

Errata

Title & Document Type: 4261A Digital LCR Meter Operating and Service Manual

Manual Part Number: 04261-90006

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HP References in this Manual

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

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Support for Your Product

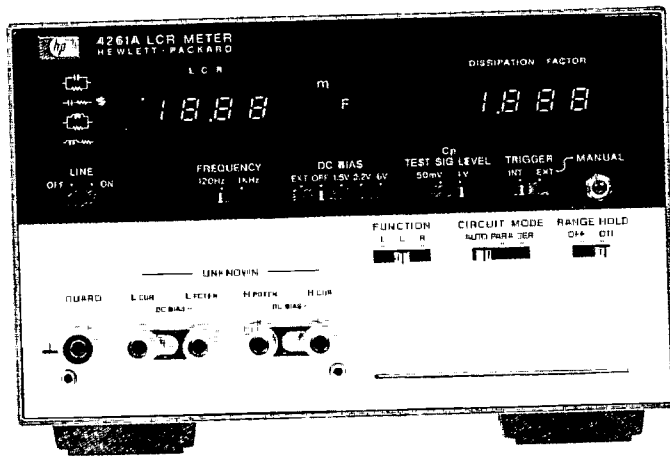
Agilent no longer sells or supports this product. You will find any other available product information on the Agilent Test & Measurement website:

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

OPERATING AND SERVICE MANUAL

4261A DIGITAL LCR METER



SAFETY SUMMARY

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

GROUND THE INSTRUMENT

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

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

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

KEEP AWAY FROM LIVE CIRCUITS

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

DO NOT SERVICE OR ADJUST ALONE

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

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

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

DANGEROUS PROCEDURE WARNINGS

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

WARNING

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

SAFETY SYMBOLS

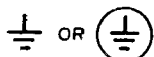
General Definitions of Safety Symbols Used On Equipment or In Manuals.



Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the instrument.



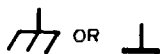
Indicates dangerous voltage (terminals fed from the interior by voltage exceeding 1000 volts must be so marked).



Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating equipment.



Low-noise or noiseless, clean ground (earth) terminal. Used for a signal common, as well as providing protection against electrical shock in case of fault. A terminal marked with this symbol must be connected to ground in the manner described in the installation (operating) manual, and before operating the equipment.



Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.



Alternating current (power line).



Direct current (power line).



Alternating or direct current (power line).

WARNING

A **WARNING** denotes a hazard. It calls attention to a procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in injury or death to personnel.

CAUTION

The **CAUTION** sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product.

Note

A **Note** denotes important information. It calls attention to a procedure, practice, condition or the like, which is essential to highlight.

Herstellerbescheinigung

Hiermit wird bescheinigt, daß das Gerät HP 4261A digital LCR meter in Übereinstimmung mit den Bestimmungen von Postverfügung 1046/84 funkentstört ist.

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

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

GERÄUSCHEMISSION

Lpa < 70 dB
am Arbeitsplatz
normaler Betrieb
nach DIN 45635 T. 19

Manufacturer's Declaration

This is to certify that this product, the HP 4261A digital LCR meter, meets the radio frequency interference requirements of directive 1046/84. The German Bundespost has been notified that this equipment was put into circulation and was granted the right to check the product type for compliance with these requirements.

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

ACOUSTIC NOISE EMISSION

Lpa < 70 dB
operator position
normal operation
per ISO 7779

MANUAL CHANGES

HP 4261A

Digital LCR Meter

MANUAL IDENTIFICATION

Model Number: HP 4261A
Date Printed: Not Specified
Part Number: 04261-90006

This supplement contains information for correcting manual errors and for adapting the manual to newer instruments that contain improvements or modifications not documented in the existing manual

To use this supplement

1. Make all ERRATA corrections
2. Make all appropriate serial-number-related changes listed below

SERIAL PREFIX OR NUMBER MAKE MANUAL CHANGES

SERIAL PREFIX OR NUMBER	MAKE MANUAL CHANGES
All	1

SERIAL PREFIX OR NUMBER MAKE MANUAL CHANGES

SERIAL PREFIX OR NUMBER	MAKE MANUAL CHANGES

► New Item

- Some LCR components used in the HP 4261A have been standardized to decrease the number of similar components. For example, if a unit uses both 6.8k Ω 5% and 6.81k Ω 1% resistors, the standard resistor will be 6.81k Ω 1%.

Change the part numbers in the Replaceable Parts List of Section 6 as given in the table on the next page.

NOTE

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

Table 1 Parts Standardization Change

Old Part		New Part	
Part Number	Description	Part Number	Description
0683-1015	Resistor 100Ω 5%	0757-0401	Resistor 100Ω 1%
0683-1025	Resistor 1kΩ 5%	0757-0280	Resistor 1kΩ 1%
0683-1035	Resistor 10kΩ 5%	0757-0442	Resistor 10kΩ 1%
0683-1045	Resistor 100kΩ 5%	0757-0465	Resistor 100kΩ 1%
0683-1055	Resistor 1MΩ 5%	0698-8827	Resistor 1MΩ 1%
0683-1225	Resistor 1.2kΩ 5%	0757-0274	Resistor 1.21kΩ 1%
0683-1235	Resistor 12kΩ 5%	0757-0444	Resistor 12.1kΩ 1%
0683-1245	Resistor 120kΩ 5%	0757-0467	Resistor 121kΩ 1%
0683-1515	Resistor 150Ω 5%	0698-3438	Resistor 147Ω 1%
0683-1535	Resistor 15kΩ 5%	0698-3156	Resistor 147kΩ 1%
0683-1825	Resistor 1.8kΩ 5%	0757-0278	Resistor 17.8kΩ 1%
0683-2215	Resistor 220Ω 5%	0698-3441	Resistor 215Ω 1%
0683-2225	Resistor 2.2kΩ 5%	0698-0084	Resistor 2.15kΩ 1%
0683-2235	Resistor 22kΩ 5%	0757-0199	Resistor 21.5kΩ 1%
0683-2715	Resistor 270Ω 5%	0698-3132	Resistor 261Ω 1%
0683-2725	Resistor 2.7kΩ 5%	0698-0085	Resistor 2.61kΩ 1%
0683-3315	Resistor 330Ω 5%	0698-3444	Resistor 316Ω 1%
0683-3325	Resistor 3.3kΩ 5%	0757-0279	Resistor 3.16kΩ 1%
0683-3335	Resistor 33kΩ 5%	0698-3160	Resistor 31.6kΩ 1%
0683-3925	Resistor 3.9kΩ 5%	0698-3153	Resistor 3.83kΩ 1%
0683-3935	Resistor 39kΩ 5%	0698-3161	Resistor 38.3kΩ 1%
0683-4705	Resistor 47Ω 5%	0698-4037	Resistor 46.4Ω 1%
0683-4725	Resistor 4.7kΩ 5%	0698-3155	Resistor 4.64kΩ 1%
0683-4735	Resistor 47kΩ 5%	0698-3162	Resistor 46.4kΩ 1%
0683-4745	Resistor 470kΩ 5%	0698-3260	Resistor 464kΩ 1%
0683-5625	Resistor 5.6kΩ 5%	0757-0200	Resistor 5.62kΩ 1%
0683-5645	Resistor 560kΩ 5%	0698-8824	Resistor 562kΩ 1%
0683-7525	Resistor 7.5kΩ 5%	0757-0440	Resistor 7.5kΩ 1%
0683-8225	Resistor 8.2Ω 5%	0757-0441	Resistor 8.25kΩ 1%

MANUAL CHANGES

HP 4261A

Digital LCR Meter

MANUAL IDENTIFICATION

Model Number: HP 4261A
 Date Printed: Dec 1986
 Part Number: 04261-90006

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- 1 Make all ERRATA corrections
 - 2 Make all appropriate serial-number related changes listed below

SERIAL PREFIX OR NUMBER	MAKE MANUAL CHANGES
All	1

SERIAL PREFIX OR NUMBER	MAKE MANUAL CHANGES

► New Item

► CHANGE 1

Page 6-7, 6-9, Table 6-3, Replaceable Parts:

Refer to the parts change list.

Table 1 Parts Change List

CHANGE	Page	Note	Reference Designator	Part Number	Description
1	6-7	►C	A5Q9 to A5Q14	1855-0091	TRANSISTOR J-FET N-CHAN
	6-9	►C	A6Q8	1855-0091	TRANSISTOR J-FET N-CHAN
		►C	A6Q9	1855-0091	TRANSISTOR J-FET N-CHAN
		►C	A6Q10	1855-0091	TRANSISTOR J-FET N-CHAN
		►C	A6Q22	1855-0091	TRANSISTOR J-FET N-CHAN
		►C	A6Q23	1855-0091	TRANSISTOR J-FET N-CHAN

►: New Item

C: Change

D. Delete

A: Add

NOTE

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

Date/Div: Jan. 14, 1988/33

Page: 1 of 1





OPERATING AND SERVICE MANUAL

MODEL 4261A
DIGITAL LCR METER
(Including Options 001, 002, 003 and 010)

SERIAL NUMBERS

This manual applies directly to instruments with serial numbers prefixed 2514J.

With changes described in Section VII, this manual also applies to instruments with serial numbers prefixed 1545J, 1622J, 1810J, and 1821J.

For additional important information about serial numbers, see **INSTRUMENTS COVERED BY MANUAL** in Section I

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9-1, TAKAKURA-CHO, HACHIOJI SHI, TOKYO, JAPAN

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SECTION I

GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This Operating and Service Manual contains the information required to install, operate, test, adjust and service the Hewlett-Packard Model 4261A Digital LCR Meter. Figure 1-1 shows the instrument and accessories supplied. This section covers specifications, instrument identification, description, operations, accessories, and other basic information.

1-3. Listed on the title page of this manual is a Microfiche part number. This number can be used to order 4 x 6 inch microfilm transparencies of the manual. Each microfiche contains up to 60 photoduplicates of the manual pages. The microfiche package also includes the latest Manual Changes supplement as well as all pertinent Service Notes. To order an additional manual use the part number listed on the title page of this manual.

1-4. SPECIFICATIONS.

1-5. Complete specifications of the Model 4261A

LCR Meter are given in Table 1-1. These specifications are the performance standards or limits against which the instrument is tested. The test procedures for the specifications are covered in Section IV Performance Tests. Table 1-2 lists general information. General information is not specifications but is typical characteristics included as additional information for the operator. When the 4261A LCR Meter is shipped from the factory, it meets the specifications listed in Table 1-1.

1-6. SAFETY CONSIDERATIONS.

1-7. The Model 4261A LCR Meter has been designed to conform to the safety requirements of an IEC (International Electromechanical Committee) Safety Class I instrument.

1-8. This operating and service manual contains information, cautions and warnings which must be followed by the user to ensure safe operation and to maintain the instrument in a safe condition.

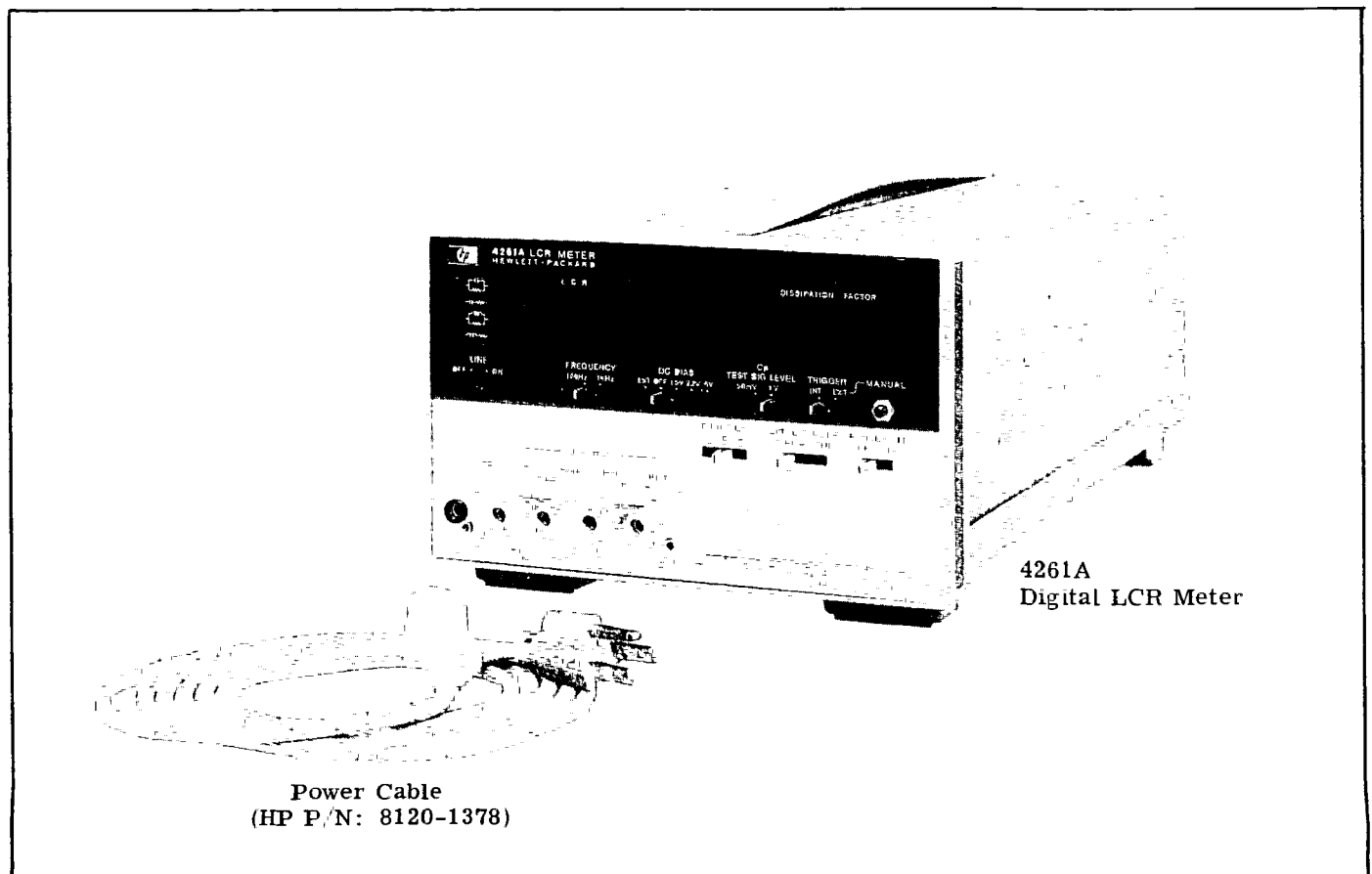






















Figure 1-1. Instrument and Accessories Supplied.

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

<u>L-D MEASUREMENT</u>										
Range	L	120Hz 1kHz	1000μH 100.0μH	10.00mH 1000μH	100.0mH 10.00mH	1000mH 100.0mH	10.00H 1000mH	100.0H 10.00H	1000H 100.0H	
	D	0.001 to 1.900, 1 range, common to all L ranges.								
Test Signal Level *1		_____				1V				
		70mA	10mA	1mA	100μA	10μA	_____			
	AUTO	Same as  Mode				Same as  Mode				
L Accuracy *2 *3		_____				0.3% + 2 counts		1% + 2 counts		
		0.2% + 2 counts + 0.2μH							_____	
	AUTO	Same as  Mode				Same as  Mode				
D Accuracy *2		_____				0.3% + (3 + Lx 500) counts		1% + (3 + $\frac{Lx}{500}$) counts		
		0.2% + (3 + 200 Lx) counts							_____	
	AUTO	Same as  Mode				Same as  Mode				

*1. Typical data, varies with value of D and number of counts.
 *2. ± (% of reading + counts). Lx is inductance readout in counts.
 *3. L accuracies are applicable only when D value is less than 1.901. See Table 1-2 for L accuracies when D is more than 1.900.

<u>R MEASUREMENT</u>									
RANGE	120Hz or 1kHz	1000mΩ	10.00Ω	100.0Ω	1000Ω	10.00kΩ	100.0kΩ	1000kΩ	10.00MΩ
Test Signal Level *1		_____				1V			
		70mA	10mA	1mA	100μA	10μA	_____		
	AUTO	Same as  Mode				Same as  Mode			
R Accuracy *2 *3		_____				0.3% + 2 counts			
		0.2% + 2 counts						_____	
	AUTO	Same as  Mode				Same as  Mode			

*1. Typical data, varies with number of counts.
 *2. ± (% of reading + counts).
 *3. R accuracies are applicable only when D value measured in L or C function is greater than 0.500. See Table 1-2 for R accuracies when D is less than 0.501

Accuracy applies over a temperature range of 23°C ±5°C (at 0°C to 55°C, error doubles).

DC BIAS

Internal Source. 1.5V, 2.2V, 6V (Accuracy ±5%).

External Source: Provision for external DC bias voltage of +30V maximum at binding posts on rear panel.

Table 1-2. General Information (Sheet 1 of 2).

READING RATE

The period between the start of a measurement and the start of next measurement is equal to the measuring time plus 30 milliseconds (typical) hold time.

MEASURING TIME

The period between start of a measurement and completion of the measurement is equal to measuring time when RANGE HOLD is set to ON (see figure below) plus time required for autoranging. The following are typical times for a measurement of approximately 1000 counts on low loss components when RANGE HOLD is set to ON.

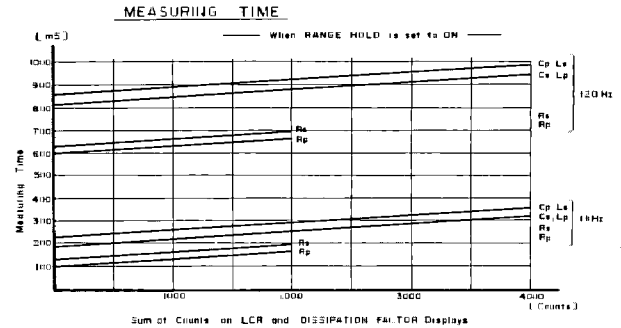
Time required for autoranging (RANGE HOLD: OFF):

1kHz: $180 \times n$ (ms)

120Hz: $670 \times n$ (ms)

where n is the number of ranges stepped by 4261A autorange circuit.

1kHz	C L	220 - 260ms
	R	120 - 160ms
120Hz	C L	900ms
	R	700ms



L-D, C-D Accuracies when $D > 1.900$ and R accuracies when $D \leq 0.500$:

For L-D, C-D accuracies when $D > 1.900$ and R accuracies when $D \leq 0.500$, the following error factors should be added to accuracy specifications:

Note

1. D display is blanked when Cp or Ls value is less than 80 counts.
2. Both displays will show 1999 counts and "OUT OF RANGE" lamp will light when measured value for Cs, Lp or Rp is less than about 60 counts (right display is blanked during R measurements).

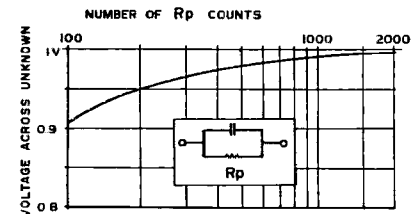
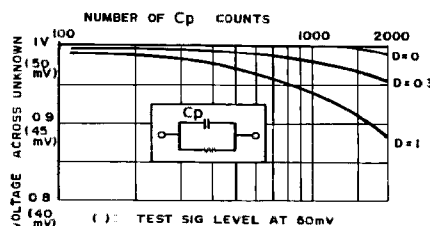
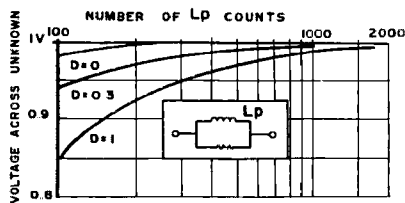
CIRCUIT MODE	Additional Error
Parallel Capacitance	D 10% of reading (Test Sig Level: 1V) D 5% of reading (Test Sig Level: 50mV)
Series Capacitance	D 5% of reading
Parallel Inductance Series Inductance	D 5% of reading
Parallel Resistance Series Resistance	0.2 D% of reading

TEST SIGNAL LEVEL

Voltage applied to sample under test and current flow through sample are to some extent changed by value and dissipation factor of the sample.

Parallel Equivalent Mode (Lp, Cp, Rp)

Since the output of constant voltage driver is somewhat affected by sample, the voltage across sample varies as shown in below charts:



Note: These charts assume that impedance between HIGH terminals and ground is infinite.

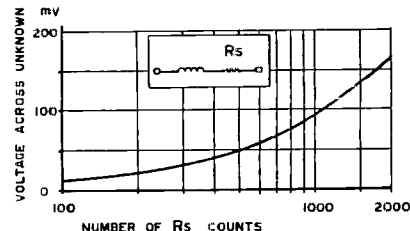
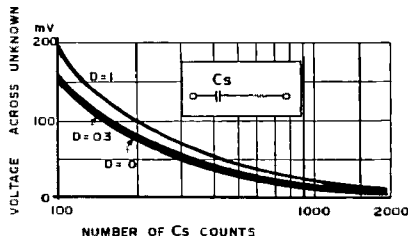
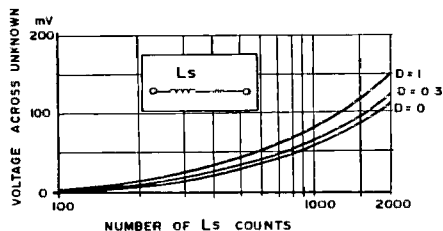
Note: This chart assumes that impedance between HIGH terminals and ground is infinite and that unknown device is an almost pure resistance.

Table 1-2. General Information (Sheet 2 of 2).

Series Equivalent Mode (Ls, Cs, Rs)

The constant current source built into the 4261A is affected by the sample. Voltage

across sample also varies with the value and dissipation factor of the sample as shown in below charts:



Note: These charts assume that impedance between HIGH terminals and ground is infinite.

Note: This chart assumes that impedance between HIGH terminals and ground is infinite and that unknown device is an almost pure resistance.

TRIGGER

Internal: When TRIGGER switch is set to INT position, the 4261A triggers itself automatically at reading rate speed.

Manual: When TRIGGER is set to EXT position, the 4261A is triggered every time the MANUAL button is depressed and released.

External: When TRIGGER is set to EXT position, the 4261A is triggered by the trailing edge of a TTL level negative going pulse applied to EXT TRIGGER input connector on rear panel or by opening center conductor of EXT TRIGGER connector after earthing. Negative pulse width of trigger should be more than 20 μs.

External Encode: When the 4261A is equipped with any option, it may be triggered by an external device. The 4261A is triggered by the trailing edge of a TTL level negative going pulse from the external device. Negative pulse width for External Encode signal should be more than 20 μs.

WARM-UP TIME

Approximately 15 minutes.

Note

Measurement accuracy is not affected by dc bias application from either internal or external bias sources (≤ 200V).

OPTIONS

Option 001: BCD Output of C, L, R and D (Simultaneous)

Option 002: BCD Output of C, D, L/D and R (Alternately)
Data (C, L, R or D) separately selectable by switch on internal board (04261-77022).
Option 003: BCD Remote Control (except for DC bias function)

ACCESSORIES AVAILABLE

- 16061A: Test Fixture (direct coupled type), 5-terminal construction.
- 16062A: Test Leads with alligator clips, 4-terminal construction (for low impedance measurements).
- 16063A: Test Leads with alligator clips, 3-terminal construction (for high impedance measurements).

OTHER

Operating Temperature:

0° C to 55° C (32° F to 131° F)

Operating Humidity:

Relative humidity less than 95% at 40° C.

Altitude: 50,000ft.

Power:

100 120 220 240Vac ±10%, 48 to 66Hz

Power Consumption: approximately 25VA (including optional configurations).

Dimensions:

Approximately 213(w) x 134 (h) x 422 (d) mm.

Weight: approximately 7.5kg.

1-9. INSTRUMENTS COVERED BY MANUAL.

1-10. Hewlett-Packard uses a two-section nine character serial number which is marked on the serial number plate (Figure 1-2) attached to the instrument rear panel. The first four digits and the letter are the serial prefix and the last five digits are the suffix. The letter placed between the two sections identifies country where instrument was manufactured. The prefix is the same for all identical instruments; it changes only when a change is made to the instrument. The suffix, however, is assigned sequentially and is different for each instrument. The contents of this manual apply to instruments with the serial number prefix(es) listed under SERIAL NUMBERS on the title page.

1-11. An instrument manufactured after the printing of this manual may have a serial number prefix that is not listed on the title page. This unlisted serial number prefix indicates the instrument is different from those described in this manual. The manual for this new instrument may be accompanied by a yellow Manual Changes supplement or have a different manual part number. This supplement contains "change information" that explains how to adapt the manual to the newer instrument.

1-12. In addition to change information, the supplement may contain information for correcting errors (called Errata) in the manual. To keep this manual as current and accurate as possible, Hewlett-Packard recommends that you periodically request the latest Manual Changes supplement. The supplement for this manual is identified with this manual's print date and part number, both of which appear on the manual's title page. Complimentary copies of the supplement are available from Hewlett-Packard. If the serial prefix or number of an instrument is lower than that on title page of this manual, see Section VII Manual Changes.

1-13. For information concerning a serial number prefix that is not listed on the title page or in the Manual Changes supplement, contact your nearest Hewlett-Packard office.

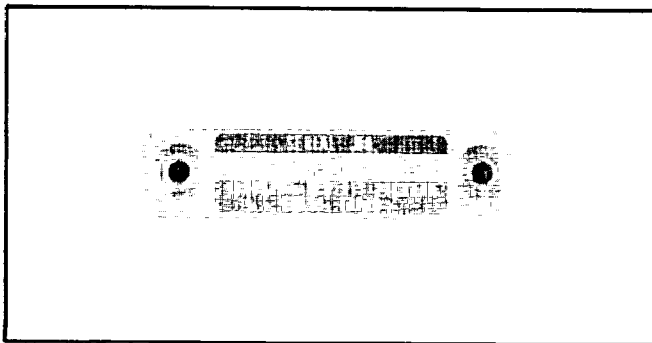


Figure 1-2. Serial Number Plate.

1-14. DESCRIPTION.

1-15. The HP Model 4261A LCR Meter is a general purpose, easy-to-use, high reliability component test instrument designed to automatically measure the parameters of an impedance element with high accuracy and at high speed. The 4261A LCR Meter measures capacitance, inductance, resistance and dissipation factor over a wide range at test frequencies of 120Hz and 1kHz in a five-terminal connection configuration between the component and the instrument. The measuring circuit for the device to be measured is capable of both parallel and series equivalent circuit measurements and the measured values are displayed on two three-full digits LED displays on the front panel.

1-16. The measuring range for capacitance is from 0.1pF to 19mF, inductance from 0.1 μ H to 1900H, and resistance from 1m Ω to 19M Ω all of which are measured with a basic accuracy of 0.2 to 0.3% depending on test signal level, frequency and measuring equivalent circuit, and at a typical measuring speed of 200 milliseconds. The wide range capability of the 4261A enables a measurement range from small capacitances such as mica capacitors and the parasitic capacitance of a semiconductor device through high capacitances such as the measurement of electrolytic capacitors to be covered. A wide range of inductance measurements from the inductance of a high frequency transformer to that of a power transformer can be measured. The wide resistance range permits the measurement of wirewound resistors through the measurement of solid resistors. In parallel capacitance measurements, the 4261A Digital LCR Meter can select either a test signal level of 1Vrms, or 50mVrms. Other versatile 4261A capabilities are, for example, the use of internal and external dc bias voltages, the availability of test fixtures, and options providing for BCD output and remote control operation (at the rear panel).

1-17. OPTIONS.

1-18. Options for the Model 4261A LCR Meter are available for adding BCD parallel data output at two rear panel connectors (opt 001), for providing a BCD parallel data output connector on the rear panel (opt 002), and for attaching a rear panel input connector for remote control of the 4261A (opt 003). Detailed descriptions of the various options follow.

1-19. Option 001.

1-20. The 4261A Option 001 provides separate BCD parallel data output of capacitance, inductance or resistance and dissipation factor simultaneously from the two rear connectors. With this option, external data processing devices such as digital printer comparators can be connected to the 4261A Digital LCR Meter. Table 1-3 lists the components required for installation of this option to a standard unit.

Table 1-3. 4261A Options.

Option	Function	Components		
		HP Part No.	Q'ty	Description
Option 001	BCD Parallel Data Output	04261-77021	1	A21 Board Ass'y
		5060-4020	2	Connector Assembly 50-pin
Option 002	Parameter Serial BCD Data Output	04261-77022	1	A22 Board Ass'y
		5060-4020	1	Connector Assembly 50-pin
		04261-85023	1	Name Plate
Option 003	BCD Remote Control	04261-77123	1	Connector Ass'y 50-pin
		04261-72023	1	50-pin Flat Cable Ass'y

1-21. Option 002.

1-22. The 4261A Option 002 provides for outputting inductance, capacitance or resistance and dissipation factor values as measured with the 4261A LCR Meter alternately from one rear connector in BCD data parallel form. When the 4261A is equipped with an option 002, a digital printer, digital comparator or other such external devices can be interfaced. The components required for installation of option 002 with a standard 4261A are listed in Table 1-3.

1-23. Option 003.

1-24. The 4261A option 003 adds remote control capability to the 4261A permitting external control of FUNCTION, RANGE, etc. functions at a rear input connector for combination with an external control device. Table 1-3 shows the components needed for installation of the Option 003.

1-25. Option 010.

1-26. The 4261A Option 010 changes 120Hz standard measurement frequency to 100Hz. All specifications given in Table 1-1 apply directly to Option 010 instruments equipped with 100Hz and 1kHz measurement frequencies. Change all 120Hz descriptions to 100Hz.

1-29. ACCESSORIES SUPPLIED.

1-30. Figure 1-1 shows the HP Model 4261A LCR Meter, power cord (HP Part No. 8120-1378), fuses (HP Part No. 2110-0201 and 2110-0202), and the Operating and Service Manual.

1-31. EQUIPMENT AVAILABLE.

1-32. Three styles of fixtures and leads for the measurement of various components are available for effective and easy measurement. These are listed in Table 1-2. A brief description of each of these fixtures and leads is given in Table 1-4. Refer to Section III paragraph 3-10 for detailed information on these devices.

1-33. RECOMMENDED TEST EQUIPMENT.

1-34. The equipment required to maintain the Model 4261A is listed in Table 1-4. Other equipment may be substituted if it meets or exceeds the critical specifications listed in the table.

Table 1-4. Equipment Available.

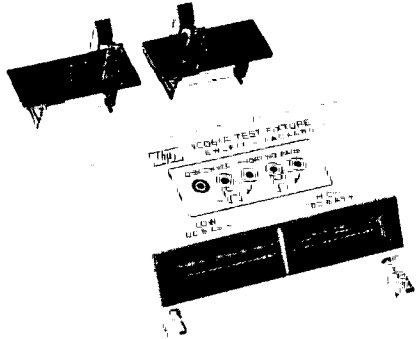
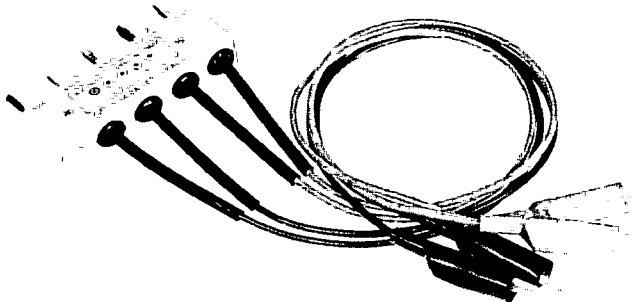
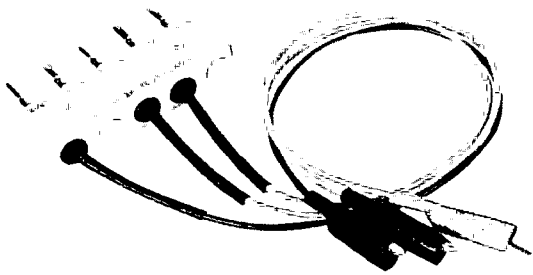
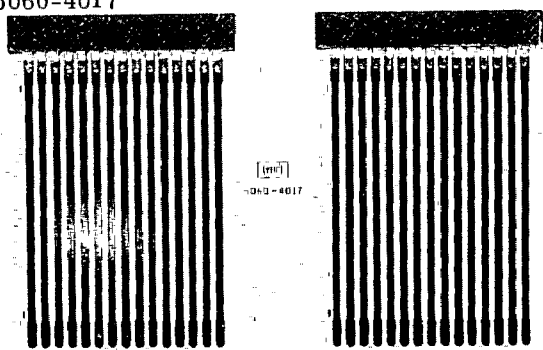
Model	Description
<p>HP 16061A</p>  <p>The image shows two black metal test fixtures and a printed circuit board. The PCB is labeled '16061A TEST FIXTURE' and includes various electrical components and connection points.</p>	<p>Test Fixture (direct coupled type) for general measurement of both axial and vertical lead components.</p>
<p>HP 16062A</p>  <p>The image shows a set of test leads with alligator clips at one end and probe tips at the other. A coiled cable is also visible.</p>	<p>Test Leads (with alligator clips) useful for low inductance, high capacitance or low resistance (less than 10kΩ) measurements.</p>
<p>HP 16063A</p>  <p>The image shows test leads similar to the HP 16062A, but with different probe tips and a coiled cable.</p>	<p>Test Leads (with alligator clips) for general component measurement and especially useful for high impedance measurements.</p>
<p>HP P, N 5060-4017</p>  <p>The image shows two vertical boards with many parallel pins or leads extending downwards. One board has a label that reads '1000-4017'.</p>	<p>Extender Board used for 4261A troubleshooting.</p>

Table 1-5. Recommended Test Equipment.

Instrument	Critical Specifications	Recommended Model	*Use
Frequency Counter	Frequency Range: 40Hz to 10kHz Sensitivity 50mVrms min.	HP 5300A w5306A	P
Capacitance Standard (See para. 4-3)	Capacitance Values: 100pF, 1000pF, 10nF 100nF, 1000nF and 10 μ F	HP 16361A	P, A
Resistance Standard (See para. 4-3)	Resistance Values 1k Ω , 10k Ω , 100k Ω and 10M Ω	HP 16361A	P, A
Inductance Standard (See para. 4-3)	Inductance Value 100mH	HP 16361A	P
DC Voltmeter	Voltage Range: 1V to 10V Sensitivity 10mV min.	HP 5300A/ w5306A	P, A
Oscilloscope	Bandwidth: 10MHz min. Vertical Sensitivity: 5mV/div. Horizontal Sweep Rate: 1 μ s/div.	HP 1740A	A
Logic State Analyzer	Repetition Rate: 0 to 1MHz Input Threshold TTL (approx. +1.5V) Minimum Clock Pulse Width: 1 μ s	HP 1601A/ w 180C HP 1600A	T
Logic Probe	Input Impedance: >25k Ω Logic one Threshold: 2V \pm 0.2V Logic zero Threshold: 0.8V +0.2V, -0.4V Input Minimum Pulse Width: 1 μ s	HP 10525T	T
*P = Performance Test A = Adjustments T = Troubleshooting			

SECTION II INSTALLATION

2-1. INTRODUCTION.

2-2. This section provides installation instructions for the Model 4261A LCR Meter. The section also includes information on initial inspection and damage claims, preparation for using the 4261A and packaging, storage and shipment.

2-3. INITIAL INSPECTION.

2-4. The 4261A LCR Meter as shipped from the factory meets all the specifications listed in Table 1-1. On receipt, inspect the shipping container for damage. If the shipping container or cushioning material is damaged, notify the carrier as well as the Hewlett-Packard office and be sure to keep the shipping materials for carrier's inspection until the contents of the shipment have been checked for completeness and the instrument has been checked mechanically and electrically. The contents of the shipment should be as shown in Figure 1-1. The procedures for checking the general electrical operation are given in Section III (Paragraph 3-5 OPERATOR'S CHECK) and the procedures for checking the 4261A LCR Meter against its specifications are given in Section IV. Firstly, do the operator's check. If the 4261A LCR Meter is electrically questionable then do the Performance Tests to determine whether the 4261A has failed or not. If contents are incomplete, if there is mechanical damage or defects (scratches, dents, broken switches, etc.), or if the performance does not meet the operator's or performance tests, notify the nearest Hewlett-Packard office (see list at back of this manual). The HP office will arrange for repair or replacement without waiting for claim settlement.

2-5. PREPARATION FOR USE.

2-6. Power Requirements.

2-7. The 4261A requires a power source of 100, 120, 220, or 240Volts ac $\pm 10\%$, 48 to 66Hz single phase. Power consumption is approximately 25 watts.

WARNING

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

2-8. Line Voltage and Fuse Selection.

CAUTION

BEFORE TURNING THE 4261A LINE SWITCH TO ON, VERIFY THAT THE INSTRUMENT IS SET TO THE VOLTAGE OF THE POWER SUPPLIED.

2-9. Figure 2-1 provides instructions for line voltage and fuse selection. The line voltage selection card and the proper fuse are factory installed for the voltage appropriate to instrument destination.

CAUTION

USE PROPER FUSE FOR LINE VOLTAGE SELECTED.

CAUTION

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

2-10. Power Cable.

2-11. To protect operating personnel, the National Electrical Manufacturer's Association (NEMA) recommends that the instrument panel and cabinet be grounded. The Model 4261A is equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cable is the ground wire.

2-12. To preserve the protection feature when operating the instrument from a two contact outlet, use a three prong to two prong adapter (HP Part No. 1251-8196) and connect the green grounding tab on the adapter to power line ground.

CAUTION

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

Operating voltage is shown in module window and is usually set to 120V at factory

SELECTION OF OPERATING VOLTAGE

- 1 Disconnect power cable and slide module window to left
- 2 Pull FUSE PULL lever and rotate to left. This removes line fuse.
- 3 Select operation voltage by orienting PC board to position desired voltage on top-left side. Push board firmly into module slot
- 4 Rotate FUSE PULL lever back into normal position and re-insert fuse in holders, using caution to select correct fuse value

FUSE SELECTION

Operating Voltage	Fuse	
	HP Part No.	Description
100Vac or 120Vac	2110-0202	0.5A 250V Slow Blow
220Vac or 240Vac	2110-0201	0.25A 250V Slow Blow

Figure 2-1. Voltage and Fuse Selection.

Table 2-1. Mating Connectors.

Mating Connector	Industry Description	HP Part No.	Alternate Source
C OFFSET	BNC, male	1250-0408	
EXT TRIGGER			
DC BIAS	Dual Banana Plug	1251-2816	
LCR DATA OUTPUT	Micro-Ribbon 50-pin	1251-0086	Amphenol 57-30500-375
D DATA OUTPUT			
REMOTE INPUT			

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

2-14. Interconnections.

2-15. When an external bias is applied to the sample capacitor through DC BIAS input connectors on the 4261A rear panel, both plus and minus sides of the external power supply should be connected to the plus and minus connectors of the 4261A DC BIAS input connectors, respectively.

CAUTION

THE MAINS PLUG MUST BE INSERTED BEFORE EXTERNAL CONNECTIONS ARE MADE TO MEASURING AND OR CONTROL CIRCUITS.

2-16. Mating Connectors.

2-17. The mating connectors used for the 4261A are shown in Table 2-1. This table identifies each connector and gives the HP Part Number and part number of an alternate source.

2-18. Operating Environment.

2-19. Temperature. The instrument may be operated in temperatures from 0°C to +55°C.

2-20. Humidity. The instrument may be operated in environments with relative humidities to 95% to 40°C. However, the instrument should also be protected from temperature extremes which cause condensation within the instrument.

2-21. Installation Instructions.

2-22. The HP Model 4261A can be operated on the bench or in a rack mount. The 4261A is ready for bench operation as shipped from the factory. For bench operation a two-leg instrument stand is used. When in use, the instrument stands are designed to be pulled towards the front of instrument.

2-23. Rack Mounting and Handle Installation

2-24. The 4261A can be installed in a rack and be operated as a component of a measurement system. Rack mounting information for the 4261A is presented in Figure 2-3. Various rack mounting configurations are shown with the necessary additional parts. To convert for rack installation or to install handles, refer to Figure 2-3 and proceed as follows:

- a. Remove the two rear feet and the two front feet with stands.
- b. Follow the instructions in Figure 2-3 for desired installation.

2-25. STORAGE AND SHIPMENT.

2-26. Environment.

2-27. The instrument may be stored or shipped in environments within the following limits:

Temperature -40°C to +75°C
Humidity to 95%
Altitude 50,000ft

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

2-28. Packaging.

2-29. Original Packaging. Containers and materials identical to those used in factory packaging are available through Hewlett-Packard offices. If the instrument is being returned to Hewlett-Packard for servicing, attach a tag indicating the type of service required, return address, model number, and full serial number. Also mark the container FRAGILE to assure careful handling. In any correspondence, refer to the instrument by model number and full serial number.

2-30. Other Packaging. The following general instructions should be used for re-packing with commercially available materials:

- a. Wrap instrument in heavy paper or plastic. If shipping to Hewlett-Packard office or service center, attach tag indicating type of service required, return address, model number, and full serial number.
- b. Use strong shipping container. A double-wall carton made of 350 pound test material is adequate.
- c. Use enough shock absorbing material (3 to 4 inch layer) around all sides of instrument to provide firm cushion and prevent movement inside container. Protect control panel with cardboard.
- d. Seal shipping container securely.
- e. Mark shipping container FRAGILE to ensure careful handling.
- f. In any correspondence, refer to instrument by model number and full serial number.

2-31. OPTION INSTALLATION.

2-32. When it is desired to add one of the available optional features to a standard 4261A instrument, perform the installation as follows:

- a. Push LINE switch to OFF.
- b. Remove instrument top cover.
- c. Follow the appropriate paragraph below:

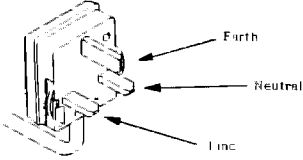

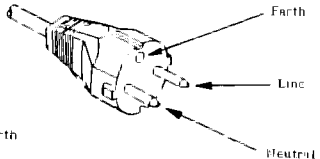
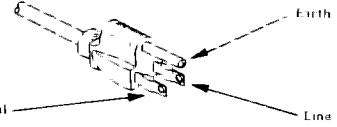
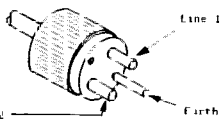
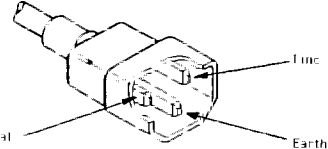
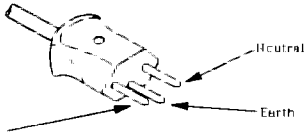
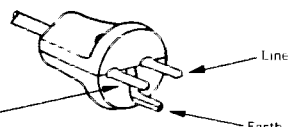
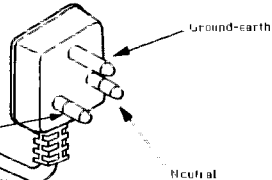
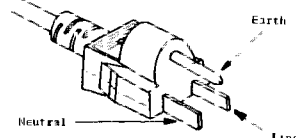
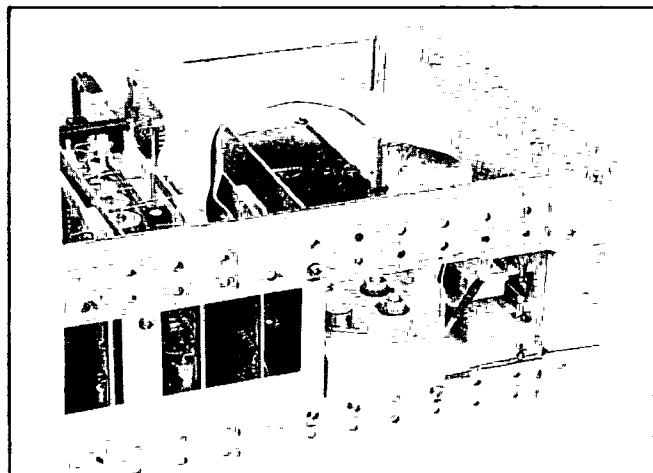
<p>OPTION 900 United Kingdom</p>  <p>Plug: BS 1363A, 250V Cable: HP 8120-1351</p>	<p>OPTION 901 Australia/New Zealand</p>  <p>Plug: NZSS 198 AS C112, 250V Cable: HP 8120-1469</p>
<p>OPTION 902 European Continent</p>  <p>Plug: CEE-VII, 250V Cable: HP 8120-1689</p>	<p>OPTION 903 U.S./Canada</p>  <p>Plug: NEMA 5-15P, 125V, 15A Cable: HP 8120-1378</p>
<p>OPTION 904 U.S./Canada</p>  <p>Plug: IEC 6-15P, 250V, 15A Cable: HP 8120-0698</p>	<p>OPTION 905* Any country</p>  <p>Plug: CEE 22-VI, 250V Cable: HP 8120-1396</p>
<p>OPTION 906 Switzerland</p>  <p>Plug: SEV 1011.1959-24507 Type 12, 250V Cable: HP 8120-2104</p>	<p>OPTION 912 Denmark</p>  <p>Plug: DHCR 107, 220V Cable: HP 8120-2956</p>
<p>OPTION 917 India/Republic of S. Africa</p>  <p>Plug: SABS 164, 250V Cable: HP 8120-4211</p>	<p>OPTION 918 Japan</p>  <p>Plug: JIS C 8505, 125V, 15A Cable: HP 8120-4755</p>
<p>NOTE: Each option number includes a 'family' of cords and connectors of various materials and plug body configurations (straight, 90° etc.).</p> <p>* Plug option 905 is frequently used for interconnecting system components and peripherals.</p>	

Figure 2-2. Power Cables Supplied

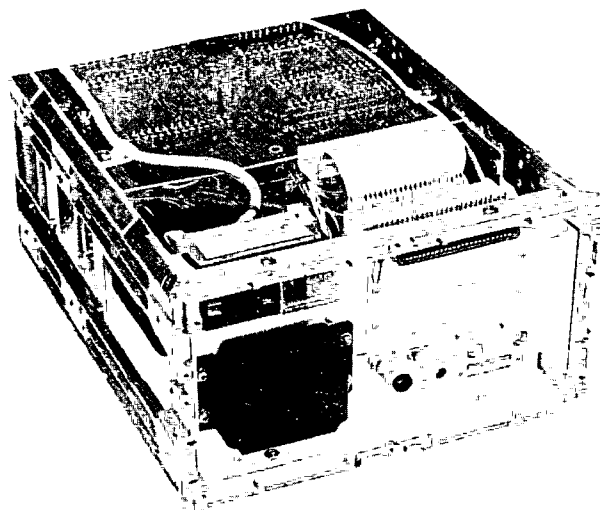
- 2-33. Option 001 BCD Parallel Data Output Installation.
- a. Remove the twotop blind covers from the rear panel.
 - b. Install two 50-pin Connector Assemblies in the openings as shown in Figure 2-4.
 - c. Insert A21 Board Assembly into optional receptacle (see Figure 2-4).
 - d. Plug flat cable assemblies from option board to connector boards of Connector Assemblies.
- 2-34. Option 002 Parameter Serial BCD Data Output Installation.
- a. Remove top blind cover on rear panel.
 - b. Install a 50-pin Connector Board Assembly in the opening as shown in Figure 2-4.
 - c. Insert A22 Board Assembly into optional plug-in receptacle (see Figure 2-4).
 - d. Plug flat cable assembly from option board to connector board of Connector Assembly.
- 2-35. Option 003 BCD Remote Control Installation.
- a. Remove instrument bottom cover and bottom blind cover from rear panel.
 - b. Install connector assembly in the opening.
 - c. Connect the flat cable assembly between connector board of connector assembly and A1 Mother board (see Figure 2-4).



Option 001 BCD Parallel Data Output

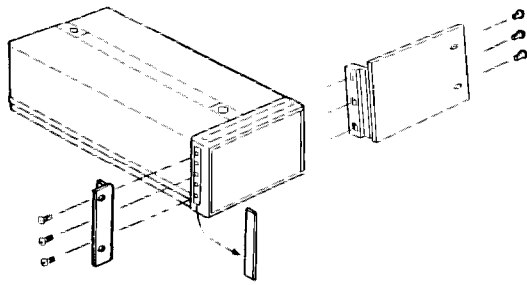


Option 002 Parameter Serial BCD Data Output

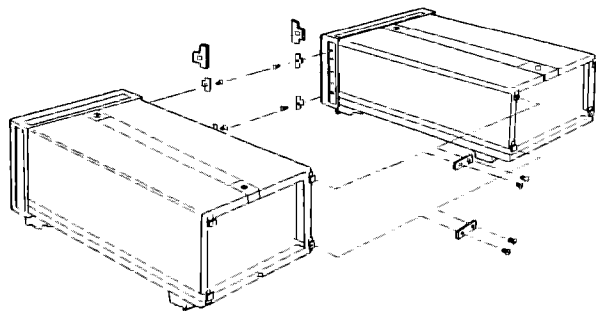


Option 003 BCD Remote Control

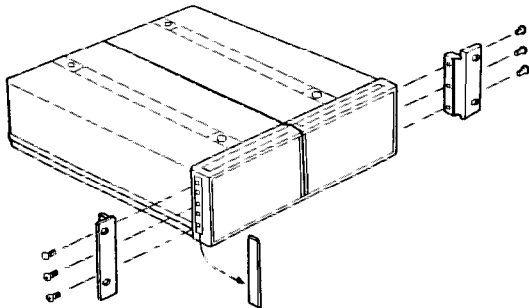
Figure 2-4. Option Installations.



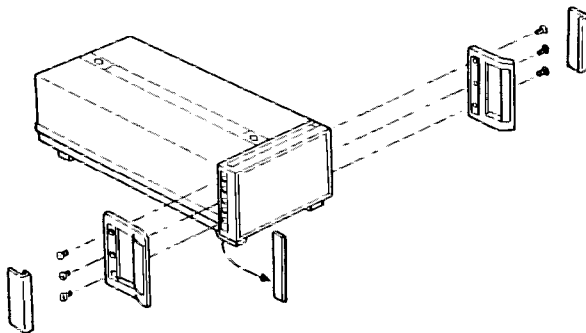
(A)



(B)



(C)



(D)

A. Rack Installation (only 4081A)

1. Remove the two plastic side trim strips from front frame.
2. Attach flange and adapter panel assembly with screws.

Parts required:

HP Part No.	Q'ty	Description
5061-9657	1	Rack Adapter Kit

B. Horizontal Lock Installation

1. Remove the plastic side trim strips from front frame.
2. Attach front horizontal lock links to side of front frames.
3. Connect the two instruments together and attach rear lock links to rear panels.

Parts required:

HP Part No.	Q'ty	Description
5061-9694	1	Vertical and Horizontal Lock Link Kit

C. Rack Installation for Horizontally Locked Unit

1. Remove the plastic side trim strips from front frame.
2. Attach flanges with screws.

Parts required:

HP Part No.	Q'ty	Description
5061-9677	1	Rack Flange Kit
Plus all parts needed for B.		

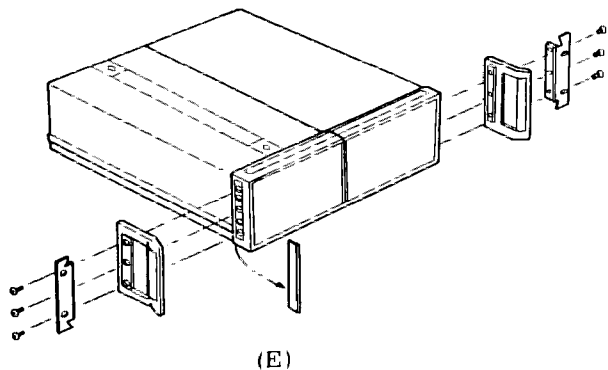
D. Handle Installation

1. Remove the plastic side trim strips from front frame.
2. Attach handles with screws.

Parts required:

HP Part No.	Q'ty	Description
5061-9689	1	Handle Kit

Figure 2-3. Rack and Handle Installation (Sheet 1 of 2).



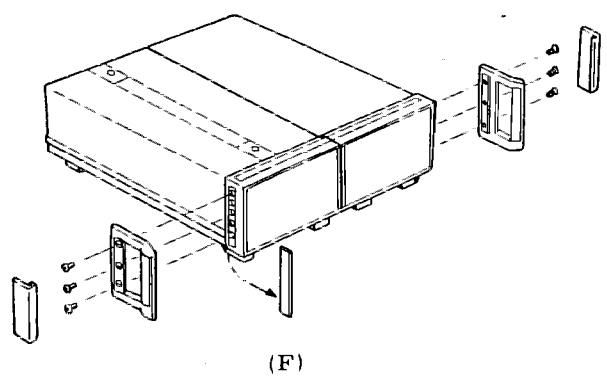
(E)

E. Handle and Rack Installation for Horizontally Locked Unit

1. Remove front side trim strips from front frame.
2. Attach Handles with screws.
3. Attach flanges with screws.

Parts required:

HP Part No.	Q'ty	Description
5061-9683	1	Handle Kit
Plus all parts needed for B.		



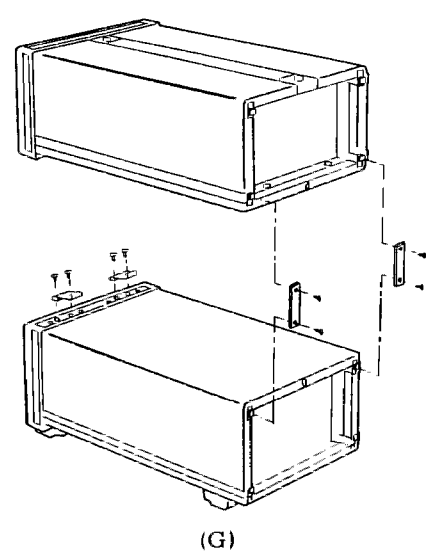
(F)

F. Handle Installation for Horizontally Locked Unit

1. Remove front side trim strips from front frame.
2. Attach handles with screws.

Parts required:

HP Part No.	Q'ty	Description
5061-9689	1	Handle Kit
Plus all parts needed for B.		



(G)

G. Vertical Lock Installation

1. Remove top trim strips from front frame of bottom instrument.
2. Attach front vertical lock links.
3. Connect the two instruments together and attach rear vertical lock links with screws.

Parts required:

HP Part No.	Q'ty	Description
5061-9694	1	Vertical and Horizontal Lock Link Kit

Figure 2-3. Rack and Handle Installation (Sheet 2 of 2).

SECTION III OPERATION

3-1. INTRODUCTION.

3-2. This section provides the operating information to acquaint the user with the 4261A LCR Meter. Basic product features and characteristics, measurement procedures for various applications, an operational check of the fundamental electrical functions and operator maintenance information are presented in this section. Operating cautions throughout the text should be carefully observed.

3-3. PANEL FEATURES.

3-4. Front and rear panel features for the 4261A are described in Figures 3-1 and 3-2. Description numbers match the numbers on the photograph. Other detailed information for panel displays and controls are covered in the Operating Instructions (paragraph 3-7).

3-5. OPERATING CHECK.

WARNING

ANY INTERRUPTION OF THE PROTECTIVE CONDUCTOR INSIDE OR OUTSIDE THE INSTRUMENT OR DISCONNECTION OF THE PROTECTIVE EARTH TERMINAL IS LIKELY TO CAUSE THE INSTRUMENT TO BE DANGEROUS. INTENTIONAL INTERRUPTION IS PROHIBITED.

WARNING

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

CAUTION

BEFORE ANY OTHER CONNECTION IS MADE, THE PROTECTIVE EARTH TERMINAL MUST BE CONNECTED TO A PROTECTIVE CONDUCTOR.

3-6. Figure 3-3, Operating Check procedure, may be performed as an incoming inspection or when the user wants to determine that the instrument works properly before making a measurement. If the instrument is suspected to be faulty during the operating check, it is best to repeat the check to verify the trouble and to clearly establish the symptoms and then to advance to the troubleshooting guide provided in Section VIII SERVICE or to performance tests in Section IV.

3-7. OPERATING INSTRUCTIONS.

3-8. General Operating Information.

3-9. Connecting DUT. The 4261A UNKNOWN terminals consist of five connectors; H_{CUR} , H_{POTEN} , L_{CUR} , L_{POTEN} and GUARD. These terminals are sometimes converted to a three terminal configuration including GUARD terminal. A four-terminal measurement configuration, which is useful for accurate low inductance, high capacitance or low resistance measurement, is also feasible. When converting to three terminals, shorting bars are attached to the instrument combine H_{CUR} and H_{POTEN} terminals, and L_{CUR} and L_{POTEN} terminals, respectively.

CAUTION

FOR CERTAIN TERMINAL MEASUREMENT CONFIGURATIONS, THE H_{CUR} TERMINAL MUST BE CONNECTED TO H_{POTEN} TERMINAL AND THE L_{CUR} TERMINAL CONNECTED TO THE L_{POTEN} TERMINAL. OTHERWISE THE DISPLAYS WILL HAVE NO MEANING AND THE LIFE OF THE RELAYS USED IN THE INSTRUMENT WILL SOMETIMES BE SHORTENED.

Note

The 4261A can not measure a sample which has one lead connected to earth (grounded).

3-10. Test Fixtures and Leads.

3-11. The 4261A has three kinds of test fixtures and leads available. These are described in Table 3-1. The characteristics of the sample to be measured should determine which accessory should be selected. In a similar way to these available accessories, user built test fixtures or leads may be constructed for special measurement requirements.

3-12. Measuring Circuit Modes. The circuit mode which treats and measures the unknown as a parallel capacitance is called the C_p (parallel capacitance) mode, and in like manner, the other measuring modes are:

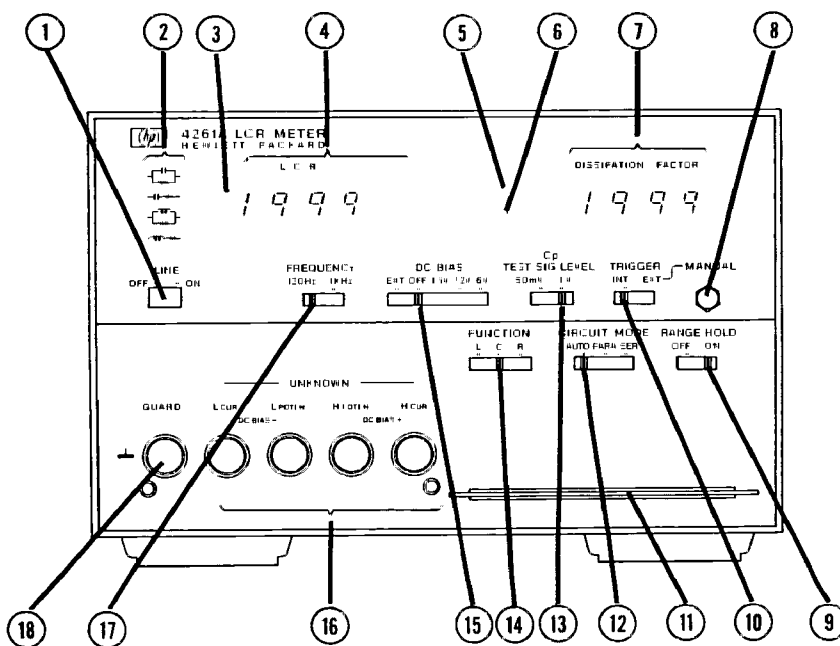
C_s mode: series capacitance.

L_p mode: parallel inductance.

L_s mode: series inductance.

R_p mode: parallel resistance.

R_s mode: series resistance.



- ① LINE ON/OFF switch: Turns instrument on and readies instrument for measurement.
- ② Circuit Mode Indicator: LED lamp, next to equivalent measuring circuit being used, lights. Sample connected to UNKNOWN terminals (16) is measured in an equivalent circuit selected by FUNCTION (14) and CIRCUIT MODE (12) switches and is indicated by appropriate LED lamp. Equivalent circuits are shown as electronic circuit symbols at the left of indicator lamps. Desired circuit parameter of component is measured in one of the following selected circuit modes:

Parallel capacitance	
Parallel resistance	
Series capacitance	
Parallel inductance	
Series inductance	
Series resistance	

- ③ Trigger Lamp: Turns on during sample measuring period. Turns off during period when instrument is not taking measurement (or hold period). There is one turn-on-and-off cycle per measurement. This lamp turns on and off repeatedly when TRIGGER (10) is set to INT.

- ④ LCR Display: Inductance, capacitance or resistance value including the decimal point and unit is displayed by this 3-1/2 digit display. Displayed counts over the range between 0 and 1900 have meaning and number counts outside this range are meaningless. Both LCR (4) and DISSIPATION FACTOR displays (7) will indicate 1999 counts and OUT OF RANGE lamp (5) will light when number of counts for inductance, capacitance or resistance is less than about 60 counts in parallel inductance (Lp), series capacitance (Cs) or parallel resistance (Rp) measurement modes. This condition does not occur when measurement mode is series inductance (Ls), parallel capacitance (Cp) or series resistance (Rs).

- ⑤ OUT OF RANGE lamp: This lamp is turned on if inductance, capacitance, resistance or dissipation factor measured is out of the measurement range as determined by selected range when RANGE HOLD (9) is set to ON; and by selected CIRCUIT MODE (12) when RANGE HOLD (9) is OFF. When OUT OF RANGE lamp lights, either one or both displays will be blank or read 1999 counts.

- ⑥ REMOTE lamp. When this lamp is on, it means that instrument is being remotely controlled by external devices connected to 4261A Option 003 or Opt on 101. Front panel FREQUENCY (17), Cp TEST SIG LEVEL (11), TRIGGER (10), FUNCTION (14), CIRCUIT MODE (12), and RANGE HOLD (9) controls are disabled when REMOTE lamp is lit.

⑦ **DISSIPATION FACTOR Display.** Value for dissipation factor is always displayed as a decimal. Dissipation factor measurements in the range of 0.000 to 1.900 can be measured with meaning. Other dissipation factor values measured with the instrument do not have meaning. This display is blanked when making resistance measurements and when number of counts for inductance (Ls) or capacitance (Cp) is less than 80 counts.

⑧ **MANUAL Trigger Pushbutton Switch.** When this button switch is pushed and released, it triggers a measurement cycle. The switch is normally used when TRIGGER ⑩ is set to EXT, but it also functions when TRIGGER ⑩ is set to INT. A measurement cycle is initiated when the TRIGGER pushbutton is released. Holding the TRIGGER pushbutton in its depressed position holds the measurement. Releasing the button initiates a measurement and permits INT (internal) triggering to continue.

⑨ **RANGE HOLD Switch.** Setting this switch to OFF enables the instrument to make measurements in autoranging mode. When RANGE HOLD is set to ON, range is held on range selected just prior to setting RANGE HOLD to ON. When RANGE HOLD is in ON position, range is scaled down by one decade when changing test frequency from 120Hz to 1kHz and scaled up by one decade by changing from 1kHz to 120Hz except in resistance measurements.

⑩ **TRIGGER Switch.** This switch selects trigger mode, INT or EXT. INT trigger is internal trigger mode and enables instrument to make repeated automatic measurements. In external trigger (EXT) mode, triggering is performed by either operating MANUAL trigger button ⑧, by a trigger signal through EXT TRIGGER input connector on rear panel or by a remote control signal via rear REMOTE INPUT connector.

⑪ **Instruction Card.** This card provides simplified measurement procedures and outlines measurement ranges.

⑫ **CIRCUIT MODE Selector Switch.** Appropriate circuit mode for taking a measurement is selected and set with this switch. A parallel equivalent circuit is selected when the switch is set to PARA position and series equivalent circuit in the SER position. The instrument automatically selects the appropriate parallel or series equivalent in when set to AUTO circuit mode position. Measurement range for each position is shown in the Instruction Card ⑪.

⑬ **Cp TEST SIG LEVEL selector switch.** This switch is effective only in parallel capacitance measurements and permits selection of test voltage to be applied to sample (50mVrms or 1Vrms). The 50mV test voltage is generally utilized in semiconductor device measurements.

⑭ **FUNCTION Switch.** This switch selects electrical circuit parameter to be measured with the instrument as follows:

FUNCTION	Parameter(s) measured
L	inductance and dissipation factor
C	capacitance and dissipation factor
R	resistance

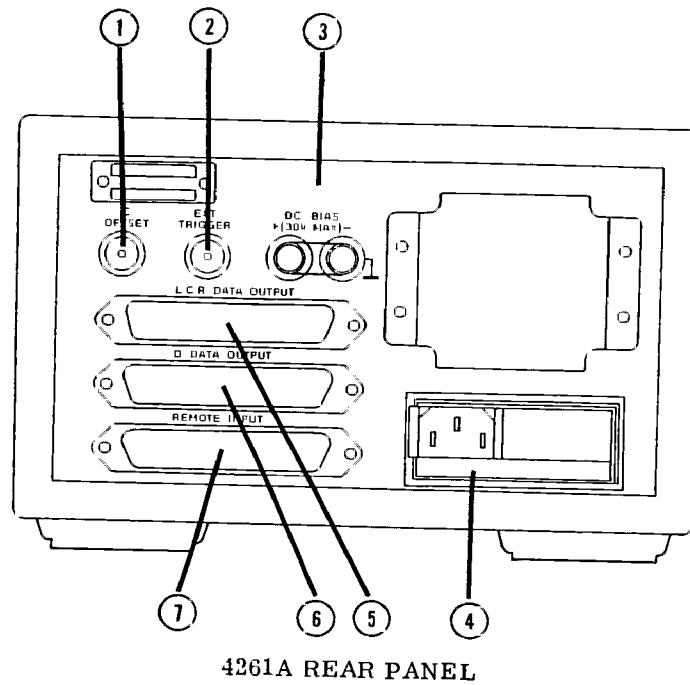
⑮ **DC BIAS Selector Switch.** This switch permits selection of internal DC bias voltage applied to sample (1.5Vdc, 2.2Vdc, or 6.0Vdc) or when switch is set to EXT, is used to apply external bias voltage from rear DC BIAS input connectors. OFF position is selected in no bias voltage is necessary.

⑯ **UNKNOWN Terminals.** Consists of four terminals: High current terminal (H_{CUR}), High potential terminal (H_{POTEN}), Low potential terminal (L_{POTEN}) and Low current terminal (L_{CUR}). The five-terminal configuration is constructed by adding the GUARD terminal ⑱. A three-terminal configuration is constructed by shorting High terminals and Low terminals together with shorting bars. The high terminals are biased with a positive DC voltage with respect to LOW terminals.

⑰ **FREQUENCY Selector Switch.** Permits selection of frequency of test signal applied to sample, either 120Hz or 1kHz.

⑱ **GUARD Terminal.** This is connected to chassis ground of instrument and can be used as Guard terminal for increasing accuracy in certain measurements.

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

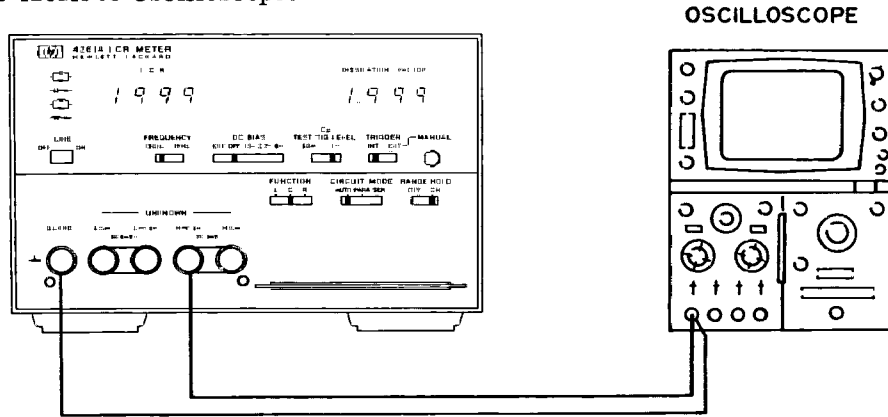


- ① C OFFSET Signal Output Connector. A capacitance offset adjustment can be made by using the signal from this connector. In addition, the test voltage applied to sample can be monitored with an ac voltmeter or oscilloscope connected to this connector. DC bias voltage is not outputted from this connector.
- ② EXT TRIGGER Connector. This connector is used for external triggering the instrument by inputting a trigger signal from an external device including a user designed triggering circuit. For external triggering, TRIGGER switch on front panel is normally set to EXT position.
- ③ DC BIAS Voltage Input Connectors. External DC bias voltage can be applied to the sample up to the maximum voltage of plus 30V through the connectors.
- ④ AC Power Input Connector. Permits line voltage selection of 100Vac, 120Vac, 220Vac or 240Vac.
- ⑤ LCR DATA OUTPUT Connector. With Option 001 BCD parallel data for inductance, capacitance and resistance measured values are outputted through this 50-pin connector. Option 002 adds dissipation factor output also in BCD parallel data form in serial with inductance or capacitance data (Option 001) from this connector.
- ⑥ D DATA OUTPUT Connector. BCD parallel data of measured dissipation factor are outputted through this 50-pin connector (Option 001).
- ⑦ REMOTE INPUT Connector. An External device can remotely control the instrument by inputting control signals through this 50-pin connector. Front panel controls for FREQUENCY, Cp TEST SIG LEVEL, FUNCTION, CIRCUIT MODE and Ranging can be controlled.

Figure 3-2. Rear Panel Features.

OPERATING CHECK

1. Connect 4261A to Oscilloscope:



2. Set 4261A to:

FUNCTION C
 CIRCUIT MODE PARA

3. Set oscilloscope and check operating frequencies, test signal levels and internal bias as follows:

Oscilloscope Settings	Frequency, Internal Bias Voltage
VOLTS/DIV: 0.05V TIME/DIV: 2msec DC input mode	Frequency displayed on oscilloscope should change as 4261A FREQUENCY control (120Hz & 1kHz) is changed. Signal level displayed on oscilloscope should change as 4261A Cp TEST SIG LEVEL control (50mV & 1V) is changed.
VOLTS DIV: 0.2V TIME DIV: 2msec DC input mode	DC level of test signal on oscilloscope should change as DC BIAS control is switched from 1.5V to 2.2V and 6V.

4. Disconnect oscilloscope.

5. Check that the circuit mode indicator lamp correctly lights when FUNCTION and CIRCUIT MODE switches are changed. Table shows FUNCTION and CIRCUIT MODE arrangement.

FUNCTION	CIRCUIT MODE	
	PARA	SER
L		
C		
R		

Figure 3-3. Operating Check (Sheet 1 of 2).

Operating Check (Continued).

6. The two 4261A displays should indicate maximum counts when 4261A controls are set as follows:

4261A Settings	Display
FUNCTION R CIRCUIT MODE AUTO TRIGGER INT UNKNOWN device .. Open ($\infty \Omega$)	Left display should read 19.99M Ω .
FUNCTION L CIRCUIT MODE PARA TRIGGER INT UNKNOWN device .. Short (0 Ω)	Right display should read 1.999.

7. Check that trigger lamp repeatedly turns on and off when 4261A TRIGGER is set to INT.

8. Measurement lamp unit display check. Measurement unit lamp displays should light sequentially when 4261A is operated as follows:

1. Set 4261A to

FUNCTION L, C or R
 CIRCUIT MODE AUTO
 FREQUENCY 120Hz
 TRIGGER EXT
 UNKNOWN device Open ($\infty \Omega$)
 RANGE HOLD OFF

2. Push MANUAL button.

3. Short High and Low terminals together.

4. As MANUAL button is pushed and released unit display should sequentially change as follows:

FUNCTION	Unit Display
L	H \rightarrow mH \rightarrow μ H
C	pF \rightarrow nF \rightarrow μ F \rightarrow mF
R	M Ω \rightarrow k Ω \rightarrow Ω \rightarrow m Ω

9. The 4261A left display will read some minimum value in milliohms (typical value may be 006m Ω , for example) when unit is set to

FUNCTION R
 CIRCUIT MODE AUTO
 TRIGGER INT
 RANGE HOLD OFF
 UNKNOWN device Short (0 Ω)

10. Set RANGE HOLD to ON.

11. Check that left display unit maintains its previous m Ω display when UNKNOWN device terminals are opened ($\infty \Omega$).

12. OUT OF RANGE lamp should light if 4261A is set as follows:

FUNCTION R
 CIRCUIT MODE AUTO
 TRIGGER INT
 UNKNOWN device Open ($\infty \Omega$)

Figure 3-3. Operating Check (Sheet 2 of 2).

Table 3-1. Test Fixtures and Leads.

Accessory	Characteristics
16061A Test Fixture	This fixture facilitates easy measurement of general tubular type components with axial or vertical leads. To install fixture, disconnect shorting bars between high terminals and between low terminals. Insert fixture plugs into UNKNOWN terminals. Tighten fixture screws to firmly attach fixture to instrument. Two kinds of inserts are included (for components with either axial or vertical leads).
16062A Test Leads	These test-leads are especially useful for the measurement of low impedances (e.g., a low inductance - less than approx. 2H at 1kHz or 20H at 120Hz, a high capacitance - more than approx. 10nF at 1kHz or 100nF at 120Hz or a low resistance - less than approx. 10kΩ). If the measuring sample is more than approx. 300μF at 1kHz or less than approx. 100μH at 1kHz, it is recommended that the respective potential leads and current leads should be twisted together.
16063A Test Leads	These test-leads are particularly useful for measuring high impedances (e.g., an inductance of more than approx. 3mH at 1kHz or 30mH at 120Hz, a capacitance lower than approx. 10μF at 1kHz or 100μF at 120Hz, or a resistance more than approx. 20Ω). They are not intended to be used for accurate measurement of small capacitances less than approx. 100pF due to the residual capacitance of the leads.

The four-terminal measurement configuration is adopted for measurements of low series inductance (Ls), high series capacitance (Cs) or low series resistance (Rs) to eliminate the effect of residual impedance of measuring terminals and lead wires. The GUARD terminal is sometimes used to compensate for the effects of stray capacitance and leakage resistance existing between terminals and lead wires when measuring low capacitance or high inductance. Table 3-2 relates the instrument measuring circuit mode to the equivalent circuit and parameter terminology.





3-13. Parameter values for a component measured in a parallel equivalent circuit and that measured in series equivalent circuit are different from each

other. For example, the parallel capacitance of a given component is not equal to the series capacitance of that component. Figure 3-4 shows the relationships between parallel and series parameters for various values of D. Applicable diagrams and equations are given in the chart. For example, a parallel capacitance (Cp) of 1000pF with a dissipation factor of 0.5, is equivalent to a series capacitance (Cs) value of 1250pF at 1kHz. As shown in Figure 3-4, inductance or capacitance values for parallel and series equivalents are almost identical when the dissipation factor is less than 0.01. The letter D in Figure 3-4 represents dissipation factor and is calculated by the equations presented in Table 3-3 for each circuit mode. The dissipation factor of a component always has the same dissipation factor at a given frequency for both parallel equivalent and series equivalent circuits.

Note

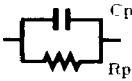


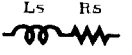
Dissipation factors displayed when CIRCUIT MODE is switched between PARA and SER may exhibit slight differences due to the measurement accuracy of the 4261A.

Table 3-2. Parameter Terminology.

Circuit Mode	Equivalent Circuit	Terminology
Cp mode Rp mode		Cp: parallel capacitance Rp: parallel resistance
Cs mode		Cs: series capacitance Rs: series resistance
Lp mode		Lp: parallel inductance Rp: parallel resistance
Ls mode Rs mode		Ls: series inductance Rs: series resistance

The reciprocal of the dissipation factor (D) is quality factor (Q) and D is often represented as tan δ which is the tangent of the dissipation angle (δ). Figure 3-5 is a graphical presentation of the equations in Table 3-3. For example, a series inductance of 1000μH which has a dissipation factor of 0.5 at 1kHz has a series resistance of 3.14 ohms.

Table 3-3. Dissipation Factor Equations.

Circuit Mode	Dissipation Factor	Conversion to other modes
Cp mode 	$D = \frac{1}{2\pi f C_p R_p} (= \frac{1}{Q})$	$C_s = (1 + D^2) C_p, R_s = \frac{D^2}{1 + D^2} \cdot R_p$
Cs mode 	$D = 2\pi f C_s R_s (= \frac{1}{Q})$	$C_p = \frac{1}{1 + D^2} C_s, R_p = \frac{1 + D^2}{D^2} R_s$
Lp mode 	$D = \frac{2\pi f L_p}{R_p} (= \frac{1}{Q})$	$L_s = \frac{1}{1 + D^2} L_p, R_s = \frac{D^2}{1 + D^2} \cdot R_p$
Ls mode 	$D = \frac{R_s}{2\pi f L_s} (= \frac{1}{Q})$	$L_p = (1 + D^2) L_s, R_p = \frac{1 + D^2}{D^2} \cdot R_s$

*f: Test signal frequency.

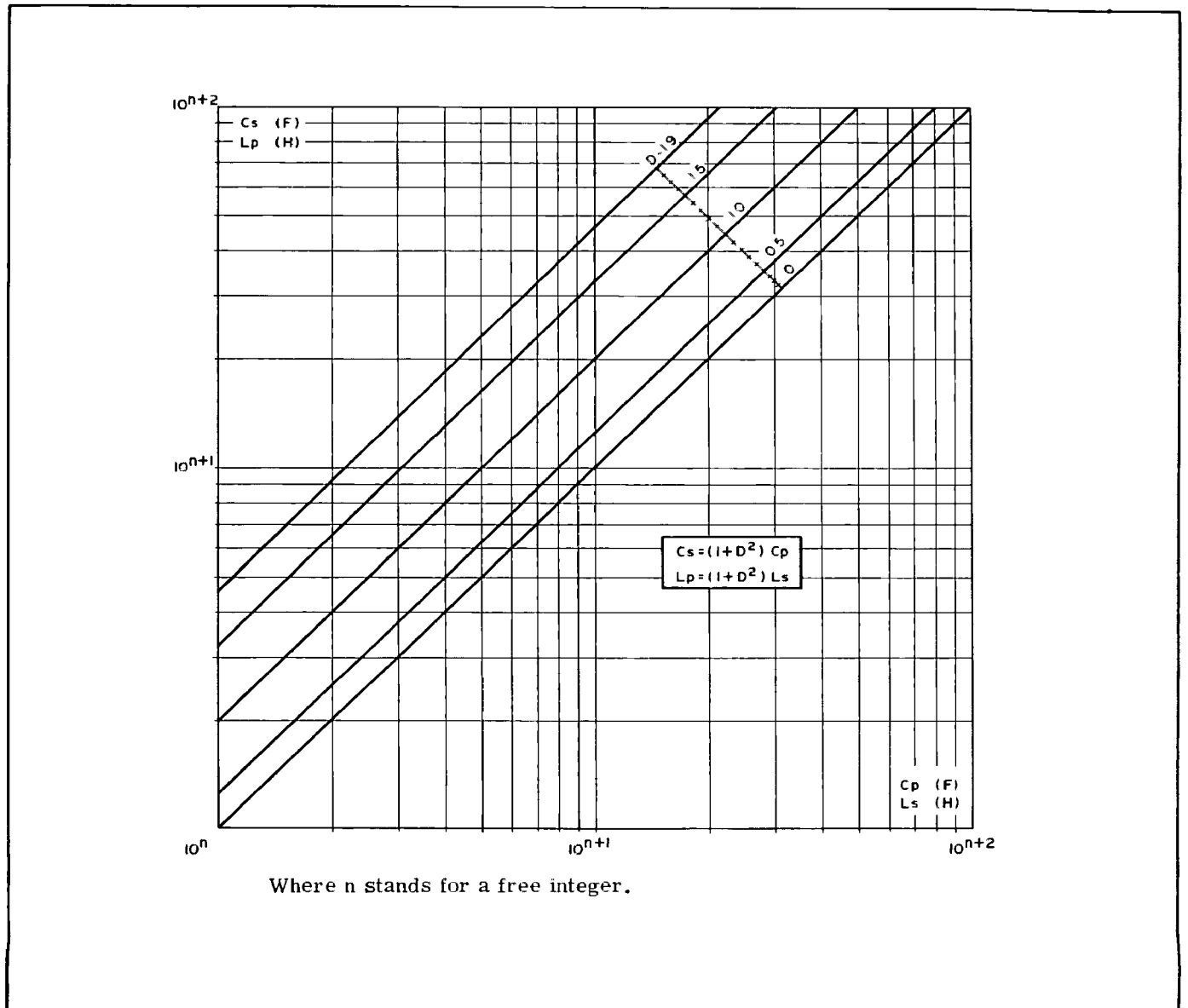


Figure 3-4. Conversion Between Parallel and Series Equivalents.

Table 3-4. Test Signal Level.

RANGE	CIRCUIT MODE					
	Ls	Lp	Cs	Cp	Rs	Rp
1	70mA rms	————	————	1V rms (50mV rms)*	70mA rms	————
2	10mA rms	————	————	1V rms (50mV rms)*	10mA rms	————
3	1mA rms	————	————	1V rms (50mV rms)*	1mA rms	————
4	100 μ A rms	1V rms	10 μ A rms	1V rms (50mV rms)*	100 μ A rms	1V rms
5	10 μ A rms	1V rms	100 μ A rms	1V rms (50mV rms)*	10 μ A rms	1V rms
6	————	1V rms	1 μ A rms	————	————	1V rms
7	————	1V rms	10mA rms	————	————	1V rms
8	————	————	70mA rms	————	————	1V rms

* When Cp TEST SIG LEVEL is set to 50mV.

3-14. Test Signals. Two test signal frequencies are available; these are 120Hz and 1kHz sinusoidal waveforms which have a frequency accuracy of 3%. The typical voltage applied to the sample or current flowing through the sample is specified in Table 3-4 for both test signal frequencies. A constant test voltage is supplied to the sample when measuring parallel parameters Lp, Cp and Rp. The constant current method is adopted for the measurement of Ls, Cs and Rs. The 50mV rms test voltage is available only for Cp measurement.

Note

Voltage or current applied to sample is detailed in Table 1-2 for the various devices under test.

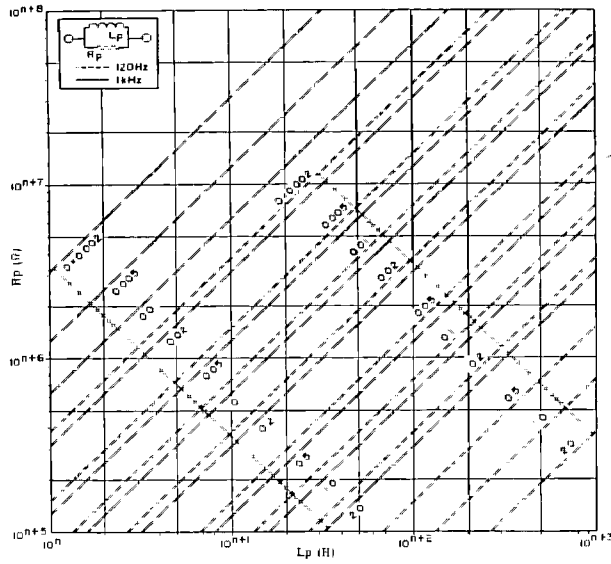
3-15. Measurement Range. The 4261A has wide measurement ranges as shown in Table 3-5. Seven or eight ranges are available (depending upon measurement function) and the range is automatically selected for the sample value connected to the 4261A. Four or five ranges, however, are used for measurements in series and parallel equivalent circuit modes. When the CIRCUIT MODE is set to AUTO, the 4261A will automatically select the circuit mode, range over all the measurement ranges shadowed in Table 3-5, and measure the sample. An instruction card attached to the instrument also outlines all measurement ranges.

3-16. Display. The 4261A has two displays, the LCR display (left side) and the DISSIPATION FACTOR display (right side). The circuit mode indicator lamp

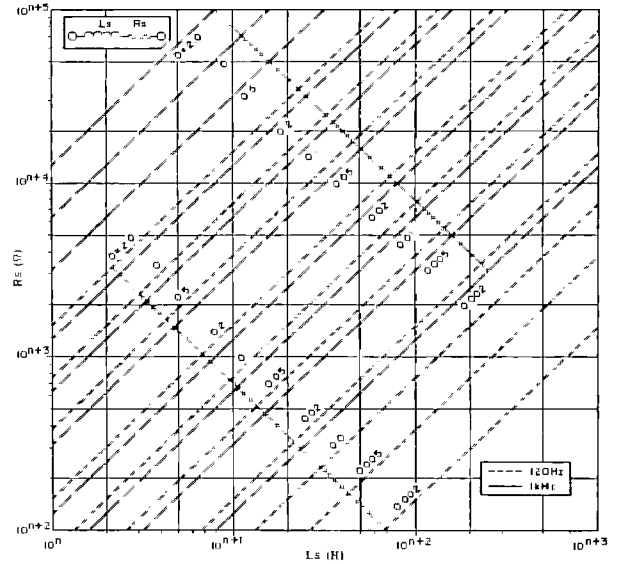
Table 3-5. Measurement Ranges.

CKT MODE	FREQUENCY	RANGE							
		1	2	3	4	5	6	7	8
Lp	120 Hz				0000mH	00.00 H	000.0 H	0000H	
	1kHz				000.0mH	0000mH	00.00 H	000.0 H	
Ls	120Hz	0000 μ H	00.00mH	000.0mH	0000mH	00.00 H			
	1kHz	000.0 μ H	0000 μ H	00.00mH	000.0mH	0000mH			
Cp	120Hz	0000pF	00.00nF	000.0nF	0000nF	00.00 μ F			
	1kHz	000.0pF	0000pF	00.00nF	000.0nF	0000nF			
Cs	120Hz				0000nF	00.00 μ F	000.0 μ F	0000 μ F	00.00mF
	1kHz				000.0nF	0000nF	00.00 μ F	000.0 μ F	0000mF
Rp	120Hz				0000 Ω	00.00k Ω	000.0k Ω	0000k Ω	00.00M Ω
	1kHz				0000 Ω	00.00k Ω	000.0k Ω	0000k Ω	00.00M Ω
Rs	120Hz	0000m Ω	00.00 Ω	000.0 Ω	0000 Ω	00.00k Ω			
	1kHz	0000m Ω	00.00 Ω	000.0 Ω	0000 Ω	00.00k Ω			

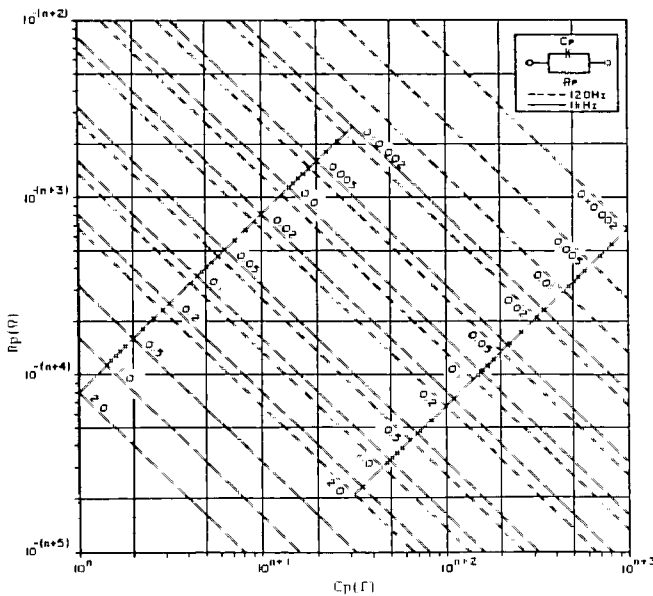
Note: 0000 μ H indicates a range of 0001 μ H to 1900 μ H (and similarly for F and Ω).



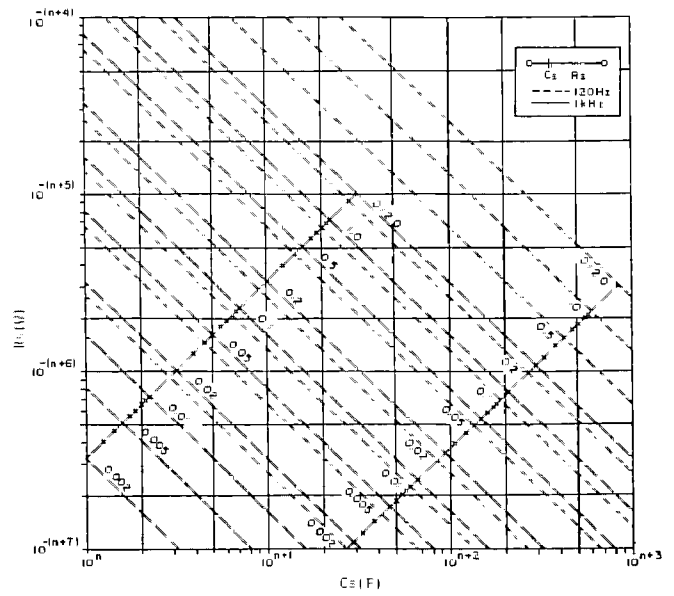
Parallel Inductance - Parallel Resistance
(A)



Series Inductance - Series Resistance
(B)



Parallel Capacitance - Parallel Resistance
(C)



Series Capacitance - Series Resistance
(D)

When n represents a free integer.

Figure 3-5. Relationship of Dissipation to Series and Parallel Resistance.

is lit as assigned by the settings of FUNCTION and CIRCUIT MODE. The unit lamps light and are read in conjunction with the numerical LCR display to their left. The right side display is blanked during resistance measurement. Table 3-6 describes operator action to be taken when OUT OF RANGE lamp is lit, when the display is blanked, or when a minus display occurs.

CAUTION

DISSIPATION FACTOR DISPLAY SOMETIMES RANDOMLY DISPLAYS A MEASUREMENT OR A BLANK CONDITION WHEN VALUE OF CAPACITANCE OR INDUCTANCE IS AROUND 80 COUNTS ON MINIMUM MEASURABLE RANGE AT ANY PANEL CONTROL SETTING.

Note

LCR display is meaningful even if D display shows 1999 counts and OUT OF RANGE lamp lights. However, measurement error will increase in proportion to increase in D value. See Table 1-2 for details.

3-17. Accuracy. Figure 3-6 is a graphic representation of the accuracy specifications provided in Table 1-1. The horizontal axis for all curves is the reading of the 4261A in counts and the vertical axis

Table 3-6. Annunciation Display Meanings.

Display	Indicated Condition	Action
OUT OF RANGE	1. At least one of two displays exceeds 1999 counts (in this case, at least one display shows 1999 counts).	a. Set 4261A to: CIRCUIT MODE: AUTO RANGE HOLD: OFF FREQUENCY: 120Hz b. Try changing FUNCTION to L, C or R.
	2. Measured value for Lp, Cs or Rp is less than about 80 counts. Both displays show 1999 counts. In Rp mode, right display is always being blanked.	
	3. Range is held to one not specified as a measurable range for parallel or series circuit modes. When this occurs, numerals (only) of both displays are blanked. Decimal point is still lit.	
Display is blanked.	1. Right display (only) is blanked during Rp or Rs measurement.	Normal operation.
	2. Range is held to one not specified as measurable range for parallel or series circuit mode. OUT OF RANGE lamp is also lit.	a. Set 4261A to: CIRCUIT MODE: AUTO RANGE HOLD: OFF FREQUENCY: 120Hz b. Check that FUNCTION is correct.
	3. Right display (only) is blanked when measured value of inductance (Ls) or capacitance (Cp) is less than 80 counts.	
	4. Right display (only) is blanked when Lp or Cs value exceeds 1999 counts. In this case, OUT OF RANGE lamp is lit.	
Minus (-) is displayed.	1. Minus display sometimes occurs when sample having a value around zero is measured.	Zero counts display is meaningful when minus (-) display repeatedly turns on and off.
	2. Sometimes a minus display occurs when a capacitor (or inductor) is measured in L (or C) FUNCTION.	Change to correct FUNCTION.
	3. Offset adjustment signal applied is too great (causes minus display).	Readjust offset signal to proper magnitude.

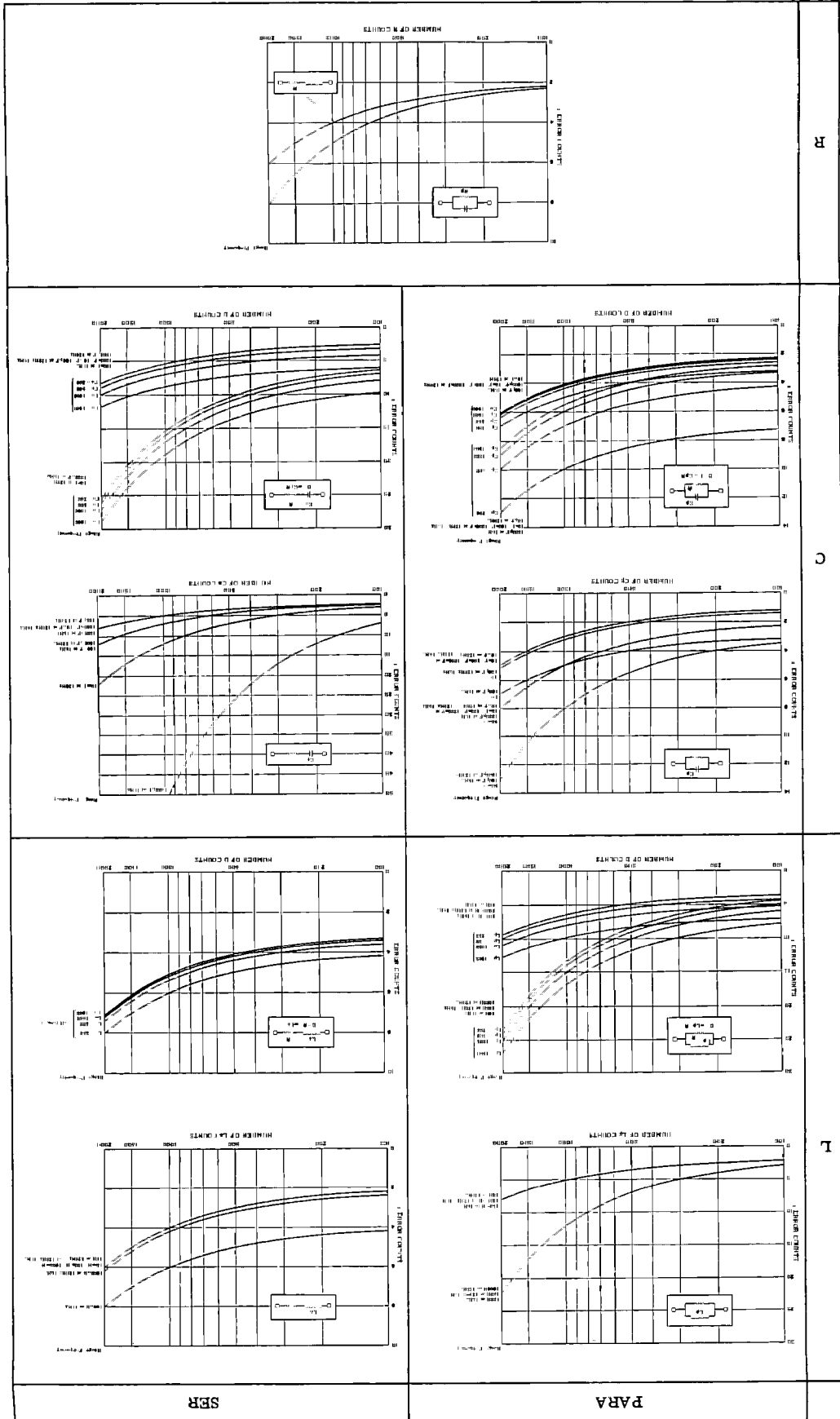
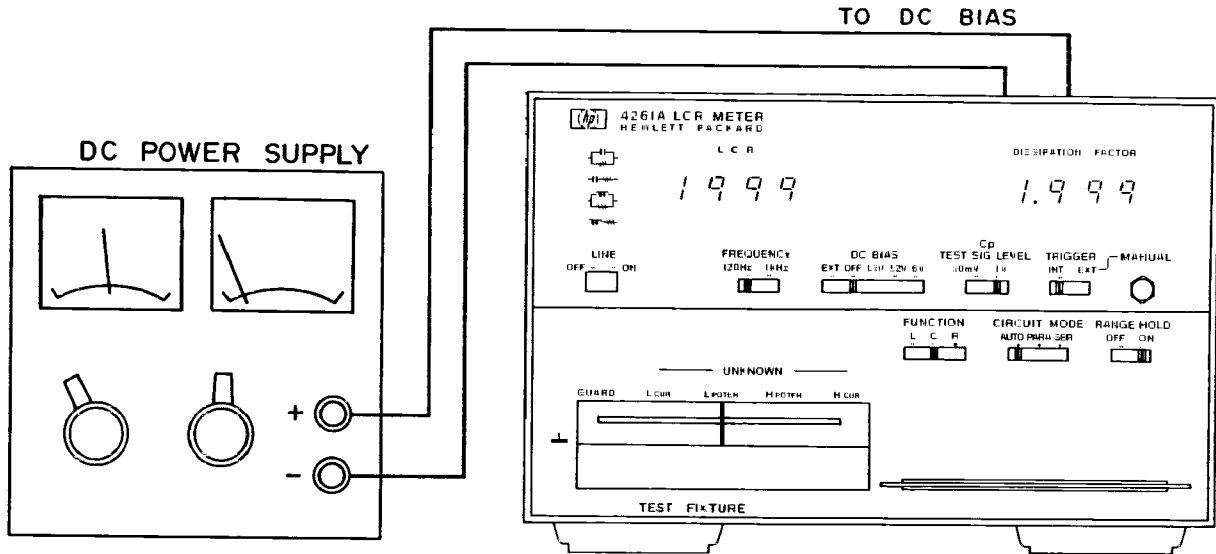


Figure 3-6. Accuracy.



1. Remove shorting bar connections between high terminals and between low terminals (all terminals are now isolated from each other). Connect 16061A Test Fixture to 4261A UNKNOWN terminals.

Note

User constructed test fixture may also be connected as stray capacitance of test fixture connection can be compensated for by using C OFFSET signal from rear connector. Refer to Figure 3-10 for details. GUARD terminal is sometimes used in small capacitance measurements. Refer to paragraph 3-9 for details.

2. Set 4261A controls as follows

FREQUENCY 120Hz or 1kHz
 DC BIAS OFF
 Cp TEST SIG LEVEL 1V
 TRIGGER INT
 FUNCTION L, C or R
 CIRCUIT MODE AUTO
 RANGE HOLD OFF

Note

If manual triggering is required, TRIGGER switch is set to EXT position and MANUAL button pushed and released to trigger measurement. In Cp mode, Cp TEST SIG LEVEL may be set to 1V for a more accurate measurement than that with 50mV test level.

3. Push LINE to turn instrument ON. Check that trigger lamp turns on and off.

Figure 3-7. General Component Measurements (Sheet 1 of 2).

4. Connect sample to be measured (L, C or R) to Test Fixture.

Note

When OUT OF RANGE, minus (-) or blank display occurs, see Table 3-6 for solution. Measured values for semiconductor devices are sometimes unreliable when Cp TEST SIG LEVEL is set to 1V position. In these instances, follow Figure 3-8 for semiconductor device measurement.

5. If internal DC bias is required, set DC BIAS switch to 1.5V, 2.2V or 6V. If not, OFF position should be selected.

Note

DC bias application may only be used for capacitance measurements.

CAUTION

POSITIVE POLE OF ELECTROLYTIC CAPACITOR MUST BE CONNECTED TO HIGH TERMINALS AS PLUS BIAS VOLTAGE IS APPLIED TO HIGH TERMINALS WITH RESPECT TO LOW TERMINALS.

Note

An external bias voltage up to +30V may be applied to EXT BIAS rear panel connector. Connect DC power supply to EXT BIAS connectors. Set DC BIAS switch to EXT.

CAUTION

EXTERNAL DC BIAS THROUGH EXT BIAS CONNECTOR MUST NEVER EXCEED +30V.

6. Read measured value on display. Refer to Figure 3-6 for accuracy of reading.

Note

It is usually best to set RANGE HOLD switch to ON when measuring multiple samples having almost the same value.

Note

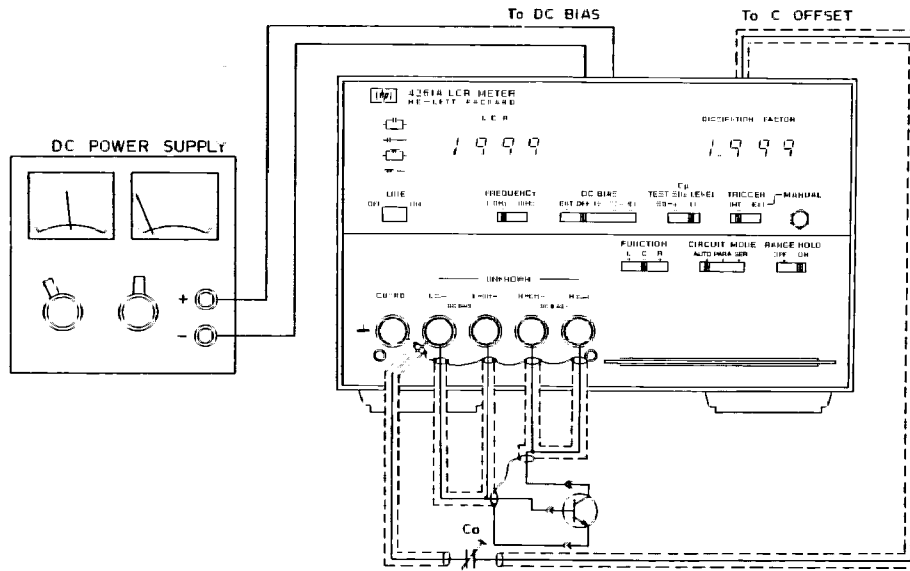
Series resistance of electrolytic capacitors, inductors or transformers can be measured in Rs measurement mode. In these cases, the number of digits is sometimes reduced. On the other hand, resistance can, of course, be indirectly measured with the C/L FUNCTION and calculated from one of the following equations:

$$R_s = D / \omega C_s \text{ (Cs-D measurement)}$$

$$R_s = \omega L_s D \text{ (Ls-D measurement)}$$

$$R_s = \omega L_p \cdot \frac{D}{1+D^2} \text{ (Lp-D measurement)}$$

Figure 3-7. General Component Measurements (Sheet 2 of 2).



Note

Base-collector junction capacitance of NPN transistor may be measured using the test setup shown in this figure (for example).

1. Construct setup as shown above:

Note

Test leads or fixture may be user designed for this measurement. If external DC bias is not necessary or capacitance offset adjustment function is not needed, arrangement and procedures associated with these functions can be deleted from setup.

2. Set 4261A controls as follows:

FREQUENCY	1kHz
DC BIAS	OFF
C _p TEST SIG LEVEL	50mV
TRIGGER	INT
FUNCTION	C
CIRCUIT MODE	PARA
RANGE HOLD	OFF

CAUTION

CIRCUIT MODE SHOULD NOT BE SET TO AUTO OR SER.
C_p TEST SIG LEVEL MUST BE IN 50mV.

3. Push LINE to turn instrument ON. Verify that trigger lamp is turning on and off.
4. If necessary, apply DC bias voltage internally or externally at rear panel DC BIAS connectors.

CAUTION

NEVER APPLY AN EXTERNAL DC BIAS OVER +30V.

Figure 3-8. Semiconductor Device Measurements (Sheet 1 of 2).

Notes

- a. DC BIAS switch must be in EXT position during application of external DC BIAS at rear panel connectors.
 - b. External dc bias source should be stable with low noise.
5. Adjust capacitance offset adjustment pot (Co) for zero capacitance reading. See Figure 3-10 for details.
6. Connect semiconductor device to test lead or to fixture. The following are examples of connections for the various parameters to be measured:

Notes

- a. It is impossible to measure junction capacitance when bias current flows through sample.
 - b. It is recommended that the device be connected directly to 4261A terminals. If test cable is used, it should be shielded.
 - c. Set TRIGGER switch to EXT and use MANUAL switch for manual triggering. External trigger at rear panel connector may also be used. See Figure 3-11 for reference. It is recommended that RANGE HOLD be set to ON when measuring multiple samples whose values are about the same.
7. Read displayed values. Refer to Figure 3-6 for accuracy.

Parameter Measured	Connections to 4261A
Base-collector junction capacitance (Cob)- Emitter current = 0	
Base-collector junction capacitance (Cre)- Common emitter	
FET gate capacitance	
Diode junction capacitance Note: Germanium diodes sometimes cannot be measured.	

Figure 3-8. Semiconductor Device Measurements (Sheet 2 of 2).

Note

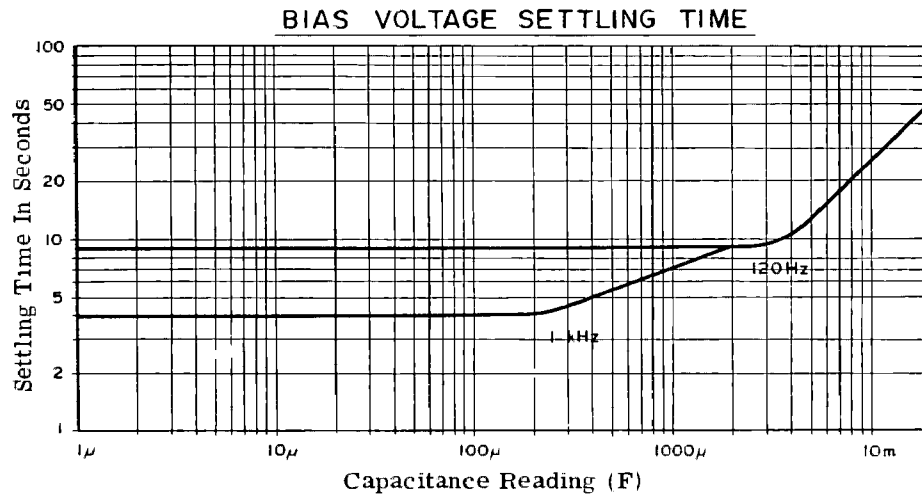
DC withstand voltage for C₁ capacitor must be greater than dc applied voltage E. Also observe polarity of capacitor C₁ with respect to applied voltage.

- Set 4261A controls as follows:

FUNCTION C
 CIRCUIT MODE PARA
 DC BIAS OFF
 Other controls any setting

- Read displayed value after allowing time for bias voltage to settle. Typical settling times are:

120Hz: 6 to 7 seconds.
 1kHz: 2 to 3 seconds.



Note

If C₁ and R₁ are larger than those given in table on Sheet 1 are connected, longer settling times are necessary.

USING CURRENT BIAS (for inductors).

- Connect dc power supply as shown below:

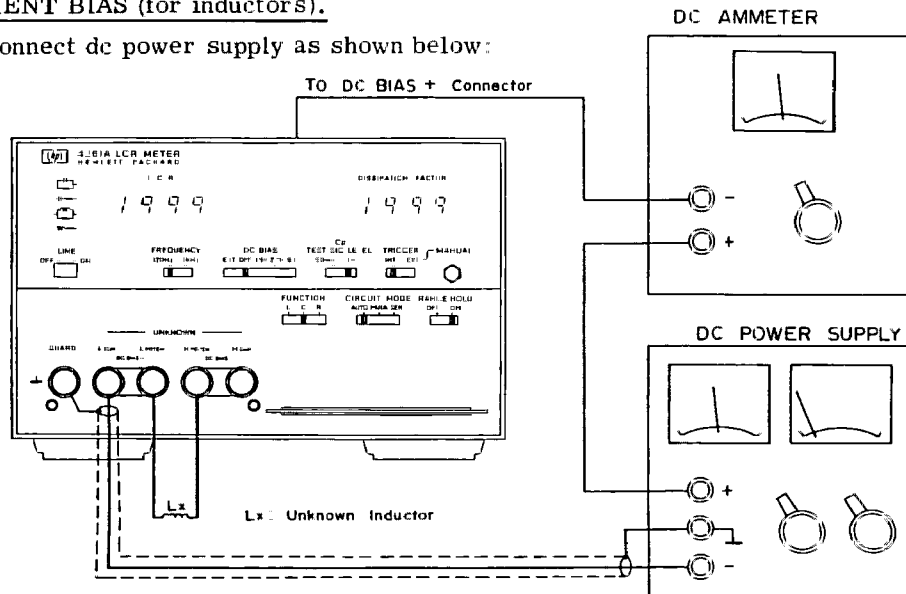


Figure 3-9. External DC Bias Circuits (Sheet 2 of 3).

Note

DC power supply should be floated from ground.

Note

If cable between low terminals of 4261A and power supply is relatively long, it should be shielded cable. The outer conductor is connected to GUARD terminal.

2. Set 4261A as follows:

FREQUENCY 120Hz or 1kHz
 DC BIAS EXT
 FUNCTION L
 CIRCUIT MODE PARA or SER
 RANGE HOLD ON

Note

First, set RANGE HOLD set to OFF and determine range by connecting sample with no dc bias current applied. Then set RANGE HOLD to ON.

3. Recommended inductance ranges and maximum bias currents are:

RANGE	120Hz	1000 μ H	10.00mH	100.0mH	1000mH	10.00H	100.0H
	1kHz	100.0 μ H	1000 μ H	10.00mH	100.0mH	1000mH	10.00H
CIRCUIT MODE	SER			PARA			
Maximum Bias Current	52mA	40mA	13mA	52mA	40mA	13mA	

CAUTION

DC BIAS OVER +30 VOLTS MUST NOT BE APPLIED TO EXTERNAL DC BIAS INPUT CONNECTOR.

Figure 3-9. External DC Bias Circuits (Sheet 3 of 3).

is the number of error counts which are added to or subtracted from the readings.

3-18. General Component Measurement.

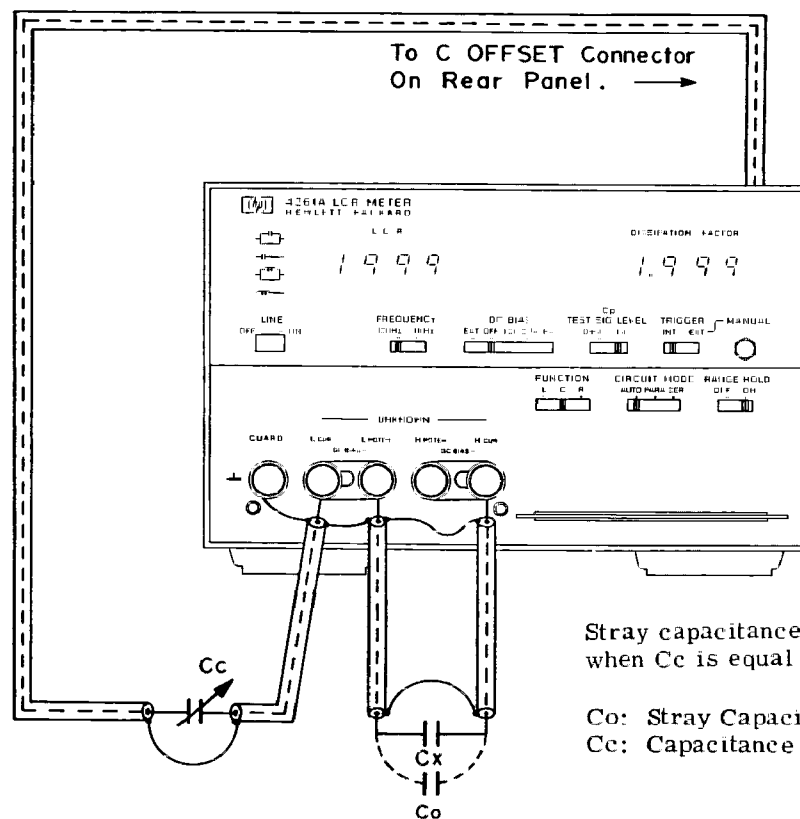
3-19. Figure 3-7 shows the operating procedures for measuring an L, C or R (inductance, capacitance or resistance) circuit component. Almost all discrete circuit components (inductors, capacitors or resistors) except for components having special shapes or dimensions can be measured with this setup. Special components may be measured by using Test Leads 16062A and 16063A or by specially designed user built fixtures instead of 16061A Test Fixture. Although both external dc bias and capacitance offset adjustment can be used with the setup shown in Figure 3-7 by connecting a DC bias source and by using the C OFFSET signal, the two functions are not covered in this procedure. For these applications refer to Figures 3-9 or 3-10.

3-20. Semiconductor Device Measurement.

3-21. The procedures for using the 4261A semiconductor device measurement capabilities are described in Figure 3-8. For example, the junction (interterminal) capacitance of diodes, collector output capacitance of transistors, etc., can easily and accurately be measured (with and without dc bias).

3-22. External DC Bias.

3-23. A special biasing circuit using external voltage or current bias, as needed for capacitor or inductor measurements, is illustrated in Figure 3-9. The figure shows sample circuitry appropriate to 4261A applications. The biasing circuits avoid permitting dc current to flow into the 4261A as dc current increase the measurement error and because the excess current sometimes may cause damage to the instrument. When applying a dc voltage to capacitors, be sure applied voltage does not exceed maximum working voltage and that you are observing



Stray capacitance C_o is compensated when C_c is equal to C_o .

C_o : Stray Capacitance
 C_c : Capacitance Offset

Procedure:

1. Connect signal from C OFFSET connector through a variable capacitor C_c to 4261A Low UNKNOWN terminals.

Notes

- a. An air capacitor is recommended for capacitor (C_c). If unavailable, other low loss capacitors may be used. Reading error for D display will be increased if a lossy capacitor is used.
 - b. It is recommended that connection between C_c and Low terminal be made with a shielded cable to eliminate the effects of noise.
2. Adjust C_c so that a display of 000 is obtained on LCR DISPLAY when no unknown capacitor is connected to UNKNOWN terminals.

Notes

- a. Compensation for stray capacitance is 0 to 100pF. Actual value of compensation realized depends upon method of connection and residual value of variable compensating capacitor (see C_c in above figure). Lowest actual compensating capacity achievable is typically on the order of a few pico-farads.
- b. A display of -000 (minus) should be avoided when adjusting compensation. Adjust for 000 display.

Figure 3-10. C OFFSET Adjustment Setup.

polarity of capacitor. Note that the external bias voltage is present at H_{CUR} and H_{POTEN} terminals.

3-24. Bias Voltage Settling Time. When a measurement with dc bias voltage superposed is performed, it takes some time for voltage across sample to reach a certain percentage of applied (desired) voltage. Figure 3-9 shows time for dc bias voltage to reach more than 99% of applied voltage and for 4261A to display a stable value. If the bias voltage across sample is not given sufficient time to settle, the displayed value may fluctuate or 1999 counts may be displayed and OUT OF RANGE lamp may light. Read measured value after display settles.

3-25. Offset Adjustments.

3-26. One of the sophisticated capabilities of the 4261A is its offset adjustment control which permits a direct, accurate display of actual measured value of sample by compensating for stray capacitance. Figure 3-10 shows recommended offset adjustment circuit and adjustment range for capacitance measurements.

3-27. External Trigger Circuit.

3-28. Figure 3-11 illustrates an example of a trigger circuit device for triggering the 4261A externally via the external triggering connector on the 4261A rear panel. In addition, both manual trigger (by MANUAL pushbutton) and electronic trigger (by TTL level trigger circuit) are also useable. The unit is set for manual triggering by switching TRIGGER switch from INT to EXT (manual) position. In the EXT trigger mode, the 4261A may be triggered by a TTL level signal that is transmitted from low (+0V) to high (+5V) state by an external trigger circuit.

Since all trigger signals, both internal and external (BNC on rear panel), are parallel connected in the 4261A, all triggers are always effective.

3-29. Operating Cautions.

3-30. Under some measurement conditions, the 4261A LCR Meter may occasionally show a display or exhibit a phenomena seems to indicate that the 4261A is faulty. These unusual displays and phenomena usually occur when the characteristics of the measured sample, residual impedance or stray conductance of the test fixture or test leads, and the measurement theory of the 4261A accumulate to produce these effects. Some of these conditions are inherent in the 4261A measurement scheme but most are not. Be sure to refer to Table 3-7 which outlines these indications their causes and countermeasures.

3-31. OPTIONAL OPERATION.

3-32. Installation information for options 001, 002, 003 and 101 is covered in Section II of this manual. Control signal timing and output data signal information with designators and pin connections for optional rear connectors are described in Section VIII (Service Sheet).

3-33. BCD Parallel Data Output (Option 001).

3-34. The 4261A option 001 outputs BCD L, C, R and D data, respectively, from two rear connectors in a parallel data scheme. In addition to L, C, R, D information, equivalent circuit mode, range, frequency, annunciation, and polarity data are simultaneously outputted. Figure 3-12 lists data outputted through the connector. Since the data from D DATA OUTPUT connector (when 4261A FUNCTION is set to R) has

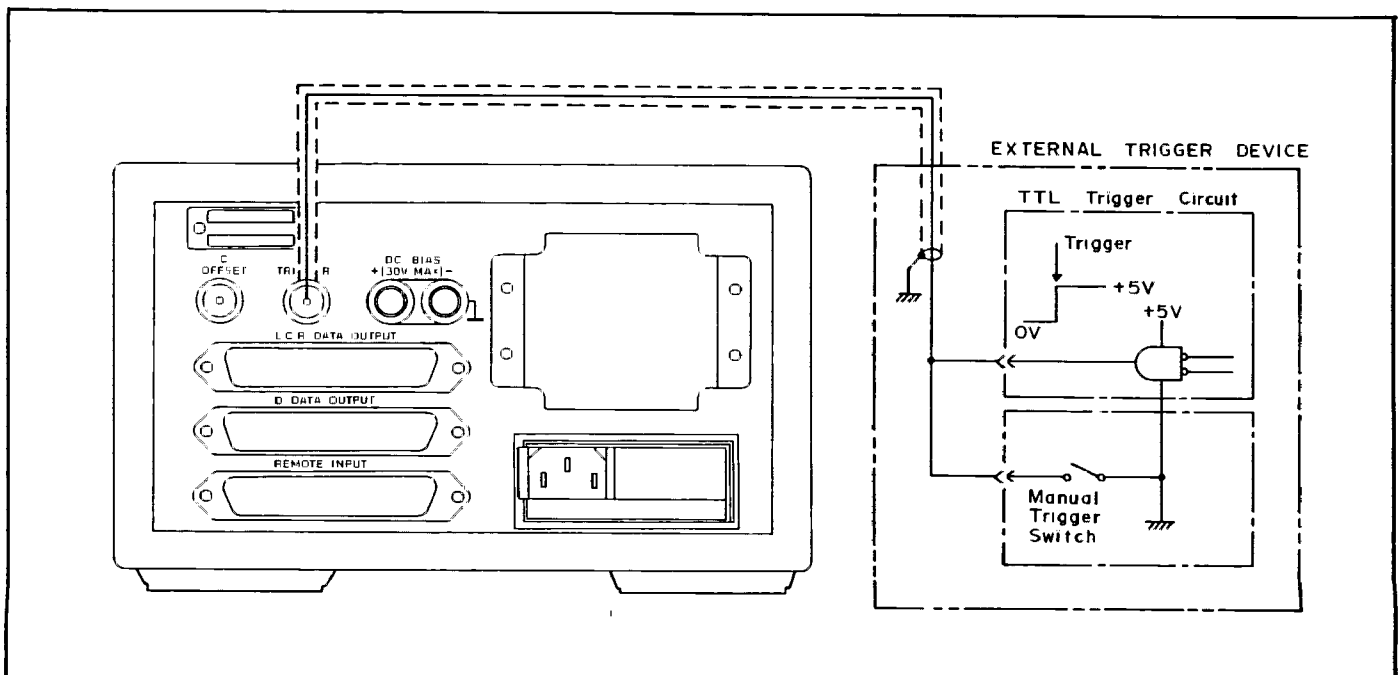


Figure 3-11. External Trigger Circuits.

Table 3-7. Unusual Operating Indications (Sheet 1 of 3).

1. Indication: A. Same sample sometimes shows quite different values between PARA and SER CIRCUIT MODE measurements. B. The decimal point moves and measurement unit changes. A and/or B may occur in the following cases.

Resistance of low loss inductor or capacitor being measured in R FUNCTION.

Inductance of lossy inductor or capacitance for lossy capacitor being measured in L or C FUNCTION.

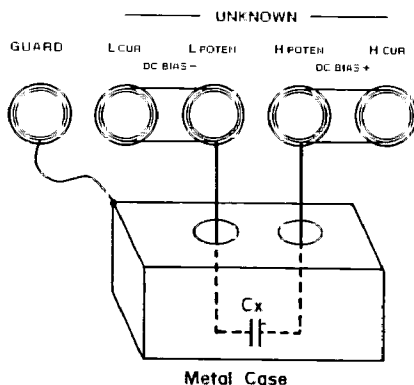
What to do: A. Do not set CIRCUIT MODE to AUTO. Set CIRCUIT MODE to a PARA or SER setting that shows a valid display. B. Set TRIGGER to EXT, push MANUAL button, set RANGE HOLD to ON and set TRIGGER to INT.

2. Indication: The displayed value fluctuates on minimum capacitance, maximum inductance or maximum resistance ranges in either PARA or SER circuit modes. Here are some of the reasons why this happens:

- A . A large size sample is being measured.
- B . A high voltage power line or similar exists near the 4261A.
- C . The 4261A and sample are connected together with relatively long, non-shielded cable.

What to do:

1. Enclose sample in metal case. Connect case electrically to 4261A GUARD terminal as shown below:



2. Use shielded cable for connection between sample and the instrument. Connect cable shield to GUARD. For reference, see also Figure 3-8 (sheet 1) page 3-14.

Table 3-7. Unusual Operating Indications (Sheet 2 of 3).

3. Indication: When measuring a low impedance (small inductance, resistance or high capacitance), measurement error is excessive.

What to do:

Cause of error	Action
1. Residual impedance (inductance, capacitance or resistance) of test leads during two terminal measurements. 2. Mutual test lead induction between current leads (H_{CUR} and L_{CUR}) and potential leads (H_{POTEN} and L_{POTEN}).	Use test leads in four-terminal configuration and measure. Twist current leads (H_{CUR} and L_{CUR}) together. Do the same with potential leads (H_{POTEN} and L_{POTEN}). Additional error is presented as $\omega^2 L_r C_x \times 100 (\%)$ for C measurement, where $\omega = 2\pi f$ $f =$ test frequency $L_r =$ residual inductance $C_x =$ unknown capacitance

4. Indication: Measurement error is excessive when high impedance (high inductance, small capacitance) is measured:

What to do:

Measurement	Cause of error	Action
High Inductance	Stray capacitance between High and Low leads.	Use shielded cable for connection between sample and 4261A UNKNOWN terminals. Connect outer conductor to GUARD terminal.
Small Capacitance	Stray capacitance between High and Low leads.	Measure stray capacitance and subtract it from measured value.

5. Indication: Excessive measurement error.

What to do Cause A . Effect of Low terminal capacitance with respect to ground. Sometimes the measurement can not be performed when a relatively large capacitance between L_{POTEN} terminal and ground exists. Allowable magnitude for the stray capacitance without additional error are:

<u>Measurement Frequency</u>	<u>Allowable Stray Capacitance Magnitude</u>
120Hz	100nF
1kHz	1000pF

Cause B . Effect of High terminal capacitance with respect to ground. The stray capacitance will reduce test signal level applied to the sample measured during capacitance measurement. This decrease in signal level will not produce an additional error even when measurement signal level is reduced to a third of its nominal level. It is necessary, of course, that special care be taken to use the proper test signal level when a device is measured whose parameters may be affected by the test signal level. Display fluctuations may sometimes appear.

Table 3-7. Unusual Operating Indications (Sheet 3 of 3).

6. **Indication:** When a sample (for example, an iron core inductor) is measured in AUTO of CIRCUIT MODE, the instrument repeats range selection and does not complete the measurement depending upon level of test current used.

What to do: Try to determine the range (test current level) that measures that sample properly by repeating ON and OFF RANGE HOLD operation several times. Must operate in Range HOLD mode for these cases.

7. **Indication:** When a capacitor is measured with dc bias voltage applied, an abnormal display occurs.

What to do: There are limitations to the permissible insulation resistance of a capacitor measured with dc bias. See below:

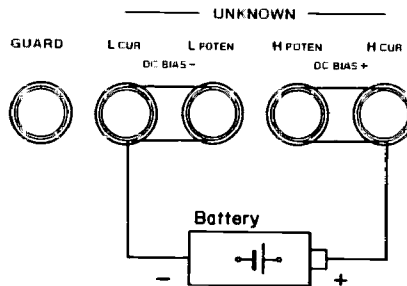
MODE		RANGE				
Cp	120Hz	1000pF	10.00nF	100.0nF	1000nF	10.00μF
	1kHz	100.0pF	1000pF	10.00nF	100.0nF	1000nF
Cs	120Hz	1000nF	10.00μF	100.0μF	1000μF	10.00mF
	1kHz	100.0nF	1000nF	10.00μF	100.0μF	1000μF
Permissible insulation resistance (Ri)		22.5MΩ	2250kΩ	225kΩ	22.5kΩ	2250Ω

Note: Ri given in above table is applicable for a dc bias of 30V. When the bias voltage is less than 30V, Ri limit is $RiVb/30$ (Ω) where Ri is value given in the table and Vb is applied dc bias voltage.

8. **Indication:** Internal resistance of a battery can not be measured.

What to do:

1. Connect sample battery (observe polarity) as illustrated below:



2. Batteries up to 30V are measured under no load conditions.
3. If battery voltage exceeds 4V, set DC BIAS to EXT and disconnect shorting bar from EXT DC BIAS connectors on rear panel.
4. Since the internal resistance of a battery is relatively very low, use the four-terminal measurement configuration.

no meaning, this connector should not be used. Figure 3-13 is the printer print format with the meaning of printed data shown. Here is an example of how to read the printed output:

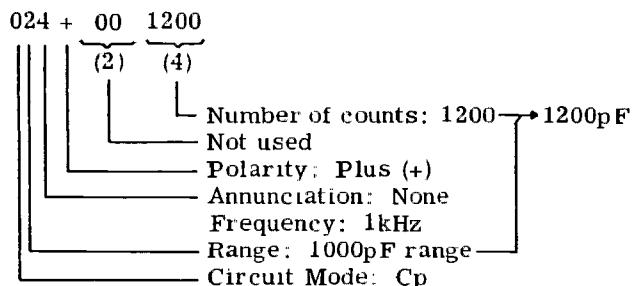


Figure 3-14 shows connections between the 4261A option 001 and HP devices. Model 4261A operation with option 001 follows standard operations described in Figure 3-7 and 3-8 except for connection of external devices. Operating information for HP printers is covered in the respective operating and service manuals.

3-35. Parameter Serial Data Output (OPT. 002).

3-36. The 4261A option 002 is capable of outputting three kinds of data selectable by switching the internal slide switch mounted on the option board (see Figure 3-15). The first form (LCR mode) for data output is to continuously output inductance, capacitance or resistance values. The second (LCR & D mode), it to output inductance, capacitance or resistance and dissipation factor data alternately through one rear connector. The third form (D mode) is dissipation factor only continuously outputted from 4261A connector. In resistance measurements, the first LCR mode should be selected because 4261A dissipation factor in resistance measurements is meaningless. Printout format for Option 002 through one connector is the same as that for 4261A option 001 (refer to Figure 3-13). The connections between the option 002 and the external devices which are HP printers (in this case) are shown in Figure 3-16. Operating procedure for an instrument equipped with

option 002 is the same as for a standard 4261A except for connections to the external device. Information for external device (e.g. printer) operation can be obtained from the operating and service manual.

3-37. Remote Control OPT. 003.

3-38. All the front panel controls except for DC BIAS can be remotely selected by control signals through the rear connector of an option 003 instrument. Remote control devices should be designed by the 4261A user since a specially designed controller from HP for the 4261A is not available. Information needed for controller design is presented in Figure 3-17. This includes pin locations, control signals and timing diagram. Controller design should include the following considerations:

1. \overline{REM} signal must be always at low level during remote control. If not, remote control functions will not occur.
2. \overline{EXE} signal triggers the 4261A when its state changes from low to high level. Pulse width of \overline{EXE} must be greater than 20 μs .
3. Remote control settings for the 4261A from remote controller should not be changed during a 4261A measurement cycle. If changed during measurement cycle, the measured values will not be reliable because of operational error in the 4261A.

3-41. OPERATOR MAINTENANCE.

3-42. Fuse Replacement.

3-43. The main ac line fuse is located at the rear of the instrument next to the line cord jack. The ac line cord must be removed to gain access to the fuse



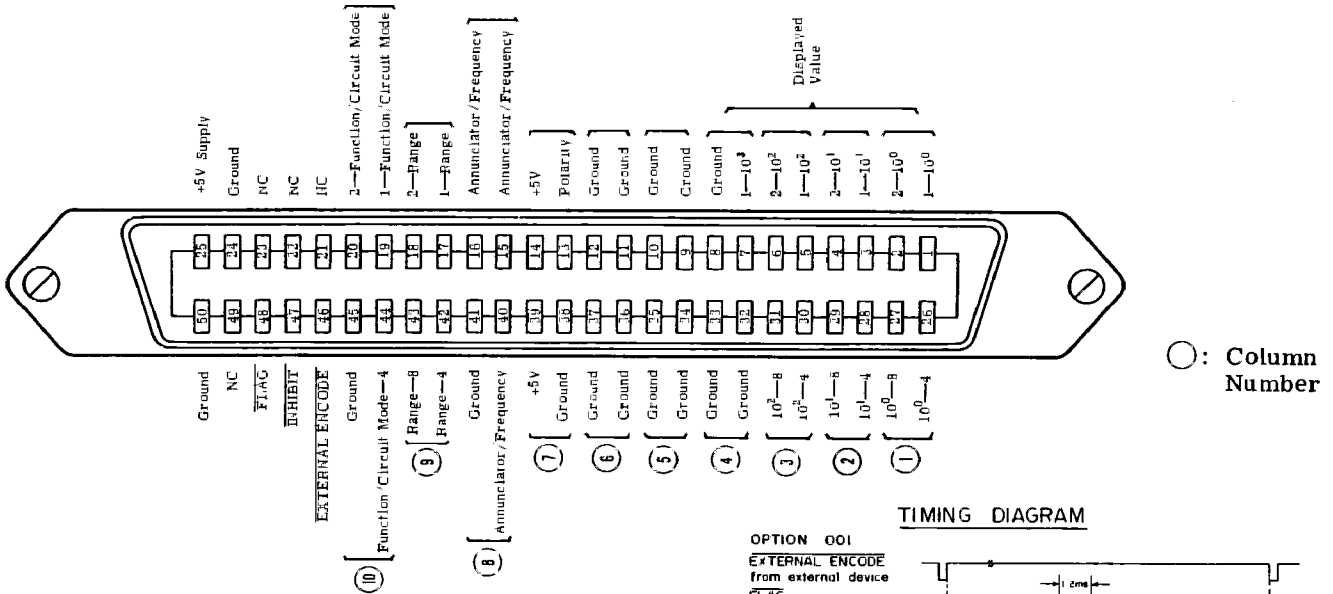
4261A FUNCTION Setting Rear Connector	L	C	R
LCR DATA OUTPUT 	Inductance Value Polarity Annunciation Test Frequency Range Function/CKT Mode	Capacitance Value Polarity Annunciation Test Frequency Range Function/CKT Mode	Resistance Value Polarity Annunciation Test Frequency Range Function/CKT Mode
D DATA OUTPUT 	D Value Polarity Annunciation Test Frequency Function/CKT Mode	D Value Polarity Annunciation Test Frequency Function/CKT Mode	1999 Polarity Annunciation/Test Frequency Function/CKT Mode

Figure 3-12. Data Outputted by Option 001.

(I) PIN LOCATIONS (LCR DATA OUTPUT, D DATA OUTPUT)



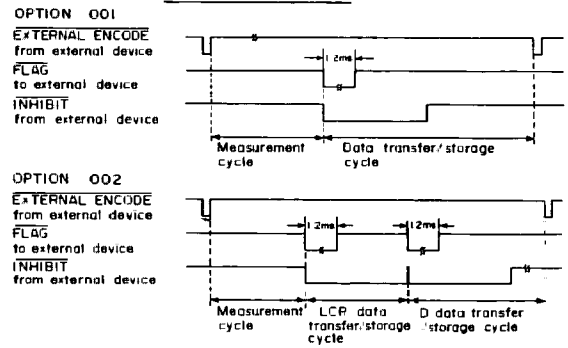
(II) PRINTOUT FORMAT

Nomenclature of Data (Column No.)	4261A Display	Character Printed
Displayed L, C, R, D Value (1 thru 4)	0	0
	1	1
	2	2
	3	3
	4	4
	5	5
	6	6
	7	7
	9	9

Nomenclature of Data (Column No.)	4261A Display	Character Printed
Polarity (7)	+ (Blanked)	+
	-	-

Nomenclature of Data (Column No.)	4261A Display, Setting	Character Printed	
Annunciation & Test Frequency (8)	No Annunciation	120Hz	0
		1kHz	4
	OUT OF RANGE	120Hz	1
		1kHz	5
	D Unavailable	120Hz	2
		1kHz	6
	OUT OF RANGE & D Unavailable	120Hz	3
		1kHz	7

TIMING DIAGRAM



Nomenclature of Data (Column No.)	4261A Full Scale Display			Character Printed
	L	C	R	
Range * (9)	100.0μH	100 0pF	1000 mΩ	1
	1000 μH	1000 pF	10.00Ω	2
	10.00mH	10.00nF	100.0Ω	3
	100.0mH	100.0nF	1000 Ω	4
	1000 mH	1000 nF	10.00kΩ	5
	10.00H	10.00μF	100.0kΩ	6
	100.0H	100.0μF	1000 kΩ	7
	1000 H	1000 μF	10.00MΩ	8
		10.00mF		9

* Range character for dissipation factor is always "0" (zero).

Nomenclature of Data (Column No.)	4261A Display			Character Printed
	L	C	R	
Function & Circuit Mode (10)	Parallel(Lp)			2
	Series(Ls)			3
		Parallel(Cp)		0
		Series(Cs)		1
			Parallel(Rp)	4
			Series(Rs)	5

Figure 3-13. Printout Format and Data Code Meanings.

compartment. The fuse may be removed by pulling FUSE PULL lever inside the fuse compartment. For 100 or 120 Vac supply source, use a 500mA fuse and for a 220 or 240Vac supply source, use a 250mA line fuse.

CAUTION

BE SURE THAT ONLY FUSES OF SPECIFIED TYPE (NORMAL BLOW, TIME DELAY, ETC.) AND REQUIRED RATED CURRENT ARE USED FOR REPLACEMENT. THE USE OF FUSES AND THE SHORT CIRCUITING OF FUSE HOLDERS MUST BE AVOIDED.

3-44. Foot and Stand Replacement.

3-45. The 4261A has four molded feet and two tilt stands for stable bench mounting. If a foot is cracked or the stand is bent, replace with new part. See instructions in Figure 3-18.

3-46. Instruction Card Replacement.

3-47. If the "pull-out" Instruction Card installed along the lower right front edge of the instrument requires replacement, proceed as follows (see Figure 3-19):

- a. Remove the four feet from bottom cover.

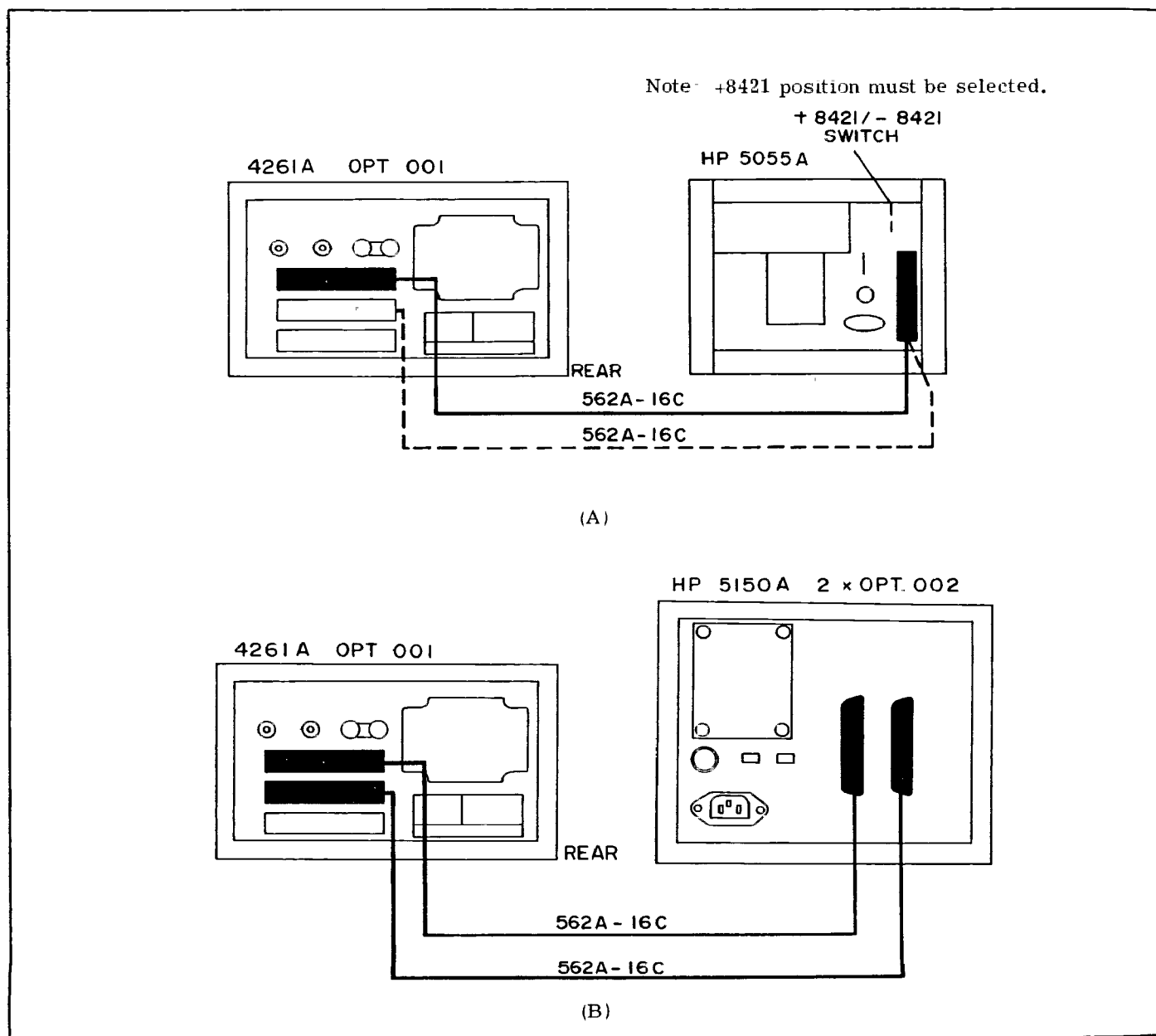


Figure 3-14. 4261A Connections to HP Printers.

- b. Remove bottom cover by removing screw at rear and sliding cover to rear.
- c. Remove button stopper from instruction card.
- d. Pull card from front panel.
- e. Insert new card into front panel slot.
- f. Attach button stopper.
- g. Replace bottom cover and feet.

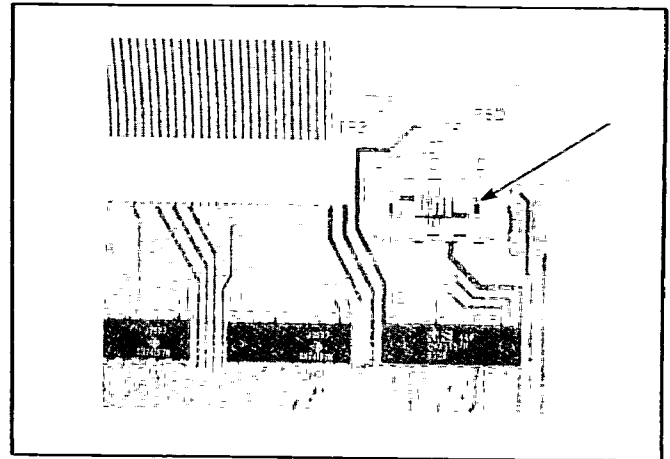


Figure 3-15. Option 002 Data Selection Switch.

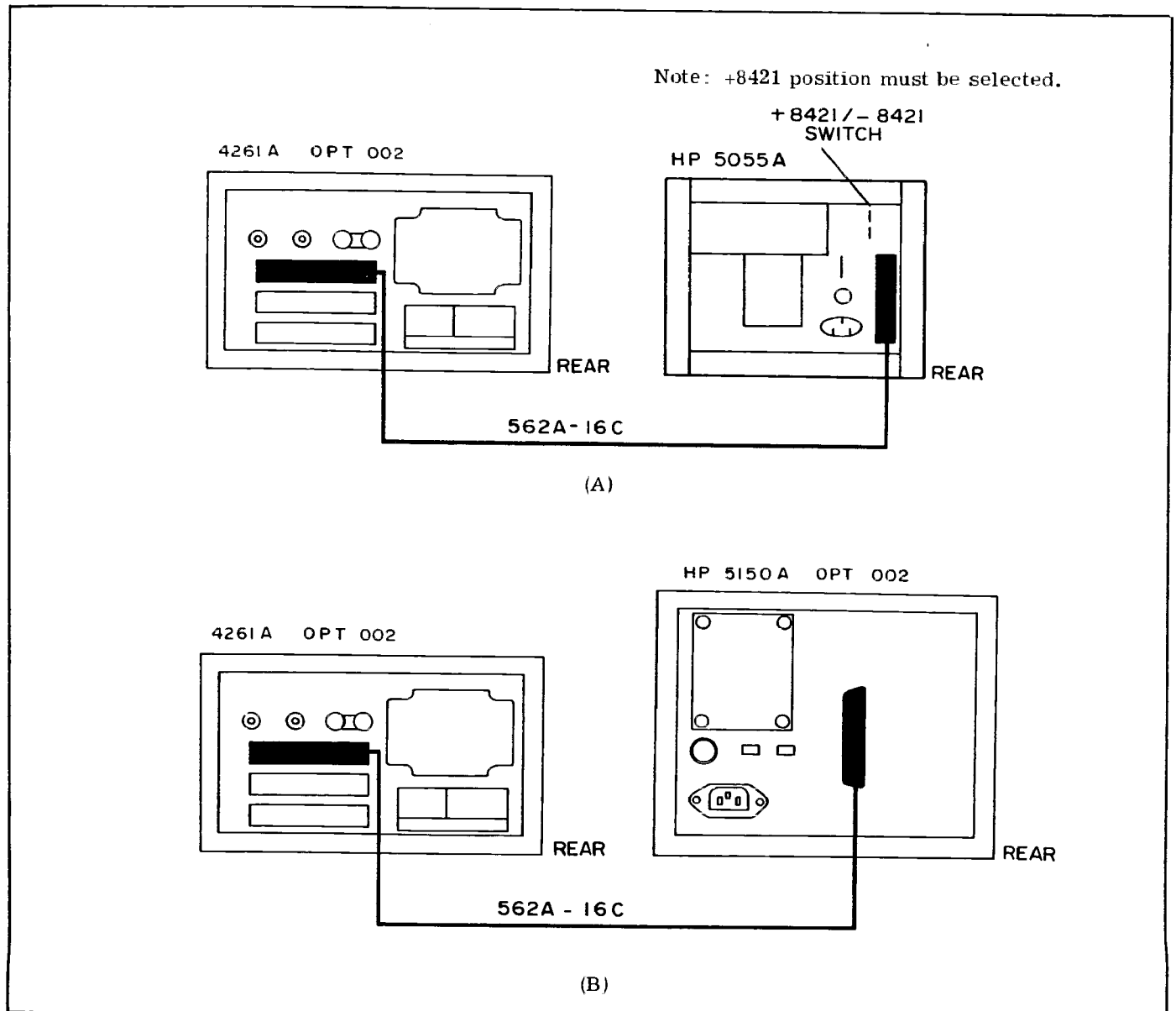
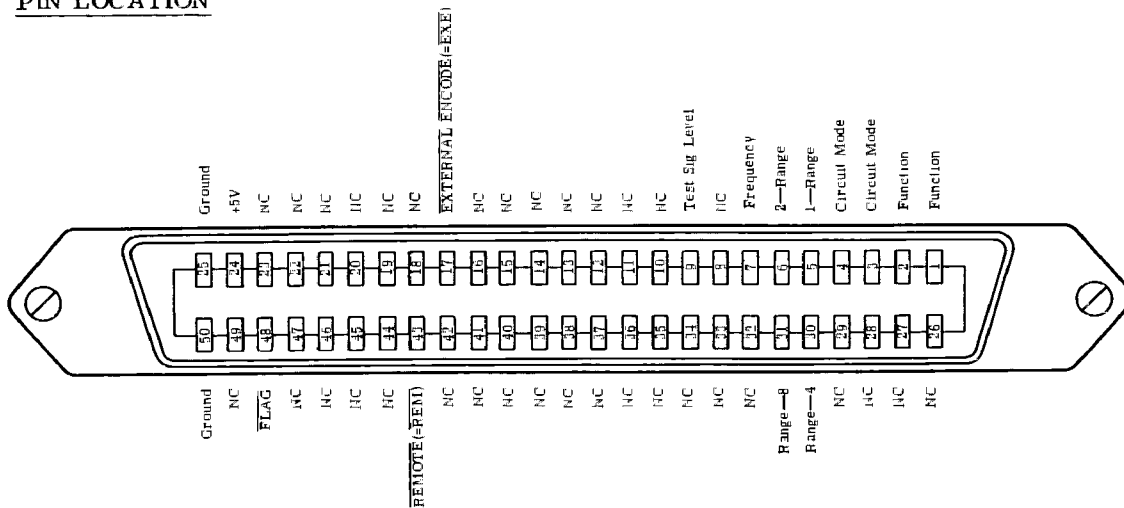


Figure 3-16. Option 002 Connection to External Printers.

PIN LOCATION



REMOTE CONTROL FORMAT

FUNCTION	PIN	
	1	2
L	High	High
C	Low	Low
R	High	Low

CIRCUIT MODE	PIN	
	3	4
AUTO	*	High
PARALLEL	Low	Low
SERIES	High	Low

FREQUENCY	PIN
	7
120Hz	High
1kHz	Low

TEST SIG LEVEL	PIN
	9
50mV	High
1 V	Low

Range	PIN				Full Scale Measurement Range			
	5	6	30	31	FUNCTION	L	C	R
1	Low	Low	Low	Low	120Hz	1000 μ H	1000 pF	1000 m Ω
					1kHz	100.0 μ H	100.0 pF	
2	High	Low	Low	Low	120Hz	10.00mH	10.00nF	10.00 Ω
					1kHz	1000 μ H	1000 pF	
3	Low	High	Low	Low	120Hz	100.0mH	100.0nF	100.0 Ω
					1kHz	10.00mH	10.00nF	
4	High	High	Low	Low	120Hz	1000 mH	1000 nF	1000 Ω
					1kHz	100.0mH	100.0nF	
5	Low	Low	High	Low	120Hz	10.00H	10.00 μ F	10.00k Ω
					1kHz	1000 mH	1000 nF	
6	High	Low	High	Low	120Hz	100.0H	100.0 μ F	100.0k Ω
					1kHz	10.00H	10.00 μ F	
7	Low	High	High	Low	120Hz	1000 H	1000 μ F	1000 k Ω
					1kHz	100.0H	100.0 μ F	
8	High	High	High	Low	120Hz	1000 H	10.00mF	10.00M Ω
					1kHz	100.0H	1000 μ F	
Auto	*	*	*	High	120Hz	1000 μ H-1000 H	1000 pF-10.00mF	1000 m Ω -10.00M Ω
					1kHz	100.0 μ H-100.0H	100.0pF-1000 μ F	

Note: High is TTL High level (>2.0V) and Low is TTL Low level (<0.8V).

*: Either logic state can be selected.

Figure 3-17. Option 003 Remote Control (Sheet 1 of 2).

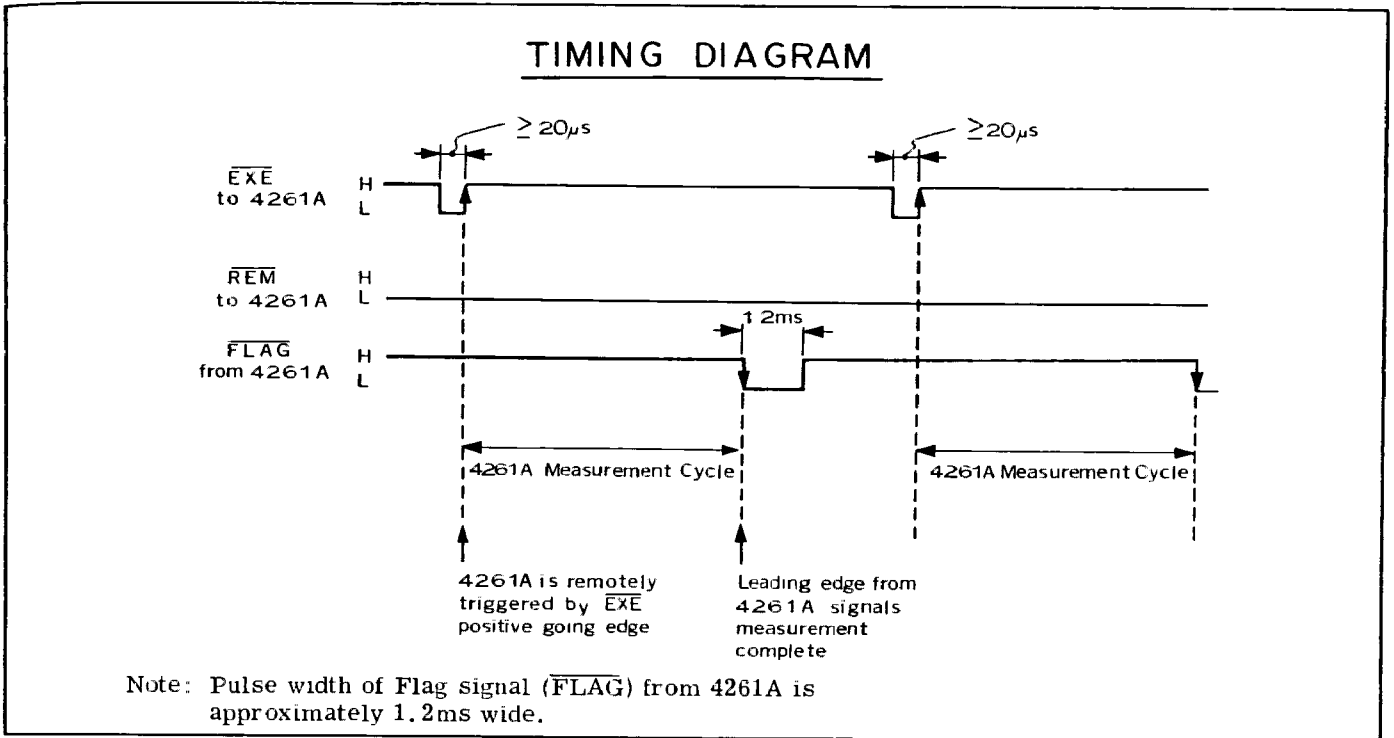


Figure 3-17. Option 003 Remote Control (Sheet 2 of 2).

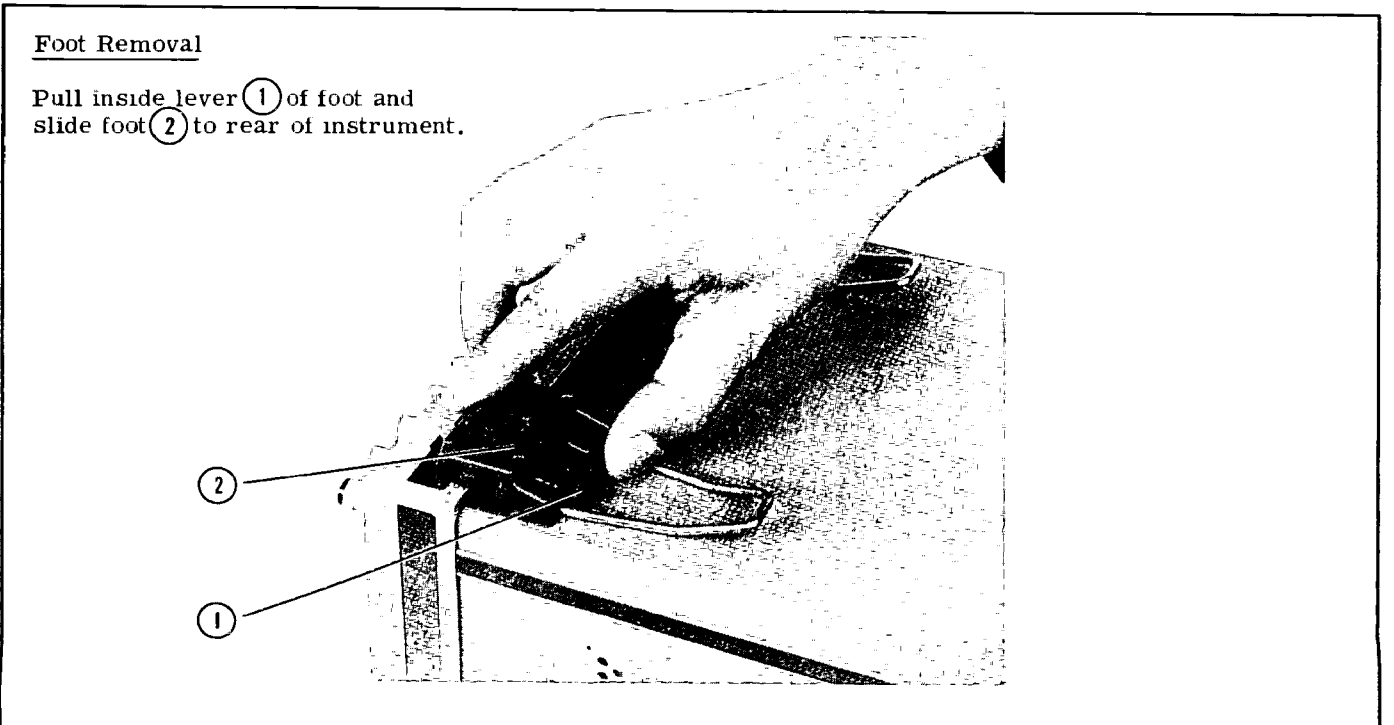


Figure 3-18. Foot Stand Replacement.

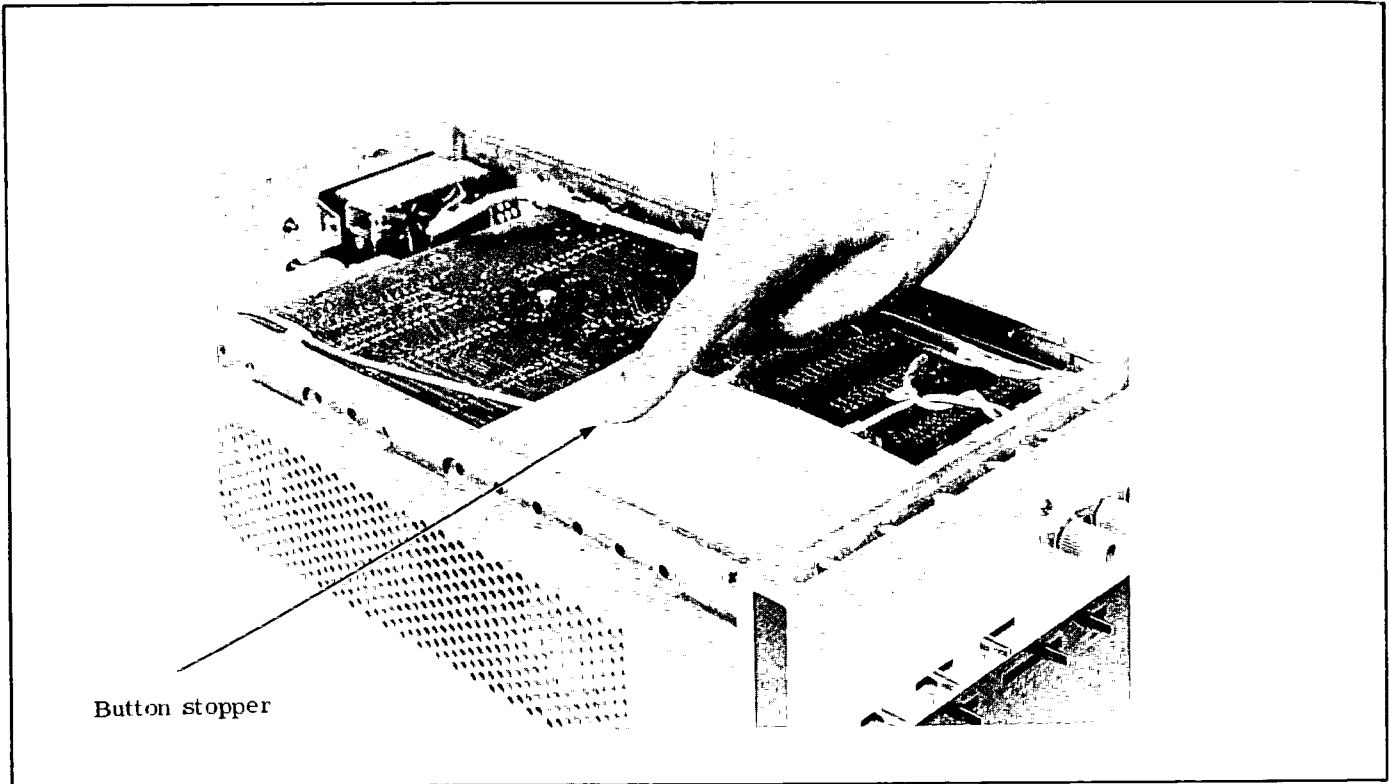


Figure 3-19. Instruction Card Replacement.

3-48. Special Modifications.

3-49. Two special functions may be added to the Model 4261A by changing the internal connections on a PC board which are easily done. These two functions are "Dissipation Factor Display Blanking" and "Local Triggering for Opt. 003". The following paragraphs describe the functions including modification procedures.

3-50. Dissipation Factor Display Blanking.

3-51. The Dissipation factor measurement can be deleted from C-D or L-D measurement modes by shorting two points (through holes) together on the A8 (04261-77108) board. This modification may be performed when D measurement and D display is not needed. This permits the measurement time to be decreased by 80 milliseconds (minimum at 1kHz) or 220 milliseconds (minimum at 120Hz). Modification procedure for deleting Dissipation Factor measurement follows:

1. Turn 4261A LINE to OFF.
2. Remove top cover from the unit.
3. Take out A8 board (04261-77108).
4. Short the two PC board points labelled "W1" and located at the left top of A8 board together (see parts locations in service sheet No. 8).

CAUTION

BE CAREFUL NOT TO SHORT ADJACENT PC BOARD CIRCUIT PATTERNS TOGETHER.

5. Reinstall A8 board and instrument cover.

3-52. Local Triggering for OPT. 003.

3-53. The 4261A can normally only be triggered by an external control device when equipped with an option 003. This modification enables local trigger of the option 003 unit from front panel without using an external device. The procedure to add this function is given below:

1. Turn 4261A LINE to OFF.
2. Remove top cover from the unit.
3. Take out A8 board (04261-77108).
4. Short together two PC board points labelled "W2" and located at left bottom of A8 board. (See part locations in service sheet No. 8).

CAUTION

BE CAREFUL NOT TO SHORT ADJACENT PC BOARD CIRCUIT PATTERNS TOGETHER.

5. Reinstall A8 board and instrument cover.

SECTION IV

PERFORMANCE TESTS

4-1. INTRODUCTION.

4-2. This section provides the check procedures that verifies the 4261A 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 Operating Check (paragraph 3-5). The performance test procedures in this section can also be used to do the 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 15-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 the Recommended Test Equipment table in Section I. 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 standard LCR components as the samples to be connected to the 4261A. HP Model 16361A DUT box, can be utilized for this purpose. HP 16361A is a DUT (device under test) box from which any desired component can be selected and connected to the 4261A through cables by use of a rotary switch. If HP

16361A is unavailable, use the discrete components recommended in Table 4-1 (See note in paragraph 4-10).

Note

All the components used as standards should be calibrated by an instrument whose specifications are traceable to NBS, PTB, LNE, NPL, NRC, JEMIC, or equivalent standards group; or all components should be calibrated directly by an authorized calibration organization such as NBS. The calibration cycle should be determined by the stability specification for each component.

4-5. TEST RECORD.

4-6. 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 acceptable 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 the "up time" of the instrument, the recommended preventive maintenance frequency for the 4261A is twice a year.

Table 4-1. Recommended Components for Accuracy Checks.

Component	HP Part Number	Alternate Source	
Capacitor:	100pF	HP Model 4440B	
	1000pF		
	10nF		
	100nF		
	1000nF	SOSHIN TM-520C	
	10μF		
	1000μF		
	10mF		
Resistor:	1kΩ	GR Type 1433-Y	
	10kΩ		
	100kΩ		
	10MΩ		
Inductor:	100mH	GR Type 1482-L	
Dissipation Factor:	1000nF in parallel with 887Ω (D ≈ 1.50 at 120Hz)	0160-3645	
	100nF in parallel with 887Ω (D ≈ 1.79 at 1kHz)	0698-4464	
		0160-1571	
		0698-4464	

PERFORMANCE TESTS

4-9. MEASUREMENT FREQUENCY TEST.

SPECIFICATION:

Measurement Frequencies: 120Hz ±3%.
1kHz ±3%.

DESCRIPTION:

This test verifies the accuracy of the measurement frequencies that are applied to sample connected to the 4261A.

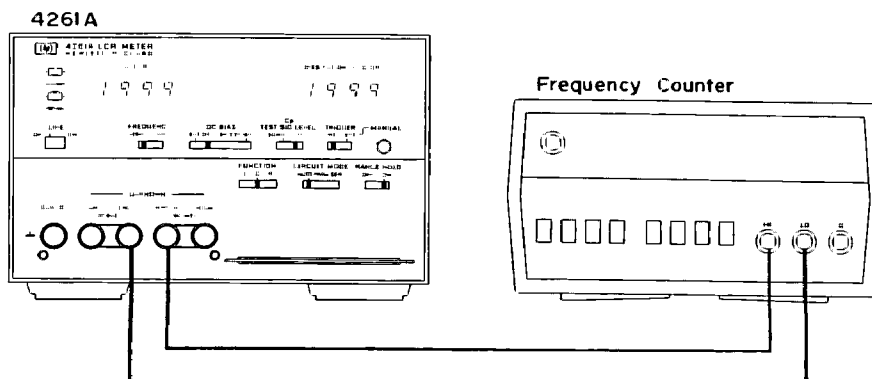


Figure 4-1. Measurement Frequency Test Setup.

PERFORMANCE TESTS

EQUIPMENT:

Frequency Counter HP 5300A w5306A

PROCEDURE:

1. Connect frequency counter to the 4261A UNKNOWN terminals as shown in Figure 4-1.
2. Set range of frequency counter as appropriate for measuring 4261A test frequencies of 120Hz and 1kHz.
3. Read display output of frequency counter when 4261A FREQUENCY is set to 120Hz or 1kHz.
4. Frequency readouts must be within the following limits (record measured frequency in table below as the data is used in paragraph 4-12):

FREQUENCY	Test Limit	Counter Readout
120Hz	116.4 - 123.6Hz	
1kHz	970 - 1030Hz	

Note

Test limits in table above do not take into account reading error caused by measurement error in test equipment.

5. If this test can not be met, refer to troubleshooting in Section VIII.



4-10. CAPACITANCE AND DISSIPATION FACTOR ACCURACY TEST.

Note

If the following tests satisfy the accuracy specifications, all the accuracy specifications listed in Table 1-1 are guaranteed.

(I) Capacitance and Dissipation Factor Accuracy

FREQ	CIRCUIT MODE	C _p TEST SIG LEVEL	100.0pF	1000pF	10.00nF	100.0nF	1000nF	10.00μF
120Hz	PARA	50mV	X					
		1V	X					
1kHz	SER	1V	X	X	X	X	X	X
		50mV	X					X
1kHz	PARA	50mV	X					X
		1V	X					X
1kHz	SER	1V	X	X	X	X	X	X
		50mV	X					X

 VALID RANGE
 NON-APPLICABLE RANGE FOR LISTED VALUE OF STANDARD

Tests for dissipation factor accuracy with above capacitance standards should be done at the same time as capacitance tests.

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

PERFORMANCE TESTS

(II) Resistance Accuracy

Resistance accuracy has only to be proved for one resistor of about full scale value on any one range to verify specifications for both 120Hz and 1kHz.

(III) Inductance Accuracy

Inductance accuracy has only to be proved for one inductor of about full scale value on any one range to verify specifications for both 120Hz and 1kHz.

(IV) Dissipation Factor Accuracy

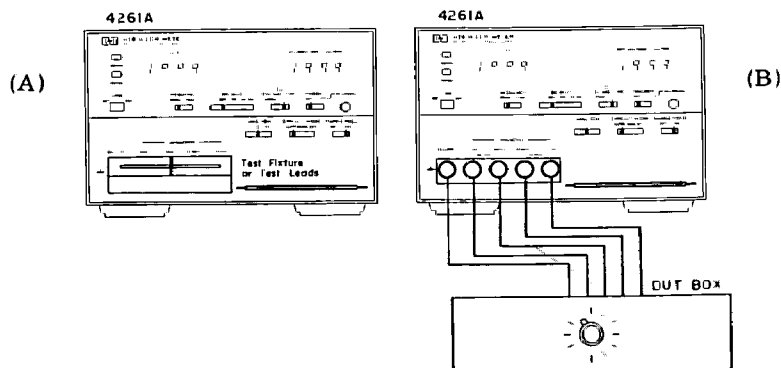
Dissipation factor accuracy for one D standard which has a D value of approx. 1.8 need only be proved to guarantee D accuracy.

Test items, except for those listed above, are also included in the performance test items outlined in paragraphs 4-10 thru 4-13.

Tests, other than those listed above, can not be made unless the test components to perform such tests are available.

DESCRIPTION:

This test checks capacitance and dissipation factor measurement accuracies for zero and full scale displays at two test frequencies and at two signal levels. This test is made by connecting a stable capacitor more accurate than the 4261A to the instrument and reading the display to verify that the 4261A meets its measurement accuracy specifications. Check all ranges in Cp mode and one range in Cs mode at both 120Hz and 1kHz frequencies to guarantee C and D measurement accuracies since all variable elements (range resistors and detecting phases) needed for C and D measurements are thus checked. In this test, almost all ranges, from minimum through maximum ranges, are being verified.



Note: Either setup can be used.

Figure 4-2. Capacitance Accuracy Test Setup.

PERFORMANCE TESTS

SPECIFICATIONS:

C-D MEASUREMENT

Range	C	120Hz 1kHz	1000pF 100.0pF	10.00nF 1000pF	100.0nF 10.00nF	1000nF 1000nF	10.00μF 1000nF	100.0μF 10.00μF	1000μF 100.0μF	10.00mF 1000μF		
	D	0.001 to 1.900, 1 range, common to all C ranges										
C Accuracy	+1 +2		0.2% + 1 count + 0.2pF					(Test signal level: 1V)				
			0.5% 3 counts	0.3% + 2 counts					(Test signal level: 50mV)			
		—————					0.3% + 2 counts		0.5% + 2 counts	1% + 2 counts + 3		
	AUTO	Same as					Mode		Same as			Mode
D Accuracy	+1		0.2% + (2 + 100 Cx) counts					(Test signal level: 1V)				
			—————	0.3% + (2 + 1000 Cx) counts					(Test signal level: 50mV)			
		—————					0.3% + (2 + Cx/500) counts			1% + (5 + Cx/500) counts		
	AUTO	Same as					Mode		Same as			Mode

- *1. ± (% of reading + counts + #). Cx is capacitance readout in counts
 - *2. C accuracies are applicable only when D value is less than 1.901. See Table 1-2 for C accuracies when D is more than 1.900
 - *3. 5% + 2 counts at 1kHz.
- Accuracy applies over a temperature range of 23°C ±5°C (at 0°C to 55°C, error doubles).

EQUIPMENT:

Test Fixture or Leads HP 16061A
 DUT Box HP 16361A

Note

User built test fixture or DUT box may be used instead of those HP provides. If user supplied, the residual impedance and stray capacitance of the fixture and box must be taken into account.

PERFORMANCE TESTS

PROCEDURE:

1. Connect test fixture or leads to 4261A UNKNOWN terminals. If DUT box is available, connect it to 4261A.
2. Set 4261A FUNCTION to C, RANGE HOLD to OFF and DC BIAS to OFF.
3. Confirm that the following table is satisfied when the measurements are made by changing FREQUENCY, CIRCUIT MODE, Cp TEST SIG LEVEL and DUT as given in table below. Record capacitance and dissipation factor readings in blank spaces provided in table.

FREQ	CIRCUIT MODE	SIGNAL LEVEL	0pF	100pF	1000pF	10nF	100nF	1000nF	10μF	1000μF	10mF	
120Hz	PARA	50mV	C. V. * ±3 counts (———)	C. V. ±4 counts (———)	C. V. ±8 counts (———)	C. V. ±5 counts (±3 counts)	C. V. ±5 counts (±3 counts)	C. V. ±5 counts (±3 counts)	C. V. ±5 counts (±3 counts)			
		1V	C. V. ±2 counts (———)	C. V. ±2 counts (±4 counts)	C. V. ±4 counts (±3 counts)	C. V. ±3 counts (±3 counts)	C. V. ±3 counts (±3 counts)	C. V. ±3 counts (±3 counts)	C. V. ±3 counts (±3 counts)	C. V. ±3 counts (±3 counts)		
	SER	1V						C. V. ±3 counts (±3 counts)	C. V. ±5 counts (±4 counts)	C. V. ±5 counts (±4 counts)	C. V. ±7 counts (±4 counts)	C. V. ±12 counts (±7 counts)
1kHz	PARA	50mV	C. V. ±3 counts (———)	C. V. ±8 counts (———)	C. V. ±5 counts (±3 counts)	C. V. ±5 counts (±3 counts)	C. V. ±5 counts (±3 counts)	C. V. ±5 counts (±3 counts)				
		1V	C. V. ±3 counts (———)	C. V. ±5 counts (±3 counts)	C. V. ±4 counts (±3 counts)	C. V. ±3 counts (±3 counts)	C. V. ±3 counts (±3 counts)	C. V. ±3 counts (±3 counts)				
	SER	1V					C. V. ±3 counts (±3 counts)	C. V. ±5 counts (±4 counts)	C. V. ±5 counts (±4 counts)	C. V. ±5 counts (±4 counts)	C. V. ±52 counts (±7 counts)	

*C. V. = Calibrated Value of Standard Component

Test limits in parentheses are those for dissipation factor measurement values.

Note

Error caused by stability of standard component is not taken into account for test limits in table above.

If tests fail, proceed to Section V ADJUSTMENTS or Section VIII SERVICE.

PERFORMANCE TESTS

4-11. RESISTANCE ACCURACY TEST.

SPECIFICATION:

R MEASUREMENT

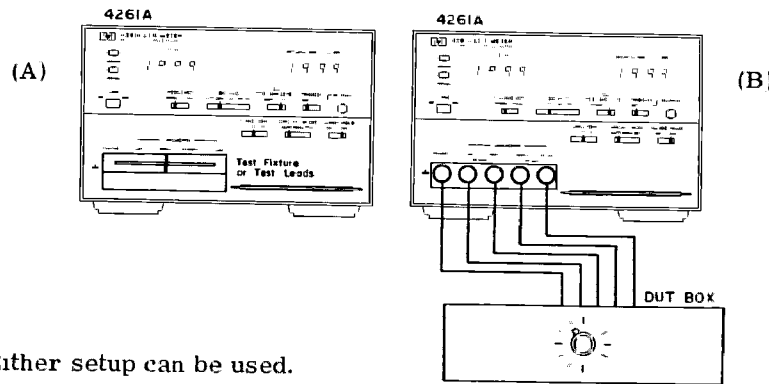
RANGE	120Hz or 1kHz	1000mΩ	10.00Ω	100.0Ω	1000Ω	10.00kΩ	100.0kΩ	1000kΩ	10.00MΩ	
R Accuracy +1		—————				0.1% + 2 counts				
		0.2% + 2 counts					—————			
	AUTO	Same as Mode			Same as Mode					

*1: ± 1% of reading + counts).

Accuracy applies over a temperature range of 23°C ± 5°C (at 0°C to 55°C, error doubles).

DESCRIPTION:

This test verifies that resistance measurement accuracies for 4261A tested meets the specifications listed above. Standard resistors (listed in table 4-1) are used to check the accuracies. The DUT box (HP16361A) can also be utilized. Although R measurement accuracies are actually guaranteed when C measurement accuracies meet the specifications, almost all ranges in Rp mode are checked in this test.



Note: Either setup can be used.

Figure 4-3. Resistance Accuracy Test Setup.

EQUIPMENT:

- Test Fixture or Leads..... HP 16061A
- DUT Box HP 16361A

Note

User built fixture/leads or DUT box can be used. If user supplied, the residual resistance must be considered.

PROCEDURE:

1. Connect test fixture or leads to 4261A UNKNOWN terminals. If DUT box is available, connect it to 4261A.
2. Set 4261A FUNCTION to R, CIRCUIT MODE to PARA, and FREQUENCY to 1kHz.

PERFORMANCE TESTS

3. Check that the resistance measurement accuracies meet specifications according to table below:

C. V. = Calibrated Value of Standard Component

DUT	1kΩ	10kΩ	100kΩ	10MΩ
Test Limits	C. V. ±5 counts	C. V. ±5 counts	C. V. ±5 counts	C. V. ±5 counts
R Readout				

Note

Error caused by stability of standard component is not taken into account for test limits in table above.

Note

If this test fails, go to Section V or Section VIII for the troubleshooting.

4-12. DISSIPATION FACTOR CONFIRMATION CHECK

SPECIFICATIONS:

C-D MEASUREMENT

Range	C	120Hz 1kHz	1000pF 100 0pF	10.00nF 1000pF	100.0nF 10.00nF	1000nF 100 0nF	10.00μF 1000nF	100.0μF 10.00μF	1000μF 100.0μF	10.00mF 1000μF	
	D	0.001 to 1.900, 1 range, common to all C ranges									
D Accuracy *1		0.2% + (2 + 100 Cx) counts					(Test signal level 1V)				
		0.3% + (2 + 1000 Cx) counts					(Test signal level 50mV)				
		0.3% + (2 + Cx/500) counts					1% + (5 + Cx/500) counts				
	AUTO	Same as Mode					Same as Mode				

*1 ± (% of reading + counts + α). Cx is capacitance readout in counts.

Accuracy applies over a temperature range of 23°C ±5°C (at 0°C to 55°C, error doubles).

L-D MEASUREMENT

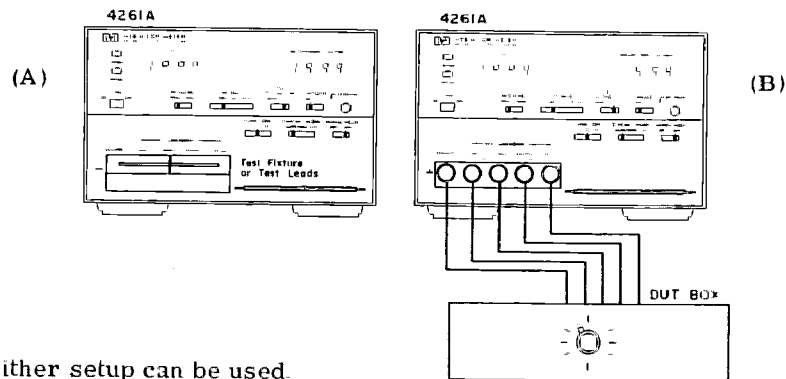
Range	L	120Hz 1kHz	1000μH 100 0μH	10.00mH 1000μH	100 0mH 10.00mH	1000mH 100.0mH	10.00H 1000mH	100.0H 10.00H	1000H 100.0H	
	D	0.001 to 1.900, 1 range, common to all L ranges								
D Accuracy *1		0.3% + (3 + Lx/500) counts				1% + (1 + Cx/500) counts				
		0.2% + (3 + 200 Lx) counts								
	AUTO	Same as Mode				Same as Mode				

*1. ± (% of reading + counts). Lx is inductance readout in counts.

PERFORMANCE TESTS

DESCRIPTION:

This test verifies that a tested 4261A satisfies dissipation factor measurement accuracies. Only one Dissipation Factor ($D = 1.8$) is checked for both 120Hz and 1kHz in this check because only one detecting phase needs to be checked. All other factors influencing D accuracy were checked in paragraphs 4-10 and 4-11.



Note: Either setup can be used.

Figure 4-4. Dissipation Factor Check Setups.

EQUIPMENT:

- Test Fixture or Leads HP 16061A
- DUT Box HP 16361A

Note

HP 16361A DUT Box is equipped with D standards ($D=1.8$) calibrated at 1kHz frequency. For the test at 120Hz frequency or if DUT box is not available, it is recommended that the following DUT's be used as D standards:

DUT	Freq	Values of components	Calculated D	Tolerance*
	120Hz	C : 1000nF (HP P/N 0160-3645) R : 887Ω (HP P/N 0698-4464)	1.495	±0.030
	1kHz	C : 100nF (HP P/N 0160-1571) R : 887Ω (HP P/N 0698-4464)	1.794	±0.036

* After calibrating capacitance C to within 0.1% and resistance R to within 0.02%, the dissipation factor tolerance is ±0.002 for each DUT.

PROCEDURE:

Note

If HP 16361A is available and connected to 4261A, perform procedure A. If not, do procedure B.

Procedure A:

1. Connect HP DUT Box 16361A to 4261A.
2. Set 4261A FUNCTION to C.
3. Check D accuracies according to following table:

PERFORMANCE TESTS

FREQ	CIRCUIT MODE	Cp TEST SIG LEVEL	D Test Limits	D Reading
1kHz	PARA	50mV	Calibrated Value · X ± 8 counts	
		1V	Calibrated Value · X ± 6 counts	
	SER	1V	Calibrated Value · X ± 8 counts	

Note

Error caused by stability of standard component is not taken into account for test limits in table above.

Procedure B:

1. Set 4261A FUNCTION to C and CIRCUIT MODE to PARA.
2. Connect D standard recommended in EQUIPMENT on page 4-9.
3. Check D accuracies according to following table.

FREQ	Cp TEST SIG LEVEL	D Test Limits	D Reading
120Hz	50mV	Calibrated Value · X ± 9 counts	
	1V	Calibrated Value · X ± 6 counts	
1kHz	50mV	Calibrated Value · X ± 9 counts	
	1V	Calibrated Value · X ± 6 counts	

Note: x in above table is produced by test frequency error and may be determined from the following equations:

$$120\text{Hz:} \quad x = \frac{fx}{120}$$

$$1\text{kHz:} \quad x = \frac{fx}{1000}$$

where fx is measured frequency from paragraph 4-9.

Note

Error caused by stability of standard component is not taken into account for test limits in table above. If the test fails, refer to Section VIII Service.

PERFORMANCE TESTS

4-13. INDUCTANCE ACCURACY TEST.

SPECIFICATIONS:

L-D MEASUREMENT

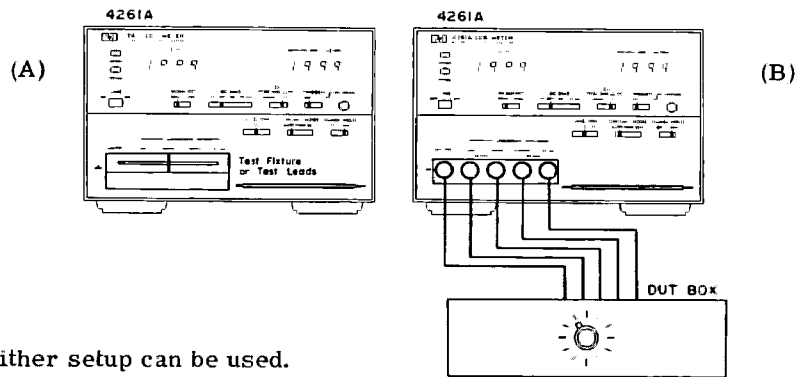
RANGE	120Hz 1kHz	1000μH 100.0μH	10.00mH 1000μh	100.0mH 10.00mH	1000mH 100.0mH	10.00H 1000mH	100.0H 10.00H	1000H 100.0H
L Accuracy		—————			0.3% + 2 counts		1% + 2 counts	
*1		0.2% + 2 counts + 0.2μH						—————
	AUTO	Same as Mode			Same as Mode			

*1 ± (% of reading + counts).

Accuracy applies over temperature range of 23°C ±5°C (at 0°C to 55°C, error doubles).

DESCRIPTION:

This test verifies that the inductance measurement accuracy satisfies the specifications listed above. L accuracy is proved to meet the specification when the results obtained in the accuracy checks of paragraphs 4-9 through 4-12 satisfies the specifications. This test is performed to confirm the L accuracy specification.



Note: Either setup can be used.

Figure 4-5. Inductance Accuracy Test Setups.

EQUIPMENT:

- Test Fixture or Leads HP 16061A
- DUT Box HP 16361A

Note

User built test fixture/leads or DUT box must take residual impedance into consideration.

PROCEDURE:

1. Connect Test Fixture or Leads to 4261A UNKNOWN terminals. If DUT box is available, connect it to the unit instead.
2. Set 4261A FUNCTION to L and Cp TEST SIG LEVEL to 1V.

PERFORMANCE TESTS

3. Connect 100mH inductor.
4. Confirm that L accuracy is within the test limits shown in table below:

Note

Test limits below are given for 100mH inductance measurement. If another inductance value is measured, refer to SPECIFICATIONS above.

FREQ	CIRCUIT MODE	Test Limits	L Readout
120Hz	PARA	Calibrated Value \pm 3 counts	
	SER	Calibrated Value \pm 3 counts	
1kHz	PARA	Calibrated Value \pm 5 counts	
	SER	Calibrated Value \pm 4 counts	

Note: Error caused by stability of standard component is not taken into account for test limits in table above. If this test fails, refer to Section VIII Service.

4-14. INTERNAL DC BIAS SOURCE TEST.

SPECIFICATIONS:

DC bias, Internal Source: 1.5V $\pm 5\%$, 2.2V $\pm 5\%$, 6V $\pm 5\%$

DESCRIPTION:

This test verifies that the internal dc bias source will apply the specified bias values to the device under test.

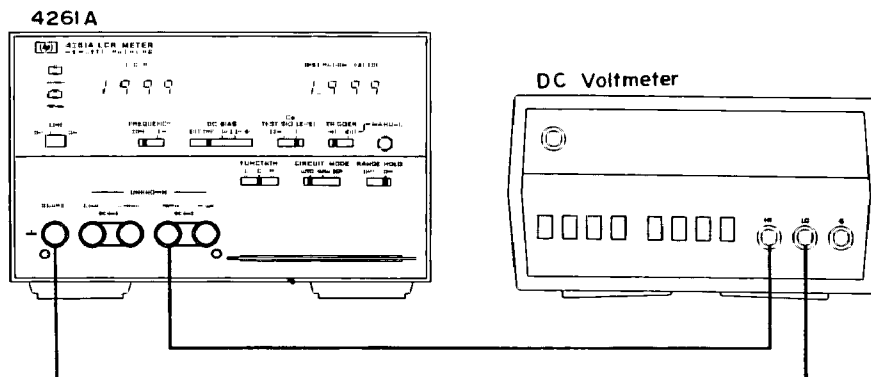


Figure 4-6. Internal DC Bias Source Test Setup.

EQUIPMENT:

DC Voltmeter HP 5300A, w 5306A

PROCEDURE:

1. Connect DC Voltmeter to 4261A UNKNOWN terminals as shown in Figure 4-6.
2. Set 4261A controls as follows:

FUNCTION C
CIRCUIT MODE PARA
Other Controls any position

Note

Do not connect anything to UNKNOWN terminals.

PERFORMANCE TESTS

3. Test limits are shown below. Read dc voltmeter output with DC BIAS switch set as follows:

DC BIAS Switch Setting	Test Limit	Voltmeter Readout
1. 5V	1. 425V thru 1. 575V	
2. 2V	2. 09V thru 2. 31V	
6V	5. 7V thru 6. 3V	

Note

Reading error caused by measurement error of test equipment is not taken into account for test limits in table above.

4. If tests fail, proceed to Troubleshooting in Section VIII.

Table 4-2. Performance Test Summary.

Test Instrument Parameters	Performance Specifications	Test Method
Measurement Frequency	Test Frequencies: 120Hz and 1kHz. Accuracy, $\pm 3\%$	Test frequency at High terminals is measured with electronic counter.
Capacitance Accuracy	Capacitance Measurement Accuracies: Cp, 1V: $0.2\% + 1 \text{ count} + 0.2\text{pF}$ *Cp, 50mV: $0.5\% + 3 \text{ counts}$ or $0.3\% + 2 \text{ counts}$ *Cs: $0.3\% + 2 \text{ counts}$, $0.5\% + 2 \text{ counts}$, $1\% + 2 \text{ counts}$ or $5\% + 2 \text{ counts}$	Stable standard capacitor is connected to 4261A and 4261A is proved to be satisfactory with an accuracy test.
Resistance Accuracy	Resistance Measurement Accuracies: Rp: $0.3\% + 2 \text{ counts}$ Rs: $0.2\% + 2 \text{ counts}$	Stable standard resistor is connected to 4261A and 4261A is proved to meet required accuracies.
Dissipation Factor Accuracy	D Measurement Accuracy: Cp, 1V: $0.2\% + (2 + 200 \cdot Cs) \text{ counts}$ *Cp, 50mV: $0.3\% + (2 + 1000 \cdot Cs) \text{ counts}$ *Cs: $0.3\% + (2 + Cx / 500) \text{ counts}$ or $1\% + (5 + Cx / 500) \text{ counts}$ *Lp: $0.3\% + (3 + Lx / 500) \text{ counts}$ or $1\% + 2 \text{ counts}$ Ls: $0.2\% + (3 + 200 \cdot Lx) \text{ counts}$	Stable D standard is connected to 4261A and 4261A is proved to meet required D accuracy specifications.
Inductance Accuracy	Inductance Measurement Accuracies: *Lp: $0.3\% + 2 \text{ counts}$ or $1\% + 2 \text{ counts}$ Ls: $0.2\% + 2 \text{ counts} + 0.2\mu\text{H}$	Stable standard inductor is connected to 4261A and the 4261A is checked to verify accuracy specification.
Internal DC Bias Source Accuracy	DC Bias Voltage Accuracy: 1.5V 2.2V, 6V $\pm 5\%$	Internal dc bias voltage at High terminals is measured with an

* Some accuracy specifications depend on range. Refer to Table 1-1, Specification pages 1 and 2 to determine how accuracies and ranges correspond with each other.

Performance Test Record

Hewlett-Packard
 Model 4261A
 LCR METER
 Serial No. _____

Tested by _____
 Data _____

Paragraph Number	Test	Results			
		Minimum	Actual	Maximum	
4-9	MEASUREMENT FREQUENCY TEST				
	120Hz 1kHz	116.4 970	_____ _____	123.6 1030	
4-10	CAPACITANCE ACCURACY TEST				
	120Hz PARA 50mV	0pF 100pF 1000pF 10nF 100nF 1000nF 10μF	C.V.* - 3 counts C.V. - 4 counts C.V. - 8 counts C.V. - 5 counts C.V. - 5 counts C.V. - 5 counts C.V. - 5 counts	_____ _____ _____ _____ _____ _____ _____	C.V. + 3 counts C.V. + 4 counts C.V. + 8 counts C.V. + 5 counts C.V. + 5 counts C.V. + 5 counts C.V. + 5 counts
	120Hz PARA 1V	0pF 100pF 1000pF 10nF 100nF 1000nF 10μF	C.V. - 2 counts C.V. - 2 counts C.V. - 4 counts C.V. - 3 counts C.V. - 3 counts C.V. - 3 counts C.V. - 3 counts	_____ _____ _____ _____ _____ _____ _____	C.V. + 2 counts C.V. + 2 counts C.V. + 4 counts C.V. + 3 counts C.V. + 3 counts C.V. + 3 counts C.V. + 3 counts
	120Hz SER 1V	100nF 1000nF 10μF 1000μF 10mF	C.V. - 3 counts C.V. - 5 counts C.V. - 5 counts C.V. - 7 counts C.V. - 12 counts	_____ _____ _____ _____ _____	C.V. + 3 counts C.V. + 5 counts C.V. + 5 counts C.V. + 7 counts C.V. + 12 counts
	1kHz PARA 50mV	0pF 100pF 1000pF 10nF 100nF 1000nF	C.V. - 3 counts C.V. - 8 counts C.V. - 5 counts C.V. - 5 counts C.V. - 5 counts C.V. - 5 counts	_____ _____ _____ _____ _____ _____	C.V. + 3 counts C.V. + 8 counts C.V. + 5 counts C.V. + 5 counts C.V. + 5 counts C.V. + 5 counts

* C. V. = Calibrated Value.

Paragraph Number	Test	Results			
		Minimum	Actual	Maximum	
4-10	CAPACITANCE ACCURACY TEST (Continued)	1kHz PARA 1V 0pF	C.V.* - 3 counts	_____	C.V. + 3 counts
		100pF	C.V. - 5 counts	_____	C.V. + 5 counts
		1000pF	C.V. - 4 counts	_____	C.V. + 4 counts
		10nF	C.V. - 3 counts	_____	C.V. + 3 counts
		100nF	C.V. - 3 counts	_____	C.V. + 3 counts
		1000nF	C.V. - 3 counts	_____	C.V. + 3 counts
		1kHz SER 1V 10nF	C.V. - 3 counts	_____	C.V. + 3 counts
		100nF	C.V. - 5 counts	_____	C.V. + 5 counts
		1000nF	C.V. - 5 counts	_____	C.V. + 5 counts
		10 μF	C.V. - 5 counts	_____	C.V. + 5 counts
		1000 μF	C.V. - 52 counts	_____	C.V. + 52 counts
		4-11	RESISTANCE ACCURACY TEST	1kΩ	C.V. - 5 counts
10kΩ	C.V. - 5 counts			_____	C.V. + 5 counts
100kΩ	C.V. - 5 counts			_____	C.V. + 5 counts
10MΩ	C.V. - 5 counts			_____	C.V. + 5 counts
4-13	INDUCTANCE ACCURACY TEST (100mH)	120Hz PARA	C.V. - 5 counts	_____	C.V. + 5 counts
		SER	C.V. - 4 counts	_____	C.V. + 4 counts
		1kHz PARA	C.V. - 5 counts	_____	C.V. + 5 counts
		SER	C.V. - 4 counts	_____	C.V. + 4 counts
4-14	INTERNAL DC BIAS SOURCE TEST	1.5V	1.425	_____	1.575
		2.2V	2.09	_____	2.31
		6 V	5.7	_____	6.3

* C.V. = Calibrated Value.

**SECTION V
ADJUSTMENT**

5-1. INTRODUCTION.

5-2. This section provides the information needed to adjust the 4261A to its specifications (listed in Table 1-1). Included in this section are test setups and procedures. Adjustment locations referred to in the individual tests are identified pictorially in Section VIII.

5-3. A fifteen minute instrument warm up is required before beginning the adjustments in this section. Required instruments for the adjustments are listed in Table 1-5. Besides the test instrumentation, only a screwdriver is needed to perform the adjustments.

5-4. SAFETY REQUIREMENTS.

5-5. Although the instrument has been designed in accordance with international safety standards, this manual contains information, cautions and warnings which must be followed to ensure safe operation and to keep the instrument in safe condition (see Sections II and III). Adjustments described in this section should be performed only by qualified service personnel.

WARNING

ANY INTERRUPTION OF THE PROTECTIVE (GROUNDING) CONDUCTOR (INSIDE OR OUTSIDE THE INSTRUMENT) OR DISCONNECTION OF THE PROTECTIVE EARTH TERMINAL IS LIKELY TO MAKE THE INSTRUMENT DANGEROUS. INTENTIONAL INTERRUPTION IS PROHIBITED.

5-6. The opening of covers or removal of parts, except those to which access can be gained by hand, is likely to expose live parts. Accessible terminals may also be live.

5-7. The instrument must be disconnected from all voltage sources before any adjustment. All work must be done by a technically skilled person who is aware of the hazard involved.

5-8. Capacitors inside instrument may still be charged even if instrument has been disconnected from its source of supply.

WARNING

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

5-9. EQUIPMENT REQUIRED.

5-10. Equipment needed to make the adjustments described in this section are listed in Table 1-5. (Page 1-9) of the Section I.

5-11. FACTORY SELECTED COMPONENTS.

5-12. Factory selected components can be recognized by an asterisk near the reference designator on the schematic diagrams in Section VIII (a nominal value is shown). Section VI, Replaceable Parts,

Table 5-1. Factory Selected Components.

Component	Nominal Value Range	Effect on Performance
A4C11	HP P/N 0160-2201 C:FXD 51pF HP P/N 0140-0205 C:FXD 62pF HP P/N 0140-0193 C:FXD 82pF HP P/N 0160-2202 C:FXD 75pF HP P/N 0160-2204 C:FXD 100pF	Maximizes D measurement accuracy on 100pF range (1kHz). If D display is low, use less capacitance; if high use more capacitance.

Table 5-2. Adjustable Components

Reference Designator	Name of Control	Purpose
A4R87 (para. 5-19)	OFFSET	To eliminate dc offset in range resistor amplifier.
A5R31 (para. 5-20) A5R40 (para. 5-20)	OFFSET-1 OFFSET-2	To eliminate dc offset in differential amplifier.
A5R54 (para. 5-20)	OFFSET-3	To eliminate dc offset in measurement signal amplifier.
A5R85 (para. 5-22)	OFFSET-4	To set auto phase adjustment circuit for optimum functioning.
A6R67 (para. 5-21) A6R68 (para. 5-21)	PHASE OFFSET ZERO OFFSET	To eliminate dc offset in phase converter and zero detector.
A9R6 (para. 5-18)	+12V ADJ.	To set output of +12V dc power supply.

lists the part number of the nominal value component. If the nominal value of the selected component is changed, the Manual Change supplement, supplied with this manual, will list the change to update the manual. Table 5-1 lists all factory selected components with their nominal value ranges and their influence on instrument performance.

5-13. Adjustable components, with reference designators, are listed in Table 5-2. The table gives the name of the control to be adjusted and the purpose of its adjustment.

5-14. ADJUSTMENT RELATIONSHIPS.

5-15. For best 4261A performance, adjustments presented in this section must be performed in the order indicated by the procedures. If adjustment is neglected, the 4261A specifications may not be met. Table 5-3 shows alignment procedures required when repairing the instrument (replacement of component or board). The adjustments in Table 5-3 assume that no other adjustments were attempted prior to board or component replacement.

5-16. ADJUSTMENT LOCATIONS.

5-17. For reference, adjustment location illustrations are given in Figure 8-15.

Table 5-3. Alignment Procedure

Assembly Repaired-Replaced	Required Adjustments
A1(04261-77001)	None
A2(04261-77002)	
A3(04261-77103)	
A4(04261-77004)	Para. 5-19 thru 5-22
A5(04261-77005)	Para. 5-19 thru 5-22
A6(04261-77006)	Para. 5-21 and 5-22
A7(04261-77007)	None
A8(04261-77108)	
A9(04261-77009)	Para. 5-18
A10(04261-77010)	None
A21(04261-77021)	
A22(04261-77022)	

ADJUSTMENTS

5-18. POWER SUPPLY VOLTAGE ADJUSTMENT.

Service Sheet No. 9.

DESCRIPTION:

This adjustment sets the dc power supply voltages for the 4261A internal circuits. Although there are three dc output voltages (+12V, -12V and +5V), only an adjustment of the +12V is required. The -12V and +5V are automatically set to appropriate values by +12V adjustment.

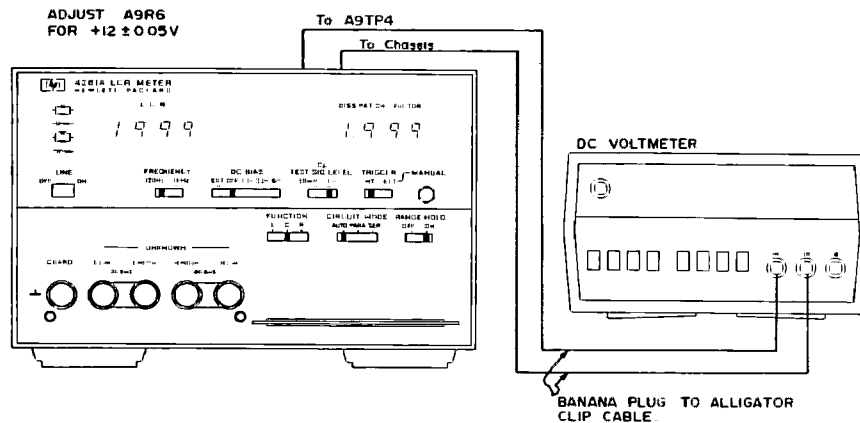


Figure 5-1. Power Supply Voltage Adjustment.

EQUIPMENT:

DC VOLTMETER HP 5300A w HP 5306A

PROCEDURE:

- Connect voltmeter plus input to 4261A test point A9TP4 and minus input to 4261A chassis with dual banana plug to alligator clip cable. See Figure 5-1.
- Set DC voltmeter range as appropriate for measuring +12 volts.
- Adjust A9R6 "+12V" for +12 volts ± 0.05 volts (see Figure 8-15 for location).
- After adjustment of +12V, check that dc voltages at A9TP5 and A9TP6 are -12V ± 0.15 V and +5V ± 0.15 V, respectively.
- Remove cables and DC voltmeter from 4261A.

Note

This adjustment is not affected by any other adjustment. If this adjustment fails to bring any of the output voltages to their specified values, refer to Section VIII Service Sheet No. 9 for troubleshooting.

ADJUSTMENTS

5-19. A4 BOARD OFFSET ADJUSTMENT.
Service Sheet No. 4.

DESCRIPTION:

This adjustment eliminates any residual dc offset voltage from range resistor amplifier to maximize accurate measurement.

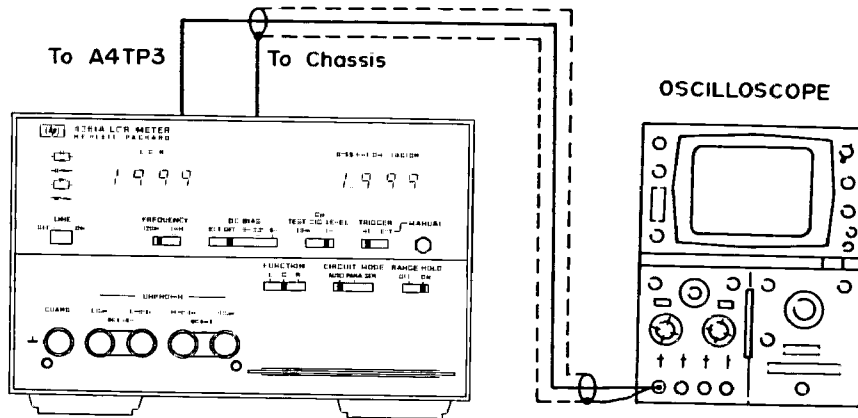


Figure 5-2. A4 Board Offset Adjustment.

EQUIPMENT:

Oscilloscope HP 180C /w 1801A /w 1821A

PROCEDURE:

- a. Connect BNC to alligator clip cable between oscilloscope and 4261A A4TP3 and 4261A chassis (see Figure 5-2).
- b. Set 4261A controls as follows:

FREQUENCY	1kHz
DC BIAS	OFF
TEST SIG LEVEL	1V
TRIGGER	INT
FUNCTION	C
CIRCUIT MODE	PARA
RANGE HOLD	OFF

- c. Connect nothing (open, $\infty \Omega$) to UNKNOWN terminals.

Note

High terminals and Low terminals, respectively, must be connected together.

- d. Set oscilloscope voltage sensitivity to 0.005 volts/div. and sweep speed to 0.5 milliseconds/div.
- e. Set input mode of oscilloscope to ground. Adjust position control of oscilloscope so that baseline is centered on the CRT.
- f. Set oscilloscope trigger mode to automatic. Set oscilloscope input mode to dc input.

ADJUSTMENTS

- g. Adjust A4R87 OFFSET until dc level of displayed waveform is within 0mV \pm 2mV. Refer to Figure 5-3 which shows well-adjusted waveform.

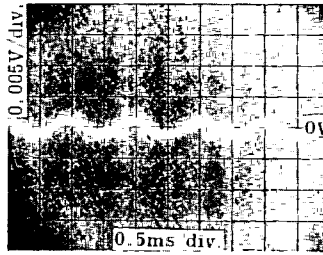


Figure 5-3. Waveform at A4TP3.

5-20. A5 BOARD OFFSET ADJUSTMENT.
Service Sheet No. 5.

DESCRIPTION:

This adjustment eliminates any residual dc offset voltage from the A5 board process amplifier assembly.

- (I) To A5TP1 or
- (II) To A5TP2 or
- (III) To A5TP3

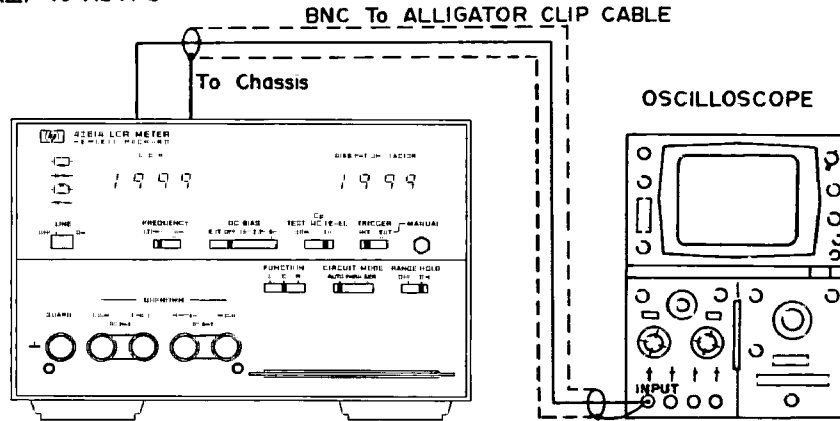


Figure 5-4. A5 Board Offset Adjustment.

EQUIPMENT

Oscilloscope HP 180C/w 1801A/w 1821A

Note

The adjustments in these steps can be performed separately. However, a power supply voltage adjustment (paragraph 5-18) must precede these adjustments. The A5 Board adjustments must be done prior to A6 Board offset adjustments (paragraph 5-21) and A5 Board final offset adjustments (paragraph 5-22). Adjustments in these steps may interact with other adjustments. If adjustments are not successful, see Section VIII service sheet for troubleshooting.

PROCEDURE:

- (I) **OFFSET-1 Adjustment**
 - a. Connect BNC to alligator clip cable between oscilloscope and 4261A A5TP1 and 4261A chassis (see Figure 5-4).

ADJUSTMENTS

b. Set 4261A controls as follows:

```

FREQUENCY ..... 1kHz
DC BIAS ..... OFF
TEST SIG LEVEL ..... 1V
TRIGGER ..... INT
FUNCTION ..... L
CIRCUIT MODE ..... SER
RANGE HOLD ..... OFF
    
```

- c. Short the four UNKNOWN terminals together.
- d. Set oscilloscope voltage sensitivity to 0.005 volts/div. and sweep speed to 0.5 milliseconds/div.
- e. Set input mode of oscilloscope to ground. Adjust position control of oscilloscope so that baseline is centered on the CRT.
- f. Set oscilloscope trigger mode to automatic. Set oscilloscope input mode to dc input.
- g. Adjust A5R31 OFFSET-1 until dc level of displayed waveform is within 0mV \pm 2mV. Refer to Figure 5-5 which shows well-adjusted waveform.

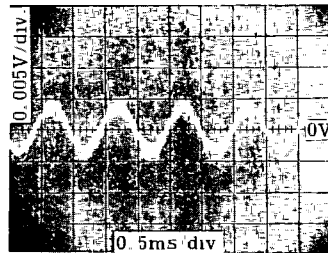


Figure 5-5. Waveform at A5TP1.

(II) OFFSET-2 Adjustment

- a. Connect BNC to alligator clip cable between oscilloscope and 4261A A5TP2 and 4261A chassis (see Figure 5-4).
- b. Change 4261A controls as follows:

```

FUNCTION ..... C
CIRCUIT MODE ..... PARA
    
```

- c. Connect nothing between UNKNOWN high terminals and low terminals.

Note

High terminals and Low terminals, respectively, must be connected together.

- d. Adjust A5R40 OFFSET-2 until dc level of displayed waveform is within 0mV \pm 2mV. Refer to Figure 5-6 which shows well-adjusted waveform.

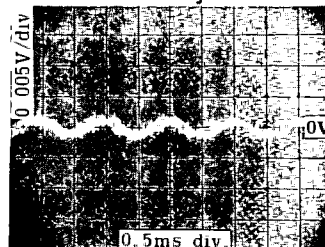
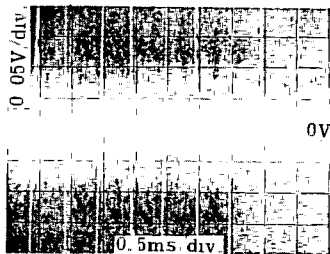


Figure 5-6. Waveform at A5TP2.

ADJUSTMENTS

(III) OFFSET-3 Adjustment.

- a. Connect BNC to alligator clip cable between oscilloscope and 4261A A5TP3 and 4261A chassis (see Figure 5-4).
- b. Change 4261A Cp TEST SIG LEVEL to 50mV.
- c. Change oscilloscope sensitivity to 0.05V/div.
- d. Adjust A5R54 OFFSET-3 until dc level of displayed waveform is within 0mV \pm 10mV. Refer to Figure 5-7 which shows well-adjusted waveform.



Note

Signal observed may be somewhat noisy. Adjust offset control so that signal is equally balanced around 0 volts dc.

Figure 5-7. Waveform at A5TP3.

5-21. A6 BOARD OFFSET ADJUSTMENT.

Service Sheet No. 6.

Note

This adjustment is affected by other adjustments. Refer to Section VIII paragraph 8-28 for troubleshooting if the adjustment fails to bring display to specified values.

DESCRIPTION:

These adjustments eliminate any residual dc offset voltage in the phase and zero detectors to minimize measurement errors. Except for the device to be connected to 4261A UNKNOWN terminals, no equipment is required for this adjustment.

PROCEDURE:

- a. Set 4261A controls as follows:

FREQUENCY 1kHz
 DC BIAS OFF
 TEST SIG LEVEL 1V
 TRIGGER INT
 FUNCTION L
 CIRCUIT MODE SER
 RANGE HOLD OFF

- b. Short UNKNOWN terminals together (0 Ω).

ADJUSTMENTS

- c. Set the slide switch on A8 Sequential Control Board Assembly (P/N 04261-77108) to TEST 2 as shown in Figure 5-8.

Note

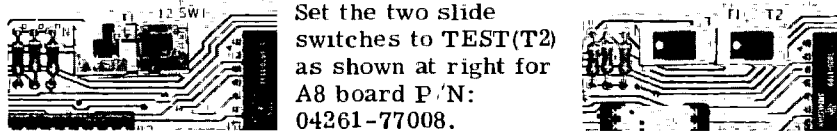


Figure 5-8. A8 Self Test Switch.

- d. Set RANGE HOLD to ON (at any time).
- e. Set OFFSET -4 potentiometer (A5R85) on A5 board (04261-77005) to its mid position.
- f. Adjust ZERO OFFSET A6R68 for 1000 \pm 2 counts on 04261A LCR display.
- g. Adjust PHASE OFFSET A6R67 for 0 to 2 counts on 4261A DISSIPATION FACTOR display.
- h. Reset A8 Self Test Switch(es) to NORMAL position(s).
- i. Change 4261A controls as follows:
FUNCTION C
CIRCUIT MODE PARA
RANGE HOLD OFF
- j. Connect a 10nF standard capacitor to 4261A UNKNOWN terminals.

Note

Standard capacitor (10nF) used in step j and resistor (100k Ω) used in step m are listed in Table 4-1. HP 16361A provides these standard components.

- k. Carefully adjust PHASE OFFSET A6R67 so that D display shows calibrated D value \pm 2 counts for the unknown component.
- l. Change 4261A FUNCTION to R.
- m. Replace unknown device with a 100k Ω resistor.
- n. Carefully adjust ZERO OFFSET A6R68 so that R display shows calibrated value \pm 2 counts of unknown resistor.

5-22. A5 BOARD FINAL OFFSET ADJUSTMENT.
Service Sheet No. 5.

Note

Since this adjustment is affected by all above adjustments, it should always be done last. If any other adjustments are performed, this adjustment must be also be done (last). If adjustment fails to bring instrument into specified range, see Section VIII for troubleshooting.

ADJUSTMENTS

DESCRIPTION:

This adjustment is the last of all 4261A adjustments used to bring the 4261A performance into specifications (per Table 1-1). This adjustment removes any residual offset voltage in the A5 board duty cycle adjustment circuit.

EQUIPMENT:

Oscilloscope HP 180C w 1801A w 1821A

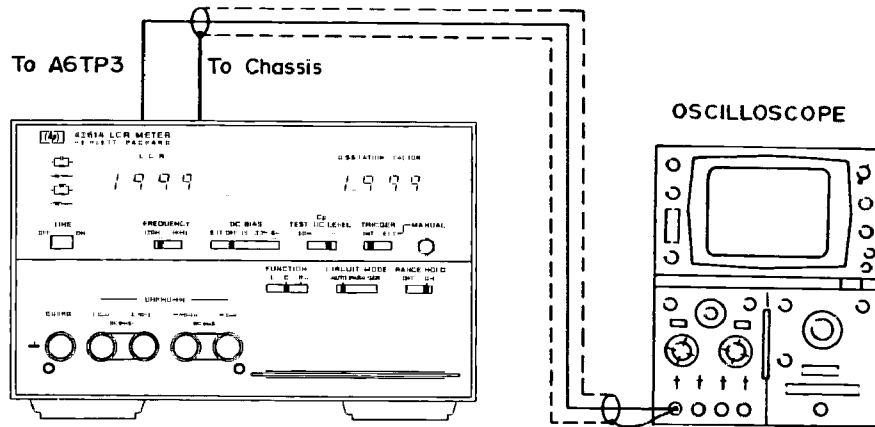


Figure 5-9. A5 Board Final Offset Adjustment.

PROCEDURE:

- a. Connect BNC to alligator clip cable between oscilloscope and 4261A A6TP3 and 4261A chassis (see Figure 5-9).
- b. Set 4261A controls as follows:

FREQUENCY	1kHz
DC BIAS	OFF
TEST SIG LEVEL	50mV
TRIGGER	INT
FUNCTION	C
CIRCUIT MODE	PARA
RANGE HOLD	OFF
- c. Set oscilloscope voltage sensitivity to 0.5 volts/div. and sweep speed to 50 milliseconds/div..
- d. Set input mode of oscilloscope to ground. Adjust position control of oscilloscope so that baseline is centered on CRT.
- e. Set oscilloscope input mode to dc input. Set oscilloscope trigger mode to automatic.
- f. Adjust OFFSET-4 A5R85 for a 0V ±1V dc level oscilloscope waveform display.

ADJUSTMENTS

5-23. CONFIRMATION CHECK.

The check in this paragraph confirms that adjustments in paragraphs 5-21 and 5-22 have been done satisfactorily.

- a. Use same setup as in paragraph 5-22.
- b. Set range of 4261A to 10.00nF range and RANGE HOLD to ON.
- c. Connect a 1000pF standard capacitor to 4261A UNKNOWN terminals.

Note

Standard capacitor (1000pF) used here is listed in Table 4-1. HP 16361A provides this component.

- d. Check that D display shows the calibrated D value for the capacitor within a tolerance of ± 2 counts.

If step d is unsatisfactory, repeat adjustments in paragraphs 5-21 and 5-23. If still unsatisfactory, refer to Section VIII troubleshooting.

SECTION VI REPLACEABLE PARTS

6-1. INTRODUCTION.

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

6-3. ABBREVIATIONS.

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

6-5. REPLACEABLE PARTS LIST.

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

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

The information for each part includes:

- a. The Hewlett-Packard part number.
- b. The total quantity (Qty) in the instrument.

Table 6-1. List of Reference Designators and Abbreviations

REFERENCE DESIGNATORS			
A = assembly B = motor BT = battery C = capacitor CP = coupler CR = diode DL = delay line DS = device signaling (lamp)	E = misc electronic part F = fuse FL = filter J = jack K = relay L = inductor M = meter MP = mechanical part	P = plug Q = transistor R = resistor RT = thermistor S = switch T = transformer TB = terminal board TP = test point	U = integrated circuit V = vacuum tube, neon bulb, photocell, etc. VR = voltage regulator W = cable X = socket Y = crystal
ABBREVIATIONS			
A = amperes A F C = automatic frequency control AMPL = amplifier B F O = beat frequency oscillator BE CU = beryllium copper BH = binder head BP = bandpass BRS = brass BWO = backward wave oscillator CCW = counter-clockwise CER = ceramic CMO = cabinet mount only COEF = coefficient COM = common COMP = composition COMPL = complete CONN = connector CP = cadmium plate CRT = cathode-ray tube CW = clockwise DEPC = deposited carbon DR = drive ELECT = electrolytic ENCAP = encapsulated EXT = external F = farads f = femto = 10 ⁻¹⁵ FH = flat head FIL H = filister head FXD = fixed G = giga = 10 ⁹ GE = germanium GL = glass GRD = grounded	H = henries HEX = hexagonal HG = mercury HR = hour(s) Hz = hertz IF = intermediate freq. IMPG = impregnated INCD = incandescent INCL = include(s) INS = insulation(ed) INT = internal k = kilo = 1000 LH = left hand LIN = linear taper LK WASH = lock washer LOG = logarithmic taper LPF = low pass filter m = milli = 10 ⁻³ M = meg = 10 ⁶ MET FLM = metal film MET OX = metallic oxide MFR = manufacturer MINAT = miniature MOM = momentary MTG = mounting MY = 'mylar' n = nano = 10 ⁻⁹ N C = normally closed NE = neon NI PL = nickel plate N O = normally open NPO = negative positive zero (zero temperature coefficient)	NPN = negative-positive-negative NRFR = not recommended for field replacement NSR = not separately replaceable OBD = order by description OH = oval head OX = oxide P = peak PC = printed circuit p = pico = 10 ⁻¹² PH BRZ = phosphor bronze PHL = Phillips PIV = peak inverse voltage PNP = positive-negative-positive P O = part of POLY = polystyrene PORC = porcelain POS = position(s) POT = potentiometer PP = peak-to-peak PT = point PWV = peak working voltage RECT = rectifier RF = radio frequency RH = round head or right hand RMO = rack mount only RMS = root-mean square	RWV = reverse working voltage S-B = slow-blow SCR = screw SE = selenium SECT = section(s) SEMICON = semiconductor SI = silicon SIL = silver SL = slide SPG = spring SPL = special SST = stainless steel SR = split ring STL = steel TA = tantalum TD = time delay TGL = toggle THD = thread TI = titanium TOL = tolerance TRIM = trimmer TWT = traveling wave tube μ = micro = 10 ⁻⁶ VAR = variable VDCW = dc working volts W ' = with W = watts WIV = working inverse voltage WW = wirewound W O = without

- 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, the description and function of the part, and the number of parts required. Address your order to the nearest Hewlett-Packard office.

6-10. SPARE PARTS KIT.

6-11. Stocking spare parts for an instrument is often done to insure quick return to service after a malfunction occurs. Hewlett-Packard has a Spare Parts Kit available for this purpose. The kit consists of selected replaceable assemblies and components for this instrument. The contents of the kit

and the Recommended Spares List are based on failure reports and repair data, and parts support for one year. A complimentary Recommended Spares List for this instrument may be obtained on request and the Spare Parts Kit may be ordered through your nearest Hewlett-Packard office.

6-12. DIRECT MAIL ORDER SYSTEM.

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

- a. Direct ordering and shipment from the HP Parts Center in Mountain View, California.
- b. No maximum or minimum on any mail order (there is a minimum order amount for parts ordered through a local HP Office when the orders require billing and invoicing).
- c. Prepaid transportation (there is a small handling charge for each order).
- d. No invoices - to provide these advantages, a check or money order must accompany each order.

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

Table 6-2. Manufacturers Code List.

MFR NO.	MANUFACTURER NAME	ADDRESS	ZIP CODE
00779	AMP INC	HARRISBURG PA	17105
01121	ALLEN-BRADLEY CO	MILWAUKEE WI	53212
01295	TEXAS INSTR INC SEMICOND CMPNT DIV	DALLAS TX	75231
02735	RCA CORP SOLID STATE DIV	SOMMERVILLE NJ	08876
02768	ILLINOIS TOOL WORKS INC FASTEX DIV	DES PLAINES IL	60016
03888	KDI PYROFILM CORP	WHIPPANY NJ	07981
04713	MOTOROLA SEMICONDUCTOR PRODUCTS	PHOENIX AZ	85008
04866	NYLOK-DETROIT CORP	TROY MI	48084
07088	KELVIN ELECTRIC CO	VAN NUYS CA	91401
07263	FAIRCHILD SEMICONDUCTOR DIV	MOUNTAIN VIEW CA	94040
10389	CHICAGO SWITCH INC	CHICAGO IL	60647
12697	CLAROSTAT MFG CO INC	DOVER NH	03820
16299	CORNING GL WK ELEC CMPNT DIV	RALEIGH NC	27604
19701	MEPCO ELECTRA CORP	MINERAL WELLS TX	76067
24546	CORNING GLASS WORKS (BRADFORD)	BRADFORD PA	16701
27014	NATIONAL SEMICONDUCTOR CORP	SANTA CLARA CA	95051
28480	HEWLETT-PACKARD CO CORPORATE HQ	PALO ALTO CA	94304
30983	MEPCO ELECTRA CORP	SAN DIEGO CA	92121
50522	MONSANTO CO ELEK SPECIAL PROD	CUPERTINO CA	95014
56289	SPRAGUE ELECTRIC CO	NORTH ADAMS MA	01247
71785	TRW ELEK COMPONENTS CINCH DIV	ELK GROVE VILLAGE IL	60007
72136	ELECTRO MOTIVE MFG CO INC	WILLMANTIC CT	06226
72962	ELASTIC STOP NUT DIV OF AMERACE	UNION NJ	07083
73734	FEDERAL SCREW PRODUCTS CO	CHICAGO IL	60618
73743	FISCHER SPECIAL MFG CO	CINCINNATI OH	45206
75042	TRW INC PHILADELPHIA DIV	PHILADELPHIA PA	19108
75915	LITTELFUSE INC	DES PLAINES IL	60016
76381	3M COMPANY	ST PAUL MN	55101
78189	ILLINOIS TOOL WORKS INC SHAKEPROOF	ELGIN IL	60126
79727	C-W INDUSTRIES	WARMINSTER PA	18974
79963	ZIERICK MFG CO	MT KISCO NY	10549
80120	SCHNITZER ALLOY PRODUCTS CO	ELIZABETH NJ	07206
80126	PACIFIC ELECTRICORD CO	GARDENA CA	90247
81073	GRAYHILL INC	LA GRANGE IL	60525
82389	SWITCHCRAFT INC	CHICAGO IL	60630
9D949	AMPHENOL SALES DIV OF BUNKER-RAMO	HAZELWOOD MO	63042
93790	NO M/F DESCRIPTION FOR THIS MFG NUMBER		

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1	04261-77001	1	SWITCH BOARD ASSEMBLY	28480	04261-77001
A1S1	5060-4801	4	SLIDE SWITCH ASSEMBLY (FREQUENCY)	28480	5060-4801
A1S2	5060-4801		SLIDE SWITCH ASSEMBLY (DC BIAS)	28480	5060-4801
A1S3	5060-4801		SLIDE SWITCH ASSEMBLY (CP TEST SIG LEVEL)	28480	5060-4801
A1S4	5060-4801		SLIDE SWITCH ASSEMBLY (TRIOPER)	28480	5060-4801
A1S5	3101-1074	1	SWITCH-PB SPST NO MOM 1A 115VAC (MANUAL)	81073	30-3
A1S6	5060-4802	3	SLIDE SWITCH ASSEMBLY (FUNCTION)	28480	5060-4802
A1S7	5060-4802		SLIDE SWITCH ASSEMBLY (CIRCUIT MODE)	28480	5060-4802
A1S8	5060-4802		SLIDE SWITCH ASSEMBLY (RANGE HOLD)	28480	5060-4802
A1W1	8120-0352	1	CABLE ASSEMBLY		
			AL MISCELLANEOUS		
	5020-3440	7	SPRING, DETENT	28480	5020-3440
	04261-30021	1	BAR (131 MM)	28480	04261-30021
	04261-30022	1	BAR (148 MM)	28480	04261-30022
	04261-30023	1	BAR (195 MM)	28480	04261-30023
A2	04261-77002	1	DISPLAY BOARD ASSEMBLY	28480	04261-77002
A2D51	1990-0452	2	DISPLAY NUM SEG 1 CHAR .3 IN HIGH	28480	1990-0452
A2D52	1990-0434	6	DISPLAY NUM SEG 1 CHAR .3 IN HIGH	28480	1990-0434
A2D53	1990-0434		DISPLAY NUM SEG 1 CHAR .3 IN HIGH	28480	1990-0434
A2D54	1990-0434		DISPLAY NUM SEG 1 CHAR .3 IN HIGH	28480	1990-0434
A2D55	1990-0452		DISPLAY NUM SEG 1 CHAR .3 IN HIGH	28480	1990-0452
A2D56	1990-0434		DISPLAY NUM SEG 1 CHAR .3 IN HIGH	28480	1990-0434
A2D57	1990-0434		DISPLAY NUM SEG 1 CHAR .3 IN HIGH	28480	1990-0434
A2D58	1990-0434		DISPLAY NUM SEG 1 CHAR .3 IN HIGH	28480	1990-0434
A2D59	1990-0517	17	OPTO-ISOLATOR LED-PKSTR	50522	MCA2-30
A2D510	1990-0517		OPTO-ISOLATOR LED-PKSTR	50522	MCA2-30
A2D511	1990-0517		OPTO-ISOLATOR LED-PKSTR	50522	MCA2-30
A2D512	1990-0517		OPTO-ISOLATOR LED-PKSTR	50522	MCA2-30
A2D513	1990-0517		OPTO-ISOLATOR LED-PKSTR	50522	MCA2-30
A2D514	1990-0517		OPTO-ISOLATOR LED-PKSTR	50522	MCA2-30
A2D515	1990-0517		OPTO-ISOLATOR LED-PKSTR	50522	MCA2-30
A2D516	1990-0517		OPTO-ISOLATOR LED-PKSTR	50522	MCA2-30
A2D517	1990-0517		OPTO-ISOLATOR LED-PKSTR	50522	MCA2-30
A2D518	1990-0517		OPTO-ISOLATOR LED-PKSTR	50522	MCA2-30
A2D519	1990-0517		OPTO-ISOLATOR LED-PKSTR	50522	MCA2-30
A2D520	1990-0517		OPTO-ISOLATOR LED-PKSTR	50522	MCA2-30
A2D521	1990-0517		OPTO-ISOLATOR LED-PKSTR	50522	MCA2-30
A2D522	1990-0517		OPTO-ISOLATOR LED-PKSTR	50522	MCA2-30
A2D524	1990-0517		OPTO-ISOLATOR LED-PKSTR	50522	MCA2-30
A2D525	1990-0517		OPTO-ISOLATOR LED-PKSTR	50522	MCA2-30
A2J1 thru J8	1200-0638		SOCKET 14 CONT		
A2R1	0683-2715	37	RESISTOR 270 5% .25W		
A2R2	0683-2715		RESISTOR 270 5% .25W		
A2R3	0683-2715		RESISTOR 270 5% .25W		
A2R4	0683-2715		RESISTOR 270 5% .25W		
A2R5	0683-2715		RESISTOR 270 5% .25W		
A2R6	0683-2715		RESISTOR 270 5% .25W		
A2R7	0683-1515	4	RESISTOR 150 5% .25W		
A2R8	0683-1015		RESISTOR 100 5% .25W	01121	CB1015
A2R9	0683-2715		RESISTOR 270 5% .25W		
A2R10	0683-2715		RESISTOR 270 5% .25W		
A2R11	0683-2715		RESISTOR 270 5% .25W		
A2R12	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A2R13	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A2R14	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A2R15	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A2R16	0683-2715		RESISTOR 270 5% .25W FC TC=-400/+500		
A2R17	0683-2715		RESISTOR 270 5% .25W FC TC=-400/+500		
A2R18	0683-2715		RESISTOR 270 5% .25W FC TC=-400/+500		
A2R19	0683-2715		RESISTOR 270 5% .25W FC TC=-400/+500		
A2R20	0683-2715		RESISTOR 270 5% .25W		
A2R21	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A2R22	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A2R23	0683-2715		RESISTOR 270 5% .25W FC TC=-400/+500		
A2R24	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A2R25	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A2R26	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A2R27	0683-1515		RESISTOR 150 5% .25W FC TC=-400/+600	01121	CB1515
A2R28	0683-1515		RESISTOR 150 5% .25W FC TC=-400/+600	01121	CB1515
A2R29	0683-1515		RESISTOR 150 5% .25W FC TC=-400/+600	01121	CB1515
A2R30	0683-2715		RESISTOR 270 5% .25W FC TC=-400/+500		

See introduction to this section for ordering information

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

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
42R31 42R32 42R33 42R34 42R35	0683-2715 0683-1015 0683-1015 0683-1015 0683-1015		RESISTOR 270 5% .25W FC TC=-400/+500 RESISTOR 100 5% .25W FC TC=-400/+500 RESISTOR 100 5% .25W FC TC=-400/+500 RESISTOR 100 5% .25W FC TC=-400/+500 RESISTOR 100 5% .25W FC TC=-400/+500	01121 01121 01121 01121	CF1015 CB1015 CB1015 CB1015
42W1 42W2 42W3	8120-0355 8120-0355 8120-0355	3	CABLE ASSEMBLY CABLE ASSEMBLY CABLE ASSEMBLY		
A2 MISCELLANEOUS					
	0520-0127 04261-10032 04261-40025 04261-40026 04261-40027 04261-85024	2 1 1 1 1 1	SCREW-MACH 2-56 .188-IN-LG PAN-HD-POZI ANGLE SPACER FOR LED LAMP SPACER FOR LED LAMP SPACER FOR LED LAMP LABEL, INFORMATION	28480 28480 28490	0520-0127 04261-10032 04261-85024
A3	04261-77103	1	DECODER BOARD ASSEMBLY	28480	04261-77103
A3C1 A3C2 A3C3 A3C4 A3C5	0180-0374 0180-0374 0180-0197 0160-2055 0160-2055	7 3 28	CAPACITOR-FXD 10UF +-10% 20VDC TA CAPACITOR-FXD 10UF +-10% 20VDC TA CAPACITOR-FXD 2.2UF +-10% 20VDC TA CAPACITOR-FXD 01UF +80-20% 100WVDC CEP CAPACITOR-FXD 01UF +80-20% 100WVDC CEP	56289 56289 56289 28480 28480	150D106X902082 150D106X902082 150D225X9020A2 0160-2055 0160-2055
A3C6 A3C7 A3C8	0160-2055 0160-2055 0180-0374		CAPACITOR-FXD 01UF +80-20% 100WVDC CEP CAPACITOR-FXD 01UF +80-20% 100WVDC CEP CAPACITOR-FXD 10UF +-10% 20VDC TA	28480 28480 56289	0160-2055 0160-2055 150D106X902082
A3J1 A3J2 A3J3 A3J4	1200-0853 1200-0853 1200-0853 1200-0613	4	SOCKET-IC 16-CONT DIP-SLDR-TERMS SOCKET-IC 16-CONT DIP-SLDR-TERMS SOCKET-IC 16-CONT DIP-SLDR-TERMS SOCKET, ELEC, IC 28-CONT DIP 5LDR TERM	28480	1200-0613
A3Q1 A3Q2 A3Q3 A3Q4	1854-0071 1854-0071 1854-0071 1854-0071	19	TRANSISTOR NPN SI PD=300MW FT=200MHZ TRANSISTOR NPN SI PD=300MW FT=200MHZ TRANSISTOR NPN SI PD=300MW FT=200MHZ TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480 28480 28480 28480	1854-0071 1854-0071 1854-0071 1854-0071
A3R1 A3R2 A3R3 A3R4 A3R5	1810-0164 1810-0164 1810-0164 0683-1025 0683-1025	5 33	NETWORK-RES 9-PIN-SIP .15-PIN-SPCG NETWORK-RES 9-PIN-SIP .15-PIN-SPCG NETWORK-RES 9-PIN-SIP .15-PIN-SPCG RESISTOR 1k 5% .25W FC TC=400/+600 RESISTOR 1k 5% .25W FC TC=400/+600	28480 28480 28480 01121 01121	1810-0164 1810-0164 1810-0164 CB1025 CB1025
A3R6 A3R7 A3R8 A3R9 A3R10	0683-1025 0683-1025 0683-1025 0698-4431 0757-0442		RESISTOR 1k 5% .25W FC TC=400/+600 RESISTOR 1k 5% .25W FC TC=400/+600 RESISTOR 1k 5% .25W FC TC=400/+600 RESISTOR 2.05k 1% RESISTOR 10k 1% .125W	01121 01121 01121	CB1025 CB1025 CB1025
A3U1 A3U2 A3U3 A3U4 A3U5	1820-1688 1820-1688 1820-0471 1820-1411 1820-0471	2 4 4	IC SN74LS247 BCD TO 7-SEGMENT DECODER IC SN74LS247 BCD TO 7-SEGMENT DECODER IC SN74 06 N INV IC SN74LS 75 N LATCH IC SN74 06 N INV	28480 28480 01295 01295 01295	1820-1688 1820-1688 SN7406N SN74LS75N SN7406N
A3U6 A3U7 A3U8 A3U9 A3U10	1820-1411 1820-0471 1820-1436 1820-1436 1820-1199	2 5	IC SN74LS 75 N LATCH IC SN74 06 N INV IC SN74LS170 N DIGITAL IC SN74LS170 N DIGITAL IC SN74LS 04 N INV	01295 01295 01295 01295 01295	SN74LS75N SN7406N SN74LS170N SN74LS170N SN74LS04N
A3U11 A3U12 A3U13 A3U14 A3U15	1820-1411 1820-1411 1820-1197 1820-1199 1820-1144	8 2	IC SN74LS 75 N LATCH IC SN74LS 75 N LATCH IC SN74LS 00 N GATE IC SN74LS 04 N INV IC SN74LS 02 N GATE	01295 01295 01295 01295 01295	SN74LS75N SN74LS75N SN74LS00N SN74LS04N SN74LS02N
A3U16 A3U17 A3U18	1820-0902 1820-0902 1818-2271	2 2 1	IC SN75 450AN DRIVER IC SN75 450AN DRIVER IC R.O.M.	01295 01295 28480	SN75450AN SN75450AN 1818-2271
A4	04261-77004	1	OSCILLATOR/RANGE RESISTOR BOARD ASSEMBLY	28480	04261-77004
A4C1 A4C2 A4C3 A4C4 A4C5	0160-1670 0160-1670 0190-0228 0180-0228 0180-1052	3 2 4	CAPACITOR-FXD 10000pF .5% CAPACITOR-FXD 10000pF .5% CAPACITOR-FXD 22UF+-10% 15VDC TA CAPACITOR-FXD 22UF+ 10% 15VDC TA CAPACITOR-FXD 220UF 6.3V	28480 28480 56289 56289 28480	0160-1670 0160-1670 150D225X9015R2 150D225X9015R2 0180-1052
A4C6 A4C7 A4C8 A4C9 A4C10	0180-1051 0180-1051 0180-1052 0180-1056	16 3	CAPACITOR-FXD 100UF 16V CAPACITOR-FXD 100UF 16V CAPACITOR-FXD 220UF 6.3V CAPACITOR-FXD 1000 UF 25VDC AL ELECT NOT ASSIGNED	28480 28480 28480 28480	0180-1051 0180-1051 0180-1052 0180-1056

See introduction to this section for ordering information

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

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
*A4C11	0160-2202	1	CAPACITOR-FXD 75pF +-5% 300WVDC MICA	28480	0160-2202
A4C12	0160-2307	1	CAPACITOR-FXD 47pF +-5% 300WVDC MICA	28480	0160-2307
A4C13	0180-1051	1	CAPACITOR-FXD 100UF 16V	28480	0180-1051
A4C14	0160-2264	1	CAPACITOR-FXD 20pF +-5% 500WVDC CER	28480	0160-2264
A4C15	0180-1051	1	CAPACITOR-FXD 100UF 16V	28480	0180-1051
A4C16	0180-1051		CAPACITOR-FXD 100UF 16V	28480	0180-1051
A4C17	0180-1051		CAPACITOR-FXD 100UF 16V	28480	0180-1051
A4C18	0180-1051		CAPACITOR-FXD 100UF 16V	28480	0180-1051
A4C19	0180-1051		CAPACITOR-FXD 100UF 16V	28480	0180-1051
A4CR1	1901-0040	42	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR2	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR3	1902-3037	1	DIODE-ZNR 3.16V 2% DO-7 PD=.4W TC=-.064%	04713	
A4CR4	1902-0554	1	DIODE-ZNR 10V 5% DO-7 PD=1W		
A4CR5	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR6	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR7	1902-0845		DIODE-ZNR 11V 5% PD=1W TC=+.07%	28480	RD11FB
A4CR8	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR9	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR10	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR11	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR12	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR13	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR14	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR15	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR16	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR17	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR18	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR19	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR20	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR21	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR22	1902-3149	5	DIODE-ZNR 9.09V 5% DO-7 PD=.4W TC=+.057%	04713	SZ 10939-170
A4CR23	1902-0845	2	DIODE-ZNR 11V 5% PD=1W TC=+.07%	28480	PD11FB
A4CR24	1902-0845		DIODE-ZNR 11V 5% PD=1W TC=+.07%	28480	RD11FB
A4CR25	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR26	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR27	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR28	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4F1	0490-0226		RELAY: REED		
A4F2	0490-0234		RELAY: REED		
A4F3	0490-0234		RELAY: REED		
A4F4	0490-0234		RELAY: REED		
A4Q1	1855-0062	8	TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0062
A4Q2	5080-3830	21	TRANSISTOR J-FET N-CHAN D-MODE SI		
A4Q3	1855-0082	1	TRANSISTOR MOSFET P-CHAN D-MODE SI	28480	1855-0082
A4Q4	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4Q5	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4Q6	1853-0020	24	TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A4Q7	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A4Q8	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4Q9	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A4Q12	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4Q13	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4Q14	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4Q15	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4Q16	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4Q17	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4Q18	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4Q19	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4Q20	5080-3830		TRANSISTOR J-FET N-CHAN D-MODE SI		
A4Q21	5080-3830		TRANSISTOR J-FET N-CHAN D-MODE SI		
A4Q22	5080-3830		TRANSISTOR J-FET N-CHAN D-MODE SI		
A4Q23	5080-3830		TRANSISTOR J-FET N-CHAN D-MODE SI		
A4Q24	5080-3830		TRANSISTOR J-FET N-CHAN D-MODE SI		
A4Q25	5080-3830		TRANSISTOR J-FET N-CHAN D-MODE SI		
A4Q26	1855-0128	1	TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0128
A4Q27	5080-3830		TRANSISTOR J-FET N-CHAN D-MODE SI		
A4Q28	1854-0013	1	TRANSISTOR NPN 2N2218A SI TO-5 PD=800MW	04713	2N2218A
A4Q29	1853-0012	1	TRANSISTOR PNP 2N2904A SI TO-5 PD=600MW	01295	2N2904A
A4Q30	1853-0020		TRANSISTOR PNP SI PD=100MW FT=150MHZ	28480	1853-0020
A4Q31	1853-0020		TRANSISTOR PNP SI PD=100MW FT=150MHZ	28480	1853-0020
A4Q32	1853-0020		TRANSISTOR PNP SI PD=100MW FT=150MHZ	28480	1853-0020
A4Q33	1853-0020		TRANSISTOR PNP SI PD=100MW FT=150MHZ	28480	1853-0020
A4Q34	1853-0020		TRANSISTOR PNP SI PD=100MW FT=150MHZ	28480	1853-0020
A4R1	0757-0486	2	RESISTOR 750k 1% .125W F TC=0+-100	24546	NA4
A4R2	0698-3136	1	RESISTOR 17.8k 1% .125W F TC=0+-100	16299	C4-1/8-T0-1782-F
A4R3	0757-0486		RESISTOR 750k 1% .125W F TC=0+-100	24546	NA4
A4R4	0757-0448	1	RESISTOR 18.2k 1% .125W F TC=0+-100	24546	C4-1/8-T0-1822-F
A4R5	0698-3451	2	RESISTOR 133k 1% .125W F TC=0+-100	16299	C4-1/8-T0-1333-F

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

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A4R6	0698-3451		RESISTOR 133K 1% .125W F TC=0+/-100	16299	C4-1/8-T0-1333-F
A4R7	0757-0317	2	RESISTOR 1.33K 1% .125W F TC=0+/-100	24546	C4-1/8-T0=1331-F
A4R8	0757-0278	1	RESISTOR 1.78K 1% .125W F TC=0+/-100	24546	C4-1/8-T0=1781-F
A4R9	0698-3155	4	RESISTOR 4.64K 1% .125W F TC=0+/-100	16259	C4-1/8-T0=4641-F
A4R10	0683-3335	38	RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335
A4R11	0683-8225	1	RESISTOR 8.2K 5% .25W FC TC=-400/+700	01121	C88225
A4R12	0698-3154	1	RESISTOR 4.22K 1% .125W F TC=0+/-100	16299	C4-1/8 T0=4221-F
A4R13	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335
A4R14	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+800	01121	C83335
A4R15	0757-0443	1	RESISTOR 11K 1% .125W F TC=0+/-100	24546	C4-1/8-T0=1102-F
A4R16	0757-0416	3	RESISTOR 511 1% .125W F TC=0+/-100	24546	C4-1/8-T0-511R-F
A4R17	0698-4442	1	RESISTOR 4.42K 1% .125W F TC=0+/-100	16299	C4-1/8-T0=4421-F
A4R18	0698-4420	1	RESISTOR 226 1% .125W F TC=0+/-100	16299	C4-1/8-T0=226R-F
A4R19	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335
A4R20	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335
A4R21	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335
A4R22	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335
A4R23	0683-4725	43	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	C84725
A4R24	0683-7525	1	RESISTOR 7.5K 5% .25W FC TC=-400/+700	01121	C87525
A4R25	0757-0442	4	RESISTOR 10K 1% .125W F TC=0+/-100	24546	C4-1/8-T0-1002-F
A4R26	0698-3515	1	RESISTOR 5.90K 1% .125W F TC=0+/-100	16299	C4-1/8-T0-5901-F
A4R27	0683-1535	3	RESISTOR 15K 5% .25W FC TC=-400/+800	01121	C81535
A4R28	0683-1535		RESISTOR 15K 5% .25W FC TC=-400/+800	01121	C81535
A4R29	0683-0275	4	RESISTOR 2.7 5% .25W FC TC=-400/+500	01121	C827G5
A4R30	0683-0275		RESISTOR 2.7 5% .25W FC TC=-400/+500	01121	C827G5
A4R31	0764-0015	1	RESISTOR 560 5% 2W MO TC=0+/-200	24546	FP42=2-T00-561-J
A4R32	0757-0465	4	RESISTOR 100K 1% .125W F TC=0+/-100	24546	C4-1/8-T0=1003-F
A4R33	0757-0442		RESISTOR 10K 1% .125W F TC=0+/-100	24546	C4-1/8-T0=1002-F
A4R35	0698-0083	2	RESISTOR 1.96K 1% .125W F TC=0+/-100	16299	C4-1/8-T0=1961-F
A4R37	0698-3440	2	RESISTOR 196 1% .125W F TC=0+/-100	16299	C4-1/8-T0=196R-F
A4R38	0698-3440		RESISTOR 196 1% .125W F TC=0+/-100	16299	C4-1/8-T0=196R-F
A4R39	0683-0825	1	RESISTOR 8.2 5% .25W FC TC=-400/+500	01121	C882G5
A4R40	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335
A4R41	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335
A4R42	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335
A4R43	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335
A4R44	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335
A4R45	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335
A4R46	0683-3335	6	RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335
A4R47	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335
A4R50	0683-5625	1	RESISTOR 5.6K 5% .25W FC TC=-400/+700	01121	C85625
A4R51	0683-2215	2	RESISTOR 220 5% .25W FC TC=-400/+700	01121	
A4R52	0698-2225	1	RESISTOR-FXD 90.0K OHM 0.05% 1/8W MF	28480	0698-2225
A4R53	0698-2295	1	RESISTOR-FXD 11.090 OHM 0.05%	28480	0698-2295
A4R54	0698-3329	1	RESISTOR 10K .5% .125W F TC=0+/-100	03888	PME55-1/8-T0-1002-J
A4R55	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	C81055
A4R56	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	C81055
A4R57	0698-2296	1	RESISTOR-FXD 1010.1 OHM 0.05%	28480	0698-2296
A4R58	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	C81055
A4R59	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	C81055
A4R60	0698-2294	1	RESISTOR-FXD 100.10HM 0.05%	28480	0698-2294
A4R61	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	C81055
A4R62	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	C81055
A4R63	0698-2298	1	RESISTOR-FXD 10 OHM 0.05%	28480	0698-2298
A4R64	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	C81055
A4R65	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	C81055
A4R66	0683-4705	2	RESISTOR 47 5% .25W FC TC=-400/+500	01121	C84705
A4R67	0683-4705		RESISTOR 47 5% .25W FC TC=-400/+500	01121	C84705
A4R68	0683-1035	11	RESISTOR 10K 5% .25W FC TC=-400/+700	01121	C81035
A4R69	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	C81035
A4R70	0757-1090	2	RESISTOR 261 1% .5W F TC=0+/-100	19701	MF7C1/2-T0-261P-F
A4R71	0683-0275		RESISTOR 2.7 5% .25W FC TC=-400/+500	01121	C827G5
A4R72	0683-0275		RESISTOR 2.7 5% .25W FC TC=-400/+500	01121	C827G5
A4R73	0757-1090		RESISTOR 261 1% .5W F TC=0+/-100	19701	MF7C1/2-T0-261R-F
A4R74	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335
A4R75	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335
A4R76	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335
A4R77	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335
A4R78	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335

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

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A4P79	0683-3335		RESISTOR 33k 5% 25W FC TC=-400/+800	01121	CB3335
A4P80	0683-3335		RESISTOR 33k 5% 25W FC TC=-400/+800	01121	CB3335
A4P81	0683-3335		RESISTOR 33k 5% 25W FC TC=-400/+800	01121	CB3335
A4P82	0683-3335		RESISTOR 33k 5% 25W FC TC=-400/+800	01121	CB3335
A4P83	0683-3335		RESISTOR 33k 5% 25W FC TC=-400/+800	01121	CB3335
A4P84	0683-3335		RESISTOR 33k 5% 25W FC TC=-400/+800	01121	CB3335
A4P85	0698-0083		RESISTOR 1 961 1% .125W F TC=0+-100	16299	C4-1/H-T0-1961-F
A4P86	0683-1065		RESISTOR 10M 5% 25W FC TC=-900/+1000	01121	CB1065
A4P87	2100-2514		RESISTOR-TPMP 20k 10% C SIDE-ADJ 1-TURN	30983	ET50W203
A4T1	9100 0846	1	TRANSFORMER-PULSE 412N3	28480	9100-0846
A4U1	1826-0139	6	IC MC 1458 OP AMP	04713	MC1458P1
A4U2	1826-0013	1	IC OP AMP	28480	1826-0013
	04261-50022	1	SUPPORTER, 8CAFD	28480	04261-50022
43	04261-77005	1	PROCESS AMPLIFIER BOARD ASSEMBLY	28480	04261-77005
43C1	0160-1678	3	C:FXD MY 0.1 UF 2% 200VDCW	28480	0160-1678
43C2	0160-2254	1	CAPACITOR-FXD 7.5PF +- .25PF 500WVDC CER	28480	0160 2254
43C3	0160-2204		CAPACITOR-FXD 100PF +-5% 300WVDC MICA	93790	RCM15F101J3C
43C4	0160-1678		C:FXD MY 0.1 UF 2% 200VDCW	28480	0160-1678
43C5	0160 2204		CAPACITOR-FXD 100PF +-5% 300WVDC MICA	93790	RCM15F101J3C
43C6	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
43C7	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160 2055
43C8	0180-1051		CAPACITOR-FXD 100UF 16V	28480	0180-1051
43C9	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
43C10	0180-1051		CAPACITOR-FXD 100UF 16V	28480	0180 1051
43C11	0160 2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
43C12	0180-1051		CAPACITOR-FXD 100UF 16V	28480	0180-1051
43C13	0160 2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
43C14	0180-1051		CAPACITOR-FXD 100UF 16V	28480	0180-1051
43C15	0160 2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
43C16	0180-1051		CAPACITOR-FXD 100UF 16V	28480	0180-1051
43C17	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
43C18	0180-1051		CAPACITOR-FXD 100UF 16V	28480	0180-1051
43C19	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
43C20	0140-0190		CAPACITOR-FXD 39pF MICA	28480	0160-2055
43CR1	1901-0376	6	DIODE-GEN PRP	28480	1901-0376
43CR2	1901-0376		DIODE-GEN PRP	28480	1901-0376
43CR4	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901 0040
43CR5	1901 0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
43CR6	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
43CR7	1901 0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
43CR8	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
43CR9	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
43CF10	1901 0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
43CF11	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
43CF12	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
43CF13	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
43CF14	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
43CF16	1901 0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
43CR18	1902-0041	5	DIODE-ZNR 5.11V 5% DO-7 PD=.4W TC=-.009%	04713	SZ 10939-98
43CR19	1902-0041		DIODE-ZNR 5.11V 5% DO-7 PD=.4W TC=-.009%	04713	SZ 10939 98
43CR20	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
43CF21	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
43CR22	1902-0049	3	DIODE-ZNR 6.15V 5% DO-7 PD=.4W TC=+.022%	04713	SZ 10939-122
43Q1	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
43Q2	1853 0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
43Q3	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
43Q4	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
43Q5	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
43Q7	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
43Q8	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
43Q9	5080-3830		TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1853-0020
43Q10	5080-3830		TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1853-0020
43Q11	5080-3830		TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1853-0020
43Q12	5080-3830		TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1853-0020
43Q13	5080-3830		TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1853-0020
43Q14	5080-3830		TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1853-0020
43Q15	1855-0062		TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0062
43Q17	1855-0062		TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0062
43Q19	1855-0062		TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0062
43Q20	1855-0062		TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0062

See introduction to this section for ordering information

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

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number	
A5R1	0683-1025	18 3	RESISTOR 1k 5% .25W FC TC=-400/+600	01121	CB1025	
A5P2	0683-2235		RESISTOR 22k 5% .25W FC TC=-400/+800	01121	CB2235	
A5R3	0683-1235		RESISTOR 12k 5% .25W FC TC=-400/+800	01121	CB1235	
A5P4	0683-2235		RESISTOR 22k 5% .25W FC TC=-400/+800	01121	CB2235	
A5P5	0683-2235		RESISTOR 22k 5% .25W FC TC=-400/+800	01121	CB2235	
A5R6	0683-2235		RESISTOR 22k 5% .25W FC TC=-400/+800	01121	CB2235	
A5P7	0683-2235		RESISTOR 22k 5% .25W FC TC=-400/+800	01121	CB2235	
A5R8	0683-1235		RESISTOR 12k 5% .25W FC TC=-400/+800	01121	CB1235	
A5R9	0683-2235		RESISTOR 22k 5% .25W FC TC=-400/+800	01121	CB2235	
A5R10	0683-2235		RESISTOR 22k 5% .25W FC TC=-400/+800	01121	CB2235	
A5R11	0683-2235		RESISTOR 22k 5% .25W FC TC=-400/+800	01121	CB2235	
A5R12	0683-2235		RESISTOR 22k 5% .25W FC TC=-400/+800	01121	CB2235	
A5R15	0683-2235		RESISTOR 22k 5% .25W FC TC=-400/+800	01121	CB2235	
A5R17	0683-2235		RESISTOR 22k 5% .25W FC TC=-400/+800	01121	CB2235	
A5R18	0683-1235		RESISTOR 12k 5% .25W FC TC=-400/+800	01121	CB1235	
A5R19	0683-2235		RESISTOR 22k 5% .25W FC TC=-400/+800	01121	CB2235	
A5R20	0683-2235		RESISTOR 22k 5% .25W FC TC=-400/+800	01121	CB2235	
A5R21	0683-2235		RESISTOR 22k 5% .25W FC TC=-400/+800	01121	CB2235	
A5P22	0698-8827		RESISTOR 1M OHM 1% .25W			
A5P23	0683-1035		RESISTOR 10k 5% .25W FC TC=-400/+700	01121	CB1035	
A5P24	0698-2297	4	RESISTOR FXD 3.01k OHM 0.05%	28480	0698-2297	
A5R25	0698-2297		RESISTOR FXD 3.01k OHM 0.05%	28480	0698-2297	
A5R26	0683-1035		RESISTOR 10k 5% .25W FC TC=-400/+700	01121	CB1035	
A5R27	0757-0273		RESISTOR 3.01k 1% .125W F TC=0+/-100	24546	C4-1/8-T0=3011-F	
A5R28	0757-0273		RESISTOR 3.01k 1% .125W F TC=0+/-100	24546	C4-1/8-T0=3011-F	
A5R29	0683-5645	4	RESISTOR 560k 5% .25W FC TC=-800/+900	01121		
A5R31	2100-2516		4	RESISTOR-TRMR 100k 10% C SIDE-ADJ 1-TURN	30983	ET50X104
A5R32	0698-8827			RESISTOR 1M 1% .25W FC TC=-800/+900		
A5R33	0698-2297			RESISTOR FXD 3.01k OHM 0.05%	28480	0698-2297
A5R34	0698-2297			RESISTOR FXD 3.01k OHM 0.05%	28480	0698-2297
A5R35	0683-1035	RESISTOR 10k 5% .25W FC TC=-400/+700		01121	CB1035	
A5R36	0757-0273	4	RESISTOR 3.01k 1% .125W F TC=0+/-100	24546	C4-1/8-T0=3011-F	
A5R37	0757-0273		RESISTOR 3.01k 1% .125W F TC=0+/-100	24546	C4-1/8-T0=3011-F	
A5R38	0683-5645		RESISTOR 560k 5% .25W FC TC=-800/+900	01121		
A5R40	2100-2516		2	RESISTOR-TRMP 100k 10% C SIDE-ADJ 1-TURN	30983	ET50X104
A5R41	0698-2207			RESISTOR FXD 900 OHM 0.05% 1/8W MF	28480	0698-2207
A5R42	0698-2206	RESISTOR FXD 100 OHM 0.05% 1/8W MF		28480	0698-2206	
A5R43	0698-2207	RESISTOR FXD 900 OHM 0.05% 1/8W MF		28480	0698-2207	
A5R44	0698-2206	RESISTOR FXD 100 OHM 0.05% 1/8W MF		28480	0698-2206	
A5R45	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055	
A5R46	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055	
A5R47	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055	
A5R48	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055	
A5R49	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055	
A5R50	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055	
A5R51	0683-1025		RESISTOR 1k 5% .25W FC TC=-400/+600	01121	CB1025	
A5R52	0683-1035		RESISTOR 10k 5% .25W FC TC=-400/+700	01121	CB1035	
A5R53	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055	
A5R54	2100-2516		RESISTOR-TRMR 100k 10% C SIDE-ADJ 1-TURN	30983	ET50X104	
A5R55	0683-1025		RESISTOR 1k 5% .25W FC TC=-400/+600	01121	CB1025	
A5R56	0683-2235		RESISTOR 22k 5% .25W FC TC=-400/+800	01121	CB2235	
A5R57	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055	
A5R59	0683-1025		RESISTOR 1k 5% .25W FC TC=-400/+600	01121	CB1025	
A5R60	0683-2235		RESISTOR 22k 5% .25W FC TC=-400/+800	01121	CB2235	
A5R61	0683-1055	1	RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055	
A5R63	0683-1025		RESISTOR 1k 5% .25W FC TC=-400/+600	01121	CB1025	
A5R64	0683-1035		RESISTOR 10k 5% .25W FC TC=-400/+700	01121	CB1035	
A5R65	0683-1025		RESISTOR 1k 5% .25W FC TC=-400/+600	01121	CB1025	
A5R66	0683-3935		RESISTOR 39k 5% .25W FC TC=-400/+800	01121	CB3935	
A5R67	0683-4725	10	RESISTOR 4.7k 5% .25W FC TC=-400/+700	01121	CB4725	
A5R68	0683-1025		RESISTOR 1k 5% .25W FC TC=-400/+600	01121	CB1025	
A5R69	0683-2235		RESISTOR 22k 5% .25W FC TC=-400/+800	01121	CB2235	
A5R70	0683-1825		RESISTOR 1.8k 5% .25W FC TC=-400/+700	01121	CB1825	
A5R71	0683-1825		RESISTOR 1.8k 5% .25W FC TC=-400/+700	01121	CB1825	
A5R72	0683-2235		RESISTOR 22k 5% .25W FC TC=-400/+800	01121	CB2235	
A5R73	0683-1025		RESISTOR 1k 5% .25W FC TC=-400/+600	01121	CB1025	
A5R74	0683-1045		RESISTOR 100k 5% .25W FC TC=-400/+800	01121	CB1045	
A5R75	0683-1025		RESISTOR 1k 5% .25W FC TC=-400/+600	01121	CB1025	
A5R76	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055	
A5R77	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055	
A5R78	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015	
A5R79	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015	
A5R80	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015	
A5R81	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015	

See introduction to this section for ordering information

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

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
45932	0683 1015		RESISTOR 100 5% .25W FC TC=+400/+500	01121	C81015
45983	0683-1015		RESISTOR 100 5% .25W FC TC=+400/+500	01121	C81015
45984	0683-1045		RESISTOR 100K 5% .25W FC TC=+400/+500	01121	C81045
45985	2100-2516		RESISTOR-TAMP 100K 10% C SIDE-ADJ 1 TURN	30993	E150X19+
45986	0683-4725		RESISTOR 4.7K 5% .25W		
45991	1826-1465	2	IC OP AMP		LT 1056CH
45992	1826-0217	2	IC PAY 4558T OP AMP		
45993	1826-0319		IC LF356H OP AMP		LF356H
45994	1826-0217		IC PAY 4558T OP AMP		
45995	1826 0139		IC MC 1458 OP AMP	04713	MC1458P1
45996	1826-0139		IC MC 1458 OP AMP	04713	MC1458P1
45997	1320 0125	1	IC UA 711C COMPARTOR	07263	711HC
45998	1320-0321	2	IC UA 710C COMPARTOR	07263	710HC
45	04261-77006 04261-66906	1	PHASE DETECTOR/TIMING PARTS BOARD ASSEMBLY OPT. 010	23430	04261 77006
45C1	0160 1586		CFXND MY 0.1 UF 10% 100VDCW	23480	0160-1515
45C2	0160-0207	2	CFXND MY 0.01 UF 5% 200VDCW	23480	0160-0207
45C3	0160 1670		CAPACITOR-FXD 10000PF 0.05%	23430	0150 1570
45C4	0160-0127	2	CAPACITOR-FXD 1UF +20% 25WVDC CER	23480	0150-0127
45C5	0160-1052		CAPACITOR-FXD 220UF 6.3V	23480	0150 1032
45C6	0160-0127		CAPACITOR-FXD 1UF +20% 25WVDC CER	23480	0150-0127
45C7	0160-1052		CAPACITOR-FXD 220UF 6.3V	23480	0150 1052
45C8	0160-0040	2	CFXND MY 0.047 UF 5% 200VDCW	23480	0160-0040
45C9	0160-0040		CFXND MY 0.047 UF 5% 200VDCW	23480	0160-0040
45C10	0160 1537	1	CFXND MY 33UF 5%	23480	0160 1537
45C11	0160-1563		CFXND MY 47UF 5% (OPT. 010)		
45C12	0160-0207		CFXND MY 0.01 UF 5% 200VDCW	23480	0160-0207
45C13	0160 1693	1	CFXND MY 1 UF 10% 100VDCW	23430	0150 1693
45C14	0160-1674	2	CFXND MY 0.33 UF 10%	23480	0160-1674
45C15	0160 1554		CFXND MY 0.33 UF 5% 100VDCW	23480	0160 1554
45C16	0160-2055		CAPACITOR-FXD 0.1UF +80 20% 100WVDC CER		
45C17	0160-2055		CAPACITOR-FXD 0.1UF +80 20% 100WVDC CER		
45C18	0160-2055		CAPACITOR-FXD 0.1UF +20-20% 100WVDC CER		
45C19	0160-0197		CAPACITOR-FXD 2.2UF+10% 20VDC TA	56246	1530225X10000
45C20	0160-0197		CAPACITOR-FXD 2.2UF+10% 20VDC TA	56249	1530225X10000
46C21	0180-1051		CAPACITOR-FXD 100UF 16V	28480	0180-1051
46C22	0180-1051		CAPACITOR-FXD 100UF 16V	28480	0180-1051
46C23	0150-0075		CAPACITOR-FXD 0.0047UF 500V	28480	0150-0075
46C24	0160-0763		CAPACITOR-FXD 5pF		0160-0763
46C25	0160-2197		CAPACITOR-FXD 10pF 5% 300WVDC MICA		0160-2197
46C26	1502-3125	1	DIODE-ZNR 6.93V 2% 0.7 PD=4W TC=+.025%	04713	SZ 10935-132
46C27	1501-0040		DIODE-SWITCHING 30V 50MA 2NS 00-35	28480	1501-0040
46C28	1501-0040		DIODE-SWITCHING 30V 50MA 2NS 00-35	28480	1501-0040
46C29	1501-0040		DIODE-SWITCHING 30V 50MA 2NS 00-35	28480	1501-0040
46C30	1502-3074	1	DIODE-ZNR 4.32V 2% 0.7 PD=4W TC=+.025%	04713	SZ 10935-73
46C31	1502-3149		DIODE-ZNR 9.09V 5% 0.7 PD=4W TC=+.025%	04713	SZ 10935-170
46C32	1502-3149		DIODE-ZNR 9.09V 5% 0.7 PD=4W TC=+.025%	04713	SZ 10935-170
46C33	1501-0040		DIODE-SWITCHING 30V 50MA 2NS 00-35	28480	1501-0040
46C34	1501-0040		DIODE-SWITCHING 30V 50MA 2NS 00-35	28480	1501-0040
46C35	1502-3149		DIODE-ZNR 9.09V 5% 0.7 PD=4W TC=+.025%	04713	SZ 10935-170
46C36	1502-3149		DIODE-ZNR 9.09V 5% 0.7 PD=4W TC=+.025%	04713	SZ 10935-170
46C37	1501-0040		DIODE-SWITCHING 30V 50MA 2NS 00-35	28480	1501-0040
46C38	1501-0040		DIODE-SWITCHING 30V 50MA 2NS 00-35	28480	1501-0040
46C39	1501-0040		DIODE-SWITCHING 30V 50MA 2NS 00-35	28480	1501-0040
46C40	1502-3149		DIODE-ZNR 9.09V 5% 0.7 PD=4W TC=+.025%	04713	SZ 10935-170
46C41	1502-0049		DIODE-ZNR 6.19V 5% 0.7 PD=4W TC=+.025%	04713	SZ 10935-122
46C42	1502-0059	1	DIODE-ZNR 3.83V 5% 0.7 PD=4W TC=+.025%	04713	SZ 10935-67
46C43	1501-0040		DIODE-SWITCHING 30V 50MA 2NS 00-35	28480	1501-0040
46C44	1501-0040		DIODE-SWITCHING 30V 50MA 2NS 00-35	28480	1501-0040
46C45	1501-0040		DIODE-SWITCHING 30V 50MA 2NS 00-35	28480	1501-0040
46C46	1501-0040		DIODE-SWITCHING 30V 50MA 2NS 00-35	28480	1501-0040
46C47	1501-0040		DIODE-SWITCHING 30V 50MA 2NS 00-35	28480	1501-0040
46C48	1501-0040		DIODE-SWITCHING 30V 50MA 2NS 00-35	28480	1501-0040
46C49	1501-0040		DIODE-SWITCHING 30V 50MA 2NS 00-35	28480	1501-0040
46C50	1502-0049		DIODE-ZNR 6.19V 5% 0.7 PD=4W TC=+.025%	04713	SZ 10935-122
46C1	1854 0071		TRANSISTOR NPN SI PD=300MW FT=20MHZ	23480	1854-0071
46C2	1854-0023		TRANSISTOR NPN SI PD=300MW	23480	1854-0071
46C3	1853-0034		TRANSISTOR PNP SI PD=300MW FT=150MHZ	23480	1853-0034
46C4	1853-0034		TRANSISTOR PNP SI PD=300MW FT=150MHZ	23480	1853-0034
46C5	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	23480	1853-0020
46C6	1855-0081		TRANSISTOR J-FET N-CHAN D-MODE SI	23480	1855-0071
46C7	1855-0081		TRANSISTOR J-FET N-CHAN D-MODE SI	23480	1854-0023
46C8	5080-3830		TRANSISTOR J-FET N-CHAN D-MODE SI		
46C9	5080-3830		TRANSISTOR J-FET N-CHAN D-MODE SI		
46C10	5080-3830		TRANSISTOR J-FET N-CHAN D-MODE SI		
46C11	1855-0081	1	TRANSISTOR J-FET N-CHAN	23430	1855-0081
46C12	1855-0570	3	TRANSISTOR J-FET		251523-L14M2
46C13	1855-0062		TRANSISTOR J-FET N-CHAN D-MODE SI	23430	1855-0062
46C14	1855-0062		TRANSISTOR J-FET N-CHAN D-MODE SI	23480	1855-0062
46C15	1855-0570		TRANSISTOR J-FET		251523-L14M2
46C16	1850-0570		TRANSISTOR J-FET		251523-L14M2
46C17	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	23480	1853-0020
46C18	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	23480	1853-0020
46C19	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	23480	1854-0071
46C20	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	23480	1853-0020

See introduction to this section for ordering information

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

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A3Q21	1853-0020		TRANSISTOR PNP SI PN=300MW FT=150MHZ	28480	1953 0020
A3Q22	5080-3830		TRANSISTOR J-FET N-CHAN D-MODE SI		
A3Q23	5080-3830		TRANSISTOR J-FET N-CHAN D-MODE SI		
A3Q24	1855 0049	1	TRANSISTOR J-FET DUAL N-CHAN D-MODE SI	28480	1855-0049
A3Q25	1855-0062		TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0062
A3R1	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A3R2	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A3R3	0698-3226	3	RESISTOR 6.49K 1% .125W F TC=0+ 100	16299	C4-1/8-TU-6491-F
A3R4	0698-3226		RESISTOR 6.49K 1% .125W F TC=0+ 100	16299	C4-1/8-TU-6491-F
A3R5	0683-4745	1	RESISTOR 470K 5% .25W	01121	
A3R6	0698-3161	1	RESISTOR 38.2K 1% .125W F TC=0+ 100	16299	C4-1/8-TU-3832-F
A3R7	0757-0416		RESISTOR 511 1% .125W F TC=0+ 100	24546	C4-1/8-TU-5111-F
A3R8	0757-0416		RESISTOR 511 1% .125W F TC=0+ 100	24546	C4-1/8-TU-5111-F
A3R9	0757-0435	1	RESISTOR 3.92K 1% .125W	16299	
A3R10	0698-3226		RESISTOR 6.49K 1% .125W F TC=0+ 100	16299	C4-1/8-TU-6491-F
A3R11	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A3R12	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A3R13	0683-1225		RESISTOR 1.2K 5% .25W		
A3R14	0683-3925	2	RESISTOR 3.9K 5% .25W FC TC=-400/+700	01121	CB3925
A3R15	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A3R16	0683-1225		RESISTOR 1.2K 5% .25W		
A3R17	0683-3925		RESISTOR 3.9K 5% .25W FC TC=-400/+700	01121	CB3925
A3R18	0683-2225		RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A3R19	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A3R20	0698-3439	1	RESISTOR 178 1% .125W F TC=0+ 100	16299	C4-1/8-TU-1781-F
A3R21	0698-4157	2	RESISTOR 10K .1% .125W F TC=0+50	24546	NC55
A3R22	0698-4157		RESISTOR 10K .1% .125W F TC=0+50	24546	NC55
A3R23	0698-6943	2	RESISTOR 20K .1% .125W F TC=0+50	24546	NC55
A3R24	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A3R25	0698-6943		RESISTOR 20K .1% .125W F TC=0+50	24546	NC55
A3R26	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A3R27	0683-5655	1	RESISTOR 5.6K 5% .25W FC TC=-900/+1100	01121	CB5655
A3R28	0683-1045		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A3R29	0698-3157	2	RESISTOR 19.6K 1% .125W F TC=0+100	16299	C4-1/8-TU-1962-F
A3R30	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A3R31	0757-0465		RESISTOR 100K 1% .125W F TC=0+100	24546	C4-1/8-TU-1003-F
A3R32	0683-4735	5	RESISTOR 47K 5% .25W FC TC=-400/+800	01121	CB4735
A3R33	0698-3157		RESISTOR 19.6K 1% .125W F TC=0+100	16299	C4-1/8-TU-1962-F
A3R34	0683-1535		RESISTOR 15K 5% .25W FC TC=-400/+800	01121	CB1535
A3R35	0757-0465		RESISTOR 100K 1% .125W F TC=0+100	24546	C4-1/8-TU-1003-F
A3R36	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A3R37	0683-4735		RESISTOR 47K 5% .25W FC TC=-400/+800	01121	CB4735
A3R38	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A3R39	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A3R40	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A3R41	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A3R42	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A3R43	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A3R44	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A3R45	0683-1245	1	RESISTOR 120K 5% .25W FC TC=-800/+900	01121	CB1245
A3R46	0683-4735		RESISTOR 47K 5% .25W FC TC=-400/+800	01121	CB4735
A3R47	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A3R48	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A3R49	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A3R50	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A3R51	0683 1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A3R52	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A3R53	0757-0290	1	RESISTOR 6.19K 1% .125W		
A3R54	0757-0349	1	RESISTOR 22.6K 1% .25W		
A3R55	0683-4735		RESISTOR 47K 5% .25W FC TC=-400/+800	01121	CB4735
A3R56	0683-4735		RESISTOR 47K 5% .25W FC TC=-400/+800	01121	CB4735
A3R57	0683-3325	2	RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A3R58	0757-1094	1	RESISTOR 1.47K 1% .125W F TC=0+ 100	24546	C4-1/8-TU-1471-F
A3R59	0698-3155		RESISTOR 4.64K 1% .125W F TC=0+100	16299	C4-1/8-TU-4641-F
A3R60	0683-3325		RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A3R61	0757-0465		RESISTOR 100K 1% .125W F TC=0+100	24546	C4-1/8-TU-1003-F
A3R62	0698-4433	1	RESISTOR 2.26K 1% .125W F TC=0+100	16299	C4-1/8-TU-2261-F
A3R63	0757-0401	2	RESISTOR 100 1% .125W F TC=0+ 100	24546	C4-1/8-TU-101-F
A3R64	0757-0401		RESISTOR 100 1% .125W F TC=0+ 100	24546	C4-1/8-TU-101-F
A3R65	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A3R66	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A3R67	2100-2522	2	RESISTOR-TMR 10K 10% C SIDE-ADJ 1-TURN	30983	ET50X103
A3R68	2100-2522		RESISTOR-TMR 10K 10% C SIDE-ADJ 1-TURN	30983	ET50X103
A3R69	0683-2265		RESISTOR 22M 5% .25W		

See introduction to this section for ordering information

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

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A5U1	1820-0630	1	IC MC 4044P DIGITAL	04713	MC4044P
A6U2	1826-0180	1	TIMER, NE555V	28480	1826-0180
A5U3	1820-0099	1	IC SN7493N	01295	SN7493N
A6U4	1820-0054	2	IC SN74 00 N GATE	01295	SN7400N
A6U5	1820-0075	1	IC SN74 73 N FLIP-FLOP	01295	SN7473N
A5U6	1820-0379	1	IC TTL 4-N AND/OR GATE	01295	SN74H52J
A6U7	1820-0054		IC SN74 00 N GATE	01295	SN7400N
A6U8	1826-0139		IC MC 1458 CP AMP	04713	MC1458P1
A6U9	1826-0139		IC MC 1456 CP AMP	04713	MC1456P1
A5U10	1826-0139		IC MC 1458 CP AMP	04713	MC1458P1
A6J11	1826-0271	5	IC UA 741C CP AMP	27014	LM741CN
A6U12	1826-0271		IC UA 741C CP AMP	27014	LM741CN
A6J13	1820-0321		IC UA 710C COMPARTOR	07263	710HC
A7	04261-77007	1	CLOCK PULSE GENERATOR/COUNTER BOARD ASSY	28480	04261-77007
A7C1	0160-2261	1	CAPACITOR-FXD 15PF + 3% 500VDC CER	28480	0160-2261
A7C2	0160-2055		CAPACITOR-FXD .01UF +80 20% 100VDC CER	28480	0160-2055
A7C3	0160-2055		CAPACITOR-FXD .01UF +80 20% 100VDC CER	28480	0160-2055
A7C4	0160-2055		CAPACITOR-FXD .01UF +80 20% 100VDC CER	28480	0160-2055
A7C5	0160-2055		CAPACITOR-FXD .01UF +80 20% 100VDC CER	28480	0160-2055
A7C6	0180-0374		CAPACITOR-FXD 10UF+ 10% 20VDC TA	56289	150E106K020H2
A7R1	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CR4725
A7R2	0683-4725		RESISTOR 4.7K 5% .25W FC TC= 400/+700	01121	CR4725
A7R3	0683-4725		RESISTOR 4.7K 5% .25W FC TC= 400/+700	01121	CR4725
A7R4	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CR4725
A7R5	0683-4725		RESISTOR 4.7K 5% .25W FC TC= 400/+700	01121	CR4725
A7R6	0683-4725		RESISTOR 4.7K 5% .25W FC TC= 400/+700	01121	CR4725
A7U1	1820-0567	1	IC MC 4024P MV	04713	MC4024P
A7U2	1820-1490	4	IC SN74LS 90 N COUNTER	01295	SN74LS90J
A7U3	1820-1490		IC SN74LS 90 N COUNTER	01295	SN74LS90J
A7U4	1820-1490		IC SN74LS 90 N COUNTER	01295	SN74LS90J
A7U5	1820-1112	5	IC SN74LS 74 N FLIP-FLOP	01295	SN74LS74J
A7U6	1820-1490		IC SN74LS 90 N COUNTER	01295	SN74LS90J
A7U7	1820-1478	2	IC SN74LS 93 N COUNTER	01295	SN74LS93J
A7U8	1820-1478		IC SN74LS 93 N COUNTER	01295	SN74LS93J
A7U9	1820-1197		IC SN74LS 00 N GATE	01295	SN74LS00J
A7J10	1820-1217	7	IC SN74LS151 N MUXR	01295	SN74LS151H
A7U11	1820-1244	2	IC SN74LS153 N DATA SEL	01295	SN74LS153H
A7U12	1820-1244		IC SN74LS153 N DATA SEL	01295	SN74LS153J
A7U13	1820-1217		IC SN74LS151 N MUXR	01295	SN74LS151H
A7U14	1820-1112		IC SN74LS 74 N FLIP-FLOP	01295	SN74LS74J
A7U15	1820-1197		IC SN74LS 00 N GATE	01295	SN74LS00J
A7U16	1820-1112		IC SN74LS 74 N FLIP-FLOP	01295	SN74LS74J
A7U17	1820-1197		IC SN74LS 00 N GATE	01295	SN74LS00J
A7U18	1820-1217		IC SN74LS151 N MUXR	01295	SN74LS151H
A7U19	1820-1217		IC SN74LS151 N MUXR	01295	SN74LS151H
A7U20	1820-1204	1	IC SN74LS 20 N GATE	01295	SN74LS20J
A7U21	1820-1440	1	IC SN74LS279 N LATCH	01295	SN74LS279H
A7W1	8150-3490		JUNPER WIRE 3cm		
A7Y1	0410-0209	1	CRYSTAL-QUARTZ: 2 5465MHZ	28430	0410-0209
A9	04261-77108	1	SEQUENTIAL CONTROL BOARD ASSEMBLY	28480	04261-77108
A3C1	0160-2055		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A3C2	0160-2055		CAPACITOR-FXD .01UF +80 20% 100VDC CER	28480	0160-2055
A3C3	0180-0291	1	CAPACITOR-FXD 1UF+ 10% 35VDC TA	56289	150E106K035H2
A3C4	0180-0374		CAPACITOR-FXD 10UF+ 10% 20VDC TA	56289	150E106K020H2
A3C5	0160-2055		CAPACITOR-FXD .01UF +80 20% 100VDC CER	28480	0160-2055
A3C6	0180-0374		CAPACITOR-FXD 10UF+ 10% 20VDC TA	56289	150E106K020H2
A3CR1	1910-0016		DIODE-GE 60V 50MA 1U5 DO-7	28480	1910-0016
A3CR2	1910-0016		DIODE-GE 60V 60MA 1U5 DO-7	28480	1910-0016
A3CR5	1901-0025	1	DIODE-GEN PHP 100V 200MA DO-7	28480	1901-0025
A3J1	1200-0853		SOCKET-IC 16-CUNT DIP-SLDR-TERMS		
A3Q1	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A3Q2	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071

See introduction to this section for ordering information

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

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A3R1	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CR4725
A3R2	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CR4725
A3R3	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CR4725
A3R4	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CR4725
A3R5	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CR4725
A3R6	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CR4725
A3R7	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CR4725
A3R8	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CR4725
A3R9	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CR4725
A3R10	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CR4725
A3R11	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CR4725
A3R12	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CR4725
A3R13	0683-1045		RESISTOR 100K 5% .25W FC TC=-400/+900	01121	CR1005
A3R14	0683-3315	1	RESISTOR 100 5% .25W FC TC=-400/+900	01121	CR1005
A3R15	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CR4725
A3R16	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CR1035
A3R17	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CR1035
A3R18	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CR4725
A3R19	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CR4725
A3R20	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CR4725
A3R21	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CR4725
A3R22	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CR4725
A3R23	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CR4725
A3R24	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CR4725
A3R25	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CR4725
A3R26	0698-4431		RESISTOR 2.05K 1%		
A3R27	0757-0442		RESISTOR 10K 1% .125W		
A851	3101-1313		SWITCH-SL SPDT-NS SUBMIN 2A 120VAC PC		
A8U1	1820-1217		IC SN74LS151 N MUX	01295	SN74LS151N
A8U2	1820-1493	2	IC MM74C163N COUNTER	27014	MM74C163N
A8U3	1820-1199		IC SN74LS04 N INV	01295	SN74LS04N
A8U4	1820-1202	4	IC SN74LS10 N GATE	01295	SN74LS10N
A8U5	1820-1729	2	IC LATCH		74LS259
A8U6	1820-1217		IC SN74LS151 N MUX	01295	SN74LS151N
A8U7	1820-1493		IC MM74C163N COUNTER	27014	MM74C163N
A8U8	1818-2272	1	IC, R.O.M	28480	1818-2272
A8U10	1820-1729		IC LATCH		74LS259
A3U11	1820-0471		IC SN74LS06 N INV	01295	SN74LS06N
A3U12	1820-1217		IC SN74LS151 N MUX	01295	SN74LS151N
A3U13	1820-1112		IC SN74LS74 J FLIP FLOP	01295	SN74LS74J
A3U14	1820-1197		IC SN74LS00 N GATE	01295	SN74LS00J
A3U15	1820-1470	3	IC SN74LS157 N GATE SCL	01295	SN74LS157N
A3U16	1820-1174	1	IC SN74LS193N COUNTER	01295	SN74LS193N
A3U17	1820-1245	1	IC SN74LS155 N DECODER	01295	SN74LS155N
A3U18	1820-1469	1	IC SN74LS107 J FLIP-FLOP	01295	SN74LS107N
A3U19	1820-1197		IC SN74LS00 N GATE	01295	SN74LS00J
A9	04261-77009	1	POWER SUPPLY BOARD ASSEMBLY	28480	04261-77009
A9C1	0180-1057	3	CAPACITOR-FXC 2200 UF 16VDCW AL ELECT	28480	0180-1057
A9C2	0180-1057		CAPACITOR-FXC 2200 UF 16VDCW AL ELECT	28480	0180-1057
A9C3	0180-1057		CAPACITOR-FXC 2200 UF 16VDCW AL ELECT	28480	0180-1057
A9C4	0180-1056		CAPACITOR-FXC 1000 UF 25VDC AL FL-CT	28480	0180-1056
A9C5	0180-1056		CAPACITOR-FXC 1000 UF 25VDC AL ELECT	28480	0180-1056
A9C6	0140-0200	1	CAPACITOR-FXD 330PF +/-5% 300WVDC MICA	72156	0140-0200
A9C7	0180-0814	3	CAPACITOR-FXC 1000UF +/-100-10% 16VDCW AL	28480	0180-0814
A9C8	0160-0814		CAPACITOR-FXC 1000UF +/-100-10% 16VDCW AL	28480	0160-0814
A9C9	0160-0814		CAPACITOR-FXC 1000UF +/-100-10% 16VDCW AL	28480	0160-0814
A9CR1	1501-0237	2	DIODE-S1, RECTIFIER BRIDGE, 200V	28480	1501-0237
A9CR2	1501-0237		DIODE-S1, RECTIFIER BRIDGE, 200V	28480	1501-0237
A9Q1	1854-0039	1	TRANSISTOR NPN 20305 SI TO-18 PD=1W	04713	1854-0039
A9Q2	5080-3078		TRANSISTOR NPN SI PD=200MW FT=200MHZ	28480	5080-3078
A9Q3	5080-3078		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	5080-3078
A9Q4	5080-3078		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	5080-3078
A9R1	0811-2771	1	RESISTOR 18 5% 1W PW TC=0+-90	75042	8W2 36/100-J
A9R2	0811-1746	2	RESISTOR 336 5% 2W PW TC=0+-300	75042	CB100F
A9R3	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CR1005
A9R4	0811-1746		RESISTOR 336 5% 2W PW TC=0+-800	75042	8W2 35/100-J
A9R5	0757-0438	1	RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4 1/8-T0-5111 F
A9R6	2100-2521	1	RESISTOR TRMR 2K 10% C SIDE ADJ 1-TURN	30983	FT50X202
A9R7	0757-0440		RESISTOR 7.5K 1% .125W F TC=0+-100	24546	C4 1/8-T0-7501 F
A9R8	0757-0289	1	RESISTOR 12.5K 1% .125W F TC=0+-100	19701	MF401/2-T0-1252 F
A9R9	0658-4020	1	RESISTOR 9.53K 1% .125W F TC=0+-100	16259	C4-1/8-T0-9531 F
A9R10	0757-0442	1	RESISTOR 10K 1% .125W F TC=0+-100	24546	14-1/8-T0-1002-F

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

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A9R11 A9R12 A9R13 A9R14 A9R15	0757-0442 0698-3155 0698-3155 0698-3431 0757-0420	1 1	RESISTOR 10K 1% .125W F TC=0+/-100 RESISTOR 4.64K 1% .125W F TC=0+/-100 RESISTOR 4.64K 1% .125W F TC=0+/-100 RESISTOR 23.7 1% .125W F TC=0+/-100 RESISTOR 750 1% .125W F TC=0+/-100	24546 16299 15299 038F8 24546	C4-1/8-TU-1002-F C4-1/8-TU-4641-F C4-1/8-TU-4641-F PME55-1/P-TU 23P7-F C4-1/8-TU-751-F
A9R16 A9R17 A9R18 A9R19 A9U1 A9U2 A9U3 A9U4	0698-3427 0757-0317 0757-0159 0683-7525 1826-0271 5080-3834 1826-0271 1826-0271	1 1	RESISTOR 13.3 1% .125W F TC=0+/-100 RESISTOR 1.33K 1% .125W F TC=0+/-100 RESISTOR 1K 1% .5W RESISTOR 7.5K 5% .25W IC UA 7+1C OP AMP IC UA 723C V RGLTR IC UA 741C OP AMP IC UA 741C OP AMP	039AB 24546 27014 07263 27014 27014	PME55-1/P-TU 13R3-F C4-1/8-TU-1231-F LM741CN 723HC LM741CN LM741CN
A10	04261-77010 04261-87010	1 1	MOTHER BOARD ASSEMBLY BOARD: BLANK	28480 28480	04261-77010 04261-87010
A10J1	1200-0853	7	SOCKET-IC 16-CONT DIP-SLDR-TERMS		
A10R1 A10R2	1810-0164 1810-0164		NETWORK-RES 9-PIN-SIP .15-PIN-SPCG NETWORK-RES 9-PIN-SIP .15-PIN-SPCG	28480 28480	1810-0164 1810-0164
A10U1 A10U2	1820-1470 1820-1470		IC SN74LS157 N DATA SEL IC SN74LS157 N DATA SEL	01295 01295	SN74LS157N SN74LS157N
			A10 MISCELLANEOUS		
	0360-1653 1251-2035 1251-0194	4 15 1	TERMINAL-STUD SGL-PIN PRESS-MTG CONNECTOR-PC EDGE 15-ONT/ROM 2-ROWS CONNECTOR-PC EDGE (PART OF 04261-72010) CABLE ASSEMBLIES	28480 71785	0360-1653 252-15-30-300
	04261-72003 04261-72004 04261-72005 04261-72006 04261-72007 04261-72010 04261-72008 04261-72023	7 1 1 1 1 1 1 1	CABLE ASSEMBLY (LCUP-A10) CABLE ASSEMBLY (LPOTEN-A10) CABLE ASSEMBLY (HCUP-A10) CABLE ASSEMBLY (HPOTEN-A10) CABLE ASSEMBLY (COFFSET-A10) CABLE ASSEMBLY (A9-PEAP PANEL) CABLE ASSEMBLY (LINE MODULE-POWER SWITCH) CABLE ASSEMBLY (OPTION 003)	28480 28480 28480 28480 28480 28480 28480 28480	04261-72003 04261-72004 04261-72005 04261-72006 04261-72007 04261-72008 04261-72023
A11 thru A20			NOT ASSIGNED		
A21	04261-77021	1	PARALLEL DATA OUTPUT BOARD ASSEMBLY (OPT ION 001)	28480	04261-77021
A21C1 A21C2 A21C3 A21C4	0160-0374 0160-2055 0160-2055 0160-2055		CAPACITOR-FXD 10UF+/-10% 20VDC TA CAPACITOR-FXD .01UF +80=20% 100VDC CER CAPACITOR-FXD .01UF +80=20% 100VDC CER CAPACITOR-FXD .01UF +80=20% 100VDC CER	56289 28480 28480 28480	150D106X902002 0160 2055 0160 2055 0160 2055
A21CR1 A21CR2	1902-0041 1902-0041		DIODE-ZNP 5.11V 5% D0-7 PD=.4W TC=-.009K DIODE-ZNP 5.11V 5% D0-7 PD=.4W TC=-.009K	04712 04713	SZ 10939 98 SZ 10939 98
A21J1 A21J2	0360-1706 0360-1706	3	RIBBON CABLE 50 TERM INSUL DSPL TYPE RIBBON CABLE 50-TERM INSUL DSPL TYPE	76581 76581	3426-0000 3426-0000
A21R1 A21R2 A21R3 A21R4 A21R5	0683-4725 0683-1825 0683-1825 0683-1825 0683-1825		RESISTOR 4.7K 5% .25W FC TC=-400/+700 RESISTOR 1K 5% .25W FC TC=-400/+600 RESISTOR 1.8K 5% .25W FC TC=-400/+700 RESISTOR 1.8K 5% .25W FC TC=-400/+700 RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121 01121 01121 01121 01121	C04725 C01925 C01825 C01825 C01925

See introduction to this section for ordering information

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

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A21R6	0683-1825	6	RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A21R7	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A21R8	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A21R9	0683-2725		RESISTOR 2.7K 5% .25W FC TC=400/+700	01121	CB2725
A21R10	0683-2725		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A21R11	0683-2725		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A21R12	0683-2725	RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725	
A21R13	0683-1025	RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025	
A21R14	0683-1025	RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025	
A21R15	0683-1025	RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025	
A21R16	0683-1025	RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025	
A21R17	0683-1025	RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025	
A21R18	0683-1025	RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025	
A21U1	1820-0305	1	IC:TTL 4-BIT BINARY FULL ADDER	01295	SN7483N
A21U2	1820-0668	2	IC SN74 07 N BUFFER	01295	SN7407N
A21U3	1820-0282	2	IC SN74 86 N GATE	01295	SN7486N
A21U4	1820-0174	2	IC SN74 04 N INV	01295	SN7404N
A21U5	1820-1197	2	IC SN74LS 00 N GATE	01295	SN74LS00N
A21U6	1820-1199	8	IC SN74LS 04 N INV	01295	SN74LS04N
A21U7	1820-1202		IC SN74LS 10 N GATE	01295	SN74LS10N
A21U8	1820-0294		IC DM 85		
A21U9	1820-0294		IC DM 85		
A21U10	1820-0294	IC DM 85			
A21U11	1820-0294	IC DM 85			
A21W1	04261-72009	3	CABLE ASSEMBLY	28480	04261-72009
A21W2	04261-72009		CABLE ASSEMBLY	28480	04261-72009
A22	04261-77022	1	PAPAMETER SERIAL PARALLEL BCD DATA OUTPUT BOARD ASSEMBLY (OPTION 002)	28480	04261-77022
A22C1	0180-0374		CAPACITOR-FXD 10UF +-10% 20VDC TA	56289	1500106X9020B2
A22C2	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A22C3	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A22C4	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A22C5	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A22C6	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A22CR1	1502-0041		DIODE-ZNR 5.11V 5% DO-7 PD=.4W TC= .009%	04713	SZ 10939 98
A22J1	0360-1706		RIBBON CABLE 50-TERM INSUL DSPL TYPE	76381	3426-000J
A22R1	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A22R2	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A22R3	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A22R4	0683-1825		RESISTOR 1.8K 5% .25W FC TC=400/+700	01121	CB1825
A22R5	0683-1825		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A22R6	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A22R7	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A22R8	0683-2725		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A22R9	0683-2725		RESISTOR 2.7K 5% .25W FC TC=400/+700	01121	CB2725
A22R10	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A22R11	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A22R12	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A22R13	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A22R14	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A22R15	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A22R16	0683-4725	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725	
A22R17	0683-4725	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725	
A22R18	0683-4725	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725	
A22R19	0683-4725	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725	
A22R20	0683-4725	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725	
A22R21	0683-4725	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725	
A22S1	3101-1313	1	SWITCH-SL DP3T-NS MINTR .5A 125VAC/DC PC	79727	G1285-0004
A22U1	1820-0910	1	IC SN74LS 83 N ADDER	01295	SN74LS83N
A22U2	1820-0511	1	IC SN74 08 N GATE	01295	SN7408N
A22U3	1820-0668		IC SN74 07 N BUFFER	01295	SN7407N
A22U4	1820-0282		IC SN74 86 N GATE	01295	SN7486N
A22U5	1820-0174		IC SN74 04 N INV	01295	SN7404N
A22U6	1820-1197	4	IC SN74LS 00 N GATE	01295	SN74LS00N
A22U7	1820-1199		IC SN74LS 04 N INV	01295	SN74LS04N
A22U8	1820-1202		IC SN74LS 10 N GATE	01295	SN74LS10N
A22U9	1820-0762		IC SN74 157 N MUXR	01295	SN74157N
A22U10	1820-0762		IC SN74 157 N MUXR	01295	SN74157N

See introduction to this section for ordering information

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

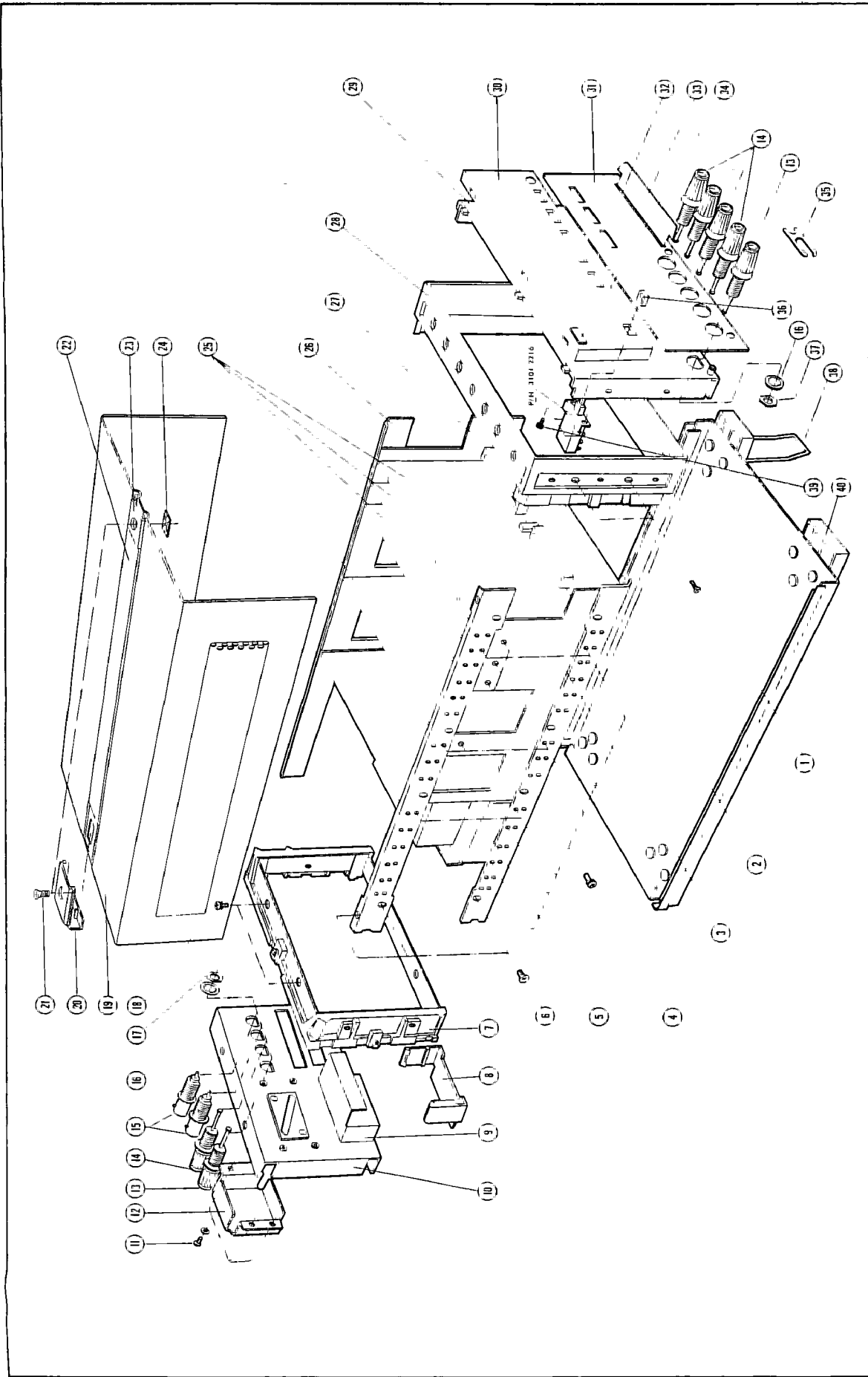
Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
422011	1820-0762		IC SN74 157 N MUXR	01295	SN74LS157N
422012	1820-0762		IC SN74 157 N MUXR	01295	SN74LS157N
422013	1820-1433		IC SN74LS164 N PGTR	01295	SN74LS164N
422014	1820-1433		IC SN74LS164 N PGTR	01295	SN74LS164N
422015	1820-1433		IC SN74LS164 N PGTR	01295	SN74LS164N
422016	1820-1433		IC SN74LS164 N PGTR	01295	SN74LS164N
422017	1820-1112		IC SN74LS 74 N FLIP FLOP	01295	SN74LS74N
422018	1820-1202		IC SN74LS 10 N GATE	01295	SN74LS10N
422019	1820-1212		IC SN74LS112 N FLIP-FLIP	01295	SN74LS112N
422020	1820-1144		IC SN74LS 02 N GATE	01295	SN74LS02N
42201	04261-72009		CABLE ASSEMBLY	28480	04261-72009
C1	0160-4259	4	CAPACITOR 0.22UF 10%	04713	SF7090-2
	2190-0205	4	WASHER (FOR TRANSISTOR RETAINING SCREWS)	04713	SK2090-2
	3050-0010	6	WASHER-FLAT	04713	IN39976
C2	0160-1586		CAPACITOR-FXD NY 0.1UF 10% 100VDCW	28480	
C3	0160-1586		CAPACITOR-FXD NY 0.1UF 10% 100VDCW	28480	
CP4	1901-0033		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
CP5	1901-0033		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
CP6	1901-0033		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
CP7	1901-0033		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
F1	2110-0201	1	FUSE .25A 250V SLO-BLO 1.25X .25 UL IEC	75915	313-2505
	2110-0202	1	FUSE .5A 250V SLO-BLO 1.25X .25 UL IEC	75915	313-5005
P1	0698-1025		RESISTOR 11 5% .25W FC TC=-400/+600	01121	CB1025
P2	0698-3391		RESISTOR 21 5% 0HM 1% 1/2W		
P3	0698-3391		RESISTOR 21 5% 0HM 1% 1/2W		
W1	8120-1378	1	CABLE ASSY 3-COND 18-AWG (POWER)	28480	8120-1378
	6960-0016	1	PLUG-HOLE TR-HD .125-DIA NYL (INST CARD STOPPER)	02768	207-080501-01-0101
	7120-0321	1	NAMEPLATE CAUTION (JAPANESE)	28480	7120-0321
	2360-0117	6	SCREW-MACH 6-32 .375-IN-LG PAN-HD-POZI FOR RETAINING A10	28480	2360-0117
	2360-0201	2	SCREW MACH 6-32 .375-IN-LG PAN-HD-POZI FOR RETAINING A10	28480	2360-0201
	1251-0048	1	CONNECTOR-AC PWR 5-15 FEM ADPTR	80126	C-0602-000-BLACK
	2950-0072	1	NUT-HEX-DBL-CHAM 1/4-32-THD .062-THK (FOR MANUAL SWITCH)	82389	P-1975
J10, J11	5060-4020	2	CONNECTOR ASSEMBLY, 50-CONTACT (OPT. 001/002)	28480	5060-4020
	7120-3185	1	LABEL, INFO CAUTION (ENGLISH)	28480	7120-3185
	5001-0439	2	TRIM SIDE	28480	5001-0439
	5040-7203	1	TRIM STRIP	28480	5040-7203
	0590-0025	2	NUT-HEX-PLSTCLNG 6-32-THD .172-THK (FOR YA9L)	72962	6SNA 97MM62
J12	04261-77123	1	CONNECTOR BOARD ASSEMBLY (OPTION 003)	28480	04261-77123
	04261-85021	1	FILM (1) ANNUNCIATOR	28480	04261-85021
	04261-40023	1	LAMP HOUSE (CIRCUIT MODE)		
	04261-40024	1	LAMP HOUSE (UNIT)		
	04261-85022	1	FILM (2) CRT MODE	28480	04261-85022
	04261-85023	1	NAMEPLATE (OPTION 002)	28480	04261-85023
	7120-5088	1	LABEL, INFO (POWER RATING)	28480	7120-5088
OPTION 010					
A4	04261-66904		OSCILLATOR/RANGE RESISTOR BOARD ASSEMBLY		
A4R2	0698-4482		RESISTOR 17 4% 0HM 1% .125W		
A4R4	0698-3136		RESISTOR 17 8% 0HM 1% .125W		
A4R5	0757-0470		RESISTOR 162% 0HM 1% .125W		
A4R6	0757-0470		RESISTOR 162% 0HM 1% .125W		
A6	04261-66906		PHASE DETECTOR/INTEGRATOR BOARD ASSEMBLY		
A6C10	0160-1563		CAPACITOR-FXD 47UF 5%		
A6CR5	1902-3083		DIODE-ZNR 4 64V 2%		

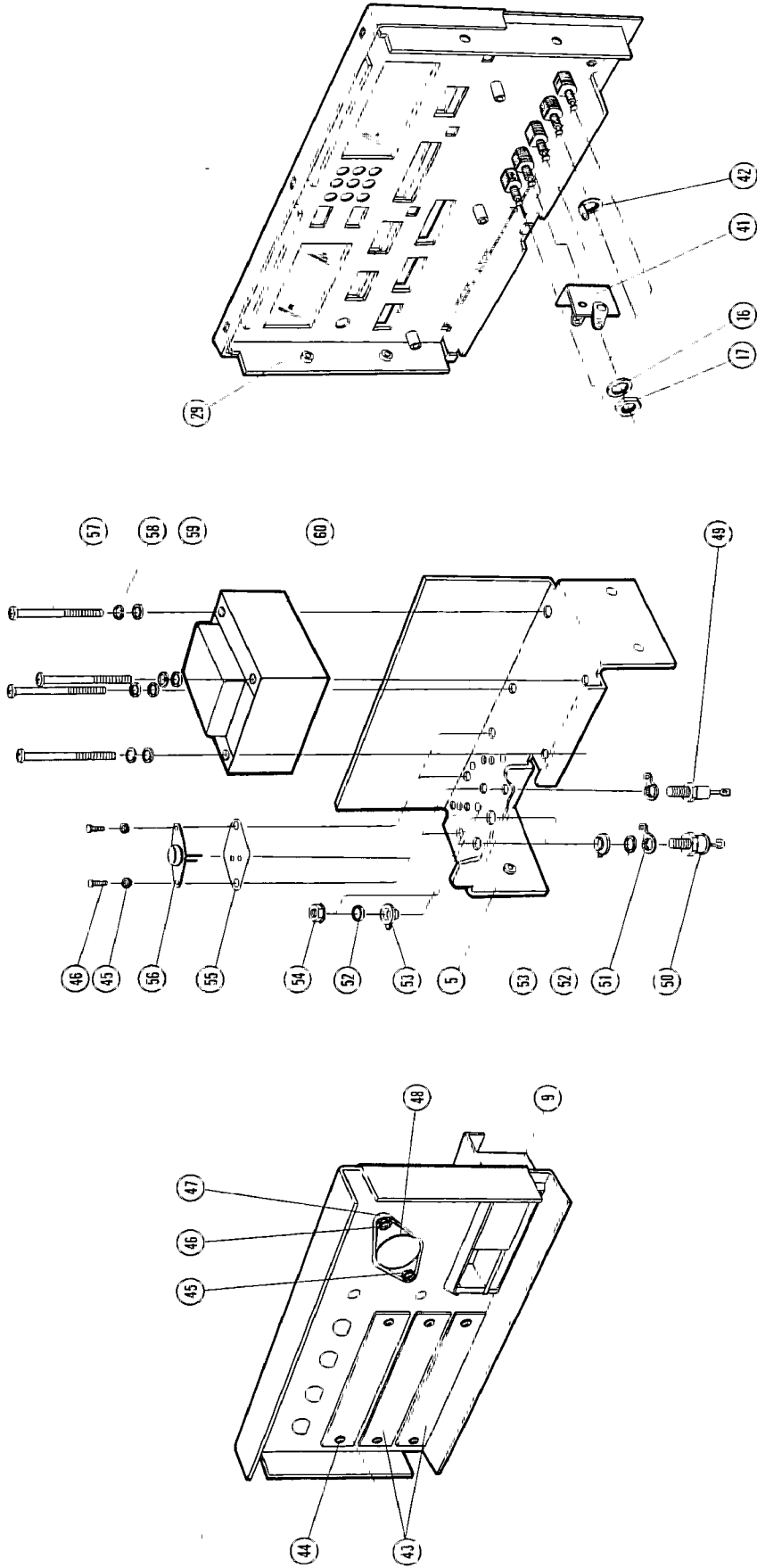
See introduction to this section for ordering information

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

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
1	0515-0889	6	SCREW-MACH M3 5	28480	
2	5061-9564	1	COVER, BOTTOM	28480	
3	04261-10024	1	DECK, LEFT	28480	04261-10024
4	2360-0115	22	SCREW-MACH 6-32 3/8-IN-LG PAN-HD-POZI	28480	2360-0115
5	04261-10026	1	HEAT SINK	28480	04261-10026
6	0515-1668	16	SCREW-MACH 1		
7	5021-5816	1	FRAME, REAR	28480	
8	5040-3318	1	COVER, L MODULE	28480	5040-3318
9	0960-0443	1	LINE MODULE	28480	0960-0443
10	04261-10001	1	PANEL, REAR	28480	04261-10001
11	2200-0141	4	SCREW-MACH 4-40 3/8-IN-LG PAN-HD-POZI	28480	2200-0141
12	04261-10030	4	TRANSISTOR COVER	28480	04261-10030
13(J1, J6)	1510-0107	2	BINDING POST-SGL 3/8-32 J6P/CBF SGL TU	28480	1510-0107
14(J2, J5, J7)	1510-0090	5	BINDING POST-SGL 3/8-32 J6P SGL TU	28480	1510-0090
15(J8, J9)	1250-0118	2	CONNECTOR-PF BNC FEM SGL HOLE FR	90949	31-2221-1022
16	2140-0016	10	WASHER-LK INTL T NO -3/8 .377-IN-ID	78189	1920-02
17	2950-0043	5	NUT-HEX-DBL-CHAM 3/8-32-THD .094-THK	73743	2X 28200
18	2360-0113	15	SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	28480	2360-0113
19	5001-0460	1	COVER, TOP	28480	5001-0460
20	5041-6820	1	STRAP, HANDLE CAP, RIGHT	28480	
21	0515-1132	2	CAP, STRAP M5.0	28480	
22	5060-9803	1	STRAP, HANDLE	28480	5060-9802
23	5041-6819	1	STRAP, HANDLE CAP, FRONT	28480	
24	0535-0081	1	NUT HEX M5 x 0.8	28480	
25	04081-10027	4	SHIELD	28480	04081-10027
26	5021-5836	4	STRUT, CORNER	28480	
27	04261-10025	1	DECK, RIGHT	28480	04261-10025
28	5021-5815	1	FRAME, FRONT	28480	
29	04261-00201	1	SUB PANEL FRONT	28480	
30	04261-50121	1	PANEL, FRONT (YHP)	28480	04261-50121
30	04261-50122	1	PANEL, FRONT (HP)	28480	04261-50122
30	04261-50124	1	PANEL FRONT (OPT. 010)		
31	04261-10021	1	PANEL, FRONT	28480	04261-10021
32	04261-10031	1	PROTECTOR	28480	04261-10031
33	04261-99901	1	INSTRUCTION CARD (ENGLISH)	28480	04261-99901
33	04261-99900	1	INSTRUCTION CARD (JAPANESE)	28480	04261-99900
33	04261-99902	1	INSTRUCTION CARD (OPT. 010)	28480	7120-0478
34	7120-0478	1	TRADE MAP (YHP)	28480	7120-0478
34	7120-1254	1	TRADE MAP (HP)	28480	7120-1254
35	5000-4206	3	SHORTING LINK	28480	5000-4206
36	0370-2159	1	KNDB PUSHBUTTON	28480	0370-2159
37	2950-0001	4	NUT-HEX-DBL-CHAM 3/8-32-THD .094-THK	12697	204-13
38	1460-1345	2	WIREFORM 1.34-W 3-LG SST	28480	1460-1345
39	2200-0101	2	SCREW-MACH 4-40 .188 IN-LG PAN-HD-POZI	28480	2200-0101
40	5040-7201	4	FOOT, FULL/HALF MODULE	28480	5040-7201
41	04261-10028	1	SHIELD	28480	04261-10028
42	0360-1190	1	TERMINAL-LUG-SLDR 3/8 SCR .078 ID	79963	720-380H
43	04271-10030	1	PLATE	28480	04261-10030
44	0520-0129	6	SCREW-MACH 2-56 PAN-HD-POZI	28480	0520-0129
45	2190-0008	8	WASHER-LK EXT T NO.-6 .141-IN-ID	73734	1341
46	0624-0045	6	SCREW-TPG 6-20 3/8-IN-LG PAN-HD PHL-PEC	28480	0624-0045
47	0340-0458	1	INSULATOR-KSTR TO-3 .003-THK	28480	0340-0458
48(Q1)	1854-0063	1	TRANSISTOR NPN 2N3055 SI TO-3 PD=115W	28480	1854-0063
49(CP1)	1902-1232	1	DIODE-ZNR 1N3997AP 5.6V 5% DO-4 PD=10W	04713	1N3997P
50(CR1, CR2)	1901-0496	2	DIODE-PWR RECT 100V 12A DO-4	04713	5P2080-2
51	0360-0270	3	TERMINAL-LUG-SLDR 10 5CP .195/ .093 ID	79963	807
52	3050-0226	4	WASHER-FL MTLG NO.-10 .203-IN-ID	80120	AN960C10L
53	1200-0080	4	INSULATOR-KSTR TRANSISTOR .19-ID	28480	1200-0080
54	2740-0003	3	NUT-HEX-W/LAMP 10-32-THD .125-THK	73734	9227
55	0340-0140	2	INSULATOR-KSTR TO-66 .003-THK	28480	0340-0140
56(Q2, Q3)	1854-0072	2	TRANSISTOR NPN 2N3054 SI TO-66 PD=25W	02735	2N3054
57	2510-0063	4	SCREW-MACH 8-32 1.5-IN-LG PAN-HD-POZI	28480	2510-0063
58	2190-0017	4	WASHER-LK HLCL NO.-8 .168-IN-ID	28480	2190-0017
59	3050-0130	4	WASHER-FL LAM 1.265-IN-ID 1.609-IN-OD	28480	3050-0130
60(T1)	9100-0850	1	TRANSFORMER POWER	28480	9100-0850

See introduction to this section for ordering information





SECTION VII MANUAL CHANGES

7-1. INTRODUCTION.

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

Serial Prefix or Number	Make Manual Changes
1545J-00320 and below	A, B, C, D, E, F, G, H
1545J-00400 and below	B, C, D, E, E, G, H
1622J00640 and below	C, D, E, F, G, H
1622J01290 and below	D, E, F, G, H
1810J and below	E, F, G, H
1821J04090 and below	F, G, H
1821J06370 and below	G, H
1821J08360 and below	H

Table 7-2. Summary of Changes by Assembly.

CHANGE	Assembly												No Prefix	
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A21	A22		
A		J1 thru J8		R53	C20									
B		04261- 40025, 04261- 40026, 04261- 40027,	A3 C8 J4 R9 R10 U18 CR1 CR2 CR3 CR4 J5 U30 U31			C13 R53 R54		A8 C8 CR2 CR3 J2 R25 R26 R27 S1 U8 CR4 CR5 J3 J4 J5 S2 U9						04261- 40023, 04261- 40024,
C				R14 R26										
D														C2 R2 C3 R3

Table 7-2. Summary of Changes by Assembly (Cont'd).

CHANGE	Assembly													
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A21	A22	No Prefix	
E				CR4 CR7 CR10 CR11 CR23 CR24 K1 - K4 Q16 - Q19 R10 R13 R19 - R22 R40 - R47 R74 - R84										
F					U1 U3 CR1 CR2 R29 R30 R38 R39 R86									
G							S1							
H														Metriation

7-6. MANUAL CHANGE INSTRUCTIONS.

CHANGE A.

1. Page 8-61, Figure 8-26, A4 circuit schematics,
Add the following note:

A4R53 is constructed by two resistors in parallel, 11.111kΩ and 5.6MΩ. Since the resistance of these paralleled resistors is equal to 11.090kΩ, use A4R53 P N: 0698-2295 for repair.

2. Page 8-63, Figure 8-29, A5 circuit schematics,
Add the following note:

In some instruments, A5C20 (39pF) is not installed in parallel with A5R31. Install A5C20 in all instruments (if not already included).

3. Page 6-3, Table 6-3, Replaceable Parts,
Delete A2J1 thru J8, HF P, N: 1200-0474; jack.

Note

Above deletion does not apply to an instrument in which a complete A2 board assembly has been used for repair.

CHANGE B.

1. Page 6-9, Table 6-3, Replaceable Parts,
Add following parts:

A6C13, HP P N: 0160-1675; C-FXD .22 μF.
A6R53, HP P N: 0757-0441; R-FXD 8.25kΩ.
A6R54, HP P N: 0757-0454; R-FXD 33.2kΩ.

Delete following parts

A6C13, HP P N: 0160-1674; C-FXD 0.33 μF.
A6R53, HP P N: 0757-0290; R-FXD 6.19kΩ.
A6R54, HP P N: 0757-0349; R-FXD 22.6kΩ.

- Page 8-65, Figure 8-32, A6 circuit schematics,
Change A6 circuit schematics partially per above changes.

2. Page 6-4, Table 6-3, Replaceable Parts,
Delete following parts:

HP P N: 04261-40025	1	SPACER FOR LED LAMP
HP P N: 04261-40026	1	SPACER FOR LED LAMP
HP P N: 04261-40027	1	SPACER FOR LED LAMP

- Page 6-15, Table 6-3, Replaceable Parts,
Delete following parts:

HP P N: 04261-40023	1	LAMP HOUSE
HP P N: 04261-40024	1	LAMP HOUSE

3. Page 6-4, Table 6-3, Replaceable Parts,
Add following parts

A3, HP P/N: 04261-77003; A3 DISPLAY DRIVER BOARD
A3C8, HP P/N: 0160-2055; C-FXD .01 μ F
A3CR1, HP P/N: 1902-3002, DIODE-ZENER 2.37V
A3CR2, HP P/N: 1902-3002; DIODE-ZENER 2.37V
A3CR3, HP P/N: 1910-0016, DIODE GE SWITCHING
A3CR4, HP P/N: 1910-0016, DIODE GE SWITCHING
A3J4, HP P/N: 1200-0468; SOCKET
A3J5, HP P/N: 1200-0468; SOCKET
A3U30, HP P/N: 04261-85001; IC ROM
A3U31, HP P/N: 04261-85002; IC ROM

Delete following parts:

A3, HP P/N: 04261-77103; A3 DISPLAY DRIVER BOARD
A3C8, HP P/N: 0180-0374; C-FXD 10 μ F
A3J4, HP P/N: 1200-0613; SOCKET
A3R9, HP P/N: 0698-4431; R-FXD 2.05k Ω
A3R10, HP P/N: 0757-0442; R-FXD 10.0k Ω
A3U18, HP P/N: 1818-2271; IC-ROM

Pages 6-11 and 6-12, Table 6-3, Replaceable Parts,
Add following parts:

A8, HP P/N: 04261-77008; A8 SEQUENCE CONTROL BOARD
A8CR2, HP P/N: 1902-3002; DIODE-ZENER 2.37V
A8CR3, HP P/N: 1910-0016; DIODE-SWITCHING
A8CR4, HP P/N: 1902-3002; DIODE-ZENER 2.37V
A8CR5, HP P/N: 1901-0025; DIODE
A8J2, HP P/N: 1200-0468; SOCKET
A8J3, HP P/N: 1200-0468; SOCKET
A8J4, HP P/N: 1200-0438; SOCKET
A8J5, HP P/N: 1200-0438; SOCKET
A8S1, HP P/N: 3101-1274; SWITCH-SLIDE
A8S2, HP P/N: 3101-1274; SWITCH-SLIDE
A8U8, HP P/N: 04261-85003; IC-ROM
A8U9, HP P/N: 04261-85004; IC-ROM

Note

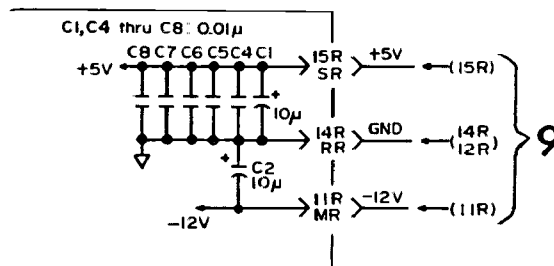
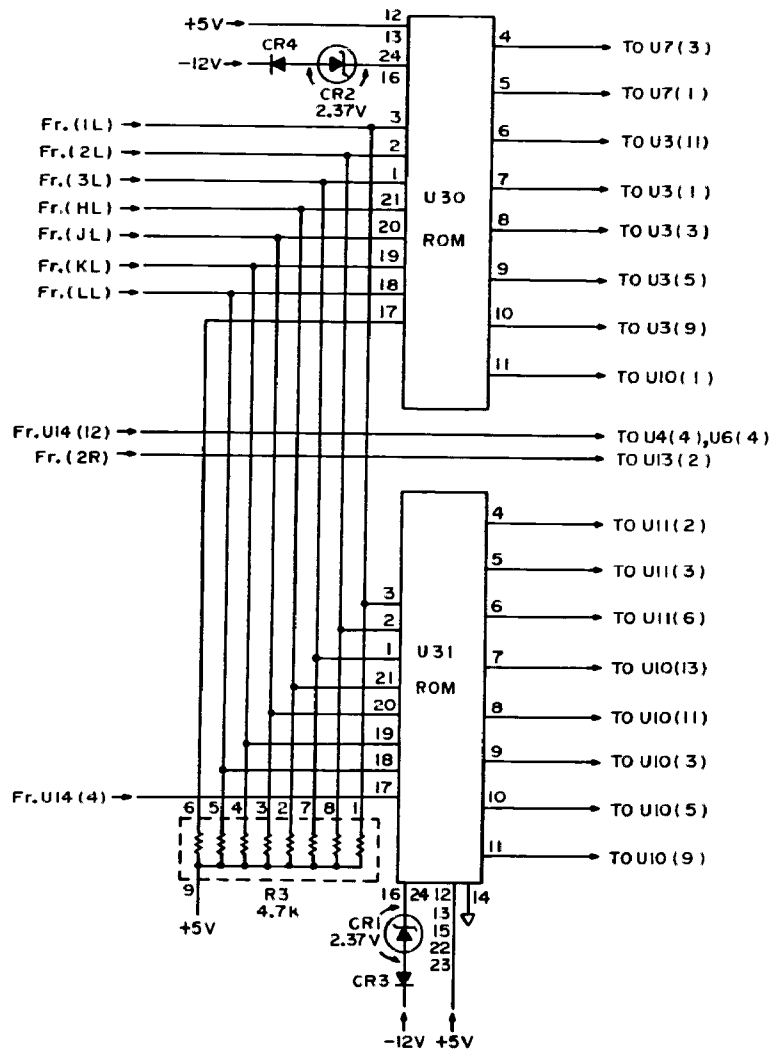
Delete following parts from above list for units serialized
1545J-00250 and below:

A8J4, HP P/N: 1200-0438, SOCKET
A8J5, HP P/N: 1200-0438, SOCKET

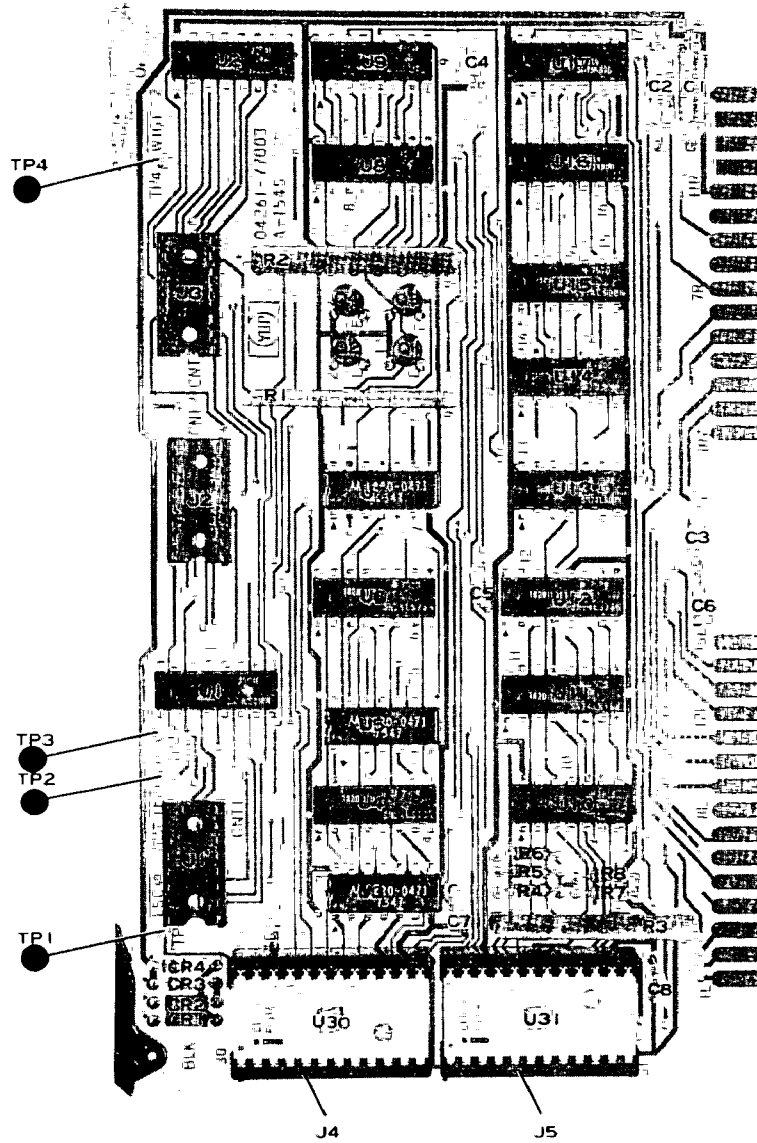
Delete following parts:

A8, HP P/N: 04261-77108; A8 SEQUENCE CONTROL BOARD
A8C8, HP P/N: 0180-0197; C-FXD 2.2 μ F
A8CR2, HP P/N: 1910-0016; DIODE SWITCHING
A8CR3, HP P/N: 1901-0025; DIODE
A8J2, HP P/N: 1200-0613; SOCKET
A8R25, HP P/N: 0683-4725, R-FXD 4.7k Ω 5%
A8R26, HP P/N: 0698-4431, R-FXD 2.05k Ω 1%
A8R27, HP P/N: 0757-0442; R-FXD 10.0k Ω
A8S1, HP P/N: 3101-1313; SWITCH-SLIDE
A8U8, HP P/N: 1818-2272, IC ROM

Page 8-59, Figure 8-23, A3 circuit schematics,
Change schematics partially as follows:

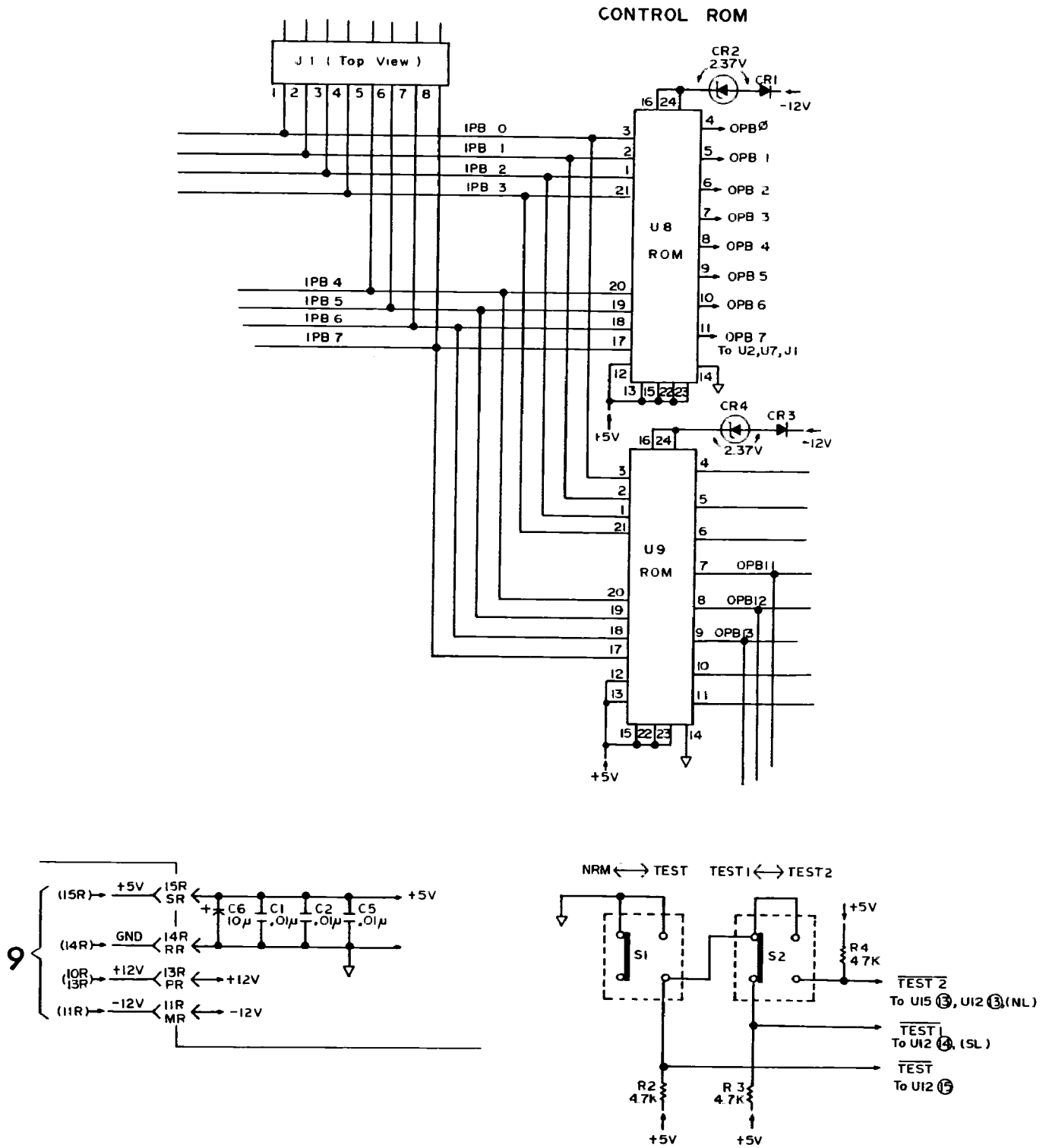


Page 8-59, Figure 8-22, A3 Parts Locations,
Change parts locations for A3 board as follows:

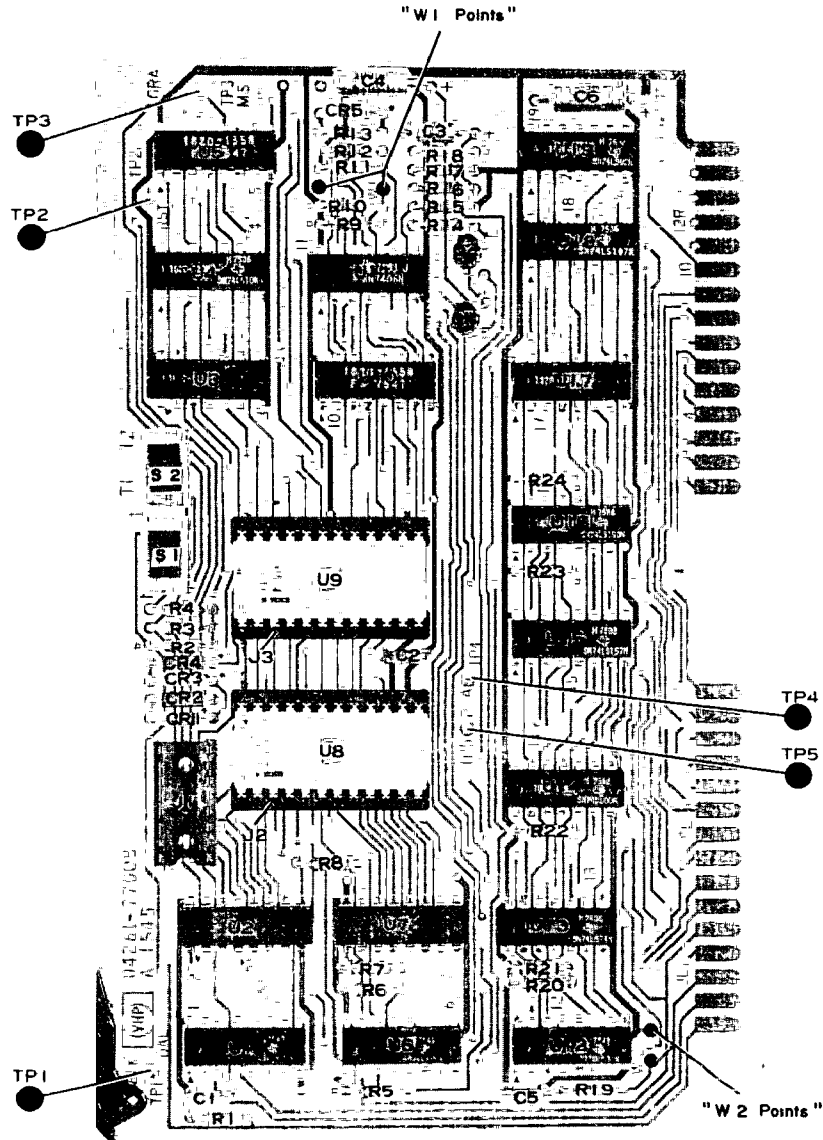


Replace A3U18 with A3U30, U31, and CR1 thru CR4 in the A3 board troubleshooting tree.

Page 8-69, Figure 8-36, A8 circuit schematics,
Change schematics partially as follows.



Page 8-69, Figure 8-35, A8 Parts Locations,
Change parts locations for A8 board as follows:



Note

J4 and J5 sockets are not installed in units serialized 1545J-00250 and below.

Replace A8U8 with A8U8, U9, and CR1 thru CR4 in troubleshooting guide Figure 8-12.

CHANGE C.

- Page 5-1, Table 5-1:
Add the following table to Table 5-1.

Component	Nominal Value Range	Effect on Performance
A4R26	HP P/N 0698-3259 R:FXD 7.87k HP P/N 0757-0440 R:FXD 7.50k HP P/N 0757-0441 R:FXD 8.25k	Changes oscillator level. If oscillator level is insufficient, use more resistance; if excessive, use less resistance.

- Page 6-6, Table 6-3:
Add the following parts:

A4R14, HP P/N: 0683-3335 ; R-FXD 33k
A4R26, HP P/N: 0698-3259 ; R-FXD 7.87k

Delete the following parts:

A4R14, HP P/N: 0683-1035 ; R-FXD 10k
A4R26, HP P/N: 0698-3515 ; R-FXD 5.90k

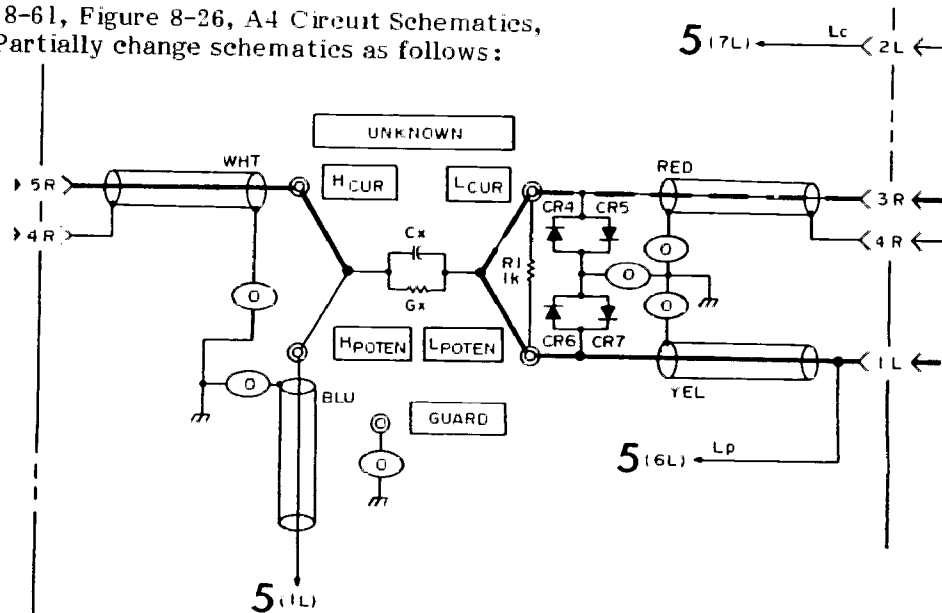
- Page 8-60, Figure 8-24:
Change the signal level limits in the first step to 6.2Vpp-7.2Vpp for both 120Hz and 1kHz.
- Page 8-61, Figure 8-26:
Change the gain value of the POWER AMPL to (x1.8) on the schematics.

CHANGE D.

- Page 6-15, Table 6-3, Replaceable Parts,
Delete following parts:

C2, HP P/N: 0160-1586 ; C-FXD 0.1 μ F
C3, HP P/N: 0160-1586 ; C-FXD 0.1 μ F
R2, HP P/N: 0698-3391 ; R-FXD 21.5 Ω
R3, HP P/N: 0698-3391 ; R-FXD 21.5 Ω

- Page 8-61, Figure 8-26, A4 Circuit Schematics,
Partially change schematics as follows:



CHANGE E.

1. Pages 6-5, 6-6 and 6-7, Table 6-3, Replaceable Parts,
Change A4 board replaceable parts list to Table A.

Table A (Sheet 1 of 3).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
*A4C11	0160-2202	1	CAPACITOR-FXD 75pF +-5% 300VDC MICA	28480	0160-2202
A4C12	0160-2207	1	CAPACITOR-FXD 47pF +-5% 300VDC MICA	28480	0160-2207
A4C13	0180-1051	1	CAPACITOR-FXD 100UF 16V	28480	0180-1051
A4C14	0160-2264	1	CAPACITOR-FXD 20pF +-5% 500VDC CEP	28480	0160-2264
A4C15	0180-1051	1	CAPACITOR-FXD 100UF 16V	28480	0180-1051
A4C16	0180-1051	1	CAPACITOR-FXD 100UF 16V	28480	0180-1051
A4C17	0180-1051	1	CAPACITOR-FXD 100UF 16V	28480	0180-1051
A4C18	0180-1051	1	CAPACITOR-FXD 100UF 16V	28480	0180-1051
A4C19	0180-1051	1	CAPACITOR-FXD 100UF 16V	28480	0180-1051
A4CR1	1901-0040	42	DIODE-SWITCHING 30V 50MA 2HS DO-35	28480	1901-0040
A4CR2	1901-0040	42	DIODE-SWITCHING 30V 50MA 2HS DO-35	28480	1901-0040
A4CR3	1902-1036	1	DIODE-ZNR 3.16V 5% DO-7 PD= 4W TC=-.064%	04713	5Z 10939-38
A4CR4	1902-1025	1	DIODE-ZNR 10V 5% DO-7 PD= 4W TC=+ .06%	04713	5Z 10939-182
A4CR5	1901-0040	1	DIODE-SWITCHING 30V 50MA 2HS DO-35	28480	1901-0040
A4CR6	1901-0040	1	DIODE-SWITCHING 30V 50MA 2HS DO-35	28480	1901-0040
A4CR7	1902-1064	1	DIODE-ZNR 33.2V 5% DO-15 PD=1W TC=+.075%	04713	5Z 11213-290
A4CR8	1901-0040	1	DIODE-SWITCHING 30V 50MA 2HS DO-35	28480	1901-0040
A4CR9	1901-0040	1	DIODE-SWITCHING 30V 50MA 2HS DO-35	28480	1901-0040
A4CR10	1902-0844	2	DIODE-ZNR 36V 5% DO-7 PD= 4W TC=+.057%	04713	5Z 10939-170
A4CR11	1902-0844	2	DIODE-ZNR 36V 5% DO-7 PD= 4W TC=+.057%	04713	5Z 10939-170
A4CR12	1901-0040	1	DIODE-SWITCHING 30V 50MA 2HS DO-35	28480	1901-0040
A4CR13	1901-0040	1	DIODE-SWITCHING 30V 50MA 2HS DO-35	28480	1901-0040
A4CR14	1901-0040	1	DIODE-SWITCHING 30V 50MA 2HS DO-35	28480	1901-0040
A4CR15	1901-0040	1	DIODE-SWITCHING 30V 50MA 2HS DO-35	28480	1901-0040
A4CR16	1901-0040	1	DIODE-SWITCHING 30V 50MA 2HS DO-35	28480	1901-0040
A4CR17	1901-0040	1	DIODE-SWITCHING 30V 50MA 2HS DO-35	28480	1901-0040
A4CR18	1901-0040	1	DIODE-SWITCHING 30V 50MA 2HS DO-35	28480	1901-0040
A4CR19	1901-0040	1	DIODE-SWITCHING 30V 50MA 2HS DO-35	28480	1901-0040
A4CR20	1901-0040	1	DIODE-SWITCHING 30V 50MA 2HS DO-35	28480	1901-0040
A4CR21	1901-0040	1	DIODE-SWITCHING 30V 50MA 2HS DO-35	28480	1901-0040
A4CR22	1902-3149	5	DIODE-ZNR 9.09V 5% DO-7 PD= 4W TC=+ .057%	04713	5Z 10919-170
A4CR23	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A4CR24	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A4CR25	1901-0040	2	DIODE-SWITCHING 30V 50MA 2HS DO-35	28480	1901-0040
A4CR26	1901-0040	1	DIODE-SWITCHING 30V 50MA 2HS DO-35	28480	1901-0040
A4CR27	1901-0040	1	DIODE-SWITCHING 30V 50MA 2HS DO-35	28480	1901-0040
A4CR28	1901-0040	1	DIODE-SWITCHING 30V 50MA 2HS DO-35	28480	1901-0040
A4R1	0490-0234	1	RELAY-PCP	28480	0490-0234
A4R2	0490-0236	1	RELAY-PCP	28480	0490-0236
A4J1	1855-0062	8	TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0062
A4J2	1855-0091	21	TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0091
A4J3	1855-0082	1	TRANSISTOR MOSFET P-CHAN D-MODE SI	28480	1855-0082
A4J4	1854-0071	1	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4J5	1854-0071	1	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4J6	1853-0020	24	TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A4J7	1853-0020	24	TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A4J8	1854-0071	1	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4J9	1853-0020	1	TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A4J10	1855-0118	2	TRANSISTOR J-FET N-CHAN 25K43P	28480	1855-0118
A4Q11	1855-0113	1	TRANSISTOR J-FET N-CHAN 25K43P	28480	1855-0113
A4Q12	1854-0071	1	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4Q13	1854-0071	1	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4Q14	1854-0071	1	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4Q15	1854-0071	1	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4Q16	1853-0020	1	TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A4Q17	1854-0474	2	TRANSISTOR PNP SI PD=360MW FT=75MHZ	28480	1854-0474
A4Q18	1853-0020	1	TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A4Q19	1854-0474	1	TRANSISTOR PNP SI PD=360MW FT=75MHZ	28480	1854-0474
A4Q20	1855-0091	1	TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0091
A4Q21	1855-0091	1	TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0091
A4Q22	1855-0091	1	TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0091
A4Q23	1855-0091	1	TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0091
A4Q24	1855-0091	1	TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0091
A4Q25	1855-0091	1	TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0091
A4Q26	1855-0117	1	TRANSISTOR J-FET N-CHAN E-108	28480	1855-0117
A4Q27	1853-0091	1	TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1853-0091
A4Q28	1854-0013	1	TRANSISTOR NPN 2M218A SI TO-5 PD=800MW	04713	2M218A
A4Q29	1853-0012	1	TRANSISTOR PNP 2M2504A SI TO-5 PC=600MW	01255	2M2504A
A4Q30	1853-0020	1	TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A4Q31	1853-0020	1	TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A4Q32	1853-0020	1	TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A4Q33	1853-0020	1	TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A4Q34	1853-0020	1	TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A4R1	0757-0486	2	RESISTOR 750K 1% .125W F TC=0+-100	24556	M4
A4R2	0448-3136	1	RESISTOR 17.8K 1% .125W F TC=0+-100	16299	C4 1/8 TO-18 17.8 K
A4R3	0757-0486	1	RESISTOR 750K 1% .125W F TC=0+-100	24556	M4
A4R4	0757-0449	1	RESISTOR 18.2K 1% .125W F TC=0+-100	24556	C4 1/8 TO-18 18.2 K
A4R5	0698-3451	2	RESISTOR 133K 1% .125W F TC=0+-100	16299	C4 1/8 TO-133 K

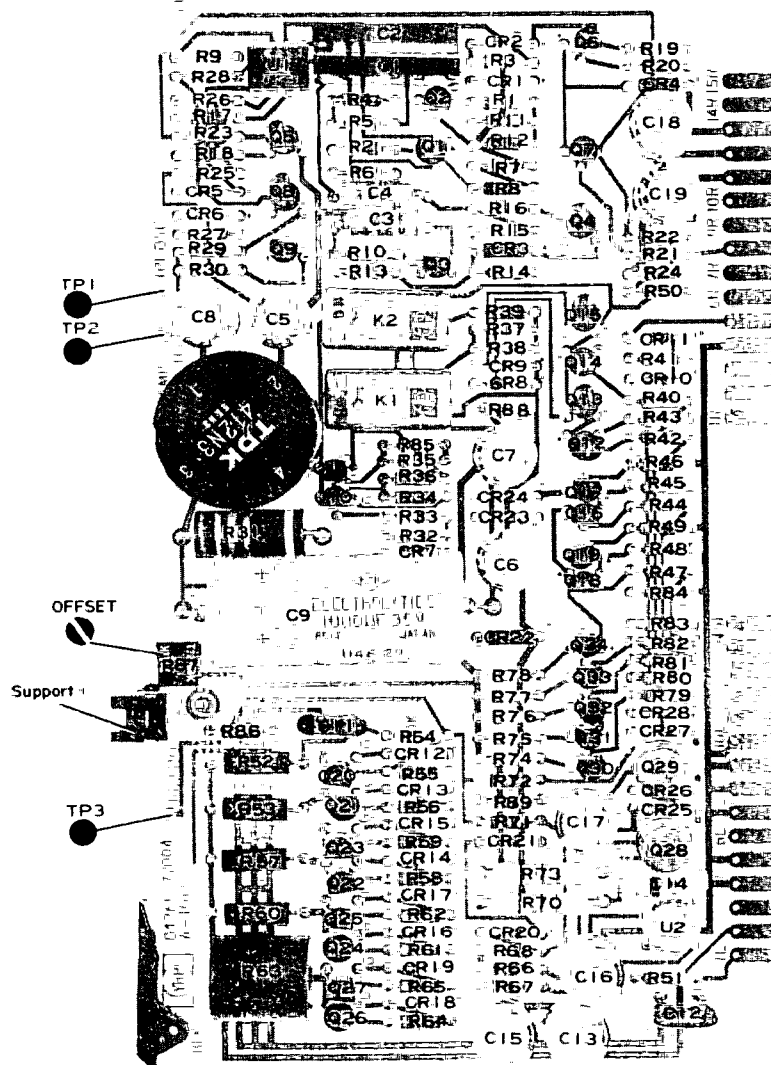
Table A (Sheet 2 of 3).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A4R6	0698 3451		RESISTOR 133K 1% .125W F TC=0+-100	16299	C4-1/8-T0-1333-F
A4R7	0757-0317	2	RESISTOR 1.33K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1331-F
A4R8	0757-0278	1	RESISTOR 1.78K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1781-F
A4R9	0698-3155	4	RESISTOR 4.64K 1% .125W F TC=0+ 100	16259	C4-1/8-T0-4641-F
A4R10	0683-3335	38	RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335
A4R11	0683 8225	1	RESISTOR 8.2K 5% .25W FC TC=-400/+700	01121	CP8225
A4R12	0698-3154	1	RESISTOR 4.22K 1% .125W F TC=0+ 100	16259	C4-1/8-T0-4221-F
A4R13	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335
A4R14	0683-1015		RESISTOR 10K 5% .25W FC TC=-400/+800	01121	C83335
A4R15	0757-0443	1	RESISTOR 11K 1% .125W F TC=0+ 100	24546	C4-1/8 T0 1102-F
A4R16	0757 0416	3	RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0 511R-F
A4R17	0698-4442	1	RESISTOR 4.42K 1% .125W F TC=0+ 100	16299	C4-1/8-T0-4421-F
A4R18	0698-4420	1	RESISTOR 226 1% .125W F TC=0+-100	16299	C4-1/8 T0-226R-F
A4R19	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335
A4R20	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335
A4R21	0683 3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335
A4R22	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335
A4R23	0683-4725	43	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A4R24	0683-7525	1	RESISTOR 7.5K 5% .25W FC TC=- 400/+700	01121	CB7525
A4R25	0757-0442	4	RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A4R26	0698-3515	1	RESISTOR 5.90K 1% .125W F TC=0+ 100	16299	C4-1/8-T0-5901-F
A4R27	0683-1535	3	RESISTOR 15K 5% .25W FC TC=-400/+800	01121	C81535
A4R28	0683-1535		RESISTOR 15K 5% .25W FC TC=-400/+800	01121	C81535
A4R29	0683-0275	4	RESISTOR 2.7 5% .25W FC TC=-400/+500	01121	CB27G5
A4R30	0683-0275		RESISTOR 2.7 5% .25W FC TC=-400/+500	01121	CB27G5
A4R31	0764-0015	1	RESISTOR 560 5% 2W MD TC=0+-200	24546	FP42-2-T00-561 J
A4R32	0757-0465	4	RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A4R33	0757-0442	4	RESISTOR 10K 1% .125W F TC=0+ 100	24546	C4-1/8-T0-1002-F
A4R34	0683-1055	28	RESISTOR 1M 5% .25W FC TC=-800/+900	01121	C81055
A4R35	0698-0083	2	RESISTOR 1.96K 1% .125W F TC=0+ 100	16299	C4-1/8-T0-1961-F
A4R36	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	C81055
A4R37	0698-3440	2	RESISTOR 196 1% .125W F TC=0+-100	16299	C4-1/8-T0-196R-F
A4R38	0698-3440		RESISTOR 196 1% .125W F TC=0+ 100	16299	C4-1/8-T0-196R-F
A4R39	0683-0825	1	RESISTOR 8.2 5% .25W FC TC=-400/+500	01121	CB82G5
A4R40	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335
A4R41	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335
A4R42	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335
A4R43	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335
A4R44	0683 3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335
A4R45	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335
A4R46	0683-1045	6	RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A4R47	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335
A4R48	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335
A4R49	0683-1045		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A4R50	0683-5625	1	RESISTOR 5.6K 5% .25W FC TC=-400/+700	01121	CB5625
A4R51	0683-2225	2	RESISTOR 2.2K 5% .25W FC TC= 400/+700	01121	CB2225
A4R52	0698-2225	1	RESISTOR FXD 90.0K OHM 0.05% 1/8W MF	28480	0698-2225
A4R53	0698-2295	1	RESISTOR FXD 11 090 OHM 0.05%	28480	0698-2295
A4R54	0698-3329	1	RESISTOR 10K .5% .125W F TC=0+-100	03888	PME55-1/8-T0-1002-D
A4R55	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	C81055
A4R56	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	C81055
A4R57	0698-2296	1	RESISTOR FXD 1010 1 OHM 0.05%	28480	0698-2296
A4R58	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	C81055
A4R59	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	C81055
A4R60	0698-2294	1	RESISTOR FXD 100.10HM 0.05%	28480	0698-2294
A4R61	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	C81055
A4R62	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	C81055
A4R63	0698-2298	1	RESISTOR FXD 10 OHM 0.05%	28480	0698-2298
A4R64	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	C81055
A4R65	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	C81055
A4R66	0683-4705	2	RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A4R67	0683-4705		RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A4R68	0683-1035	11	RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A4R69	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A4R70	0757-1090	2	RESISTOR 261 1% .5W F TC=0+-100	19701	MF7C1/2-T0-261P-F
A4R71	0683-0275		RESISTOR 2.7 5% .25W FC TC=-400/+500	01121	CB27G5
A4R72	0683-0275		RESISTOR 2.7 5% .25W FC TC=-400/+500	01121	CB27G5
A4R73	0757-1090		RESISTOR 261 1% .5W F TC=0+-100	19701	MF7C1/2-T0-261R-F
A4R74	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335
A4R75	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335
A4R76	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335
A4R77	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335
A4R78	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	C83335

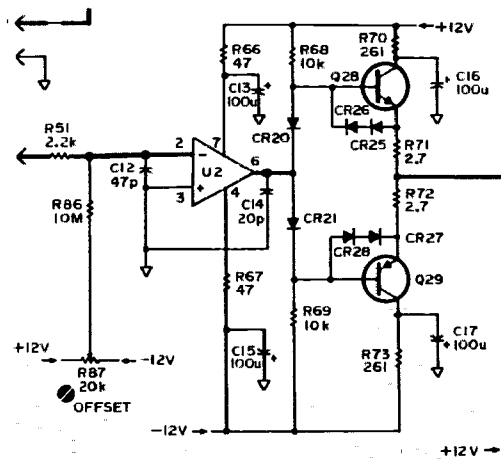
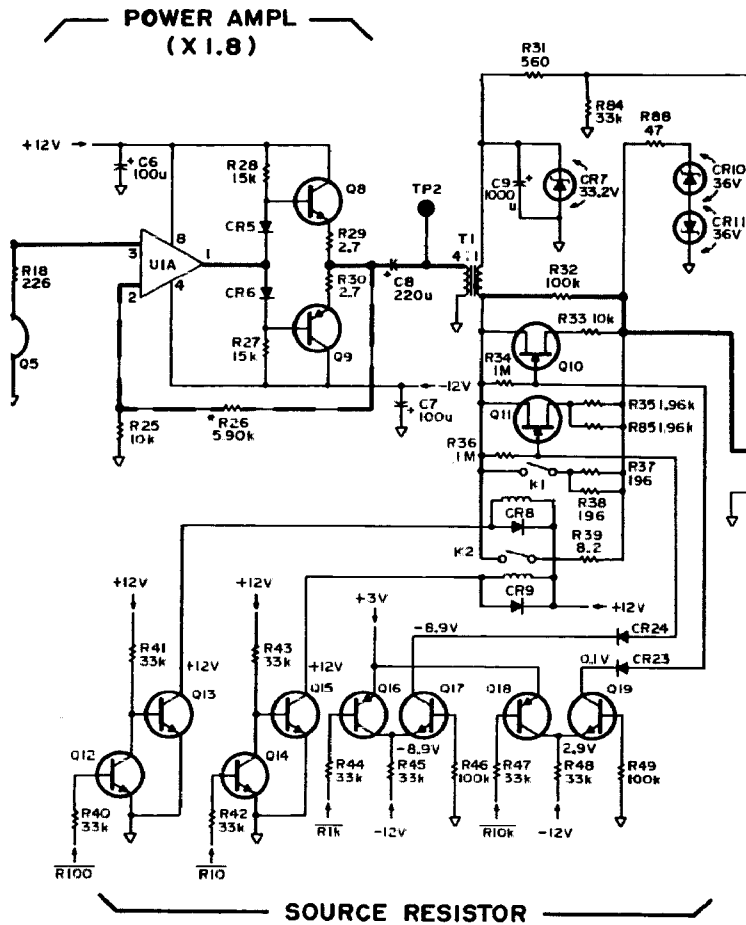
Table A (Sheet 3 of 3).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A4R79	0683-3335		RESISTOR 33K 5% 25W FC TC=-400/+800	01121	CB3335
A4R80	0683-3335		RESISTOR 33K 5% 25W FC TC=-400/+800	01121	CB3335
A4P81	0683-3335		RESISTOR 33K 5% 25W FC TC=-400/+800	01121	CB3335
A4P82	0683-3335		RESISTOR 33K 5% 25W FC TC=-400/+800	01121	CB3335
A4R83	0683-3335		RESISTOR 33K 5% 25W FC TC=-400/+800	01121	CB3335
A4R84	0683-3335		RESISTOR 33K 5% 25W FC TC=-400/+800	01121	CB3335
A4R85	0698-0083		RESISTOR 1.96K 1% 125W F TC=0/+100	16299	C4-1/8-T0-1961-F
A4R86	0683-1065	1	RESISTOR 10M 5% 25W FC TC=-900/+1000	01121	CB1065
A4P87	2100-2514	1	RESISTOR-TRMP 20K 10% C SIDE-ADJ T-TURN	30983	ET50M203
A4P88	0683-4705		RESISTOR 470HM		
A4T1	9100-0846	1	TRANSFORMER-PULSE 412ND	28480	9100-0846
A4U1	1826-0139	6	IC MC 1458 OP AMP	04713	MC1458P1
A4U2	1826-0013	1	IC OP AMP	28480	1826-0013
	04261-50022	1	SUPPORTER, BCARD	28480	04261-50022

2. Page 8-61, Figure 8-25, A4 board component locations, Change A4 board component location illustration as follows:



3. Page 8-61, Figure 8-26, A4 board schematic diagram,
Partially change A4 board schematic diagram as follows:



4. Page 8-60, Figure 8-24, A4 board Troubleshooting Guide, Change A4 board Troubleshooting Guide to Figure A.

NOTE
TOLERANCE VALUES GIVEN IN THIS PROCEDURE DO NOT INCLUDE MEASURING EQUIPMENT ERROR

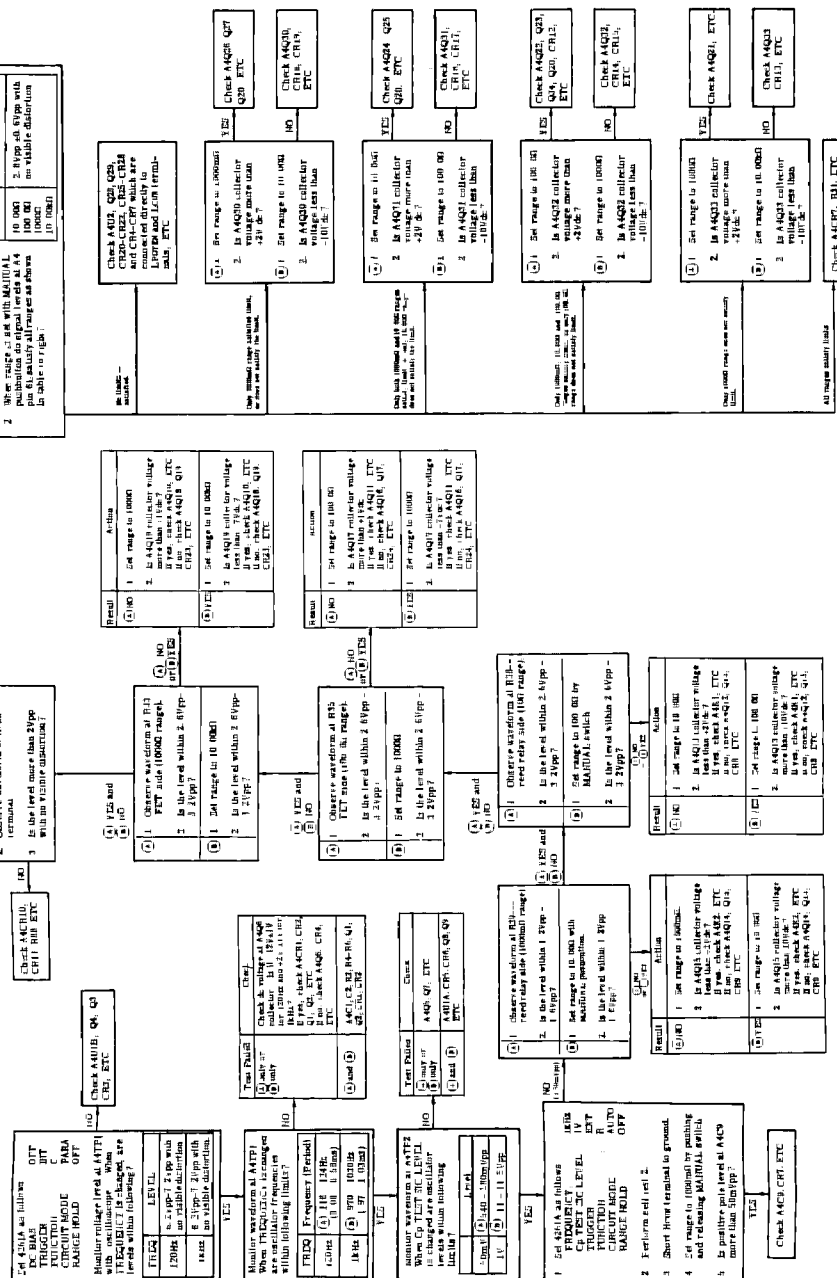


Figure A

CHANGE F.

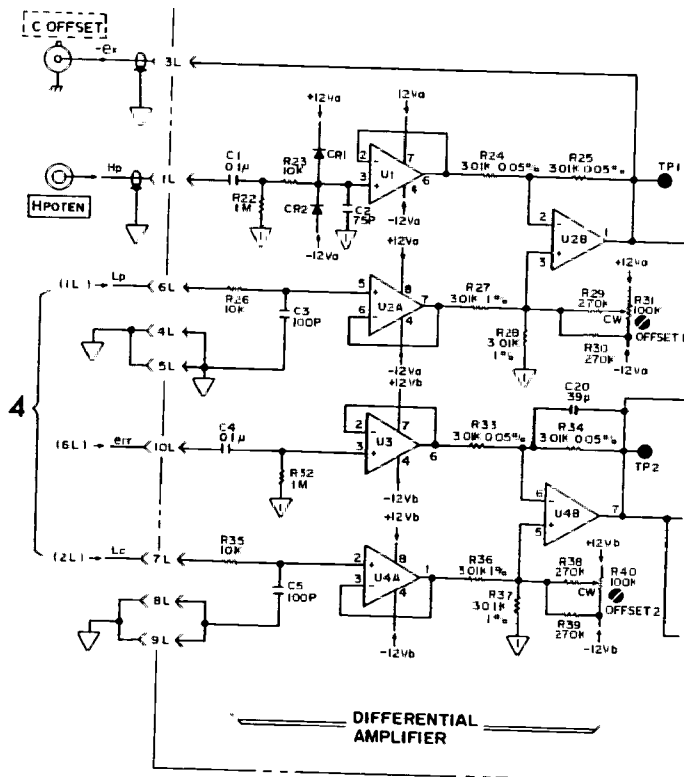
- Pages 6-8 and 6-9, Table 6-3, Replaceable Parts,
Add following parts:

A5CR1, HP P/N: 1901-0033; DIODE-GEN PRP 180V 200MA
 A5CR2, HP P/N: 1901-0033; DIODE-GEN PRP 180V 200MA
 A5CR3, HP P/N: 1902-3149; DIODE-ZNR 9.09V 5% PD=.4W
 A5R29, HP P/N: 0683-2745; R-FXD 270K 5% .25W
 A5R30, HP P/N: 0683-2745; R-FXD 270K 5% .25W
 A5R38, HP P/N: 0683-2745; R-FXD 270K 5% .25W
 A5R39, HP P/N: 0683-2745; R-FXD 270K 5% .25W
 A5U1, HP P/N: 1826-0043; IC LM 307 OP AMP
 A5U3, HP P/N: 1826-0043; IC LM 307 OP AMP

Delete following parts:

A5CR1, HP P/N: 1901-0376; DIODE-GEN PRP
 A5CR2, HP P/N: 1901-0376; DIODE-GEN PRP
 A5R29, HP P/N: 0683-5645; R-FXD 560K 5% .25W
 A5R38, HP P/N: 0683-5645; R-FXD 560K 5% .25W
 A5R86, HP P/N: 0683-4725; R-FXD 4.7K 5% .25W
 A5U1, HP P/N: 1826-0319; IC LF356H OP AMP
 A5U3, HP P/N: 1826-0319; IC LF356H OP AMP

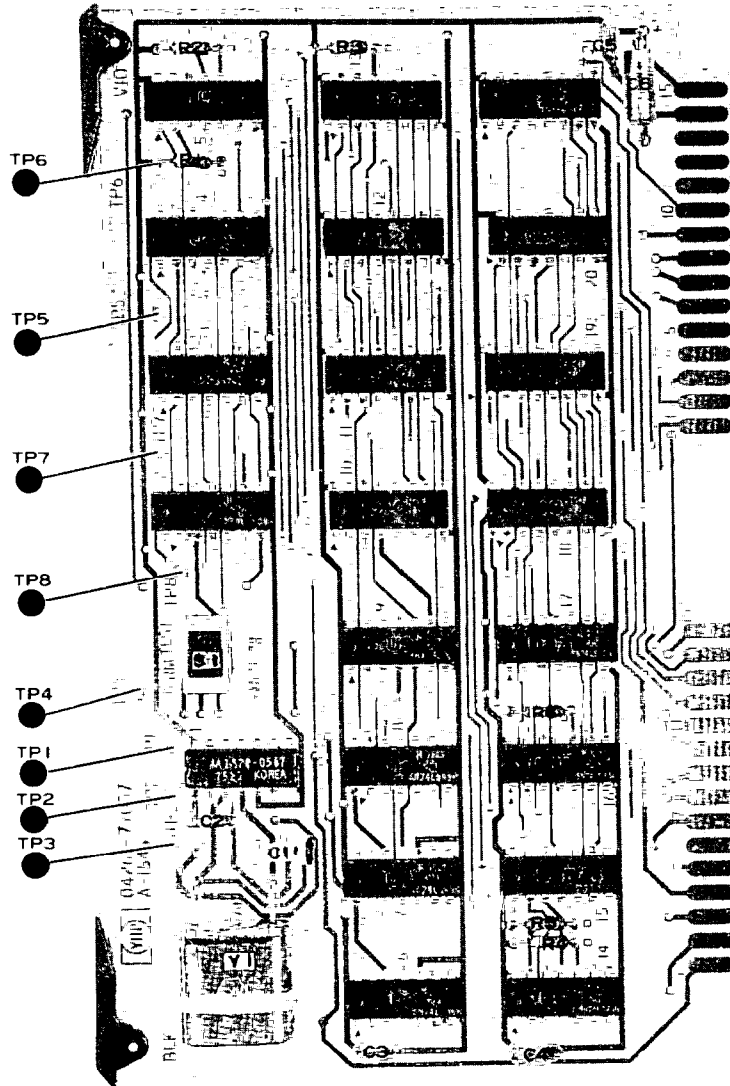
- Page 8-63, Figure 8-29, A5 circuit schematics,
Change schematics partially as follows:



CHANGE G.

1. Page 8-67, Figure 8-33. A7 Board Assembly Component Locations:

Change parts locations for the A7 board as follows:



Note

A switch, A7C1, is installed in place of jumper A7W1 on units serial-numbered 1821J06370 and below.

CHANGE H.

1. Page 6-4, Table 6-3;

Change the part number of the ANGLE (PN 04261-10032) to 04261-10029.

2. Page 6-16, Table 6-3;

Change the part numbers and descriptions as shown below.

Reference Designation	HP Part Number	Description
1	2360-0533	SCREW-MACH 6-32 100 DEG FL HD POZI REC
2	5060-9964	COVER BOTTOM
6	2510-0192	SCREW-MACH 8-32 100 DEG FL HD POZI REC
7	5020-8816	FRAME, REAR
20	5040-7220	CAP, STRAP HANDLE, REAR
21	2680-0172	SCREW-MACH 10-32 .575-IN-LG 100 DEG
23	5040-7219	CAP, STRAP HANDLE, FRONT
24	0590-0639	NUT
26	5020-8836	STRUT, CORNER
28	5020-8815	FRAME, FRONT
29	04261-10022	SUB PANEL, FRONT

SECTION VIII SERVICE

8-1. INTRODUCTION.

8-2. This section contains information on servicing the Model 4261A including the theory of operation, troubleshooting and repair. Overall theory of operation of the instrument is covered in the first part of this section and detailed explanations are presented in the service sheets including detailed theory, component level troubleshooting, circuit schematics and parts location. Interior views, which show adjustment locations, are also included in this section.

8-3. THEORY OF OPERATION.

8-4. A general explanation of the theory of operation of the 4261A LCR Meter follows. Since detailed circuit descriptions for each assembly are covered in the service sheets, the explanation that follows is limited to:

- Basic Theory
- Block Diagram Discussions
- Timing Diagram Discussions

8-5. BASIC THEORY.

8-6. Figure 8-1 is the basic block diagram of the

4261A and shows the fundamentals of how the 4261A measures inductance L, capacitance C, resistance R and or dissipation factor D. The output of an oscillator is applied through a source resistor R_o to the unknown device and range resistor R_r . The effect of amplifier R_r is to cause the same current that flows through the unknown device to flow through R_r , and, as a result, to drive the junction of the unknown device and R_r to zero volts. Voltages E_1 and E_2 across the unknown device and across R_r , respectively, are connected to selector switches S_1 and S_2 which have two important functions. First, S_1 selects either E_1 or E_2 as the voltage to drive the four phase generator (this also establishes the measurement mode - either series or parallel which is automatically or manually set (PARA or SER) as selected at the front panel) and, secondly, S_2 selects either E_1 or E_2 as the measurement voltage to charge or discharge the integrator (as appropriate to the measurement function and mode, i.e. C_p , C_s , L_p , L_s , R_p or R_s). The Vector Voltage-Ratio Measurement Section calculates an L, C, R or D measurement by ascertaining the voltage ratio of E_1 and E_2 through a dual-slope (type) analog to digital conversion technique. This technique is popularly used in digital voltmeters. The analog section receives its measurement instructions from a digital section.

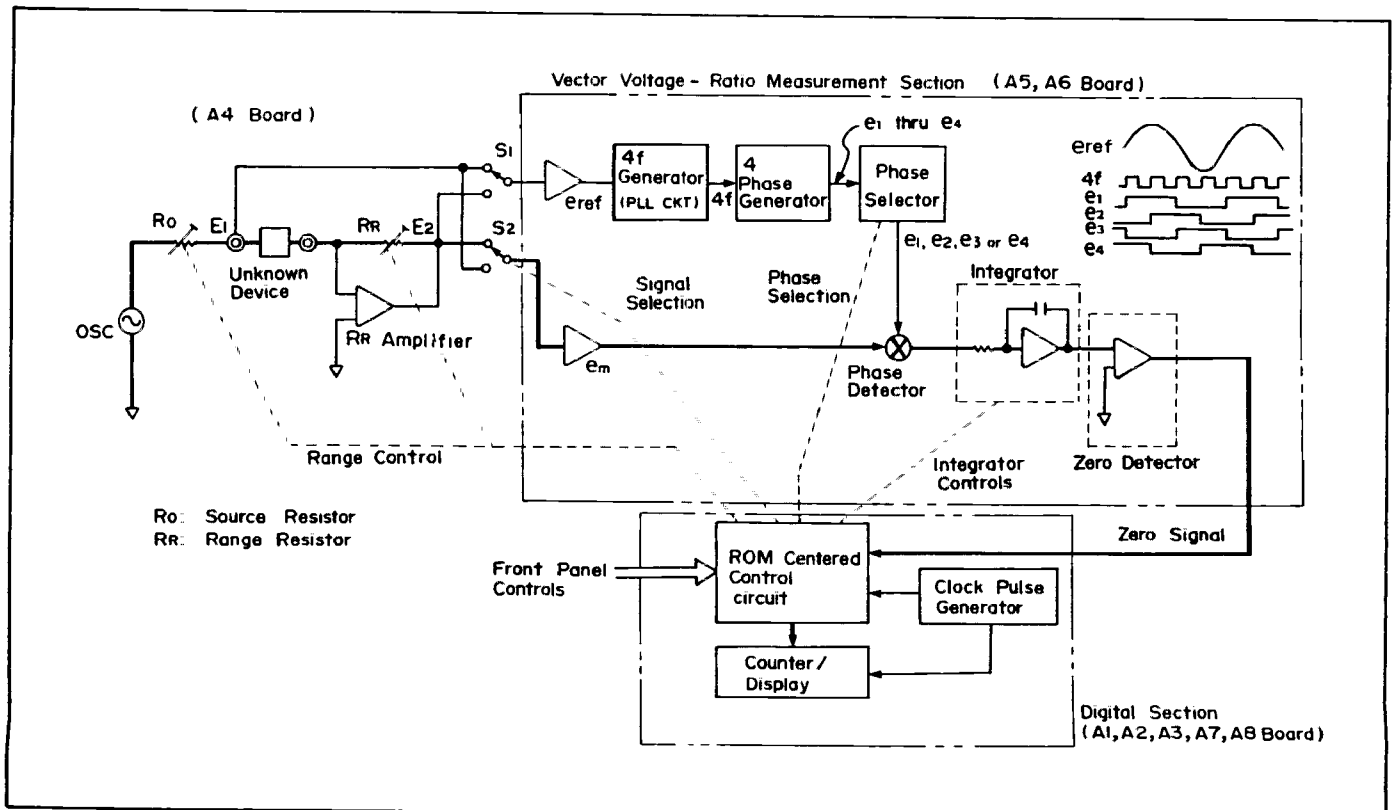


Figure 8-1. Basic Block Diagram.

8-7. Source and range resistors, R_o and R_r , are automatically selected by digital control circuits. For a series equivalent circuit measurement (L_s , C_s or R_s), R_o is set to a value much greater than the impedance of unknown device. Thus a constant current drive to the unknown device is realized. On the other hand, for a parallel equivalent circuit measurement (L_p , C_p or R_p), R_o is set to a much smaller value than the impedance of the unknown to achieve a constant voltage drive to the unknown. The resistance values of R_o and R_r are always equal.

8-8. Vector Voltage-Ratio Measurement Section. The e_m signal selected by S_2 (as directed by the logic circuit) is detected by a phase detector that outputs the rectangular component or in-phase component to an integrator. Phase detector signals e_1 thru e_4 supplied to the phase detector are produced in the following manner: A 4f signal is generated from an e_{ref} signal as selected by Switch S_1 (the 4f generator is a phase lock loop circuit). This creates signals e_1 thru e_4 , each being different by 90 degrees in phase from one another (a 4 phase generator). One of these signals, as directed by the digital circuitry, detects the e_m measurement signal. The phase of signals e_1 thru e_4 is very accurate as a PLL (phase lock loop) circuit is used for generating the reference phase signal to minimize measurement error. A zero detector takes the output of the integrator and generates a zero detection signal (ZERO) every time the integrator output crosses the zero level. This furnishes a ZERO signal to the Digital Section.

8-9. The Digital Section is a kind of algorithmic state machine that is driven by the state clock from a built-in clock pulse generator. The major functions of this section are to manage the various sequences required to perform the desired measurements, to measure L, C, R and D values converted into time periods, and to display these values at the 4261A front panel.

8-10. The parallel capacitance C_p measurement principle is discussed in this paragraph. To simplify the explanation, the example used here is that of measuring an ideal capacitor. See Figure 8-2, C_p Measurement. During time T_1 , the integrator is charged by that portion of the E_2 sinusoidal waveform which is synchronously phase detected by the e_2 pulse train. Both S_1 and S_2 switches select the E_1 signal that is fed to discharge the integrator after being phase-detected by the e_1 signal. Since time period T_2 , for the integrator to discharge to zero volts, is proportional to the value of C_x , C_x can be directly obtained from the contents of a counter if the values for R_r and T_1 are properly and accurately set. Other measurements are done similar to the C_p measurement.

8-11. BLOCK DIAGRAM DISCUSSION.

8-12. Analog Block Diagram. Figure 8-3 is a detailed block diagram of the 4261A analog section. The construction of this diagram is based on the actual printed circuit board assembly. It is useful for troubleshooting.

8-13. A4 Oscillator and Range Resistor Board. Oscillator output is fed through an attenuator (A3R17, R18 and Q5) and a power amplifier to transformer T1. The oscillator output can only be attenuated (A3Q5 turned on) when a C_p measurement is being made. In all other measurements, A3Q5 never turns on. The oscillator signal from the secondary of T1 is provided via source resistor R_o to the unknown device (C_x in diagram). The current that flows through C_x also flows through range resistor R_r via the Range Resistor Amplifier. R_o and R_r are selected by a range control signal from the digital section. A note in Figure 8-3 describes how the resistors are controlled. The GUARD terminal is connected directly to the instrument chassis. The circuit common for all PC boards is also finally connected to the chassis. DC bias voltages up to +30 volts can be applied to the unknown device through A1S2 DC BIAS switch through A4R31, secondary wiring of T1, and R_o from A9 Power Supply (internal) or from an external dc bias source connected to EXT BIAS connectors on rear panel.

8-14. A5 Process Amplifier. Voltages across the unknown device and across R_r are inputs for this assembly which feeds e_{ref} signal (reference phase signal used for phase detection) and e_m signal (signal measured by the integrator) to A6 Board. The two input signals are selected according to specific measurement rules and are used as e_{ref} and e_m signals. The e_{ref} signal is chosen when the measurement circuit mode is selected. Setting the CIRCUIT MODE switch to PARA selects the voltage across C_x as the e_{ref} signal. The SER position of the CIRCUIT MODE switch selects the voltage across R_r as the e_{ref} . If the switch is set to AUTO, the e_{ref} signal selection is done automatically and applied in a manner similar to the above. The selected e_{ref} signal is amplified by A5U6A and is wave-shaped by A5U6B and U8 which also adjust the duty cycle of e_{ref} by a control input (APAO signal) from A6 Board.

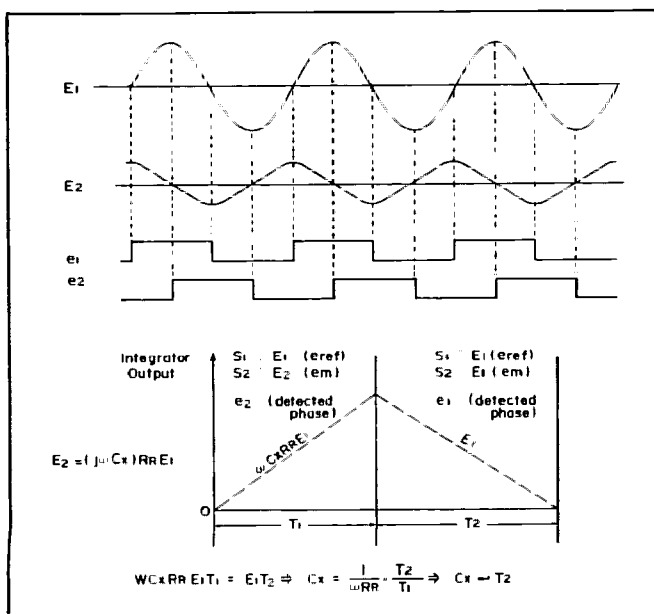


Figure 8-2. C_p Measurement Principle.

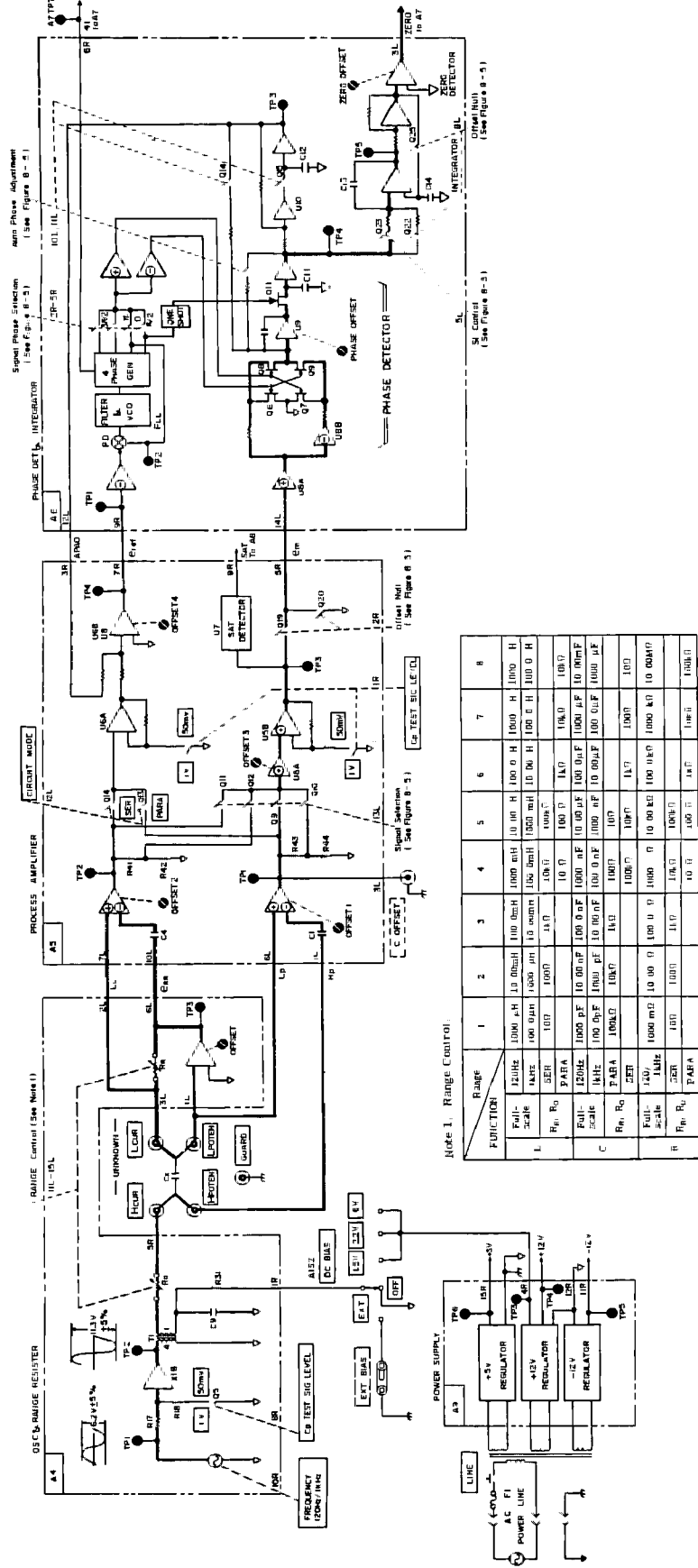


Figure 8-3 Analog Section Block Diagram

The E_m signal is selected by FET switches A5Q9 thru Q12 which are, in turn, controlled by signal selection signals from the digital section. The method of selecting the E_m signal is graphically shown in Figure 8-5 Timing Diagrams. The selected E_m signal is amplified by A5U5A, U5B and becomes an input signal for the phase detector on A6 Board. C OFFSET signal on rear panel is a signal opposite in phase to the signal at the H_{CUR} terminal. When Cp TEST SIG LEVEL switch is set to 50mV position, the gain of amplifier A5U6A, U5B is increased. An SAT Detector detects an E_m signal level that exceeds approximately ± 5 volts and transfers SAT signals to digital section (A8 Board).

8-15. A6 Phase Detector and Integrator. In this board, the two input signals E_{ref} and E_m are converted to a ZERO signal which is fed to the A8 Board (digital Section). The E_m signal is used as an APAO (Auto Phase Adjustment Output) signal only when auto phase adjustment signal is fed to A6 Board to minimize any phase error which could cause a measurement error. However, firstly, E_{ref} is fed into the Phase Locked Loop (PLL) circuits consisting of a phase detector (PD), filter and VCO (voltage controlled oscillator) and is converted into four reference phase signals each being different by 90 degrees in phase one from the other. These four signals are individually selected by the digital circuitry and one is used as the phase detection signal for phase detector A6U6 thru U9 which phase detects the selected E_m signal. The dc output of the phase detector is applied to the integrator. The output of the integrator is monitored by the Zero Detector to observe the time that the zero level is crossed. This zero signal is sent to Digital Section (A7 Board) by Zero Detector. The output of the phase detector is also provided through A6U10, Q15, C12, etc. to A5 Board as an APAO (Auto Phase Adjustment Output) signal for the period of auto phase adjustment. All logic switches on this board are controlled by control signals from the digital section. See Figure 8-5 for details.

8-16. A9 Power Supply Board. This circuitry develops the dc power for the instrument. These voltages are the +5V, +12V and -12V. Internal dc bias voltages of 1.5V, 2.2V and 6V are also provided.

8-17. Digital Block Diagram. Figure 8-4 is the block diagram of the 4261A digital section. The construction of this diagram is based on the actual printed circuit board assembly. Thus, the diagram may be quite helpful when studying the function of an individual board or its schematic and trying to relate it to overall digital circuitry. In the following several paragraphs, each board assembly is described somewhat in detail.

8-18. A2 Display Board. This board displays the measured values with the measurement unit. All data signals, unit signals, circuit mode signals and the annunciation signal are sent from A3 Display Driver board which also provides anode driver signals to A2 Board to light the numeric displays.

8-19. A3 Display Driver Board. This board is divided into two parts, one of which is a numeric display driver (top left in Figure 8-4). The other circuit is a unit, circuit mode driver and range, phase decoder (right bottom in Figure 8-4). In the numeric display driver, the measured serial data from A7 Board is filed in A3U8 and U9 registers whose outputs are decoded into a data format suitable for lighting the 7-segment displays on the A2 Board; this is accomplished by the A3U1 and U2 decoders and the anode drive signals generated by A3U14 thru U16 and A3Q1 thru Q4 by inputting RSA and RSB signals from A7 Board. In the unit, circuit mode driver section of the board, decoder ROM U18 functions as a unit, circuit mode decoder and as a range control decoder only when the $\overline{LSC0}$ signal is enabled. During other periods, the ROM works as the decoder for phase selection control and V TEST signal generation. Information on unit, circuit mode and range is stored in latches A3U4, U6, U11 and U12 to hold the information for at least one measurement cycle.

8-20. A7 Clock Pulse Generator / Counter Board. Clock Pulse Generator (A7Y1, U1, U6 thru U8) consists of two state clocks, SCL1 and SCL2. Both clocks have a frequency of 127kHz but have a phase difference of 90 degrees to each other. The CPG also generates a 31.83kHz clock for the Data Counter and RSA RSB signals used for data register, display and measurement control. In the Data Counter Gate circuit, either a 4f or a 31.83kHz signal is selected by the 4fS signal from A8 Board and sent to Data Counter as a clock pulse. The Data Counter Gate also generates an SI signal to control A6 Integrator. Data Counter counts the input clock pulses as directed by GATE, \overline{SDC} and \overline{CDC} control signals. A parallel to serial converter A7U21 and U12 converts parallel BCD data into serial BCD data by control of RSA and RSB signals and sends the data to register files in A3 Board. All input multiplexers (A7U10, U13, U18 and U19 on the A7 board and A8U12 and U6 on the A8 board) receive various data signals, control signals, measurement condition signals, etc., and provide outputs as directed and assigned by OPB8 thru OPB10 control signals. All multiplexer outputs are taken from the A8 board.

8-21. A8 Sequence Control Board. Output signals ($\overline{MPX0}$, MPX1, $\overline{MPX2}$, MPX3, MPX4 and MPX5) from the six input multiplexers are applied to A8U1 Multiplexer which selects one of these input signals as directed by OPB11 thru OPB13 control signals. Multiplexer output is gated with OPB15 of A8U8, synchronized with SCL2 (State Clock 2) by A8U13 and becomes a qualifier input to State Counter/ Register (A8U2, U7) which produces the input signals (IBP0 thru IPB7) to Control ROM U8 in synchronization with SCL1 (State Clock 1) from next address signal (OPB0 thru OPB7 of A8U8) and qualifier input signal. Control ROM A8U8 outputs OPB0 thru OPB15 which are used for next address signal, input multiplexer control signal, Multiplexer (A8U1) control signal and provides for various instruction outputs through Decoder (A8U17). The instruction outputs are control signals for both analog and digital circuitry.

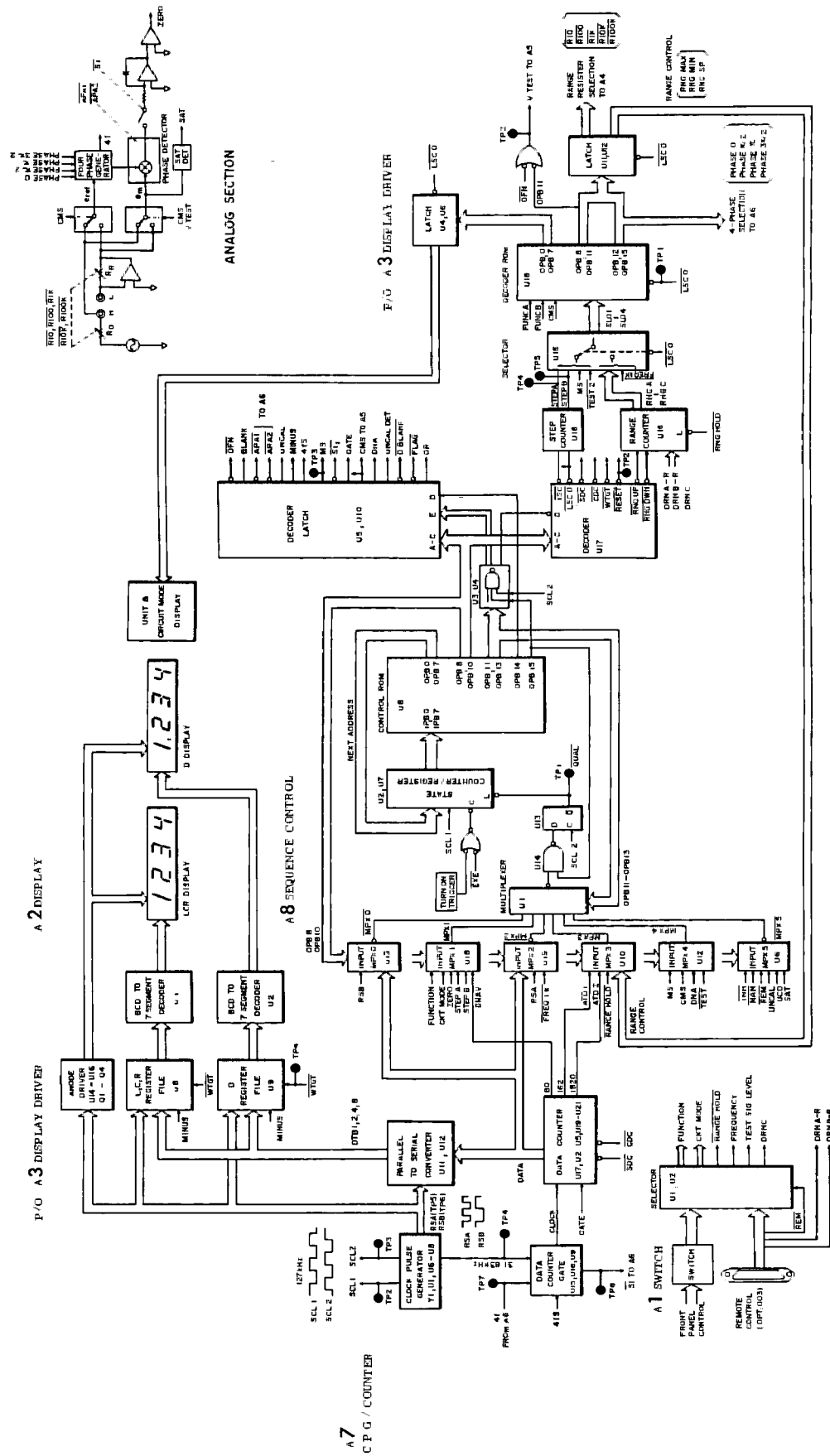


Figure 8-4. Digital Section Block Diagram.

A8U18 is a Step Counter and determines measurement step. A8U16 Range Counter receives range control signals and outputs range signals (RNG A, RNG B, RNG C) to A8U15 Selector which selects range signals only when $\overline{\text{LSC0}}$ signal is enabled or step signals (STEP A, STEP B or some step combination) when $\overline{\text{LSC0}}$ is disabled. The outputs of A8U15 Selector are sent as SLO1 thru SLO4 signals to A3 Decoder ROM input.

8-22. ROM State Machine. Since the 4261A has adopted a ROM-centered design in the digital section (A3 and A8 boards), only a brief explanation for its operation is presented here. The state machine has a state address (code) that manages the operation of the ROM state machine. ROM output is determined by the address inputted to the ROM. The state address for A8 ROM U8 is determined by next address from the ROM output and qualifier input. And it should be noted that the ROM output signal is also utilized for the control of qualifier signal. The state address sometimes increases one by one, repeats the same address several times, or jumps to higher or lower addresses. For example, if some condition should be maintained for a certain period, the state address repeats the same address during the desired number of state clocks. In this case, the instruction output does not change. Note that the ROM used in the A3 board functions as a decoder which has no feedback from ROM output to the input. The ASM chart in Figure 8-6 is very convenient for understanding the ROM-centered circuits.

8-23. A10 Mother Board. includes a selector circuit which selects local or remote control signals. If $\overline{\text{REM}}$ signal is at low level, remote control signals are selected and if at high level, local control signals are fed to internal circuitry. DRNA-R and DRNB-R signals are provided without passing through the selector.

8-24. TIMING DIAGRAM DISCUSSION.

8-25. Figure 8-5 presents a timing diagram for the 4261A. Firstly, output waveforms of the integrator, excute time for each measurement sequence, and main control signals are shown in the upper part of the diagram. The sequence excute times are different for measurement frequencies of 120Hz and 1kHz since the electrical response time for the frequencies are different and a 4f signal (four times the measurement frequency) is sometimes used for determining the charging cycle. Note that the excute time for the discharge sequence is variable. As you can understand from the diagram, the instrument first measures the L/C or R value and then the Dissipation Factor (D). To minimize error, offset null and auto phase adjustment sequences precede the L/C and R

measurements. Only an offset null sequence precedes a D measurement.

8-26. The lower part of the diagram shows how the analog circuits are controlled. Waveforms for the V TEST signal voltages (which control E_m voltage selection -- selecting either the voltage across Rr or the voltage across the UNKNOWN) and detection phase for phase detector on A6 board are shown for each circuit mode in the table in Figure 8-5. Both upper and lower sections of the waveform timing diagram have the same time scale. $-E_x$, $-E_x/10$, $-E_y$ and $-E_y/10$ in the E_m column are names for the voltages shown in diagram Note 2. The detection phases 0, $\pi/2$, π , or $3\pi/2$ are the same as the phase selection signals sent to the A6 board. The phase relationships of the voltages applied to phase detector FET switches A6Q6 and Q9 are shown in diagram Note 3 along with the phase of the E_{ref} signal at A6TP1. In R measurements, measurement steps 1 and 2 in D measurement cycle are skipped.

8-27. ASM (Algorithmic State Machine) Chart.

Figure 8-6 is an ASM chart which is similar to a flow chart and describes all the digital operations, including, of course, analog circuit control. This chart can be read in almost the same manner as a conventional flow chart. The chart is probably best used, as necessary, in combination with Figure 8-4 Digital Section Block Diagram, Table 8-1 Mnemonic Information, and circuit schematics. The chart is essential in troubleshooting the digital circuits (A3, A7 and A8 boards), so it may be referred to throughout the following section on digital troubleshooting.

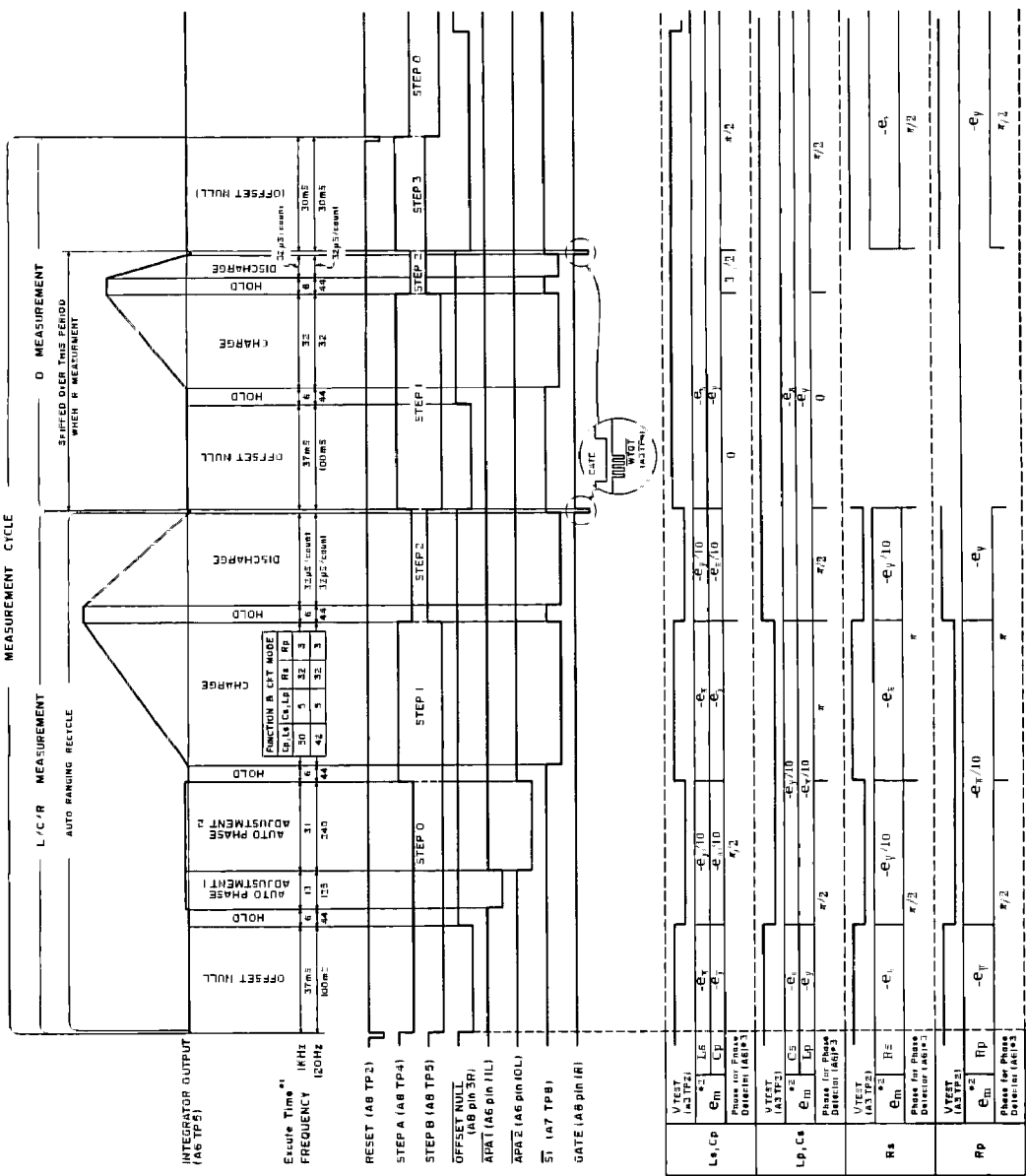
The ASM chart is a diagrammatic description of the output function and the next-state function of the state machine. The symbols used in the ASM chart are for the State Box and the Decision Box.

The ASM chart has three basic elements; the state, the qualifier and the conditional output. A single state is indicated by a state box which contains state outputs as noted in Figure 8-6.

The output consists of mnemonics selected from a defined set of operations. The mnemonics name outputs which are given during the state time. The exit path of the state box leads to other state boxes or to decision boxes.

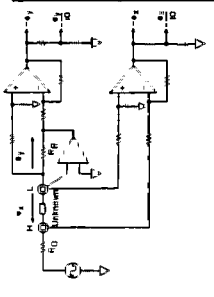
The Decision Box describes inputs to the state machine. The structure of the decision box is given in Figure 8-6. Each decision box has two exit paths.

One path is taken when the condition is true and the other when the condition is false. These two paths are usually indicated by 1 for true and 0 for false. The inputs are also called qualifiers in the sense that they qualify an output or a transition.



Note 1. Limit for escape time is msec except for discharge sequence

Note 2. Selection of E_m



Note 3. Phase for Phase Detector (A8P3, Q9)

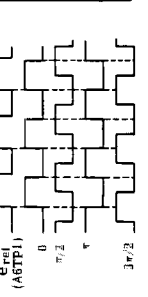


Figure 8-5. Timing Diagram.
8-7

Table 8-1. Mnemonic Information (Sheet 1 of 2).

Mnemonic	Description	Mnemonic	Description
$\overline{\text{ALT}}$	select output data for LCR or D (OPT. 002)	DRNB	direct range setting, bit B
ANOD 1 thru ANOD 4	anode driver signal 1 for data display thru anode driver signal 4 for data display.	DRNC	direct range setting, bit C
APAO	error output for auto phase adjustment	DRND	direct range setting, bit D
$\overline{\text{APA 1}}$	perform 1st auto phase adjustment	DTB 1 thru DTB 8	data bit 1 from counter thru data bit 8 from counter
$\overline{\text{APA 2}}$	perform 2nd auto phase adjustment	e_m (EM)	phase detector input voltage
ATD 1	detected output for 162 counts	e_{ref} (E REF)	AC reference phase signal
ATD 2	detected output for 1820 counts	e_{rr}	range resistor voltage
$\overline{\text{AUTRG}}$	enable local triggering when in remote control	$-e_x$ (-EX)	AC voltage for C OFFSET
BIAS	DC bias voltage	$\overline{\text{EXE}}$	external encode signal
BLANK	blank display	EXT B (EXT BIAS)	external bias voltage
B 1.5V	set internal bias voltage to 1.5V	$\overline{\text{FLAG}}$	flag signal to external device
B 2.2V	set internal bias voltage to 2.2V	$\overline{\text{FREQ 1k}}$ (FREQ)	set test signal frequency to 1kHz
$\overline{\text{C}}$	light "F" unit on front panel	FUNC A (FNC A)	function control, bit A
$\overline{\text{CDC}}$	clear data counter	FUNC B (FNC B)	function control, bit B
CL I	clock input	GATE	gate control signal for counter
CLO	clock output	H_p	voltage at H_{POTEN} terminal
CMA	circuit mode signal, bit A	$\overline{\text{INH}}$	inhibit signal from external device
CMB	circuit mode signal, bit B	INT B	internal bias voltage
CMS	set circuit mode to series	$\overline{\text{ISC}}$	increment step counter
$\overline{\text{CpRp}}$	light circuit mode indicator for Cp or Rp measurement	$\overline{\text{k}}$	light "k" on front panel
$\overline{\text{C QAL}}$	clear qualifier flip-flop	$\overline{\text{L}}$	light unit "H" on front panel
$\overline{\text{Cs}}$	light circuit mode indicator for Cs measurement	L'c	voltage at L'_{CUR} terminal
CTEN	enable counter to count 4f signal	Lp	voltage at L_{POTEN} terminal
$\overline{\text{D BLANK}}$	blank Dissipation Factor display	$\overline{\text{L}_{PA}}$	light circuit mode indicator for Lp measurement
DNA	generate $\overline{\text{D BLANK}}$ signal	$\overline{\text{LSC 0}}$	load zero to step counter
DNAV	detected output for less than 80 counts in Cp Ls.	$\overline{\text{LSD a thru LSD g}}$	light segment "a" for left side numeric display thru light segment "g" for left side numeric display
$\overline{\text{DP b}}$	light decimal point for LCR display	$\overline{\text{LsRs}}$	light circuit mode indicator for Ls or Rs measurement
$\overline{\text{DP c}}$	light decimal point for LCR display	$\overline{\text{M}}$	light "M" on front panel
$\overline{\text{DP-Loss}}$	light decimal point for Dissipation Factor display	$\overline{\text{m}}$	light "m" on front panel
DRNA	direct range setting, bit A	$\overline{\text{MAN}}$	manual trigger signal from panel control.
		$\overline{\text{MINUS}}$	display minus (-) mark on front panel

Table 8-1. Mnemonic Information (Sheet 2 of 2).

Mnemonic	Description	Mnemonic	Description
MPX 0 thru MPX 5	multiplexer 0 output thru multiplexer 5 output	RSB	read select bit B for A3 register files
MS	measurement status. If D measurement, MS is at high.	$\overline{\text{RSD a}}$ thru $\overline{\text{RSD g}}$	light segment "a" for right side numeric display thru light segment "g" for right side numeric display
\bar{n}	light "n" on front panel	$\overline{\text{R100k}}$	set range resistor to 100k Ω
N2 - 4	output BCD signal, bit weight 4 for 2nd digit	$\overline{\text{R10k}}$	set range resistor to 10k Ω
$\overline{\text{OFN}}$	perform auto offset null adjustment	$\overline{\text{R1k}}$	set range resistor to 1k Ω
OFNA	perform auto offset null adjustment	$\overline{\text{R100}}$	set range resistor to 100 Ω
OPB 0 thru OPB 15	output bit 0 from A8 ROM thru output bit 15 from A8 ROM	$\overline{\text{R10}}$	set range resistor to 10 Ω
OR	out of range	SAT	signal indicating e_m saturation
\bar{p}	light "p" on front panel	SCL 1	state clock 1
PHASE 0 (PHB 1)	select 0 detection phase	SCL 2	state clock 2
PHASE $\pi/2$ (PHB 2)	select $\pi/2$ detection phase	$\overline{\text{SDC}}$	set data counter to 1999
PHASE π (PHB 3)	select π detection phase	$\overline{\text{SI}}$	set integrator to function
PHASE $3\pi/2$ (PHB 4)	select $3\pi/2$ detection phase	$\overline{\text{SI}_1}, \overline{\text{SI}_2}$	set integrator to function
$\overline{\text{QUAL}}$	qualifier input to state counter/ register	SLO 1 thru SLO 4	selector output 1 from A8 thru selector output 4 from A8
$\overline{\text{R}}$	light "R" unit on front panel	$\overline{\text{SQAL}}$	set qualifier flip-flop
REF V	reference voltage for bias voltages	STEP A (STP A)	measurement step, bit A
$\overline{\text{REM}}$	remote signal from external device	STEP B (STP B)	measurement step, bit B
$\overline{\text{RESET}}$	turn off trigger lamp on front panel	$\overline{\text{TEST}}$	perform test operation
RNG A	range signal, bit A	$\overline{\text{TEST 1}}$	perform test 1 sequence
RNG B	range signal, bit B	$\overline{\text{TEST 2}}$	perform test 2 sequence
RNG C	range signal, bit C	TL	test level signal from A10
RNG DWN	step down one decade range	$\overline{\text{TLL}}$	set test signal level to 50mV
$\overline{\text{RNG HOLD}}$	hold measurement range	$\overline{\text{TRG L}}$	light trigger lamp on front panel
RNG MAX	maximum range signal	$\overline{\text{TOT}}$	turn-on trigger
RNG MIN	minimum range signal	UCD	detected output for UNCAL signal
RNG SP	special range that 4261A does not measure	UNCAL	detected output for SAT signal
RNG UP	step up one decade range	V TEST	select signal for e_m by working with CMS
RSA	read select bit A for A3 register files	$\overline{\text{WTGT}}$	enable data transfer
		$\overline{\text{ZERO}}$	zero detector output
		$\bar{\mu}$	light " μ " on front panel
		4f (4F)	clock 4 times test frequency
		4fs	set 4f signal as clock to counter

Table 8-2. ASM Chart Check Procedures (Sheet 1 of 16).

Note

If 4261A settings are not specified in this table, any setting is acceptable except that TRIGGER must be set to INT and RANGE HOLD must be set to OFF.

State code is expressed in the octal system. It is recommended that the logic state analyzer be operated in the single trigger mode. Unless otherwise noted, the "start display" trigger word is given in the "Trigger Word for Logic State Analyzer" column of the table.

Sequence Check for ① INITIAL SETUP TIME.

4261A Settings	Trigger Word for Logic State Analyzer (HP 1601A)	State Code Order
Normal (not Self Test) Operation		
Any settings Push 4261A RESET	001	001 002 003 004 005 006 007 010 011 037
CIRCUIT MODE: PARA	037	037 040 041 035 013
CIRCUIT MODE: SER	037	037 040 055
CIRCUIT MODE: AUTO FUNCTION: C Unknown: Open	037	037 042 043 046 047 050 013
CIRCUIT MODE: AUTO FUNCTION: C Unknown: Shorted	043	043 044 051 052 013
CIRCUIT MODE: AUTO FUNCTION: R Unknown: Shorted	043	043 046 052 013
CIRCUIT MODE: AUTO FUNCTION: L Unknown: Open	043	043 044 051 047 050 013

(Continued)

Table 8-2. ASM Chart Check Procedures (Sheet 2 of 10).

Sequence Check for ① INITIAL SETUP TIME (Cont'd)

4261A Settings	Trigger Word for Logic State Analyzer (HP 1601A)	State Code Order
CIRCUIT MODE: AUTO FUNCTION: L, C or R Unknown: in-range component (do not use max. or min. ranges).	043	043 044 045 013
1. RANGE HOLD: OFF TRIGGER: INT 2. CIRCUIT MODE: SER FUNCTION: C Unknown: Open 3. RANGE HOLD: ON TRIGGER: EXT 4. CIRCUIT MODE: AUTO Push RESET for LSA. 5. Change FUNCTION C to L.	043	043 046 052 053 054 055 035
1. RANGE HOLD: OFF TRIGGER: INT 2. CIRCUIT MODE: PARA FUNCTION: C Unknown: Short 3. RANGE HOLD: ON TRIGGER: EXT 4. CIRCUIT MODE: AUTO Push RESET for LSA. 5. Change FUNCTION C to L.	043	043 044 051 047 053 054 041 035
1. TRIGGER: INT RANGE HOLD: OFF CIRCUIT MODE: AUTO FUNCTION: C Unknown: Open TRIGGER: EXT Push RESET for LSA 2. Change FUNCTION C to L.	042	042 053 054 055 035
Self Test Operation		
TEST 1, TRIGGER: INT RANGE HOLD: OFF	011	011 012 013
TEST 2 FUNCTION: C RANGE HOLD: OFF TRIGGER: INT	011	011 012 031 032 034 036 035

(Continued)

Table 8-2. ASM Chart Check Procedures (Sheet 3 of 16).

Sequence Check for ① INITIAL SETUP TIME (Cont'd)

4261A Settings	Trigger Word for Logic State Analyzer (HP 1601A)	State Code Order
TEST 2 FUNCTION: L RANGE HOLD: ON TRIGGER: INT	011	011 012 031 033 034 035

Sequence Check for ② AUTO OFFSET NULL TIME.

4261A Settings	Trigger Word for Logic State Analyzer (HP 1601A)	State Code Order
Normal Operation		
FREQUENCY: 1kHz	013	013 014 015 016 020
FREQUENCY: 120Hz	016	016 017 017
	020 End Display	017 020
FREQUENCY: 1kHz	020 End Display	020 020 021 022
FUNCTION: C CIRCUIT MODE: PARA Unknown: Shorted	022	022 024 025 027 030 025
FUNCTION: C CIRCUIT MODE: PARA Unknown: Open Note: Push RESET for LSA several times.	022	022 024 025 027 025
	056 End Display	025 026 056
Test Operation		
TEST 1	022	022 023 026 056

Sequence Check for ③ HOLD TIME

FREQUENCY: 1kHz	056	056 057 063 063
	064 End Display	063 064

(Continued)

Table 8-2. ASM Chart Check Procedures (Sheet 4 of 16).

Sequence Check for (3) HOLD TIME (Cont'd)

4261A Settings	Trigger Word for Logic State Analyzer (HP 1601A)	State Code Order
<p>FREQUENCY: 120Hz</p> <p>Note: Push RESET for LSA several times. The state code order should be as shown in the three blocks to the right.</p>	057	057 060 060
	061 End Display	060 061
	064 End Display	061 061 062 064
	064	064 175 064 065 066 064 065 114 141
<p>FUNCTION: R</p> <p>CIRCUIT MODE: SER</p> <p>Note: Push RESET for LSA several times</p>	141	141 142 143 162 117 120
<p>FUNCTION R</p> <p>CIRCUIT MODE: PARA</p>	143	143 162 163 164
<p>FUNCTION C</p> <p>CIRCUIT MODE: PARA</p> <p>FREQUENCY: 120Hz</p>	143	143 144 145 146 147
<p>FUNCTION: C</p> <p>CIRCUIT MODE: PARA</p> <p>FREQUENCY: 1kHz</p>	143	143 144 145 166 167
<p>FUNCTION: C</p> <p>CIRCUIT MODE: SER</p> <p>FREQUENCY: 120Hz</p>	143	143 144 154 155 156
<p>FUNCTION: C</p> <p>CIRCUIT MODE: SER</p> <p>FREQUENCY: 1kHz</p>	143	143 144 154 146 147
<p>FUNCTION: L</p> <p>CIRCUIT MODE: PARA</p>	141	141 142 153 154

(Continued)

Table 8-2. ASM Chart Check Procedures (Sheet 5 of 16).

Sequence Check for (3) HOLD TIME (Cont'd)

4261A Settings	Trigger Work for Logic State Analyzer (HP 1601A)	State Code Order
FUNCTION: L CIRCUIT MODE: SER Unknown: Short Note: Push RESET for LSA several times.	141	141 142 153 145
	117 End Display	114 141 117
FUNCTION: R CIRCUIT MODE: SER	056 End Display	120 120 121 174 056
FUNCTION: R CIRCUIT MODE: PARA	174 End Display	164 164 165 174
FUNCTION: C CIRCUIT MODE: PARA FREQUENCY: 1kHz	171 End Display	167 167 170 171
	173 End Display	171 171 172 173
	174 End Display	173 173 174
FUNCTION: C CIRCUIT MODE: PARA FREQUENCY: 120Hz	151 End Display	147 147 150 151
	173 End Display	151 151 152 173
FUNCTION: C CIRCUIT MODE: SER FREQUENCY: 120Hz	160 End Display	156 156 157 160
	173 End Display	160 160 161 173
Test Operation		
TEST 1	114	114 115 116
TEST 2	114	114 115 117

(Continued)

Table 8-2. ASM Chart Check Procedures (Sheet 6 of 16).

Sequence Check for (4) AUTO PHASE ADJUSTMENT TIME

4261A Settings	Trigger Word for Logic State Analyzer (HP 1601A)	State Code Order
Normal Operation		
FREQUENCY: 120Hz	066	066 067 070 071 071
	073 End Display	071 072 073
	101 End Display	073 073 074 076 077 100 101
FREQUENCY: 1kHz	070	070 075
	076 End Display	075 075 076
	113 End Display	101 101 102 112 113
FREQUENCY: 120Hz	103 End Display	101 102 103 103
	105 End Display	103 104 105
	107 End Display	105 105 106 107
	111 End Display	107 107 110 111
	056 End Display	111 111 112 113 056

(Continued)

Table 8-2. ASM Chart Check Procedures (Sheet 7 of 16).

Sequence Check for ⑤ DISCHARGE TIME.

4261A Settings	Trigger Word for Logic State Analyzer (HP 1601A)	State Code Order	
Normal Operation			
FUNCTION: C CIRCUIT MODE: PARA Unknown: Open Note: Check that 4261A is not displaying minus (-).	175	175 176 177 200 201 202 203 204	
	212 End Display	204 203 205 206 212	
FUNCTION: C CIRCUIT MODE: SER Unknown: Open	212 End Display	203 204 205 206 212	
FUNCTION: L CIRCUIT MODE: AUTO Unknown: capacitor of a few μ F. Note: Check that 4261A is displaying minus (-).	212 End Display	201 207 210 211 212	
FUNCTION: C CIRCUIT MODE: SER Unknown: Open Note: Two code orders should be displayed on LSA. Push RESET for LSA several times.	212	212 213 224 226 257 260	212 213 224 226 257 227
RANGE HOLD: ON	212	212 213 224 226 227	
Test Operation			
TEST 1	212	212 213 214	
TEST 2	212	212 213 224 225 227	

(Continued)

Table 8-2. ASM Chart Check Procedures (Sheet 8 of 16).

Sequence Check for (6) AUTORANGING TIME

4261A Settings	Trigger Word for Logic State Analyzer (HP 1601A)	State Code Order
Normal Operation		
FUNCTION: C CIRCUIT MODE: PARA FREQUENCY: 120Hz Unknown: Open	260	260 261 270 271 272 305 227
FUNCTION: C CIRCUIT MODE: SER Unknown: Open	260	260 261 262 263 305 227
FUNCTION: R CIRCUIT MODE: SER Unknown: Open	261	261 262 304 264 227
FUNCTION: R CIRCUIT MODE: PARA Unknown: Open	261	261 270 276 301 302 264 227
FUNCTION: C CIRCUIT MODE: PARA Unknown: Short	261	261 262 263 264 227
FUNCTION: C CIRCUIT MODE: SER Unknown: Shorted	261	261 270 276 277 302 264
FUNCTION: L CIRCUIT MODE: PARA Unknown: Shorted	261	261 262 304 305
1. FUNCTION: C CIRCUIT MODE: PARA Unknown: Open 2. TRIGGER: EXT RANGE HOLD: ON 3. Unknown: Shorted Push RESET for LSA. 4. RANGE HOLD: OFF	261	261 262 263 264 265 010

Table 8-2. ASM Chart Check Procedures (Sheet 9 of 16).

Sequence Check for ⑥ AUTORANGING TIME (Cont'd)

4261A Settings	Trigger Word for Logic State Analyzer (HP 1601A)	State Code Order
<p>FUNCTION: C CIRCUIT MODE: SER Unknown: 100Ω < , < 1kΩ</p>	277	<p>277 302 303 227</p>
<p>1. FUNCTION: C CIRCUIT MODE: PARA Unknown: Open 2. RANGE HOLD: ON 3. Unknown: 2000pF 4. Push RESET for LSA. RANGE HOLD: OFF</p>	276	<p>276 277 300 264</p>
<p>1. FUNCTION: R CIRCUIT MODE: PARA Unknown: Shorted 2. RANGE HOLD: ON 3. Unknown: 2kΩ 4. Push RESET for LSA. RANGE HOLD: OFF</p>	276	<p>276 301 302 264</p>
<p>1. FUNCTION: C CIRCUIT MODE: SER Unknown: Shorted 2. TRIGGER: EXT RANGE HOLD: ON 3. Unknown: Open Push RESET for LSA. 4. RANGE HOLD: OFF</p>	261	<p>261 262 263 305 306 010</p>
<p>FUNCTION: C CIRCUIT MODE: PARA Unknown: approx. 1000pF</p>	261	<p>261 270 271 227</p>
<p>1. FUNCTION: C CIRCUIT MODE: PARA Unknown: Open 2. RANGE HOLD: ON TRIGGER: EXT 3. Push RESET for LSA. 4. CIRCUIT MODE: SER RANGE HOLD: OFF</p>	260	<p>260 266 267 304</p>

(Continued)

Table 8-2. ASM Chart Check Procedures (Sheet 10 of 16).

Sequence Check for (6) AUTORANGING TIME (Cont'd)

4261A Settings	Trigger Word for Logic State Analyzer (HP 1601A)	State Code Order
1. FUNCTION: L CIRCUIT MODE: SER Unknown: Shorted 2. TRIGGER: EXT RANGE HOLD: ON 3. Push RESET for LSA. 4. CIRCUIT MODE: PARA RANGE HOLD: OFF	260	260 266 263
FUNCTION: C CIRCUIT MODE: PARA Unknown: more than $1k\Omega$	272	272 273 274 275 227
FUNCTION: L CIRCUIT MODE: SER Unknown: $10\Omega <, < 1k\Omega$	273	273 307 227
1. FUNCTION: L CIRCUIT MODE: AUTO Unknown: more than $1k\Omega$ 2. TRIGGER: EXT 3. Push RESET for LSA. 4. CIRCUIT MODE: PARA	301	301 302 303 227
1. FUNCTION: C CIRCUIT MODE: SER Unknown: Shorted 2. RANGE HOLD: ON 3. Unknown: approx. $0.1\mu F$, $1\mu F$ or $10\mu F$ 4. Push RESET for LSA. 5. RANGE HOLD: OFF	273	273 274 305
1. FUNCTION: L CIRCUIT MODE: PARA Unknown: Open 2. RANGE HOLD: ON 3. Unknown: approx. $10mH$, $100mH$ or $1000mH$ 4. Push RESET for LSA. 5. RANGE HOLD: OFF	273	273 307 310 305

(Continued)

Table 8-2. ASM Chart Check Procedures (Sheet 11 of 16).

Sequence Check for (7) DNA DETECTION TIME

4261A Settings	Trigger Word for Logic State Analyzer (HP 1601A)	State Code Order	
Normal Operation	227	227	
FUNCTION: R CIRCUIT MODE: SER Unknown: Shorted		230	
		244	
		245	
		246	
		247	
		237	
		242	
		243	
		311	
1. FUNCTION: R CIRCUIT MODE: SER Unknown: Shorted	246	246	
2. RANGE HOLD: ON		256	
3. CIRCUIT MODE: PARA		240	
		241	
		311	
FUNCTION: R CIRCUIT MODE: SER Unknown: Open	246	246	
		247	
		250	
		240	
FUNCTION: L CIRCUIT MODE: SER Unknown: Open	244	244 or	244
		251	251
		232	232
		233	253
		234	254
		235	235
		236	236
		240	240
FUNCTION: L CIRCUIT MODE: PARA Unknown: Shorted	244	244	
		251	
		252	
		233	
		234	
		235	
FUNCTION: C CIRCUIT MODE: PARA Unknown: Open	230	230	
		231	
		232	
		253	
		254	
		235	
		237	
		242	
FUNCTION: C CIRCUIT MODE: SER Unknown: Shorted	230	230	
		231	
		252	
		253	
		254	
FUNCTION: C CIRCUIT MODE: SER Unknown: Shorted	237	237	
		240	
Note: Push RESET for LSA several times			

(Continued)

Table 8-2. ASM Chart Check Procedures (Sheet 12 of 16).

Sequence Check for (7) DNA DETECTION (Cont'd)

4261A Settings	Trigger Word for Logic State Analyzer (HP 1601A)	State Code Order
1. FUNCTION: C CIRCUIT MODE: PARA Unknown: Open 2. RANGE HOLD: ON 3. Unknown: Short	232	232 233 234
1. FUNCTION: L CIRCUIT MODE: SER Unknown: Shorted 2. RANGE HOLD: ON 3. CIRCUIT MODE: PARA	252	252 233 234 256 240
1. FUNCTION: C CIRCUIT MODE: SER Unknown: Shorted 2. RANGE HOLD: ON 3. CIRCUIT MODE: PARA	253	253 255 256
FUNCTION: C CIRCUIT MODE: PARA Unknown: Shorted Note: Push RESET for LSA several times.	234 End Display	227 234
FUNCTION: C CIRCUIT MODE: PARA Unknown: capacitor of approx. 1000pF. Check that D value is displayed on front panel. Note: Push RESET for LSA several times.	227	227 234 235 237 242 311

Sequence Check for (8) DISPLAY TIME

Normal Operation		
FUNCTION: C CIRCUIT MODE: PARA Unknown: Open	312 End Display	311 311 312
	315 End Display	312 313 312 314 315
	317 End Display	315 315 316 317
	321 End Display	317 317 320 321

(Continued)

Table 8-2. ASM Chart Check Procedures (Sheet 13 of 16).

Sequence Check for (8) DISPLAY TIME(Cont'd)

4261A Settings	Trigger Word for Logic State Analyzer (HP 1601A)	State Code Order
*FUNCTION: R CIRCUIT MODE: SER Unknown: Shorted	241 End Display	321 322 323 324 325 336 337 241
*FUNCTION: C CIRCUIT MODE: PARA Unknown: Shorted	325 End Display	325 326 330 331
**FUNCTION: R	241 End Display	321 321 322 323 324 325 336 337 241
**FUNCTION: C CIRCUIT MODE: SER Unknown: Open	324	324 325 326 330 374 375 013
**1. FUNCTION: C CIRCUIT MODE: SER Unknown: Open 2. Shortcircuit jumper wire W1 on A8 board	324	324 325 326 330 331 336
FUNCTION: C CIRCUIT MODE: PARA Unknown: Shorted	340 End Display	323 332 333 334 335 340
1. FUNCTION: C CIRCUIT MODE: SER Unknown: Shorted 2. RANGE HOLD: ON 3. CIRCUIT MODE: PARA	340 End Display	323 332 334 335 340
FUNCTION: C CIRCUIT MODE: PARA Unknown: Open	340 End Display	333 334 340

Note: Perform tests marked "***" only for units serialized 1545J-00400 and below (instead of test marked "***)").

(Continued)

Table 8-2. ASM Chart Check Procedures (Sheet 14 of 16).

Sequence Check for (8) DISPLAY TIME (Cont'd).

4261A Settings	Trigger Word for Logic State Analyzer (HP 1601A)	State Code Order
Test Operation	325	325 326 327 214
TEST 1		

Sequence Check for (9) DATA TRANSFER TIME

Normal Operation	340	340 341 342 343 344 345		
FUNCTION: C CIRCUIT MODE: AUTO				
Note Push RESET for LSA several times.			347 End Display	345 345 346 347
			352 End Display	347 350 351 352
			357 End Display	352 353 355 357
	004 End Display	357 357 360 004		
Test Operation	361 End Display	355 356 361		
TEST 1				
TEST 2 RANGE HOLD: ON				

Sequence Check for (10) TEST 1 & TEST 2

Test Operation	361	361 362 363 366
TEST 1 FREQUENCY: 1kHz		
	372 End Display	370 370 371 372

(Continued)

Table 8-2. ASM Chart Check Procedures (Sheet 15 of 16).

Sequence Check for (10) TEST 1 & TEST 2(Cont'd)

4261A Settings	Trigger Word for Logic State Analyzer (HP 1601A)	State Code Order
Test Operation		
TEST 1 (Cont'd) FREQUENCY: 1kHz Note: push RESET for LSA several times.	004 End Display	372 372 373 004
TEST 1 FREQUENCY: 120Hz	364 End Display	362 363 364
	371 End Display	364 364 365 371

Sequence Check for (11) TEST 1

Test Operation		
TEST 1 FUNCTION: C CIRCUIT MODE: PARA Unknown: Open	116	116 122 123 124 134 137 140 117
1. TEST 1 FUNCTION: C TRIGGER: EXT 2. Push MANUAL button until 4261A displays 1888 μ F. 3. Push RESET for LSA. 4. Push MANUAL.	123	123 127 130 134
1. TEST 1 FUNCTION: L TRIGGER: EXT 2. Push MANUAL until 4261A display 1888mH. 3. Push RESET for LSA. 4. Push MANUAL.	123	123 127 133 135 136 137
1. TEST 1 FUNCTION: C TRIGGER: EXT 2. Push MANUAL until 4261A display 1888nF (Cp). 3. Push RESET for LSA. 4. Push MANUAL.	123	123 127 130 131 132 137

(Continued)

Table 8-2. ASM Chart Check Procedures (Sheet 16 of 16)

Sequence Check for ⑪ TEST 1 (Cont'd).

4261A Settings	Trigger Word for Logic State Analyzer (HP 1601A)	State Code Order
1. TEST 1 FUNCTION: L FREQUENCY: 1kHz TRIGGER: EXT 2. Push MANUAL until 4261A display 188.8H 3. Push MANUAL one more time. 4261A still displays 188.8H. 4. Push RESET for LSA. 5. Push MANUAL.	123	123 127 133 134 137
1. TEST 1 FUNCTION L FREQUENCY: 1kHz TRIGGER: EXT 2. Push MANUAL until 4261A displays no numeric display. 3. Push RESET for LSA. 4. Push MANUAL.	122	122 125 126 137
1. TEST 1 FUNCTION: C FREQUENCY: 1kHz TRIGGER: EXT 2. Push MANUAL until 4261A displays no numeric displays. 3. Push RESET for LSA. 4. Push MANUAL.	122	122 125 136 137
TEST 1 RANGE HOLD ON	116	116 117

Sequence Check for ⑫ TEST 1

Test Operation		
TEST 1	214	214 215 216
	217 End Display	216 216 127
	220 End Display	217 217 220
	221 End Display	220 220 221
	227 End Display	221 221 222 223 227

(Continued)

Digital Section Troubleshooting Using Logic State Analyzer.

A logic state analyzer (for example the HP 1601A or 1600A) is very convenient for troubleshooting the 4261A ROM centered (state machine) logic circuitry. Figure 8-6 and Table 8-2 are provided to assist you in this kind of troubleshooting. Figure 8-6 is complete set of flow diagrams (ASM charts) for the 4261A. It also includes summarized flow diagrams for normal, Test 1, and Test 2 operations. Table 8-2 provides ASM chart check procedures that test all the flows included in Figure 8-6. Troubleshooting, using the logic state analyzer, should be done after the defective component is isolated to the digital section.

How to connect logic state analyzer to the 4261A: Although data inputs can be monitored directly at the pins of A8U8 (input address bits IPB0 thru IPB7) using the input probes of the logic state analyzer, it is recommended that the Service Cable (HP P N: 04261-65001) be connected to the spare jack (A8J1) on the A8 board and logic state analyzer input probes be connected to each cable line (see Figure 8-14). Clock inputs should be taken from A7TP2 (state clock 1).

How to troubleshoot: When the measurement is being repeated (trigger lamp turns on and off), first set the trigger word to 004 in octal and check the ASM chart. Then repeat the test, increasing the trigger word, so that the measurement sequence is executed according to the front panel conditions (control settings, displays and the unknown device). The trouble may be located in the circuit corresponding with the signal that generates the flow that is inconsistent with front panel conditions.

If the measurement can not be repeated, set 4261A TRIGGER to EXT and the logic state analyzer SAMPLE MODE to SINGLE. The logic state analyzer can now check that the flow shown in the ASM chart block (① thru ⑫) in Figure 8-6) is or is not being executed when the trigger word is set to the last word of the chart block and the 4261A MANUAL button is operated (the trigger word will be displayed on the logic state analyzer if the chart block is properly executed). By doing this check, starting from ASM chart block (①), the trouble may be in the logic circuitry that corresponds to the chart block which does not execute. Locate that line in the abnormal chart block that halts the sequence. Check the circuitry that corresponds to the signal that halts the sequence.

Note

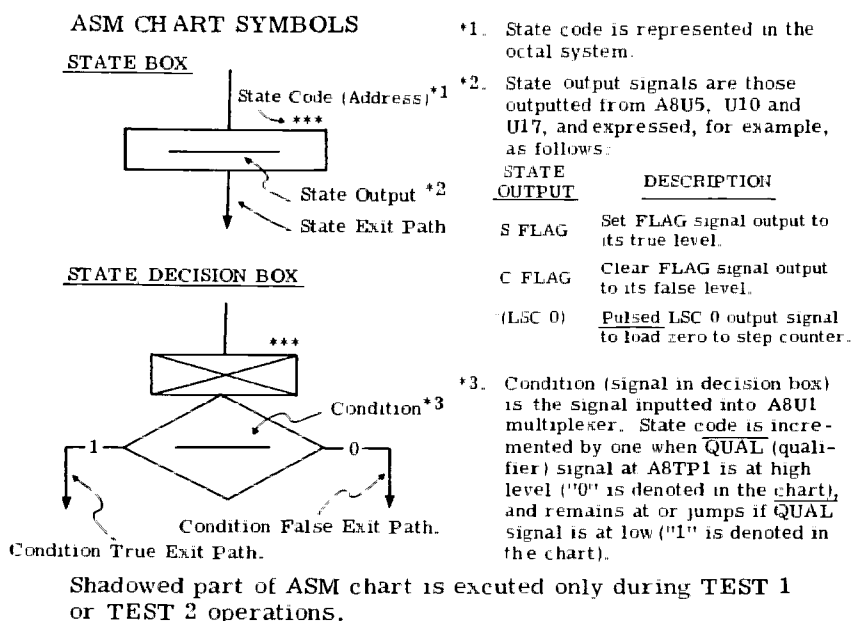


Figure 8-6. ASM Chart (Sheet 1 of 7).

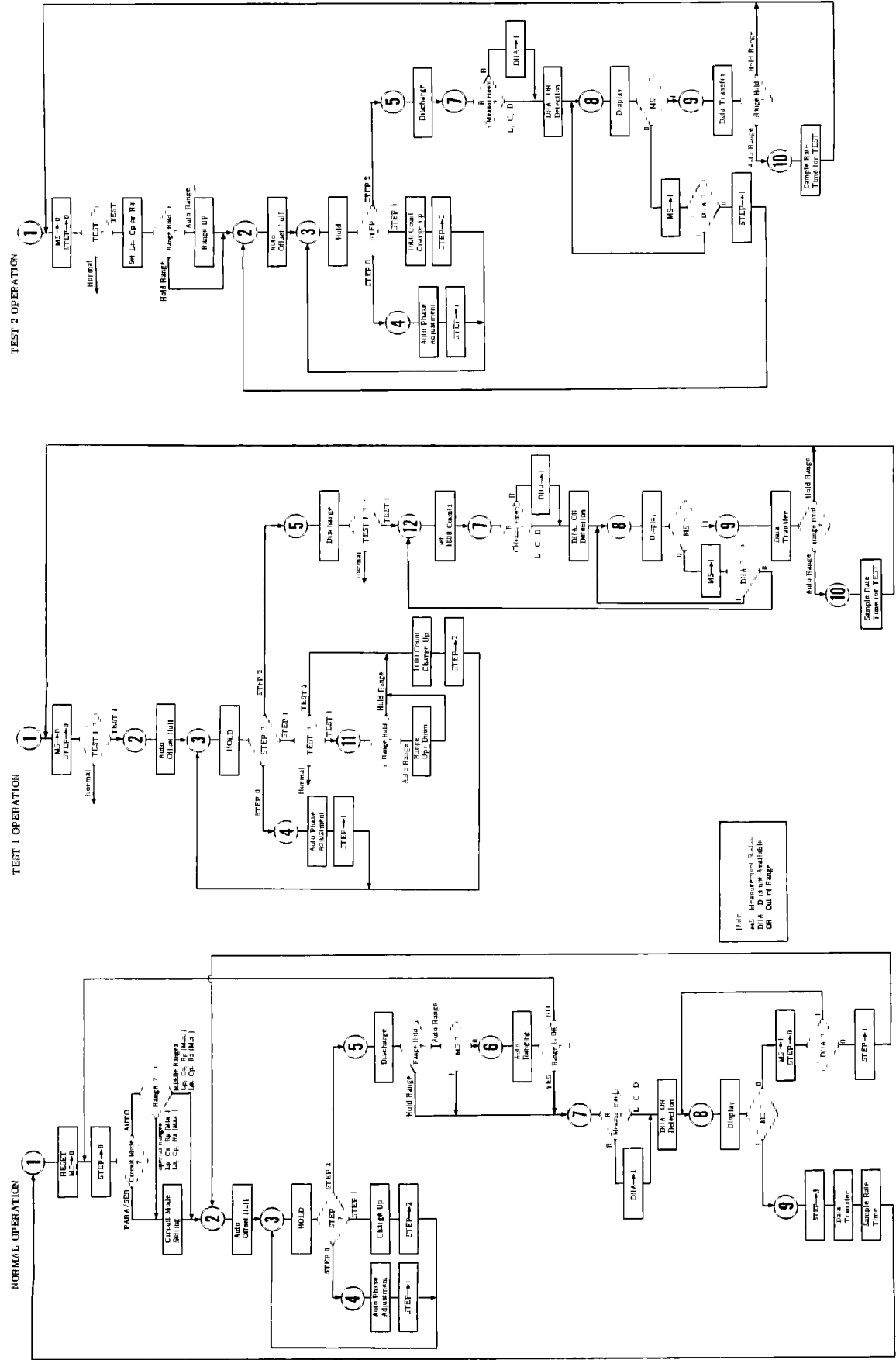


Figure 8-6. ASM Chart (Sheet 2 of 7).
8-27

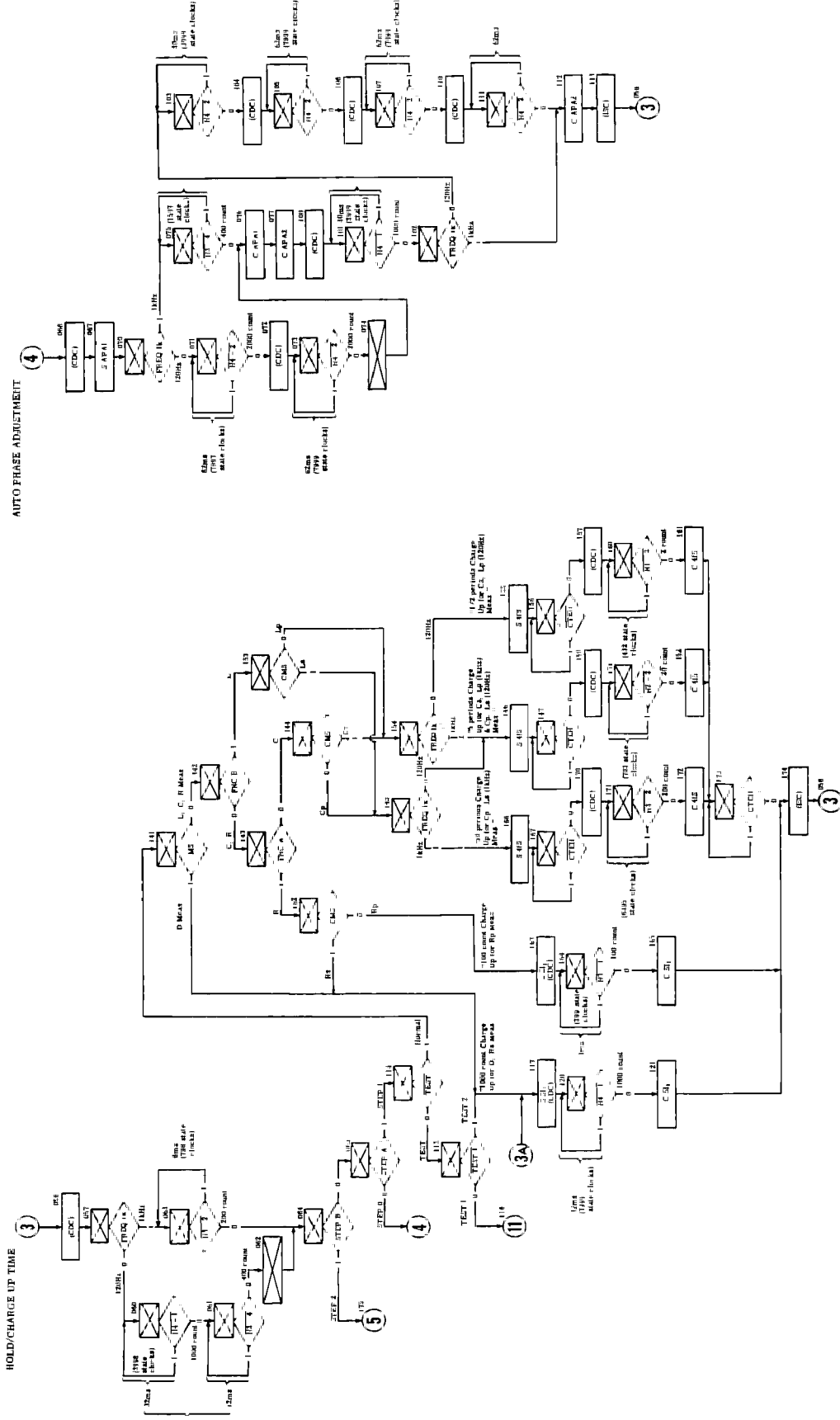


Figure 8-6. ASM Chart (Sheet 4 of 7).
8-31

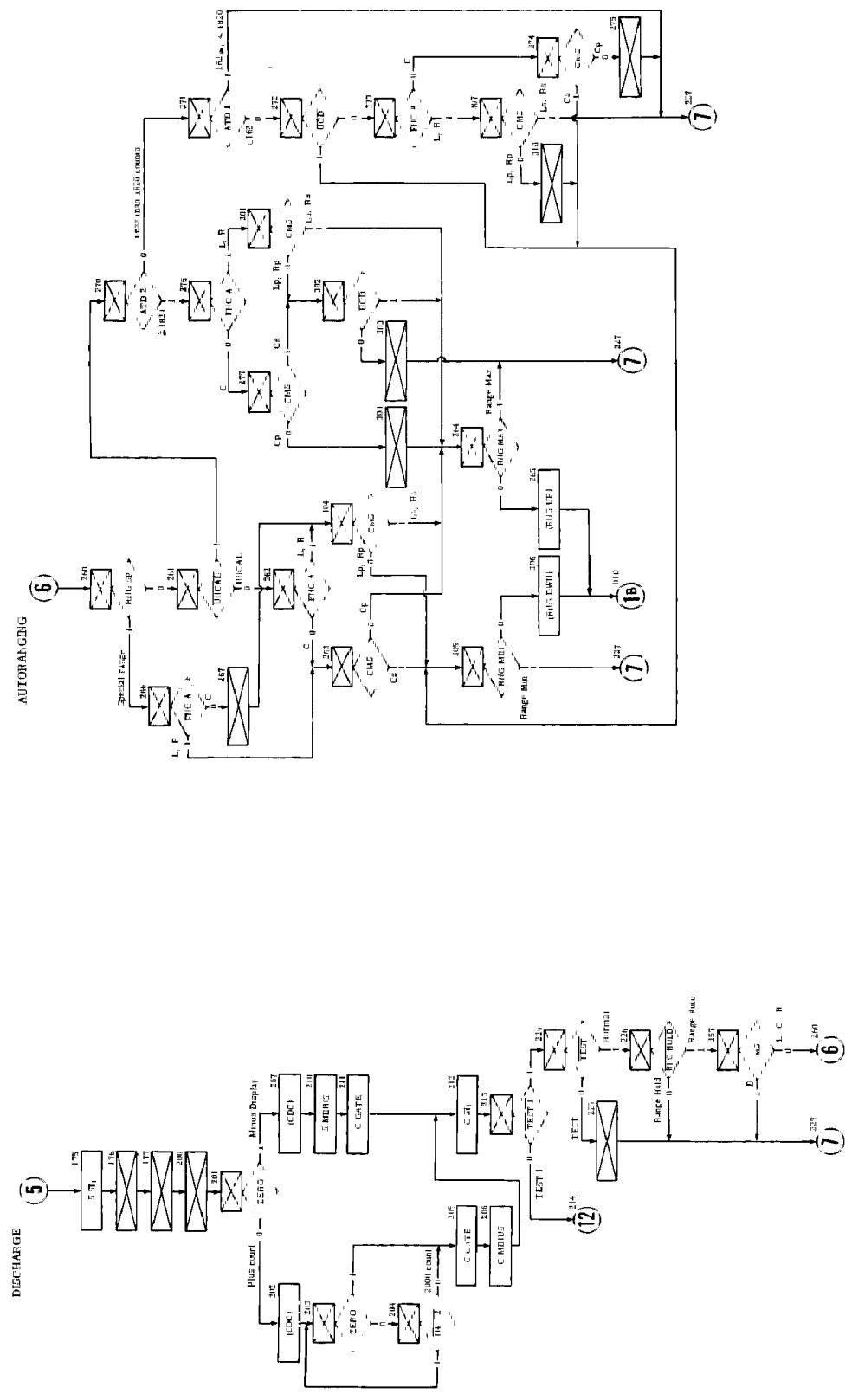


Figure 8-6. ASM Chart (Sheet 5 of 7).
8-33

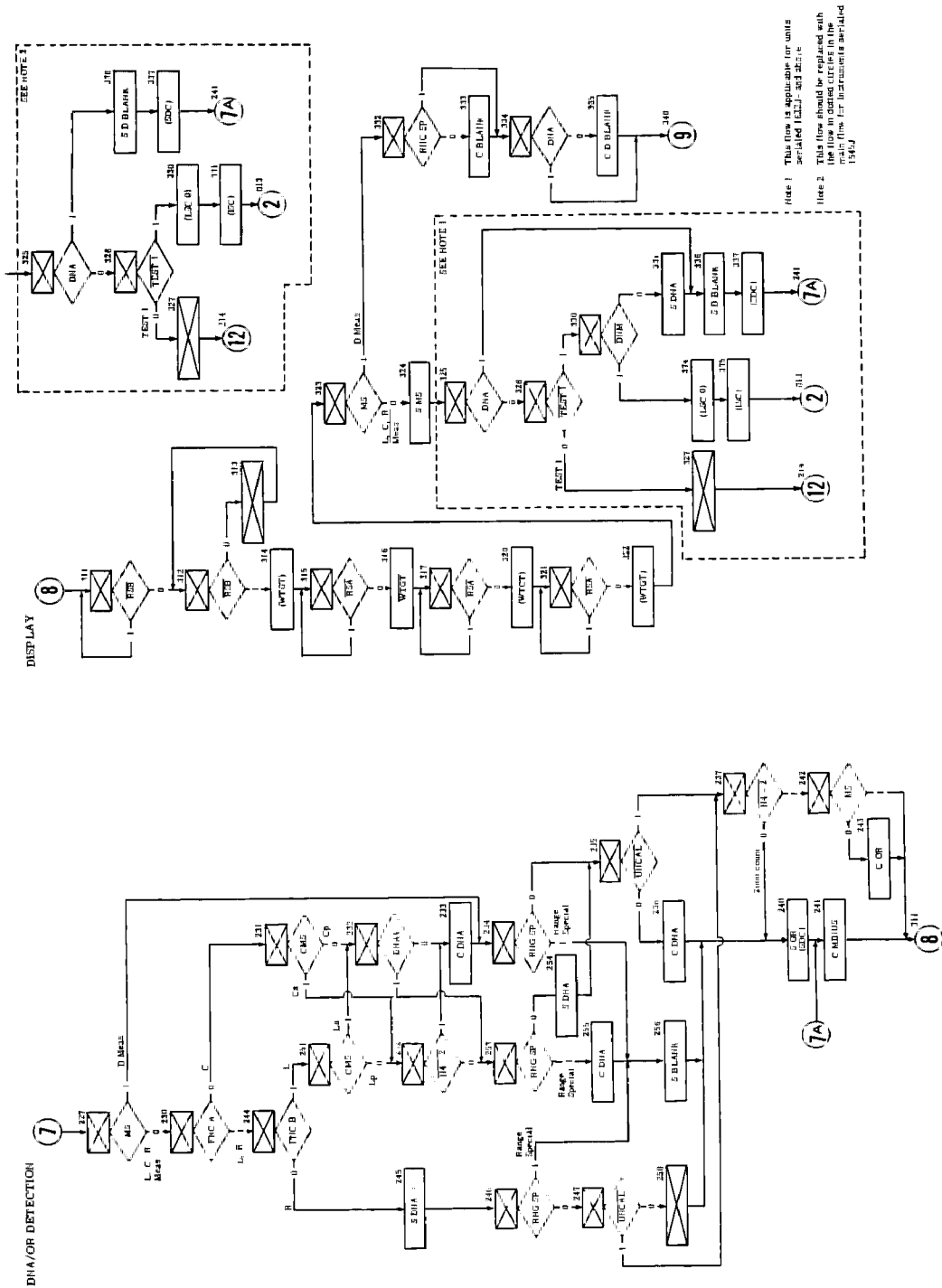


Figure 8-6. ASM Chart (Sheet 6 of 7).

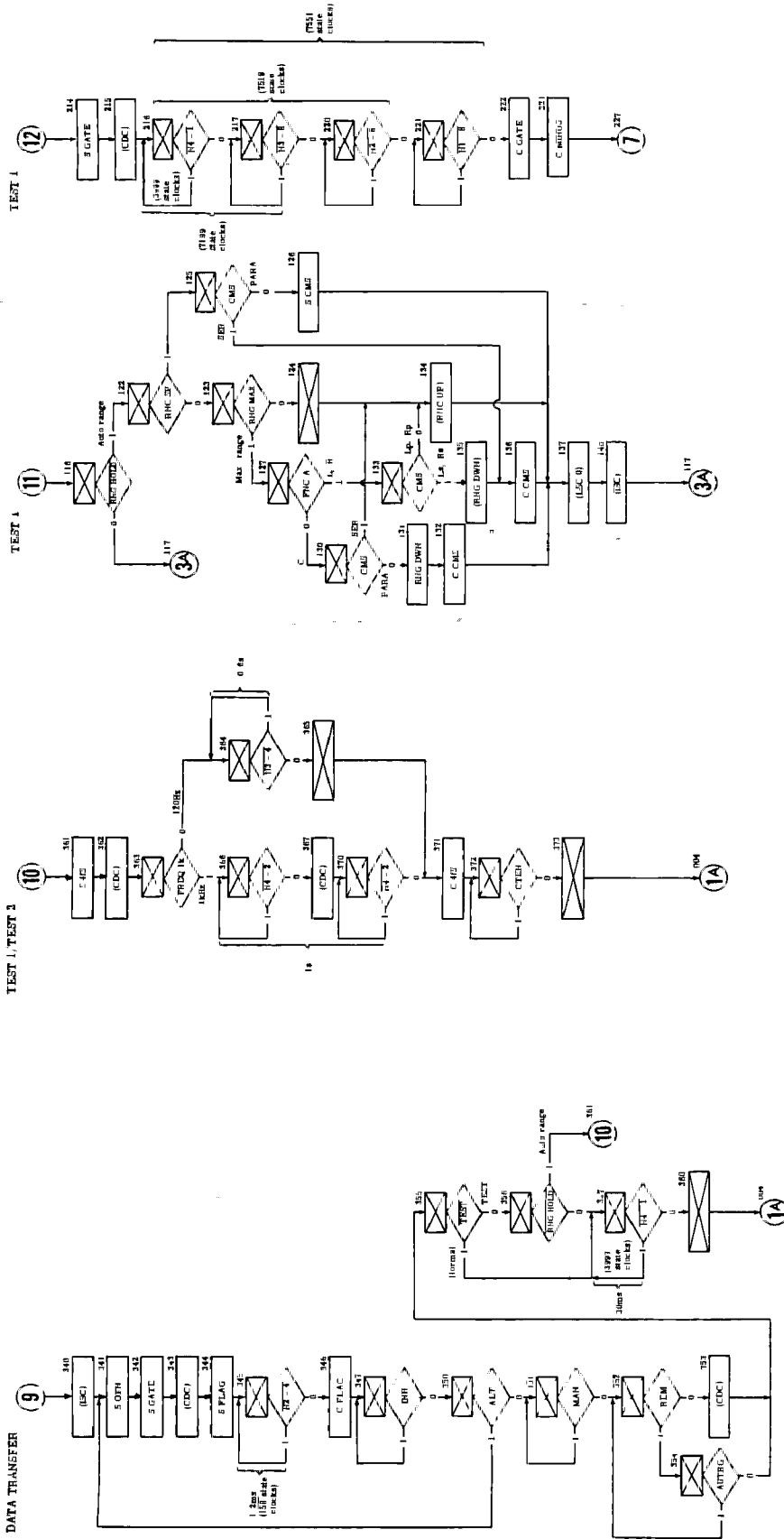


Figure 8-6. ASM Chart (Sheet 7 of 7).
8-37

8-28. TROUBLESHOOTING.

CAUTION

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.

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

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.

8-29. Figure 8-8 "How to Use Troubleshooting Guides" is helpful when starting to troubleshoot the 4261A. Charts and diagrams to assist in troubleshooting are provided in this section under "Theory of Operation" and include:

Simplified Block Diagram	Figure 8-1
Analog Section Detailed Block Diagram	Figure 8-3
Digital Section Detailed Block Diagram	Figure 8-4
Timing Diagram	Figure 8-5
Logic Flow Diagrams (ASM Charts)	Figure 8-6

Table 8-1 Mnemonics Information will also be helpful in troubleshooting. The troubleshooting guide in Figure 8-9 first isolates the power supply or option sections from an overall unit and then describes how to tell whether the faulty assembly is located in the analog or digital section. Figure 8-7 describes typical front panel symptoms present when 4261A internal controls are not well-adjusted. A search for and interpretation of trouble symptoms by operating front panel controls is very important and often gives hints as to trouble location. For example, if the problem only occurs when FREQUENCY control is set to 120Hz, it is obvious you need only check the section which develops the test frequencies or which controls these frequencies. Figure 8-9 is an example of such approach to troubleshooting. Table 8-3, which employs the built-in self test functions, is also helpful in overall troubleshooting. Refer to paragraph 8-35 to learn about self-test. Figure 8-10 isolates a faulty board assembly in the analog section, and Figure 8-11 checks whether the A1, A2 or A10 boards are malfunctioning or not. Figure 8-12 and Table 8-2 are troubleshooting guides for the state machine section (A3, A7 and A8 boards) and assist in locating a malfunctioning part to the component level. This guide should be used even when the trouble remedy specified is, for example, board replace-

8-38

ment. Component level troubleshooting guides are outlined in service sheets for each major assembly (other than for A7 and A8 boards).

CAUTION

A3 THRU A9 BOARDS (P/N's 04261-77003 THRU 04261-77009) INSTALLED IN 4261A's SERIALIZED 1545J-00400 AND BELOW ARE COATED WITH SILICONE EXCEPT FOR TEST POINTS AND BOARD PIN CONNECTORS. MONITORING OF THESE CIRCUITS SOMETIMES CAN NOT BE DONE WITH A VOLTMETER, OSCILLOSCOPE OR OTHER TEST EQUIPMENT UNLESS THIS PROTECTIVE COATING IS FIRST REMOVED. IN ORDER TO PREVENT DEGRADING PERFORMANCE IN HIGH HUMIDITY AREAS, THE COATING MUST BE REPLACED AFTER REPAIR.

A10 BOARD (P/N: 04261-77010) IN ALL INSTRUMENTS IS COATED WITH SILICONE AFTER APPLICATION OF THE SOLDER RESISTIVE MASKING.

A1 (P/N: 04261-77001), A2 (P/N: 04261-77002), A21 (P/N: 04261-77021) AND A22 (P/N: 04261-77022) BOARDS ARE NOT COATED WITH SILICONE.

8-30. How to Isolate Trouble to Either Analog or Digital Sections.

8-31. Follow the troubleshooting procedure in Figure 8-8 which provides specific instructions for isolating the Analog and Digital sections from each other.

WARNING

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

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.

Misadjusted Control	Symptom
A4R87 (OFFSET)	When Cp TEST SIG LEVEL is set to 50mV, autoranging operation sometimes does not work well. DC level at A4TP3 varies on each range.
A5R31 (OFFSET-1)	Measurement accuracy when measuring as series equivalent is sometimes lower (due to improper dc level at A5TP3).
A5R40 (OFFSET-2)	Measurement error when measuring as parallel equivalent is sometimes excessive (due to improper dc level at A5TP3) especially when Cp TEST SIG LEVEL is set to 50mV.
A5R54 (OFFSET-3)	Measurement accuracy will decrease when offset voltage at A5TP3 is not 0 volts. This is usually more noticeable when Cp TEST SIG LEVEL is set to 50mV.
A5R84 (OFFSET-4)	D measurement error sometimes exceeds specifications (impossible to automatically adjust the detection phase of phase detector). This symptom is present when auto phase signal adjustment at A6TP3 exceeds 0 ±3 volts.
A6R65 (ZERO OFFSET)	Measurement errors for both LCR and D values have increased. The error is maximum for a 2000 count displays for either Cs, Lp and Rp measurements.
A6R67 (PHASE OFFSET)	D measurement has significant error (detection phase error).
A9R6 (+12V ADJ.)	DC supply voltages at A9TP4 (+12V), A9TP5 (-12V) and A9TP6 (+5V) have shifted to improper dc levels.

Figure 8-7. Front Panel Symptoms of Internal Control Misadjustment.

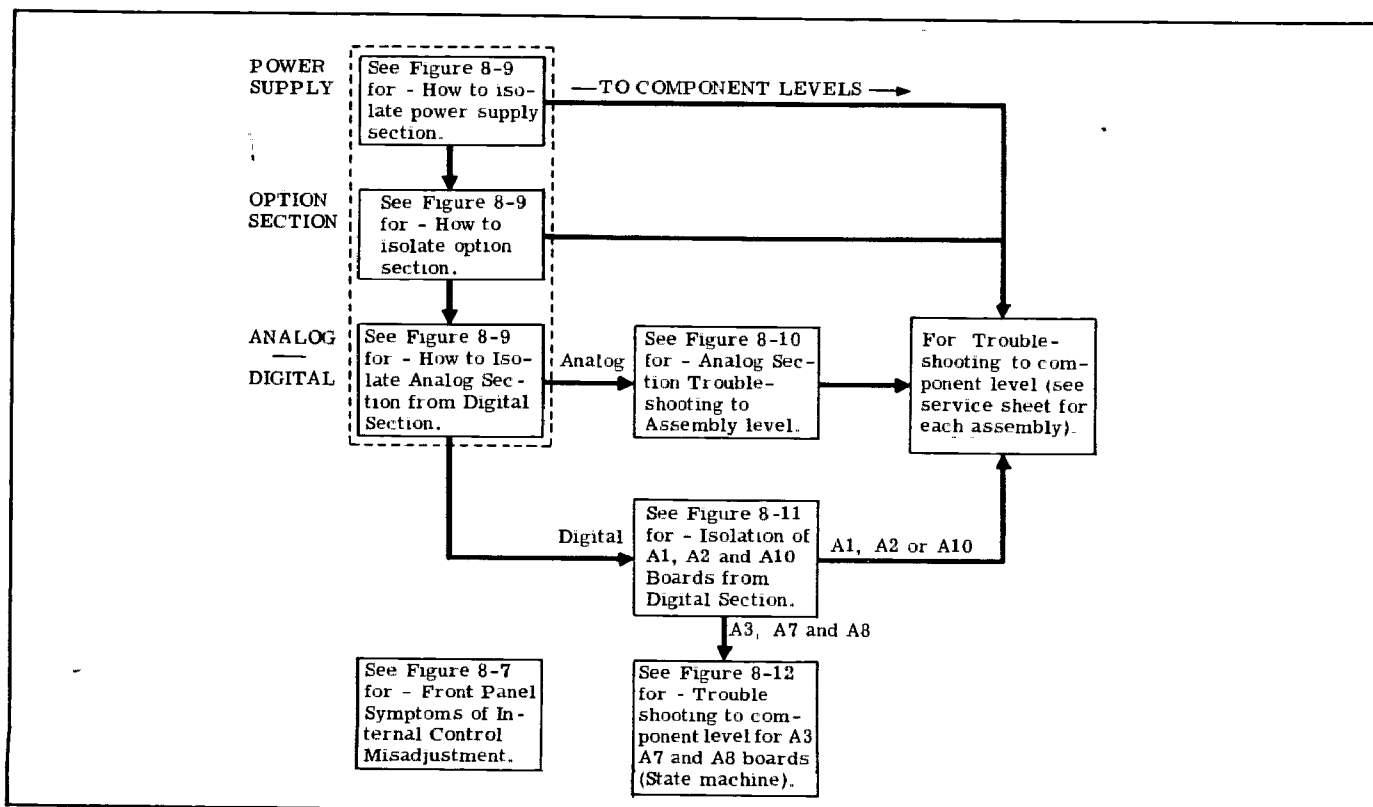


Figure 8-8. How to Use Troubleshooting Guides.

The following is a complete list of control signals from the digital circuits (A3, A7 and A8 boards) to the analog section:

TLL	A3 → A4
R100k, R10k, R1k, R100, R10	A3 → A4
V TEST	A3 → A5
PHASE 0, PHASE π , 2, PHASE π , PHASE 3, 2	A3 → A6
SI	A7 → A6
OFN	A8 → A5
OFNA	A8 → (A5) → A6
APA 1, APA 2	A8 → A6

Only three signals are fed from the analog section (A4, A5 and A6 boards) to the digital section. These are.

SAT	A5 → A8
4f	A6 → A7
ZERO	A6 → A7

8-32. Troubleshooting Analog Section to Assembly Level.

8-33. Follow the troubleshooting procedures in Figure 8-10 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.

8-34. Digital Section Troubleshooting.

8-35. Figures 8-11, 8-12 and Table 8-2 are troubleshooting guides for isolating A1, A2 and A10 boards from the digital section and provide help in locating the defective part in the state machine consisting of the A3, A7 and A8 board circuitry. Refer to the individual service sheet in this section for component level troubleshooting for the A1, A2, A3 or A10 boards. Final troubleshooting to the component level is covered in Figure 8-12 for the A3, A7 and A8 boards since these boards comprise the state machine in which it is difficult to isolate a defective part. Troubleshooting data for these boards is not provided in individual service sheets, so Figure 8-12 should be referred to when troubleshooting boards A3, A7 and A8 to the component level. Figure 8-6 also gives digital section troubleshooting using a logic state analyzer and the complete ASM chart. When using Figure 8-6, the Table 8-2 ASM chart check procedures will be helpful in troubleshooting.

8-36. Built-in Self Test Function.

8-37. The 4261A has a built-in self test function that checks whether the analog or digital section is working properly or not. To perform a self test, the slide switch mounted on the A8 board assembly (04261-77108) must be set to the proper position. Test operations are continuously repeated when EXT TRIGGER is set to INT; so it is usually better to set the TRIGGER selector to EXT and, for easy observation of front panel display, to advance the operation step-by-step with the MANUAL pushbutton. The following paragraphs explain self tests 1 and 2.

8-38. TEST 1 is a test position for the digital circuitry and almost all the digital circuitry can be checked merely by observing the front panel displays.

TEST 1 can be done without regard to the analog signal section except that the sample rate time is shortened when the 4f signal is not inputted. Thus, if the TEST 1 results are false, the trouble is probably located in the digital circuitry. Conversely, if TEST 1 results are true, the electrical defect can usually (but not always) be isolated to the analog circuits. TEST 1 permits a constant 1888 counts to the counter and displays these counts for each measurement range with the decimal point inserted as appropriate. The range is stepped automatically. Thus, if the range does not step properly in this test, the trouble may be in the autoranging circuit. Table 8-3 shows the display sequence for TEST 1 and TEST 2 for each function with the condition at the UNKNOWN terminals. Figure 8-6 shows flow diagrams for both TEST 1 and TEST 2.

8-39. TEST 2 is designed to check the analog circuitry. If the digital section is functioning satisfactorily and analog circuitry is not defective, the front panel display will follow Table 8-3. TEST 2 integrates the reference signal for a period of 1000 counts and discharges the integrator with the same reference signal. The e_{ref} signal is phase-detected as an in-phase signal with respect to e_{ref} for LCR measurements and is phase-shifted by $\pi/2$ ($= 90^\circ$) with respect to e_{ref} for D measurements. Therefore, the LCR display will be about 1000 counts and the D display will be about 0 counts (if the phase error of the detecting signal is very small). This operation is performed sequentially for each range and includes an Ls, Cp and Rs test. Unknown connectors should be shorted together to perform TEST 2 for L, R FUNCTIONS and open for a C FUNCTION test. If the results of TEST 1 are good and those of TEST 2 abnormal, the analog circuits are probably defective. LCR display must show 1000 counts ± 5 counts and D display must show 0~5 counts. If the displays are out of these ranges, the 4261A may not satisfy its measurement specifications. Successful results of both tests does not necessarily mean that the 4261A meets all its specifications even though the counts are within the above limits. However, what it does mean is that, if any one range displays 1000 counts on LCR display and 0 counts on D display, respectively, then the A5 circuitry (after signal selector), A6 phase detector, integrator and zero detector are probably normal.

8-40. If TEST 1 is normal and TEST 2 is attempted on normal ranges when the ZERO signal from the analog section remains continuously at LOW level, the display will always read 1999 counts. If ranging is abnormal under these conditions, the display will be blank. Conversely, if the conditions are the same as above except that the ZERO signal remains continuously at HIGH level, then the display results for TEST 2 will be as shown in the table which follows:

FUNCTION	Unknown	Display
L R	Open	1999 counts
L R	Short	-000
C	Open	-000
C	Short	1999

If ranging is abnormal under these conditions, the display will be blank.

Note

When LCR display shows -000 counts, D display is blanked.

Even if a 4f signal is not received by the digital section, both TEST 1 and 2 will appear normal except that the sample rate time will decrease.

8-41. RECOMMENDED TEST EQUIPMENT.

8-42. Since a logic state analyzer is usually used when monitoring the state codes of the state machine for troubleshooting the logic circuitry, Hewlett-Packard provides a service cable which is helpful in connecting 4261A circuits to the logic state analyzer input cables. The HP part number for this cable is 04261-65001. Figure 8-14 is an illustration of the cable connections to HP logic state analyzer input cables. Extender Board P.N 5060-4017, is useful for troubleshooting, and is available from Hewlett-Packard. The extender is listed in Table 1-4.

8-43. Table 1-5 lists all test equipment used for the troubleshooting outlined in this section. Hewlett-Packard often prepares a board kit or a spare parts kit to assist in troubleshooting and to reduce repair time. Contact your nearest HP office for information.

8-44. REPAIR.

8-45. Q1 Removal.

- a. Remove Q1 transistor cover (rear panel).
- b. Remove Q1 from rear panel by removing its two mounting screws.
- c. Install new Q1.
- d. Replace cover.

8-46. Removal of Q2 or Q3.

- a. Remove top cover from instrument.
- b. Remove the two transistor mounting screws.
- c. Lift out transistor.
- d. Install new transistor.

8-47. Removal of CR1 thru CR3.

- a. Remove top and bottom covers from instrument.

Note

If any option is installed in instrument, remove flat cable from rear connector assembly.

- b. Unsolder diode wire lead.
- c. Remove 3/8" nut with hex driver.

- d. Install new diode.
- e. Solder lead to diode and mount diode on deck.

8-48. Removal of A1 Switch Board.

Note

Removal procedure for A2 Display board is printed on the angle bracket of A2 board. Remove top cover to locate and read these instructions.

- a. Remove top cover from the instrument.
- b. Remove both adhesive side trim strips from front frame.
- c. Remove the four screws from side frames.
- d. Pull front panel slightly forward.

Note

Do not use excessive force or wire connections to unknown terminals may break.

- e. Remove MANUAL switch mounting nut from front panel. Use 5/16 inch hex driver.
- f. Remove the A3 board by disconnecting the three flat cables.
- g. Remove the three screws which mount the A1 switch board to the front panel. A screw driver should be inserted in the opening between A3 board and front frame.
- h. Remove A1 board flat cable connector from A10 mother board.
- i. Push A1 board to rear and lift out.

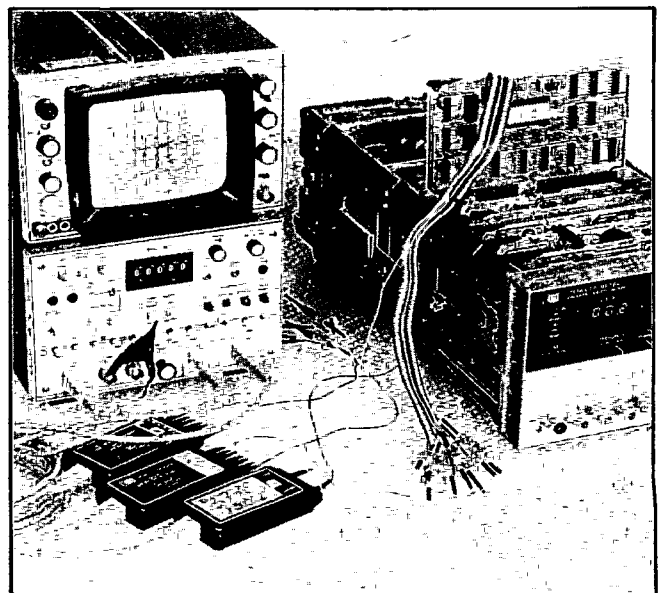


Figure 8-13. Service Cable Connections.

8-49. PRODUCT SAFETY CHECKS.

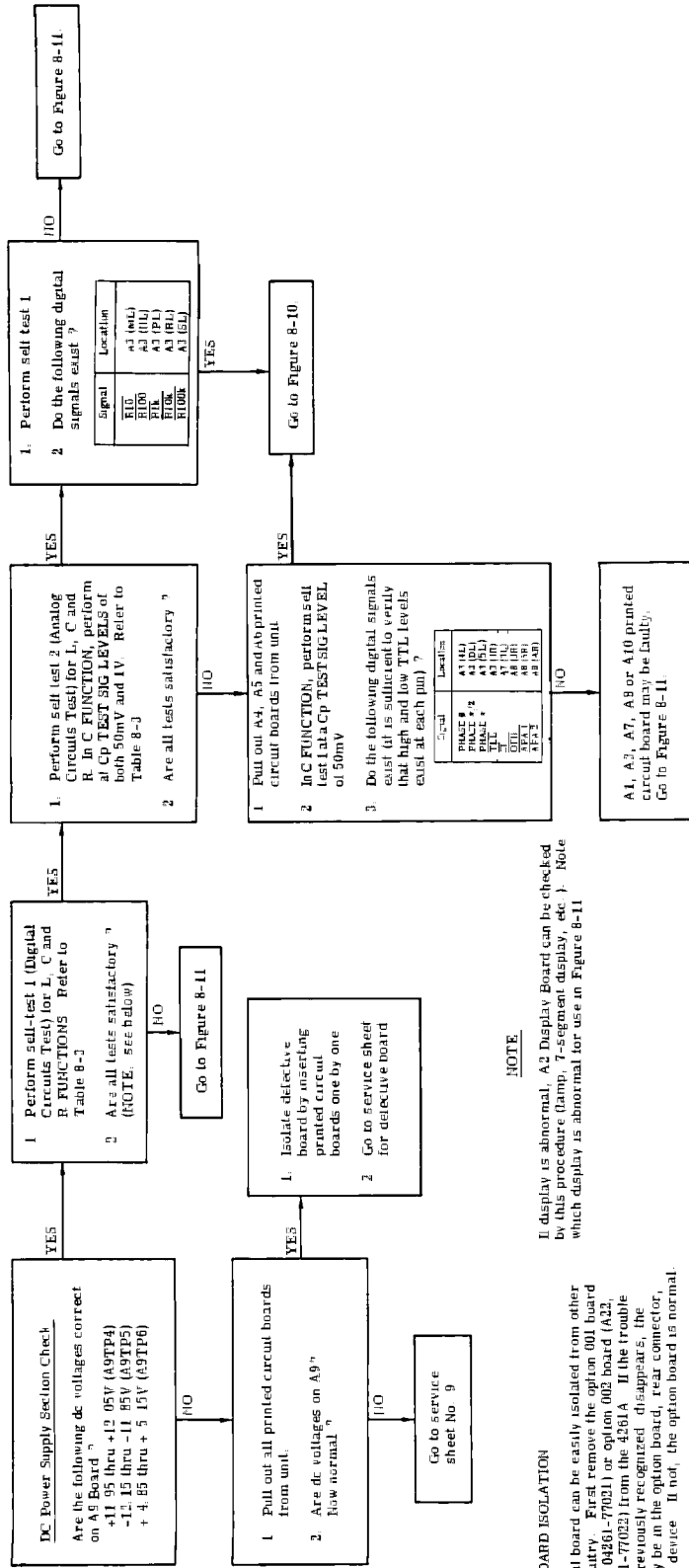
WARNING

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.

8-50. The following five checks are recommended to verify the product safety of the 4261A 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 internally generated 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 GUARD 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.



OPTION BOARD ISOLATION

The optional board can be easily isolated from other 4261A circuitry. First remove the option 001 board (A21 P/N: 04261-77021) or option 002 board (A22, P/N: 04261-77022) from the 4261A. If the trouble symptom previously recognized disappears, the trouble may be in the option board, rear connector, or external device. If not, the option board is normal.

To isolate a trouble in option 003, remove the flat cable which combines the rear connector with the A10 mother board from the A10 board. If the 4261A functions properly in local control, the trouble may be located in the option 003 cable, connector or external device. If not, the option 003 is not defective.

Figure 8-9 How to Isolate Analog Section from Digital Section

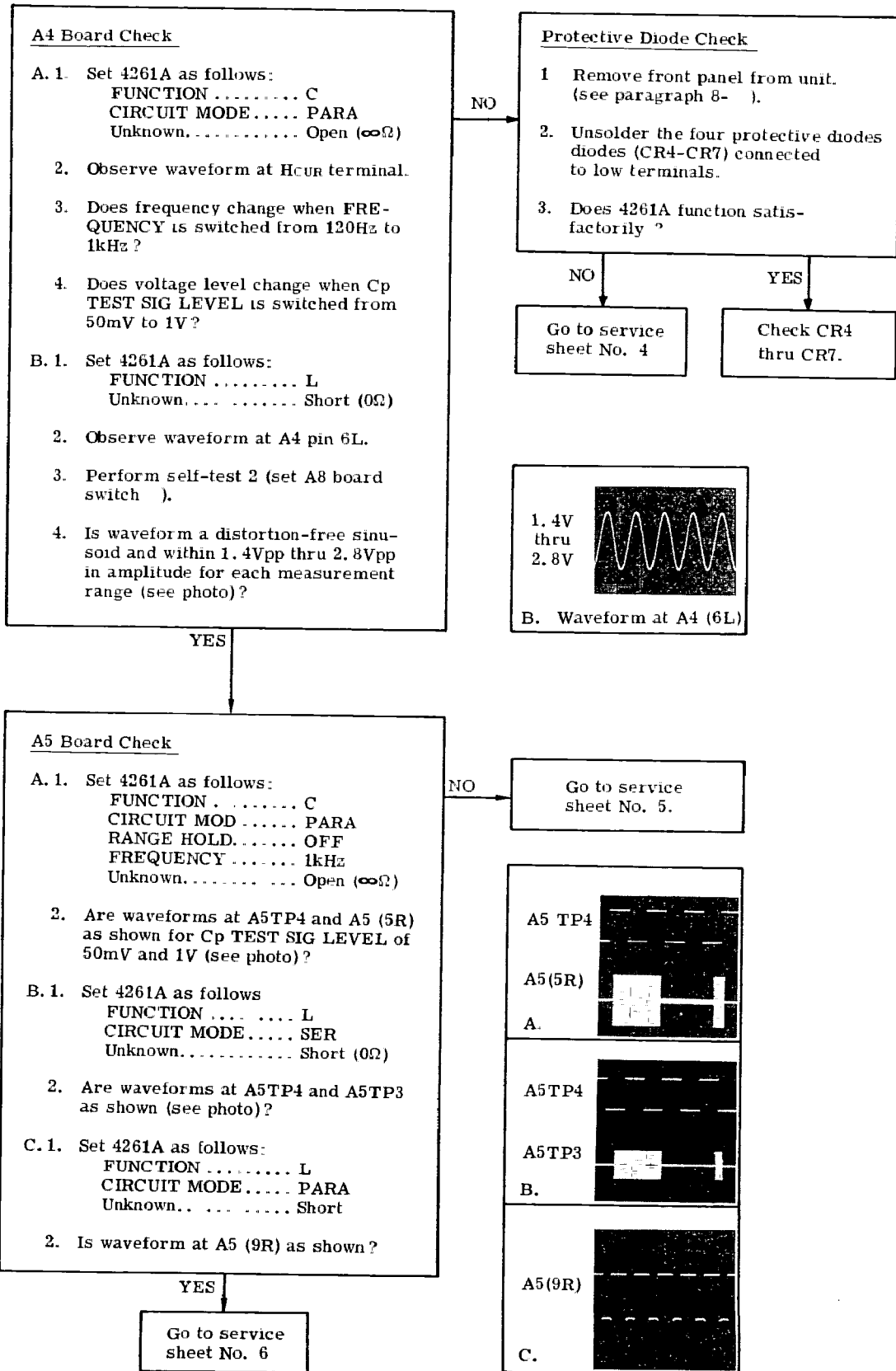


Figure 8-10. Analog Section Troubleshooting to Assembly Level.

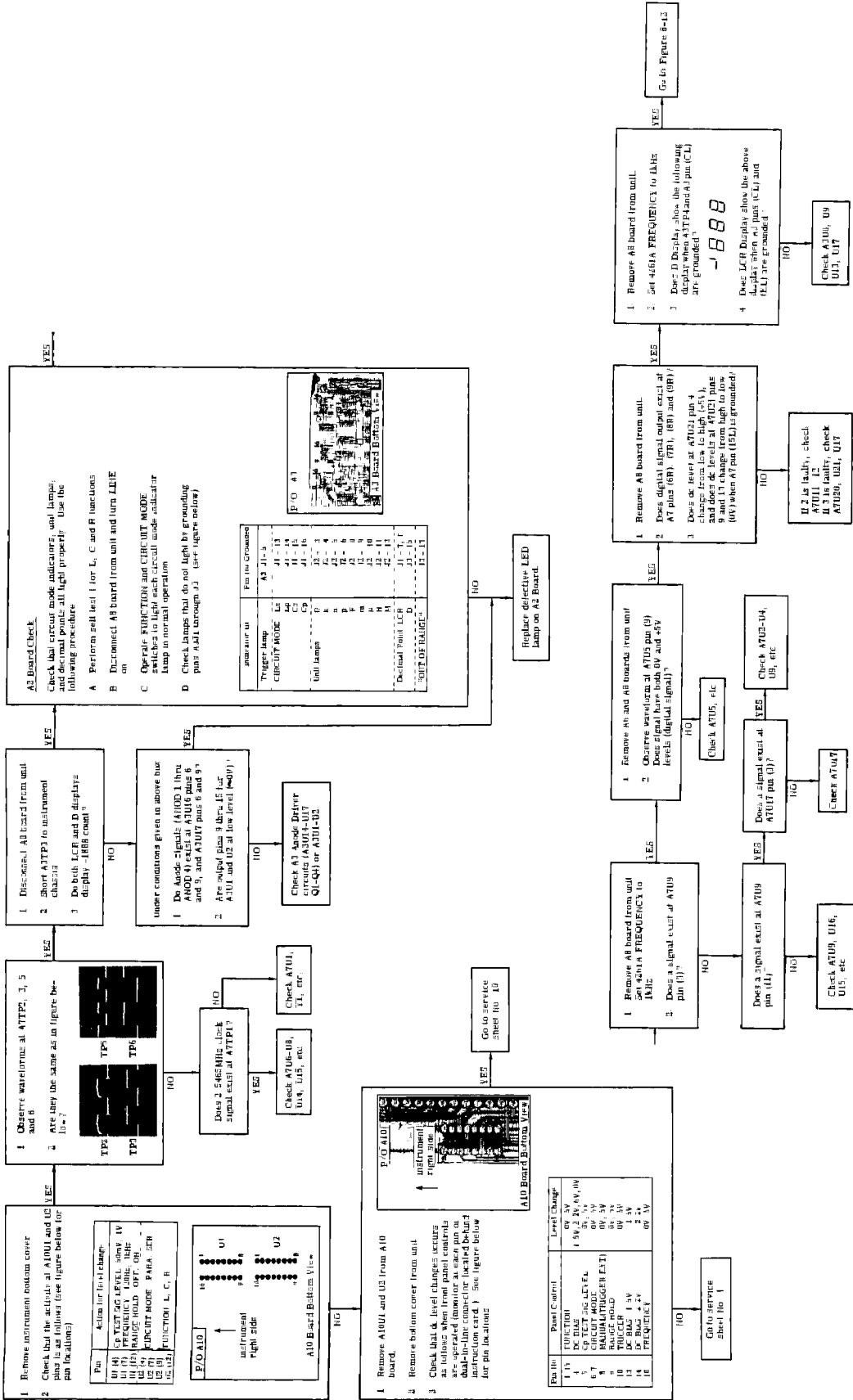


Figure 8-11 Isolation of A1, A2 and A10 Boards in Digital Section

This troubleshooting can be done with a logic probe (BP 106.57 for example) as well as with an oscilloscope.

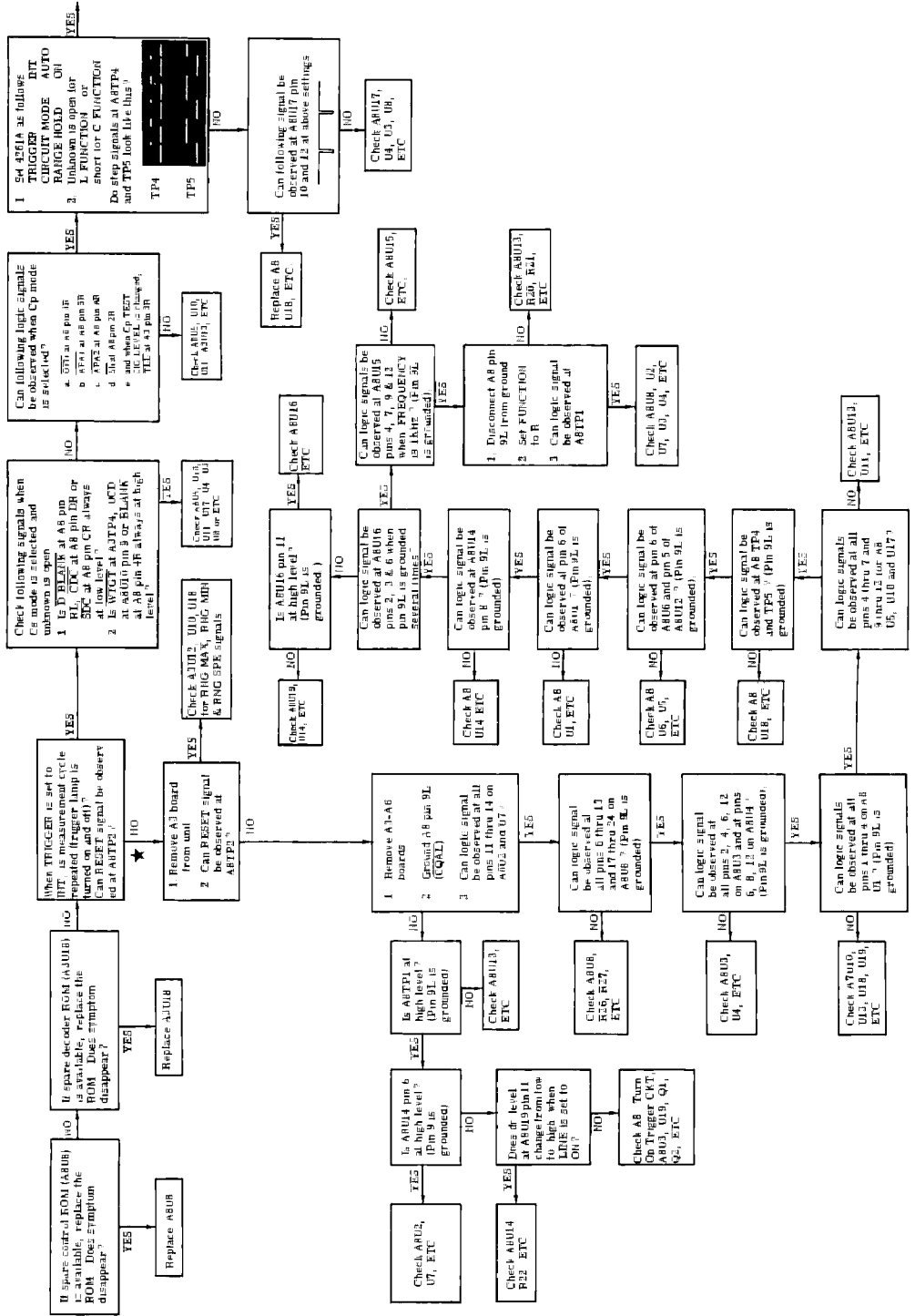


Figure 8-12. Troubleshooting to Component Level for A3, A7 and A8 Boards.

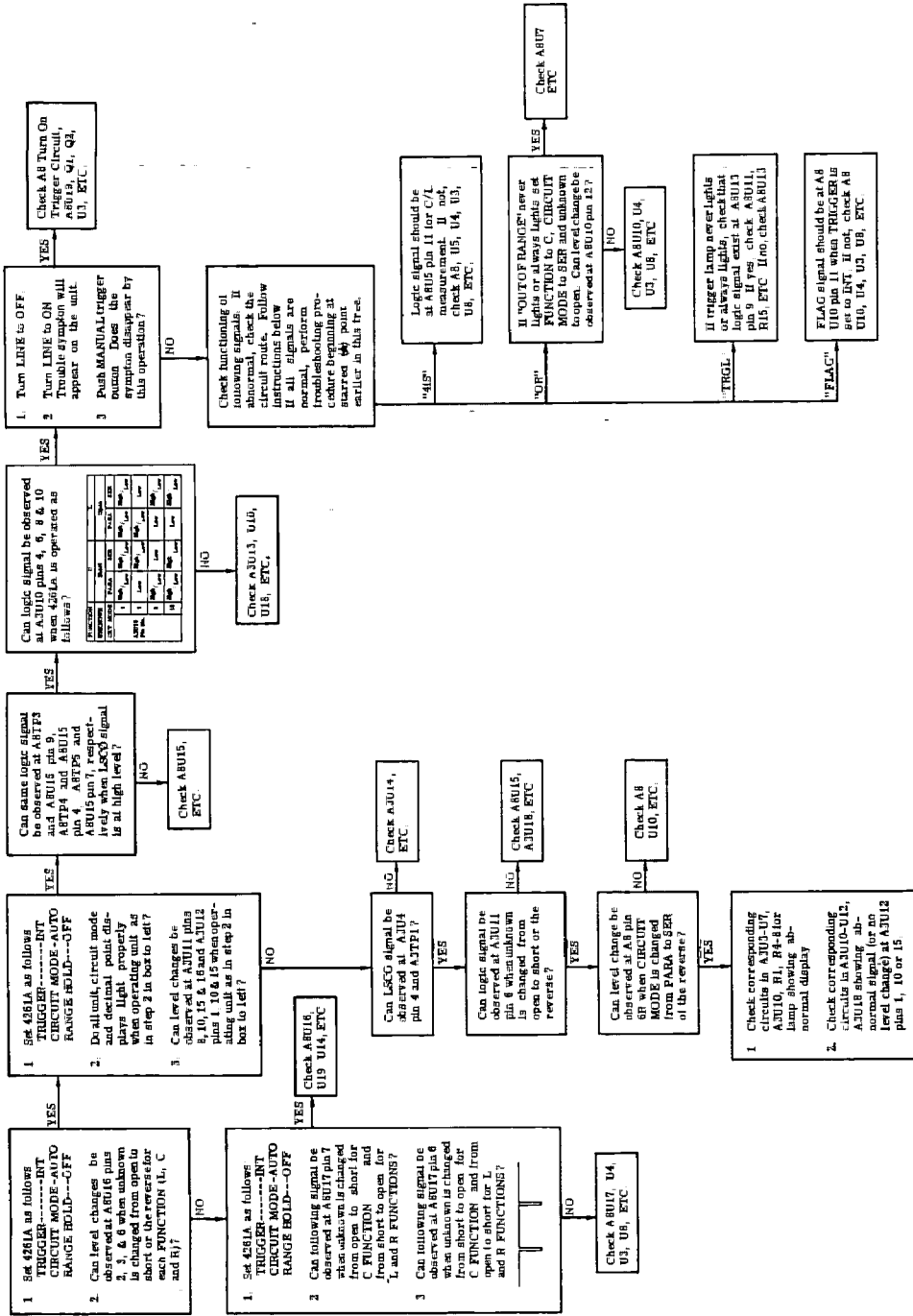


Figure 8-12. Troubleshooting to Component Level for A3, A7 and A8 Boards.

Table 8-3. Self Test Display Sequences (Sheet 1 of 2).

Note

1. It is easier to read display sequences with TRIGGER set to EXT and operating MANUAL button.
2. RANGE HOLD should be set to OFF for all display sequences.
3. TEST 1 is not affected by conditions at UNKNOWN terminals (shorted, DUT connected or otherwise).
4. In a TEST 2 operation, when Unknown terminals are open in L R FUNCTION or shorted in FUNCTION C, both 4261A displays will show 1999 counts and OUT OF RANGE lamp will be lit (except when sequencing produces an OUT OF RANGE condition --- here, display will be blanked).

TEST 1, FUNCTION L

	FREQUENCY: 120Hz				FREQUENCY: 1kHz			
	L Display	Unit		D Display	L Display	Unit		D Display
Ls	1888	μ H		1.888	188.8	μ H		1.888
	18.88	mH		1.888	1888	μ H		1.888
	188.8	mH		1.888	18.88	mH		1.888
	1888	mH		1.888	188.8	mH		1.888
	18.88	H		1.888	1888	mH		1.888
Lp	1888	mH		1.888	188.8	mH		1.888
	18.88	H		1.888	1888	mH		1.888
	188.8	H		1.888	18.88	H		1.888
	1888	H		1.888	188.8	H		1.888
	1888	H		1.888	188.8	H		1.888
	(Blank)	μ H	OUT OF RANGE	(Blank)	(Blank)	μ H	OUT OF RANGE	(Blank)

TEST 1, FUNCTION: C

	FREQUENCY: 120Hz				FREQUENCY: 1kHz			
	C Display	Unit		D Display	C Display	Unit		D Display
Cp	1888	pF		1.888	188.8	pF		1.888
	18.88	nF		1.888	1888	pF		1.888
	188.8	nF		1.888	18.88	nF		1.888
	1888	nF		1.888	188.8	nF		1.888
	18.88	μ F		1.888	1888	nF		1.888
Cs	1888	nF		1.888	188.8	nF		1.888
	18.88	μ F		1.888	1888	nF		1.888
	188.8	μ F		1.888	18.88	μ F		1.888
	1888	μ F		1.888	188.8	μ F		1.888
	18.88	mF		1.888	1888	μ F		1.888
	(Blank)	pF	OUT OF RANGE	(Blank)	(Blank)	pF	OUT OF RANGE	(Blank)

Table 8-3. Self Test Display Sequences (Sheet 2 of 2).

TEST 1. FUNCTION: R

FREQUENCY: 120 kHz			
	R Display	Unit	
Rs	1888	mΩ	
	18.88	Ω	
	188.8	Ω	
	1888	Ω	
	18.88	kΩ	
Rp	1888	Ω	
	18.88	kΩ	
	188.8	kΩ	
	1888	kΩ	
	18.88	MΩ	
	(Blank)	mΩ	OUT OF RANGE

TEST 2. FUNCTION: R, Unknown: Short

FREQUENCY: 120 kHz			
	R Display	Unit	
Rs	1000 ±5	mΩ	
	10.00 ±5	Ω	
	100.0 ±5	Ω	
	1000 ±5	Ω	
	10.00 ±5	kΩ	
	(Blank)	kΩ	OUT OF RANGE
	(Blank)	kΩ	OUT OF RANGE
	(Blank)	kΩ	OUT OF RANGE
	(Blank)	MΩ	OUT OF RANGE
	(Blank)	MΩ	OUT OF RANGE

TEST 2. FUNCTION: L, Unknown: Short

	FREQUENCY: 120Hz				FREQUENCY: 1kHz			
	L Display	Unit		D Display	L Display	Unit		D Display
Ls	1000 ±5	μH		000 ⁺⁵ ₋₀	100.0 ±5	μH		.000 ⁺⁵ ₋₀
	10.00 ±5	mH		000 ⁺⁵ ₋₀	1000 ±5	μH		.000 ⁺⁵ ₋₀
	100.0 ±5	mH		000 ⁺⁵ ₋₀	10.00 ±5	mH		.000 ⁺⁵ ₋₀
	1000 ±5	mH		000 ⁺⁵ ₋₀	100.0 ±5	mH		.000 ⁺⁵ ₋₀
	10.00 ±5	H		000 ⁺⁵ ₋₀	1000 ±5	mH		.000 ⁺⁵ ₋₀
	(Blank)	H	OUT OF RANGE	(Blank)	(Blank)	H	OUT OF RANGE	(Blank)
	(Blank)	H	OUT OF RANGE	(Blank)	(Blank)	H	OUT OF RANGE	(Blank)
	(Blank)	H	OUT OF RANGE	(Blank)	(Blank)	H	OUT OF RANGE	(Blank)

TEST 2. FUNCTION: C, Unknown: Open

	FREQUENCY: 120Hz				FREQUENCY: 1kHz			
	C Display	Unit		D Display	C Display	Unit		D Display
Cp	1000 ±5	pF		000 ⁺⁵ ₋₀	100.0 ±5	pF		.000 ⁺⁵ ₋₀
	10.00 ±5	nF		000 ⁺⁵ ₋₀	1000 ±5	pF		.000 ⁺⁵ ₋₀
	100.0 ±5	nF		000 ⁺⁵ ₋₀	10.00 ±5	nF		.000 ⁺⁵ ₋₀
	1000 ±5	nF		000 ⁺⁵ ₋₀	100.0 ±5	nF		.000 ⁺⁵ ₋₀
	10.00 ±5	μF		000 ⁺⁵ ₋₀	1000 ±5	nF		.000 ⁺⁵ ₋₀
	(Blank)	μF	OUT OF RANGE	(Blank)	(Blank)	μF	OUT OF RANGE	(Blank)
	(Blank)	μF	OUT OF RANGE	(Blank)	(Blank)	μF	OUT OF RANGE	(Blank)
	(Blank)	mF	OUT OF RANGE	(Blank)	(Blank)	μF	OUT OF RANGE	(Blank)

Inductance is in microhenries, resistance is in ohms and capacitance is in microfarads unless otherwise noted.










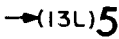
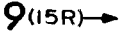



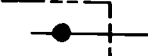
P/O	Part of		Encloses front panel designations
	Screwdriver adjustment.		Encloses rear panel designations
	Circuit assembly borderline.		
*	Asterisk denotes a factory selected value. Value shown is typical. Part may be omitted.		
	Heavy line indicates main signal path.		
	Heavy dashed line indicates main feedback path.		
	Wiper moves towards CW with clockwise rotation of control (as viewed from shaft or knob).		
	Numbered test point. Measurement aid provided.		
	Encloses wire color code. Code used is the same as the resistor color code (e.g., 947 denotes white yellow violet).		
	Indicates an output from a schematic that goes to an input identified as 13L (board plug pin number) on Service Sheet 5.		
	Indicates an input to a schematic that comes from an output identified as 15R (board plug pin number) on Service Sheet 9.		
	Indicates direct conducting connection to the earth.		
	Indicates conducting connection to a chassis or frame.		
	Indicates circuit common connections.		
	Non plug-in connection information. Soldered connection.		

Figure 8-14. Schematic Diagram Notes.

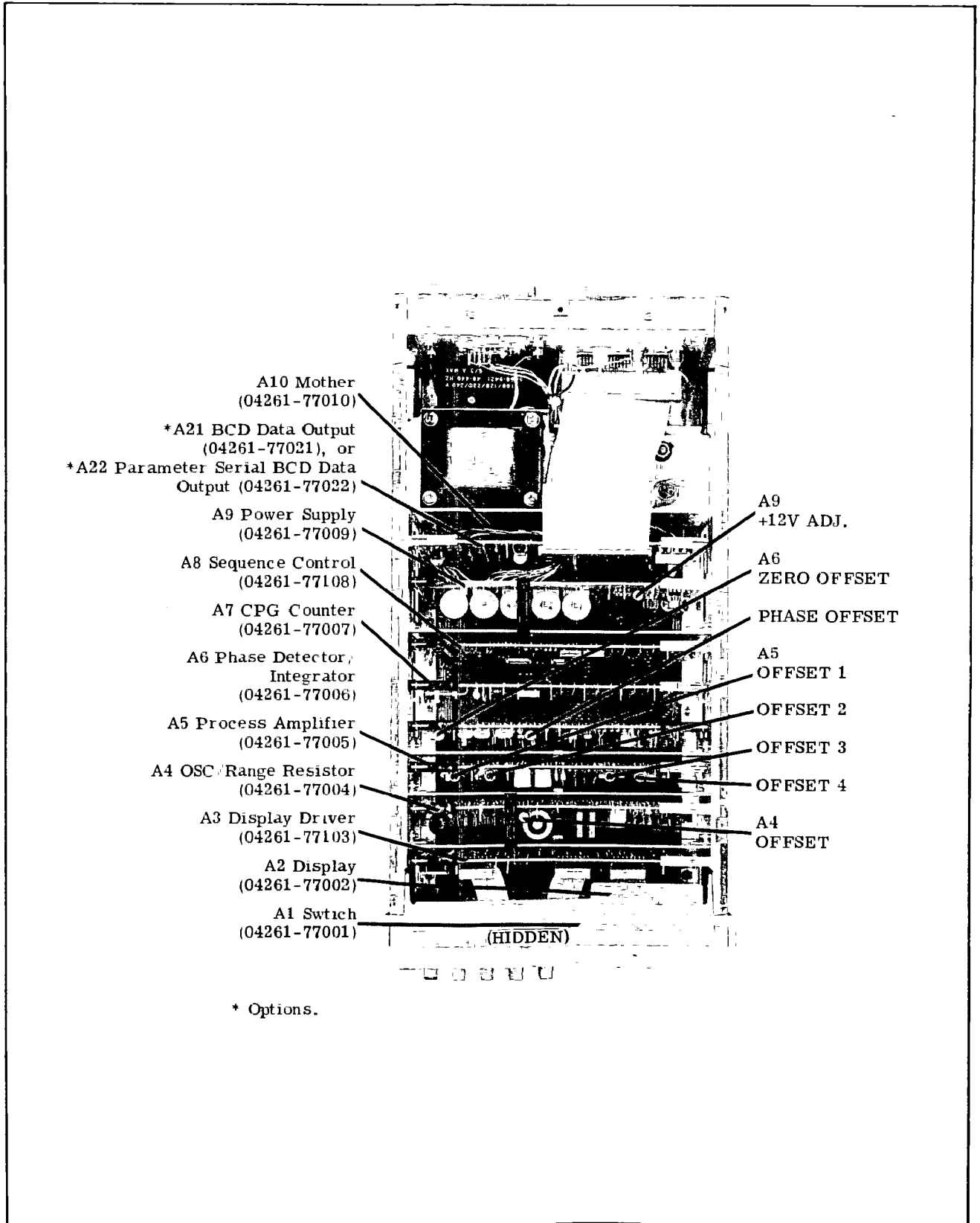


Figure 8-15. Assembly and Adjustment Locations.
 (Top Internal View)

1, A1

CIRCUIT DESCRIPTION

The A1 Switch Board Assembly consists of seven slide switches and one normally open pushbutton switch which control various measurement functions of the 4261A. The control signals set by the switches are transferred to A10 Mother board assembly through a 16-line flat cable (A1W1). Local control by the A1 board assembly is only disabled when 4261A Option 003 or 101 are installed and an external device controls the 4261A. The control signals transmitted to A10 Mother board have the electrical conditions shown in table. An external encode (= EXE) signal is generated when either FREQUENCY, Cp TEST SIG LEVEL, FUNCTION, CIRCUIT MODE or the RANGE HOLD control is changed to any other setting or when MANUAL pushbutton is depressed and released. An EXE signal resets all the

4261A circuits and starts the measurement. The GND line is connected to instrument chassis through the A10 Mother board.

TROUBLESHOOTING INFORMATION

A1 Switch Removal Procedure is given in paragraph 8-48.

A1 Switch Check.

Check voltages at A1W1 connector pins (component side of A1) with oscilloscope to verify they follow above table when controls are set to the various positions. The trouble could be, for example, the wearing away of switch board pattern or the loss spring tension in switch.

Table A. Front Panel Control Signals.

Signal and Connector Pin No.		FREQUENCY	
		120Hz	1kHz
$\overline{\text{FREQ 1kHz}}$ (= FREQ)	16	High	Low

Signal and Connector Pin No.		Cp TEST SIG LEVEL	
		50mV	1V
Test Level Low (= TLL)	5	High	Low

Signal and Connector Pin No.		DC BIAS				
		EXT	OFF	1.5V	2.2V	6V
REF Voltage	2	0V	0V	1.5V	2.2V	6V
BIAS	3	Voltage applied to EXT BIAS input at rear panel.		1.5V	2.2V	6V
Internal Bias (= INT B)	4	0V	0V	1.5V	2.2V	6V
External Bias (= EXT B)	12	Voltage applied to EXT BIAS input at rear panel.	Voltage applied to EXT BIAS input at rear panel.	Voltage applied to EXT BIAS input at rear panel.	Voltage applied to EXT BIAS input at rear panel.	Voltage applied to EXT BIAS input at rear panel.
BIAS 1.5V	13	0V	0V	1.5V	0V	0V
BIAS 2.2V	14	0V	0V	0V	2.2V	0V

Signal and Connector Pin No.		TRIGGER	
		INT	EXT
$\overline{\text{MANUAL}}$	10	High	Low

Signal and Connector Pin No.		CIRCUIT MODE		
		AUTO	PARA	SER
Circuit Mode A (= CMA)	6	High	Low	High
Circuit Mode B (= CMB)	7	High	Low	Low

Signal and Connector Pin No.		FUNCTION		
		L	C	R
FUNCTION A	1	High	Low	High
FUNCTION B (= FNC B)	15	High	Low	Low

Signal and Connector Pin No.		RANGE HOLD	
		OFF	ON
Range Hold	9	High	Low

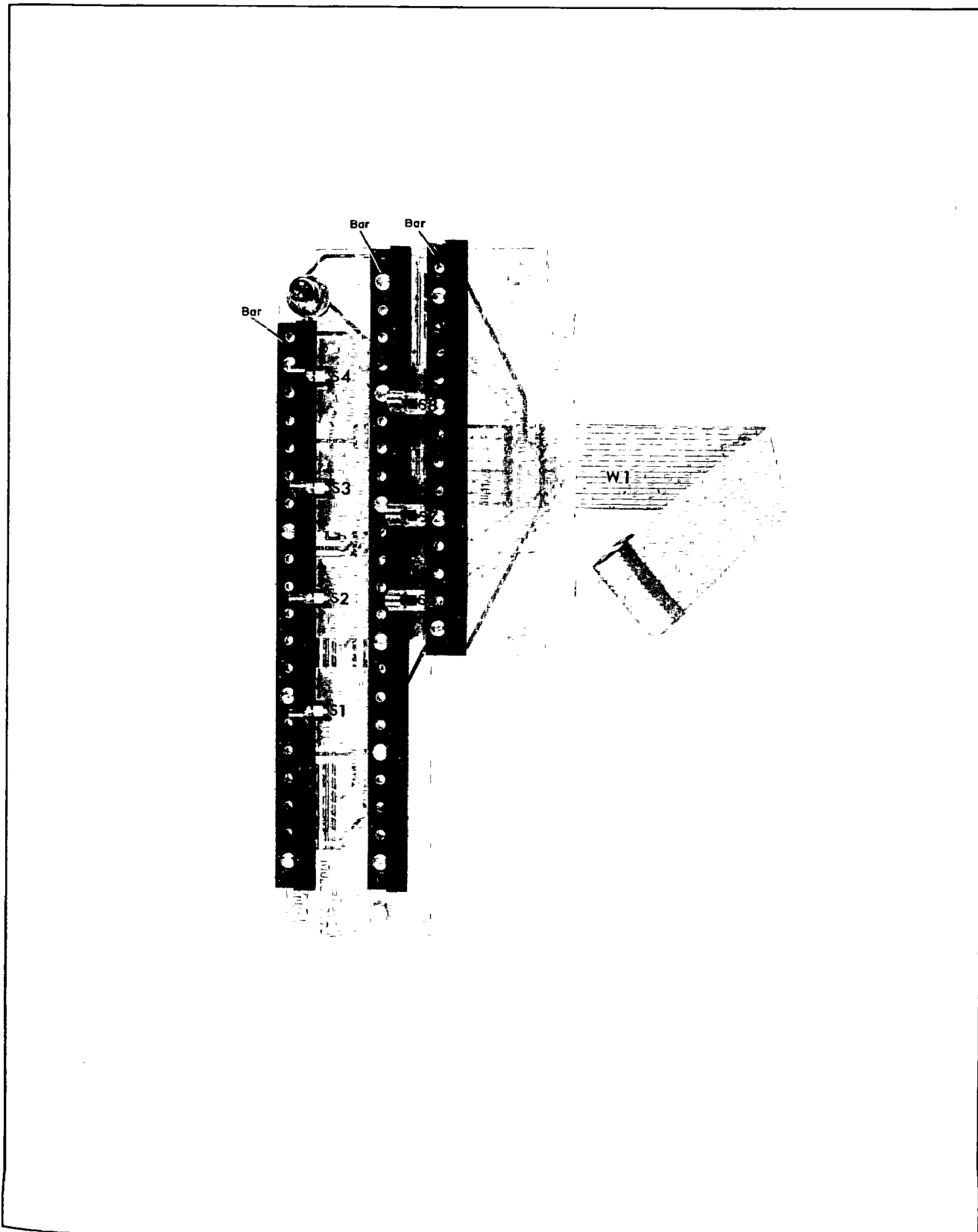
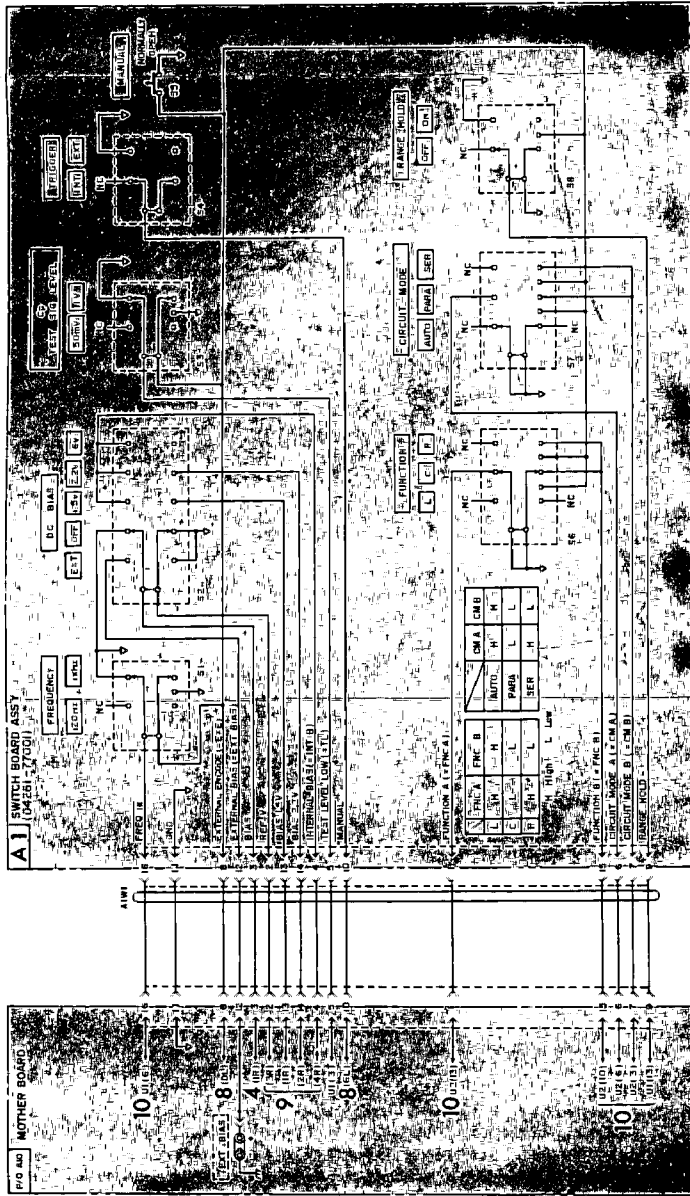


Figure 8-16. A1 Switch Board Assembly Component Locations.



Note

1. This schematic shows circuit condition that exist when front panel controls are set as follows:

- FREQUENCY 1KHz
- DC BIAS OFF
- Cp TEST SIG LEVEL 1V
- TRIGGER INT
- FUNCTION C
- CIRCUIT MODE AUTO
- RANGE HOLD OFF

2. A1W1 includes connector plus flat cable NC means No Connection.

Figure 8-17. A1 Switch Board Assembly Schematic Diagram.
 8-55

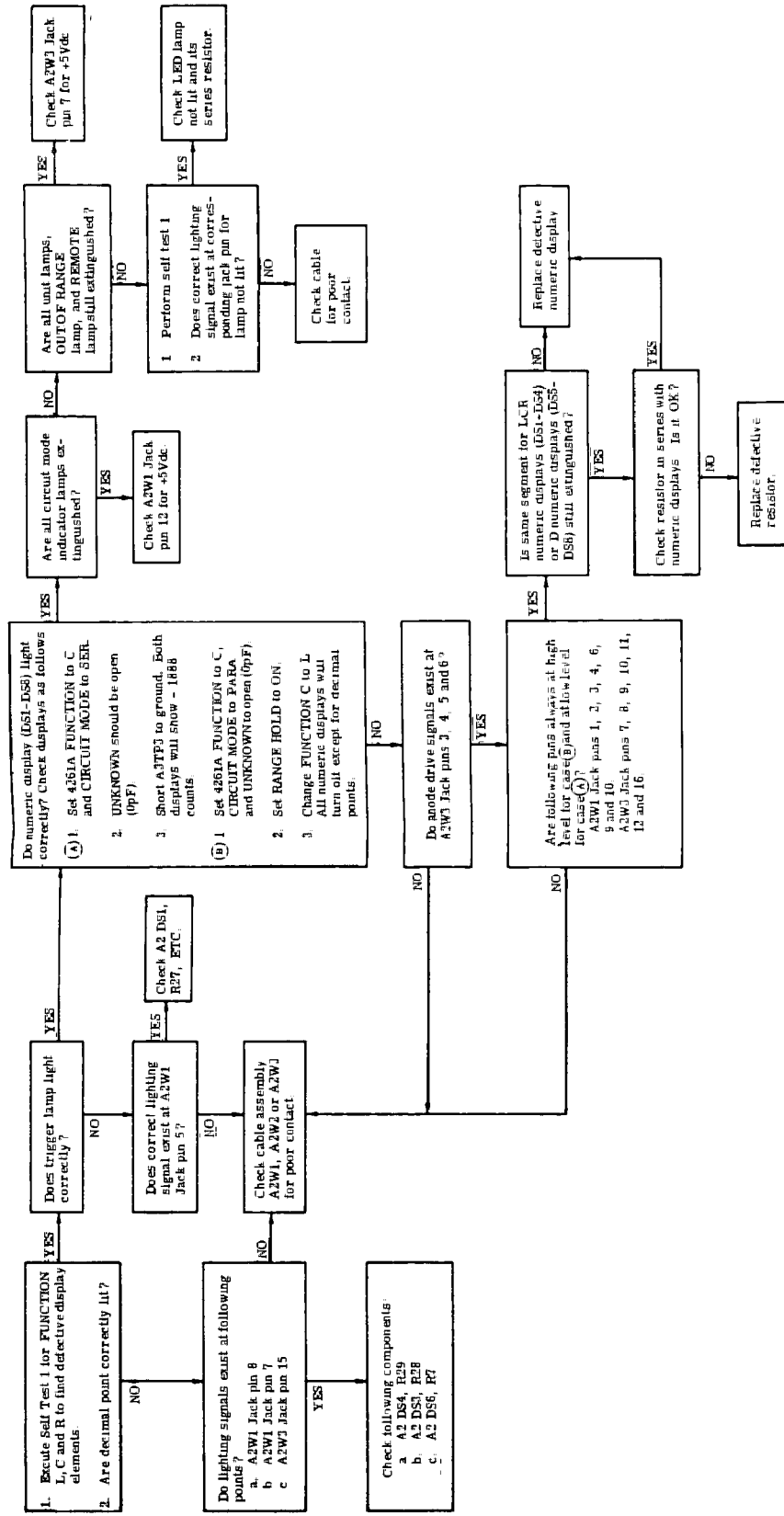


Figure 8-18. A2 Display Board Troubleshooting Guide.

Switch Board Assembly (A1)
SERVICE SHEET 1

CIRCUIT DESCRIPTION

A2 Display Board Assembly receives display control signals from A3 Display Driver (via three flat cables), and displays the measured values with unit and annunciation. DS1 thru DS8 are seven-segment LED numeric displays and DS9 thru DS25 are single LED elements. All LED elements light when a TTL low signal is applied. The numeric displays (DS1 thru DS8) are driven sequentially by ANOD 1 thru ANOD 4 signals which supply dc power to each numeric display only during assigned period. LED dynamic lighting is graphically shown in Figure A below. For example, DS2 and DS6 can be lit in accordance with their control signals only when ANOD 2 signal is at high level.

TROUBLESHOOTING INFORMATION

Almost all troubles on A2 board may be found by executing Self Test 1 (Digital Test) per procedure given below. The troubleshooting tree to be followed is also outlined.

To check displays, perform the following:

- a. Remove top cover.
- b. Set 4261A TRIGGER to INT and RANGE HOLD to OFF
- c. Short A3TP3 (display test) to the instrument chassis (ground).

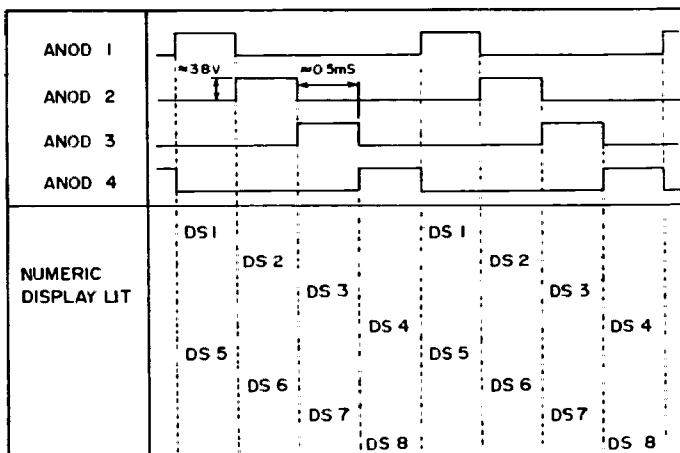


Figure A. Dynamic Lighting.

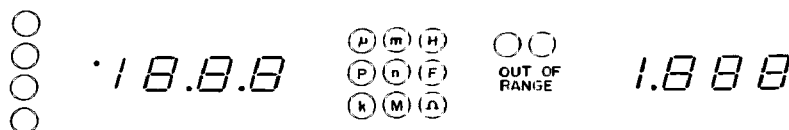


Figure C. LED Elements Lit.

- d. Set FUNCTION to L and CIRCUIT MODE to SER. Connect nothing to UNKNOWN terminals ($\infty \Omega$).
- e. Check that all numeric displays are lit (-1888 count display). OUT OF RANGE lamp is turned on and trigger lamp turns on and off.
- f. Set the slide switch mounted on A8 board (P.N: 04261-77108) to TEST 1 as shown in Figure B below.
- g. When FUNCTION is set to L, C or R, check that LED elements for unit, circuit mode, and decimal point (except REMOTE) light as shown in Figure C below.

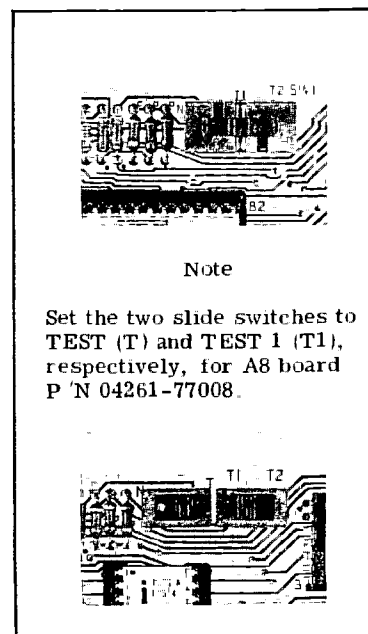
Note

Each LED element lights sequentially according to a format determined for each setting of FUNCTION switch (L, C or R).

- h. REMOTE turns on only when an external device to remotely control the 4261A is connected to a 4261A Option 003 or Option 101. To check the LED's for REMOTE, ground pin 43 of REMOTE INPUT connector on rear panel (REMOTE lamp lights).

Note

Removal procedure for A2 Display Board is outlined on angle plate of A2 board assembly. This instruction label can easily be located after top cover has been removed.



Note

Set the two slide switches to TEST (T) and TEST 1 (T1), respectively, for A8 board P.N 04261-77008.

Figure B. Self Test Switch Position(s).

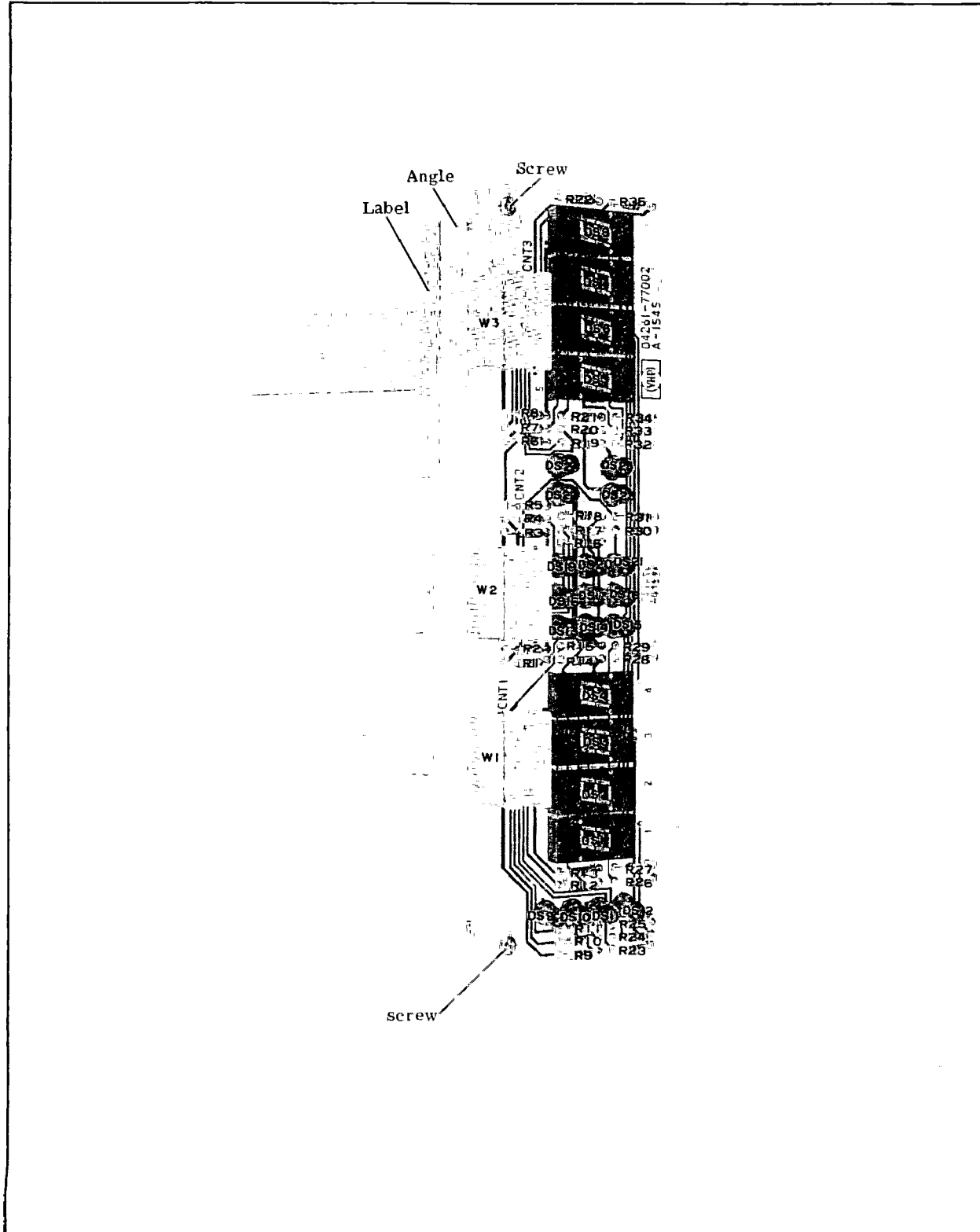
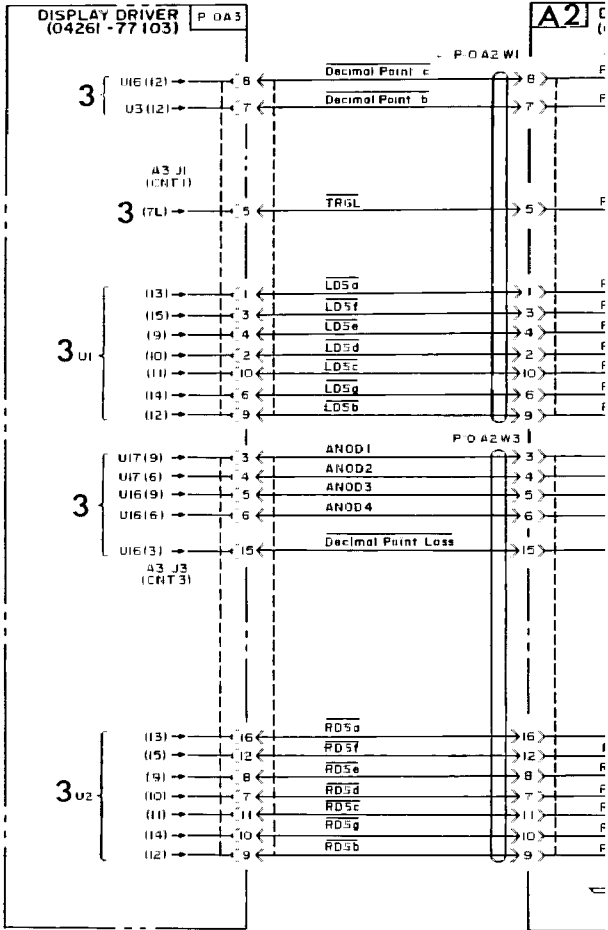
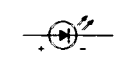
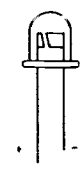
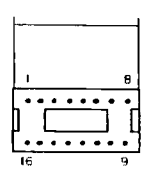
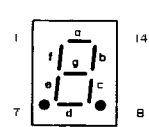
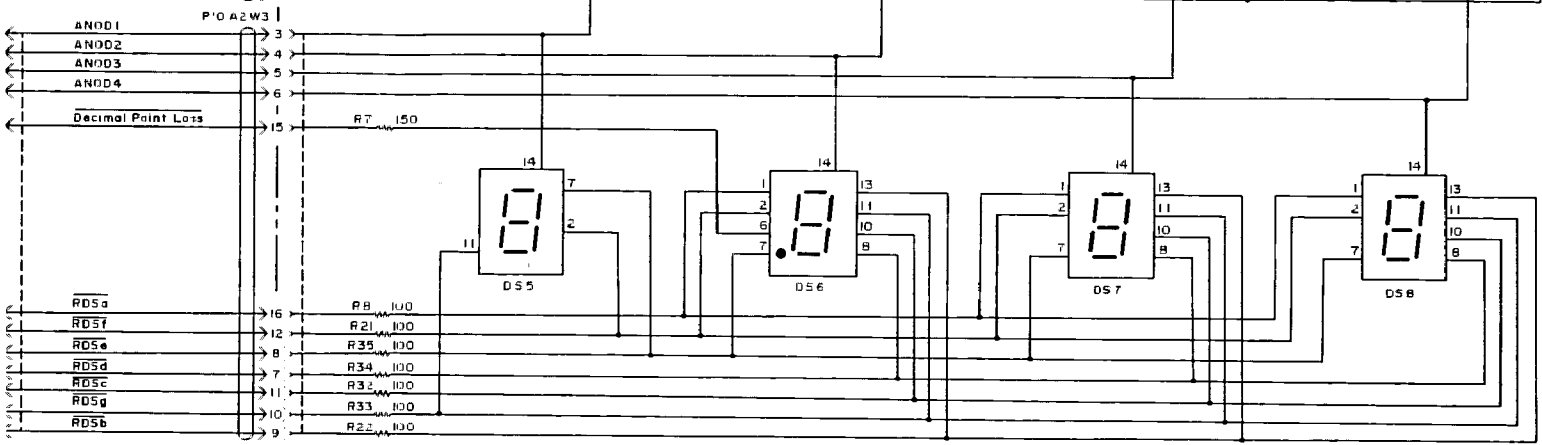
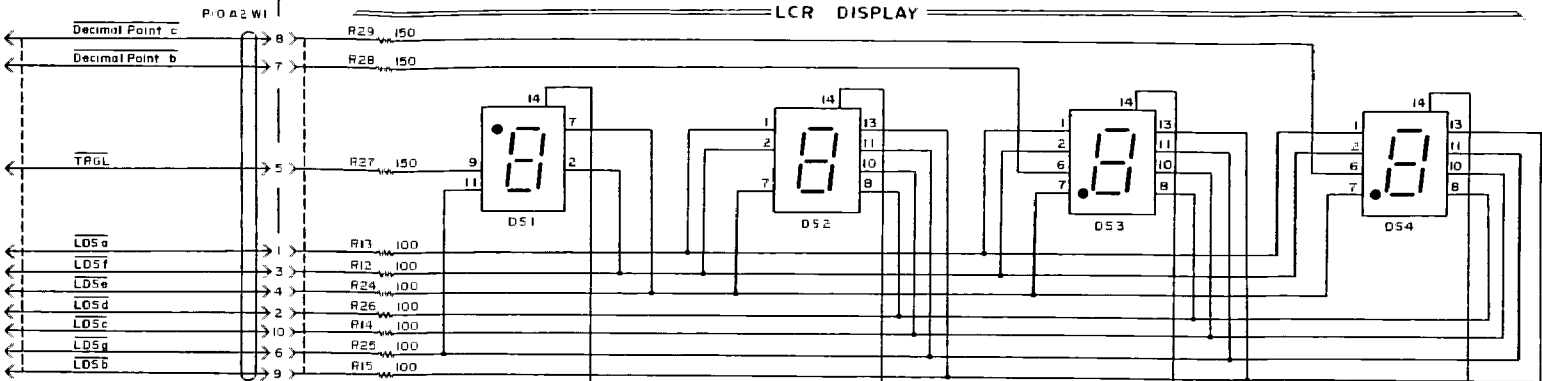


Figure 8-19. A2 Display Board Assembly Component Locations.



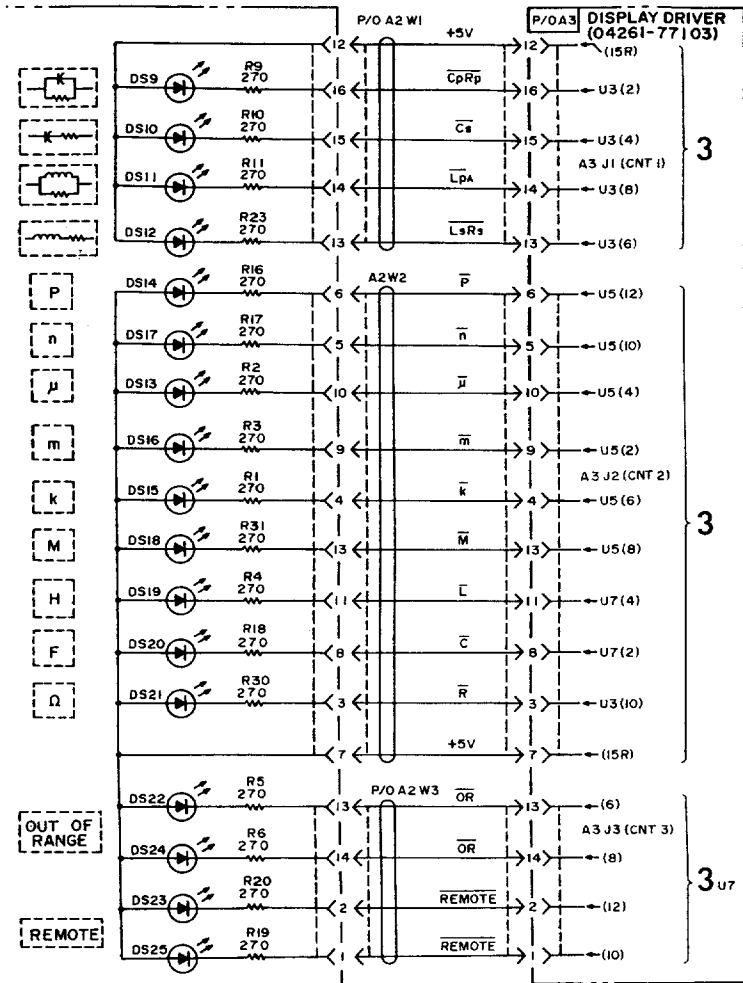
A2 DISPLAY BOARD ASS'Y
(04261-77002)

LCR DISPLAY



1. Pin Locations of DS1 thru DS8.
Note that mounting positions of DS1 and DS5 are reverse to that of other numeric displays
2. Pin Locations of W1 thru W3.
Component side view of plug to A3 board.
3. DS9 - DS25 Polarity.
CAUTION: Never apply stress to legs of LED during soldering, or LED will open

P
n
μ
m
k
M
H
F
Ω
OUT
RAN
REM



2 A2, A3

Figure 8-20. A2 Display Board Assembly Schematic Diagram.

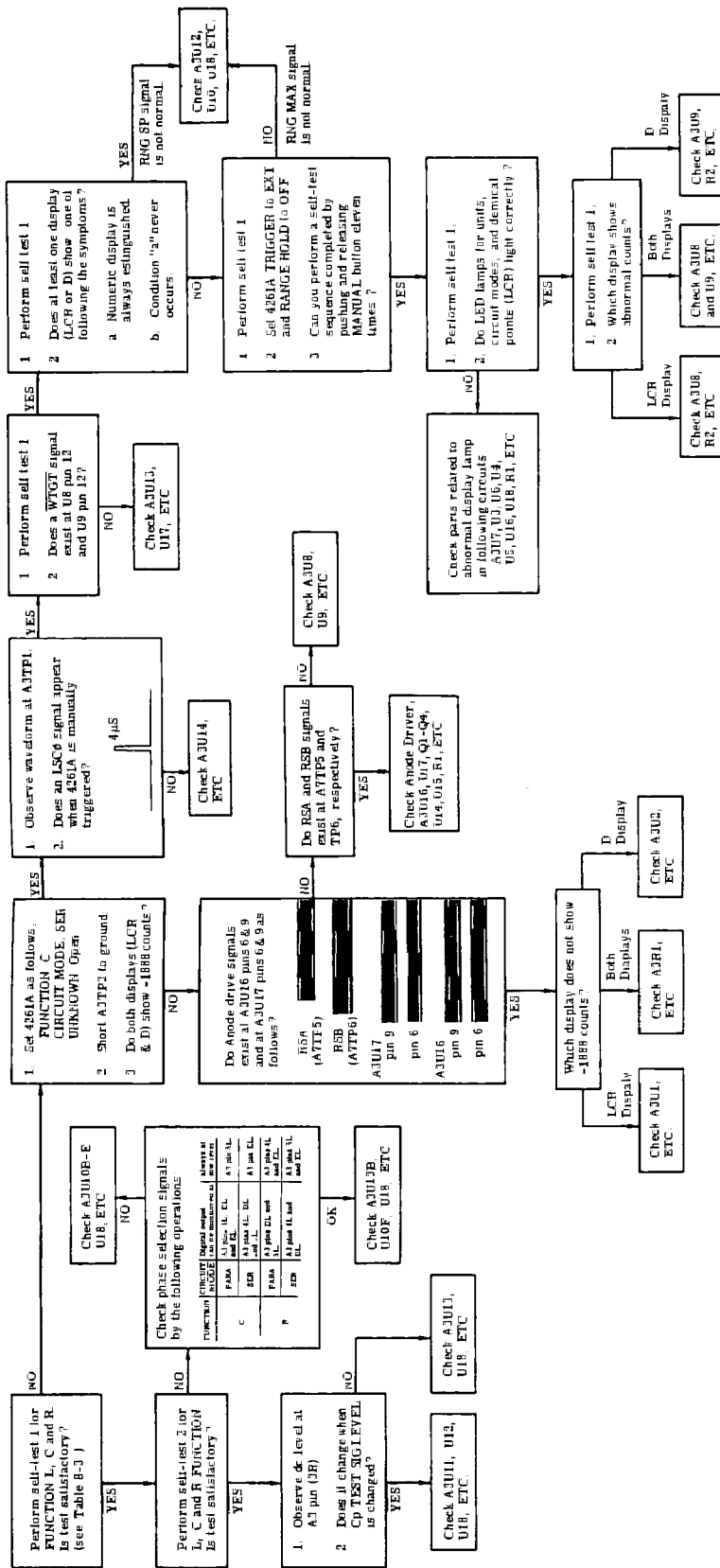
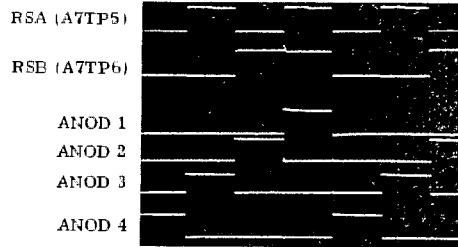


Figure 8-21. A3 Display Driver Board Troubleshooting Guide.

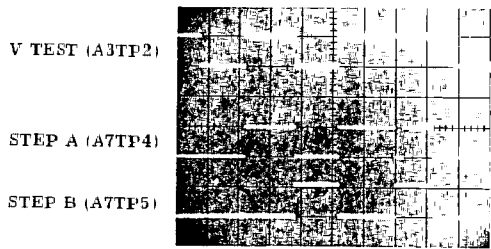


Measurement conditions:
 FUNCTION C
 CIRCUIT MODE PARA
 FREQUENCY 1kHz
 Cp TEST SIG LEVEL . . . 1V

≈ 0.3ms div.

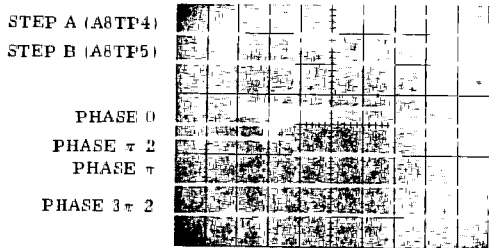
Note

To observe waveforms ANOD 1 thru ANOD 4, connect a 500Ω resistor (approx.) between the oscilloscope probe tip and ground.



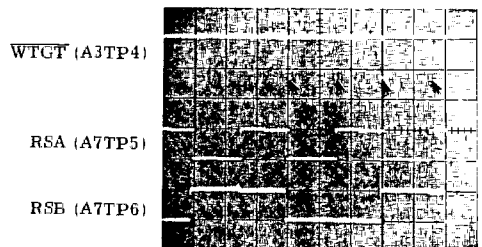
Measurement conditions:
 FUNCTION C
 CIRCUIT MODE PARA
 FREQUENCY 1kHz
 Cp TEST SIG LEVEL . . . 1V
 Unknown 11μF

≈ 30ms div



Measurement conditions:
 FUNCTION C
 CIRCUIT MODE PARA
 FREQUENCY 1kHz
 Cp TEST SIG LEVEL . . . 1V

≈ 20ms div



Measurement conditions:
 FUNCTION C
 CIRCUIT MODE PARA
 FREQUENCY 120Hz
 Cp TEST SIG LEVEL . . . 1V

≈ .3ms div

CIRCUIT DESCRIPTION

A3 Display Driver Board is functionally divided into two sections: these are the numeric display driver section and the LED lamp driver-phase decoder-range resistor decoder section. Firstly, data signals (DATA BIT 1, DATA BIT 2, DATA BIT 4, DATA BIT 8) converted to BCD code in A7 Board are inputted to U8 and U9 register files. U8 and U9 can store four BCD code signals. U8 memorizes L, C or R four-digit data BCD and U9 stores D four-digit data. These numeric data are stored on instructions of a \overline{WTGT} (WRITE GATE) signal as synchronized with RSA and RSB signals. See Figure A.

BCD data stored in U8 and U9 are sent to U1 and U2 BCD to 7 segment Decoder, Driver in the order determined by RSA and RSB signals and their outputs are fed to A2 display board. At the same time, RSA and RSB signals are converted to Anode Drive signals (ANOD 1 thru ANOD 4) to dynamically light the numeric displays (U14, U15, Q1 thru Q4, U16 and U17). The read only memory (ROM) U18 has been programmed to light unit, circuit mode lamps on A2

board in proper sequence and to select range resistor on A4 board and to pass selected range information (RANGE MAX, RANGE MINIMUM, RANGE SPECIAL) to A7 board. Here, the inputs to the ROM are functions (FUNC A or FUNC B), circuit mode (CMS) and range information (SLO 1 thru SLO 4). These output data are fixed during one measurement cycle by latches U4, U6, U11 and U12 when $\overline{LSC 0}$ signal is at low level. See Figure B below.

When $\overline{LSC 0}$ signal is at high level, ROM U18 is (additionally) used to select phase of detection signal fed to phase detection on A6 board (PHASE 0, PHASE $\pi/2$, PHASE π or PHASE $3\pi/2$) and to control V TEST signal to A5 board. Input signals to the ROM are the functions (FUNC A and FUNC B), circuit mode, step and MS (measurement status) signals which are identified as SLO 1 thru SLO 4 signals in the schematics.

TROUBLESHOOTING INFORMATION

Troubleshooting tree to be followed is presented at the left.

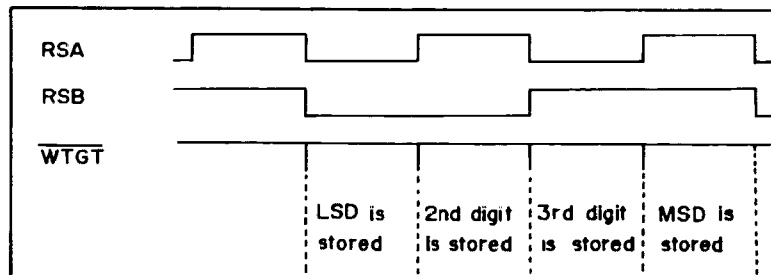


Figure A. Data Store Timing.

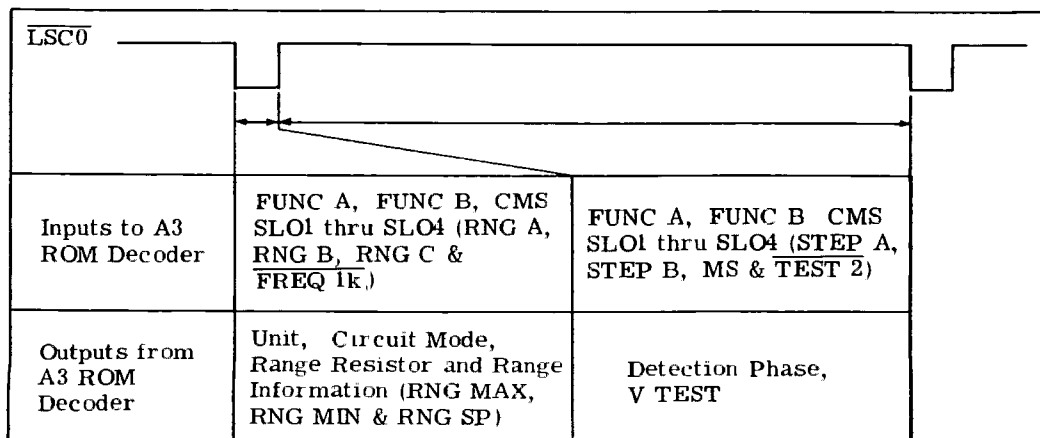


Figure B. ROM Operation.

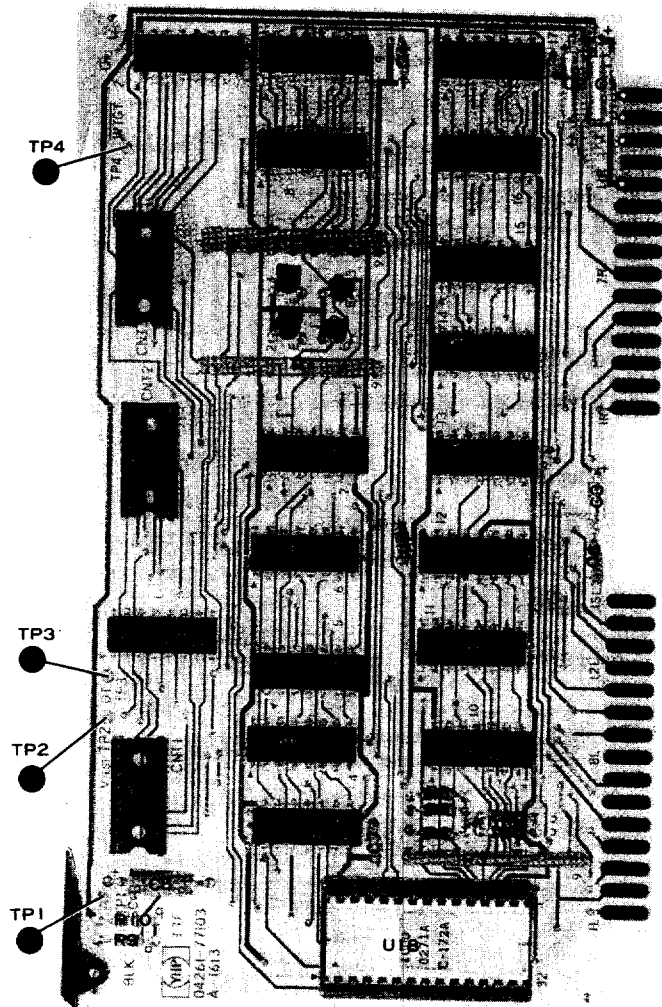
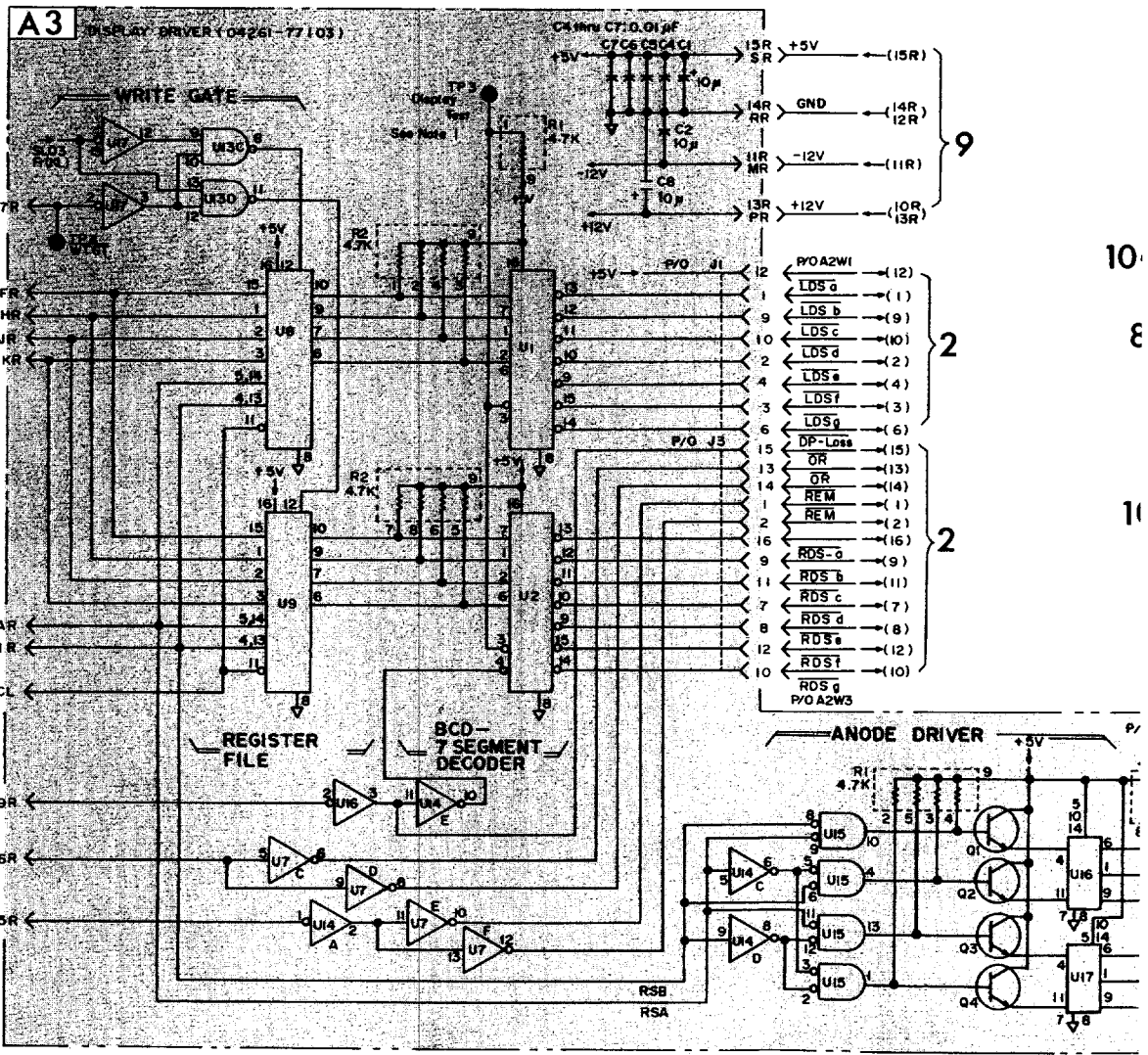


Figure 8-22. A3 Display Driver Board Assembly Component Locations.

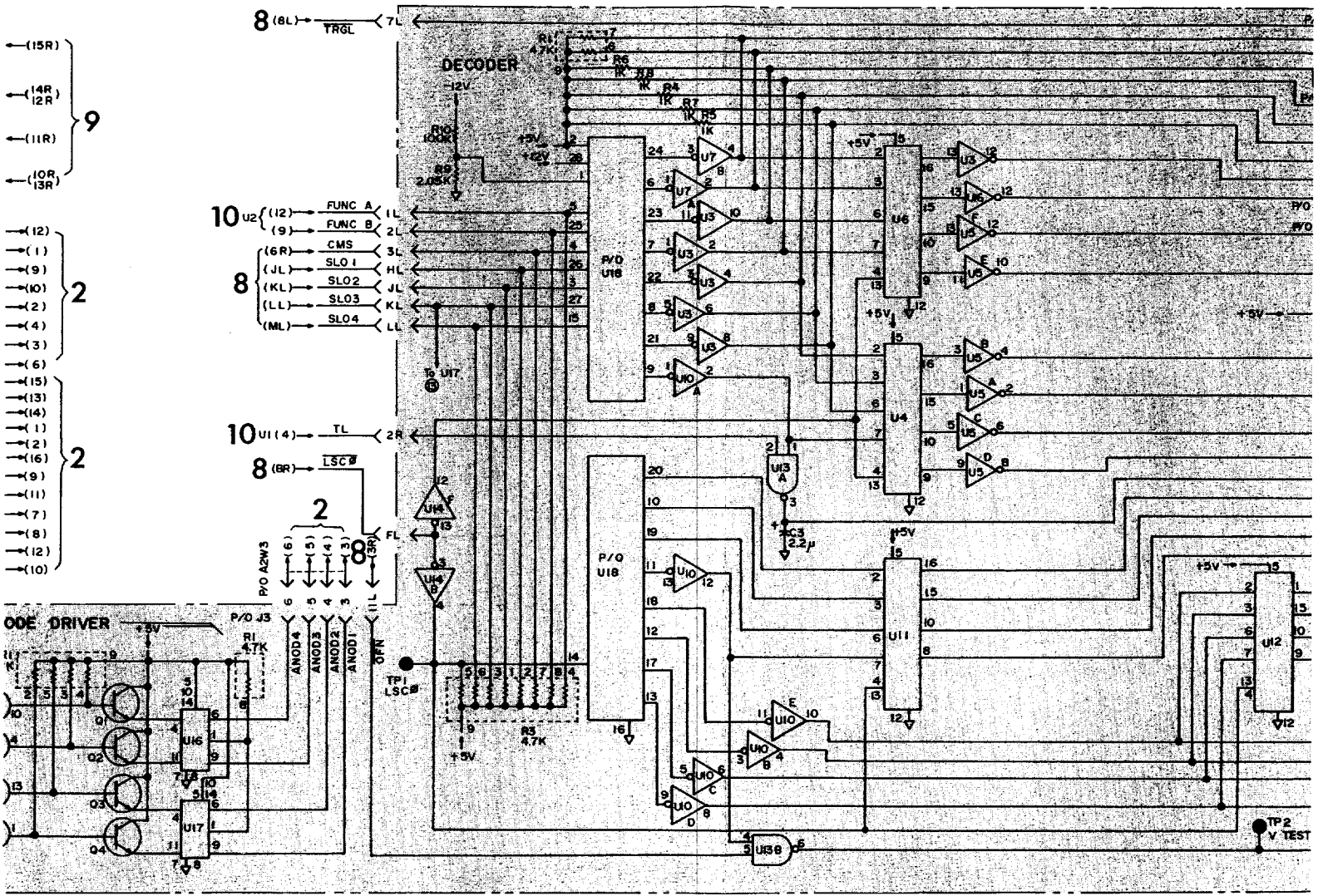


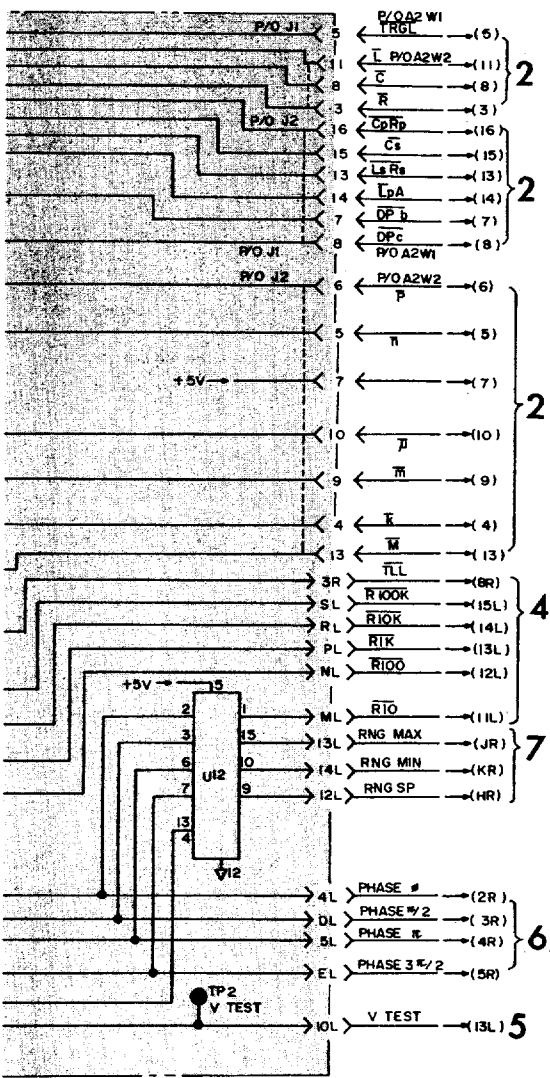
- 8 (7R) → WTGT → 7R
- 7 (6R) → DTB1 → FR
- 7 (7R) → DTB2 → HR
- 7 (8R) → DTB4 → JR
- 7 (9R) → DTB 8 → KR
- 7 (LL) → RSA → AR
- 7 (ML) → RSB → IR
- 8 (4R) → BLANK → CL
- 8 (9R) → 0 BLANK → GR
- 8 (FR) → OR → GR
- 10 U1(1) → REM → 5R

- 15R 5R → +5V
- 14R 12R → GND
- 11R MR → -12V
- 10R 13R → +12V

- 12 P/O A2WI → (12)
- 1 LDS a → (1)
- 9 LDS b → (9)
- 10 LDS c → (10)
- 2 LDS d → (2)
- 4 LDS e → (4)
- 3 LDS f → (3)
- 6 LDS g → (6)
- 15 DP-Loss → (15)
- 13 OR → (13)
- 14 REM → (14)
- 1 REM → (1)
- 2 REM → (2)
- 16 REM → (16)
- 9 RDS-a → (9)
- 11 RDS b → (11)
- 7 RDS c → (7)
- 8 RDS d → (8)
- 12 RDS e → (12)
- 10 RDS f → (10)
- 10 RDS g → (10)
- P/O A2WS

10
8
11





Note

1. When A3TP3 (DT = Display Test) is short-circuited to chassis, the display should show -1888 counts except for the blanked displays. A2 numeric displays (A2DS1 - DS8) and A3U1 & U2 can be tested by the above method. Never apply a voltage to A3TP3.

3
A3

Figure 8-23. A3 Display Driver Board Assembly Schematic Diagram.

NOTE - TOLERANCE VALUES GIVEN IN THIS PROCEDURE DO NOT INCLUDE MEASURING INSTRUMENT ERROR

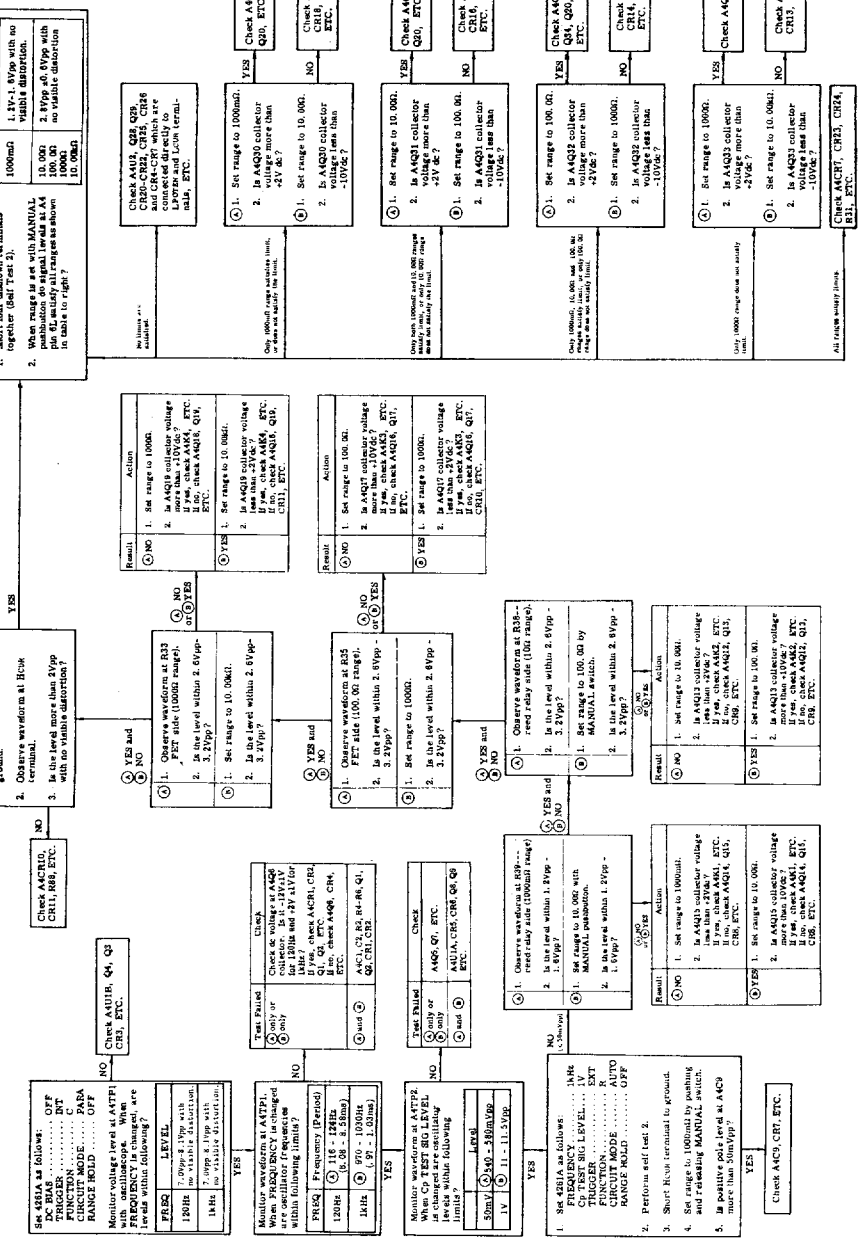
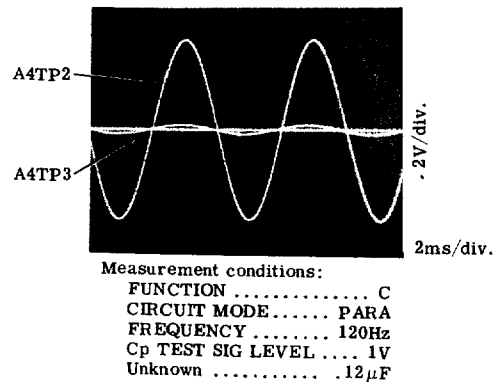
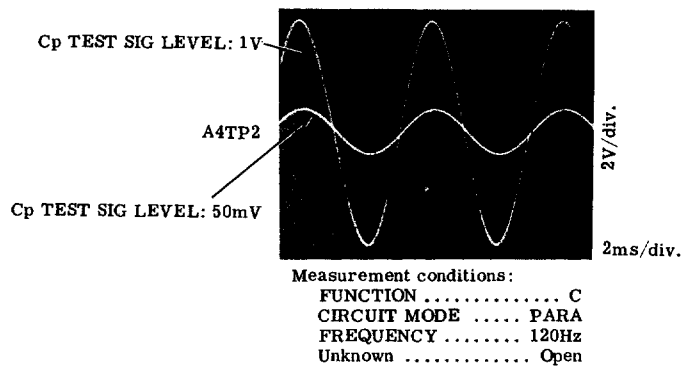
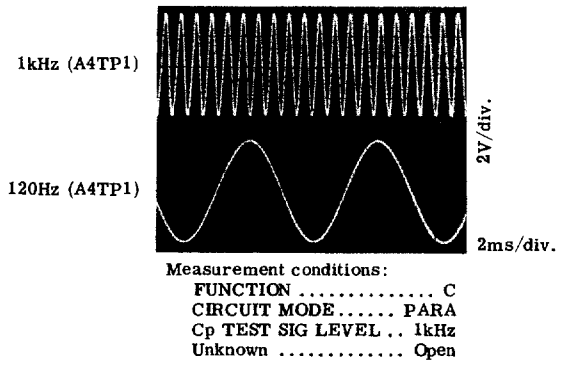


Figure 8-24. A4 Oscillator/Range Resistor Board Troubleshooting Guide.



4, A4

CIRCUIT DESCRIPTION

The two parts of A4 are an oscillator and a range resistor section. The oscillator generates the 120Hz or 1kHz test signals using the Wien bridge technique. The range resistor section supplies a variable voltage proportional to the sample connected to UNKNOWN terminals and a constant reference voltage.

Oscillator Section. U1A, Q1 thru Q4 and associated components make up a Wien bridge oscillator with automatic level control. The 120Hz oscillator frequency is derived from the equation: $f = 1 / (2\pi\sqrt{R_5R_6C_1C_2})$. When generating the 1kHz signal, FET's Q1 and Q2 are turned on and the frequency is then derived from the formula: $f = 1 / (2\pi\sqrt{(R_2/R_5) \cdot (R_4/R_6)C_1C_2})$. The oscillator output level at TP1 is maintained constant at 6.8Vp-p by automatic level control circuits (Q3 and Q4) which control the gain of U1A. For example, when the oscillator output level rises above 6.8Vp-p, Q4 is turned on for a longer period, the voltage across C5 increases, and Q3 is moved nearer to an OFF condition. Therefore, the feedback to U1A increases and the gain of U1A is decreased which lowers its output level to the proper amplitude.

The oscillator output level at TP1 is attenuated to 1/20 value only when Cp mode (FUNCTION: C, CIRCUIT MODE: PARA) and 50mV are selected. U1B, Q8, Q9, CR5 and CR6 form a class B power amplifier having a voltage gain of approximately 1.8. R32, R33, R35, R87, R37 thru R39 are source resistors through which the test signal is applied to the

device under test, and they are automatically selected as appropriate to the device under test (DUT). The resistance of the 100Ω and 10Ω source resistances include not only the resistance of resistances R37 thru R39 but also include the output resistance of transformer T1. The circuit which protects the DUT against excessive dc bias voltage is formed by R31, R84, C9 and CR7. The circuit, which includes R88, CR10 and CR11, protects the 4261A internal circuitry from high voltages which may invade the instrument through the UNKNOWN terminals.

Range Resistor Section. The purpose of the amplifier consisting of U2, Q28, Q29, CR20 and CR21 is to cause the same current flowing in the unknown device to flow through the range resistor. The result of this drive, is to bring the potential at the low terminals to approximately zero volts. The feedback to amplifier is taken from the range resistor which is automatically selected by the range resistor selecting circuitry as directed by selection signals (R10, R100, R1k, R10k or R100k) from the A3 Display Driver and Range Control sections. Table below shows the relationship of selected source and range resistors to the 4261A FUNCTION, CIRCUIT MODE and Range Settings. At any setting, both the range resistor (R_R) and source resistor (R_O) have the same value.

TROUBLESHOOTING INFORMATION

If troubles occur, it is recommended you follow the troubleshooting tree presented here.

Table A. Range Resistor (R_R) and Source Resistors (R_O) Selections.

FUNCTION \ Range		Range		1	2	3	4	5	6	7	8	
		120Hz	1kHz									
L	Full-scale	120Hz		1000 μH	10.00mH	100.0mH	1000 mH	10.00 H	100.0 H	1000 H	1000 H	
		1kHz		100.0μH	1000 μH	10.00mH	100.0mH	1000 mH	10.00 H	100.0 H	100.0 H	
	R_R, R_O	SER		10Ω	100Ω	1kΩ	10kΩ	100kΩ				
		PARA					10 Ω	100 Ω	1kΩ	10kΩ	10kΩ	
C	Full-scale	120Hz		1000 pF	10.00 nF	100.0 nF	1000 nF	10.00 μF	100.0μF	1000 μF	10.00mF	
		1kHz		100.0pF	1000 pF	10.00 nF	100.0 nF	1000 nF	10.00μF	100.0μF	1000 μF	
	R_R, R_O	PARA		100kΩ	10kΩ	1kΩ	100Ω	10Ω				
		SER					100kΩ	10kΩ	1kΩ	100Ω	10Ω	
R	Full-scale	120 kHz		1000 mΩ	10.00 Ω	100.0 Ω	1000 Ω	10.00 kΩ	100.0kΩ	1000 kΩ	10.00MΩ	
		1kHz										
	R_R, R_O	SER		10Ω	100Ω	1kΩ	10kΩ	100kΩ				
		PARA					10 Ω	100 Ω	1kΩ	10kΩ	100kΩ	

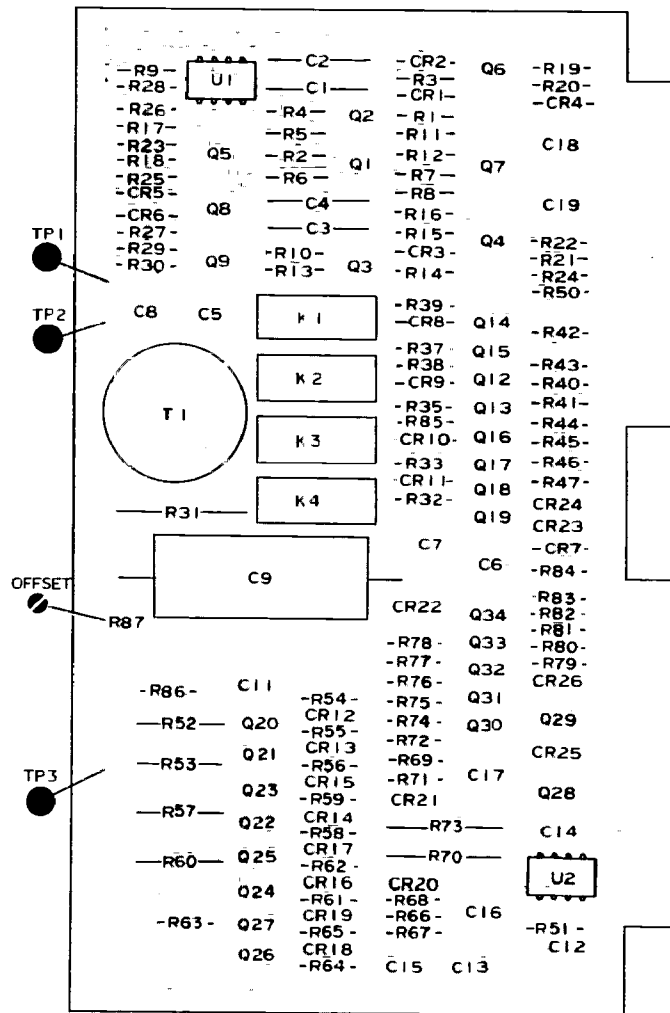
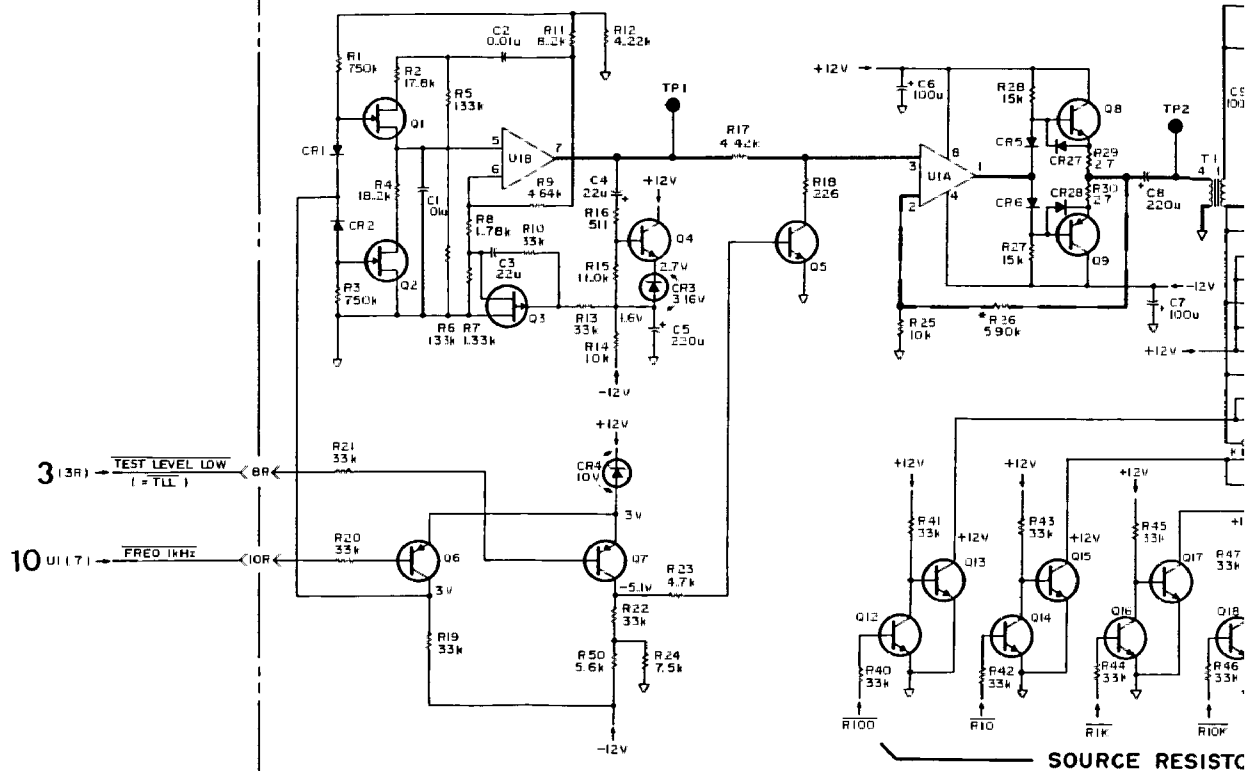


Figure 8-25. A4 Oscillator Range Resistor Board Assembly Component Locations.

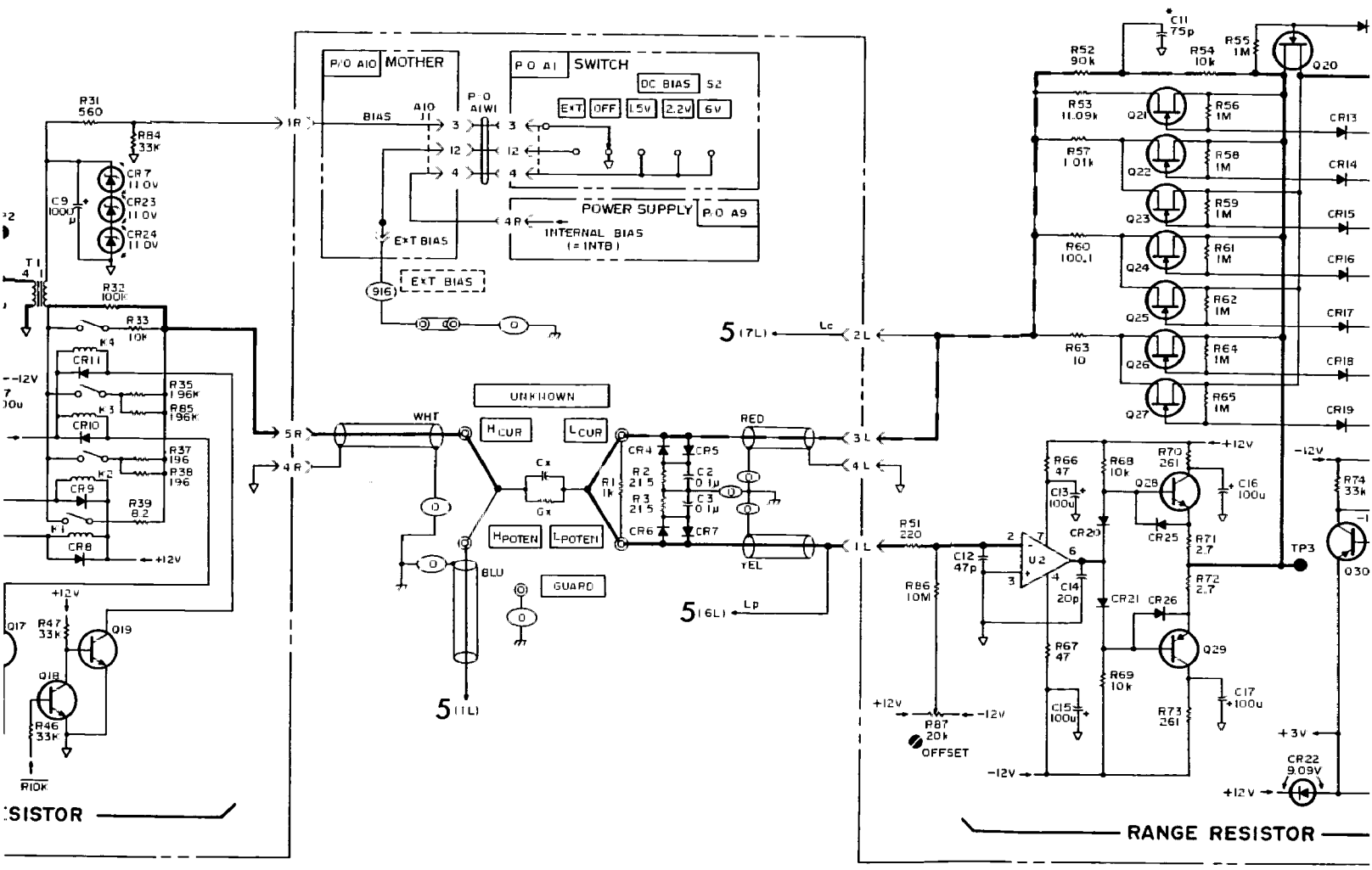
A4 OSCILLATOR/RANGE RESISTOR
(04261-77004)

120Hz/1kHz OSCILLATOR

POWER AMPL (X1.6)

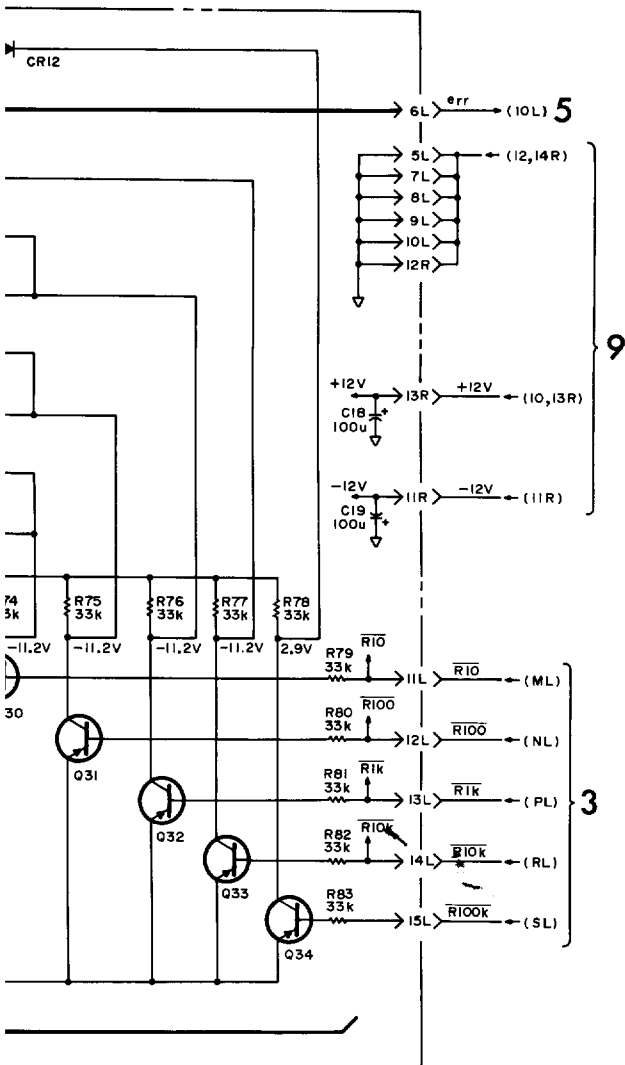


SOURCE RESISTOR



DIODE

RANGE RESISTOR



Note

1. Protective diodes CR4 thru CR7 and resistor R1 are mounted directly between unknown terminals and chassis inside the front panel.
2. Voltages denoted on the schematics are values under the following control settings:

FREQUENCY 1kHz
 DC BIAS OFF
 Cp TEST SIG LEVEL 1V
 FUNCTION C
 CIRCUIT MODE AUTO
 RANGE HOLD OFF
 Unknown open

4

A4, A1, A9, A10

Figure 8-26. A4 Oscillator/Range Resistor Board Assembly Schematic Diagram.

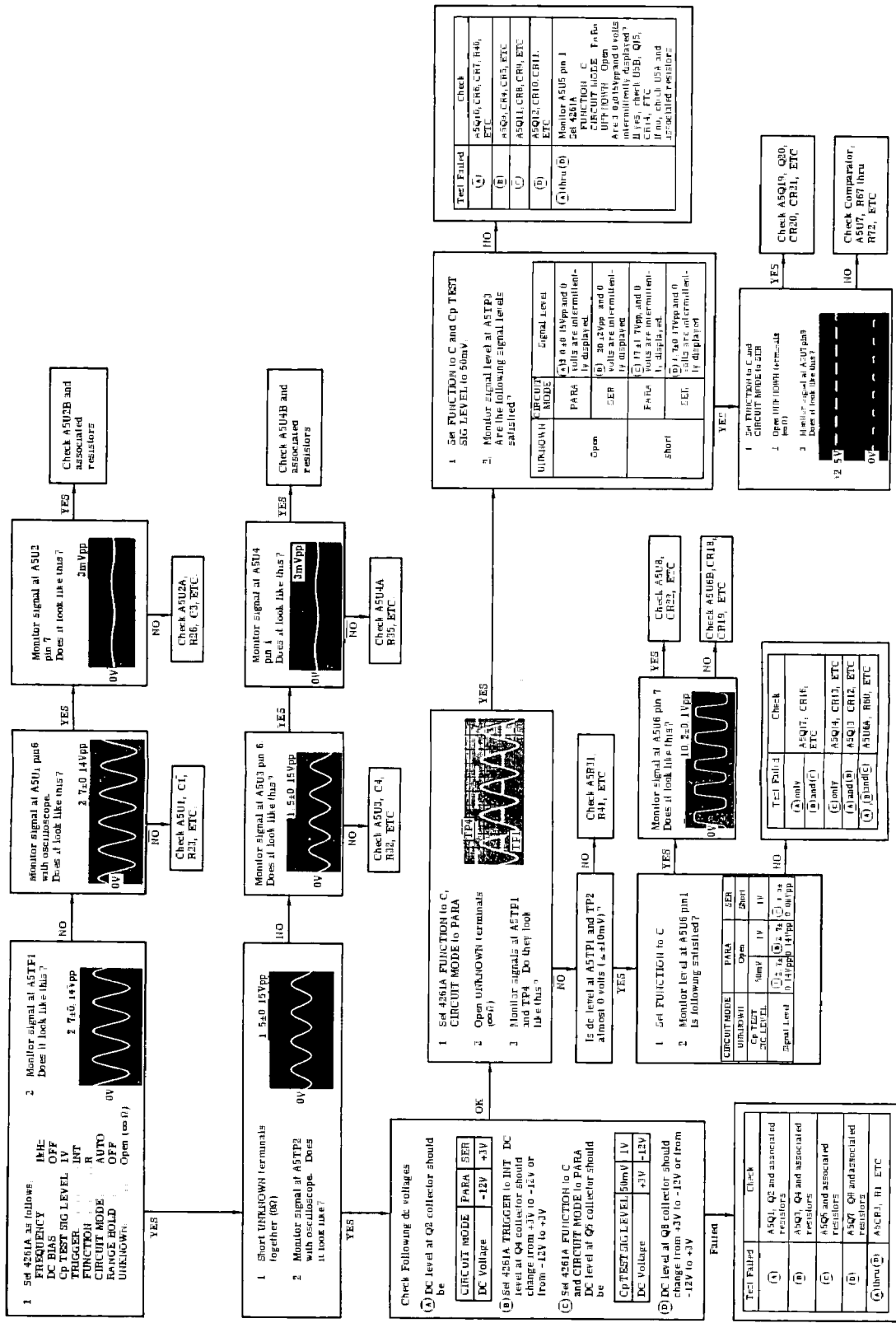
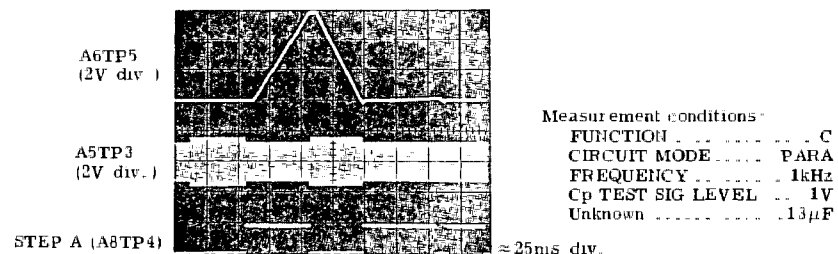
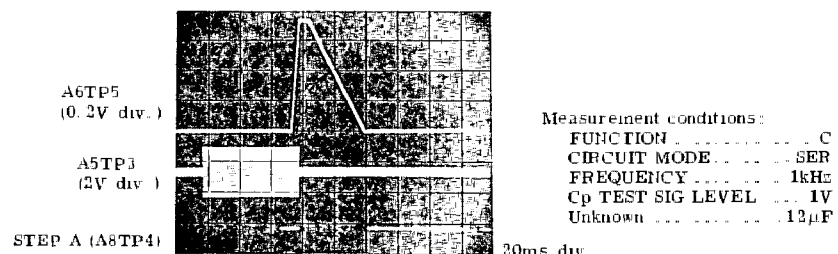
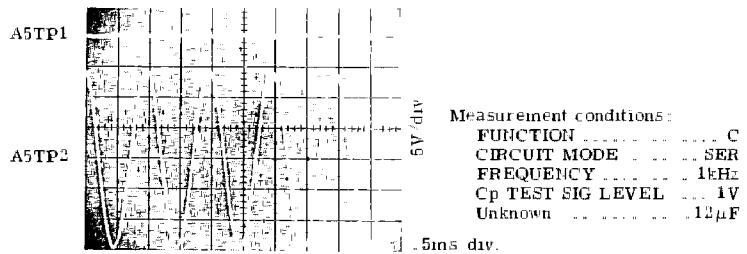
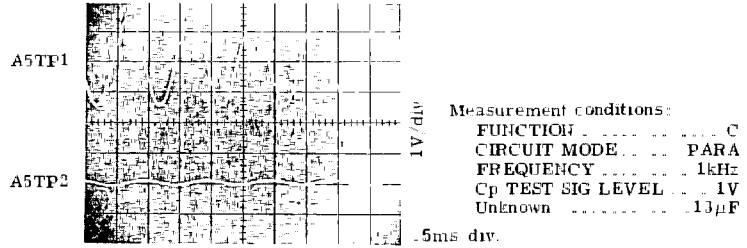


Figure 8-27. A5 Process Amplifier Board Troubleshooting Guide.



CIRCUIT DESCRIPTION.

A5 Process Amplifier Board receives analog signals H_p (from H_{POTEN} terminal), L_p (from L_{POTEN} terminal through the mother board), L_c and e_{rr} (from A4 board through the mother board), and outputs e_m and e_{ref} signals to the A6 board. Operational amplifiers U1 thru U4 are buffer amplifiers which present a high input impedance to the analog input signals. RC networks (R23, C2, R26, C3, R35 and C5) preceding the buffer amplifiers restrict high frequency noise (which affects the measurement accuracy) from entering the instrument through the UNKNOWN terminals. C1 and C4 are dc voltage blocking capacitors. Differential amplifiers U2B and U4B amplify the differences between H_p and L_p signals, and between e_{rr} and L_c signals, respectively. The voltage gain of the differential amplifiers is set to precisely one by external resistors R24, R25, R33 and R34 which have an accuracy of ± 0.05 percent. An offset adjustment circuit maintains the output dc level of the differential amplifiers to approximately zero volts. The output of the amplifier is divided by ten by resistors R41 thru R44.

Signal selector circuit Q9 through Q13 selects appropriate differential amplifier output required for measurement by control signals Voltage Select (V TEST) and Circuit Mode Series (= CMS) which are fed from A3 and A8 boards, respectively. Figure A shows signal selection by V TEST and

CMS signals. The e_m signal selected by Signal Selector Circuits is amplified by U5A and U5B and fed to A6 Phase Detector and Integrator board. e_{ref} signal is amplified by U6A and is then converted to a pulse train by wave shaping circuits U6B and U8. APAO (Auto Phase Adjustment Output) signal is applied to input of U6B through R66 to control the duty cycle of e_{ref} signal for auto phase adjustment. CR18 and CR19 are used for clamping. U7 is a window comparator which outputs SAT (Saturation) signal to A8 Board when voltage level at A5TP3 exceeds ± 5 volts. In this board, the dc power supply line is divided into three channels to avoid mutual interaction.

AUTO PHASE ADJUSTMENT (PHASE CONTROL).

The waveforms drawn in solid lines in Figure B are those that exist when 0V DC input (APAO) is applied. Waveforms in dotted lines are those that are present when a plus DC input (APAO) is applied. When AC signals with different dc levels are inputted, e_{ref} signals with different duty factors are generated as the AC signals are amplified with respect to a fixed (0V) reference. Therefore, the phase of the PLL output used for phase detection will vary since the PLL circuits detect only the trailing edge of an e_{ref} signal.

TROUBLESHOOTING INFORMATION.

If troubles occur, it is recommended that the troubleshooting tree presented at the left be followed.

CMS signal	PARALLEL		SERIES	
VIST signal	High		Low	
Signal for e_m	Signal at A5TP2	Signal at A5TP1 10	Signal at A5TP1	Signal at A5TP2 10
Signal for e_{ref}	Signal at A5TP1		Signal at A5TP2	

Figure A. Signal Selection.

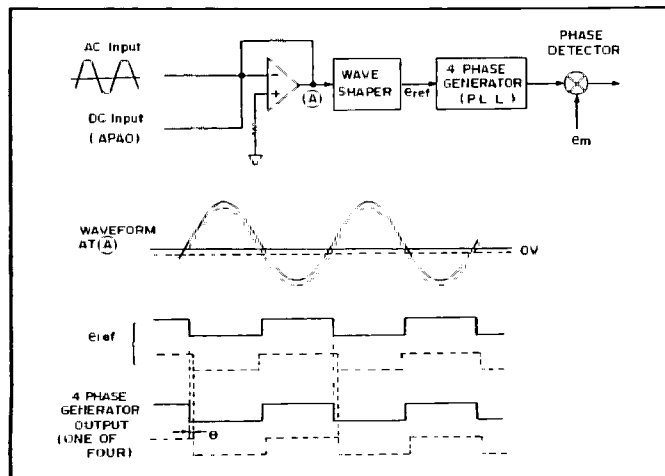


Figure B. Auto Phase Adjustment.

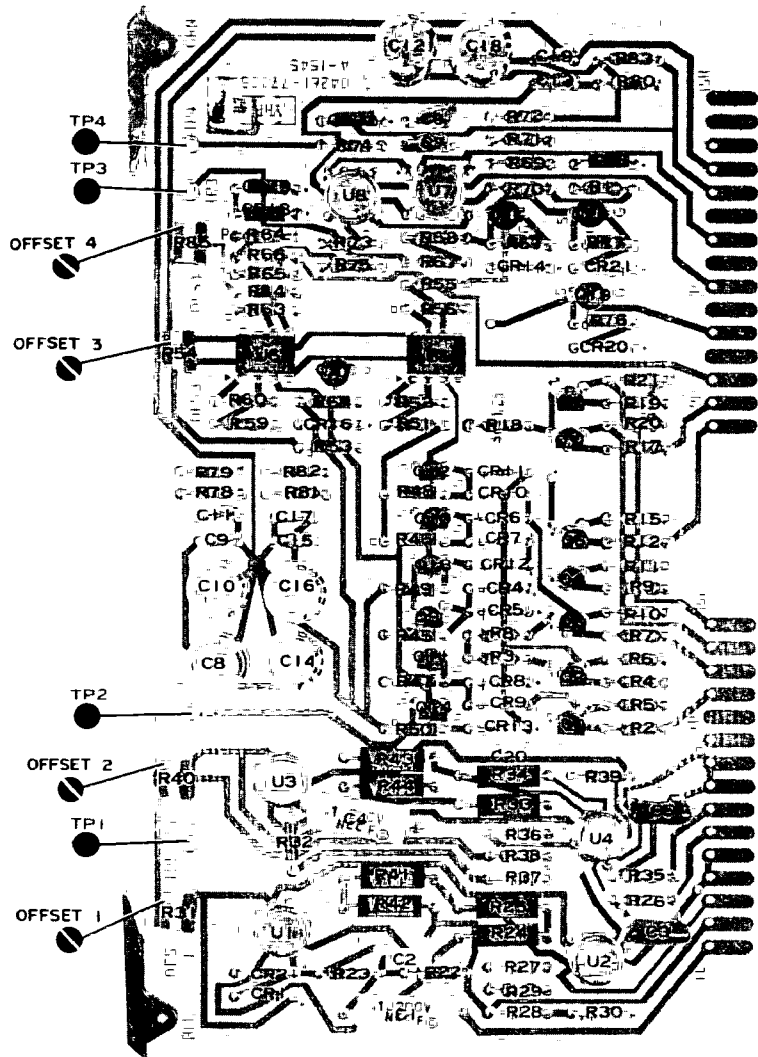


Figure 8-28. A5 Process Amplifier Board Assembly Component Locations.

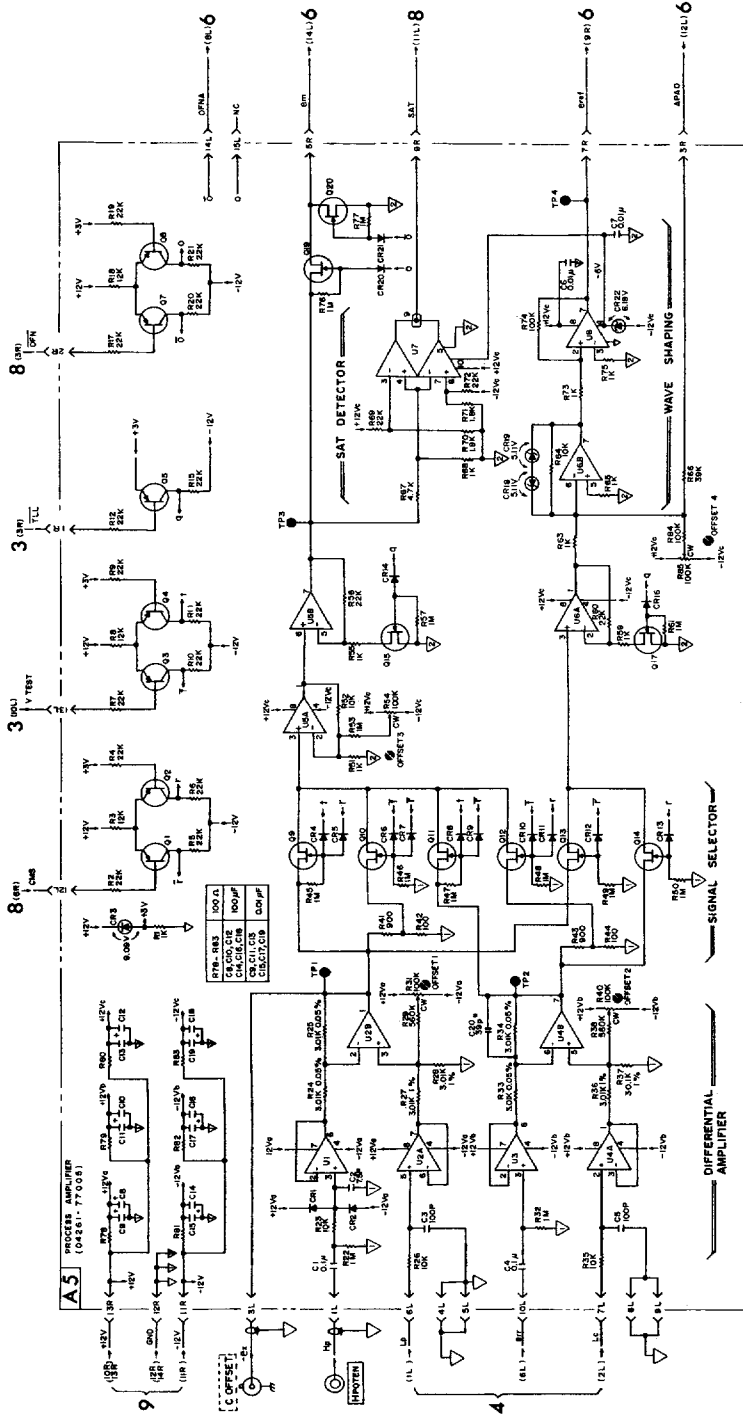


Figure 8-29. A5 Process Amplifier Board Assembly Schematic Diagram.
 8-63

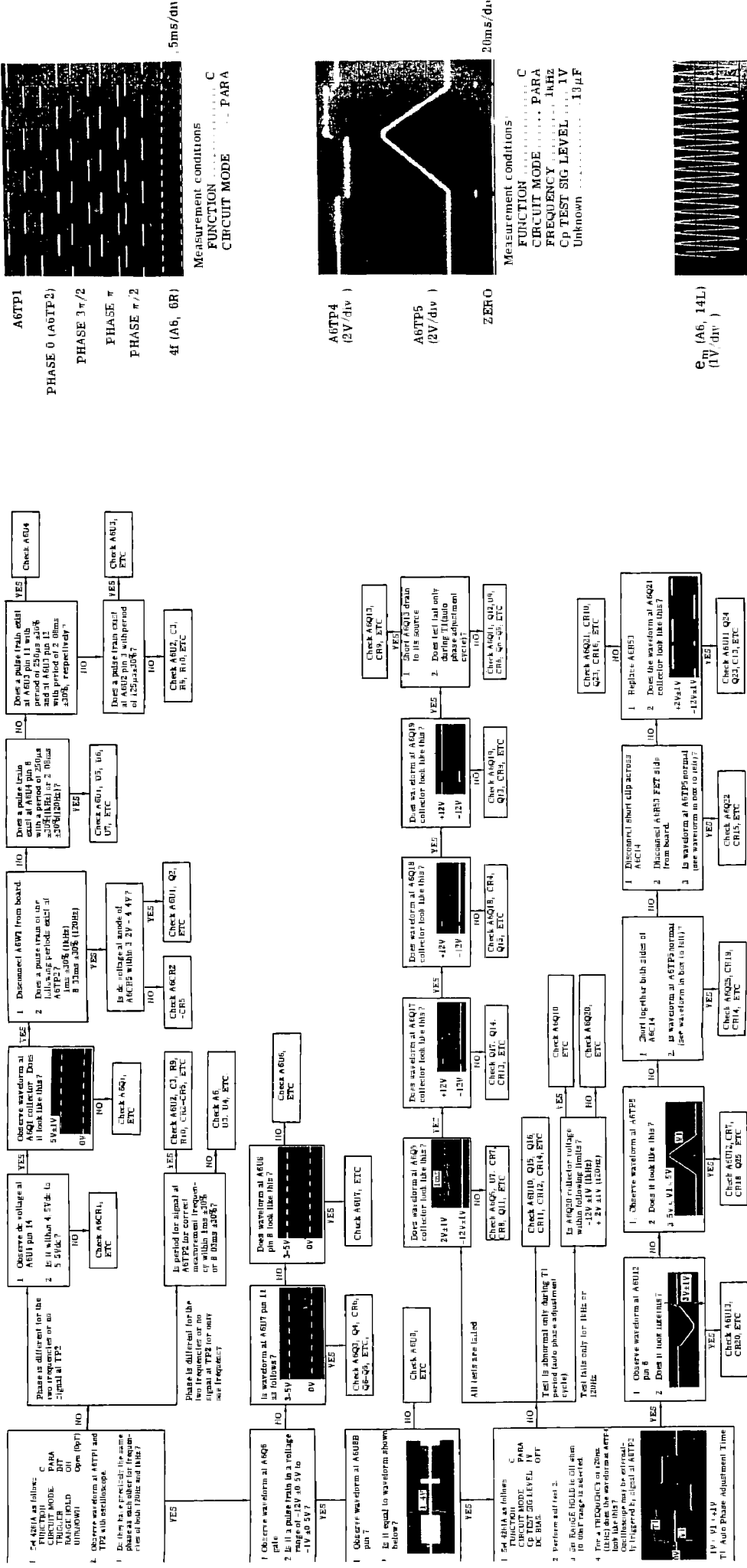
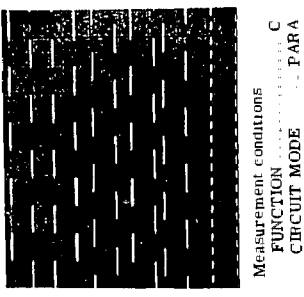
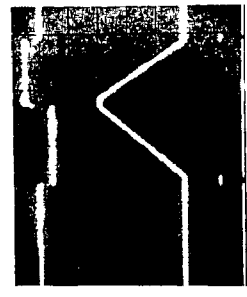


Figure 8-30. A6 Phase Detector/Integrator Board Troubleshooting Guide.



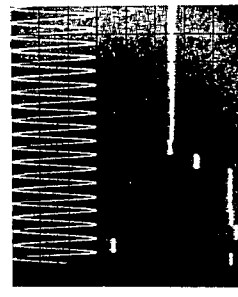
A6T1
PHASE 0 (A6T2)
PHASE $3\pi/2$
PHASE π
PHASE $\pi/2$
4f (A6, 6R)

Measurement conditions
FUNCTION C
CIRCUIT MODE PARA



A6T4
(2V/div)
A6T5
(2V/div)
ZERO

Measurement conditions
FUNCTION C
CIRCUIT MODE PARA
FREQUENCY 1kHz
Cp TEST SIG LEVEL 1V
Unknown 10 μ F



e_m (A6, 14L)
(1V/div)
A6T6
(50mV/div)

Measurement conditions
FUNCTION C
CIRCUIT MODE PARA
FREQUENCY 1kHz
Cp TEST SIG LEVEL 1V
Unknown Open

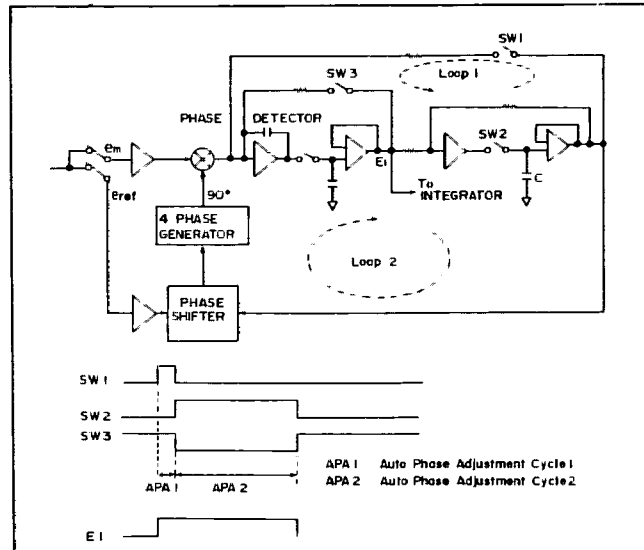


Figure D Auto Phase Adjustment.

The Auto Phase Adjustment is automatically performed to minimize the measurement error due to detection phase error. In the APA2 (Auto Phase Adjustment Cycle 2) period, the same signal is applied to both the phase detector and the phase shifter, and the four phase generator outputs a 90 degree phase shifted pulse. If any phase error exists between e_m and e_{ref} signals, the phase detector outputs an E_1 signal which is the integrator output for such error signal. This E_1 signal is amplified by the amplifier which follows. The output of this amplifier is sent to a phase shifter to adjust the phase of the 4 phase generator output so that the phase error is minimized. The operation discussed above is performed with Loop 2 (SW3: OFF, SW2: ON). After the APA2 period, SW3 is closed and SW2 is turned off to memorize the dc voltage (phase control signal) stored in capacitor C which will be maintained during the measurement. For APA1 (Loop 1, Auto Phase Adjustment Cycle 1) period done prior to APA2, SW1 is closed to provide a phase control signal to the phase detector. APA1 establishes the proper condition for phase adjustment of phase detector and helps to achieve a shorter auto phase adjustment cycle. APA1 and APA2 are performed before every measurement and establish the condition for minimum phase error between the e_m and e_{ref} channels.

Figure D. Auto Phase Adjustment

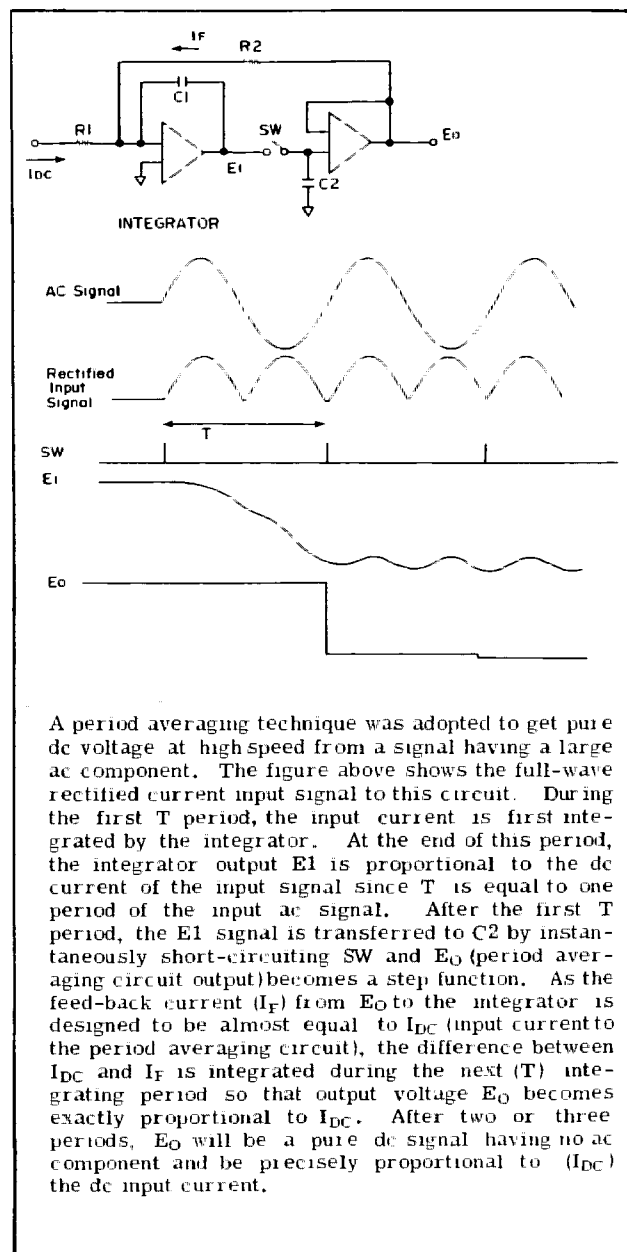
CIRCUIT DESCRIPTION

A6 Phase Detector and Integrator board assembly receives e_{ref} and e_m signals from A5 Process amplifier. These signals are converted into signals required for the measurement by control signals from logic circuits. The output of this board is the ZERO signal detected by the zero detector. The ZERO signal establishes the point at which the measurement is taken. It is sent on to the logic section for further processing. e_{ref} signal pulse trains are first multiplied to four times their frequency, by the Phase Locked Loop Circuits, U1 thru U5, Q1 thru Q3, etc. Then these $4f$ pulse trains are converted to four square wave signals, each having an exact phase difference of 0° , 90° , 180° and 270° with respect to the negative edge of the e_{ref} signal. One of the four pulse trains is appropriately selected by a phase selection signal (PHASE 0, PHASE $\pi/2$, PHASE π , or PHASE $3\pi/2$) from A3 board, amplified by Q3 and Q4 circuits and applied to phase detector circuit U8, Q6 thru Q9.

The Phase Detector is a kind of the AC to DC converter using a period averaging technique (U9, Q11, etc.) which is further discussed below. Integrator circuit (Q24, U11, etc.) receives the output of the phase detector and integrates this signal. The integrator output about the zero volt level is amplified by U12 amplifier whose output is sent to zero comparator whose output is +3.4Vdc only when the integrator output is in the minus voltage region.

TROUBLESHOOTING INFORMATION

The troubleshooting tree (guide) for A6 board is presented at the left.



A period averaging technique was adopted to get pure dc voltage at high speed from a signal having a large ac component. The figure above shows the full-wave rectified current input signal to this circuit. During the first T period, the input current is first integrated by the integrator. At the end of this period, the integrator output E_1 is proportional to the dc current of the input signal since T is equal to one period of the input ac signal. After the first T period, the E_1 signal is transferred to C_2 by instantaneously short-circuiting SW and E_O (period averaging circuit output) becomes a step function. As the feedback current (I_F) from E_O to the integrator is designed to be almost equal to I_{DC} (input current to the period averaging circuit), the difference between I_{DC} and I_F is integrated during the next (T) integrating period so that output voltage E_O becomes exactly proportional to I_{DC} . After two or three periods, E_O will be a pure dc signal having no ac component and be precisely proportional to (I_{DC}) the dc input current.

Figure A. Period Averaging Technique.

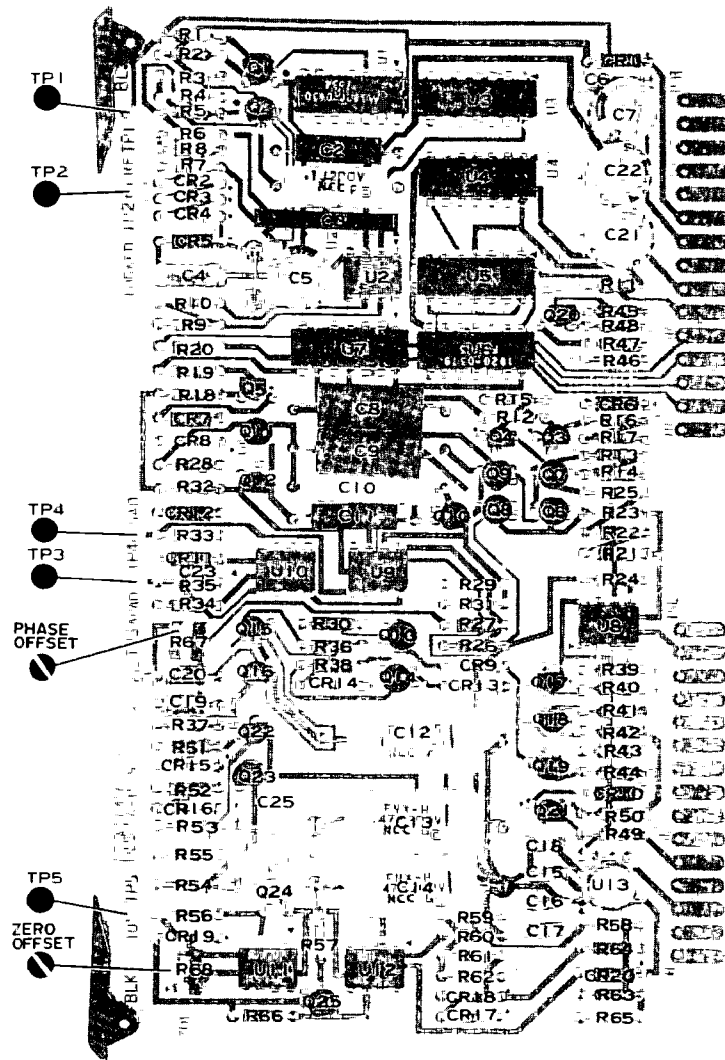


Figure 8-31. A6 Phase Detector Integrator Board Assembly Component Locations.

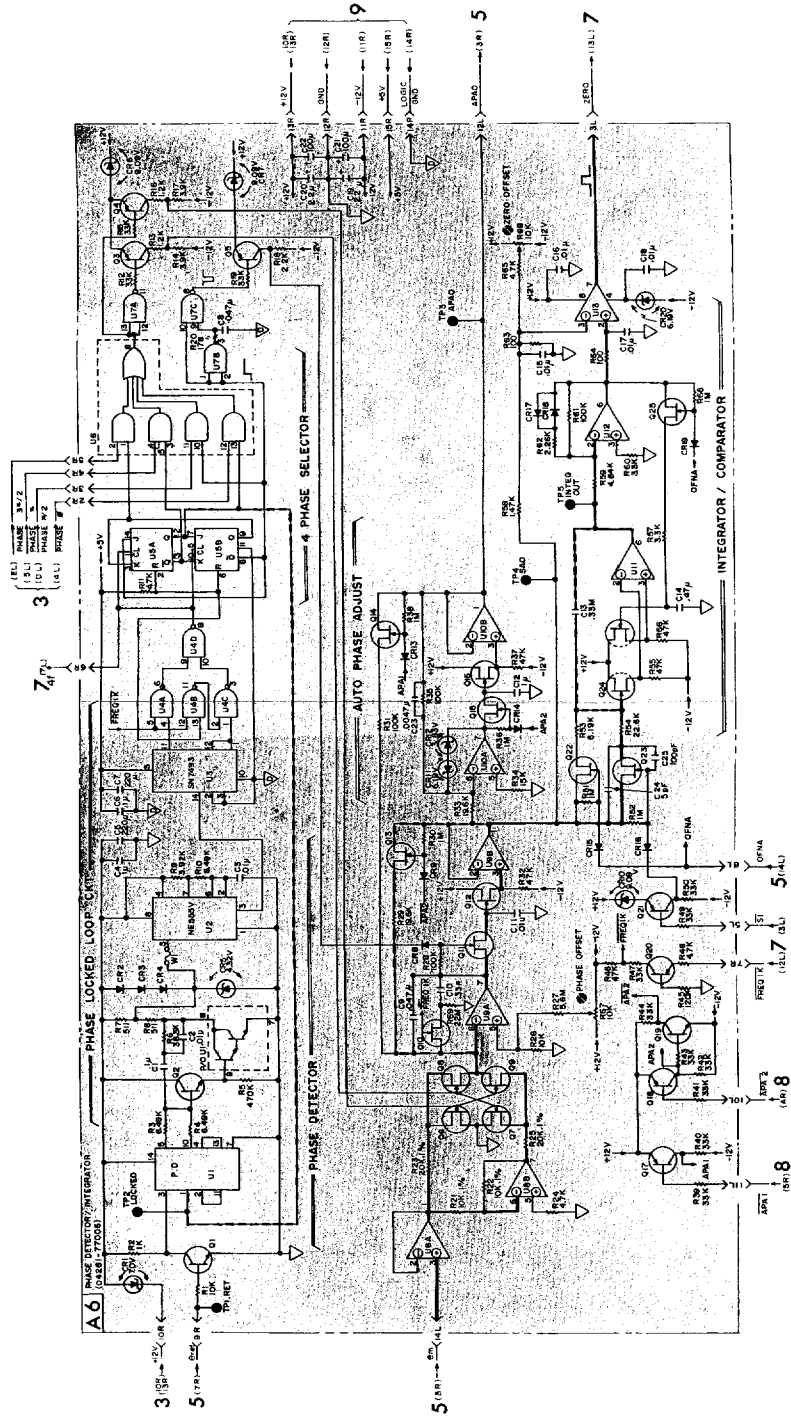
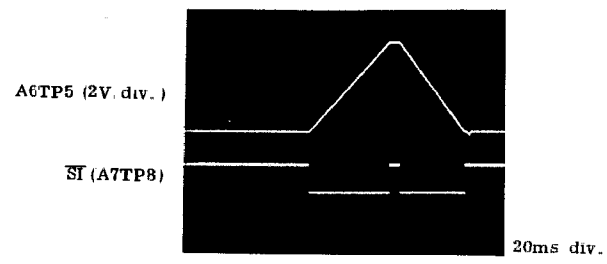
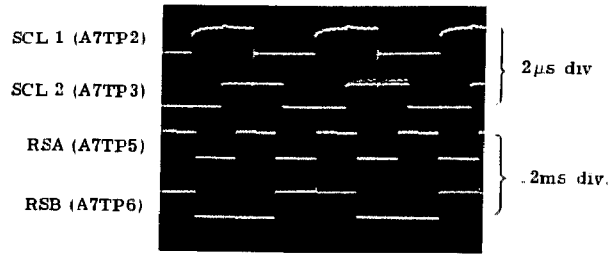


Figure 8-32. A6 Phase Detector/Integrator/Board Assembly Schematic Diagram.



Measurement conditions:

FUNCTION C

CIRCUIT MODE PARA

FREQUENCY 1kHz

Cp TEST SIG LEVEL 1V

Unknown13 μ F

7, A7**CIRCUIT DESCRIPTION**

A7 Board contains Clock Pulse Generator (Y1, U1, U6 thru U8, U14A/B and U15), Data Counter Gate (U9, U15 and U16), Data Counter (U17, U2 thru U5, U20 and U21), Parallel to Serial Converter (U11 and U12) and four Input Multiplexers (U10, U13, U18 and U19).

Clock Pulse Generator. Crystal Y1 and U1 comprise the crystal oscillator whose frequency is 2.5465MHz (TP1). The clock pulse of 31.83kHz at TP4 is generated by dividing 2.5465MHz with U6 and U7. This clock is fed to Data Counter through Data Counter Gate. RSA (at TP5) and RSB (at TP6) signals are outputs of U8 counter and have frequencies of 1.99kHz and 0.99kHz, respectively. These signals are used as the control signals for the Parallel to Serial Converter and sent to A3 board for display control. State clock pulses SCL1 at TP2 and SCL2 at TP3 have a frequency of 127.3kHz with a phase difference of 90° to each other. These signals are used to advance the state of ROM with which they are synchronized.

Data Counter Gate (U9) selects a clock pulse from either of two clocks, the 4f signal (at TP7) or 31.83 kHz (at TP4), as directed by 4fS (4f Select) control signal which is at high level only during L/C measurement and test. For R and D measurements the 31.83kHz clock is selected and fed to Data Counter.

\overline{SI}_2 signal is at low level during charging period in L or C measurements, and \overline{SI}_1 is low during charging period in R or D measurements and discharge period for all measurements. \overline{SI} signal is at low when either \overline{SI}_1 or \overline{SI}_2 is at low level.

Data Counter is a 3-1/2 digit counter. \overline{CDC} (Clear Data Counter) signal resets contents of counter to zero counts. \overline{SDC} (Set Data Counter) signal sets counter to 1999 counts. U17, U20 and U21 detects 162 and 1820 counts for autoranging and 80 counts for D measurement.

Parallel to Serial Converter U11 and U12 converts parallel BCD data of the counter to serial BCD data with RSA and RSB control signals and its outputs to the A3 board appear as shown in Figure A below.

Input Multiplexer. The four input multiplexers receive various signals: contents of the counter, test frequency, function, range, circuit mode, step, and ZERO, RSA, RSB signals, etc; they each select one of these signals as required and as directed by control signals OPB8 (Output Bit 8) thru OPB10 from A8 board and output the selected signal to A8U1 Multiplexer on A8 Board.

TROUBLESHOOTING INFORMATION

The troubleshooting guide to component level for the A7 board is not given in this service sheet. See Figures 8-11 and 8-12 for A7 troubleshooting.

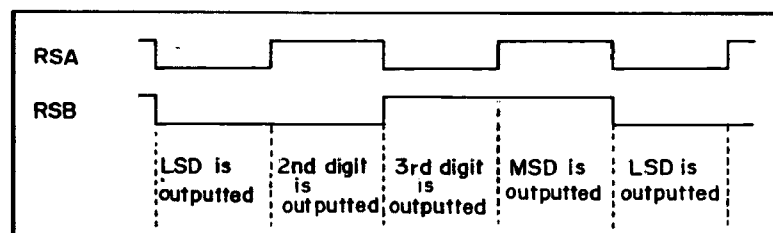


Figure A. Parallel to Serial Conversion.

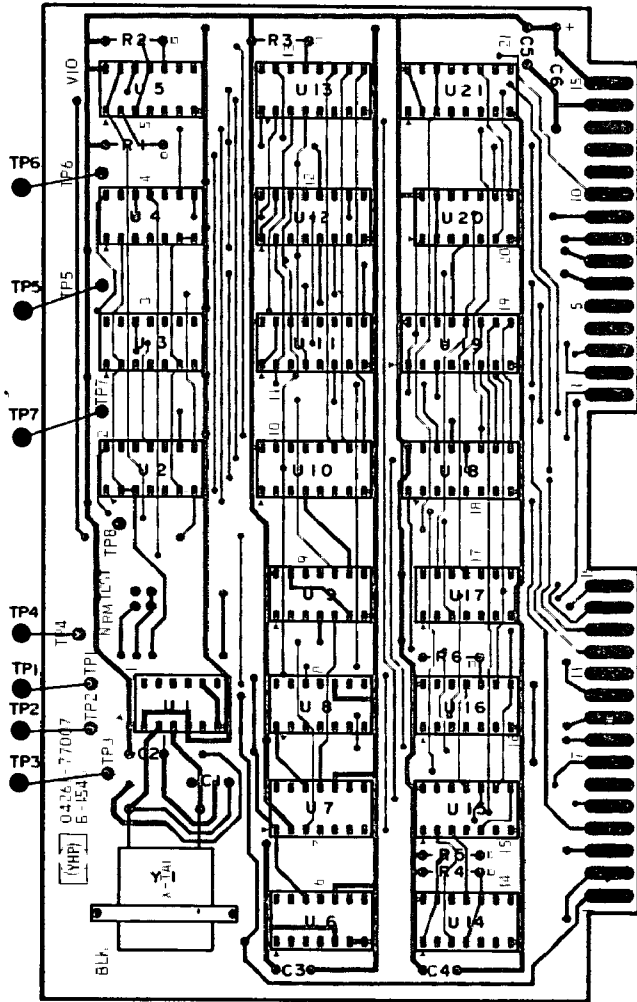
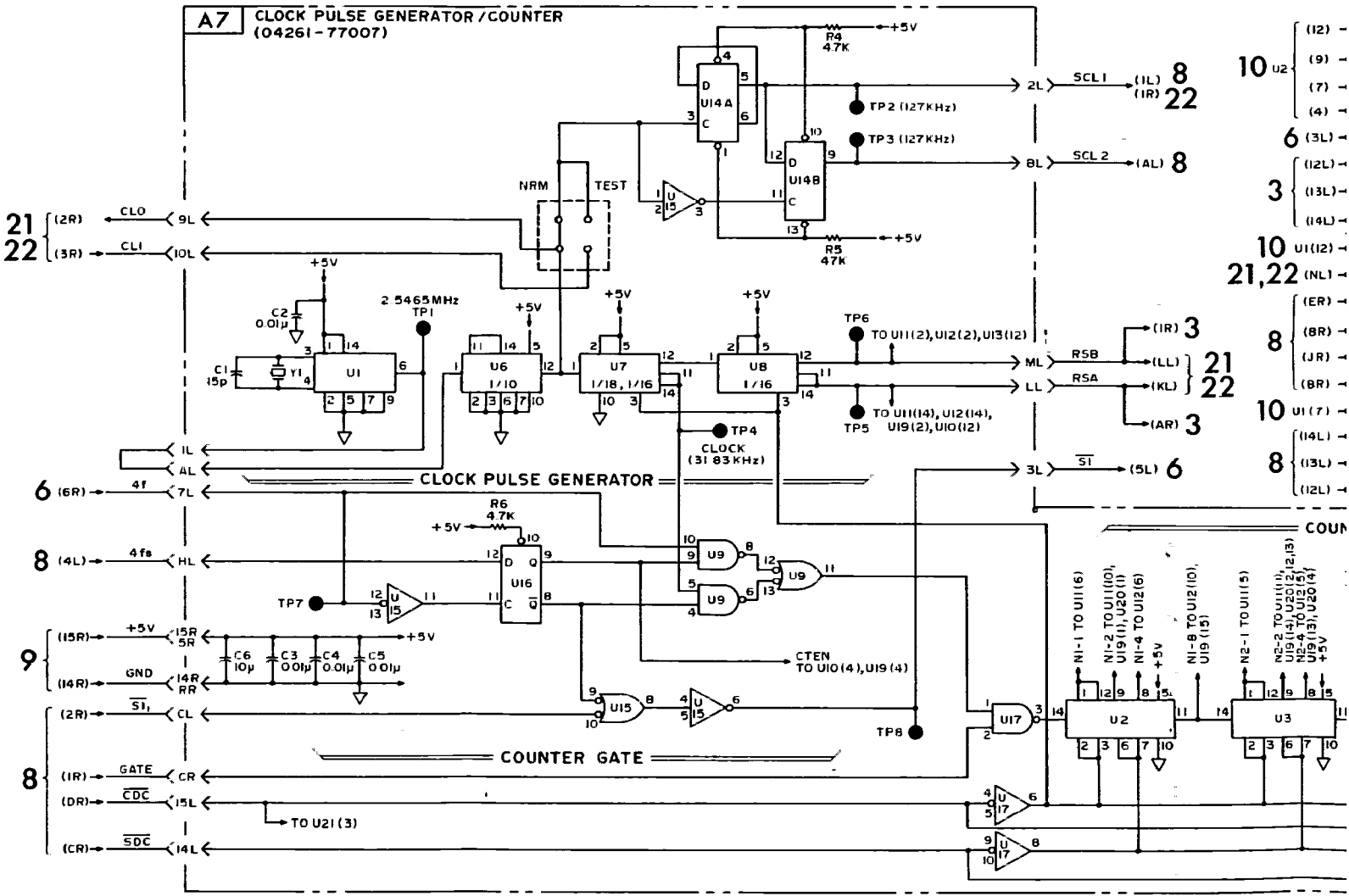


Figure 8-33. A7 Clock Pulse Generator/Counter Board Assembly Component Locations.

A7 CLOCK PULSE GENERATOR /COUNTER
(04261-77007)



21 (2R) ← CLO ← 9L
22 (3R) ← CLI ← 10L

6 (6R) → 4f ← 7L

8 (4L) → 4fs ← HL

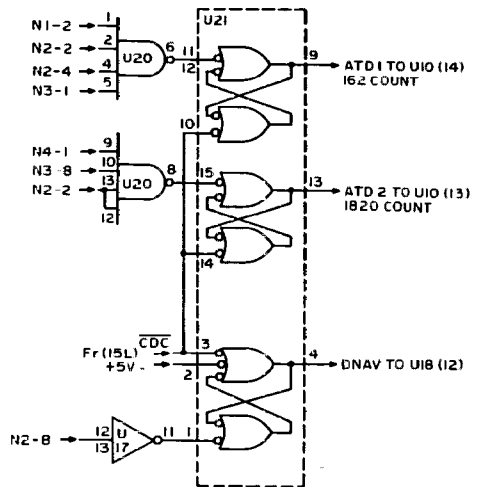
9 (15R) → +5V ← 15R
(14R) → GND ← 14R
(2R) → $\overline{S1}$ ← CL

8 (1R) → GATE ← CR
(DR) → \overline{CDC} ← 15L
(CR) → \overline{SDC} ← 14L

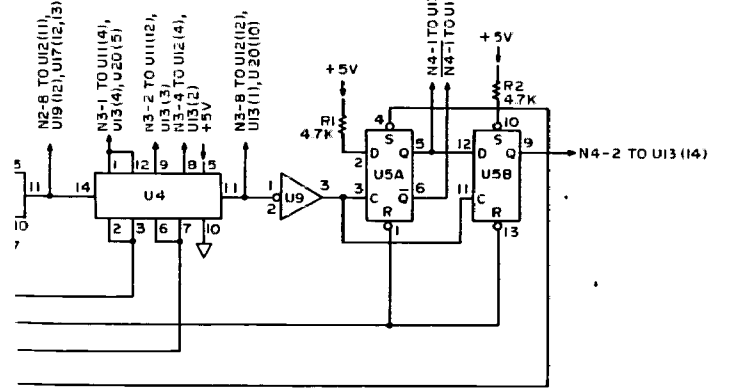
8 SCL1 (1L) (1R)
8 SCL2 (AL)
3 (IR) (LL) (AR)
8 (BR) (JR) (BR) (AR)
10 (12L) (13L) (14L) (12L) (13L) (14L)

10 U1(12) (NL) (ER) (BR) (JR) (BR) (AR)
10 U1(7) (14L) (13L) (12L)
COUN

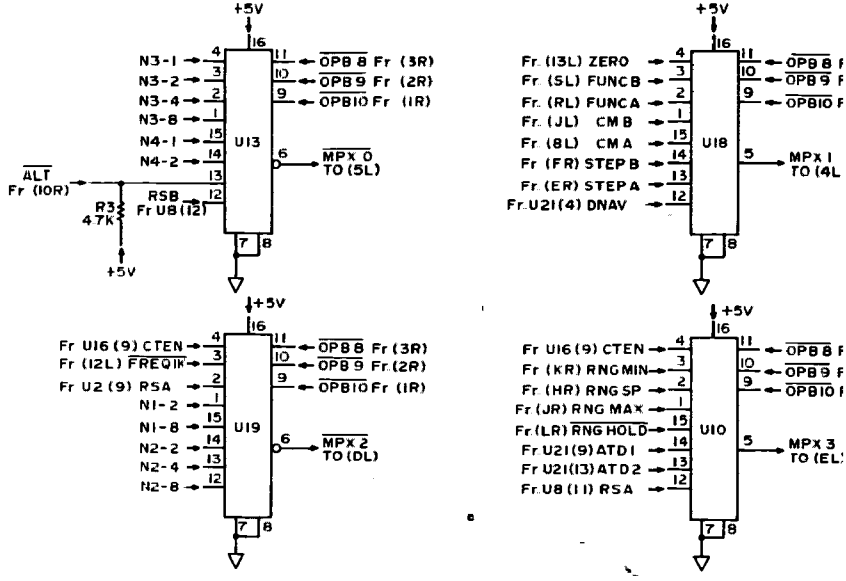
- 1) → FUNC A < RL ←
- 2) → FUNC B < SL ←
- 3) → CMA < BL ←
- 4) → CMB < JL ←
- 5) → ZERO < 13L ←
- 6) → RNG SP < HR ←
- 7) → RNG MAX < JR ←
- 8) → RNG MIN < KR ←
- 9) → RNG HOLD < LR ←
- 10) → ALT < 10R ←
- 11) → MINUS < DR ←
- 12) → STEPA < ER ←
- 13) → STEP B < FR ←
- 14) → LSC 0 < NL ←
- 15) → FREQ I K < 12L ←
- 16) → OPB 8 < 3R ←
- 17) → OPB 9 < 2R ←
- 18) → OPB 10 < 1R ←



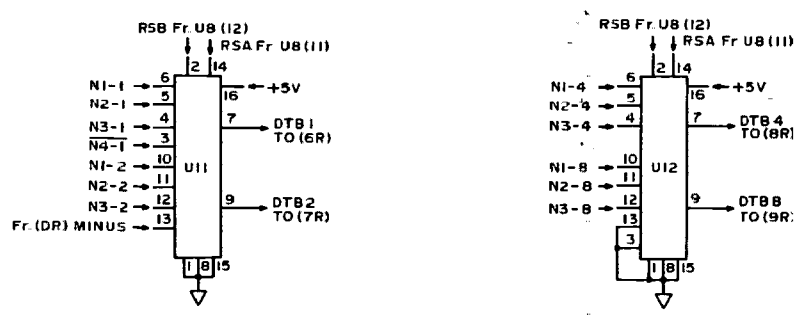
ENTER



INPUT MULTIPLEXER



PARALLEL TO SERIAL CONVERTER



Note

1. Truth table for A7U18 is given below. A7U10 operates the same as A7U18. A7U13 and U19 also operate similar to A7U18 except that the output is the complement of the selected input level.

OPB10 (9)	OPB9 (10)	OPB8 (11)	MPX1 (5)
L	L	L	ZERO
L	L	H	FUNC B
L	H	L	FUNC A
L	H	H	CMB
H	L	L	CMA
H	L	H	STEP B
H	H	L	STEP A
H	H	H	DNAV

H: high level
 L: low level

2. Truth table for A7U11 is given below. A7U12 operates the same as A7U11.

RSB (2)	RSA (14)	DTB 1 (7)	DTB 2 (9)
L	L	N1 - 1	N1 - 2
L	H	N2 - 1	N2 - 2
H	L	N3 - 1	N3 - 2
H	H	N4 - 1	MINUS

H: high level
 L: low level

3. A7S1 should be set to NRM position.

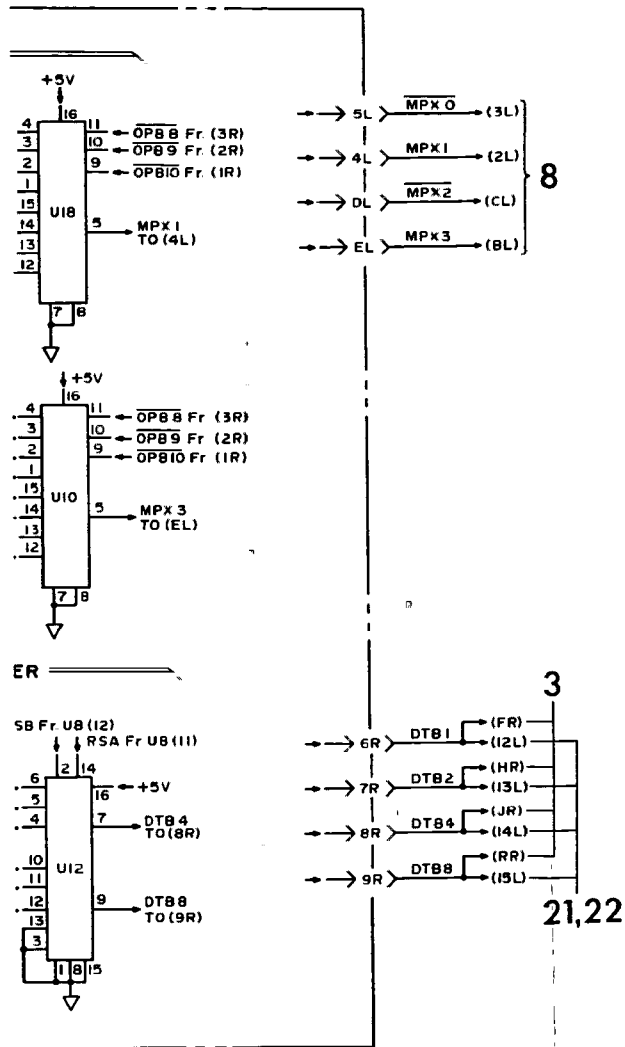
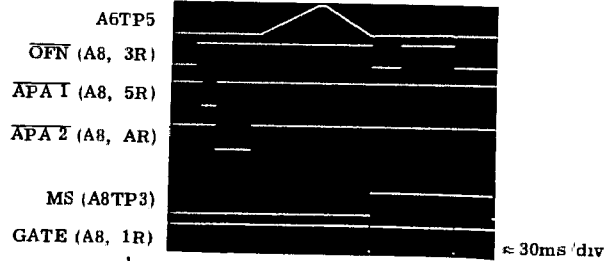
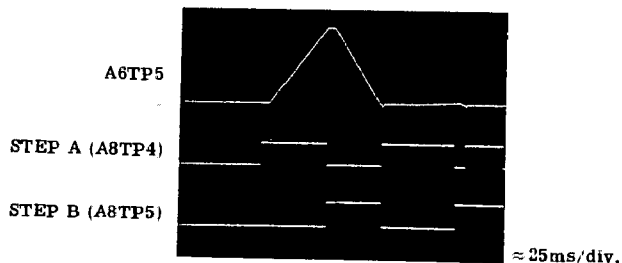


Figure 8-34. A7 Clock Pulse Generator/Counter Board Assembly Schematic Diagram.





Measurement conditions:
 FUNCTION C
 CIRCUIT MODE PARA
 FREQUENCY 1kHz
 Cp TEST SIG LEVEL 1V
 Unknown 13μF



Measurement conditions:
 FUNCTION C
 CIRCUIT MODE PARA
 FREQUENCY 1kHz
 Cp TEST SIG LEVEL 1V
 Unknown 13μF

CIRCUIT DESCRIPTION

The A8 Measurement Sequence Control board is the heart of the 4261A Digital Section and manages various Analog Section operations including the autoranging. This control board includes the Multiplexers, State Counter Register, ROM, Step Counter, Decoders and Range Step Selector. The Input Multiplexers (U12, U6) receive CMS, MS (Measurement Status), SAT (Saturation), and remove control signals, etc., and select one signal from among them as directed by control signals $\overline{\text{OPB8}}$ (output Bit 8) thru $\overline{\text{OPB10}}$ and output selected signal as $\overline{\text{MPX4}}$ and $\overline{\text{MPX5}}$. Multiplexer U1 receives outputs from six input multiplexers (two on A8 board and four on A7 board) and selects one signal as directed by control signals $\overline{\text{OPB11}}$ thru $\overline{\text{OPB13}}$. The output of Multiplexer U1 is fed through U14 to U13 where it is synchronized with SCL2 (State Clock 2). Qualifier signal at TP1 is an output of U13 and is sent to State Counter/Register (U2, U7) which works as a latch for $\overline{\text{OPB0}}$ thru $\overline{\text{OPB7}}$ signals when the qualifier signal is at low level, or as a counter for SCL1 signal when qualifier is at high level. The outputs for State Counter Register are fed to ROM U8 which outputs $\overline{\text{OPB0}}$ thru $\overline{\text{OPB15}}$ signals. Signals $\overline{\text{OPB0}}$ thru $\overline{\text{OPB7}}$ are fed back to State Counter Register to determine the next state of the ROM. Signals $\overline{\text{OPB8}}$ thru $\overline{\text{OPB10}}$ are sent to Input Multiplexers to select one signal and also sent to Decoders U5, U10 and U17 to output various instructions to Analog Section, Multiplexers and other circuits.

When the $\overline{\text{LSC0}}$ signal is at low level, the U16 Presetable Up/down Counter receives range control signals ($\overline{\text{RNG UP}}$ and $\overline{\text{RNG DWN}}$ when RANGE HOLD is set to OFF), takes a counts, and outputs the counts as RNG A, RNG B and RNG C signals which are, in turn, selected by U15 selector and fed to A3 board as SLO1 thru SLO4 signals.

When $\overline{\text{LSC0}}$ signal is high, U15 selects STEP A, STEP B, MS and $\overline{\text{TEST2}}$ signals and outputs them as SLO1 thru SLO4. U18 is a step counter, whose input signal is $\overline{\text{ISC}}$ (Increment Step Counter), assigns the measurement step. U13 and U11 form a trigger lamp driver. The Turn On Trigger Generator consists of U19, U3, Q1 and Q2. It outputs a turn-on-trigger signal only when LINE switch is turned to ON.

TROUBLESHOOTING INFORMATION

See Figures 8-11 and 8-12 for A8 troubleshooting to the component level as an A8 troubleshooting guide is not provided in this service sheet.

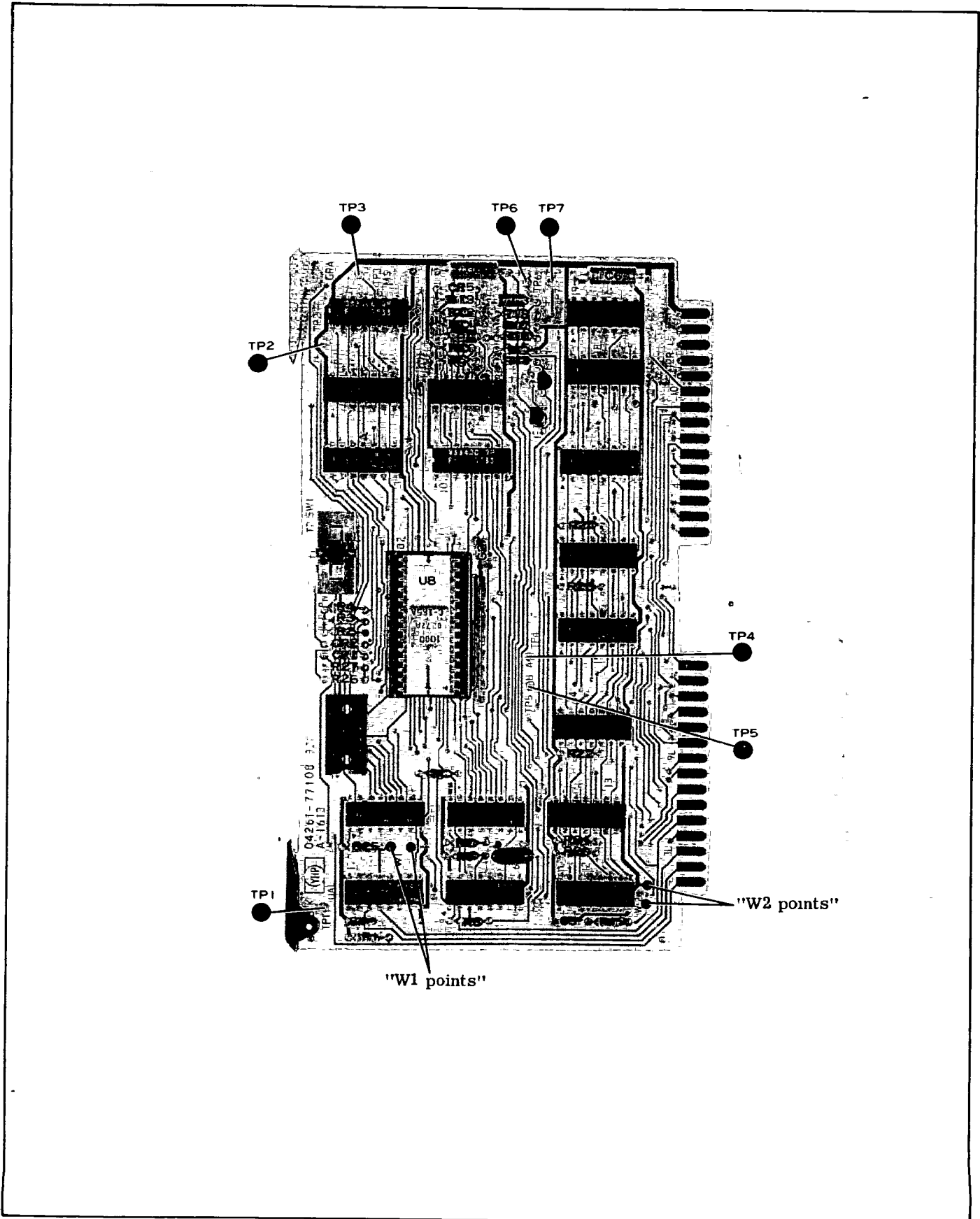
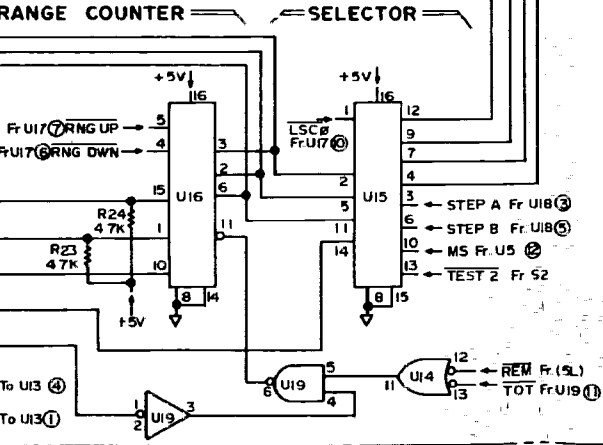
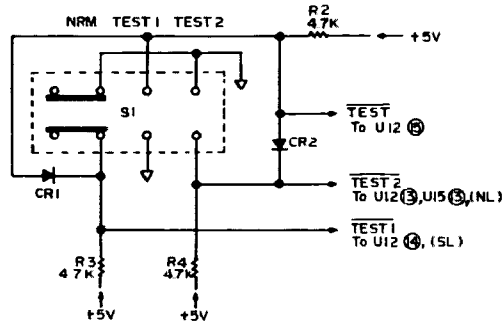
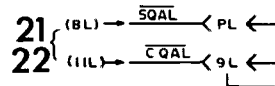
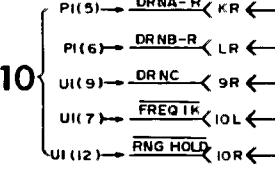
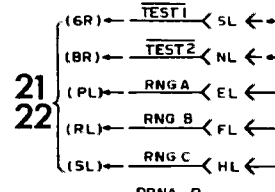
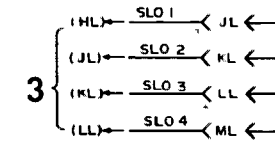
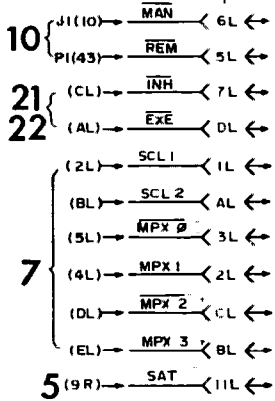


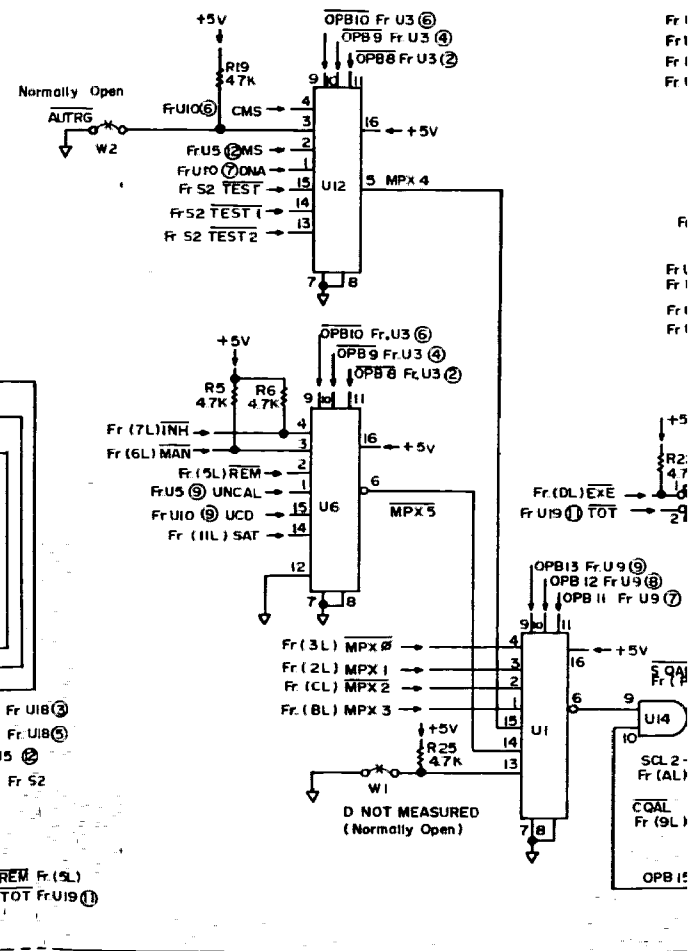
Figure 8-35. A8 Sequence Control Board Assembly Component Locations.

A8

SEQUENCE CONTROL (04261-77108)

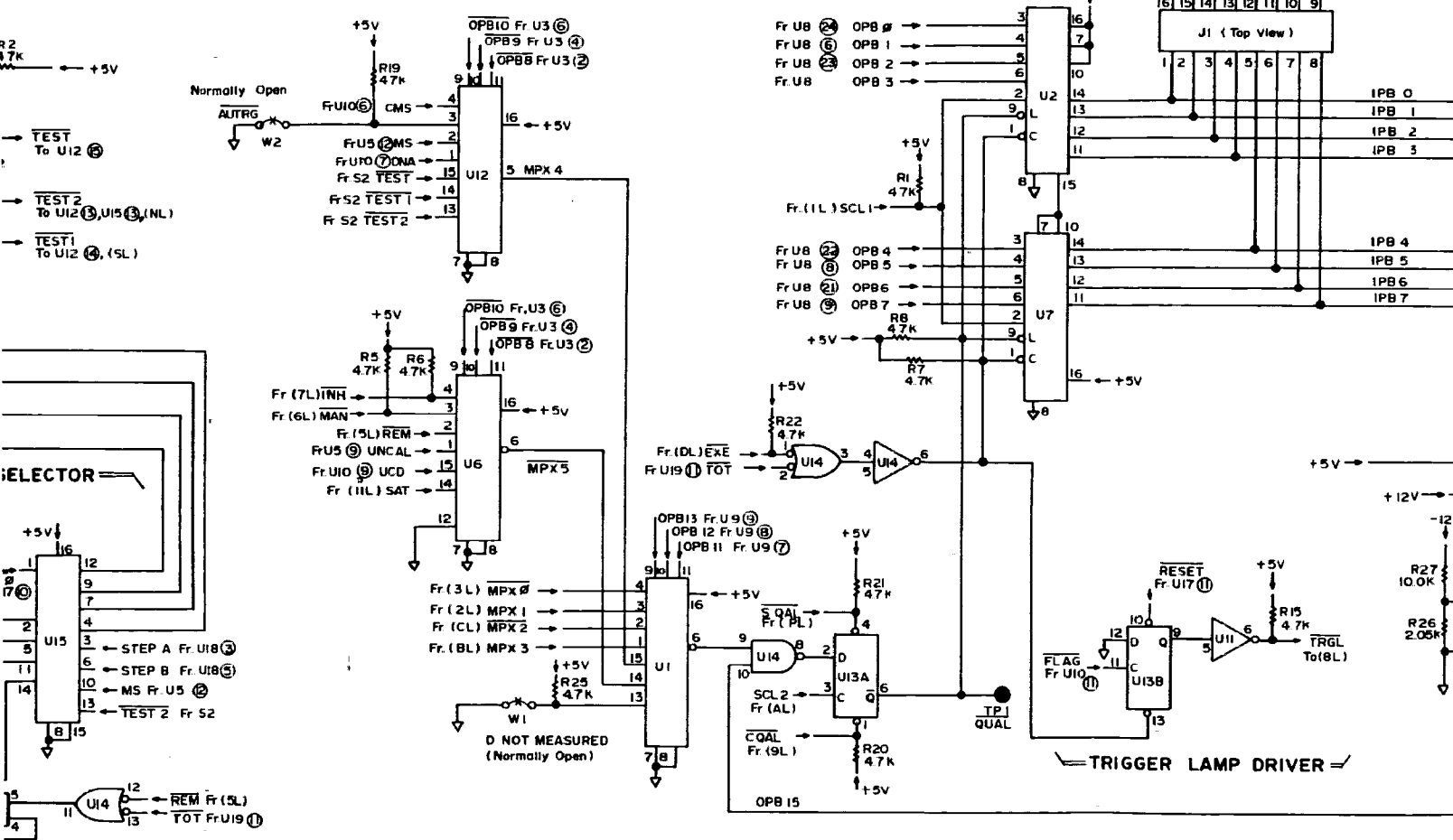


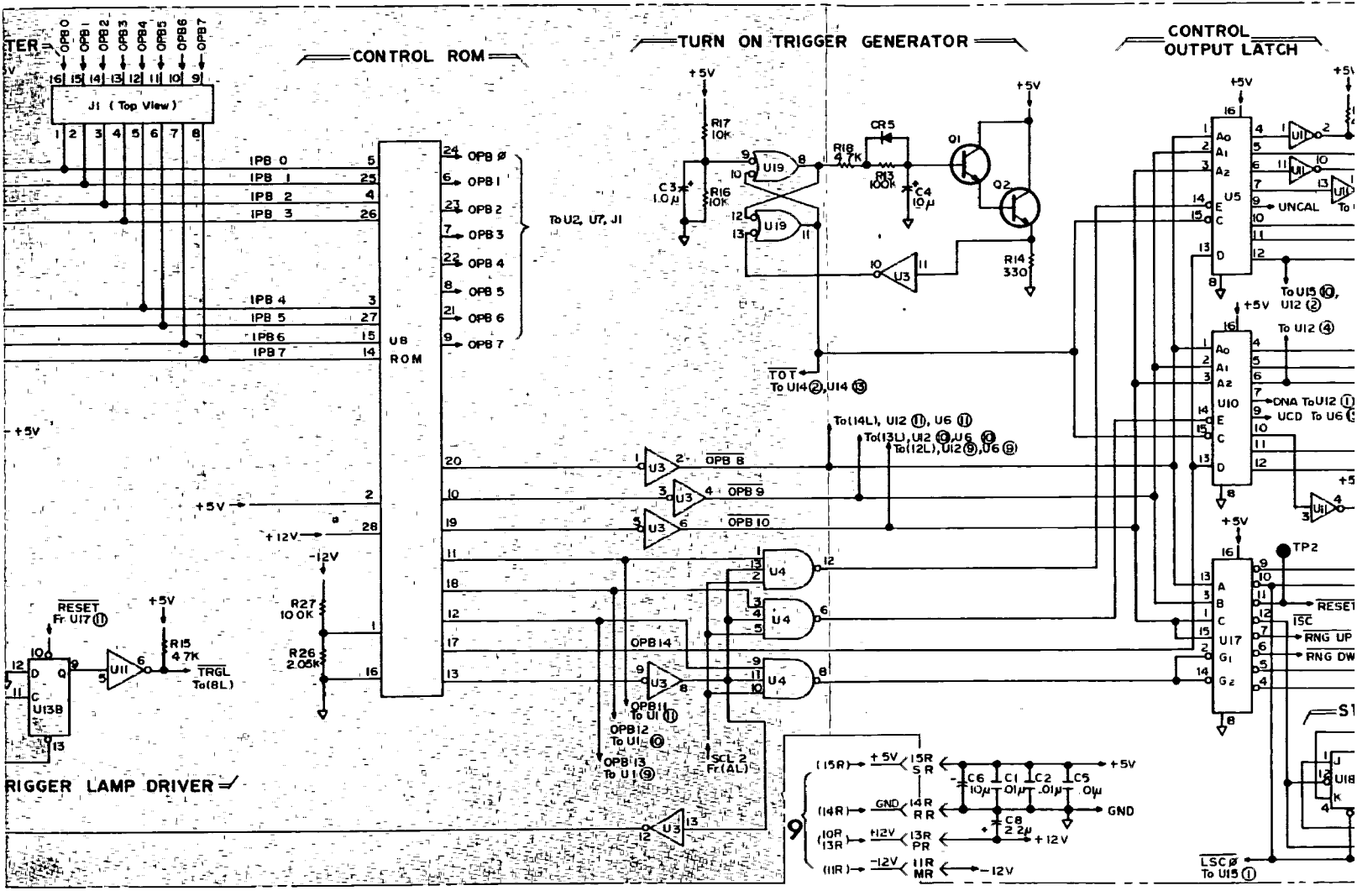
INPUT MULTIPLEXER

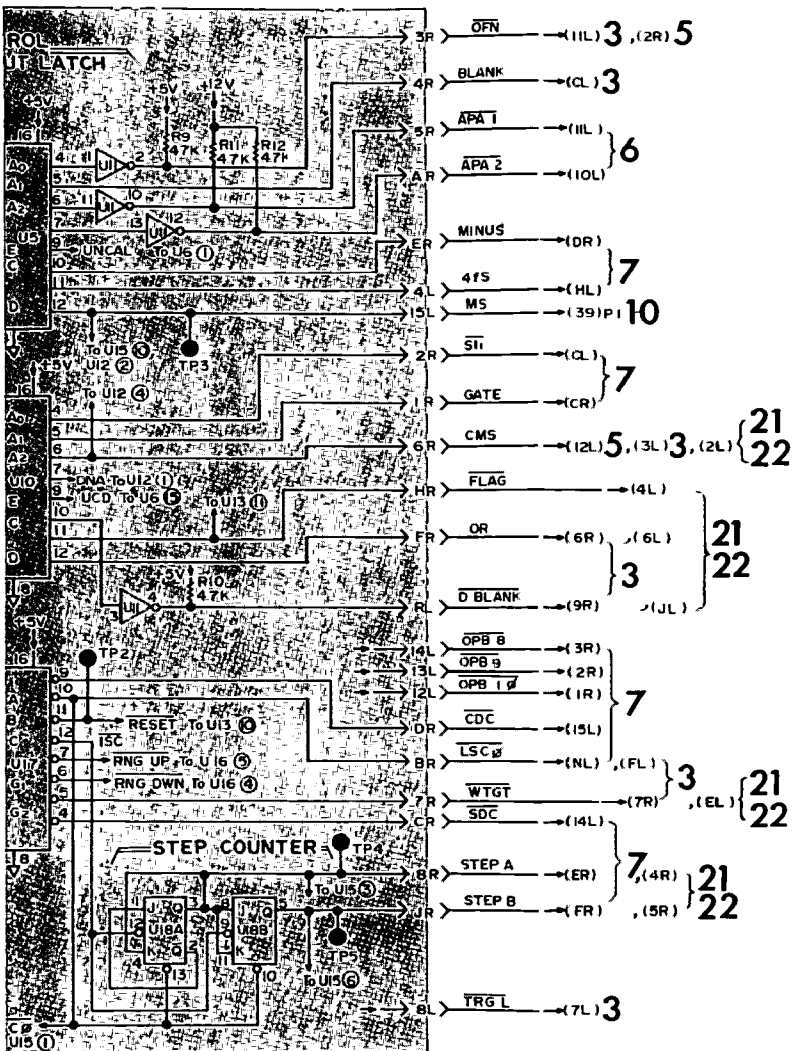


INPUT MULTIPLEXER

STATE COUNTER / REGISTER







- Note
1. Truth table for A8U1, U6 and U12. See note 1 on A7 board circuit schematic.
 2. See Section III paragraph 3-48 for "how to use A8W1 and W2 jumper wire connections".
 3. Truth table for A8U15:

LSC 0 (1)	SLO 1 (4)	SLO 2 (7)	SLO 3 (9)	SLO 4 (12)
L	RNG A	RNG B	RNG C	FREQ 1k
H	STEP A	STEP B	MS	TEST 2

8
A8

Figure 8-36. A8 Sequence Control Board Assembly Schematic Diagram.

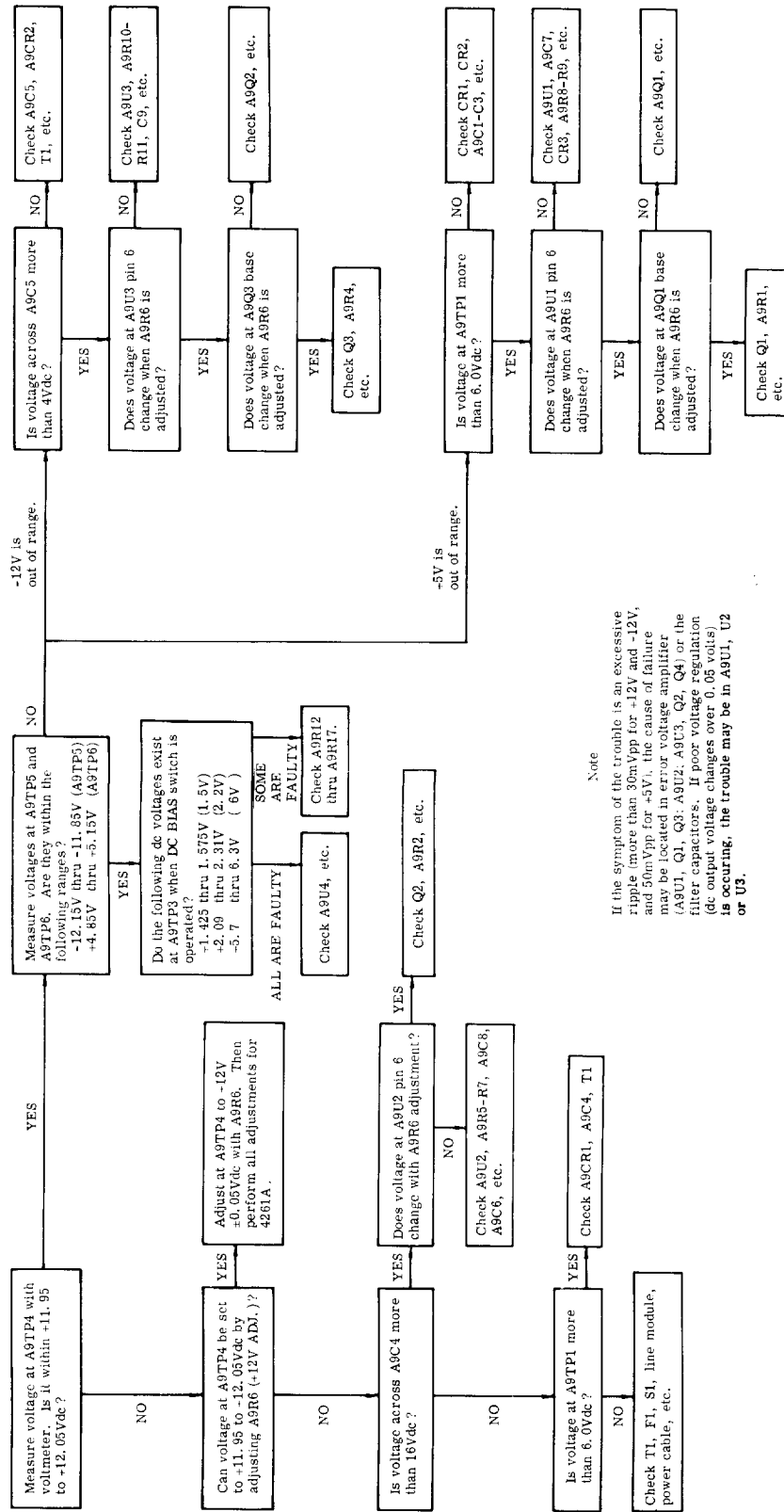


Figure 8-37. DC Power Supply Section Troubleshooting Guide.

Sequence Control Board Assembly (A8)
SERVICE SHEET 8

CIRCUIT DESCRIPTION

AC line power is inputted to power transformer T1 through the power cable and a line module which houses a built-in filter and a line voltage selection card. A fuse (F1), of proper rating, is inserted in the line module. The three ac outputs from T1 are rectified and stabilized to dc voltages by their respective regulator circuits. Regulator transistor Q1 is mounted on the rear panel and diodes CR1 thru CR3 and transistors Q2 and Q3 are mounted directly on the instrument rear deck for best thermal radiation. A 5V dc voltage is developed by the circuitry consisting of CR1, CR2, Q1, A9Q1, A9U1, etc. A9R5 is a sensor resistor for over current protection and CR3 is an over voltage protection zener diode. The +12Vdc is generated by circuitry which includes A9CR1, Q2, A9U2, etc. and the -12Vdc by Q3, A9CR2, A9Q2 and Q3, A9U3, etc. Output dc voltages can be adjusted by A9R8 which sets the +12V to its exact operating voltage along with the +5V and -12V supplies. Note that exact +5V and -12V voltages depend directly on an exact setting of the +12V. A9U4 and associated resistors provide the internal dc bias source for +1.5V, 2.2V and 6V. The reference voltage for the bias source is the regulated +12V and divider.

TROUBLESHOOTING INFORMATION

The troubleshooting tree (guide) for the power supply section is presented at the left.

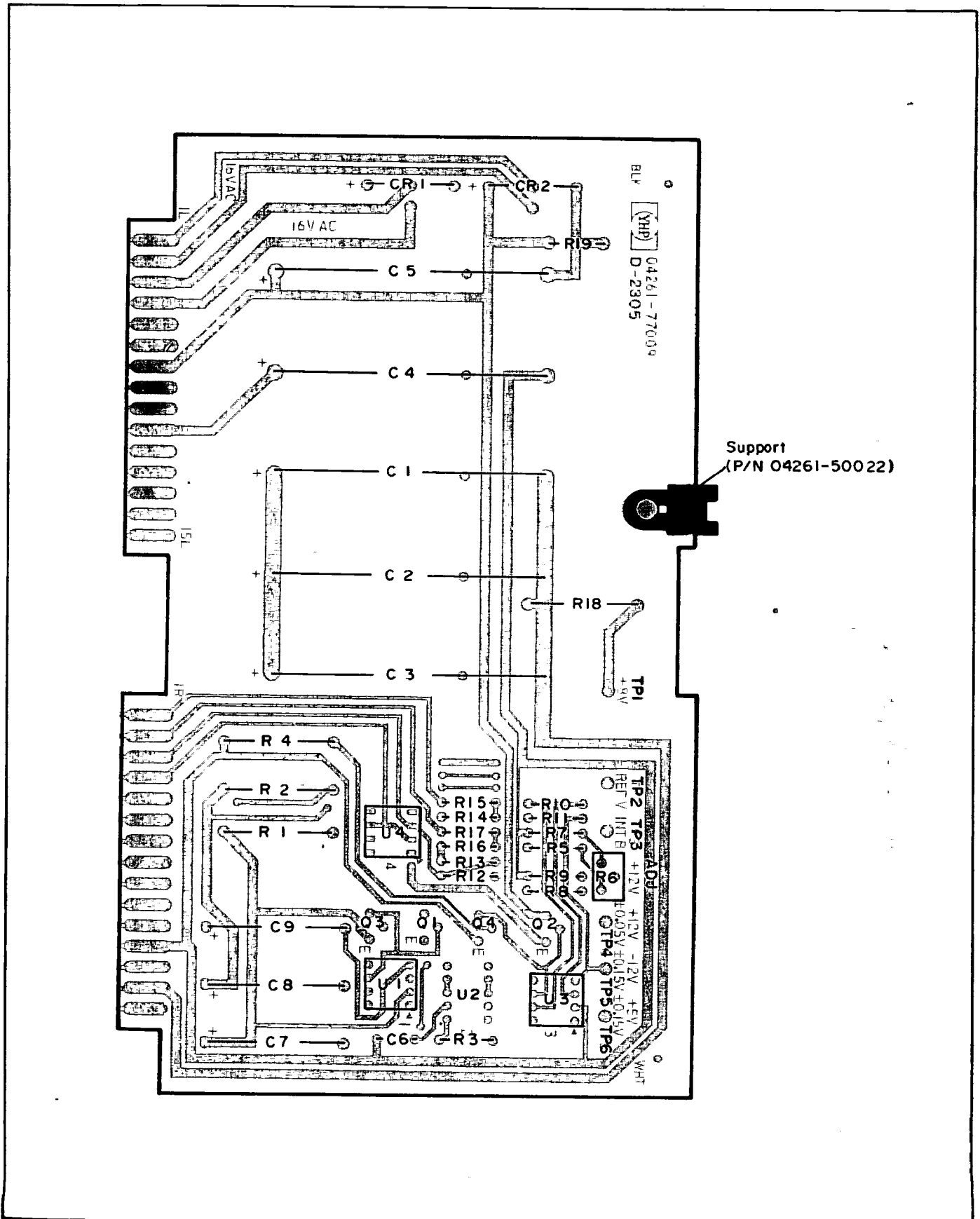
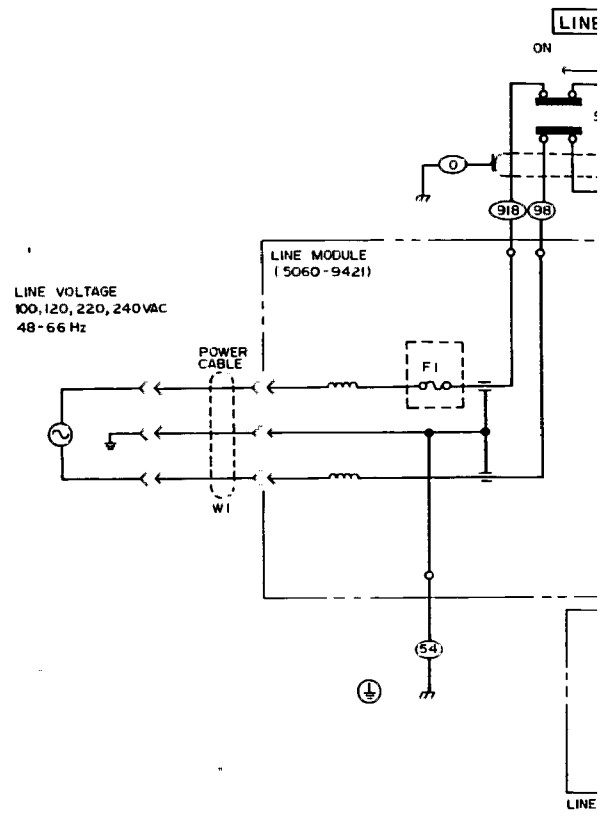


Figure 8-38. A9 Power Supply Board Assembly Component Locations.



LINE VOLTAGE
100, 120, 220, 240 VAC
48-66 Hz

POWER
CABLE

F1

LINE MODULE
(5060-9421)

W1

54

LINE

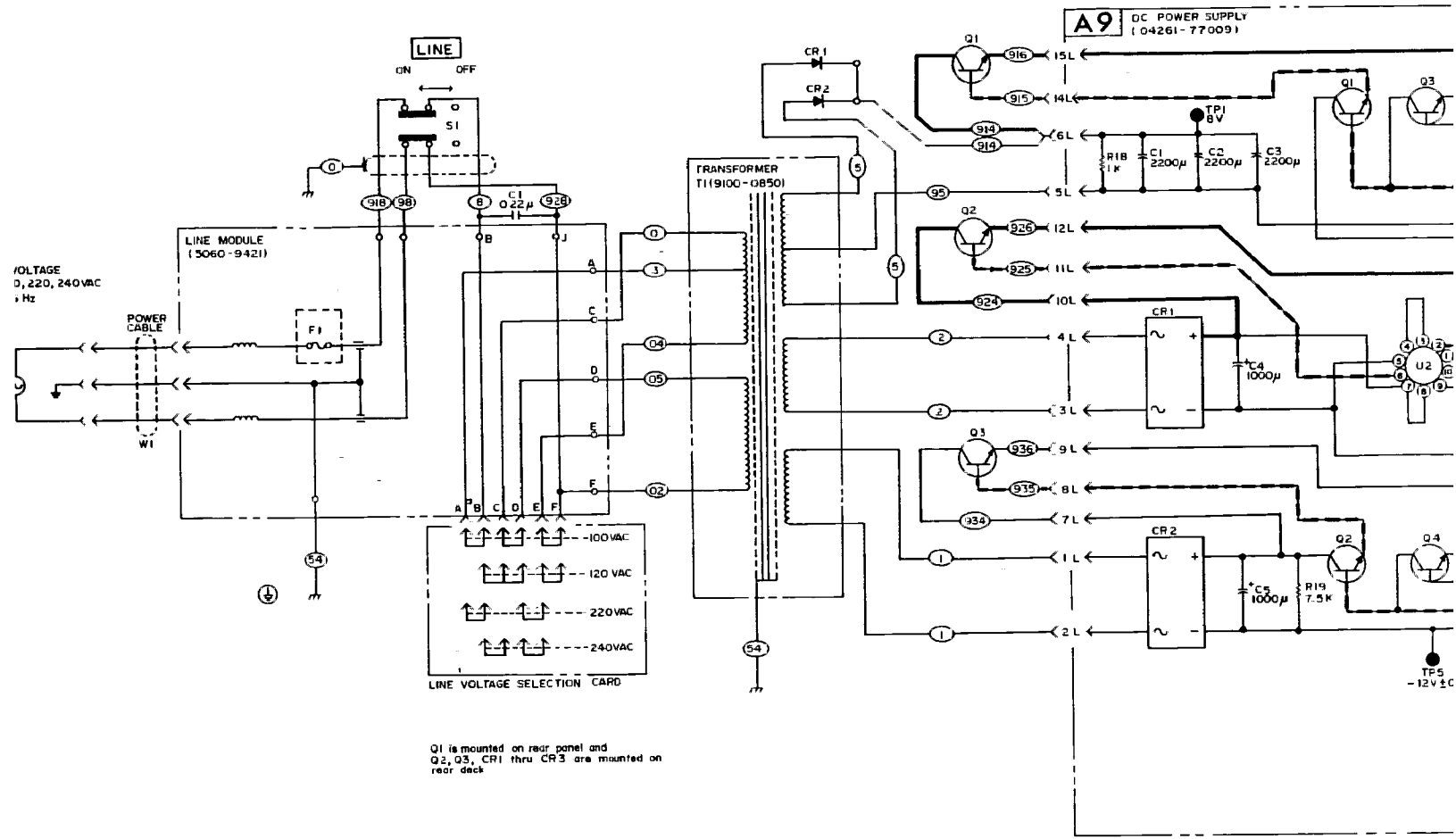
ON

918

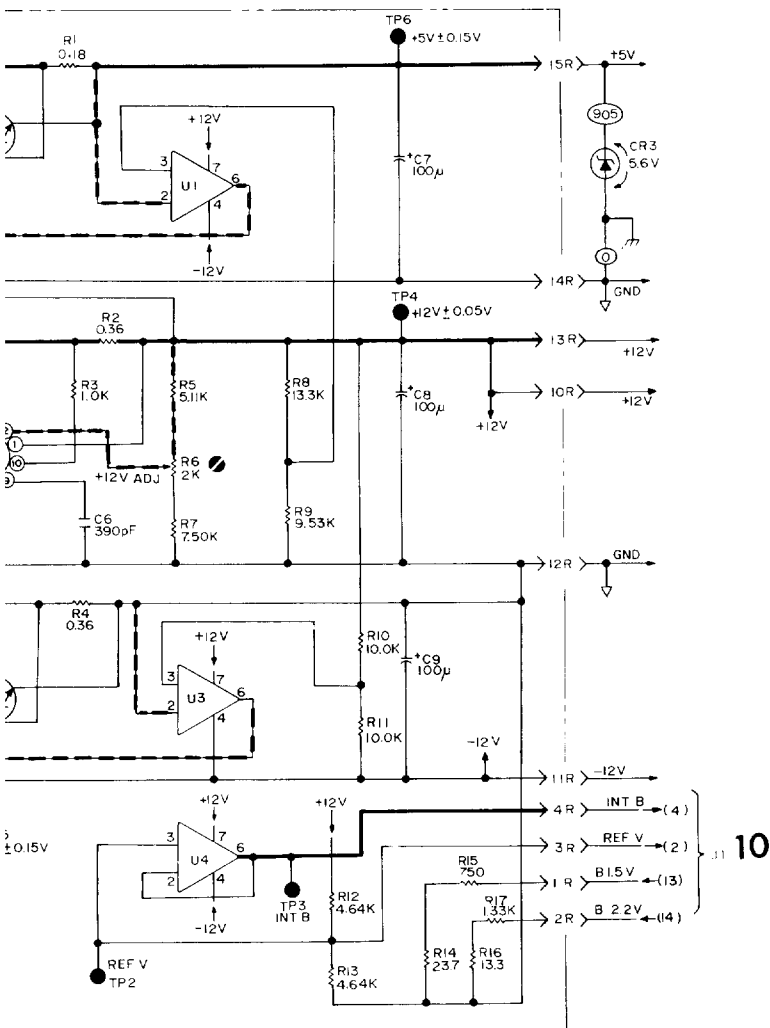
98

LINE

Q1 #
Q2,
rear



Q1 is mounted on rear panel and Q2, Q3, CR1 thru CR3 are mounted on rear deck



Note

1. Q1 is mounted on rear panel and Q2, Q3, CR1 thru CR3 are mounted on rear deck.
2. The part number of the cable assembly that connects the A9 board to the chassis mounted components (Q1 through Q3, CR1, CR2 and T1) is 04261-72010. The part number of the edge connector attached to the cable assembly is 1251-0194.

9
A9

Figure 8-39. DC Power Supply Section Schematic Diagram.

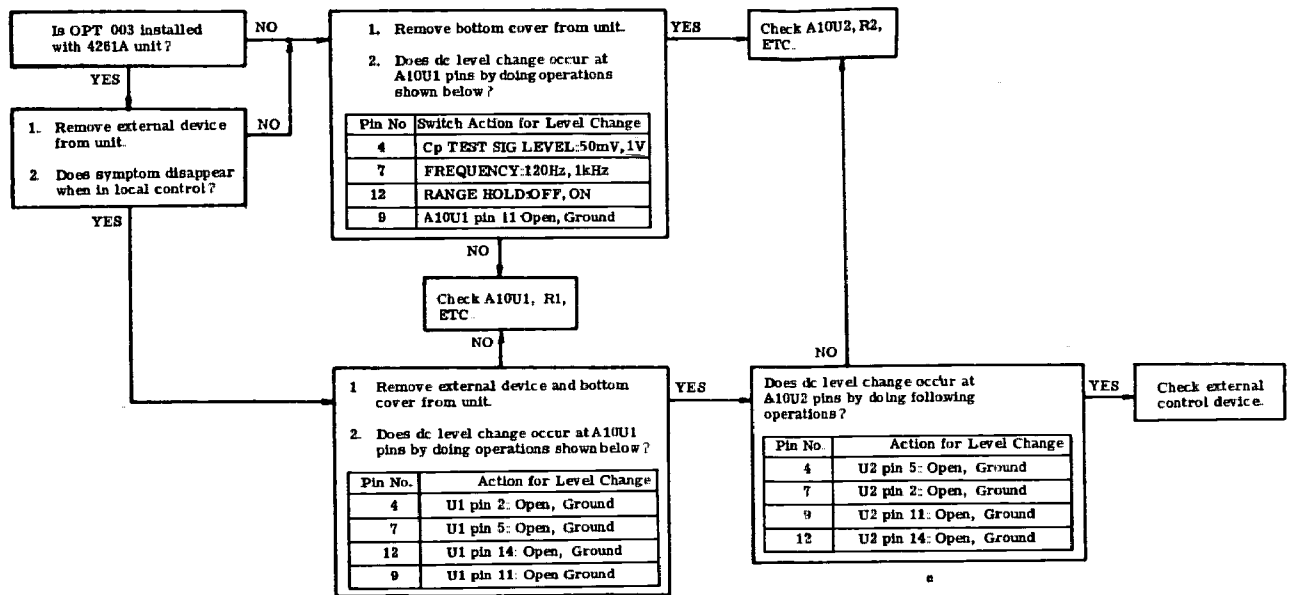


Figure 8-40. A10 Motherboard Troubleshooting Guide.

CIRCUIT DESCRIPTION

The A10 Mother board assembly is the interconnection between nearly all other board assemblies. All these interconnections are not shown in the circuit schematics for the A10 board. For A10 board troubleshooting, only the main connections are presented. The A10 Mother board includes a selector circuit for selecting either remote control or local control signals. Remote control signals are sent through the remote control plug of the A10 board from the rear panel remote input connector (OPT. 003), and local signals are transferred via a flat cable from the A1 switch board (front panel control). The selector (A10U1 & U2) outputs local control signals when pin 1 of both A10U1 and U2 (\overline{REM} signal) are at high level, and outputs remote control signals when the \overline{REM} signal is at low level. Two signals, DRNG A, DRNG B, are sent to 4261A internal circuit without going through the A10 selector. The A10 board plug not only receives the remote control signals, but also outputs the various signals shown in right bottom section of the circuit schematic and are utilized for automatic test in the factory. The lead wires from the UNKNOWN terminals are soldered directly to the A10 board. Wired connections for rear connectors such as EXT BIAS and C OFFSET are made on the A10 board.

TROUBLESHOOTING INFORMATION

The A10 board troubleshooting guide is presented at the left.

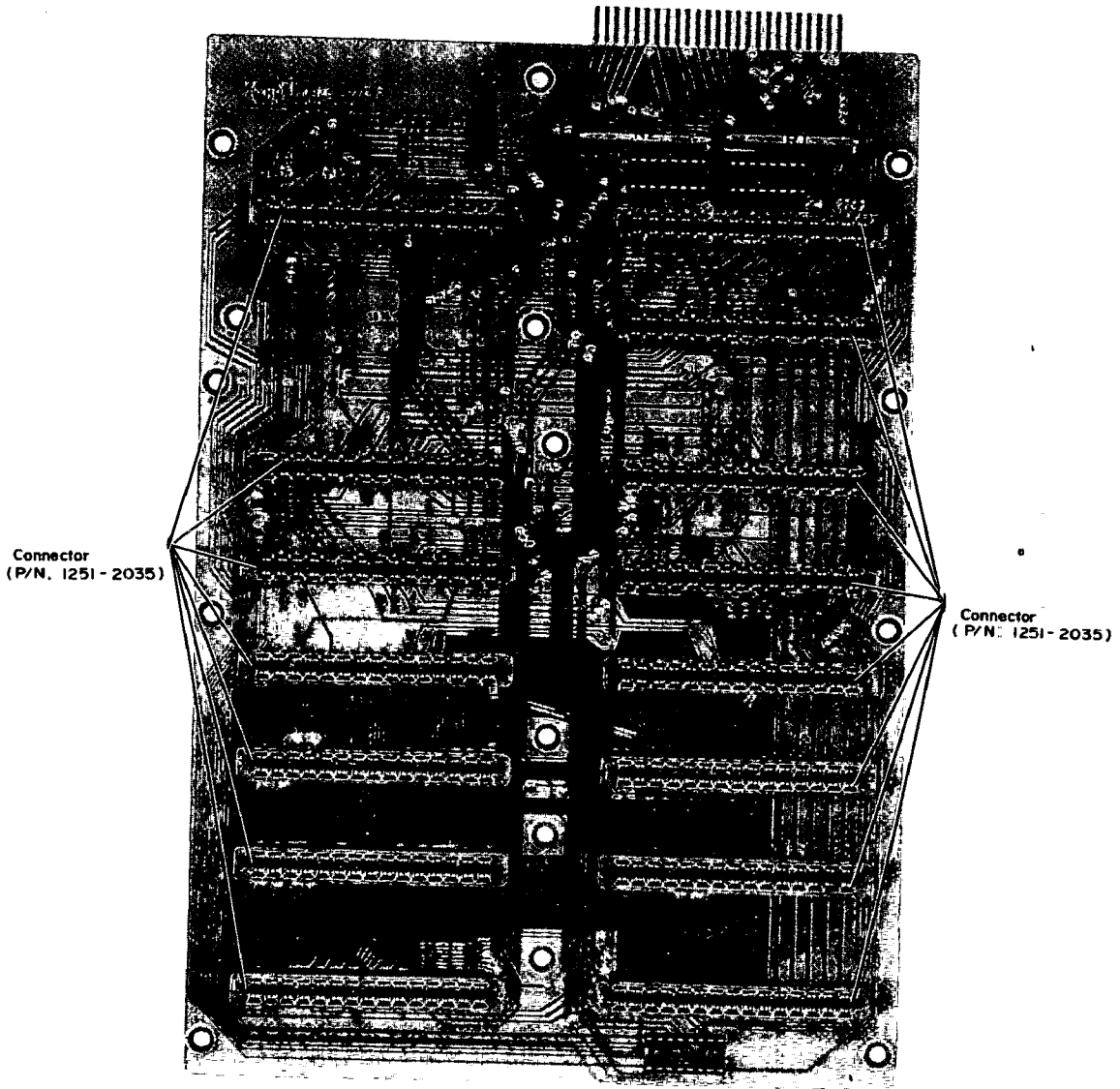
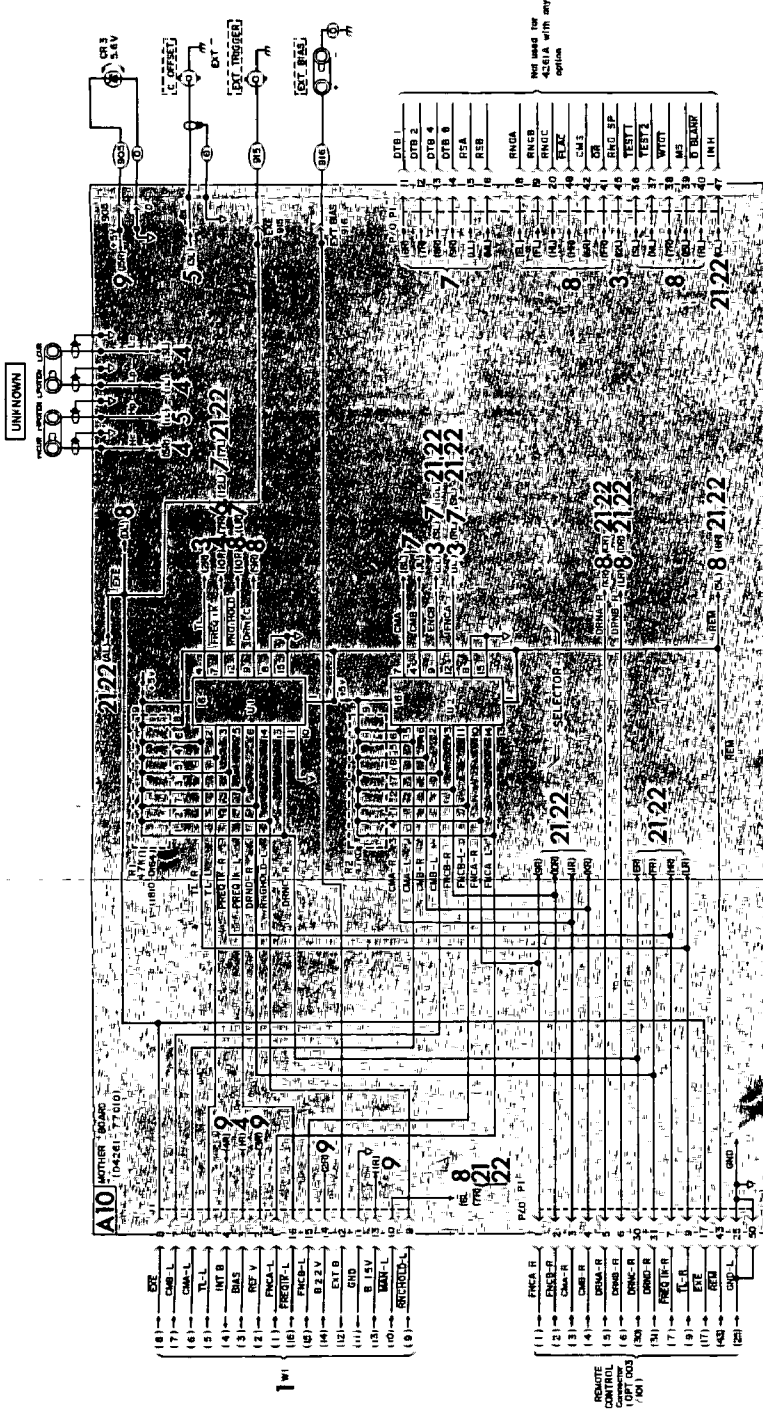


Figure 8-41. A10 Motherboard Assembly Component Locations.



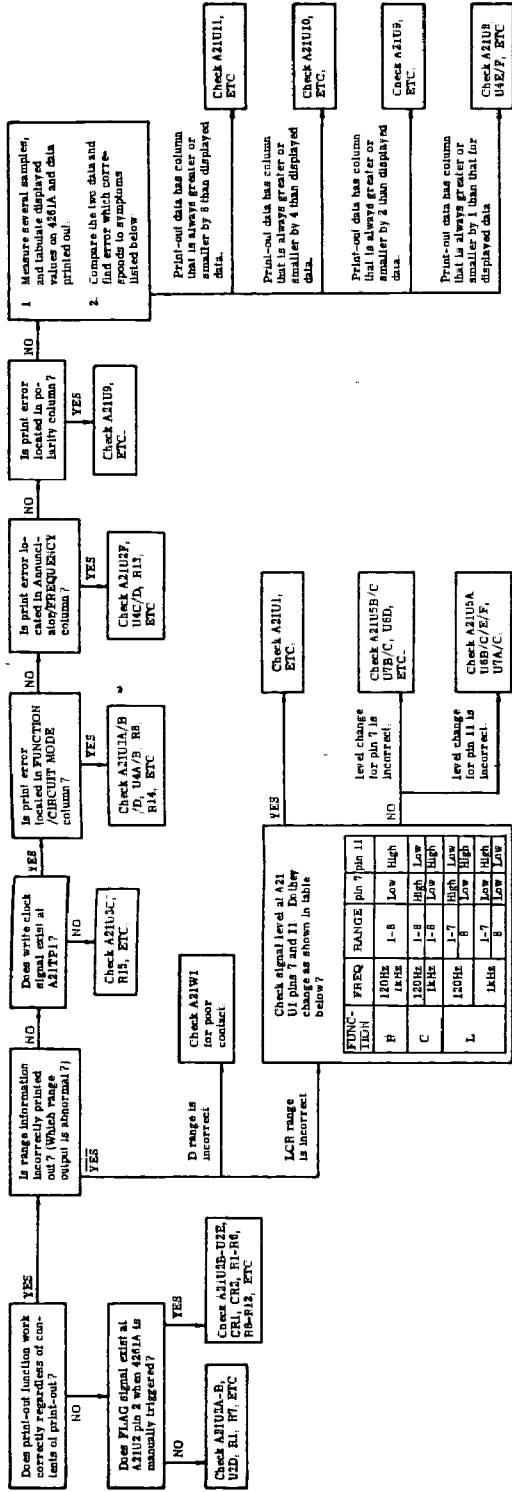


Figure 8-43. A21 Parallel BCD Data Output Board (OPT. 001) Troubleshooting Guide.

Table A. Output Data Format (Cont'd).

DATA OUTPUT (Column No.)	4261A Display Setting		Pin No.				Character Printed
			15	16	40	41*	
Annunciation & Test Frequency (8)	No Annunciation	120Hz	L	L	L	L	0
		1kHz	L	L	H	L	4
	OUT OF RANGE	120Hz	H	L	L	L	1
		1kHz	H	L	H	L	5
	D Unavailable	120Hz	L	H	L	L	2
		1kHz	L	H	H	L	6
	OUT OF RANGE D Unavailable	120Hz	H	H	L	L	3
1kHz		H	H	H	L	7	

DATA OUTPUT (Column No.)	4261A Full Scale Display			Pin No.				Character Printed
	L	C	R	17	18	42	43	
Range (9)	100 0μH	100.0pF	1000mΩ	H	L	L	L	1
	1000μH	1000pF	10.00Ω	L	H	L	L	2
	10.00mH	10.00nF	100.0Ω	H	H	L	L	1
	100.0mH	100.0nF	1000Ω	L	L	H	L	4
	1000mH	1000nF	10.00kΩ	H	L	H	L	5
	10.00H	10.00μF	100.0kΩ	L	H	H	L	6
	100.0H	100.0μF	1000kΩ	H	H	H	L	7
	1000H	1000μF	10.00MΩ	L	L	L	H	8
		10.00mF		H	L	L	H	9
	D: 1.000			L	L	L	L	0

DATA OUTPUT (Column No.)	4261A Display			Pin No.				Character Printed
	L	C	R	19	20	44	45*	
Function & Circuit Mode (10)	PARA(Lp)			L	H	L	L	2
	SER (Ls)			H	H	L	L	3
		PARA(Cp)		L	L	L	L	0
		SER (Cs)		H	L	L	L	1
			PARA(Rp)	L	L	H	L	4
			SER (Rs)	H	L	H	L	5

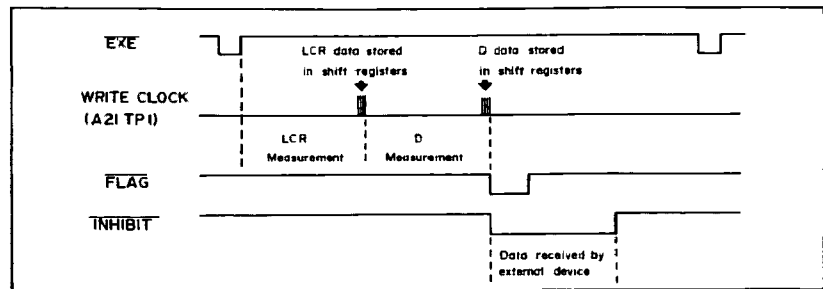


Figure A. Timing Diagram.

CIRCUIT DESCRIPTION

The A21 Board Assembly receives the measured data, range, function, circuit mode, annunciation and frequency signals from the standard 4261A unit and outputs them to an external device through rear panel connectors. The transfer of these signals is managed by control signals FLAG, INHIBIT and EXE. A range decoder outputs range signals (RANGE 1, RANGE 2, RANGE 4 and RANGE 8) in BCD form. The range decoder includes A21U1 (full adder) that sums range signals RNG A, RNG B and RANGE C (A8 Range Counter output), and B1 and B2 signals. B1 and B2 signals are developed by A21 U5, U6 and U7 gates in the following manner:

B1 is High and B2 is Low when either of the following measurements - are being made:

- a C measurement at 1kHz, or
- an L measurement at 1kHz and when at least one of either RNG A, RNG B and RNG C is at low level, or
- an R measurement, or
- an L measurement at 120Hz and when RNG A, RNG B and RNG C are all at high level.

B2 is High and B1 is low when either of these measurements are being made:

- a C measurement at 120Hz, or
- an L measurement at 120Hz and when at least one of either RNG A, RNG B and RNG C is at low level.

Both B1 and B2 are low when these measurements are being made:

- an L measurement at 1kHz and RNG A, RNG B and RNG C are all at high level.

Both B1 and B2 at high level never occurs.

Function, circuit mode, frequency, annunciation and FLAG signal are transferred to the external device, and EXE and INHIBIT signals are transferred to the 4261A via buffer gates on this board. A21U8 thru U11 integrated circuits are shift registers which input serial data signals (DTB1, DTB2, DTB4, DTB8) from A7 board synchronized with WRITE CLOCK signal at A21TP1 and which output the data in a parallel scheme to an external device after the FLAG signal goes to low level. The fundamental data transfer timing diagram is presented at the left. A table showing digital signals at each pin of the output connectors is included.

TROUBLESHOOTING INFORMATION

The troubleshooting tree (guide) for A21 board is presented at the left.

Table A. Output Data Format.

DATA OUTPUT (Column No.)	4261A Display		Pin No.				Character Printed				
		Digit	1	2	26	27					
		10 ⁰						3	4	28	29
		10 ¹						5	6	30	31
		10 ²						7	8*	32*	33*
Displayed L C R D Value (1 thru 4)	0	L	L	L	L	0					
	1	H	L	L	L	1					
	2	L	H	L	L	2					
	3	H	H	L	L	3					
	4	L	L	H	L	4					
	5	H	L	H	L	5					
	6	L	H	H	L	6					
	7	H	H	H	L	7					
	8	L	L	L	H	8					
	9	H	L	L	H	9					

DATA OUTPUT (Column No.)	4261A Display	Pin No.				Character Printed
		13	14*	38*	39*	
Polarity (7)	+ (Blanked)	L	H	L	H	+
	-	H	H	L	H	-

* These pins are grounded except for pins 14 and 39 which are pulled up to +5V.

Note L: TTL Low Level.
H: TTL High Level

(Continued)

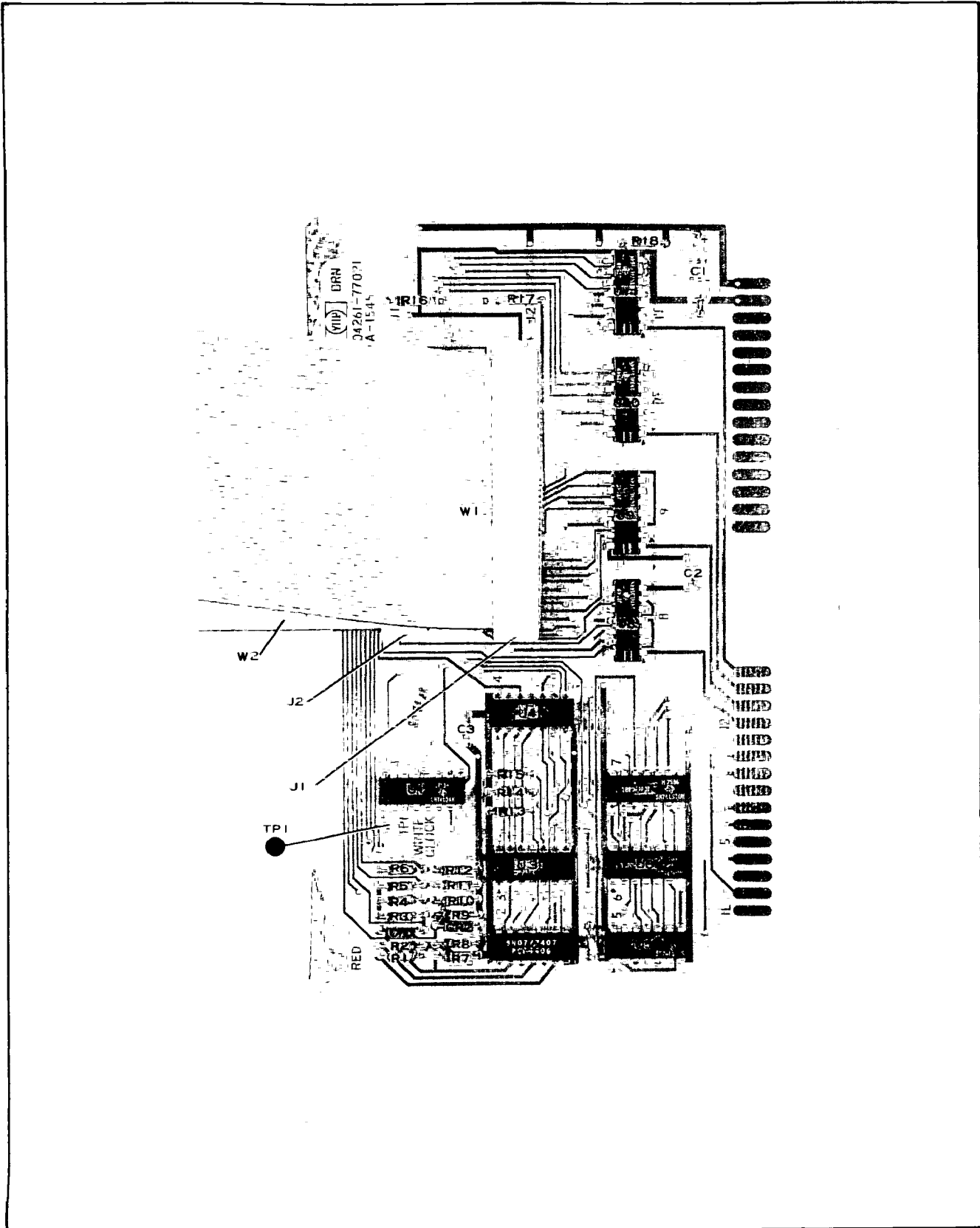
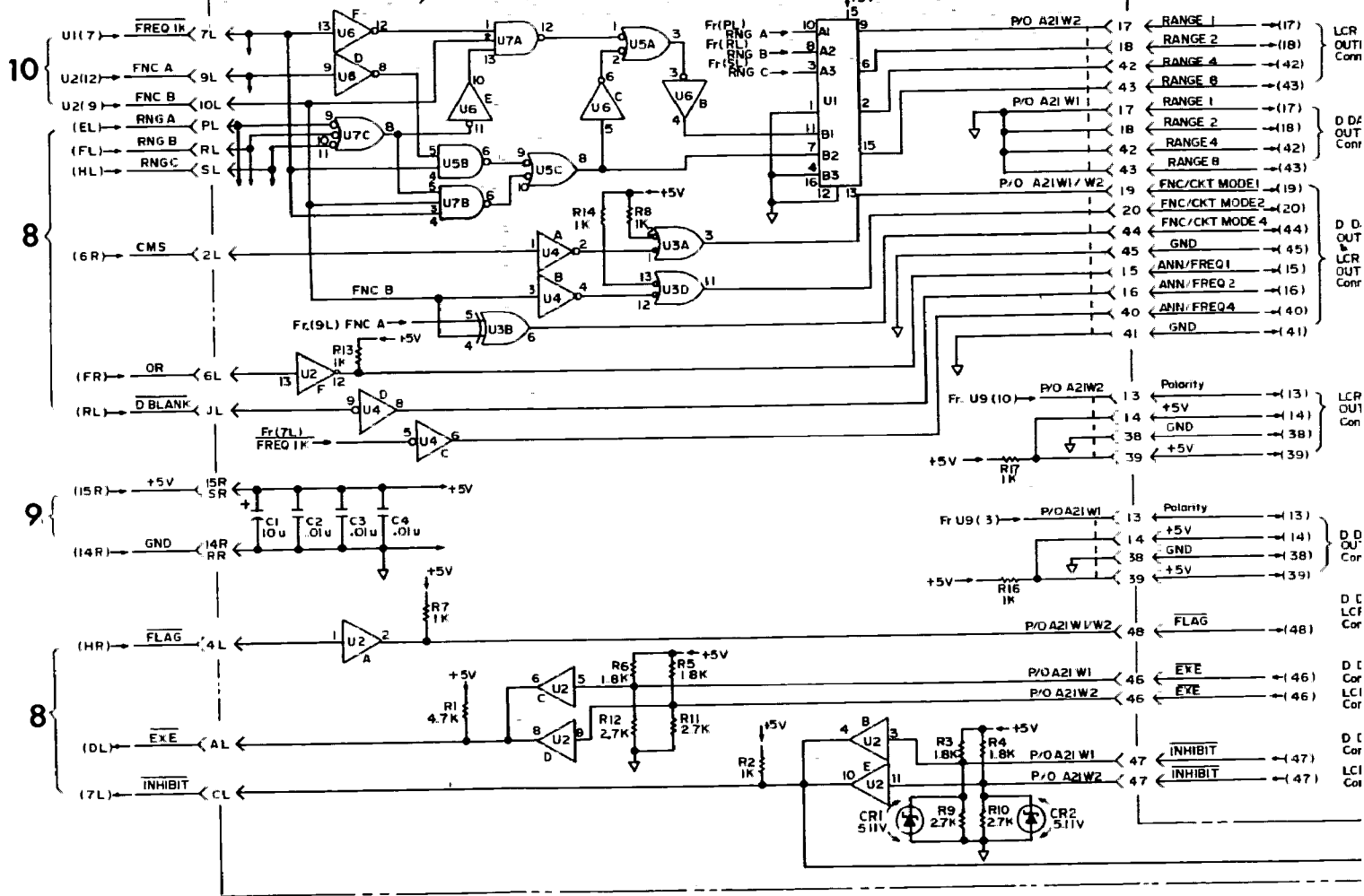
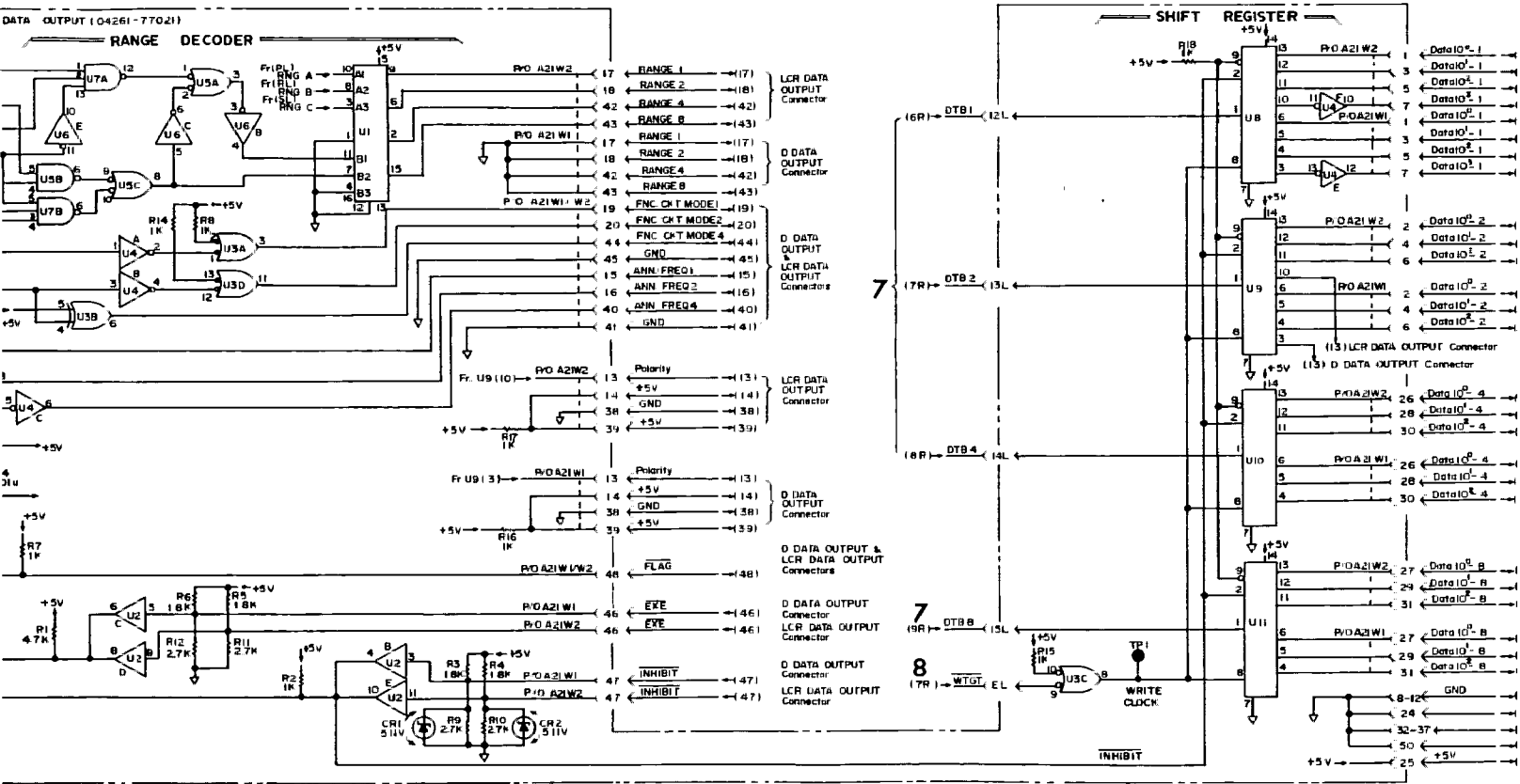


Figure 8-44. A21 Parallel BCD Data Output Board Assembly Component Locations.

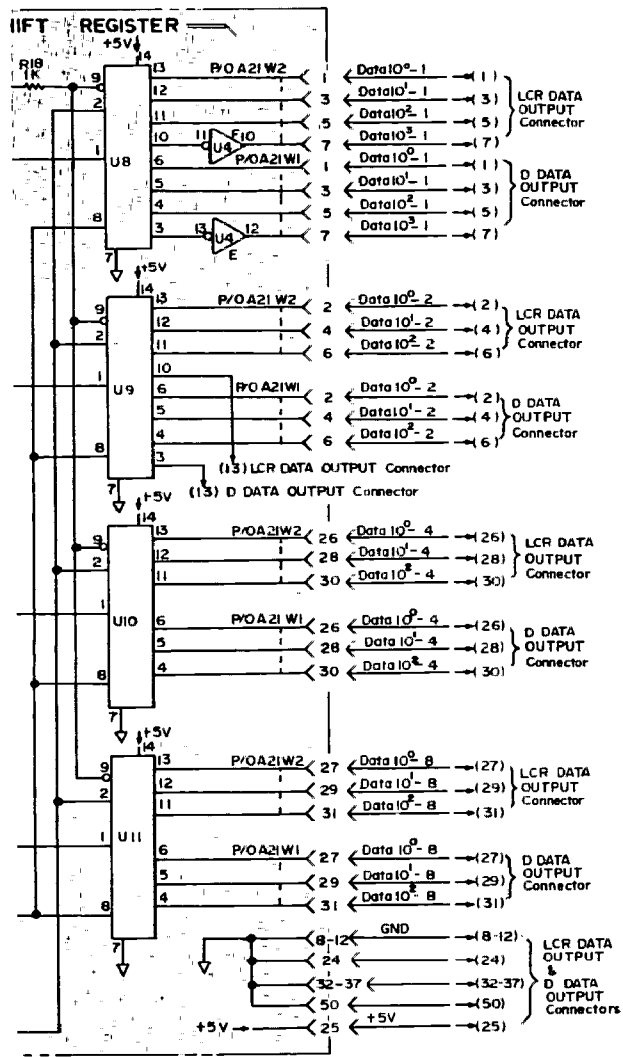
A 21 PARALLEL BCD DATA OUTPUT (04261-77021)

RANGE DECODER





Figure



Note

1. A21U1, 4bit binary full adder, works as follows:

$$E1 + 2^1 E2 + 2^2 \cdot E3 + 2^3 \cdot E4$$

$$= (A1 + 2^1 \cdot A2 + 2^2 \cdot A3) + (B1 + 2^1 \cdot B2 + 2^2 \cdot B3)$$

E: output, A, B: input

21
A21

Figure 8-45. A21 Parallel BCD Data Output Board Assembly (OPT. 001) Schematic Diagram.

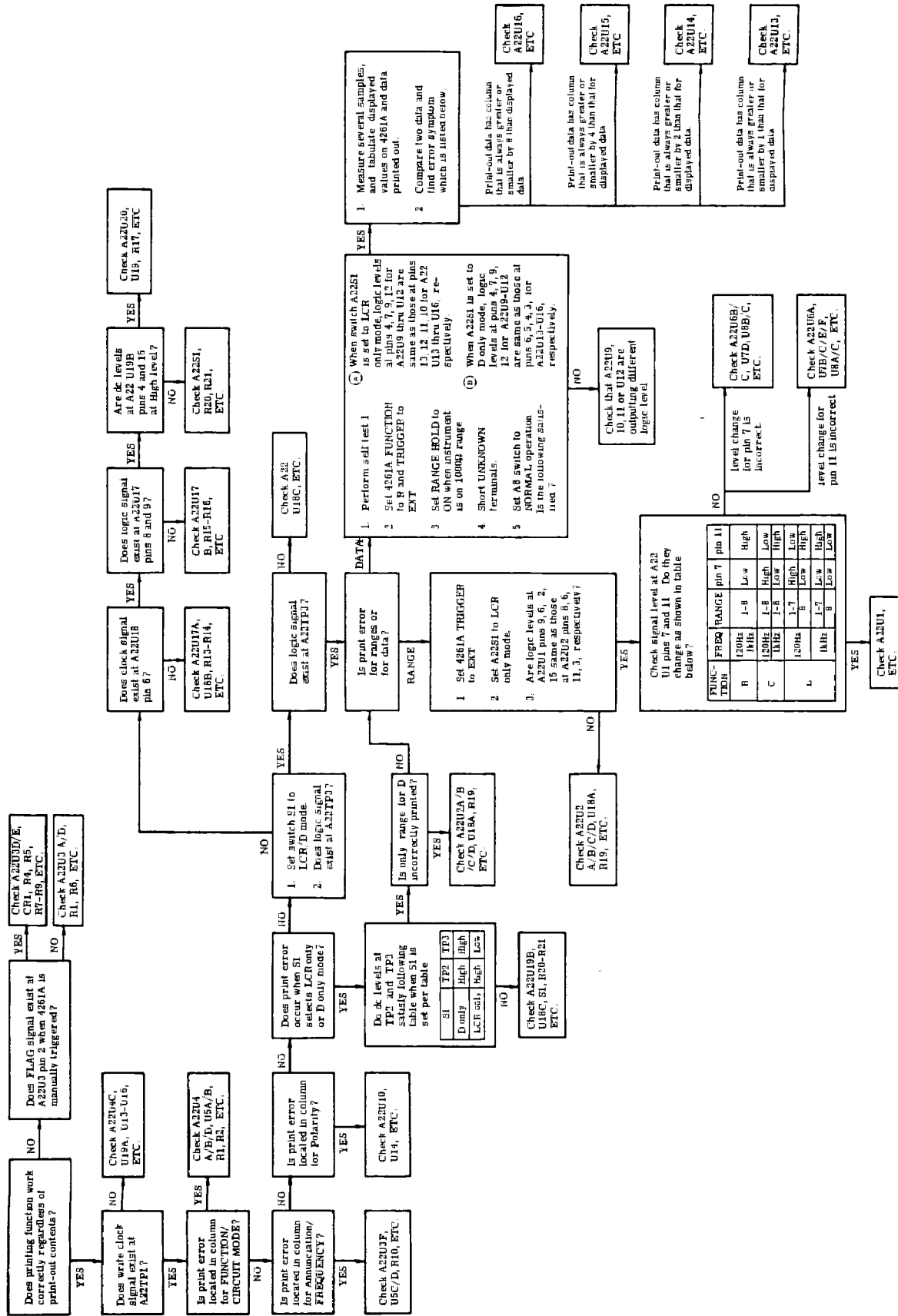


Figure 8-46. A22 Parameter Serial Parallel BCD Data Output Board (OPT. 002) Troubleshooting Guide.

Table A. Output Data Format (Cont'd).

DATA OUTPUT (Column No.)	4261A Display Setting		Pin No.				Character Printed
			15	16	40	41*	
Annunciation & Test Frequency (8)	No Annunciation	120Hz	L	L	L	L	0
		1kHz	L	L	H	L	4
	OUT OF RANGE	120Hz	H	L	L	L	1
		1kHz	H	L	H	L	5
	D Unavailable	120Hz	L	H	L	L	2
		1kHz	L	H	H	L	6
		OUT OF RANGE D Unavailable	120Hz	H	H	L	L
		1kHz	H	H	H	L	7

DATA OUTPUT (Column No.)	4261A Full Scale Display			Pin No.				Character Printed
	L	C	R	17	18	42	43	
Range (9)	100 0μH	100.0pF	1000mΩ	H	L	L	L	1
	1000μH	1000pF	10.00Ω	L	H	L	L	2
	10.00mH	10.00nF	100.0Ω	H	H	L	L	3
	100.0mH	100.0nF	1000Ω	L	L	H	L	4
	1000mH	1000nF	10.00kΩ	H	L	H	L	5
	10.00H	10.00μF	100.0kΩ	L	H	H	L	6
	100.0H	100.0μF	1000kΩ	H	H	H	L	7
	1000H	1000μF	10.00MΩ	L	L	L	H	8
		10.00mF		H	L	L	H	9
		D 1.000		L	L	L	L	0

DATA OUTPUT (Column No.)	4261A Display			Pin No.				Character Printed
	L	C	R	19	20	44	45*	
Function & Circuit Mode (10)	PARA(Lp)			L	H	L	L	2
	SER (Ls)			H	H	L	L	3
		PARA(Cp)		L	L	L	L	0
		SER (Cs)		H	L	L	L	1
			PARA(Rp)	L	L	H	L	4
			SER (Rs)	H	L	H	L	5

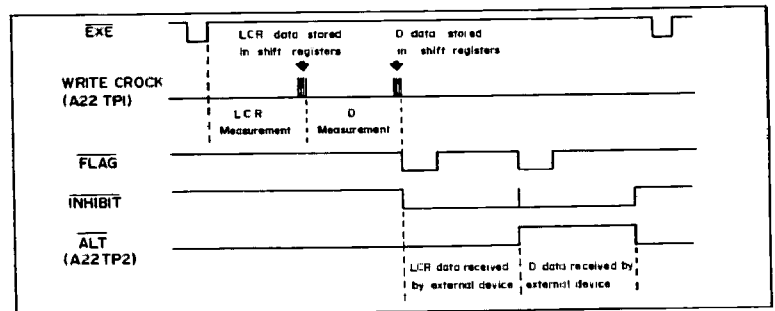


Figure A. Timing Diagram.

CIRCUIT DESCRIPTION

The A22 board assembly receives measured data, range, function, circuit mode, annunciation and frequency signals from the standard unit and outputs them to an external device through rear panel connectors. LCR and D data are serially transferred. A22S1 can select the output data as: LCR data only, LCR and D data, or D data only. The range decoder (A21U6, U7, U8, U1, U2) section works in the same manner as the range decoder on the A21 board (see service sheet No. 21) except that the outputted range signals (RANGE 1, RANGE 2, RANGE 4 and RANGE 8) are set to zero (low level) by being gated at A22U2 with the signal from A22TP3. The Data Selection Control section manages the selection of outputted data (LCR data or D data) and sends the D range signal to A22U18 and U2. The input signals for this section are INHIBIT, SCL 1, WTGT and signals from

S1. SCL 1 signal is used as a clock for advancing the function of this section similar to that of a state machine. The WTGT signal initially resets the level at A22TP3 to low level. The logic level at TP3 is changed by the trailing edge of the INHIBIT signal. Shift registers A22U13 thru U16 store the measured data (LCR and D) from the A7 board and are synchronized with the WRITE CLOCK signal at A22TP1. A22U9 thru U12 are selectors which select LCR data when the voltage level at A22TP3 is low, and D data when TP3 is high. The following diagram shows the fundamental timing of data transfer. Digital signals at each pin of the output connector are included in the associated table below:

TROUBLESHOOTING INFORMATION

The troubleshooting tree (guide) for A22 board is presented at the left.

Table A. Output Data Format.

DATA OUTPUT (Column No.)	4261A Display		Pin No.				Character Printed
		Digit					
		10 ⁰	1	2	26	27	
		10 ¹	3	4	28	29	
		10 ²	5	6	30	31	
		7	8*	32*	33*		
Displayed L C R, D Value (1 thru 4)	0	L	L	L	L	0	
	1	H	L	L	L	1	
	2	L	H	L	L	2	
	3	H	H	L	L	3	
	4	L	L	H	L	4	
	5	H	L	H	L	5	
	6	L	H	H	L	6	
	7	H	H	H	L	7	
	8	L	L	L	H	8	
9	H	L	L	H	9		

DATA OUTPUT (Column No.)	4261A Display	Pin No.				Character Printed
		13	14*	38*	39*	
Polarity (7)	+(Blanked)	L	H	L	H	+
	-	H	H	L	H	-

* These pins are grounded except for pins 14 and 39 which are pulled up to +5V.

Note: L: TTL Low Level.
H: TTL High Level.

(Continued)

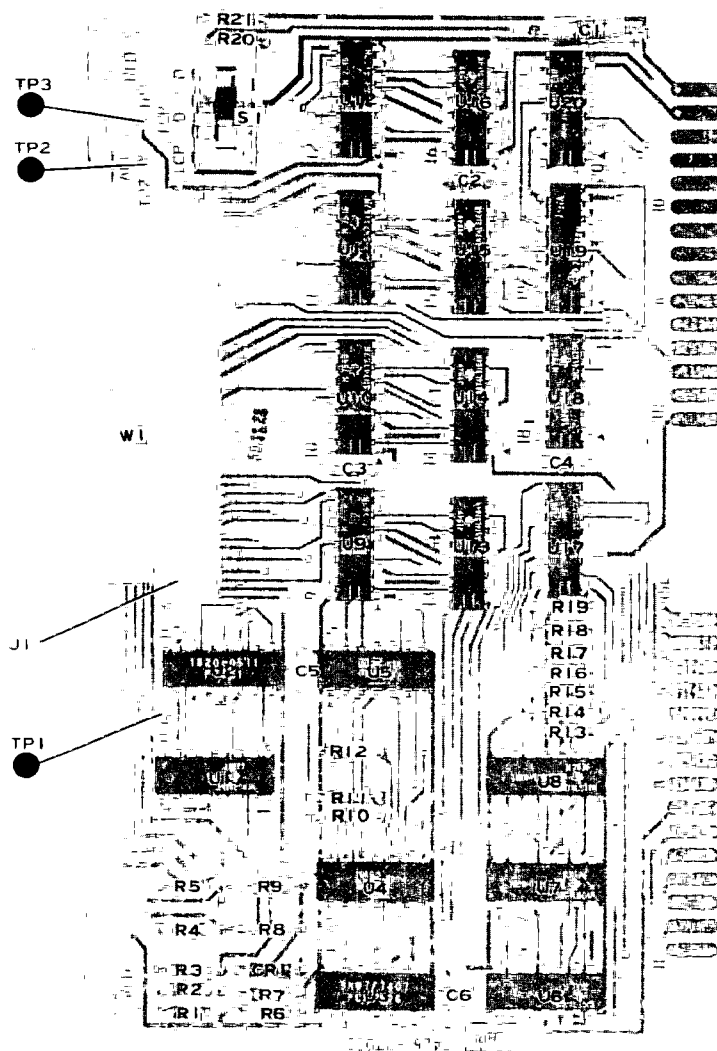
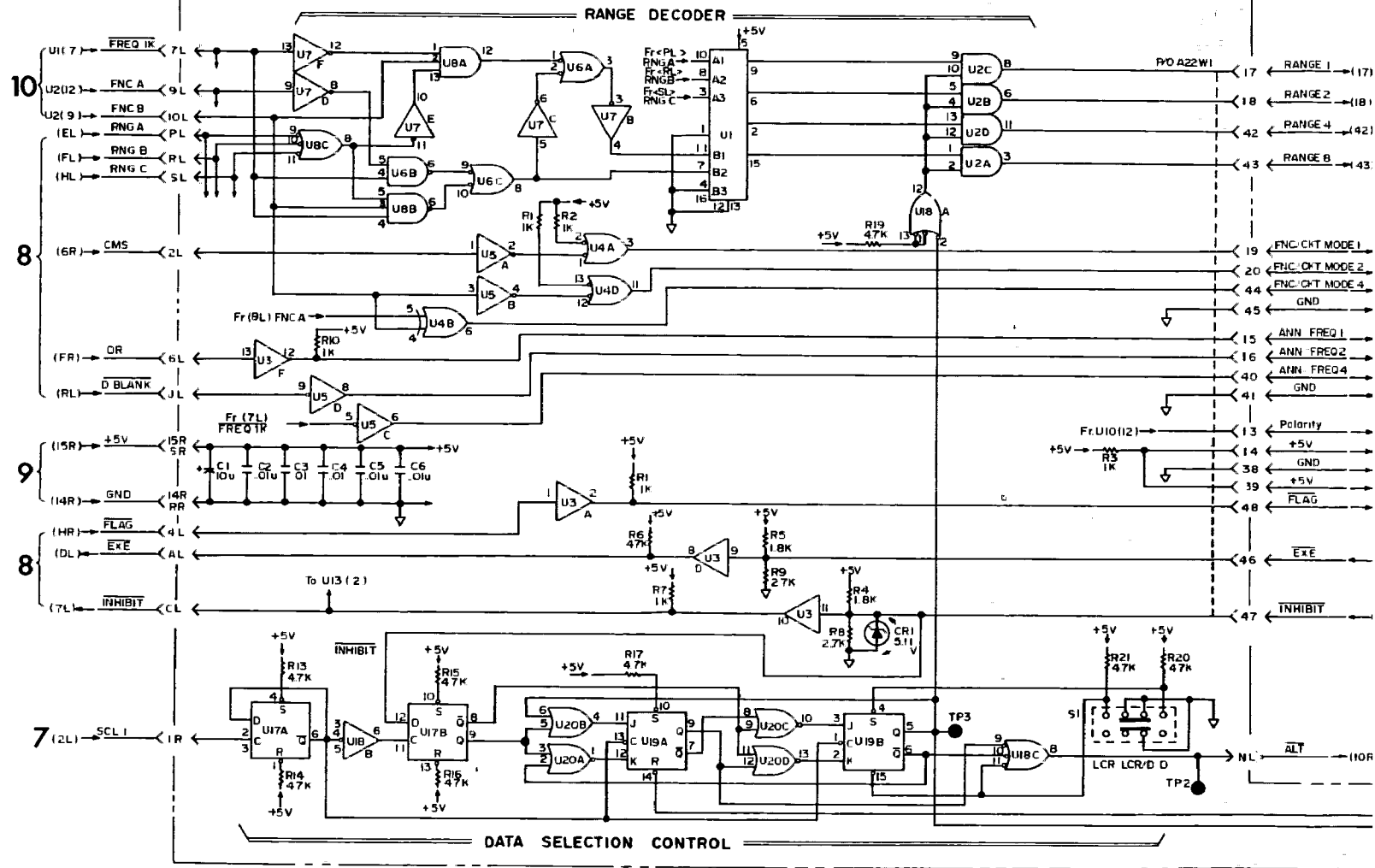


Figure 8-47. A22 Parameter Serial Parallel BCD Data Output Board Assembly Component Locations.

A22 PARAMETER SERIAL BCD DATA OUTPUT (04261-77022)



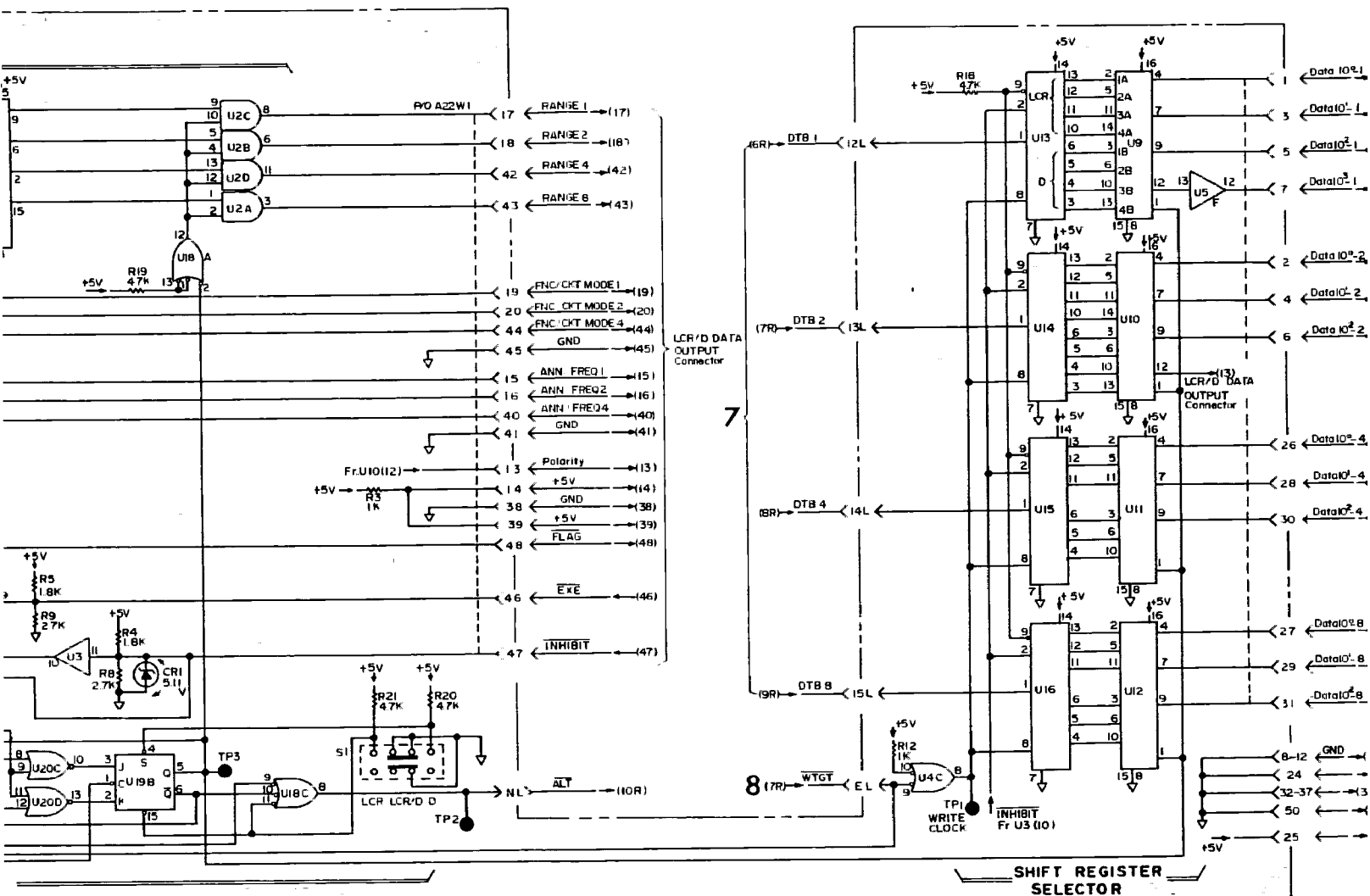
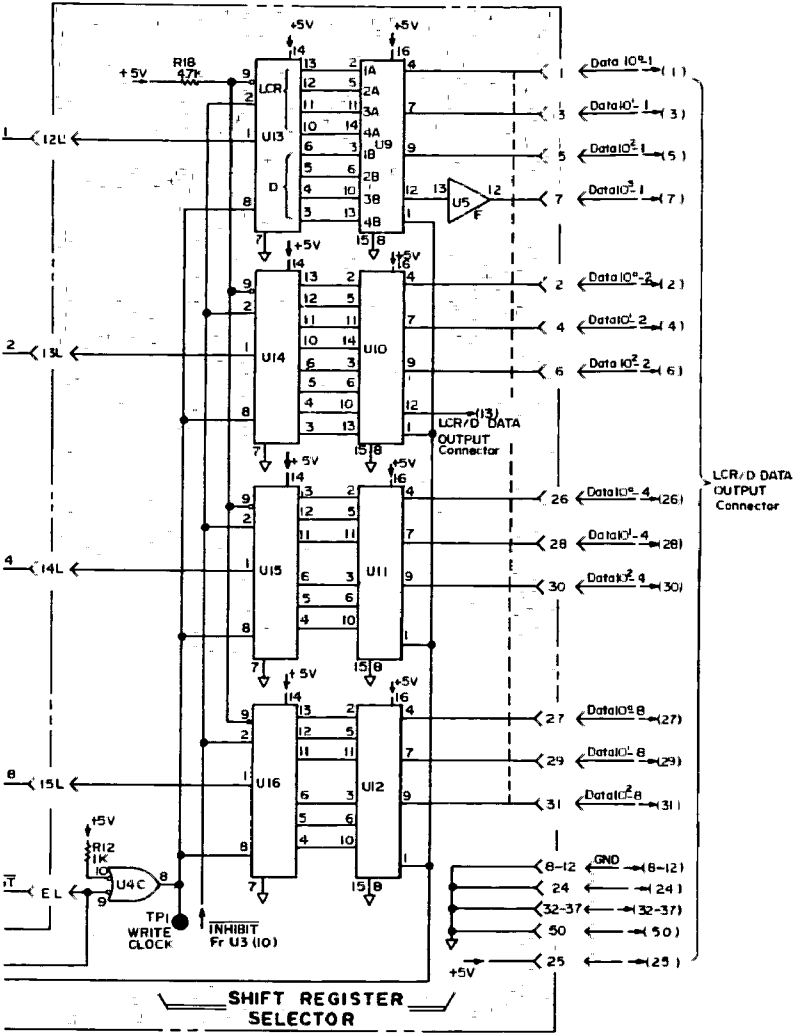


Figure 8-48. A22 Paramete



Note
 1. See note 1 on A7 board circuit schematics for A8U1 operation.

22
A22

Figure 8-48. A22 Parameter Serial Parallel BCD Data Output Board Assembly (OPT. 002) Schematic Diagram.