Wayne Kerr Electronics

HF LCR Meters
6500P Series

Product Specification

Issue B1

UK – GLOBAL HQ

Wayne Kerr Electronics

Vinnetrow Business Park

Vinnetrow Road

Chichester

West Sussex PO20 1QH

Tel: +44 (0)1243 792200

Fax: +44 (0)1243 792201

email: sales@wayne-kerr.co.uk

email: service@wayne-kerr.co.uk

www.waynekerrtest.com

Europe

Wayne Kerr Europe GmbH
Märkische Str. 38 - 40
58675 Hemer
Germany

Tel: +49 (0) 2372 557 870
Fax: +49 (0) 2372 557 8790
E-mail: info@waynekerr.de

USA

Wayne Kerr Electronics Inc
165L New Boston Street
Woburn MA 01801-1744
USA

Tel: 781 938 8390
Fax: 781 933 9523
Email: sales@waynekerrusa.com

Taiwan

Wayne Kerr Electronics Corp
No228-21, Sec 2, Bei Hsin Rd
Hsin Tien City
Taipei 231

Tel: +886 (2) 2915 8990
Fax: +886 (2) 2915 5775
E-mail: sales@waynekerrtest.com.tw

China

Wayne Kerr Asia
A604 Pengdu Building,
Guimiao Road,
Nanshan District,
Shenzhen, Guangdong

Tel: +86 138 2525 7230
Fax: +86 755 2652 3875
Email: sales@waynekerr.com
service@waynekerr.com

India

Wayne Kerr Electronics Pvt Ltd
FF-73, Amrit Plaza Commercial Complex
B Block, Surya Nagar
Ghaziabad (UP)
India

Tel: +91 (0) 12 0262 9612
Fax: +91 (0) 12 0262 9613
E-mail: waynekerrindia@gmail.com

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1 SPECIFICATION

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

1.1 Models

Model	Minimum measurement frequency	Maximum measurement frequency
6505P	20Hz	5MHz
6510P	20Hz	10MHz
6515P	20Hz	15MHz
6520P	20Hz	20MHz
6530P	20Hz	30MHz
6550P	20Hz	50MHz
65120P	20Hz	120MHz

1.2 Measurement Parameters

AC Functions

Two parameters can be displayed at the same time as Term 1 and Term 2. Any of the parameters can be selected and displayed on the instrument using the following letter:

Parameter	Letter	Parameter	Letter
Impedance	Z	Phase Angle	θ
Capacitance	C	Dissipation Factor	D
Inductance	L	Quality Factor	Q
AC Resistance	R	Conductance	G
Susceptance	B	Reactance	X
Admittance	Y		

The following display formats are available:

Series or Parallel Equivalent Circuit

C, D, L, Q, R, G, B, and X – any combination (both as series or both as parallel)

Polar Form

Z + Phase Angle, Y + Phase Angle

1.3 Test Conditions

1.3.1 AC Drive

Frequency Range

Model	Frequency Range
6505P	20Hz to 5MHz
6510P	20Hz to 10MHz
6515P	20Hz to 15MHz
6520P	20Hz to 20MHz
6530P	20Hz to 30MHz
6550P	20Hz to 50MHz
65120P	20Hz to 120MHz

Frequency Accuracy

Accuracy of set frequency: ±0.005%

Frequency Step Size

Frequency step size: ≤1mHz

Drive Level (AC Measurements)

AC Drive	Drive Range	Frequency	Detail
Voltage	10mV to 1Vrms	<50MHz	into open circuit
	10mV to 0.5Vrms	>50MHz	into open circuit
Current	200µA to 20mArms	<50MHz	into short circuit
	200µA to 10mArms	>50MHz	into short circuit

Source Impedance

50Ω nominal

1.3.2 Internal DC Bias /D1 (Optional)

Voltage

0 to +40Vdc

Current

0 to +100mAdc

1.3.3 Internal DC Bias /D2 (Optional)

Voltage

-40 to +40Vdc

1.4 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

When set to the maximum speed the typical 6500P measurement times are as follows:-

Frequency	Meter Mode
1kHz	250ms
10kHz	70ms
100kHz	70ms
>1MHz	60ms

1.5 Measurement Accuracy

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

AC Drive Level: 1V/20mA

Speed: SLOW

Fixture: 1J1011

Instrument fully trimmed

Temperature range: 23±5°C

30 minute warm up period.

1.5.1 Resistance / Reactance (R / X)

±0.05% *

1.5.2 Conductance / Susceptance (G / B)

±0.05% *

1.5.3 Capacitance (C)

±0.05% *

1.5.4 Inductance (L)

±0.05% *

1.5.5 Dissipation Factor (D)

±0.0005 $(1+D^2)$*

1.5.6 Quality Factor (Q)

±0.05% (Q+1/Q)*

*Varies with frequency, drive level and measured impedance.

1.6 Measurement Ranges

Parameter	Range	
R, Z , X	0.01mΩ to >2GΩ	10^{-5} to $>2x10^{9}\Omega$
G, Y, B	0.01nS to >2kS	10^{-11} to $>2x10^{3}$S
L	0.1nH to >2kH	10^{-10} to $>2x10^{3}$H
C	1fF to >1F	10^{-15} to >1F
D, Q	0.00001 to >1000	10^{-4} to $>10^{4}$

1.6.1 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	>5k	Up to 1MHz
6	>50k	Up to 100kHz
7	>500k	Up to 10kHz

1.7 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.

1.8 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.

1.9 Setup Data

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

1.10 General

1.10.1 Power Supply

Parameter	Specification
Voltage	90 to 264V AC autoranging
Frequency	45 to 63Hz
VA	150VA max
Input fuse rating	2.5A T

1.10.2 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.

1.10.3 Printer Output

HP-PCL compatible graphics printing

Ethernet direct print

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

1.10.4 Remote Control

Designed to GPIB IEEE-488.2 and SCPI 1992.0.

1.10.5 Remote Trigger

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

1.10.6 Universal Serial Bus (USB)

Two Universal Serial Bus Interfaces

USB 1.0 compliant

1.10.7 VGA External Monitor

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

1.10.8 Local Area Network (LAN)

10/100-BASETX Ethernet controller.

RJ45 connector

1.10.9 Mouse

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

1.10.10 Keyboard interface

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

1.10.11 Mechanical

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

1.11 Environmental Conditions

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

1.11.1 Temperature Range

Parameter	Specification
Storage	-20°C to +60°C
Operating	0°C to 40°C
Normal accuracy	18°C to 28°C

1.11.2 Relative Humidity

Up to 80% non-condensing.

1.11.3 Altitude

Up to 2000m.

1.11.4 Installation Category

II in accordance with IEC664.

1.11.5 Pollution Degree

2 (mainly non-conductive)

1.11.6 Safety

Complies with the requirements of EN61010-1.

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

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

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

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

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

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

2.3 Series/Parallel Conversions

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

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

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

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.