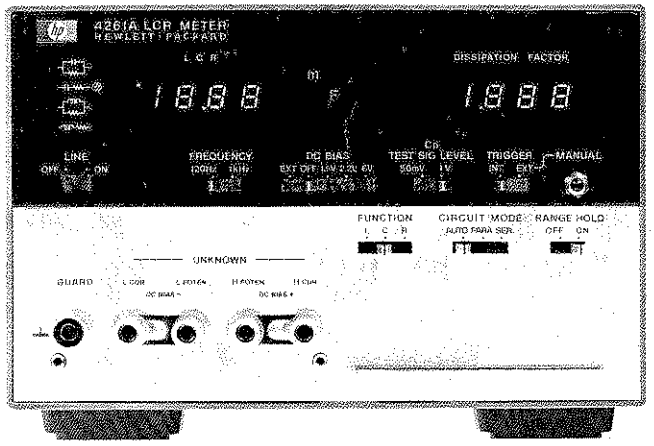
OPERATING AND SERVICE MANUAL

4261A
DIGITAL LCR METER



HEWLETT PACKARD

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OPERATING AND SERVICE MANUAL

MODEL 4261A
DIGITAL LCR METER

(Including Options 001, 002, 003 and 101)

SERIAL NUMBERS

This manual applies directly to instruments with serial numbers prefixed 1821J- and above.

Manual Part No. 04261-90006
Microfiche Part No. 04261-90056

Printed: AUG. 1980

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, options, 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 1 of 2).

COMMON SPECIFICATIONS

Parameters Measured: C-D, L-D and R.

Display: 3 1/2 Digits, Max. Display 1900

Circuit Modes: Auto, Parallel and Series.

Measurement Circuit: Five-terminal Method.

Range Mode: Auto or Range Hold.

Measurement Frequencies:

120Hz ±3%
1kHz ±3%

Trigger: Internal, Manual or External.

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								
Test Signal Level *1		1V or 50mV								
		—				10μA	100μA	1mA	10mA	70mA
	AUTO	Same as	Mode			Same as	Mode			
C Accuracy *2 *3		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% + 2counts	1% + 2counts *4	
	AUTO	Same as	Mode			Same as	Mode			
D Accuracy *2		0.2% + (2 + 200/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. Typical data, varies with value of D and number of counts.
*2. ± (% of reading + counts + α). Cx is capacitance readout in counts.
*3. 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.
*4. 5% + 2 counts at 1kHz.

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

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

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.							
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.

R MEASUREMENT

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.

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

MEASURING TIME

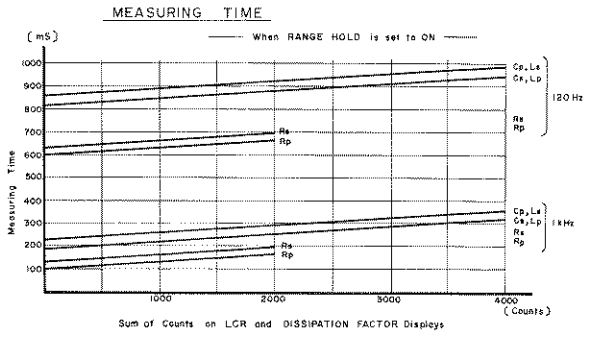
The period between start of a measurement and completion of the measurement is equal to measuring time when RANGE HOLD is set to ON (see figure below) plus time required for autoranging. The following are typical times for a measurement of approximately 1000 counts on low loss components when RANGE HOLD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

Time required for autoranging (RANGE HOLD: OFF):

1kHz: 180 x n (ms)

120Hz: 670 x n (ms)

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



L-D/C-D Accuracies when D > 1.900 and R accuracies when D ≤ 0.500:

For L-D/C-D accuracies when D > 1.900 and R accuracies when D ≤ 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).

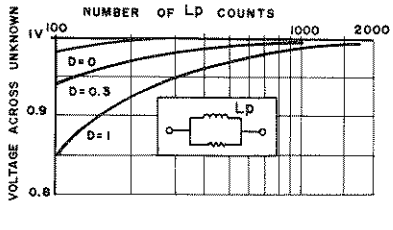
CIRCUIT MODE	Additional Error
Parallel Capacitance	D/10 % of reading (Test Sig Level: 1V) D/5 % of reading (Test Sig Level: 50mV)
Series Capacitance	D/5 % of reading
Parallel Inductance Series Inductance	D/5% of reading
Parallel Resistance Series Resistance	0.2/D % of reading

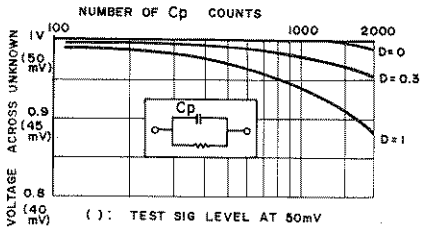
TEST SIGNAL LEVEL

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

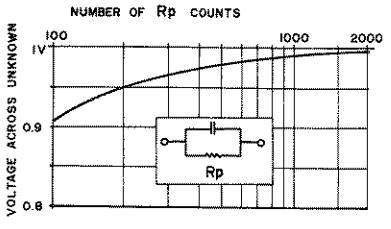
Parallel Equivalent Mode (Lp, Cp, Rp)

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.

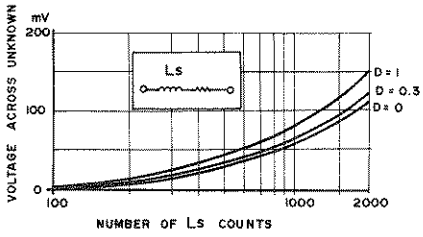


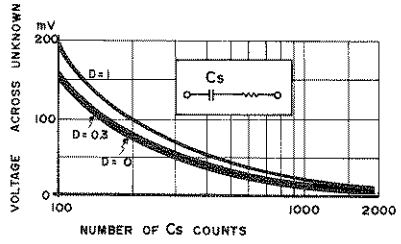
Note: This chart assumes that impedance between HIGH terminals and ground is infinite and that unknown device is an almost pure resistance.

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

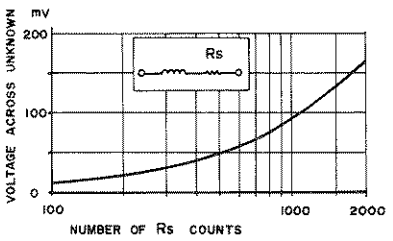
Series Equivalent Mode (Ls, Cs, Rs)

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 ($\leq$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)

Option 101: HP-IB Remote Control and Data Output, Includes Opt 001, 003 and 16414A (4081A Opt 261, 10631B, etc.).

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.

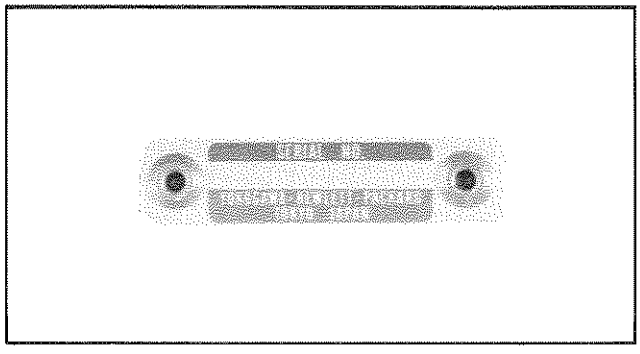


Figure 1-2. Serial Number Plate.

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 0.1μH to 1900H, and resistance from 1mΩ to 19MΩ 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), for attaching a rear panel input connector for remote control of the 4261A (opt 003), and to enable the 4261A LCR Meter be used with the Hewlett-Packard Interface Bus (HP-IB) system (opt 101). Expanded 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 5060-4020	1 2	A21 Board Ass'y Connector Assembly 50-pin
Option 002	Parameter Serial BCD Data Output	04261-77022 5060-4020 04261-85023	1 1 1	A22 Board Ass'y Connector Assembly 50-pin Name Plate
Option 003	BCD Remote Control	04261-77123 04261-72023	1 1	Connector Ass'y 50-pin 50-pin Flat Cable Ass'y
Option 101	HP-IB Remote Control and Data Output	4261A Option 001 4261A Option 003 HP 4081A Option 261 HP 10631B 04081-72005 8120-1378 16414-99000	1 1 1 1 3 1 1	BCD Parallel Data Output Remote Control HP-IB Coupler Bus Cable Cable Assembly Power Cable Operating Manual

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.

1-27. Option 101.

1-28. Option 101 consists of 4261A Options 001 and 003 plus HP Model 4081A Option 261 HP-IB coupler and interface cables. When the 4261A LCR Meter is equipped with Option 101, the 4261A can function as an HP-IB system component. For example, Option 101 is very useful for testing or sorting numbers of components when integrated with the HP-IB system. The components needed for installing Option 101 are included in Table 1-3.

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 (HP Part No. 04261-90003).

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.

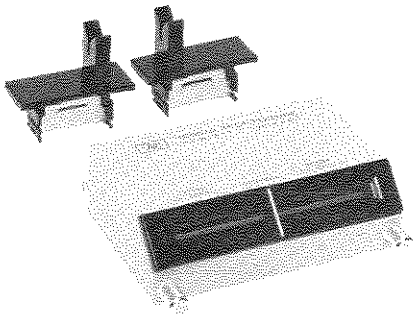
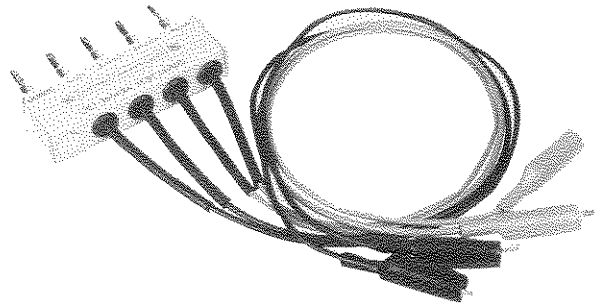
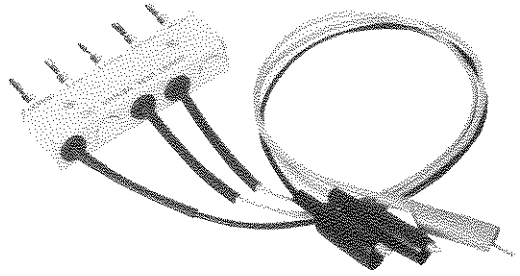
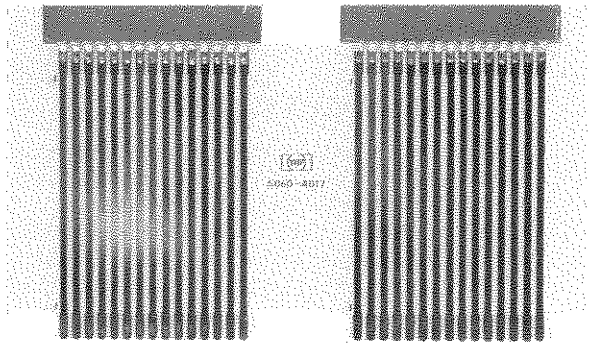
Model	Description
HP 16061A 	Test Fixture (direct coupled type) for general measurement of both axial and vertical lead components.
HP 16062A 	Test Leads (with alligator clips) useful for low inductance, high capacitance or low resistance (less than 10kΩ) measurements.
HP 16063A 	Test Leads (with alligator clips) for general component measurement and especially useful for high impedance measurements.
HP P/N 5060-4017 	Extender Board used for 4261A troubleshooting.

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 10μF	HP 16361A	P, A
Resistance Standard (See para. 4-3)	Resistance Values: 1kΩ, 10kΩ, 100kΩ and 10MΩ	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: 1μs/div.	HP 180C/ w 1801A/ w 1821A	A
Logic State Analyzer	Repetition Rate: 0 to 1MHz Input Threshold: TTL (approx. +1.5V) Minimum Clock Pulse Width: 1μs	HP 1601A/ w 180C HP 1600A	T
Logic Probe	Input Impedance: >25kΩ Logic one Threshold: 2V $\pm$0.2V Logic zero Threshold: 0.8V +0.2V, -0.4V Input Minimum Pulse Width: 1μs	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 manaul). 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 ±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.

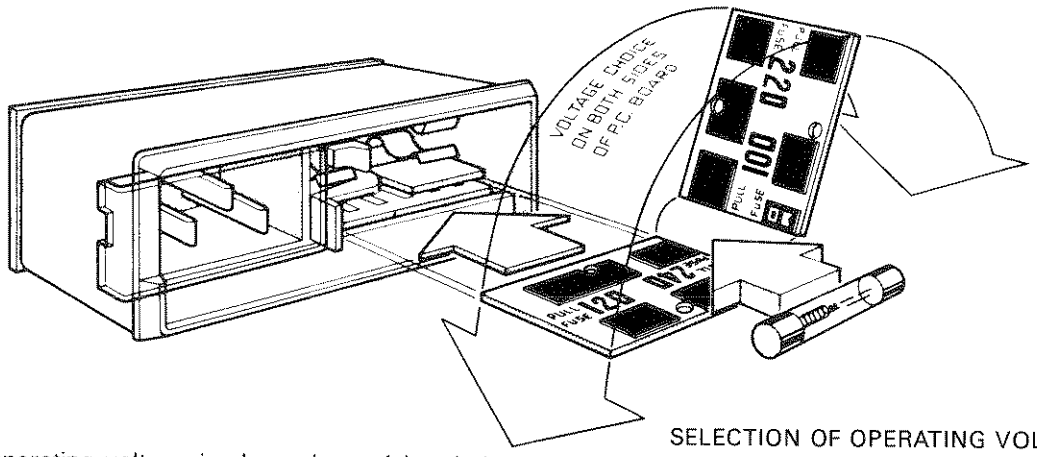
2-10. Power Cable.

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.

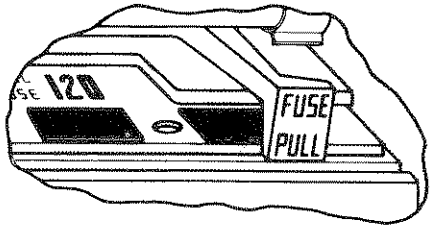
2-12. To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter (HP Part No. 1251-0048) and connect the green pigtail on the adapter to power line ground.

CAUTION

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



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.

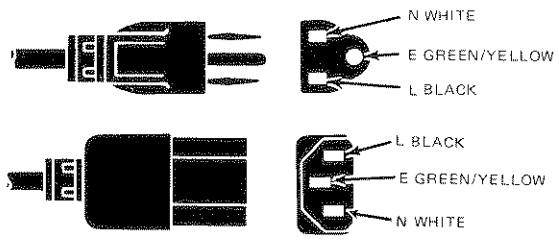
2-31. OPTION INSTALLATION.

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

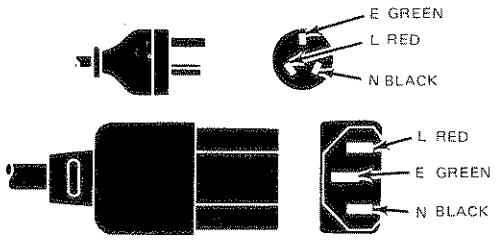
a. Push LINE switch to OFF.

b. Remove instrument top cover.

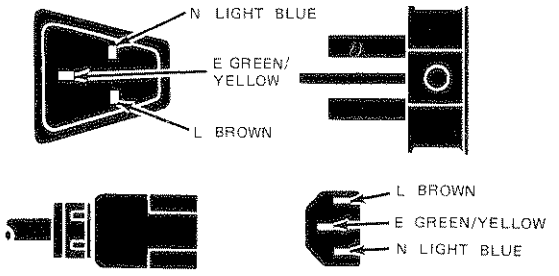
c. Follow the appropriate paragraph below:



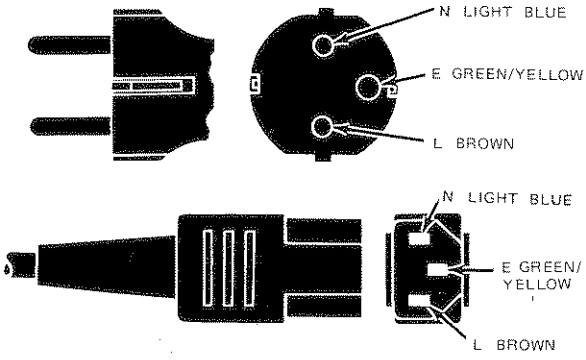
HP Part No. 8120-1378
NEMA 5-15P
Color: JADE GRAY
Furnished for countries other than listed below.



HP Part No. 8120-1369
AS-C112, N.Z.S.S. 198
Color: GRAY
250V, 6A
for Australia, New Zealand, etc.



HP Part No. 8120-1351
BS 1363A
Color: MINT GRAY
250V, 5A
for Great Britain, South Africa, India, Rhodesia, Singapore, etc.



HP Part No. 8120-1689
CEE7-VII
Color: MINT GRAY
250V, 6A
for East/West Europe, Iran, etc.

Note E: Earth or safety ground.
L: Line of active conductor.
N: Neutral or identified conductor.

Figure 2-2. Power Cables Supplied.

2-33. Option 001 BCD Parallel Data Output Installation.

a. Remove the two top 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.

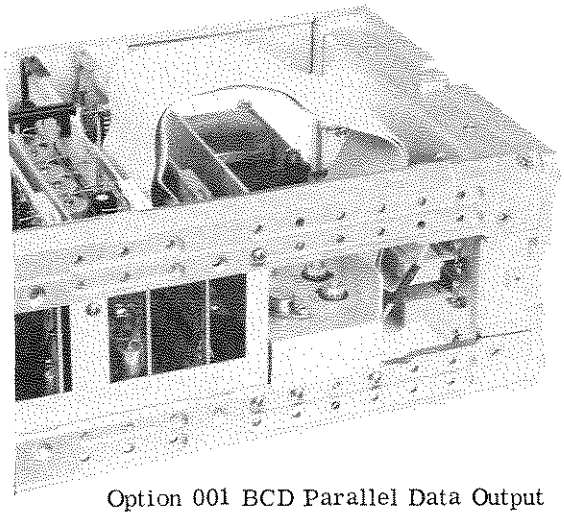
a. Remove instrument bottom cover and bottom blind cover from rear panel.

b. Install connector assembly in the opening.

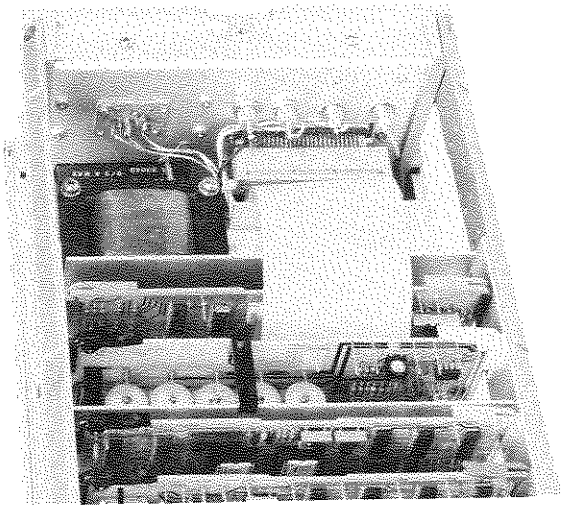
c. Connect the flat cable assembly between connector board of connector assembly and A1 Mother board (see Figure 2-4).

2-36. Option 101 HP-IB Remote Control and Data Output Installation.

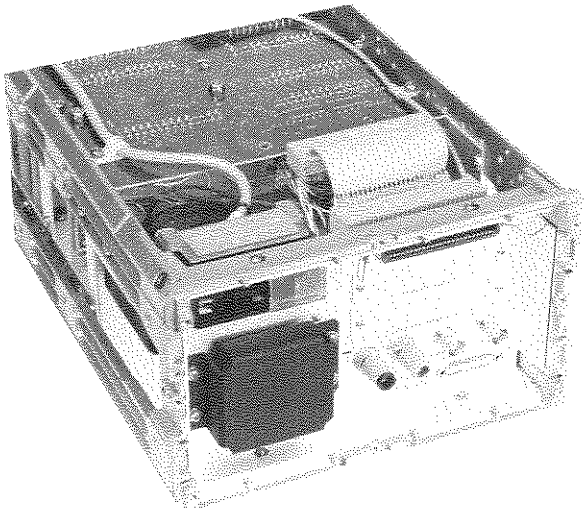
2-37. Since Option 101 is almost equivalent to 4261A Option 001 plus Option 003 plus HP Model 4081A Option 261 Coupler, refer to paragraphs 2-33 and 2-35 for installation and proceed similarly.



Option 001 BCD Parallel Data Output

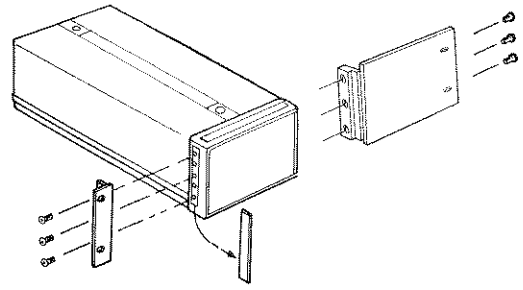


Option 002 Parameter Serial BCD Data Output

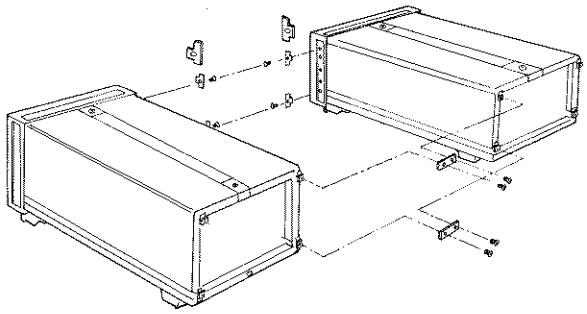


Option 003 BCD Remote Control

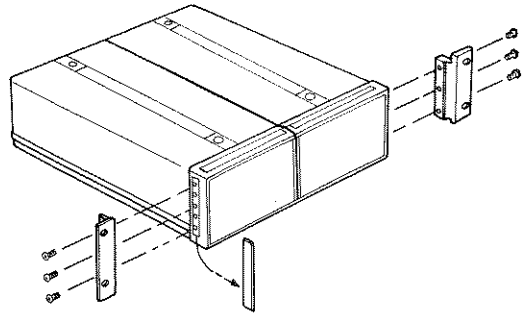
Figure 2-4. Option Installations.



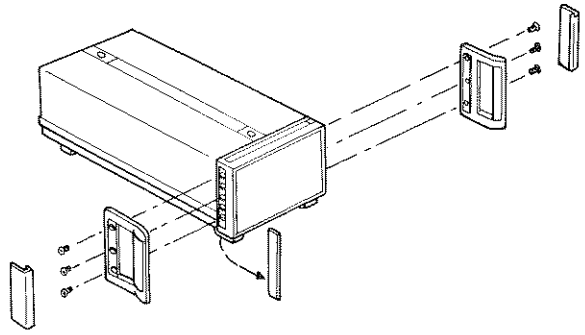
(A)



(B)



(C)



(D)

A. Rack Installation (only 4261A)

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
5061-0057	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
0050-0515	4	front horizontal lock link
2510-0192	4	screw
0050-0516	2	rear horizontal lock link
2360-0360	4	screw

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
5061-0077	1	Rack Flange Kit
Plus all parts needed for B.		

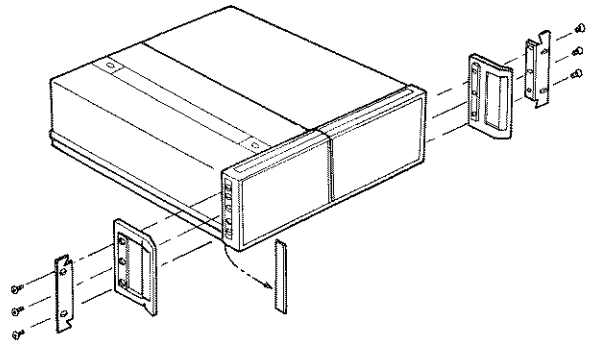
D. Handle Installation

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

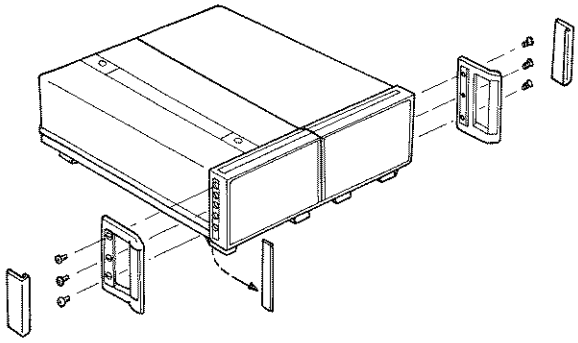
Parts required:

HP Part No.	Q'ty	Description
5061-0089	1	Handle Kit

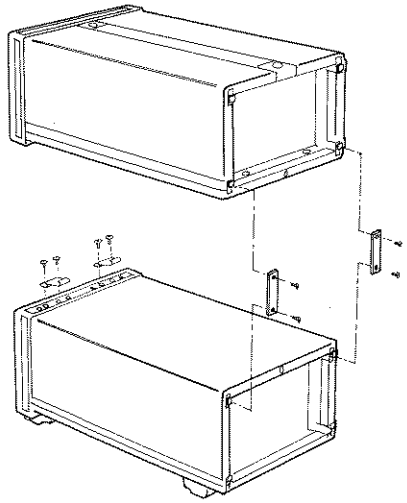
Figure 2-3. Rack and Handle Installation (Sheet 1 of 2).



(E)



(F)



(G)

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
5061-0083	1	Handle Kit
Plus all parts needed for B.		

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
5061-0089	1	Handle Kit
Plus all parts needed for B.		

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
1600-0367	2	front vertical lock link
2360-0330	4	screw
0050-0517	2	rear vertical lock link
2360-0360	4	screw

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; HCUR, HPOTEN, LCUR, LPOTEN 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 HCUR and HPOTEN terminals, and LCUR and LPOTEN terminals, respectively.

CAUTION

FOR CERTAIN TERMINAL MEASUREMENT CONFIGURATIONS, THE HCUR TERMINAL MUST BE CONNECTED TO HPOTEN TERMINAL AND THE LCUR TERMINAL CONNECTED TO THE LPOTEN 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 Cp (parallel capacitance) mode, and in like manner, the other measuring modes are:

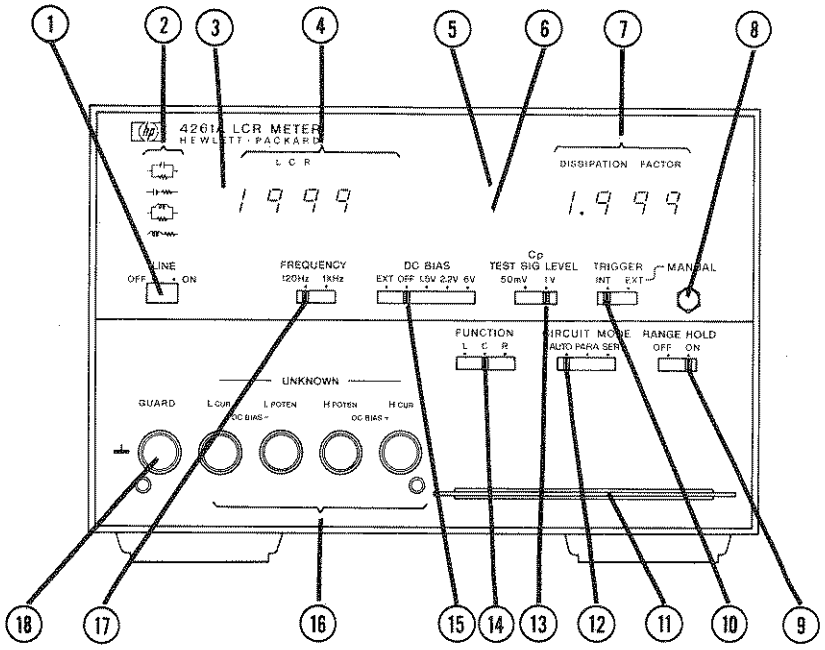
Cs mode: series capacitance.

Lp mode: parallel inductance.

Ls mode: series inductance.

Rp mode: parallel resistance.

Rs 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 (13), TRIGGER (10), FUNCTION (14), CIRCUIT MODE (12), and RANGE HOLD (9) controls are disabled when REMOTE lamp is lit.

Front Panel Features (Sheet 1 of 2).

(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

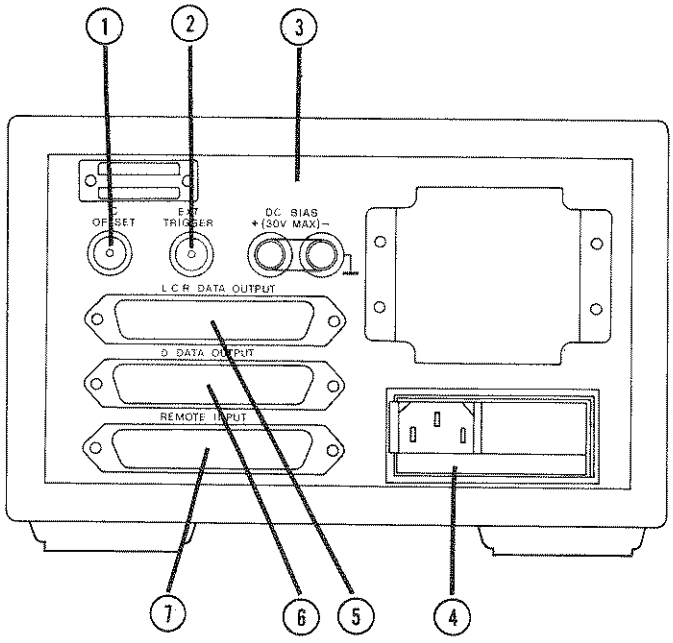
(15) DC BIAS Selector Switch. This switch permits selection of internal DC bias voltage applied to sample (1.5Vdc, 2.2Vdc, or 6.0Vdc) or when switch is set to EXT, is used to apply external bias voltage from rear DC BIAS input connectors. OFF position is selected in no bias voltage is necessary.

(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).



4261A REAR PANEL

(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.

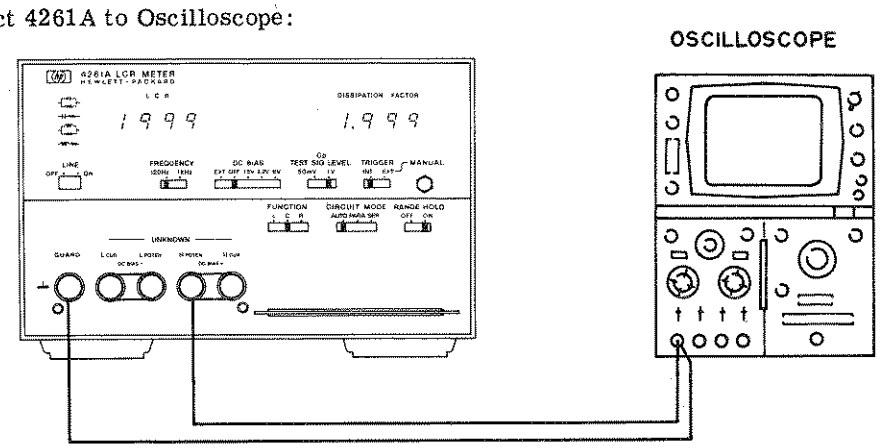
(6) D DATA OUTPUT Connector. BCD parallel data of measured dissipation factor are outputted through this 50-pin connector (Option 001).

(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.

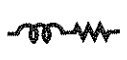
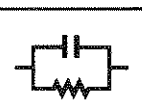
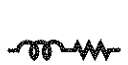
FUNCTION	CIRCUIT MODE	
	PARA	SER
L		
C		
R		

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 19.99MΩ.
FUNCTION ..... L CIRCUIT MODE ..... PARA TRIGGER ..... INT UNKNOWN device .. Short (0Ω)	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 → mH → μH
C	pF → nF → μF → mF
R	MΩ → kΩ → Ω → mΩ

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

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

10. Set RANGE HOLD to ON.

11. Check that left display unit maintains its previous mΩ 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.

Table 3-2. Parameter Terminology.

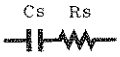
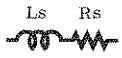
Circuit Mode	Equivalent Circuit	Terminology
Cp mode Rp mode		Cp: parallel capacitance Rp: parallel resistance
Cs mode		Cs: series capacitance Rs: series resistance
Lp mode		Lp: parallel inductance Rp: parallel resistance
Ls mode Rs mode		Ls: series inductance Rs: series resistance

Note

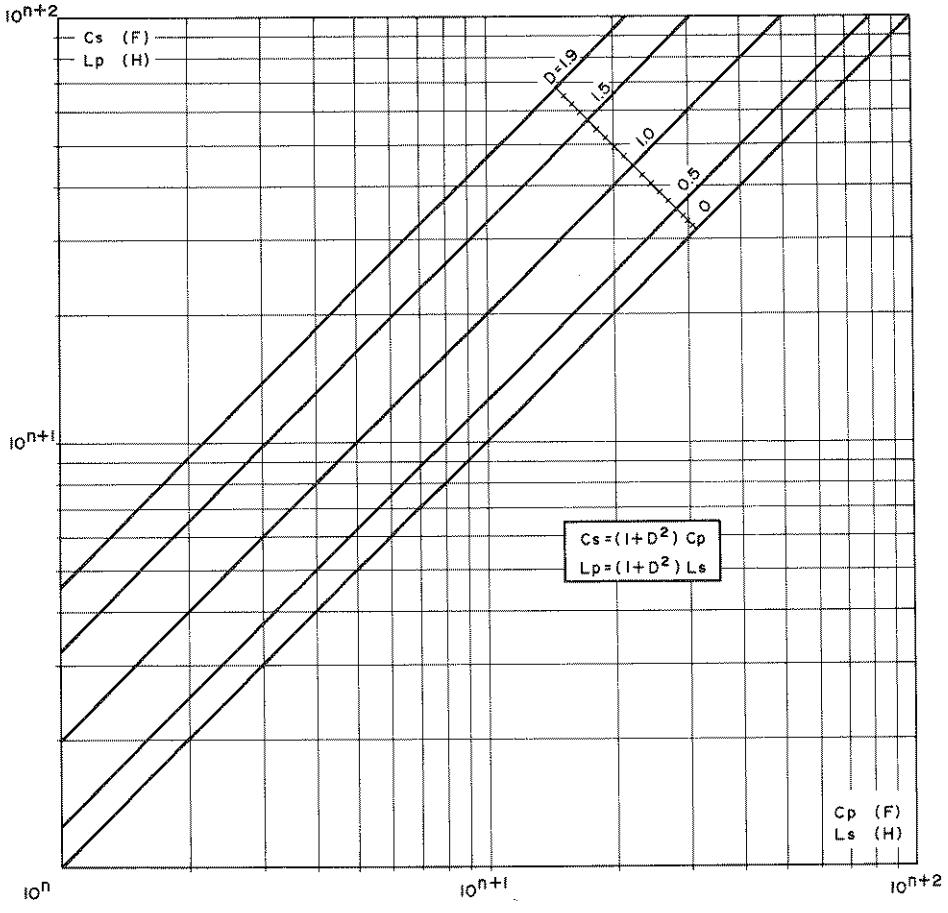
Dissipation factors displayed when CIRCUIT MODE is switched between PARA and SER may exhibit slight differences due to the measurement accuracy of the 4261A.

The reciprocal of the dissipation factor (D) is quality factor (Q) and D is often represented as $\tan\delta$ 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		$D = \frac{1}{2\pi fCpRp} \left(= \frac{1}{Q}\right)$	$Cs = (1 + D^2)Cp,\ Rs = \frac{D^2}{1 + D^2} \cdot Rp$
Cs mode		$D = 2\pi fCsRs \left(= \frac{1}{Q}\right)$	$Cp = \frac{1}{1 + D^2} Cs,\ Rp = \frac{1 + D^2}{D^2} \cdot Rs$
Lp mode		$D = \frac{2\pi fLp}{Rp} \left(= \frac{1}{Q}\right)$	$Ls = \frac{1}{1 + D^2} Lp,\ Rs = \frac{D^2}{1 + D^2} \cdot Rp$
Ls mode		$D = \frac{Rs}{2\pi fLs} \left(= \frac{1}{Q}\right)$	$Lp = (1 + D^2)Ls,\ Rp = \frac{1 + D^2}{D^2} \cdot Rs$

*f: Test signal frequency.



Where n stands for a free integer.

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 μA rms	1V rms	10 μA rms	1V rms (50mV rms)*	100 μA rms	1V rms
5	10 μA rms	1V rms	100 μA rms	1V rms (50mV rms)*	10 μA rms	1V rms
6	———	1V rms	1 μA rms	———	———	1V rms
7	———	1V rms	10mA rms	———	———	1V rms
8	———	———	70mArms	———	———	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 thourh 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.

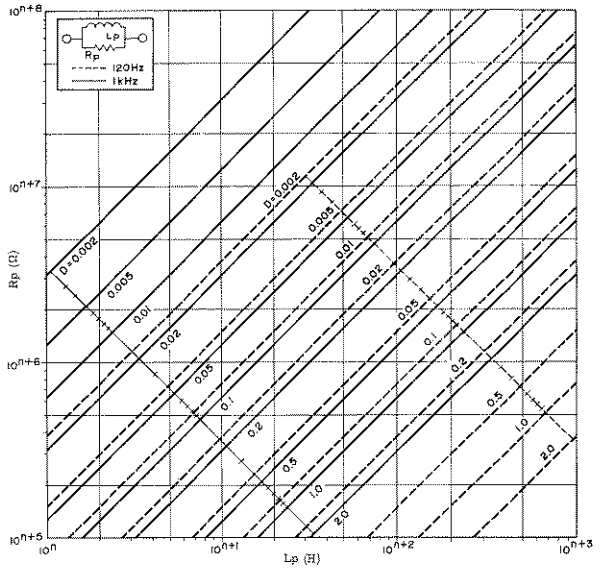
3-15. Measurement Range. The 4261A has wide measurement ranges as shown in Table 3-5. Seven or eight ranges are available (depending upon measurement function) and the range is automatically selected for the sample value connected to the 4261A. Four or five ranges, however, are used for measurements 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

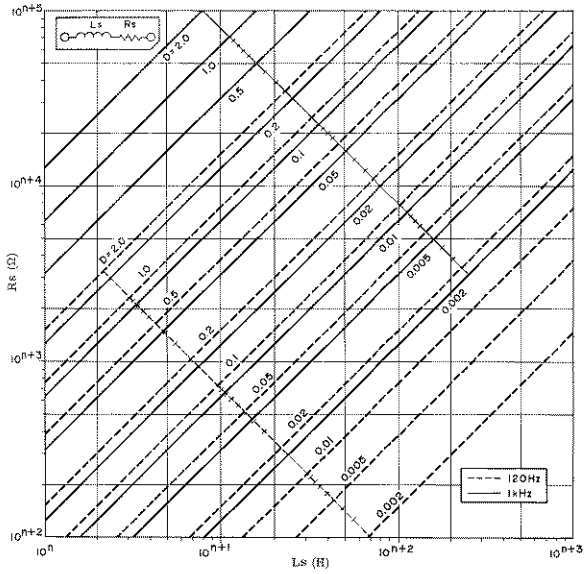
Table 3-5. Measurement Ranges.

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	0000μH	00.00mH	000.0mH	0000mH	00.00 H			
	1kHz	000.0μH	0000μH	00.00mH	000.0mH	0000mH			
Cp	120Hz	0000pF	00.00nF	000.0nF	0000nF	00.00μF			
	1kHz	000.0pF	0000pF	00.00nF	000.0nF	0000nF			
Cs	120Hz				0000nF	00.00μF	000.0μF	0000μF	00.00mF
	1kHz				000.0nF	0000nF	00.00μF	000.0μF	0000MF
Rp	120Hz				0000Ω	00.00kΩ	000.0kΩ	0000kΩ	00.00MΩ
	1kHz				0000Ω	00.00kΩ	000.0kΩ	0000kΩ	00.00MΩ
Rs	120Hz	0000mΩ	00.00Ω	000.0Ω	0000Ω	00.00kΩ			
	1kHz	0000mΩ	00.00Ω	000.0Ω	0000Ω	00.00kΩ			

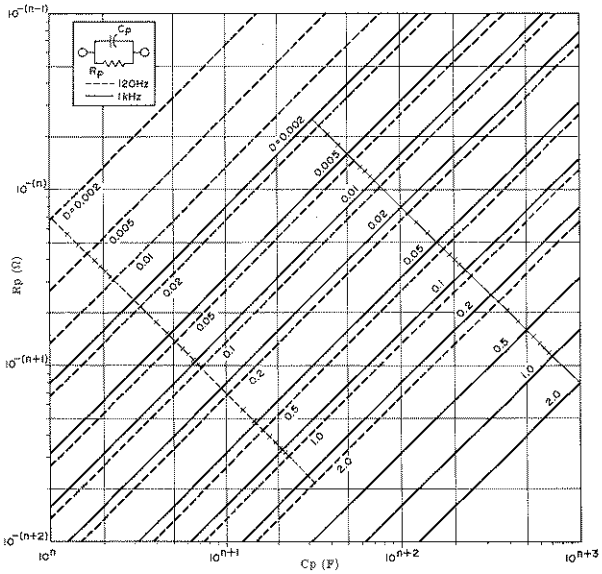
Note: 0000μH indicates a range of 0001 μH to 1900μH (and similarly for F and Ω).



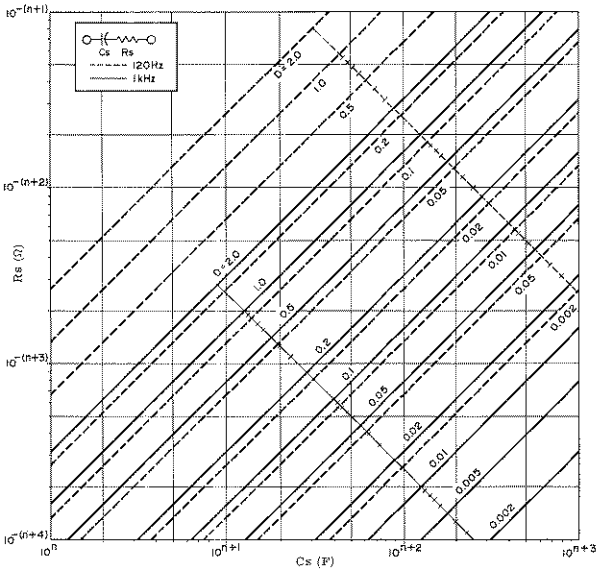
Parallel Inductance - Parallel Resistance
(A)



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.

Note

LCR display is meaningful even if D diaplay 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.

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 MEASUREABLE RANGE AT ANY PANEL CONTROL SETTING.

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.

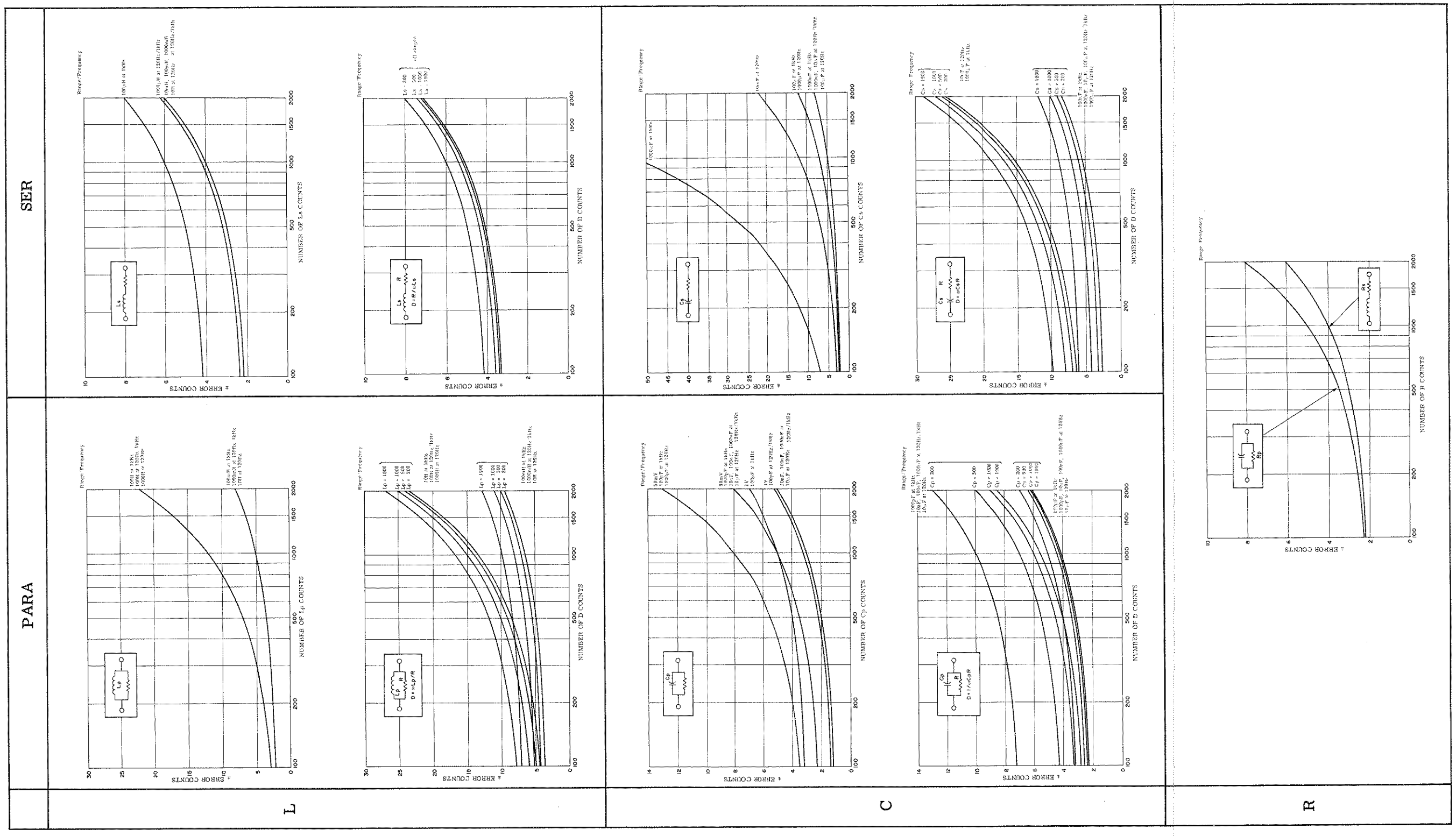
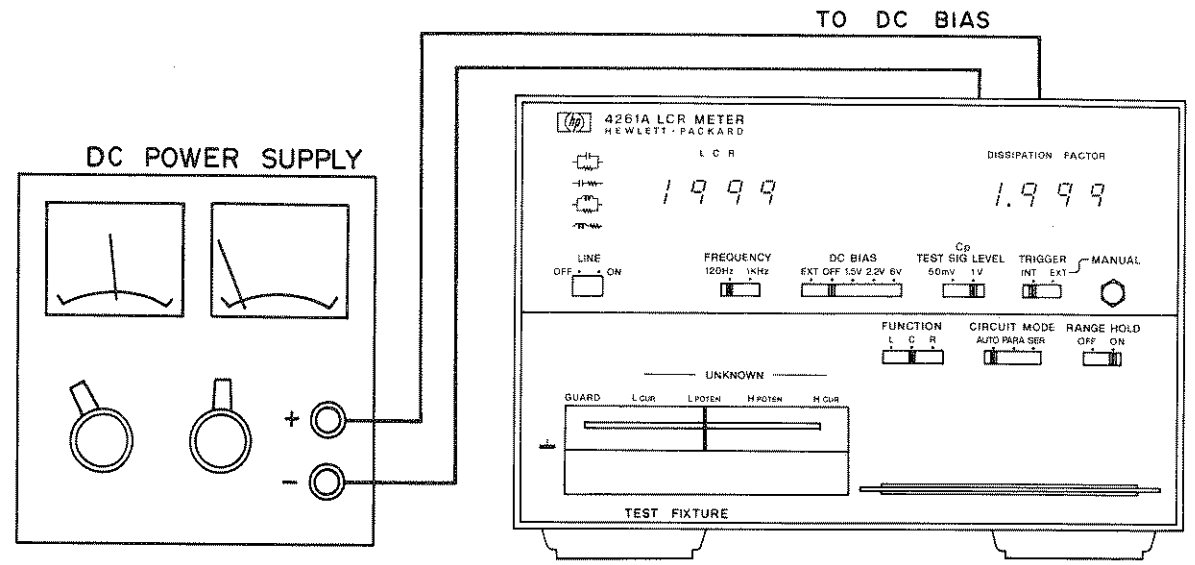


Figure 3-6. Accuracy.



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

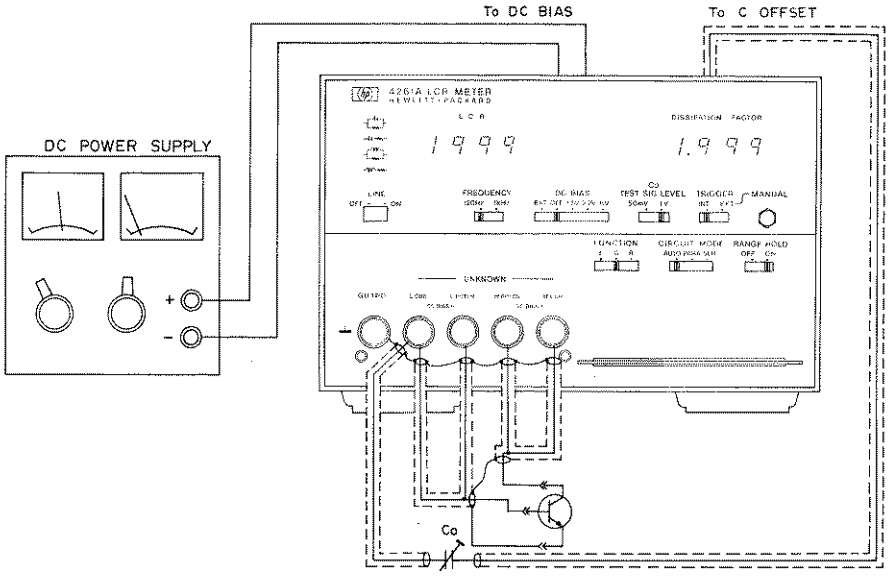
It is usually best to set RANGE HOLD switch to ON when measuring multiple samples having almost the same value.

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:

$$Rs = D/\omega Cs \text{ (Cs-D measurement)}$$
$$Rs = \omega Ls \cdot D \text{ (Ls-D measurement)}$$
$$Rs = \omega Lp \cdot \frac{D}{1+D^2} \text{ (Lp-D measurement)}$$

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
Cp 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.
Cp 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.

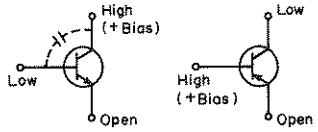
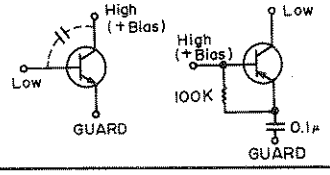
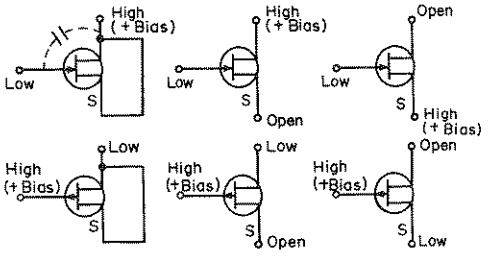
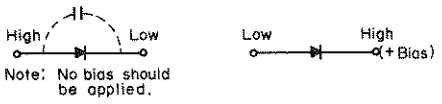
Parameter Measured	Connections to 4261A
Base-collector junction capacitance (Cob)- Emitter current = 0	
Base- collector junction capacitance (Cre)- Common emitter	
FET gate capacitance	
Diode junction capacitance Note: Germanium diodes sometimes cannot be measured.	

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

External DC Voltage Bias Circuits (30V < , < 200V)

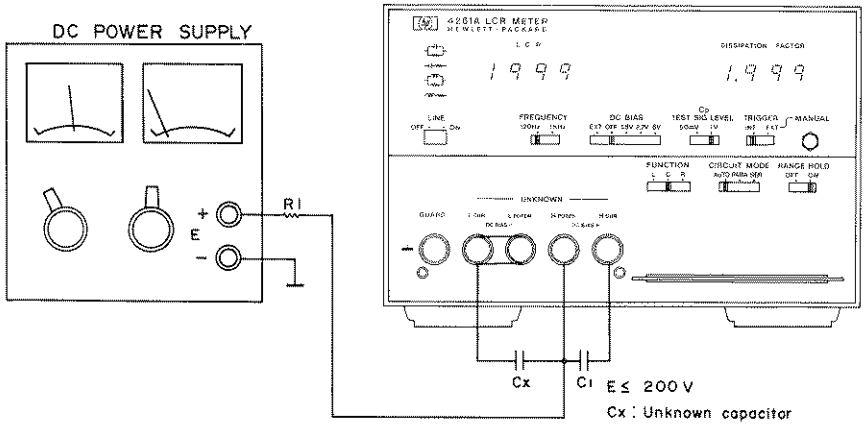
1. Connect external dc bias source as shown in diagram:

CAUTION

DO NOT APPLY DC VOLTAGE EXCEEDING 200 VOLTS. IF APPLIED, 4261A CIRCUITRY WILL BE DAMAGED.

Note

+E voltage is applied to Cx in figure. -E voltage can be applied to Cx in this figure. In this arrangement, the polarity of Cx and C1 must be taken into consideration.



CAUTION

NEVER SHORT BETWEEN H_{POTEN} AND LOW TERMINALS WHEN R_1 IS SMALLER THAN 1kΩ. IT IS BETTER TO MAKE SURE THAT UNKNOWN CAPACITOR IS NOT DEFECTIVE BEFORE CONNECTING TO INSTRUMENT.

Note

Ripple or noise on external dc bias source should be as low as possible. The low frequency noise of bias source should be less than 1mVrms for a Cp TEST SIG LEVEL of 50mV and 30mVrms for 1V.

2. Minimum values for C1 (dc blocking capacitor) and minimum values R1 are given in table below:

Note

Insulation resistance for Cx must be greater than a certain value. Refer to Table 3-7, page 3-23 of Unusual Operating Indications.

Range	120Hz	1000pF	10.00nF	100.0nF	1000nF	10.00μF
	1kHz	100.0pF	1000pF	10.00nF	100.0nF	1000nF
Minimum C_1(F)	120Hz	0.01μF	0.1μF	1μF	10μF	100μF
	1kHz	0.01μF	0.01μF	0.1μF	1μF	10μF
Minimum R_1 (Ω)		300kΩ	100kΩ	10kΩ	1kΩ	100Ω

Figure 3-9. External DC Bias Circuits (Sheet 1 of 3).

Note

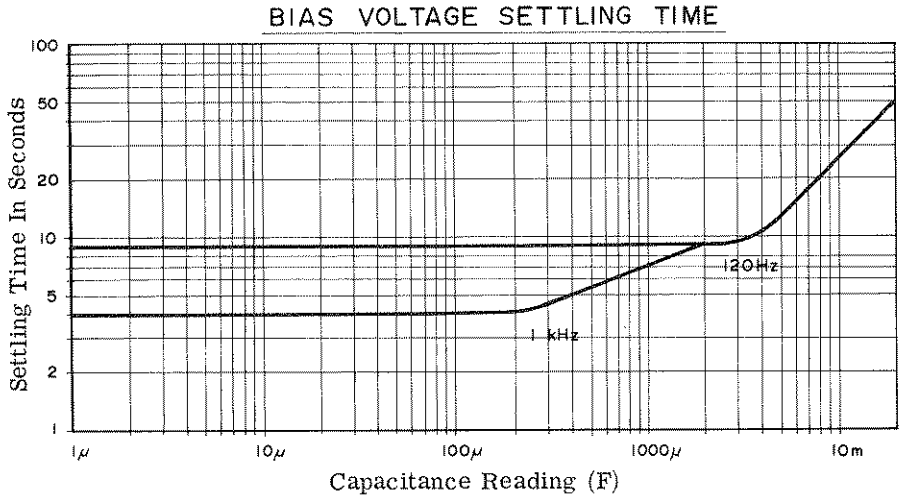
DC withstand voltage for C_1 capacitor must be greater than dc applied voltage E. Also observe polarity of capacitor C_1 with respect to applied voltage.

3. Set 4261A controls as follows:

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

4. 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 C_1 and R1 are larger than those given in table on Sheet 1 are connected, longer settling times are necessary.

USING CURRENT BIAS (for inductors).

1. Connect dc power supply as shown below:

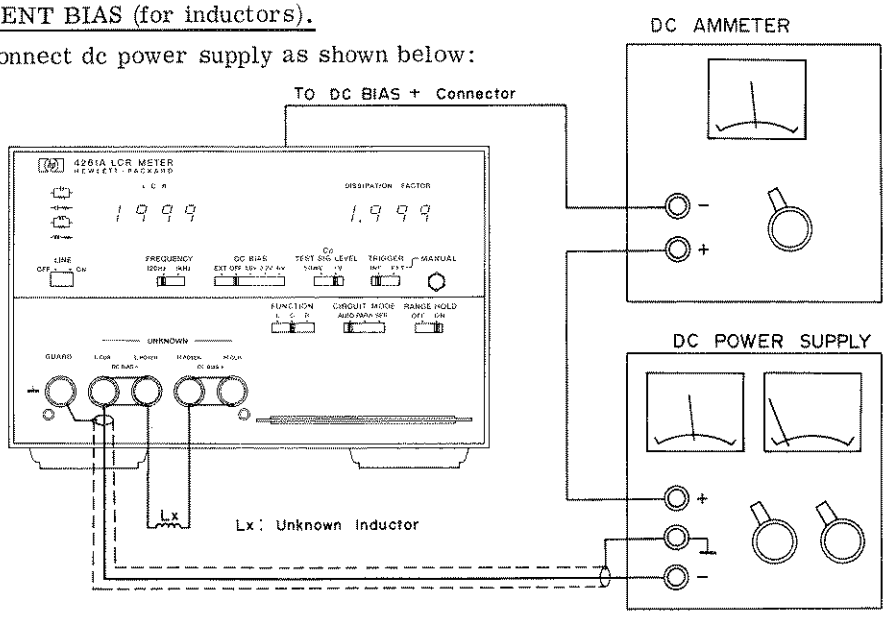


Figure 3-9. External DC Bias Circuits (Sheet 2 of 3).

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	1000μH	10.00mH	100.0mH	1000mH	10.00H	100.0H
	1kHz	100.0μH	1000μH	10.00mH	100.0mH	1000mH	10.00H
CIRCUIT MODE		SER			PARA		
Maximum Bias Current*		52mA	40mA	13mA	42mA	40mA	13mA

* Bias current when +30V is applied to DC BIAS connector.

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.

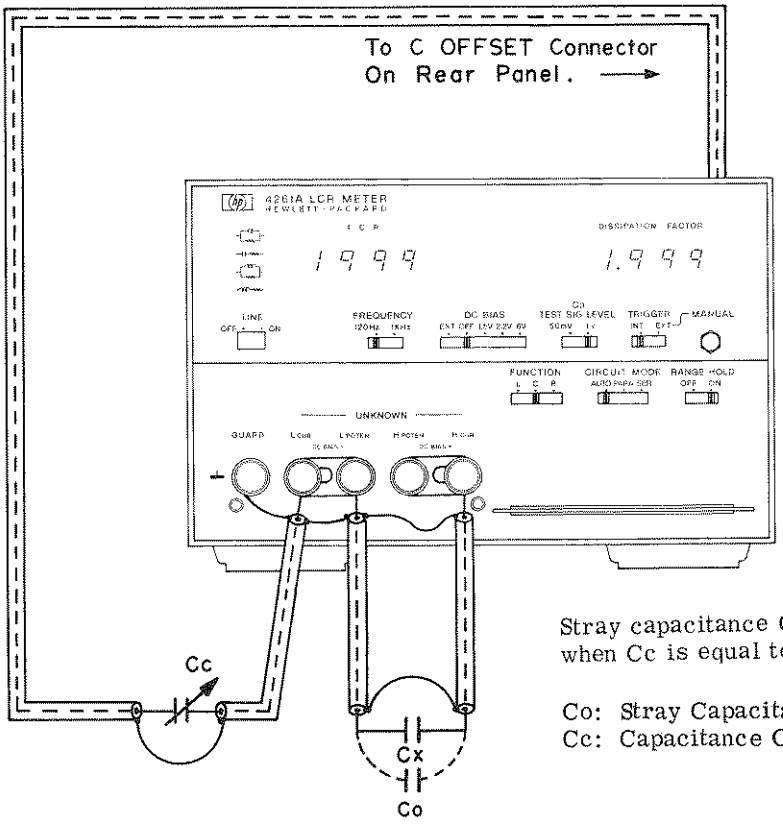
3-19. Figure 3-7 shows the operating procedures for measuring an L, C or R (inductance, capacitance or resistance) circuit component. Almost all discrete circuit components (inductors, capacitors or resistors) except for components having special shapes or dimensions can be measured with this setup. 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 Co is compensated when Cc is equal to Co.

Co: Stray Capacitance
Cc: Capacitance Offset

Procedure:

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

Notes

a. An air capacitor is recommended for capacitor (Cc). 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 Cc and Low terminal be made with a shielded cable to eliminate the effects of noise.

2. Adjust Cc 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 Cc 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 HCUR and HPOTEN 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 reange 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

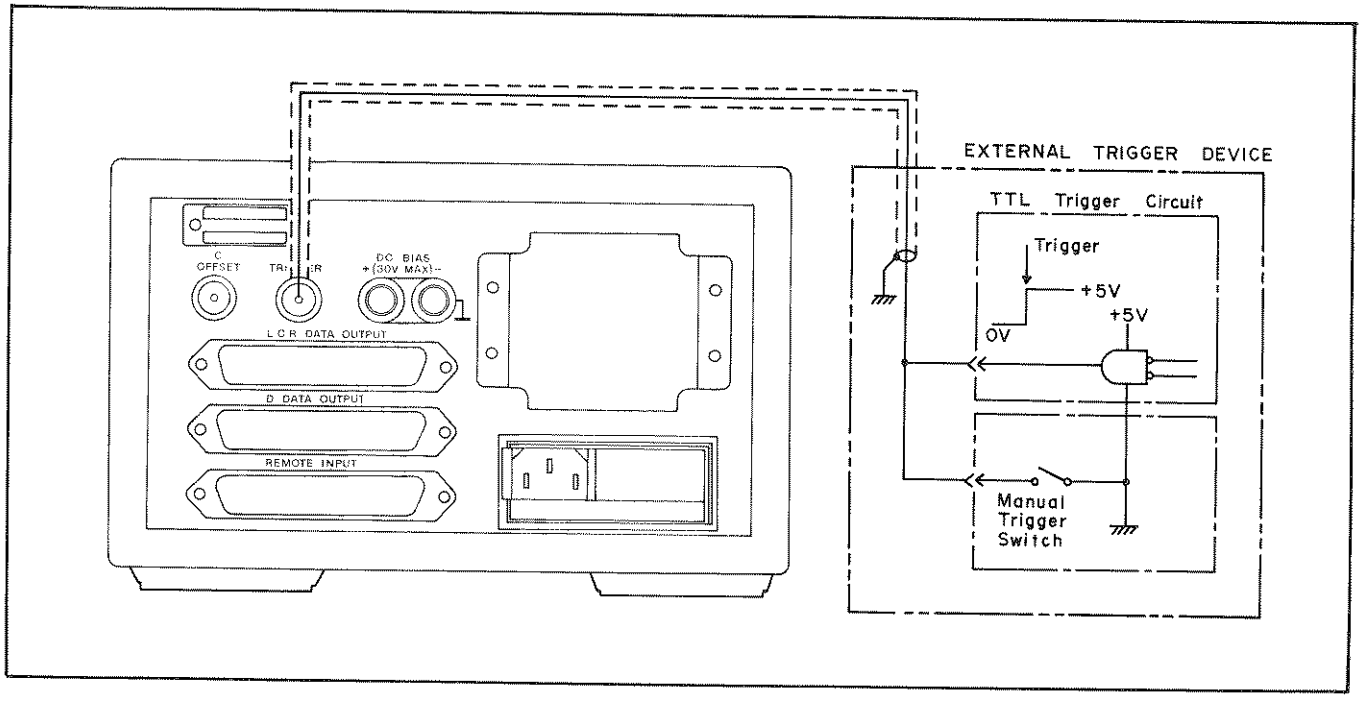


Figure 3-11. External Trigger Circuits.

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:

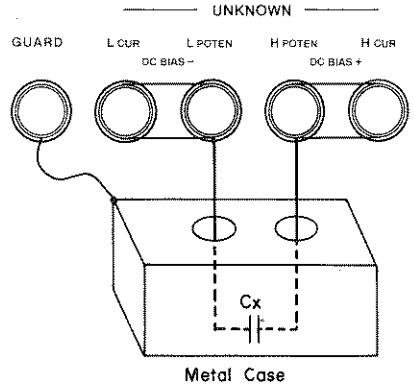
   A . A large size sample is being measured.

   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 ω^2LrCx X 100 (%) for C measurement, where: ω = 2πf f = test frequency Lr = residual inductance Cx = 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:

Measurement Frequency	Allowable Stray Capacitance Magnitude
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 neccessary, 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:

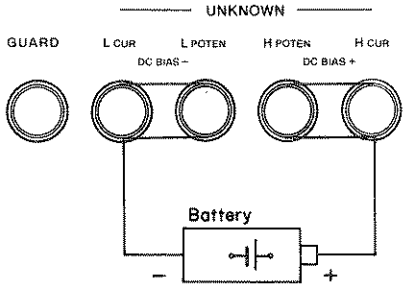
MODE		RANGE				
Cp	120Hz	1000pF	10.00nF	100.0nF	1000nF	10.00μF
	1kHz	100.0pF	1000pF	10.00nF	100.0nF	1000nF
Cs	120Hz	1000nF	10.00μF	100.0μF	1000μF	10.00mF
	1kHz	100.0nF	1000nF	10.00μF	100.0μF	1000μF
Permissible insulation resistance (Ri)		22.5MΩ	2250kΩ	225kΩ	22.5kΩ	2250Ω

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:

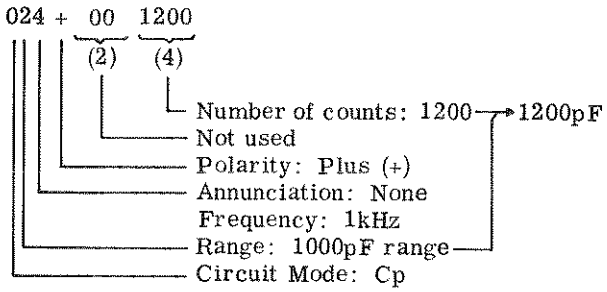


Figure 3-14 shows connections between the 4261A option 001 and HP devices. Model 4261A operation with option 001 follows standard operations described in Figure 3-7 and 3-8 except for connection of external devices. Operating information for HP printers is covered in the respective operating and service 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. $\overline{\text{REM}}$ signal must be always at low level during remote control. If not, remote control functions will not occur.
2. $\overline{\text{EXE}}$ signal triggers the 4261A when its state changes from low to high level. Pulse width of $\overline{\text{EXE}}$ 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.

3-39. HP-IB Compatible (OPT. 101).

3-40. This 4261A Option 101 includes all the components for compatibility with an HP-IB system as shown in Table 1-3. Operating information for this option is provided in the HP Model 4261A Option 101 HP-IB SUBSYSTEM Operating Manual.

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

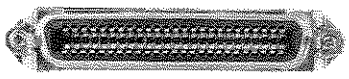
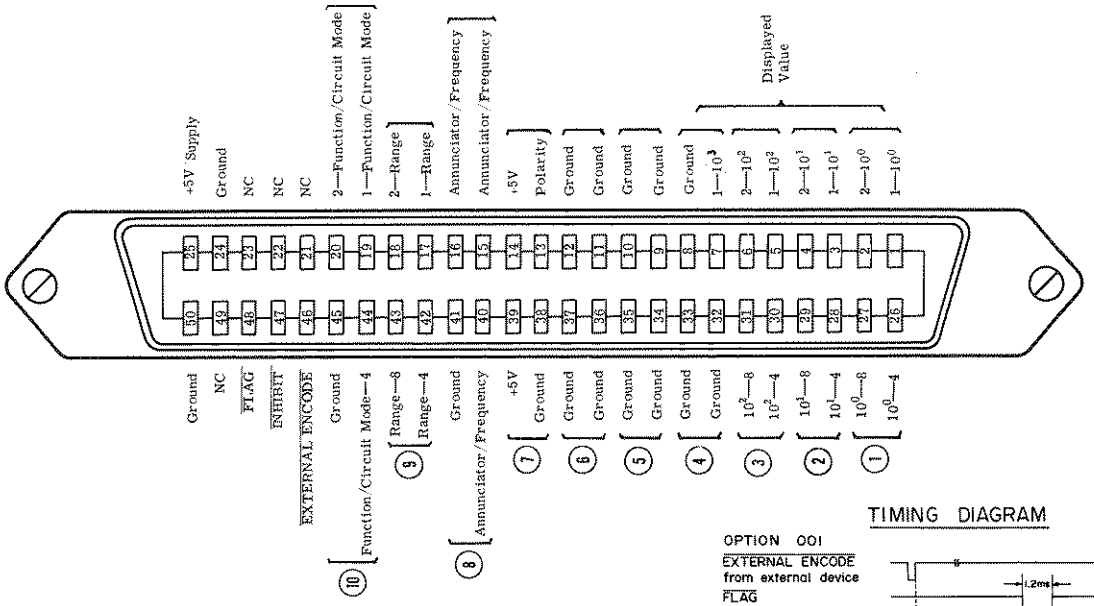
4261A FUNCTION Setting / Rear Connector	L	C	R
LCR DATA OUTPUT 	Inductance Value Polarity Annunciation/Test Frequency Range Function/CKT Mode	Capacitance Value Polarity Annunciation/Test Frequency Range Function/CKT Mode	Resistance Value Polarity Annunciation/Test Frequency Range Function/CKT Mode
D DATA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

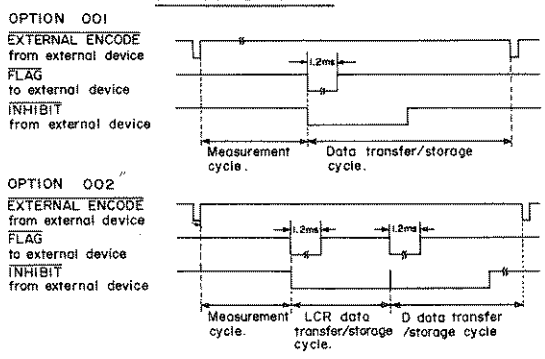
Figure 3-12. Data Outputted by Option 001.

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



○: Column Number

TIMING DIAGRAM



(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
	8	8
	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

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.

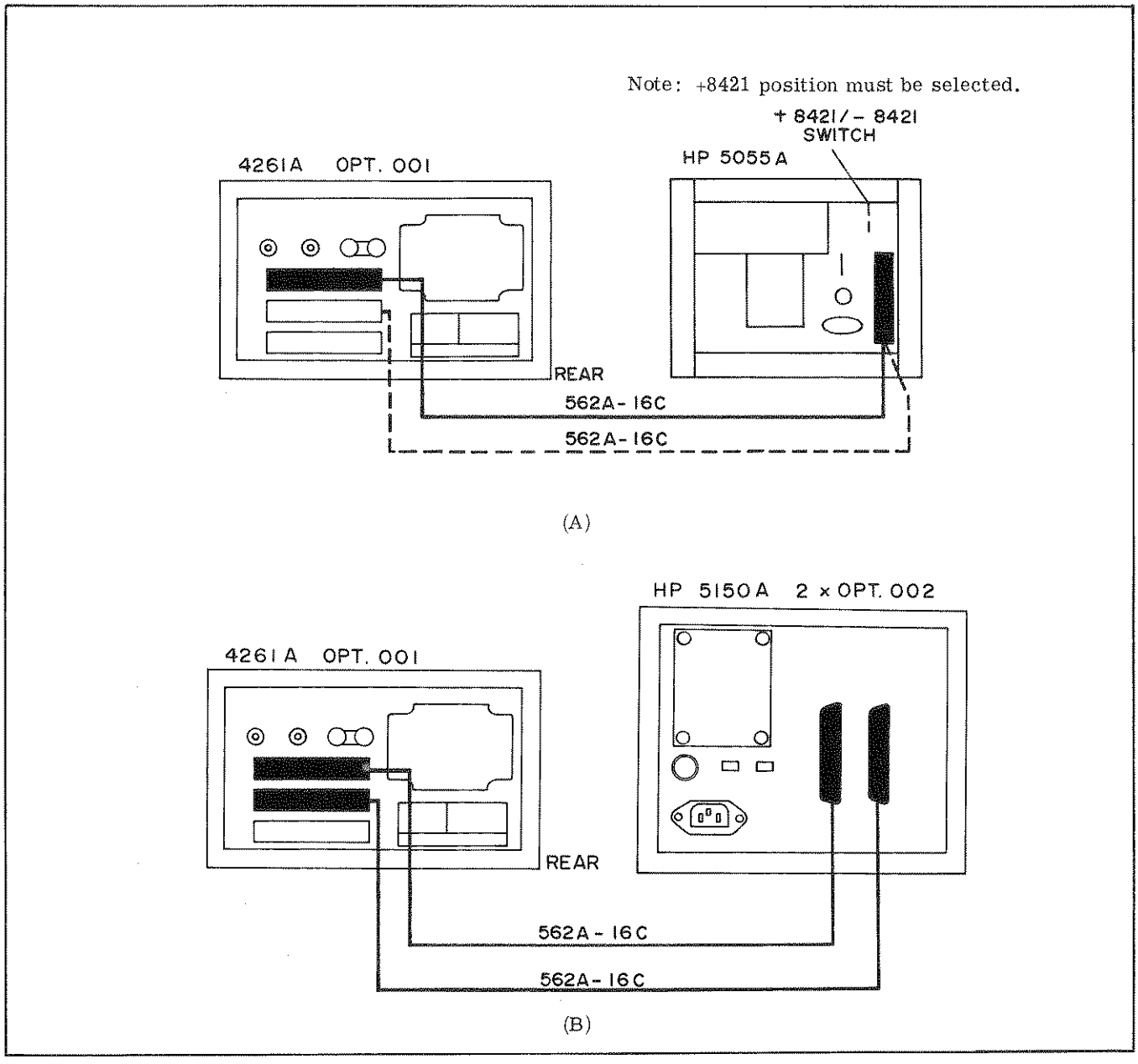


Figure 3-14. 4261A Connections to HP Printers.

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.

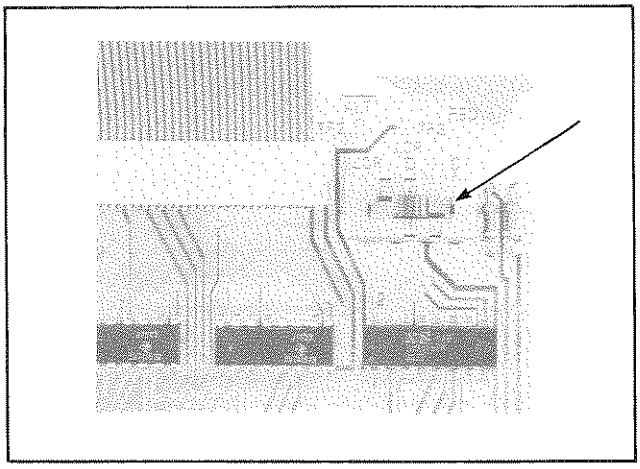


Figure 3-15. Option 002 Data Selection Switch.

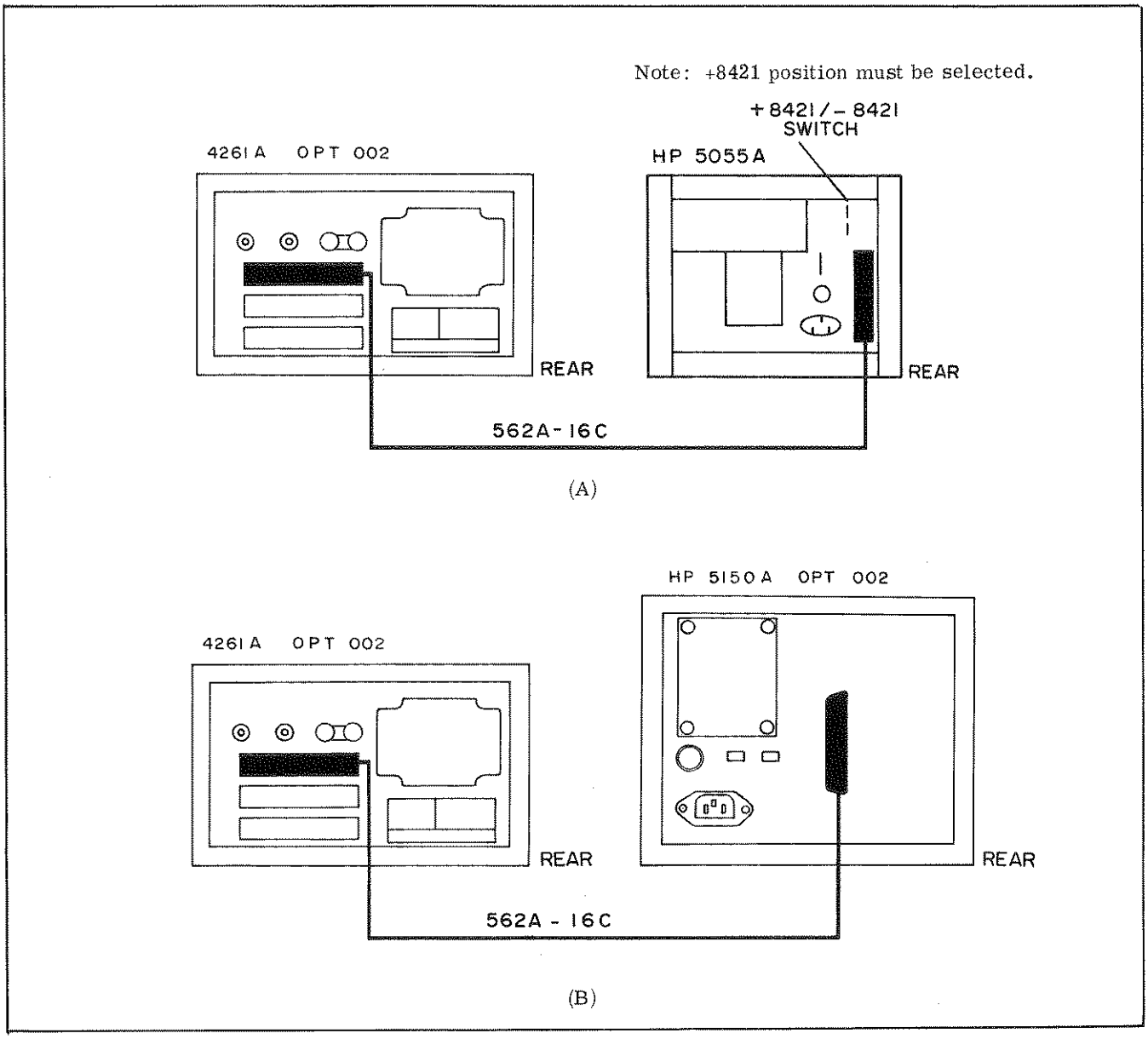
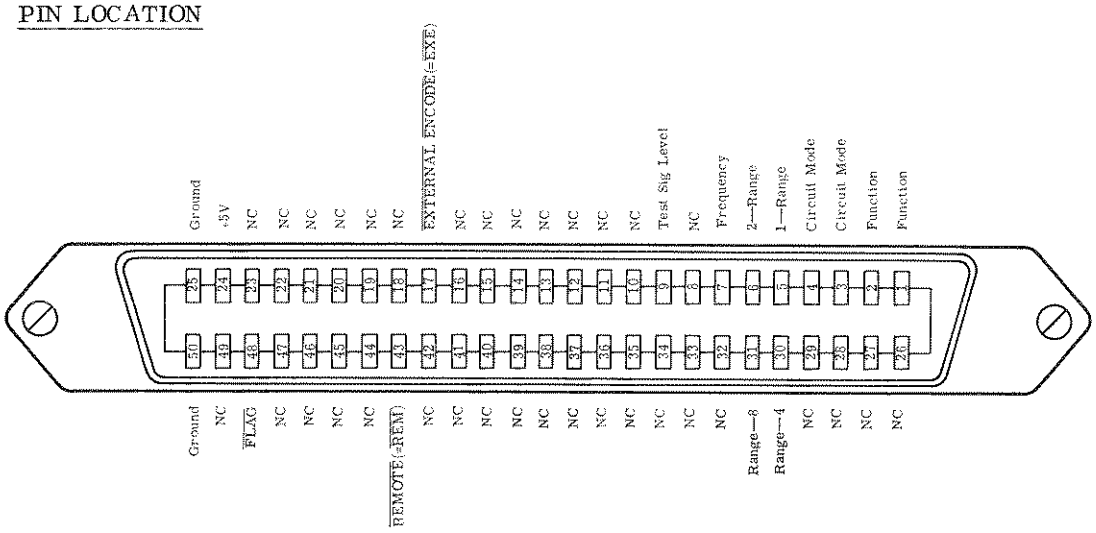


Figure 3-16. Option 002 Connection to External Printers.

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

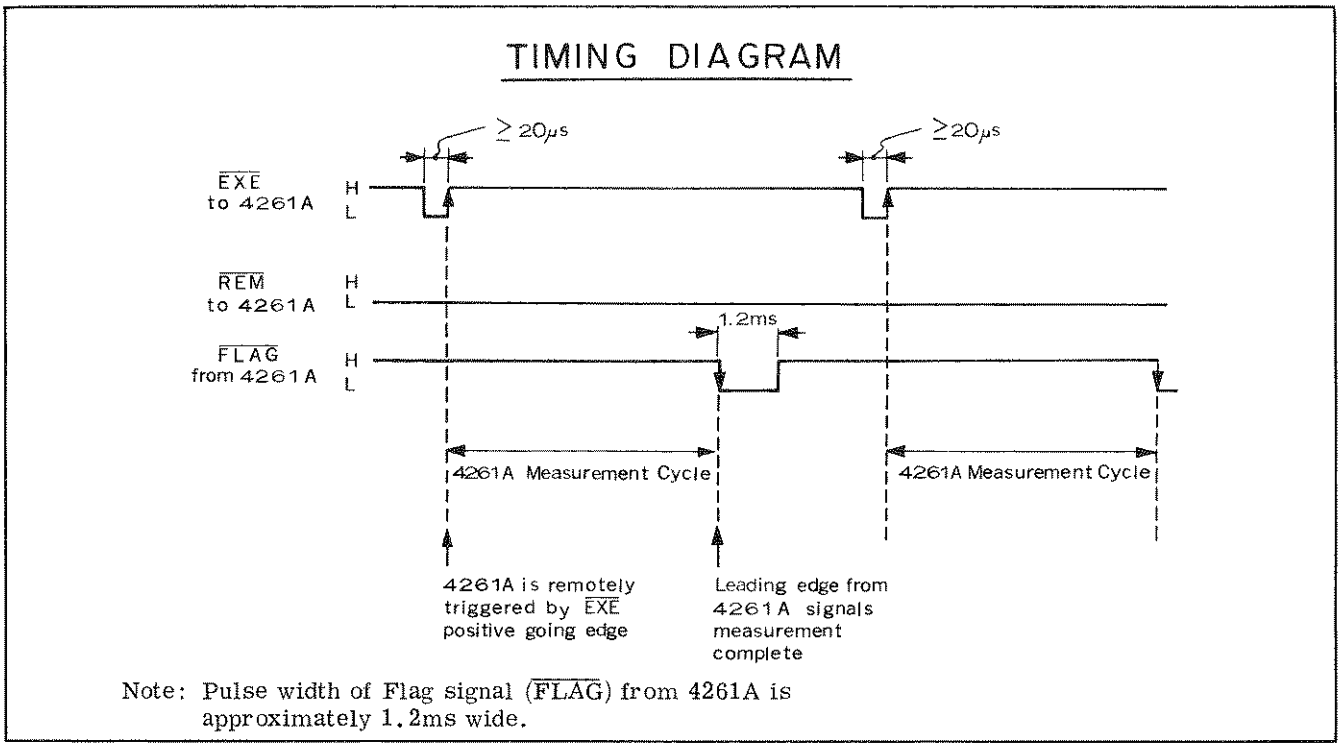
TEST SIG LEVEL	PIN
	9
50mV	High
1 V	Low

Range	PIN				Full Scale Measurement Range			
	5	6	30	31	FUNCTION / FREQUENCY	L	C	R
1	Low	Low	Low	Low	120Hz	1000 μH	1000 pF	1000 mΩ
					1kHz	100.0μH	100.0pF	
2	High	Low	Low	Low	120Hz	10.00mH	10.00nF	10.00Ω
					1kHz	1000μH	1000 pF	
3	Low	High	Low	Low	120Hz	100.0mH	100.0nF	100.0Ω
					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	10.00μF	10.00kΩ
					1kHz	1000 mH	1000 nF	
6	High	Low	High	Low	120Hz	100.0H	100.0μF	100.0kΩ
					1kHz	10.00H	10.00μF	
7	Low	High	High	Low	120Hz	1000 H	1000 μF	1000 kΩ
					1kHz	100.0H	100.0μF	
8	High	High	High	Low	120Hz	1000 H	10.00mF	10.00MΩ
					1kHz	100.0H	1000 μF	
Auto	*	*	*	High	120Hz	1000 μH-1000 H	1000 pF-10.00mF	1000 mΩ-10.00MΩ
					1kHz	100.0μH-100.0H	100.0pF-1000 μF	

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).



Note: Pulse width of Flag signal (FLAG) from 4261A is approximately 1.2ms wide.

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

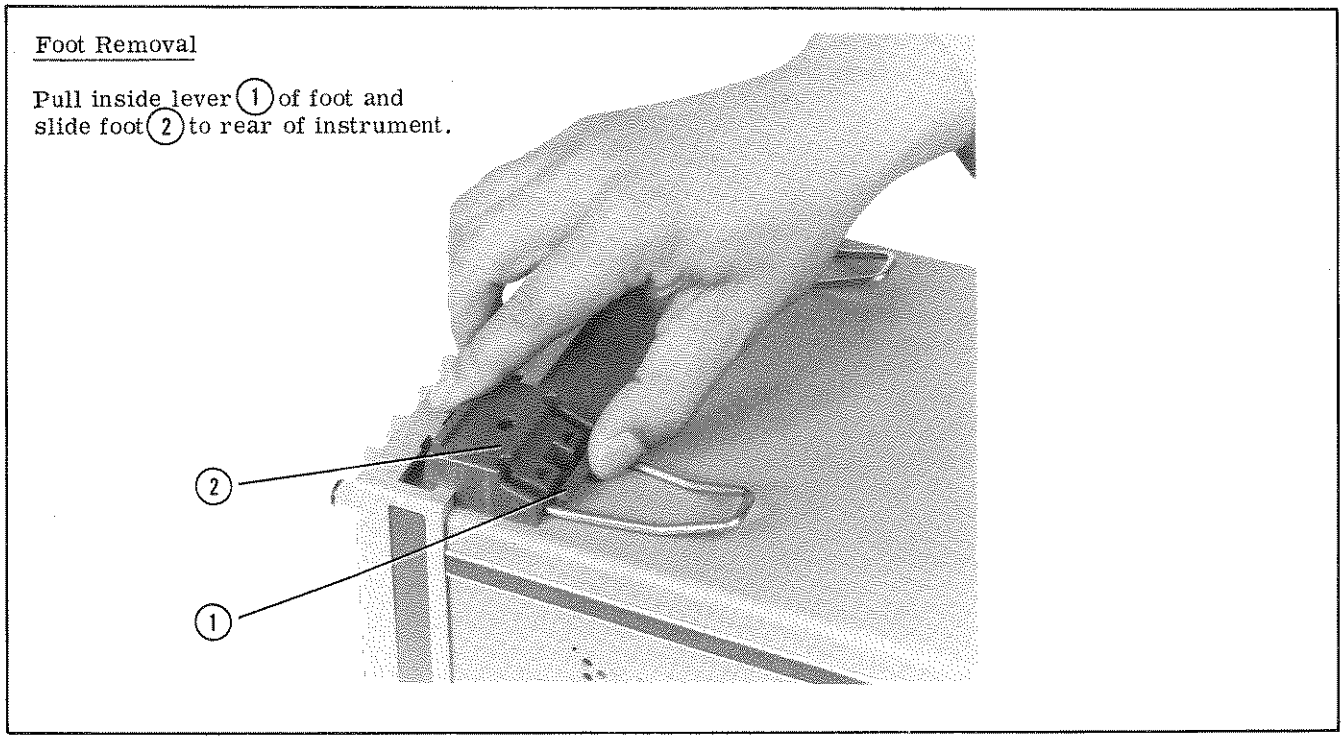


Figure 3-18. Foot/Stand Replacement.

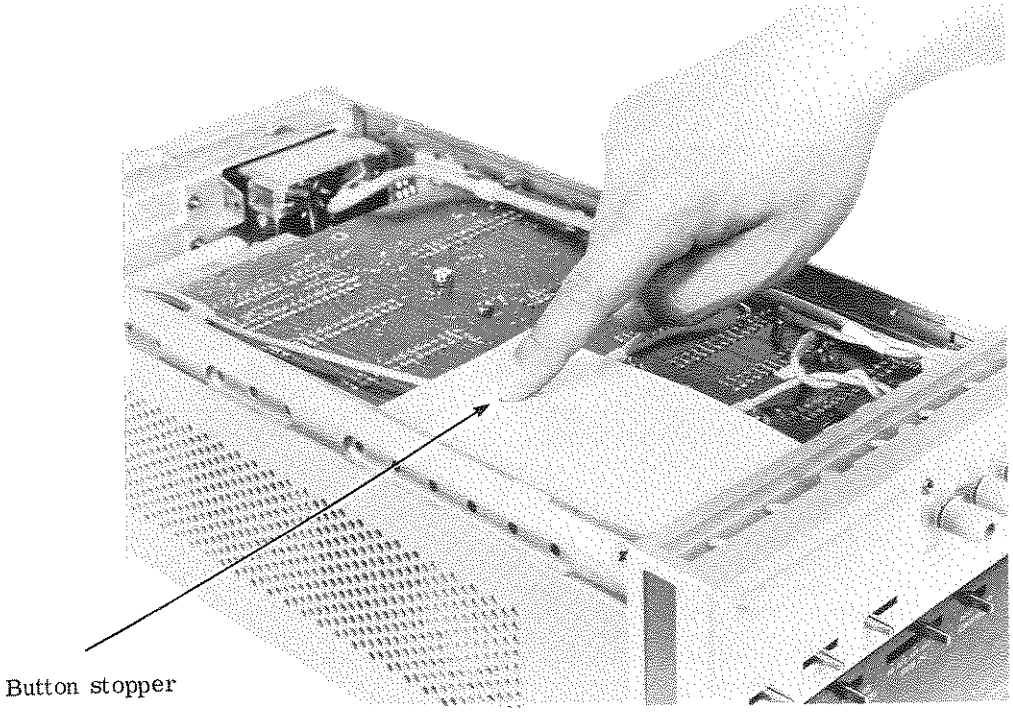


Figure 3-19. Instruction Card Replacement.

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.