

# MODEL 2150/2160 VideoBridge™

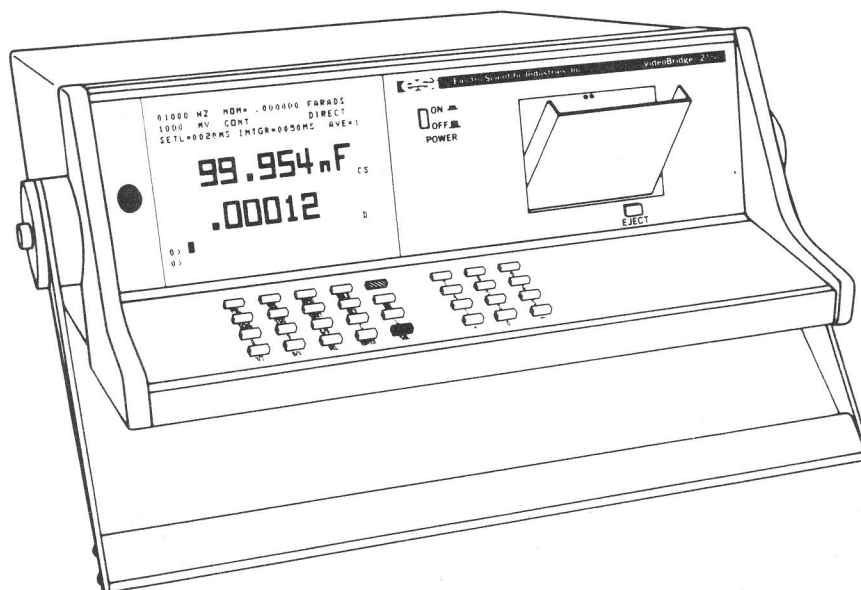
Auto LRC Meter

**PRELIMINARY**

Service Manual

Part Number 54327B

September 1985



## PLEASE NOTE

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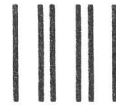
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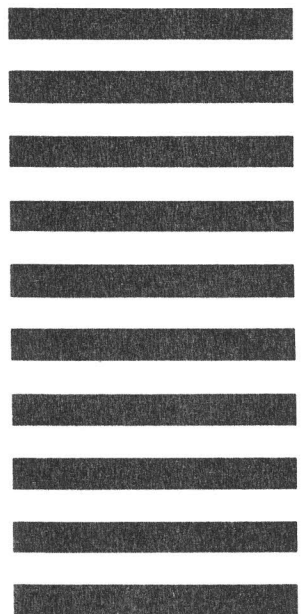
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# PROTECT AGAINST ELECTROSTATIC DISCHARGE

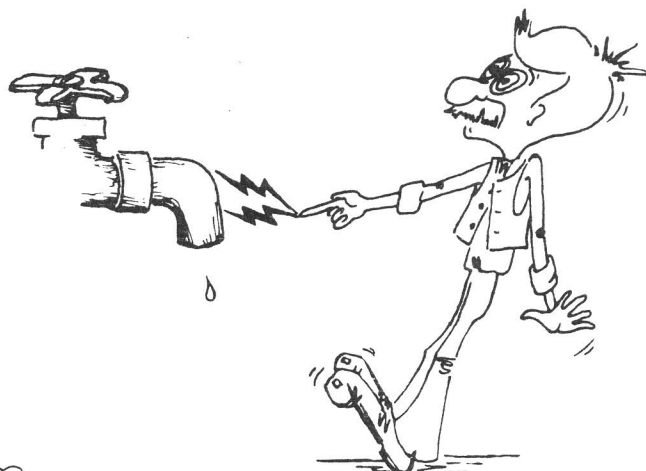
In this instrument there are MOSFET semiconductors, which can be damaged by electrostatic discharge during handling. The following precautionary procedures are recommended to minimize this possibility.



**HANDLE STATIC SENSITIVE DEVICES ONLY AT A GROUNDED, STATIC-FREE WORK STATION**



**BE SURE YOUR SOLDERING IRON TIP IS GROUNDED AND DO NOT USE SOLDER-SUCKERS THAT ARE NOT ANTI-STATIC PROTECTED**



**DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES**

**HANDLE DEVICES BY THE BODY. DO NOT TOUCH THE DEVICE LEADS.**



**USE ANTI-STATIC PACKAGING FOR HANDLING AND TRANSPORT**

**KEEP PARTS IN MANUFACTURER'S PROTECTED CONTAINERS**



**AVOID HANDLING WHENEVER POSSIBLE**

**DO NOT SLIDE STATIC SENSITIVE DEVICES OVER ANY SURFACE AND AVOID PLASTIC, VINYL AND STYROFOAM IN WORK AREAS**

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### WARNING

ELECTRICAL SHOCK HAZARD EXISTS WHEN BIAS SUPPLIES ARE CONNECTED TO THIS INSTRUMENT. WHEN EXTERNAL BIAS SUPPLIES ARE ATTACHED, THE BIAS VOLTAGES ARE PRESENT ON THE REAR PANEL BNC CONNECTORS. USE ONLY BIAS VOLTAGES UP TO +50VDC WITH EACH BIAS SUPPLY CURRENT LIMITED AT 100MA. DO NOT TOUCH, CONNECT, OR DISCONNECT THE MEASURED COMPONENT OR THE BNC CABLES WHILE BIAS VOLTAGES ARE APPLIED.

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## SECTION S

### SAFETY INFORMATION

#### S.1 INTRODUCTION

Read and follow the CAUTIONS and WARNINGS in this manual. They are designed to emphasize safety during all phases of operation and maintenance.

#### S.2 SAFETY TERMS AND MEANINGS:

CAUTION -- Statements that identify conditions or practices that could result in damage to the equipment or property.

WARNING -- Statements that identify conditions or practices that could result in personal injury or loss of life. In addition, damage to the equipment or other property may result.

DANGER -- Indicates a personal injury hazard is near the marking.

#### S.3 WARNINGS APPEARING IN THIS MANUAL:

##### **DANGER**

THE VIDEO CIRCUITRY CONTAINS DANGEROUSLY HIGH VOLTAGE. EXERCISE EXTREME CARE TO AVOID POSSIBLE ELECTRIC SHOCK WHICH MAY RESULT IN SEVERE INJURY OR DEATH.

##### **DANGER**

ALL PARTS OF THE POWER SUPPLY ASSEMBLY INCLUDING INPUT CIRCUIT COMMON ARE AT OR ABOVE POWER LINE VOLTAGE. THE ENERGY AVAILABLE AT ANY POINT ON THE ASSEMBLY MAY BE LIMITED ONLY BY THE INPUT FUSE. DO NOT ATTEMPT SERVICE OPERATIONS. FAILURE TO OBSERVE THIS WARNING MAY RESULT IN SEVERE INJURY OR DEATH.

**DANGER**

ELECTRICAL SHOCK HAZARD EXISTS WHEN A BIAS SUPPLY IS CONNECTED TO THIS INSTRUMENT. USER SUPPLIED BIAS VOLTAGE MAY BE PRESENT AT INSTRUMENT TERMINALS AND TEST FIXTURES. USE ONLY BIAS VOLTAGES UP TO +200VDC AND BIAS SUPPLIES CURRENT LIMITED AT 100mA. DO NOT TOUCH, CONNECT, OR DISCONNECT THE UNKNOWN COMPONENT OR BNC CABLES WHILE A BIAS VOLTAGE IS APPLIED. FAILURE TO OBSERVE THIS WARNING MAY RESULT IN SEVERE INJURY OR DEATH.

**WARNING**

ELECTRICAL SHOCK HAZARD EXISTS WHEN BIAS SUPPLIES ARE CONNECTED TO THIS INSTRUMENT. WHEN EXTERNAL BIAS SUPPLIES ARE ATTACHED, THE BIAS VOLTAGES ARE PRESENT ON THE REAR PANEL BNC CONNECTORS. USE ONLY BIAS VOLTAGES UP TO +50VDC WITH EACH BIAS SUPPLY CURRENT LIMITED AT 100mA. DO NOT TOUCH, CONNECT, OR DISCONNECT THE MEASURED COMPONENT OR THE BNC CABLES WHILE BIAS VOLTAGES ARE APPLIED.

**WARNING**

TO PREVENT POSSIBLE ELECTRICAL SHOCK OR DAMAGE TO THE INSTRUMENT, CHECK LOCAL ELECTRICAL STANDARDS BEFORE SELECTING A POWER CORD. THE INFORMATION PRESENTED HERE MAY NOT BE CORRECT FOR ALL LOCATIONS WITHIN THE REFERENCED AREAS.

**WARNING**

TO AVOID PERSONAL INJURY FROM ELECTRIC SHOCK DO NOT REMOVE INSTRUMENT COVERS OR PERFORM ANY MAINTENANCE OTHER THAN DESCRIBED IN THIS MANUAL. INSTALLATION AND MAINTENANCE PROCEDURES DESCRIBED IN THIS MANUAL ARE TO BE PERFORMED BY QUALIFIED SERVICE PERSONNEL ONLY.

**WARNING**

REMOVAL OF INSTRUMENT COVERS MAY CONSTITUTE AN ELECTRICAL HAZARD AND SHOULD BE ACCOMPLISHED BY QUALIFIED SERVICE PERSONNEL ONLY.

**WARNING**

TO AVOID ELECTRIC SHOCK FROM DANGEROUSLY HIGH VOLTAGES, USE THE FOLLOWING PROCEDURES ONLY WHEN TROUBLESHOOTING THE ANALOG AND DIGITAL CIRCUITS OF THIS INSTRUMENT. DO NOT USE THIS PROCEDURE TO TROUBLESHOOT THE POWER SUPPLY OR CRT CIRCUITRY.

**WARNING**

HANDLE THE CRT WITH CARE. ROUGH HANDLING OR SCRATCHING CAN CAUSE THE CRT TO IMplode. TO AVOID PERSONAL INJURY FROM IMPLOSION WEAR PROTECTIVE GOGGLES AND CLOTHING WHEN WORKING WITH THE CRT. ONLY WORK WITH THE CRT IF YOU ARE QUALIFIED TO DO SO.

**WARNING**

DISCONNECT ALL POWER TO THE INSTRUMENT BEFORE REPLACING COMPONENTS. FAILURE TO DO SO MAY RESULT IN ELECTRICAL SHOCK.

**WARNING**

THE CRT IS CAPABLE OF STORING A HIGH VOLTAGE CHARGE AFTER POWER HAS BEEN REMOVED. TO PREVENT PERSONAL INJURY FROM ELECTRIC SHOCK, USE AN OSHA OR UL APPROVED SHORTING STRAP TO DISCHARGE ALL HIGH VOLTAGE POINTS TO CHASSIS GROUND. THIS PROCEDURE MUST BE PERFORMED BY QUALIFIED PERSONNEL ONLY.

**WARNING**

TO AVOID ELECTRIC SHOCK FROM DANGEROUSLY HIGH VOLTAGES, USE ONLY INSULATED PLASTIC TRIM TOOLS TO PERFORM THE VIDEO ADJUSTMENTS DESCRIBED BELOW.

**CAUTION**

BECAUSE OF DIFFERING POWER REQUIREMENTS, INSTRUMENTS SHIPPED OUTSIDE THE UNITED STATES MAY REQUIRE A DIFFERENT POWER CORD CONNECTOR. WHEN PLACING A NEW CONNECTOR ON THE POWER CORD, CARE MUST BE TAKEN TO ASSURE ALL THREE WIRES (E,N,L) ARE CONNECTED PROPERLY. THE GREEN OR GREEN-WITH-YELLOW-STRIPED WIRE IS ALWAYS CONNECTED TO EARTH GROUND (E). THE WHITE OR LIGHT-BLUE WIRE IS CONNECTED TO THE NEUTRAL SIDE OF THE POWER LINE (N). THE BLACK OR BROWN WIRE IS CONNECTED TO THE HIGH SIDE OF THE POWER LINE (L). FIGURE 2-6 ILLUSTRATES THE AVAILABLE POWER CORD CONFIGURATIONS ACCORDING TO COUNTRY WHICH MAY BE USED IN VARIOUS COUNTRIES INCLUDING THE STANDARD POWER CORD FURNISHED WITH THE INSTRUMENT.

**CAUTION**

WHEN PERFORMING ANY CALIBRATION OR MAINTENANCE OPERATION, DO NOT REMOVE OR REPLACE CIRCUIT CARDS WHILE THE POWER IS TURNED ON. FAILURE TO TURN POWER OFF MAY RESULT IN ELECTRIC SHOCK OR DAMAGE TO THE INSTRUMENT.

**CAUTION**

AVOID THE USE OF CHEMICAL CLEANING AGENTS WHICH MIGHT DAMAGE THE PLASTICS USED IN THIS UNIT. DO NOT APPLY ANY SOLVENT CONTAINING KETONES, ESTERS, OR HALOGENATED HYDROCARBONS. TO CLEAN, USE ONLY WATER SOLUBLE DETERGENTS, ETHYL, METHYL, OR ISOPROPYL ALCOHOL.

**CAUTION**

THE BRIGHTNESS CONTROL LOCATED AT THE REAR OF THE INSTRUMENT CAN BE EASILY DISTURBED WHEN WRAPPING THE POWER CORD ON THE REAR FEET. VERIFY THE CORRECT SETTING OF THIS CONTROL BEFORE CONTINUING WITH ADDITIONAL ADJUSTMENTS.

**CAUTION**

DO NOT USE AN OHMMETER SCALE THAT HAS A HIGH INTERNAL CURRENT. HIGH CURRENTS MAY DAMAGE THE DIODES UNDER TEST.

**CAUTION**

IF THE INSTRUMENT IS PLACED WITHIN A STRONG MAGNETIC FIELD, THE VIDEO DISPLAY MAY BECOME PERMANENTLY DISTORTED. IF THIS CONDITION OCCURS, DEGAUSSING THE VIDEOBRIDGE CASE IS REQUIRED TO RETURN THE DISPLAY TO NORMAL OPERATION. THIS MUST BE DONE BEFORE CONTINUING WITH ADDITIONAL ADJUSTMENTS.

**CAUTION**

USE OF ANY OTHER TOOL THAN THE RECOMMENDED HEX HEAD PLASTIC TRIM TOOL MAY RESULT IN ELECTRICAL SHOCK OR DAMAGE TO THE TUNING SLUG.

**CAUTION**

DO NOT ATTEMPT TO LOAD OBJECT CODE TAPES USING 13 CODE. THE INSTRUMENT WILL BECOME "HUNG UP" AND MUST HAVE POWER SHUT OFF TO RESET. THIS CAN CAUSE LOSS OF DATA.

**CAUTION**

DO NOT USE NEGATIVE TEST CODES IF NOT LISTED. ILLEGAL ENTRIES MAY CAUSE INSTRUMENT MALFUNCTION ALONG WITH LOST OR ALTERED DATA. IF THE VIDEOBRIDGE BECOMES "HUNG UP", POWER MUST BE SHUT OFF TO RESET.



FORMATTING A TAPE DESTROYS ANY AND ALL DATA WHICH MAY HAVE BEEN PREVIOUSLY SAVED ON THE TAPE.



DO NOT ENTER TEST CODE 6 OR TEST CODE -6 WITHOUT ZRAM OPTION INSTALLED.

#### S.4 LOCATION OF WARNING LABELS APPEARING ON THE INSTRUMENT

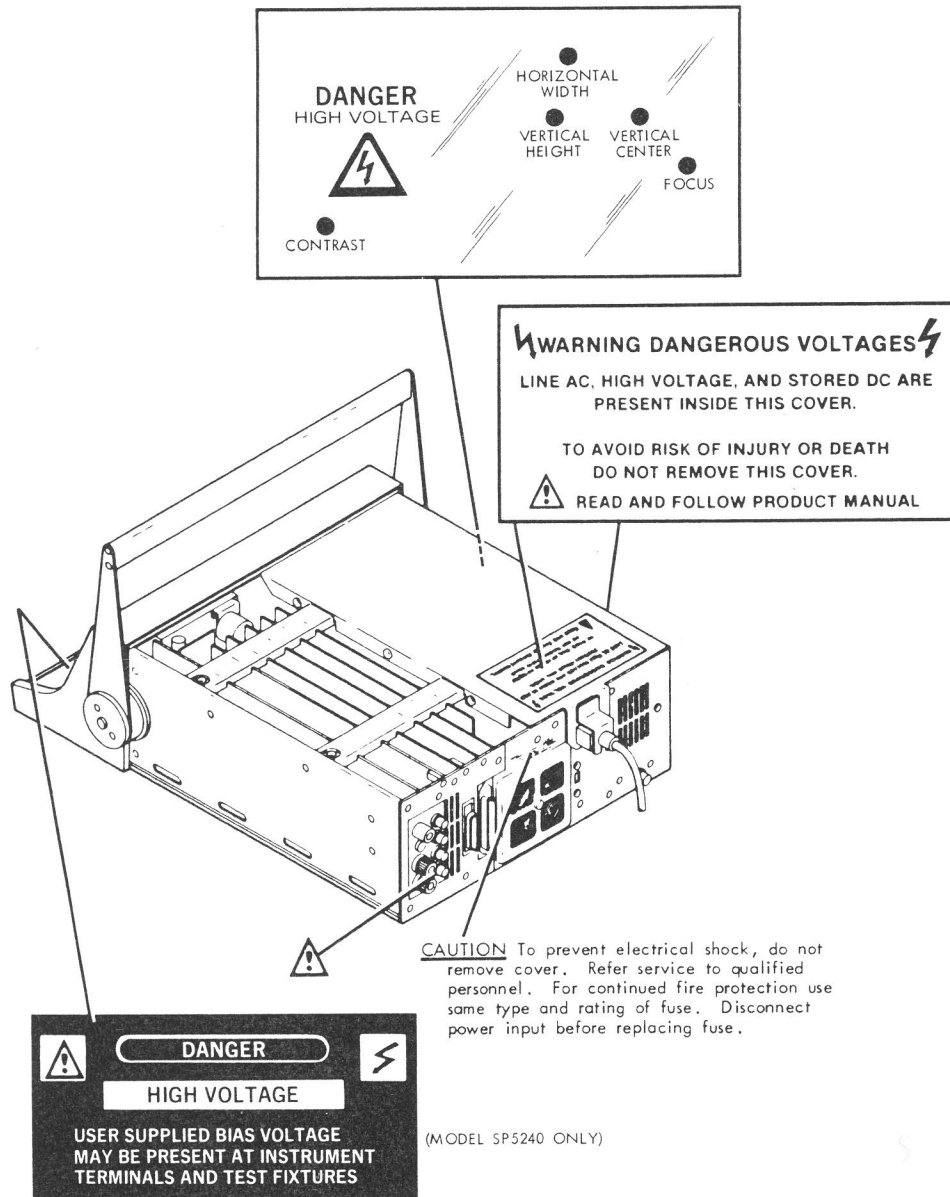


Figure S-1. Warning Label Locations

# SECTION 1

## DESCRIPTION

### 1.1 INTRODUCTION

ESI's Model 2150 and Model 2160 Auto LRC Meters are two extremely versatile impedance measuring instruments. They feature variable test frequencies up to 150kHz, programmable test-signal levels, component sorting, and CRT displays. They measure inductors (L), resistors (R), capacitors (C), and display up to 16 impedance characteristics.

The 2150/2160 LRC meter is basically composed of a frequency selectable sinewave generator, a test-level regulator, precision range resistors, a phase-sensitive voltmeter, and a charge balancing analog-to-digital converter. All measurements, calculations, and displays are under the control of the 2150/2160's Z80 microprocessor.

**NOTE:** Due to the extended frequency capabilities of the 2150/2160, measurements above 10kHz (1kHz for capacitors) are sensitive to the position of test connections. We strongly recommend that you familiarize yourself with the sections in this manual concerning Connections to the Unknown and Test Leads vs. Test Fixtures (Sections 2.3.3 and 2.3.4). We hope this will help you improve measurement reliability and utilize your VideoBridge more productively.

All functions, procedures, and specifications listed in this manual assume a minimum of 10 minutes warm-up time.

The 2150/2160 also offers a wide variety of test conditions:

- . Test frequencies -- from 20Hz to 150kHz, 3023 total.  
(Section 2.5.1)
- . Test signal levels -- from 5mV to 1500mV or from 0.1mA to 100mA. (Section 2.5.2)
- . Preset Measurement Parameters -- choose from 3 preset combinations of settling time, integration time, and number of measurements averaged. Programmed for FAST, MEDIUM, or SLOW operation, you can select these combinations or enter your own. (Section 2.8.1)
- . Settling times -- from 2ms to 1500ms (in 1ms steps).  
(Section 2.8.3)
- . Integration times -- from 2ms to 600ms. (Section 2.8.2)
- . Measurement averages -- select from 1 to 20 measurements to be averaged. (Section 2.8.4)

Special measurement features built into the instruments include:

- . Zero calibration -- The 2150/2160 performs zero calibration to measure and correct offsets for different settings of the test conditions mentioned above. The offset corrections for as many as four combinations of these settings are stored in memory. Each offset correction is recalled whenever the corresponding combination of settings is re-entered. This saves you the time of re-calibrating. (Section 2.3.5)



- . Display test level -- to the unknown. The actual test level supplied may vary from the programmed value because of mismatches that might occur when attempting to use constant voltage on a low impedance device or constant current on a high impedance device. (Section 2.5.2)

Sorting operations offer unique features both in ease of operation and diagnosing setup problems. These include:

- . Deviation -- from a nominal value is displayed in either absolute or percentage terms. (Section 2.6)
- . Component sorting -- characterizes components into 11 tolerance categories, a major reject, or a minor reject while counting the number of components that fall into each category. (Section 2.7)
- . PASS/FAIL test -- indicators are displayed on the CRT for hand operated GO/NO-GO testing. (Section 2.7)

Mass storage for test parameter setups and measurement results is the feature that sets the Model 2160 apart from the Model 2150. The 2160 has a cassette tape deck that uses mini-cassette tapes for storing and reloading test parameter programs along with STAT and ANALOG applications programs. Cassette features include:

- . Directory -- of all files on a tape
- . Alphanumeric -- character entry for file names
- . Autostart -- feature loads and executes a file automatically when instrument power is applied.

(For more information, refer to Section 2.9 Cassette Tape Loader.)

Communication interfacing -- the transfer of meaningful information between instrument and operator is the reason for the cathode-ray tube (CRT) display. The 5-inch CRT provides different measurement information utilizing two display formats:

- 1 -- In the direct display format, the CRT provides large easy-to-read alphanumeric characters to highlight up to 6 digits of measurement information, and small alphanumeric characters to display the settings for frequency, nominal value, measurement mode, test signal level, settling time, integration time, and number of measurements averaged.
- 2 -- In the status display format, the instrument simultaneously displays + and - limits for all component tolerance bins, and their component counters capable of up to 65535 counts for each bin.

**NOTE:** In the direct display format, some measurement values may contain half-sized zeroes. These appear to the right of the last significant digit due to factors affecting resolution. For example, when a D factor of .00012 is displayed in parts per million, it becomes 120 ppm-D).

One to six digits of measurement information can be displayed on the CRT. The number of digits displayed is related to the resolution contained in the A/D conversion process. More commonly, the number of digits displayed depends upon selectable factors such as measurement speed, test frequency, and impedance range. Of these, measurement speed has the greatest effect on number of digits displayed: more digits require more time.

A special test mode (27 CODE) allows display of more digits at faster speeds if desired. However, these expanded readings may not improve true measurement resolution due to actual signal-to-noise ratios.

The Model 2150/2160 offers maximum flexibility with a wide range of options. Many options are field installable and are designed to tailor instrument operation to specific testing requirements. They operate as stand-alone benchtop testers or can be used with auxiliary handling equipment to fit easily into sophisticated automatic testing systems.

**NOTE:** The RS-232C Interface capability comes standard on the Model 2160 VideoBridge and is located on the same board as the cassette control circuitry. Since the Model 2150 VideoBridge has no cassette control circuit, the RS-232C Interface is available as a field installable option kit, P/N 46724.

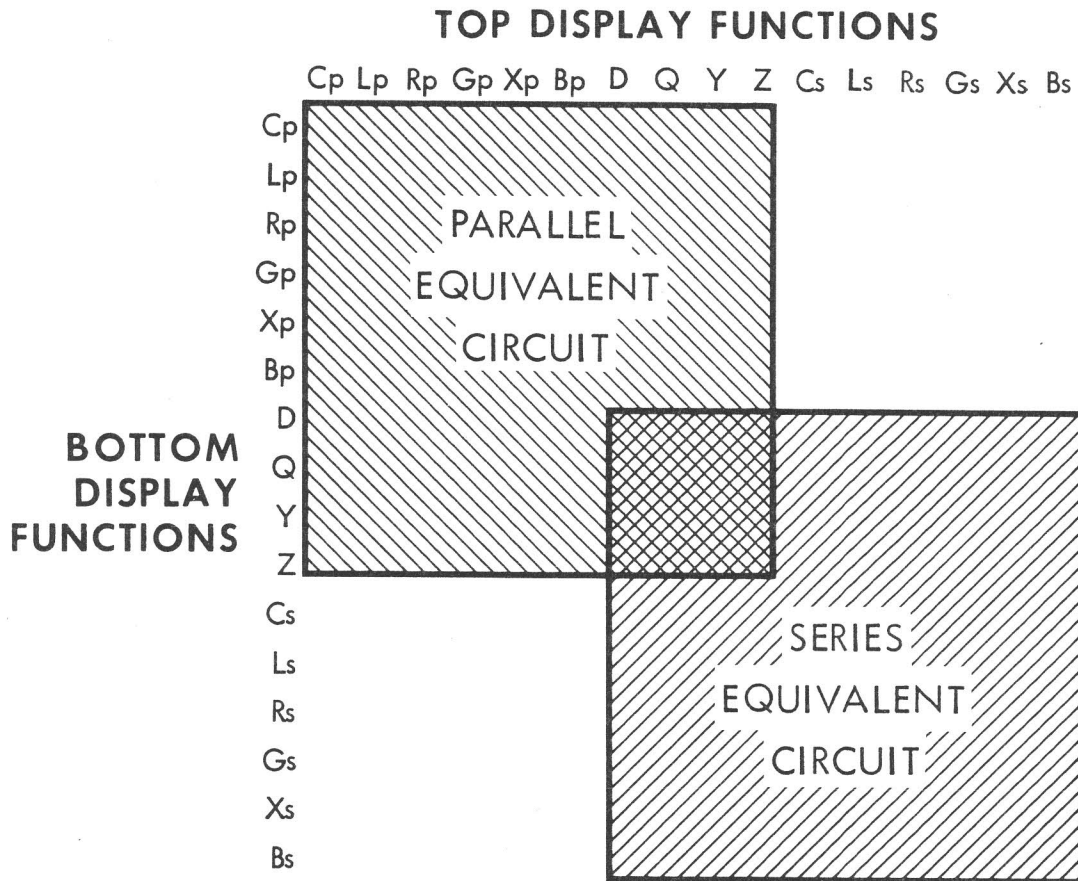
RS-232C Interface circuit operation is the same for each model, however and is described in Section A.2.

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## 1.2 SPECIFICATIONS

### 1.2.1 Electrical Specifications

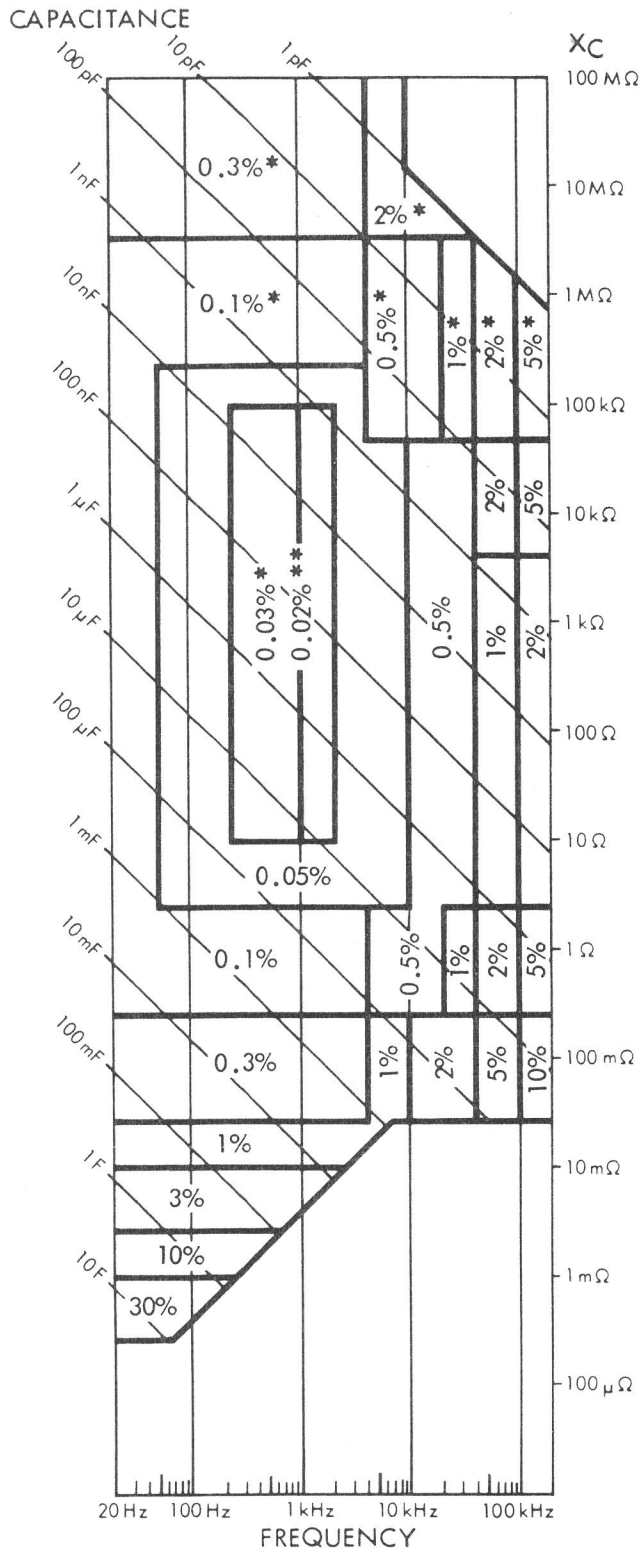
Measurement Functions:



**NOTE:** Any top display can be displayed with any bottom display within the shaded areas.

Display Characteristics: 5-inch CRT, direct and status formats, interchangeable positioning of major and minor functions, 2 sizes of alphanumeric characters.

Table 1-1. Capacitance Measurement Accuracy



$$* + \left( \frac{0.01 \text{ pF}}{f(\text{kHz})} + 0.01 \text{ pF} \right)$$

\*\*0.02% at 1 kHz from Approximately 1 nF to 10 μF

If  $D > 1$ , add  $\left[ 0.05\% (1 + 0.3D^2) \right]$  to accuracies shown

TEST CONDITIONS:

Level -1000 mV/100 mA  
 Speed -Medium †  
 Range -Auto  
 Bias -Off  
 Zero -Calibrated  
 Connections -Fully Shielded ††

$V_{\text{test}} = 800 \text{ mV to } 1500 \text{ mV}$   
 $I_{\text{test}} = 50 \text{ mA to } 100 \text{ mA}$

For  $V_{\text{test}} < 800 \text{ mV}$  Multiply Basic Accuracy  
 by  $\left( 1 + \frac{300}{\text{mV}} \right) \left( 1 + \frac{\text{kHz}}{10} \right)$

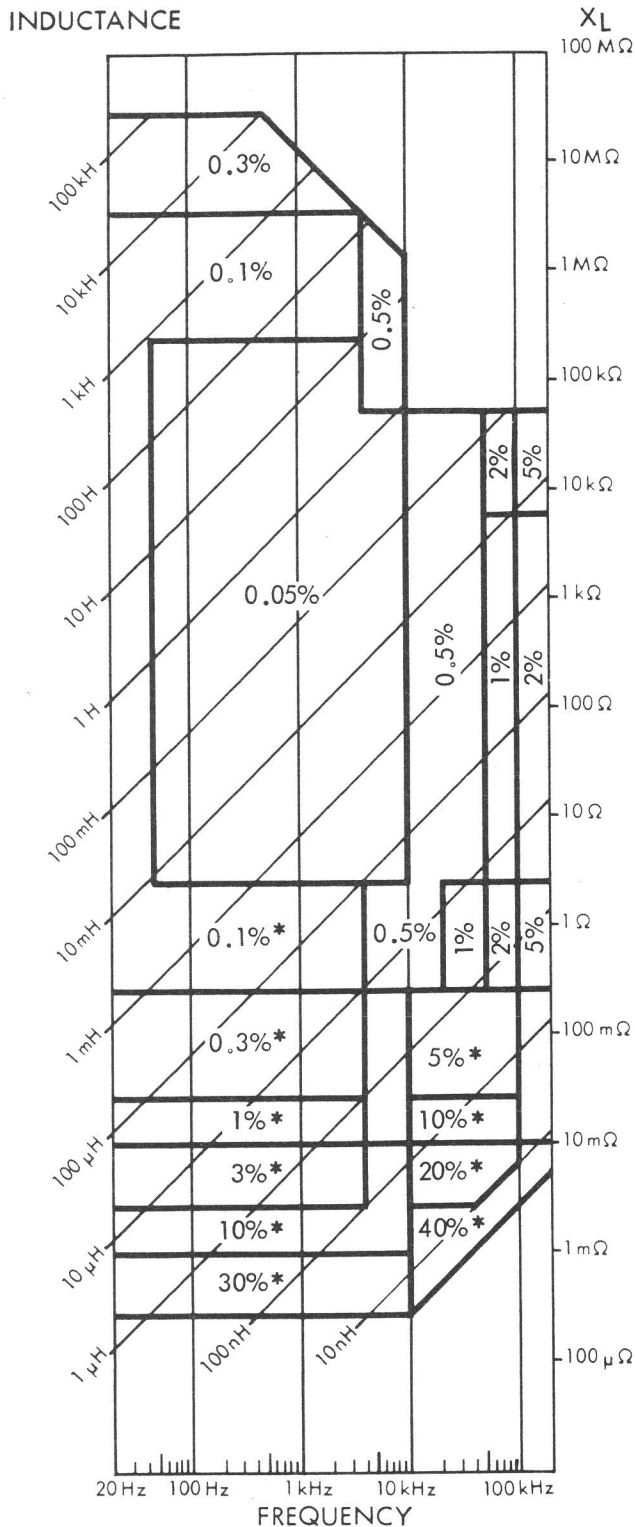
For  $I_{\text{test}} < 50 \text{ mA}$  ( $Z > 16 \Omega$ )  
 Multiply Basic Accuracy by  $\left( 1 + \frac{300}{\text{mA} \times Z(\Omega)} \right)$

For  $I_{\text{test}} < 50 \text{ mA}$  ( $Z \leq 16 \Omega$ )  
 Multiply Basic Accuracy by  $\left( 1 + \frac{30}{\text{mA}} \right)$

† Accuracy specification applies to Medium and Slow Speed. If Fast Speed, add 0.05% to accuracies shown.

†† Properly shielded test leads and connections to the unknown are required to achieve specified accuracy.

**Table 1-2. Inductance Measurement Accuracy**



$$* + \left( \frac{0.01 \mu\text{H}}{f(\text{kHz})} + 0.01 \mu\text{H} \right)$$

If  $D > 1$ , add  $[0.1\% (1 + 0.3D^2)]$   
to accuracies shown

**TEST CONDITIONS:**

Level -1000mV/100mA  
Speed -Medium†  
Range -Auto  
Bias -Off  
Zero -Calibrated  
Connections -Fully Shielded††

$$V_{\text{test}} = 800\text{mV to } 1500\text{mV}$$

$$I_{\text{test}} = 50\text{mA to } 100\text{mA}$$

For  $V_{\text{test}} < 800\text{mV}$  Multiply Basic Accuracy

$$\text{by } \left( 1 + \frac{300}{\text{mV}} \right) \left( 1 + \frac{\text{kHz}}{10} \right)$$

For  $I_{\text{test}} < 50\text{mA}$  ( $Z > 16\Omega$ )

$$\text{Multiply Basic Accuracy by } \left( 1 + \frac{300}{\text{mA} \times Z(\Omega)} \right)$$

For  $I_{\text{test}} < 50\text{mA}$  ( $Z \leq 16\Omega$ )

$$\text{Multiply Basic Accuracy by } \left( 1 + \frac{30}{\text{mA}} \right)$$

† Accuracy specification applies to Medium and Slow Speed. If Fast Speed, add 0.05% to accuracies shown.

†† Properly shielded test leads and connections to the unknown are required to achieve specified accuracy.





LEVEL

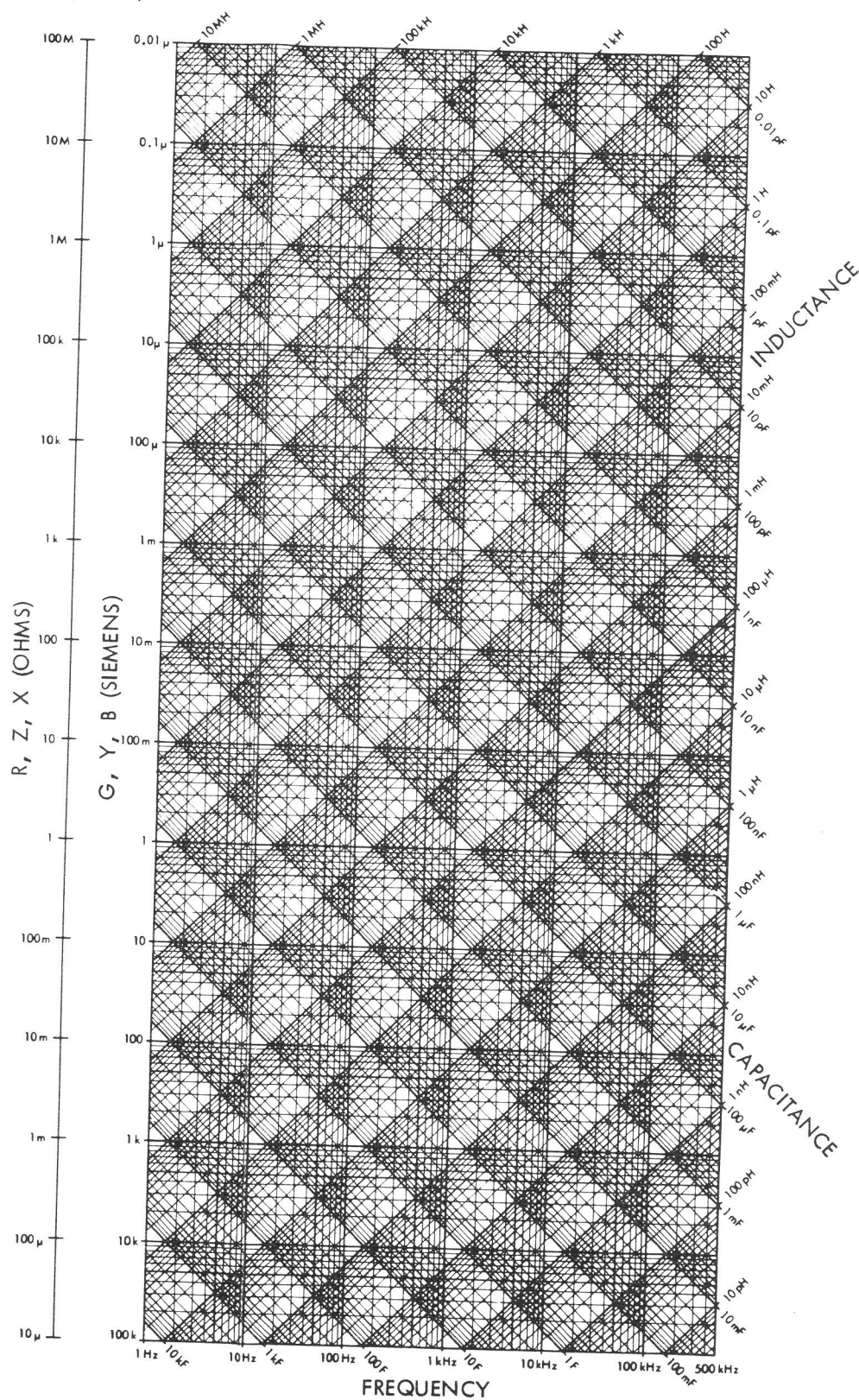
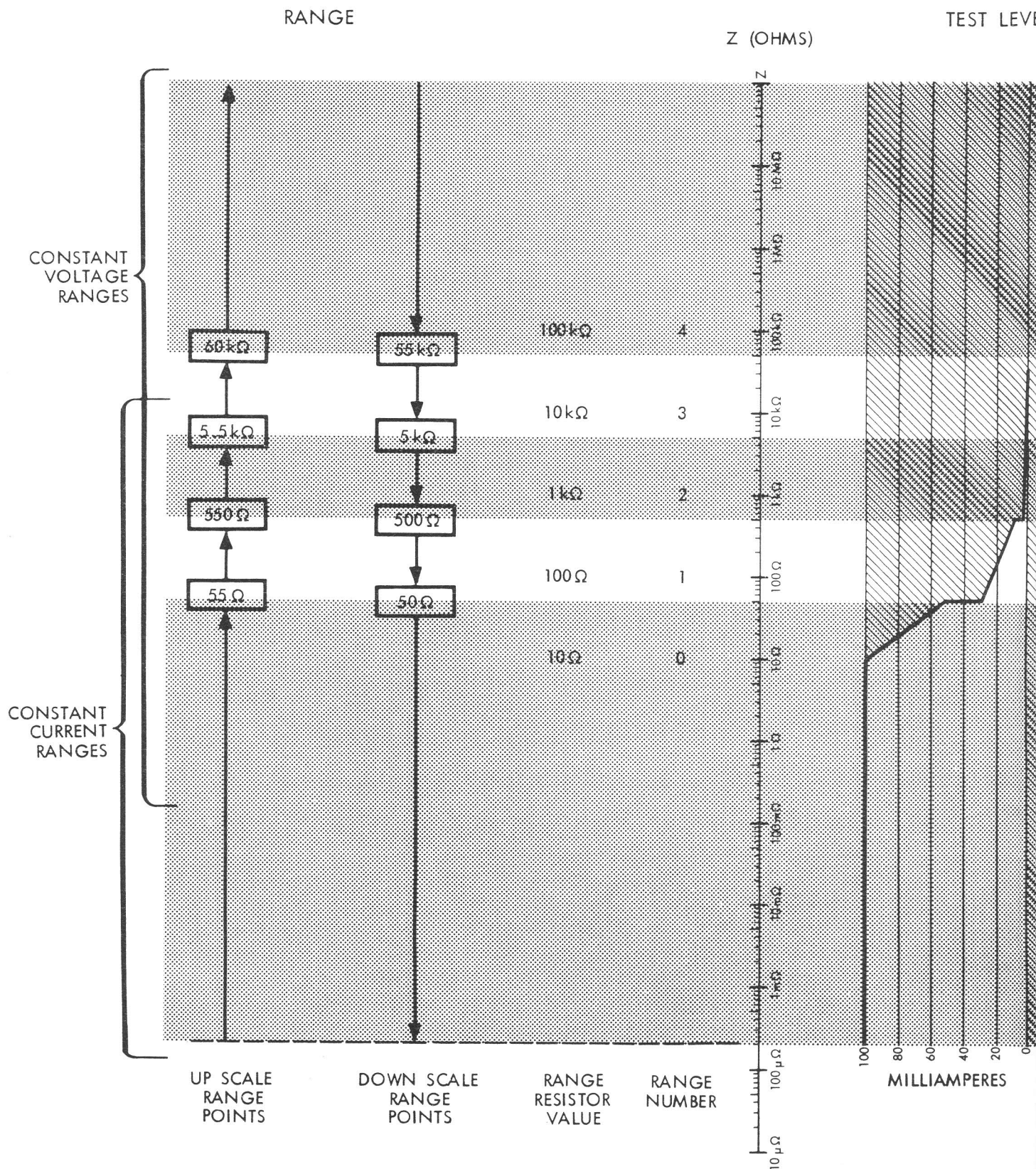


Table 1-4. Impedance Ranges vs.



### BASIC D ACCURACY

Capacitance (Medium, Slow speed):  $\pm 0.00025(1+D^2)*$

Inductance (Medium, Slow speed):  $\pm 0.00035(1+D^2)*$

Capacitance (Fast speed):  $\pm 0.0005(1+D^2)*$

Inductance (Fast speed):  $\pm 0.0005(1+D^2)*$

### BASIC Q ACCURACY

All Components (Medium, Slow speed):  $\pm 0.035 \left[ Q + \left( \frac{1}{Q} \right) \right] \%$

All Components (Fast speed):  $\pm 0.05 \left[ Q + \left( \frac{1}{Q} \right) \right] \%$

---

#### \*Correction Factors

For HI Z ( $Z \geq 10M\Omega$ ) add  $0.0005 \left( \frac{Z \text{ (in } M\Omega)}{10M\Omega} \right)$  to basic D or Q accuracy

For LO Z ( $Z \leq 1\Omega$ ) add  $0.0005 \left( \frac{1\Omega}{Z \text{ (in } \Omega)} \right)$  to basic D or Q accuracy

For Frequencies  $< 200\text{Hz}$  multiply basic D or Q accuracy

$$\text{by } \left( 1 + \frac{60}{F_{\text{test}} \text{ in Hz}} \right)$$

For Frequencies  $> 1000\text{Hz}$  and  $\leq 10\text{kHz}$  multiply basic D or Q accuracy

$$\text{by } \left( 1 + \frac{F_{\text{test}} \text{ in Hz}}{3000} \right)$$

For Frequencies  $> 10\text{kHz}$  multiply basic D or Q accuracy

$$\text{by } \left( 1 + \frac{F_{\text{test}} \text{ in kHz}}{3} \right) \left( 1 + \frac{Z \text{ in k}\Omega}{100\text{k}\Omega} \right)$$

For  $V_{\text{test}} < 800\text{mV}$  multiply basic D or Q accuracy

$$\text{by } \left( 1 + \frac{300}{V_{\text{test}} \text{ (in mV)}} \right)$$

For  $I_{\text{test}} \leq 100\text{mA}$  multiply basic D or Q accuracy

$$\text{by } \left( 1 + \frac{300}{I_{\text{test}} \text{ (in mA)} \times Z \text{ (in } \Omega)} \right)$$

### 100kHz D ACCURACY

Capacitance; Ranges 0-2 ( $\geq 319\text{pF}$ ); Medium, Slow speed:  
 $\pm 0.003(1+D^2)$

Capacitance; Ranges 0-2 ( $\geq 319\text{pF}$ ); Fast speed:  
 $\pm 0.005(1+D^2)$

Capacitance; Range 3 ( $< 319\text{pF}$ ); Medium, Slow speed:  
 $\pm 0.008(1+D^2)*$

Capacitance; Range 3 ( $< 319\text{pF}$ ); Fast speed:  
 $\pm 0.01(1+D^2)*$

### 100kHz ESR ACCURACY

ESR accuracy (at 100kHz) = [D accuracy (at 100kHz)  $\times X_{s_{\text{unk}}}$ ] +  $1.0\text{m}\Omega$

---

### \* 100kHz D Correction Factor

If  $C_{\text{unk}} < 30\text{pF}$ , multiply 100kHz accuracy by  $1 + \frac{30\text{pF}}{C_{\text{unk}}}$

## TEST SIGNALS

Frequency:

3023 programmable steps between 20Hz and 150kHz.

$f = 60\text{kHz}/N_1$  Where:  $N_1$  is an integer  $1 \leq N_1 \leq 3000$

OR

$f = 300\text{kHz}/N_2$  Where:  $N_2$  is an integer  $2 \leq N_2 < 30$

Accuracy:

+/- 0.01%

Level Set

Voltage Level:

5mV to 1500mV RMS in 1mV steps

Accuracy:

+/- (4% of set value + 2mV)

Current Level:

0.1mA to 100mA RMS in 0.1mA steps

Accuracy:

+/- [4% of set value + (2/R)mA]  
where R = value of the range resistor (in ohms) for range of measured part ( $10 \leq R \leq 10,000$ ).

## EXTERNAL VOLTAGE BIAS

Voltage:

+50VDC maximum (+200V optional)

Fuse:

0.5A, 250V, 3AG Fast Blow

## LOADS TO GUARD

Total load impedance (Z) to the guard point must be greater than or equal to the impedance of the device under test.

## INPUT PROTECTION

The 2150/2160 input terminals have a circuit which prevents damage to the instrument if a charged capacitor is connected to these terminals. Protection limits can be calculated from the equation:

$$V_{MAX} = \sqrt{\frac{2}{C}} \quad C_{MAX} = \frac{2}{V^2}$$

Where      V = capacitor voltage in volts  
            C = capacitor value in farads

The protection circuit allows a maximum energy of 1 joule up to a maximum voltage of 1kV. Table 1-5 below gives examples of maximum voltages for various capacitance values.

**Table 1-5. Input Protection Limits**

1kV	0 to 2uF
315V	20uF
100V	200uF
31V	2mF
10V	20mF
3V	200mF
1V	2F

When limits are exceeded (above 100V), the fuse on the rear panel will burn out and must be replaced with a 0.5A 3AG Fast Blow fuse. TO PREVENT POSSIBLE DAMAGE TO THE INSTRUMENT, USE ONLY THE PROPER REPLACEMENT FUSE.



## MEASUREMENT SPEED

**NOTE:** To determine overall Measurement Speed, test conditions must be specified (e.g. test frequency, test signal level, value of component, etc.). Display mode, measurement mode and external devices also affect measurement speed. For a detailed description on calculating measurement speed, see Section 2.8.

**NOTE:** Three preset combinations of Integration Time, Settling Time, and Measurement Averages are available. The FAST, MEDIUM, and SLOW keys provide quick, convenient selection of these combinations. Approximate speeds for these combinations under some typical modes of operation are listed.

**NOTE:** The following speeds are for the following test conditions: test frequency -- 1kHz, test signal level -- 1000mV, value of component-under-test -- 1nF, measurement mode -- Continuous (except where noted) ranging status -- RANGE HOLD.

	SETL	I.T.	AVG
Fast	5ms	10ms	1
Medium	50ms	50ms	1
Slow	50ms	50ms	10

	DIRECT	SORT and GO/NO-GO	HANDLER*
FAST	~4 measurements/second	~11 measurements/second	~6/second ~9/second**
MEDIUM	~2 measurements/second	~2 measurements/second	~2 measurements/second
SLOW	~5 seconds/measurement	~5 seconds/measurement	~5 seconds/measurement

\*Single mode only, 8 CODE enabled

\*\*2ms SETL, 2ms I.T., frequency  $\geq 500$  Hz

**NOTE:** For remote GPIB measurements, add 350ms per measurement for FAST and SLOW, 400ms for MEDIUM.

### 1.2.2 Environmental Specifications

#### HUMIDITY

Operating:	20% to 80% Relative
Storage:	0% to 90% Non-Condensing

#### TEMPERATURE

Operating:	10°C to 45°C (50°F to 113°F)
Storage:	-40°C to 71.1°C (-40°F to 160°F)

### 1.2.3 General Specifications

#### POWER REQUIREMENTS

Line power:	90-132VAC (115 nominal) 48/66Hz 180-250VAC (230 nominal) 48/66Hz
Powerline Fuse:	2A, 250V Slow Blow (3AG) for 115VAC 1.6A, 250V Slow Blow (5 x 20mm) for 230VAC
Power Consumption:	100W maximum

#### DIMENSIONS

Height:	144mm (5.7 in.) with feet
Width:	384mm (15.1 in.) with handle
Length:	559mm (22 in.) with handle
Weight:	14.5kg (32 lb)



#### 1.2.4 Cassette Specifications (2160 Only)

Tape Cassette Type: Braemar Computer Devices Type  
CMC-50 (50ft long)

File Storage Information: All displayed measurement  
parameters, binning limits,  
and bin counter information;  
also, test conditions, alpha-  
numeric file names, and nom-  
inal values

Storage Capacity: 2 sides per tape, each side  
with the following  
specifications:

80 blocks per 50 foot side

256 bytes per block

6 blocks per file (mimimum)

13 file entries per side (this  
is a maximum number and may be  
decreased by large files)

### 1.3 OPTIONS AND ACCESSORIES

#### 1.3.1 Accessories (must be ordered separately unless indicated)

	<u>ESI Part No.</u>
Model 2001 Sorting Fixture, 4-terminal (requires 4 five-foot BNC-to-BNC cables)	32001
Model 2003 Sorting Fixture, 4-terminal (requires 4 five-foot BNC-to-BNC cables)	32003
Model 2004 Zero Insertion Force Sorting Fixture, 4-Terminal (requires 4 five-foot BNC-to-BNC cables)	32004
Model 2005 Chip Tweezers, 4-Terminal (for chip components)	32005
BNC-to-BNC Cable Assembly (five foot length, set of 4)	53155
BNC to KELVIN KLIPS® cable assembly (shipped with all Model 2150's and 2160's)	47454
Alpha Character Keyboard Overlay (shipped with all Model 2160's)	55413
Statistics Application Software Kit (available for 2160 only)	55104
Analog Application Software Kit (available for 2160 only)	55103
Cassette Tape, blank and formatted (2160 only)	55852

### 1.3.2 Options (factory installed only)

	<u>ESI Part No.</u>
Non-Volatile Memory ZRAM	55843
+200V DC Bias capability	SP5240

**NOTE:** Contact your ESI sales representative for details on upgrading instruments purchased without factory options.

### 1.3.3 Options (field installable)

	<u>ESI Part No.</u>
General Purpose Interface Bus (IEEE-488)	46725
RS-232C Interface (2150 only)	46724
Handler Interface Options*	
1. "General" -- For interfacing to Engineered Automation, Q Corporation, Ismeca, Systemation, Heller, and other handlers	47895
2. "Daymarc" -- For interfacing to Daymarc Type 147 and 149 handlers	47896
3. "MCT Browne" -- For interfacing to MCT Browne handlers	47897

**NOTE:** Model 2160 can take only one of the following field installable options: GPIB or Handler Interface. Model 2150 can take only two of the following options: RS-232C, GPIB or Handler Interface.

\*Consult factory for interface to other handlers