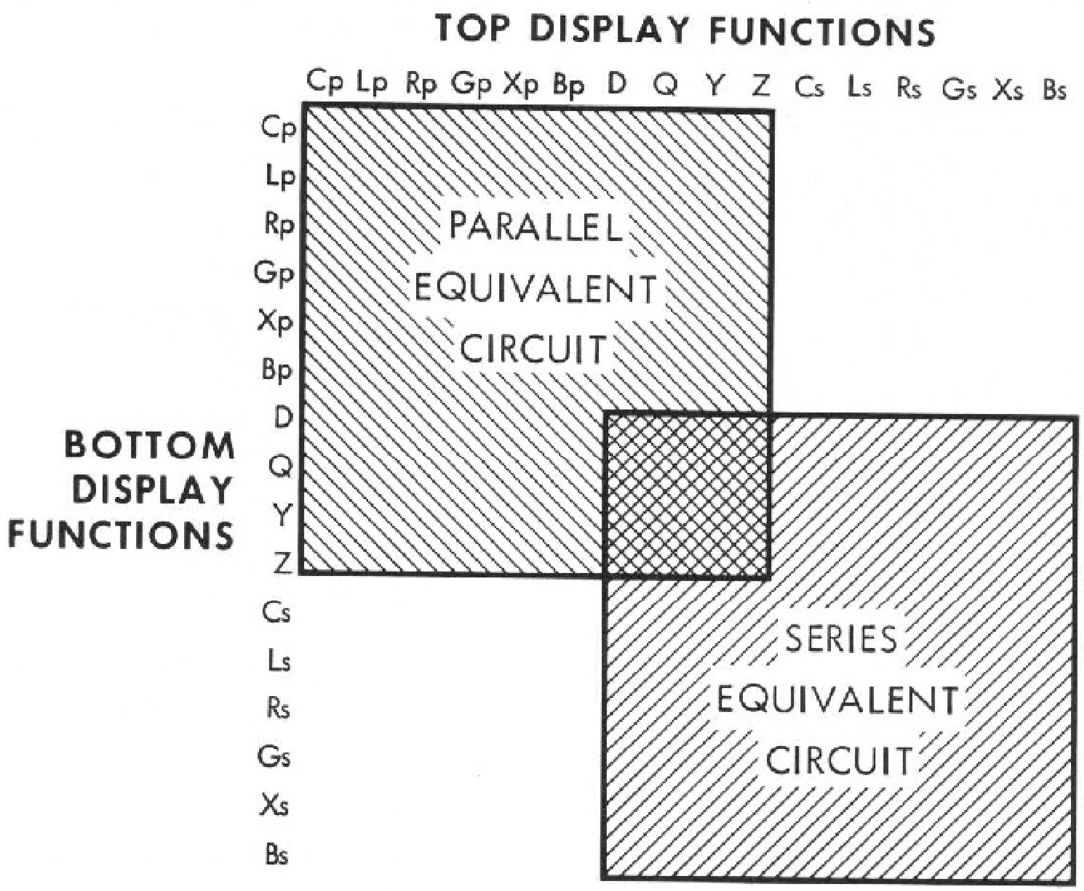
1.2 SPECIFICATIONS

1.2.1 Electrical Specifications

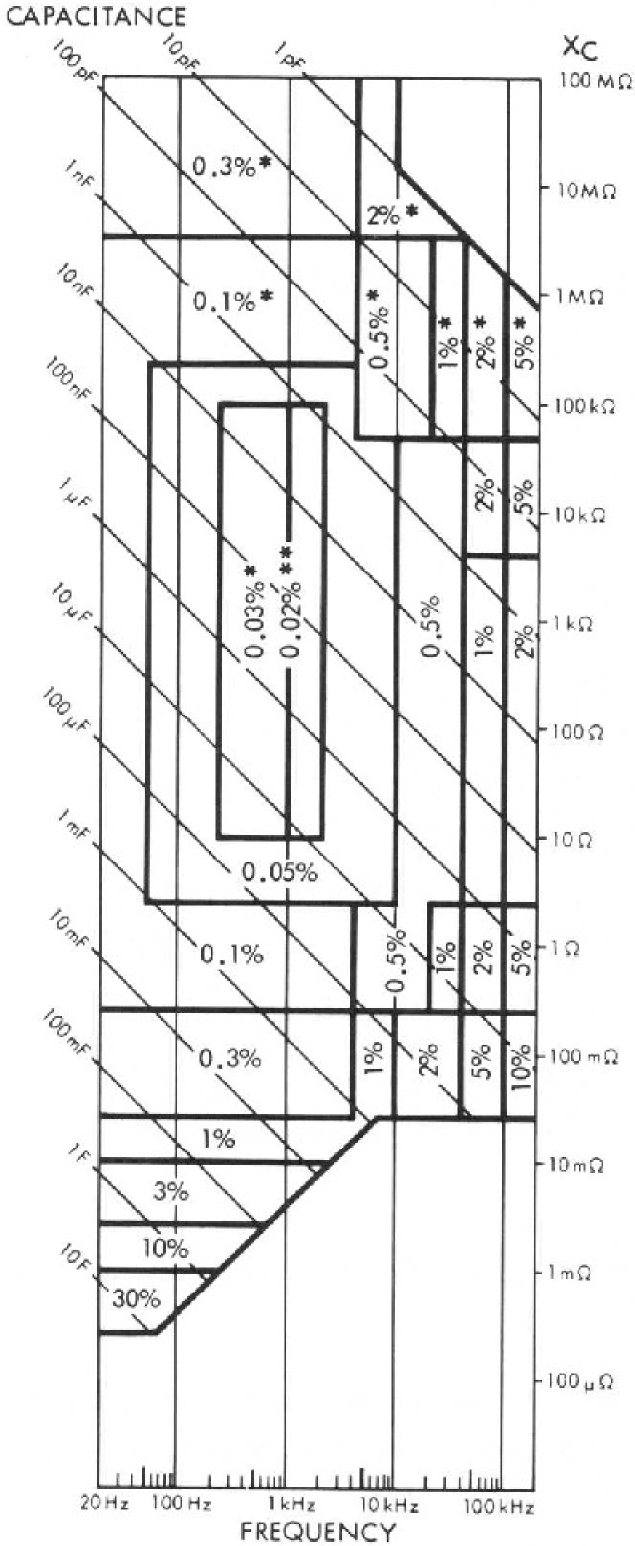
Measurement Functions:



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 1kHz from Approximately 1nF to 10µF

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

TEST CONDITIONS:

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

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

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

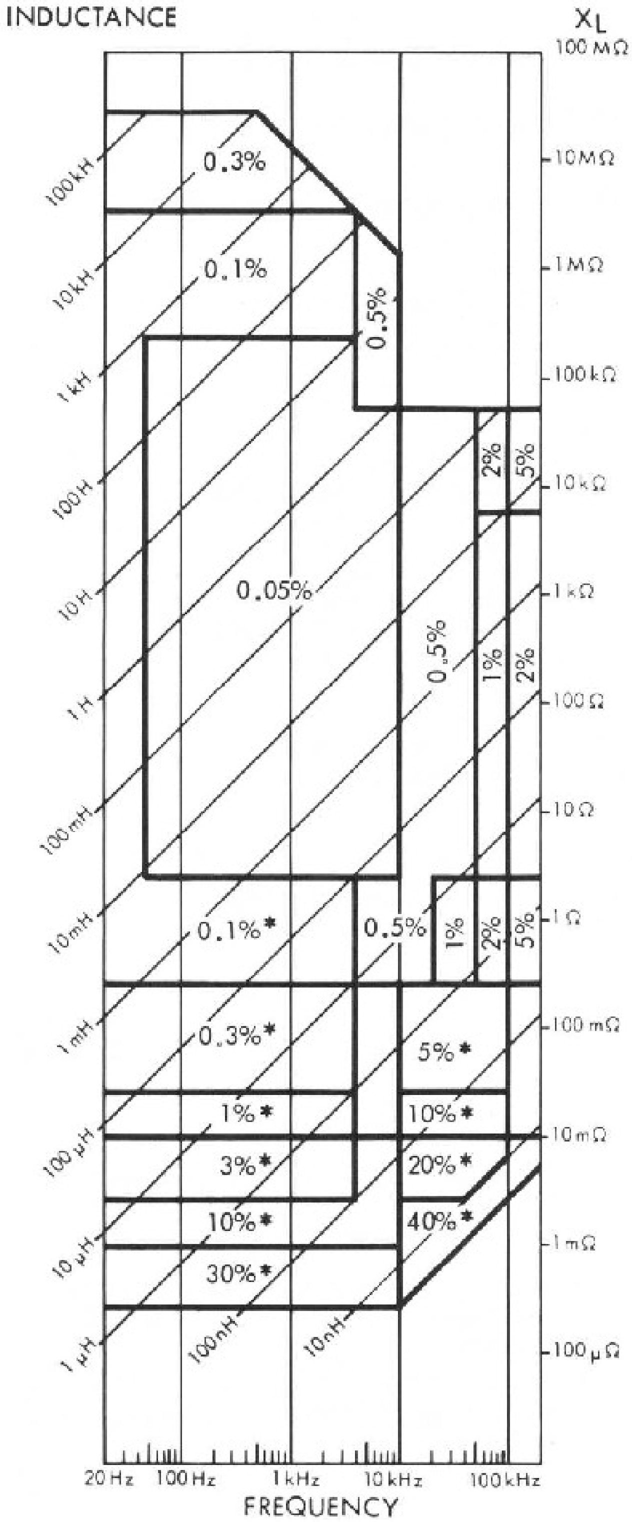
For I_{test} <50mA ($Z > 16\Omega$)
Multiply Basic Accuracy by $\left(1 + \frac{300}{\text{mA} \times Z(\Omega)}\right)$

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



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

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

TEST CONDITIONS:

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

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

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

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

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

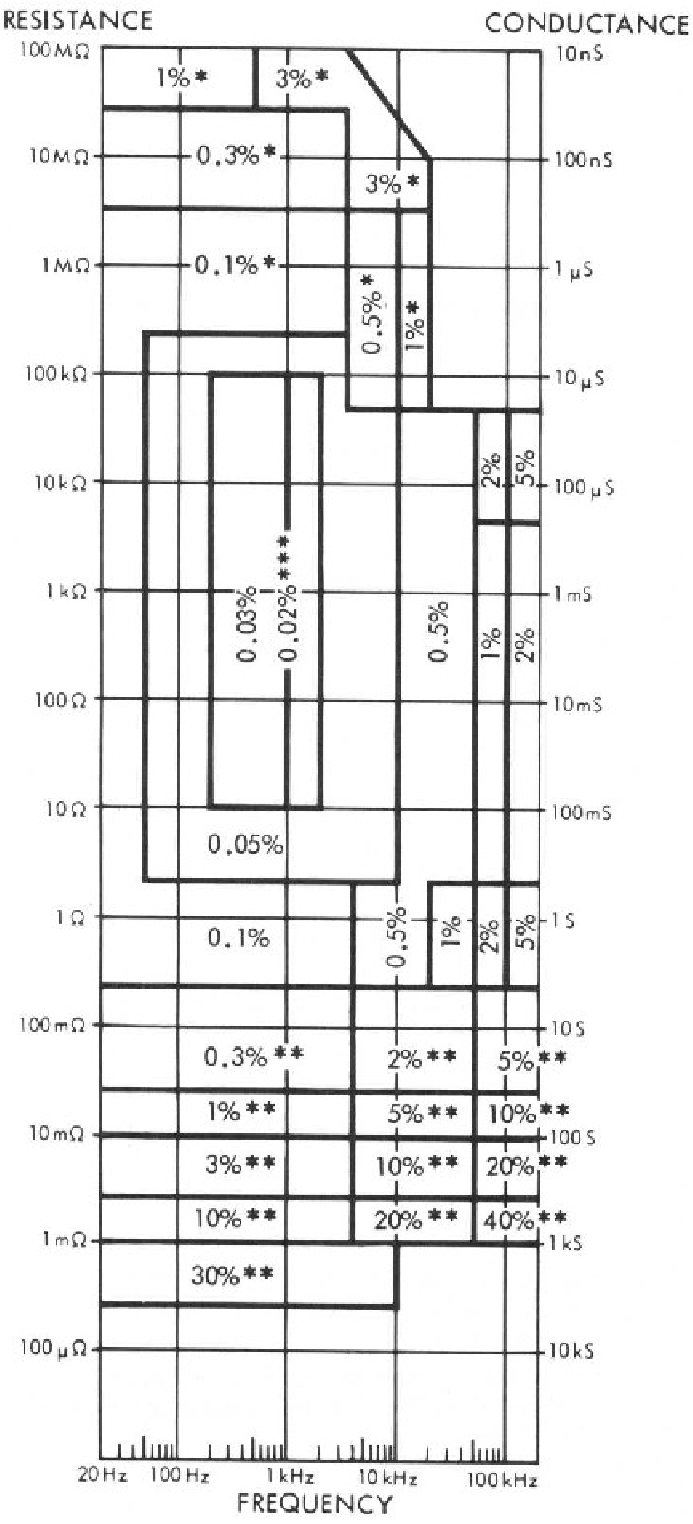
For I_{test} <50mA ($Z \leq 16\Omega$)

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

† 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 1-3. Resistance/Conductance Measurement Accuracy



* $+\left[0.1\,nS \times f(kHz) + 0.5\,nS\right]$

** $+\left[0.01\,m\Omega \times f(kHz) + 0.1\,m\Omega\right]$

*** 0.02% at 1 kHz for 10 Ω to 100 kΩ

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

TEST CONDITIONS:

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

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

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

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

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

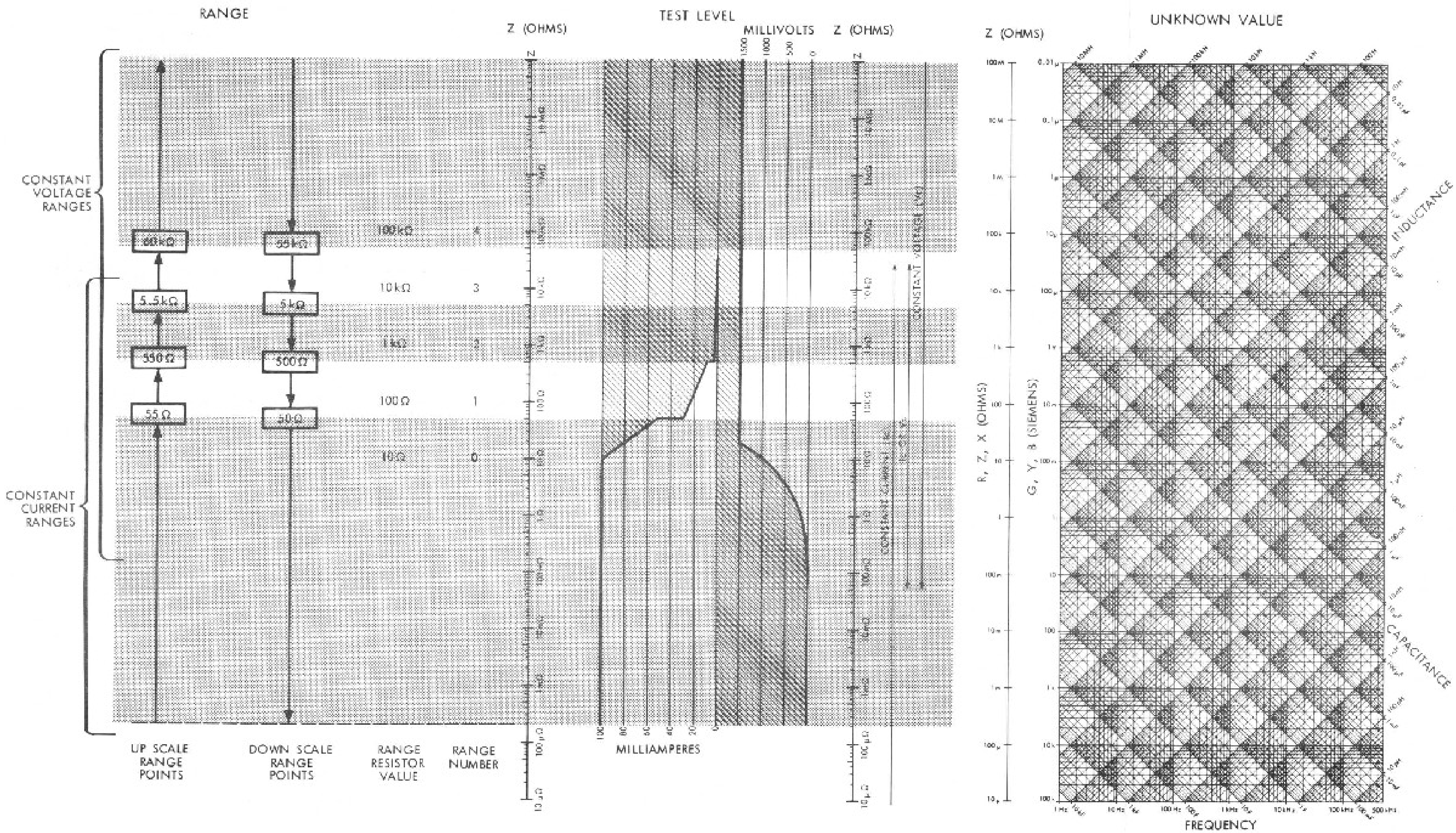
For I_{test} <50 mA ($Z \leq 16\Omega$)

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

† 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 1-4. Impedance Ranges vs. Test Signal Level (typical at 1kHz)



BASIC D ACCURACY

Capacitance (Medium, Slow speed): $+/- 0.00025(1+D^2)$*
Inductance (Medium, Slow speed): $+/- 0.00035(1+D^2)$*

Capacitance (Fast speed): $+/- 0.0005(1+D^2)$*
Inductance (Fast speed): $+/- 0.0005(1+D^2)$*

BASIC Q ACCURACY

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

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

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*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 < 200Hz multiply basic D or Q accuracy

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

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

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

For Frequencies > 10kHz multiply basic D or Q accuracy

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

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

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

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

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

100kHZ D ACCURACY

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

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

Capacitance; Range 3 (< 319pF); Medium, Slow speed:
$+/- 0.008(1+D^2)$*

Capacitance; Range 3 (< 319pF); Fast speed:
$+/- 0.01(1+D^2)$*

100kHZ ESR ACCURACY

ESR accuracy (at 100kHz) = [D accuracy (at 100kHz) x Xs_{unk}] + 1.0mΩ

* 100kHz D Correction Factor

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

TEST SIGNALS

Frequency: 3023 programmable steps between 20Hz and 150kHz.

$f = 60kHz/N_1$ Where: N_1 is an integer $1 \le N_1 \le 3000$

OR

$f = 300kHz/N_2$ Where: N_2 is an integer $2 \le N_2 < 30$

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 ($10 \le R \le 10,000$).

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:

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

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 ≥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 nominal 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 (minimum)
	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)

	ESI Part No.
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 49839
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)

	ESI Part No.
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)

	ESI Part No.
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