Precision Impedance Analyzers
6500 Series

Product Specification

Issue B

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1 SPECIFICATION

Wayne Kerr Electronics Limited reserves the right to change specification without notice.

1.1 Measurement Parameters

Any of the following parameters can be measured and displayed.

1.2 AC Functions

Capacitance (C), Inductance (L), Resistance (R), Reactance (X), Conductance (G), Susceptance (B), Dissipation Factor (D), Quality Factor (Q), Impedance (Z), Admittance (Y) and Phase Angle (θ).

1.2.1 Equivalent Circuit

Series or Parallel.

1.3 Test Conditions

1.3.1 Frequency Range

6520A

1kHz to 15MHz *

6530A

1kHz to 50MHz *

6540A

1kHz to 120MHz *

*** Accuracy of set frequency ±0.005%**

Frequency step 0.1mHz

1.3.2 AC Drive

Drive Level (AC Measurements)

Open Circuit Voltage	Short Circuit Current
10mV to 1V rms (< 50 MHz)	200µA to 20mA rms (< 50 MHz)
10mV to 0.5V rms (> 50 MHz)	200µA to 10mA rms (> 50 MHz)

Signal source impedance: 50Ω nominal

1.3.3 Internal DC Bias (Optional)

Current

Up to 100mA.

Voltage

Up to 40V

1.3.4 Measurement Speeds

Four selectable speeds for all measurement functions. Selecting slower measurement speed increases reading resolution and reduces measurement noise.

Maximum speed.
Fast speed.
Medium speed.
Slow speed.

A custom speed may be set which allows for user defined measurement speeds to be set to enhance noise performance.

Custom speed 1-256

1.3.5 Measurement Accuracy

The accuracy statements given apply when the instrument is used under the following measurement conditions.

1.3.6 Resistance / Reactance (R / X)

±0.05% *

1.3.7 Conductance / Susceptance (G / B)

±0.05% *

1.3.8 Capacitance (C)

±0.05% *

1.3.9 Inductance (L)

±0.05% *

1.3.10 Dissipation Factor (D)

±0.0005% $(1+D^2)$*

1.3.11 Quality Factor (Q)

±0.05% (Q+1/Q)*

***Varies with frequency, drive level and measured impedance.**

1.4 Measurement Ranges

R, Z, X	0.01mΩ to >2GΩ
G, Y, B	0.01nS to >2kS
L	0.1nH to >2kH
C	1fF to >1F
D	0.00001 to >1000
Q	0.00001 to >1000

1.4.1 Hardware Ranges

The impedance of the Device Under Test and the measurement frequency determine the hardware range used. Auto ranging is available which sets the most appropriate range for a measurement.

Range	Impedance Ω	Frequency Range
1	< 5	Full range
2	<50	Full range
3	>50	Full range
4	>500	Full range
5	>5000	Up to 1MHz
6	>50000	Up to 100kHz
7	>500000	Up to 10kHz

1.5 Measurement Connections

4 front panel BNC connectors permit 3- and 4-terminal connections with the screens at ground potential.

Terminals withstand connection of charged capacitor up to 500V.

1.6 Analysis Mode (Graphical Sweep)

Any two measurement parameters may be selected and measurements made while varying frequency.

1.7 Meter Mode

Provides a standard LCR meter interface presenting numerical results of single or repetitive measurements. All instrument measurement parameters may be set prior to making measurements.

1.8 Setup Data

Up to 20 instrument setups may be locally stored for each mode.

1.9 General

1.9.1 Power Supply

Input Voltage	90V – 264V AC, auto-ranging
Frequency	47 – 63Hz
VA rating	150VA max
Input fuse rating	2.5AT

1.9.2 Display

8.4” high contrast colour VGA (640 x 480 pixels) TFT module with CPL back lighting.

Touch screen interface.

Visible area 170 x 130mm.

1.9.3 Printer Output

HP-PCL compatible graphics printing

Ethernet direct print

Centronics/parallel printer port, Epson compatible text/ticket printing

1.9.4 Remote Control (Optional)

Designed to GPIB IEEE-488.2 and SCPI 1992.0.

1.9.5 Remote Trigger

Rear panel BNC with internal pull-up, operates on logic low or contact closure.

1.9.6 Universal Serial Bus (USB)

Two Universal Serial Bus Interfaces

USB 1.0 compliant

1.9.7 VGA External Monitor

15-way D-type connector to drive an external monitor in addition to the instrument display.

1.9.8 Local Area Network (LAN)

10/100-BASETX Ethernet controller.

RJ45 connector

1.9.9 Mouse

Standard USB or PS/2 mouse port. Touch screen remains enabled when the mouse is connected.

1.9.10 Keyboard interface

Standard USB or PS/2 keyboard port. Instrument front panel remains active with keyboard plugged in

1.9.11 Mechanical

Height	190mm (7.5")
Width	440mm (17.37")
Depth	525mm (20.7")
Weight	13.8kg (30.4 lbs)

1.10 Environmental Conditions

This equipment is intended for indoor use only in a non-explosive and non-corrosive atmosphere.

1.10.1 Temperature Range

Storage:	-20°C to +60°C.
Operating:	0°C to 40°C.
Normal accuracy:	18°C to 28°C.

1.10.2 Relative Humidity

Up to 80% non-condensing.

1.10.3 Altitude

Up to 2000m.

1.10.4 Installation Category

II in accordance with IEC664.

1.10.5 Pollution Degree

2 (mainly non-conductive)

1.10.6 Safety

Complies with the requirements of EN61010-1.

1.10.7 EMC

Complies with EN61326 for emissions and immunity.

2 THEORY REFERENCE

2.1 Abbreviations

B	Susceptance (= 1/X)	R	Resistance
C	Capacitance	X	Reactance
D	Dissipation factor (tan δ)	Y	Admittance (= 1/Z)
E	Voltage	Z	Impedance
G	Conductance (= 1/R)	ω	2π x frequency
I	Current		
L	Inductance	Subscript s ($_s$) = series	
Q	Quality (magnification) factor	Subscript p ($_p$) = parallel	

2.2 Formulae

$$Z = \frac{E}{I} \qquad \text{(all terms complex)}$$

$$Y = \frac{I}{E} = \frac{1}{Z}$$

$$Z_s = R + jX = R + j\omega L = R - \frac{j}{\omega C}$$

$$|Z_s| = \sqrt{(R^2 + X^2)}$$

$$|Z_p| = \frac{RX}{\sqrt{(R^2 + X^2)}}$$

$$Y_p = G + jB = G + j\omega C = G - \frac{j}{\omega L}$$

$$|Y_p| = \sqrt{(G^2 + B^2)}$$

$$|Y_s| = \frac{GB}{\sqrt{(G^2 + B^2)}}$$

where $X_L = \omega L$ $X_C = \frac{1}{\omega C}$ $B_C = \omega C$ $B_L = \frac{1}{\omega L}$

$$Q = \frac{\omega L_S}{R_S} = \frac{1}{\omega C_S R_S} \qquad \text{(series R, L, C values)}$$

$$Q = \frac{R_P}{\omega L_P} = \omega C_P R_P \qquad \text{(parallel R, L, C values}$$

$$D = \frac{G_P}{\omega C_P} = \omega L_P G_P \qquad \text{(parallel G, L, C values)}$$

$$D = \frac{R_S}{\omega L_S} = \omega C_S R_S \qquad \text{(series R, L, C values)}$$

Note : The value $Q = \frac{1}{D}$ is constant regardless of series/parallel convention

2.3 Series/Parallel Conversions

$$R_S = \frac{R_P}{(1+Q^2)} \qquad R_P = R_S(1+Q^2)$$

$$C_S = C_P(1+D^2) \qquad C_P = \frac{C_S}{(1+D^2)}$$

$$L_S = \frac{L_P}{\left(1+\frac{1}{Q^2}\right)} \qquad L_P = L_S\left(1+\frac{1}{Q^2}\right)$$

Conversions using the above formulae will be valid only at the test frequency.

2.4 Polar Derivations

$$R_S = |Z|\cos\theta \qquad G_P = |Y|\cos\theta$$

$$X_S = |Z|\sin\theta \qquad B_P = |Y|\sin\theta$$

Note that, by convention, +ve angle indicates an inductive impedance or capacitive admittance.

If capacitance is measured as inductance, the L value will be –ve.

If inductance is measured as capacitance, the C value will be –ve.

$D = \tan\delta$ where $\delta = (90 - \theta)^\circ$ admittance measurement.

$Q = \frac{1}{\tan\delta}$ where $\delta = (90 - \theta)^\circ$ impedance measurement.