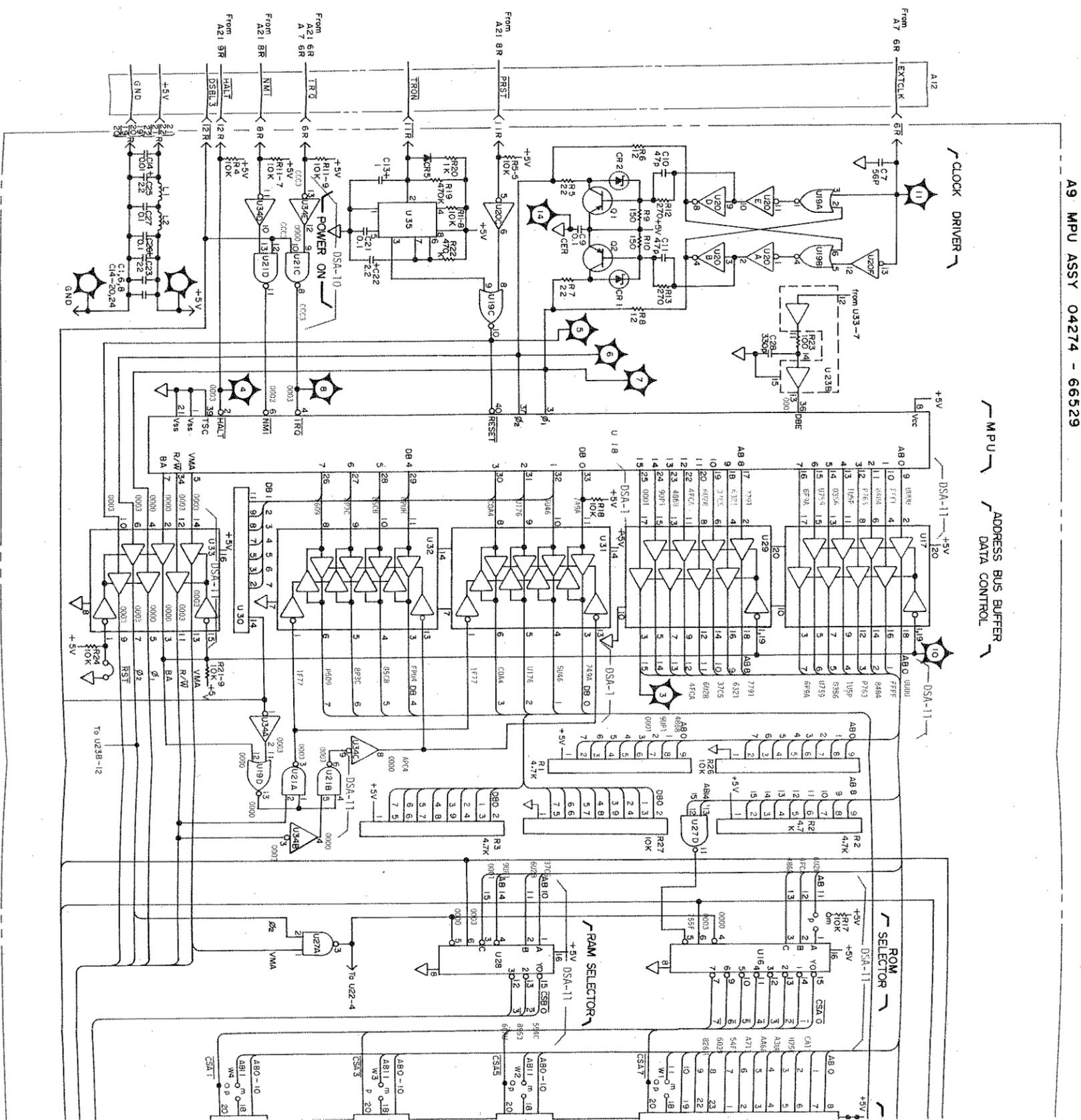


FIGURE 8-47. A9 MPU ASSEMBLY COMPONENT LOCATIONS.



A9 MPU ASSY 04274 - 66529

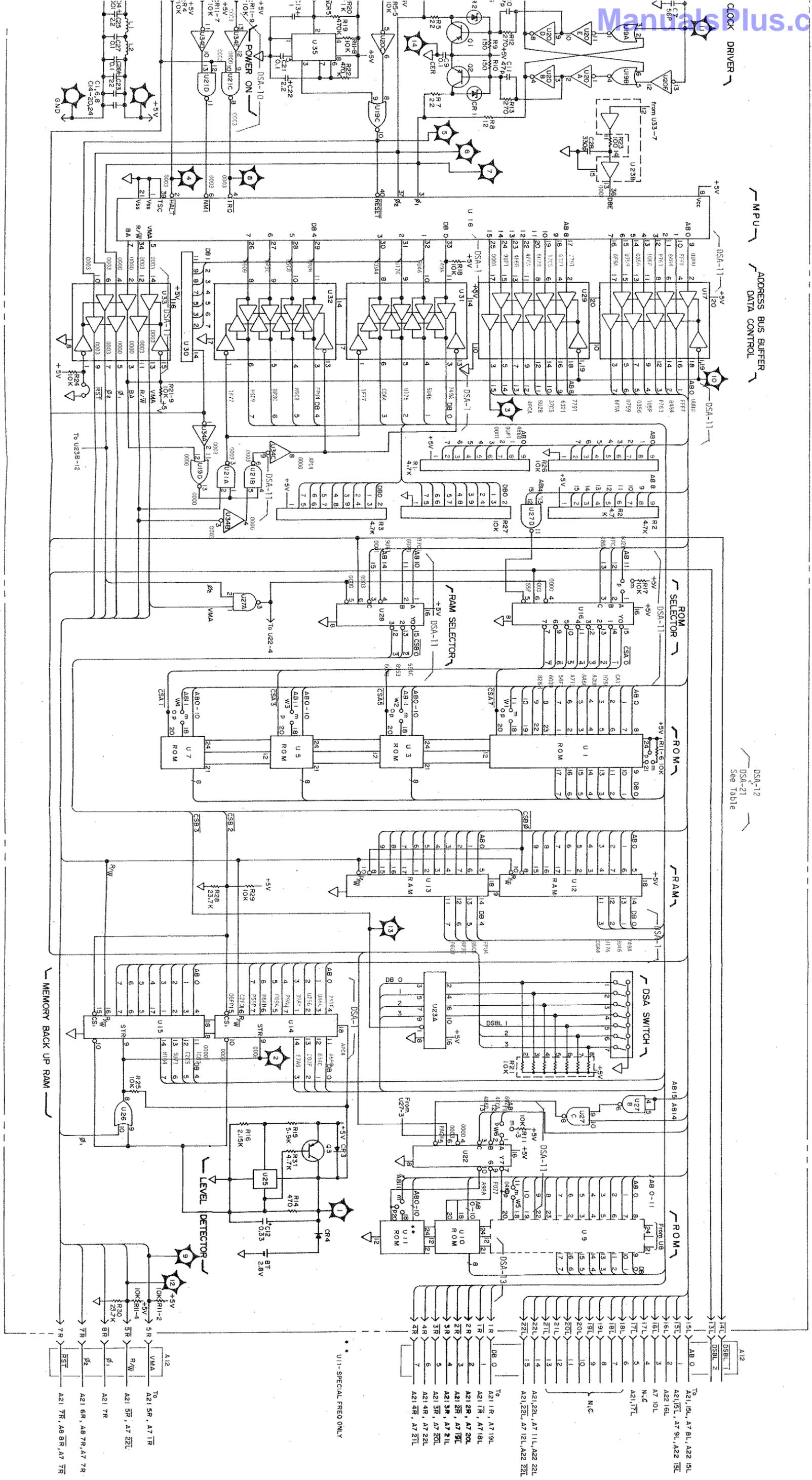


FIGURE 8-48, A9 MPU ASSEMBLY SCHEMATIC DIAGRAM.

Signature Connections Window (+5V) : ZUUP

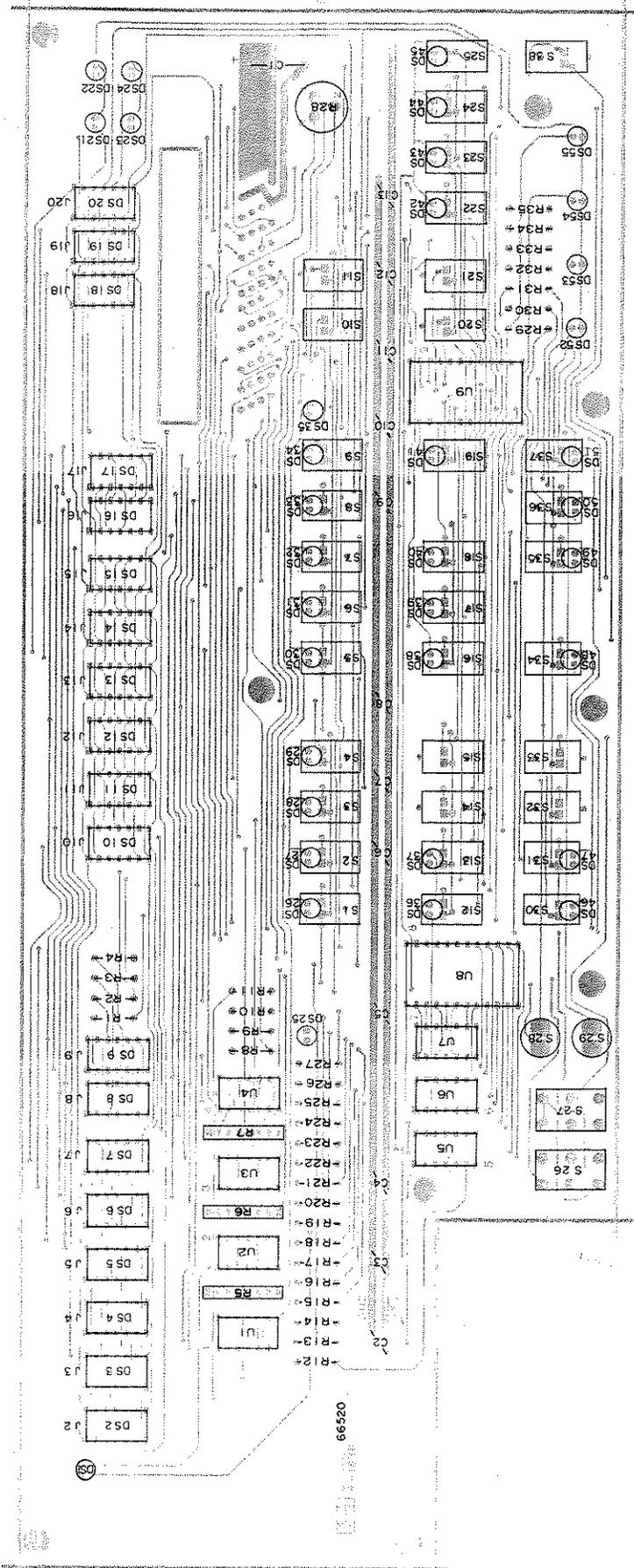
DSA NO	START	STOP	CLOCK	A9 DSA-SW
DSA-7	A9Tp-13	A9Tp-13	A9Tp-7	
DISPLAY				

Other Settings:

Set A8S1-B switch to ON.

Disconnect one side of A8W1.

FIGURE 8-49. A10 DISPLAY AND KEY ASSEMBLY COMPONENT LOCATIONS.



026599

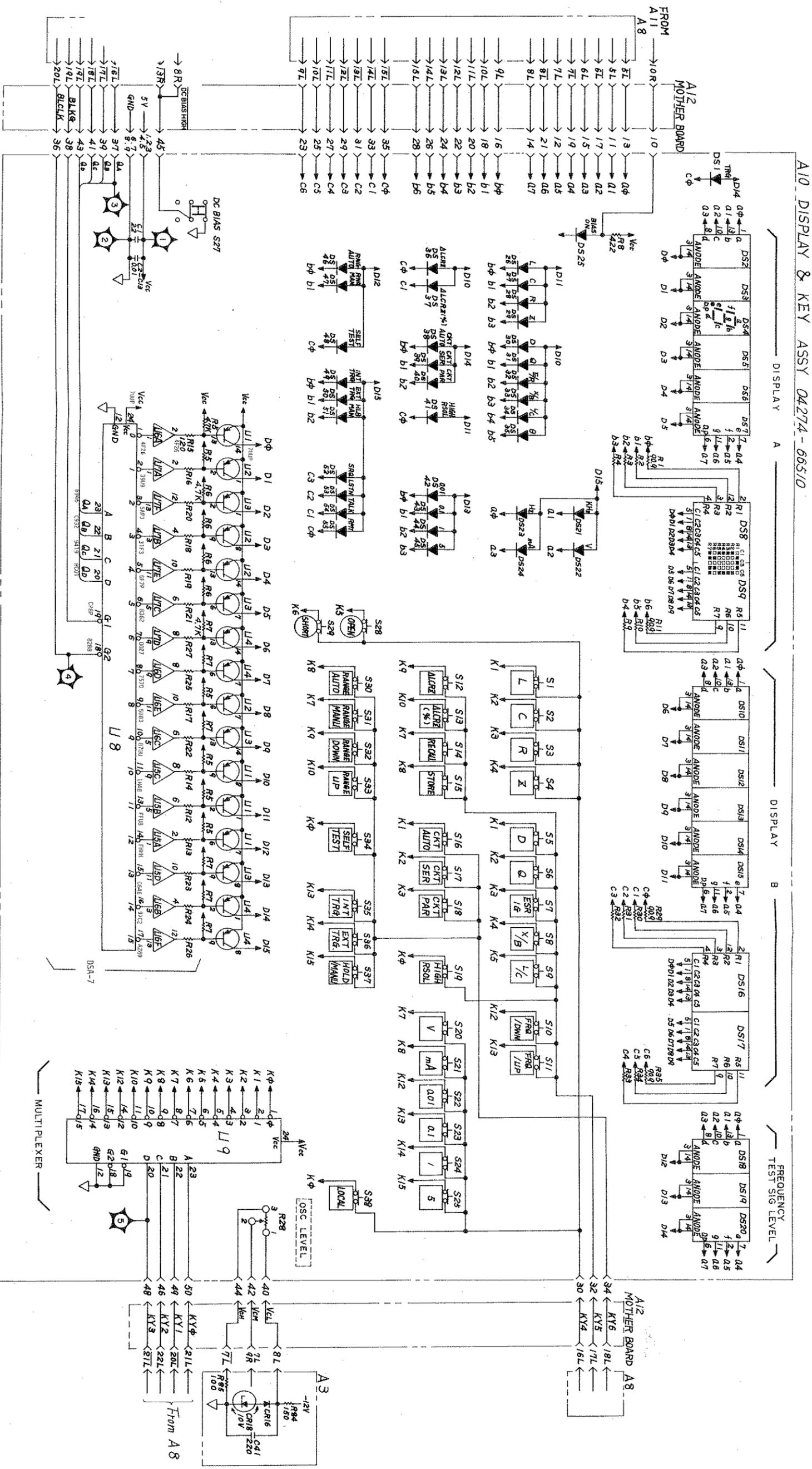
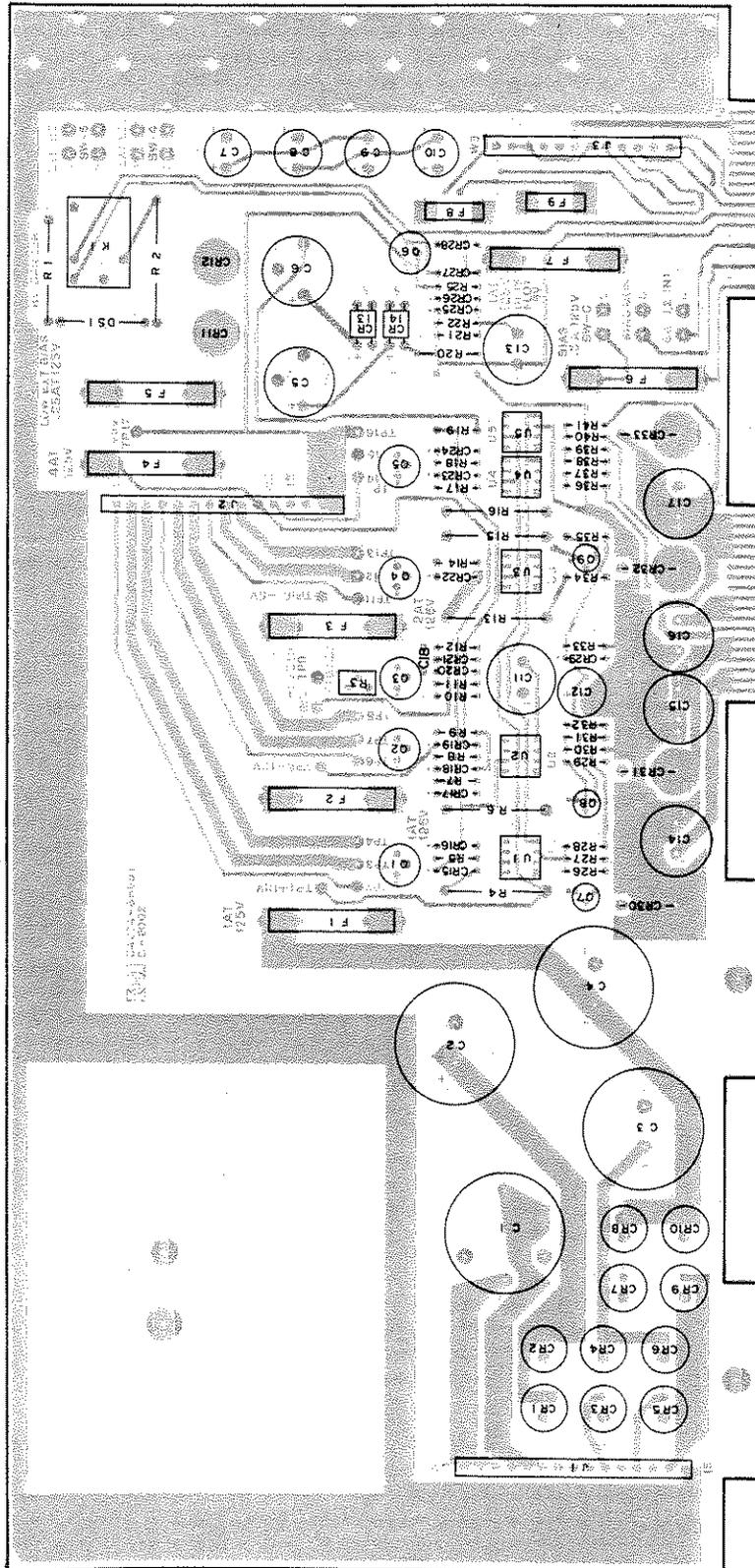
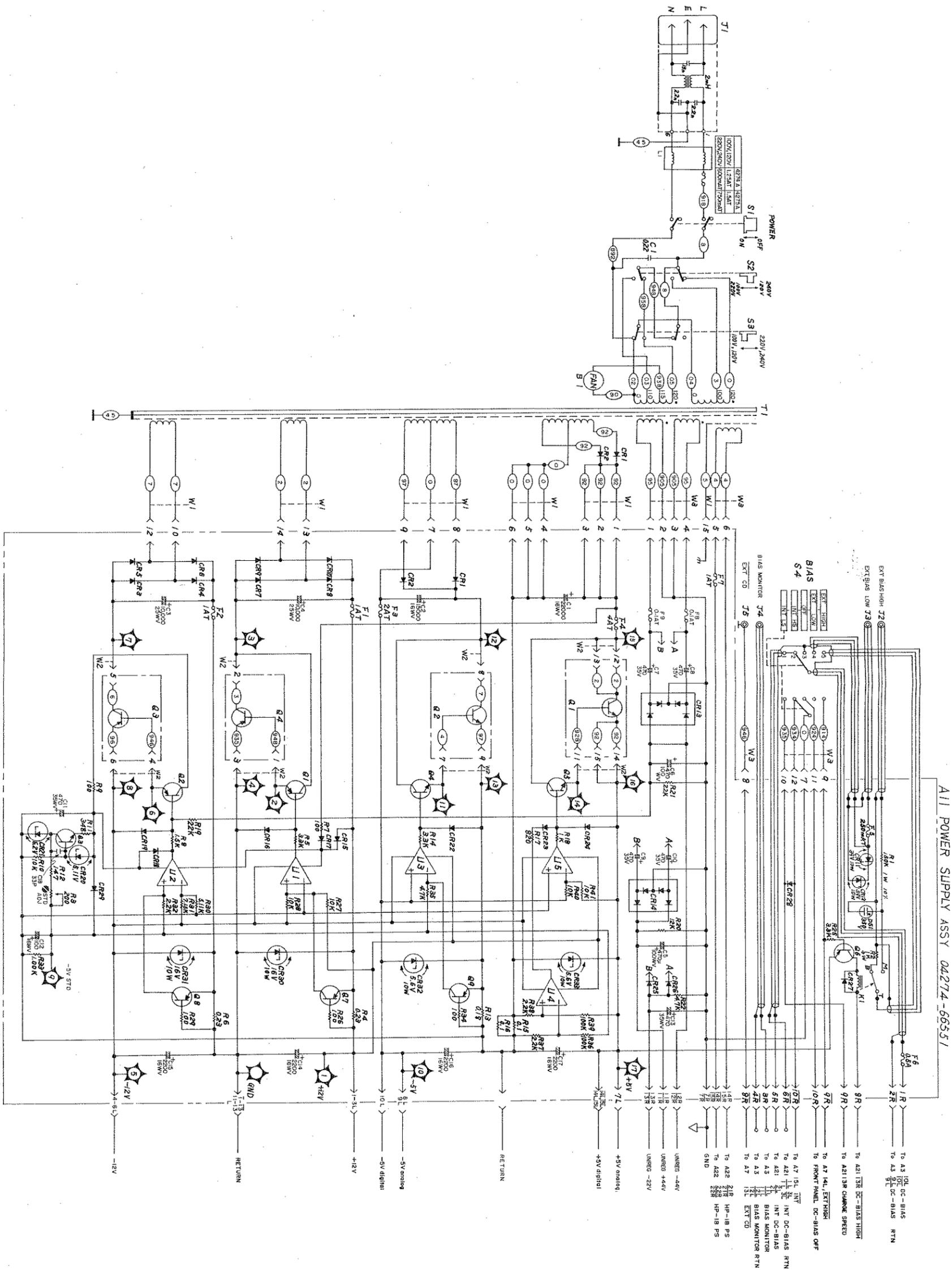


FIGURE 8-50. A10 DISPLAY AND KEY ASSEMBLY SCHEMATIC DIAGRAM.

FIGURE 8-51. ALL POWER SUPPLY ASSEMBLY COMPONENT LOCATIONS.





Figures 8-51 and 8-52

FIGURE 8-52. ALL POWER SUPPLY ASSEMBLY SCHEMATIC DIAGRAM.

Signature Connections		Window (+5V) : 3U8U		
DSA NO	START	STOP	CLOCK	A9 DSA-SW
DSA-8	A9Tp-13	A9Tp-13	A9Tp-7	OFF ON
DC-Bias				

Other Settings:
 Connect a short jumper wire to A21SC1 (A23SC1) and A21SC2 (A23SC2).
 [In this condition, the left and right sockets are shorted.]

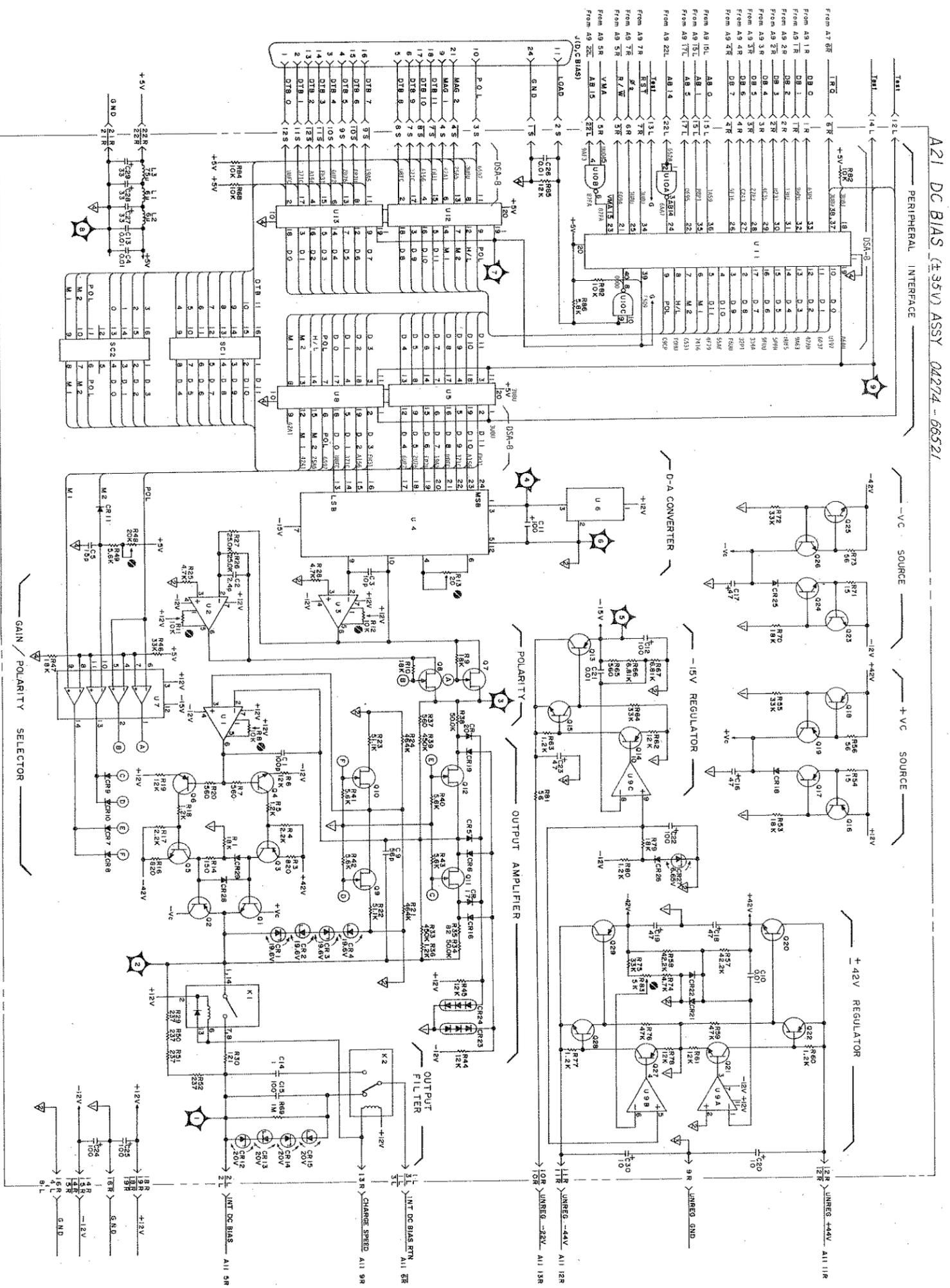


FIGURE 8-54. A21 DC BIAS (+5V) ASSEMBLY SCHEMATIC DIAGRAM.

