High Frequency LCR Meters

6500P Series

User Manual

Issue A1

Part Nº 9H6500P

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CONTENTS

1. SAFETY

This chapter details the safety guidelines which must be observed when operating a 6500 series Precision Impedance Analyzer. Ensure that all sections of this chapter have been read and guidelines followed prior to using the instrument.

CHAPTER CONTENTS

General

This equipment has been designed to meet the requirements of EN61010-1 ‘Safety requirements for electrical equipment for measurement, control & laboratory use’ and has left the factory in a safe condition.

The following definitions in EN61010-1 are applicable:

OPERATOR	Person operating equipment for its intended purpose. **Note: The OPERATOR should have received training appropriate for this purpose.**
RESPONSIBLE BODY	Individual or group responsible for the use and maintenance of equipment and for ensuring that operators are adequately trained.

The RESPONSIBLE BODY must ensure that this equipment is only used in the manner specified. If it is not used in such a manner, the protection provided by the equipment may be impaired.

This product is not intended for use in atmospheres which are explosive, corrosive or adversely polluted (e.g. containing conductive or excessive dust). It is not intended for use in safety critical or medical applications.

The equipment can cause hazards if not used in accordance with these instructions. Read them carefully and follow them in all respects.

Do not use the equipment if it is damaged. In such circumstances the equipment must be made inoperative and secured against any unintentional operation.

Wayne Kerr Electronics and the associated sales organizations accept no responsibility for personal or material damage, nor for any consequential damage that results from irresponsible or unspecified operation or misuse of this equipment.

AC Power Supply

Power Cable

Power cable and connector requirements vary between countries. Always use a cable that conforms to local regulations, terminated in an IEC320 connector at the instrument end.

If it is necessary to fit a suitable AC power plug to the power cable, the user must observe the following colour codes:

WIRE	EUROPEAN	NORTH AMERICAN
LIVE	BROWN	BLACK
NEUTRAL	BLUE	WHITE
GROUND	GREEN/YELLOW	GREEN

Table 1-1 AC Power Cable Colours

The user must also ensure that the protective ground lead would be the last to break should the cable be subject to excessive strain.

If the plug is fused, a 3-amp fuse should be fitted.

If the power cable electrical connection to the AC power plug is through screw terminals then, to ensure reliable connections, any solder tinning of the cable wires must be removed before fitting the plug.

WARNING!

Any interruption of the protective ground conductor inside or outside the equipment or disconnection of the protective ground terminal is likely to make the equipment dangerous. Intentional interruption is prohibited.

North America

When this product is used with 180VAC - 250VAC mains with no neutral, connect the two live wires to the L(live) and N(neutral) terminals on the input connector. In this instance double pole fusing must be used.

Adjustment, Maintenance and Repair

WARNING!

The equipment must be disconnected from all voltage sources before it is opened for any adjustment, replacement, maintenance, or repair.

When the equipment is connected to the local AC power supply, internal terminals may be live and the opening of the covers or removal of parts (except those to which access can be gained by hand) is likely to expose live parts.

Capacitors inside the equipment may still be charged even if the equipment has been disconnected from all voltage sources.

Any adjustment, maintenance, or repair of the opened equipment under voltage must be carried out by a skilled person who is aware of the hazards involved.

Service personnel should be trained against unexpected hazards.

Ensure that only fuses with the required rated current and of the specified type are used for replacement. The use of makeshift fuses and short-circuiting of fuse holders is prohibited.

Safety Interlock

The /D1 DC Bias Option permits a DC bias current to flow in the Device Under Test while measurements are being made. This is a safe and permissible condition. However if the DUT is inductive, and if the User then interupts the measurement circuit, a back EMF will be generated. This condition must be avoided. The value of this EMF will be dependent on the value of the inductance and the size of the DC bias current. It is possible that the back EMF will exceed the limits for non-hazardous voltages.

The Responsible Body must take all necessary precautions to ensure that the measurement circuit cannot be interupted while a DC bias current is flowing. A Safety Interlock socket (see Installation – Safety Interlock) is provided on the rear panel to assist the Responsible Body in taking the necessary precautions. A typical solution is to locate the Device Under Test inside a transparent box with a lid, so that when the lid is opened (and the DUT becomes accessible), a micro-switch located on the lid breaks the safety interlock circuit and inhibits the DC bias current.

Static Electricity

The unit supplied uses static-sensitive devices. Service personnel should be alerted to components which require handling precautions to avoid damage by static electrical discharge.

Before handling circuit board assemblies containing these components, personnel should observe the following precautions:

1) The work surface should be a conductive grounded mat.

2) Soldering irons must be grounded and tools must be in contact with a conductive surface to ground when not in use.

3) Any person handling static-sensitive parts must wear a wrist strap which provides a leaky path to ground, impedance not greater than 1MΩ.

4) Components or circuit board assemblies must be stored in or on conductive foam or mat while work is in progress.

5) New components should be kept in the suppliers packaging until required for use

2. INTRODUCTION

For a detailed specification of each instrument in the range see Chapter 11, Specifications.

CHAPTER CONTENTS

Figure 2-1 6500P HF LCR Meter

The 6500P series of High Frequency LCR Meters provides impedance measurement capability of components from 20Hz up to 120MHz.

A comprehensive range of functions enables a component to be accurately characterised over a wide frequency range.

The Graphical User Interface (GUI) combined with the large touch screen TFT display enables measurement parameters to be modified easily and quickly.

The instruments may be remotely controlled using the GPIB or LAN interfaces.

Measurement Parameters

A comprehensive range of AC functions enables a wide range of components to be accurately characterised. Each measurement displays two user selectable component parameters, which allow specific component characteristics to be monitored.

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

All the above functions can be selected via manual front panel control or controlled remotely via the GPIB or LAN interfaces for fully-automated high-speed testing.

3. INSTALLATION

Ensure that all sections of Chapter 1 and the installation guidelines within this chapter have been read prior to using the instrument for the first time.

CHAPTER CONTENTS

ILLUSTRATIONS

TABLES

AC Line Connections

Before connecting the AC power, read the AC Power Supply section page 1–3.

Power Cable

The unit is provided with a power cable capable of carrying the input current for both 115V and 230V operation. This cable should be connected via a suitable connector to the local AC power supply. The colour code employed is as follows:

WIRE	EUROPEAN	NORTH AMERICAN
LIVE	BROWN	BLACK
NEUTRAL	BLUE	WHITE
GROUND	GREEN/YELLOW	GREEN

Table 3-1 AC Power Cable Colours

North America

When this product is used with 180VAC - 250VAC mains with no neutral, connect the two live wires to the L(live) and N(neutral) terminals on the input connector. In this instance double pole fusing must be used.

AC Input Voltage and Frequency Adjustment

No adjustment is required for variation of supply frequency or mains supply voltage.

AC Input Fuse Rating

Ensure that the fuse rating is correct. The fuse is located below the mains inlet connector within a snap in carrier.

NOMINAL MAINS VOLTAGE	FUSE RATING
115V	2.5A-T
230V	2.5A-T

Table 3-2 AC Fuse Rating

The instrument is not suitable for battery operation.

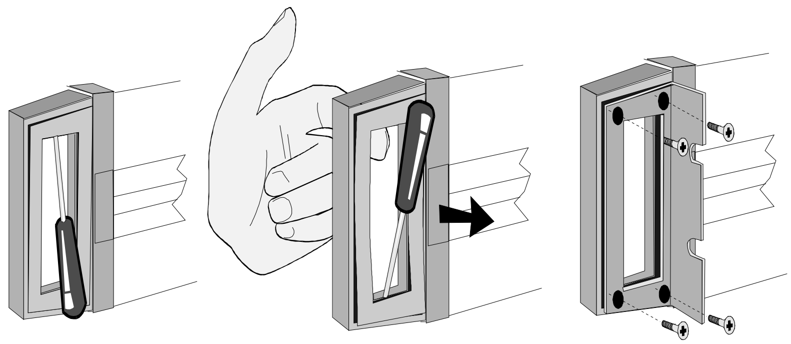
The power switch is located on the right of the front panel.

Location

The 6500P series instruments may be bench or rack mounted. The instrument is cooled with the aid of a rear panel mounted fan and care must be taken not to restrict any of the air paths.

Rack Mounting

There is a rack mounting kit available as an option (part number 7SM5593) to fit a standard 19" rack. This kit contains the mounting brackets and screws required for the conversion. To fit these brackets, carefully remove the insert in the outer face of both front handles, see Figure 3-1 below. Fit each bracket into the recess formed by the removal of the insert and secure using the bolts provided (M4 x 10mm CSK). It is important that some provision be made to support the rear of the unit when using the rack mounting brackets.



Insert small screwdriver into the gap between insert and handle body. Prise away one end slightly and hold in position with finger. Note operation of insert with styling cut-out opposite cut-out in handle.

Insert screwdriver into other end and repeat procedure. This will relieve the small tapered pins of the insert from the threaded holes in the handle. Remove insert in the direction of arrow.

Insert rack mounting bracket into recess in handle in attitude shown and secure firmly with 4 M4x10 C'SK HD screws supplied.

Figure 3-1 Procedure for Attachment of Rack Mounting Bracket

WARNING!

This equipment is intended for use by suitably trained and competent persons.

This product can cause hazards if it is not used in accordance with these instructions. Read them carefully and follow them in all respects. Double check connections to the unit before use.

DO NOT USE THIS EQUIPMENT IF IT IS FAULTY OR DAMAGED.

The Rear Panel

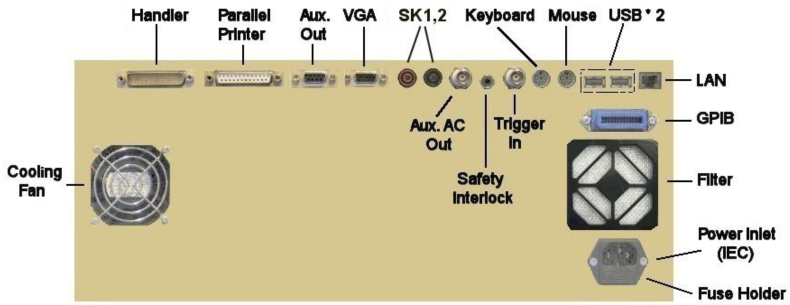


Figure 3-2 The Rear Panel

IEC Socket and Fuse Holder

Read Chapter 1 before using the instrument for the first time.

WARNING!

Disconnect the mains supply before opening the fuse holder.

Any replacement fuse must comply with the AC Input Fuse Rating on page 3–2.

This equipment should only be serviced by suitably trained and competent persons.

DO NOT USE THE INSTRUMENT IF IT IS FAULTY OR DAMAGED.

Cooling Fan and Air Filter

The instrument is cooled with the aid of a rear panel mounted cooling fan and filtered inlet. To avoid overheating the instrument should be at least 150mm from any obstruction.

The filter assembly includes a replaceable element, which should be changed periodically. To change the filter carefully unclip the outer cover and remove the element. Insert a new element into the filter cover and using even pressure replace the outer cover.

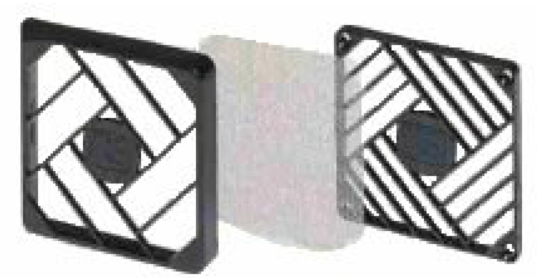


Figure 3-3 Rear Panel Filter Replacement

Rear Panel Control Connections

Many of the external interface connectors are mounted on the rear panel. For the location of each interface please see Figure 3-2 The Rear Panel

Label	Type	Use
Handler	25-way D-type (male)	Bin Handler option
Parallel Printer	25-way D-type (female)	To send results to local printer
Aux. Out	9-way D-type (female)	For future expansion
VGA	15-way DSUB (female)	External monitor (640 x 480)
SK1 SK2	Two 4mm sockets	For future expansion
Aux AC Out	BNC	For future expansion
Safety Interlock	3 pole 3.5mm jack socket	Used in conjunction with an interlock fixture
Trigger in	BNC	For external trigger
Keyboard	6-way mini DIN	PS/2 compatible
Mouse	6-way mini DIN	PS/2 compatible
USB	Type A USB connector	Universal Serial Bus
LAN	RJ 45	Local Area Network
GPIB	GPIB connector	GPIB (IEEE) remote control

Table 3-3 Rear Panel Connections

Handler

Bin Handler option provides signals to sort the Device Under Test in bins based upon the measurements and limits set by the user.

Parallel Printer

A HP-PCL compatible graphics printer or Epson compatible text/ticket printer may be used with the Centronics compatible parallel printer interface.

Parallel Printer Output

Pin	Description	Pin	Description
1	Strobe	14	Auto Feed
2	Data Line 0	15	Error
3	Data Line 1	16	Initialize Printer
4	Data Line 2	17	Select Input
5	Data Line 3	18	Ground (Data bit 0)
6	Data Line 4	19	Ground (Data bit 1)
7	Data Line 5	20	Ground (Data bit 2)
8	Data Line 6	21	Ground (Data bit 3)
9	Data Line 7	22	Ground (Data bit 4)
10	Acknowledge	23	Ground (Data bit 5)
11	Busy	24	Ground (Data bit 6)
12	Paper End	25	Ground (Data bit 7)
13	Select		

Table 3-4 Parallel Printer Interface Pin Assignment

Auxiliary Control Out

For future expansion.

VGA

The display screen image may be displayed on a VGA (640 x 480 @ 60Hz) monitor connected to the industry standard 15 way mini sub D type connector. Ensure that any monitor connected to the instrument complies with the overall environmental specification for the instrument. See page 11–7 .

The touch screen interface continues to operate when an external monitor is connected.

SK1, SK2

For future expansion.

AUX AC OUT

For future expansion.

Safety Interlock (DC Bias Option /D1)

DC bias is inhibited until the safety interlock circuit is complete. This is achieved by completing the connection between the Sleeve and Ring terminals of the Safety Interlock Plug when it is plugged into the Safety Interlock Socket on the rear panel.

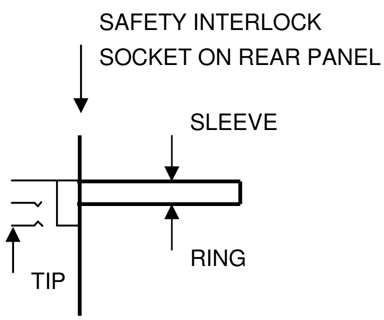


Figure 3-4 Safety Interlock Connections

Chapter 7 – DC Bias Operation describes how the DC Bias function is used.

Trigger In

The TRIGGER IN BNC socket duplicates the action of the front panel trigger key. The input is TTL compatible; and when taken logic low is equivalent to operating the front panel trigger key. This input is level sensitive and fully debounced, and includes a pull up resistor to enable shorted contacts such as relays or footswitches to be used.

Keyboard

An external PS2 compatible keyboard may be connected to the instrument using the industry standard 6 pin mini DIN connector or USB port. Ensure the instrument is switched off when connecting the keyboard if the mini DIN connector is used.

Mouse

A PS2 compatible mouse may be used in place of the touch screen display. The mouse may be connected using the industry standard 6 pin mini DIN or USB port. Ensure the instrument is switched off when connecting the mouse if the mini DIN connector is used.

Universal Serial Bus (USB)

Two USB compatible ports are available. An external mouse and keyboard may be connected via these ports. The ports may also be used with the USB memory supplied with the instrument to transfer test results, screen shots and software upgrades.

Local Area Network (LAN)

The industry standard RJ45 connector enables the instrument to be connected to a 10/100Mbps Fast Ethernet compatible network. A networked HP-PCL compatible graphics printer may be also used with the instrument. See chapter 10, Remote Control for further information.

General Purpose Interface Bus (GPIB)

The General Purpose Interface Bus (GPIB) is designed to be used for communication between instruments and control devices such as PCs fitted with a suitable interface card. See chapter 10, Remote Control for further information.

4. OPERATION

This chapter describes the basic operation of the instrument. Topics covered include front panel controls, trimming, calibration and making a basic component measurement.

CHAPTER CONTENTS

ILLUSTRATIONS

The Front Panel

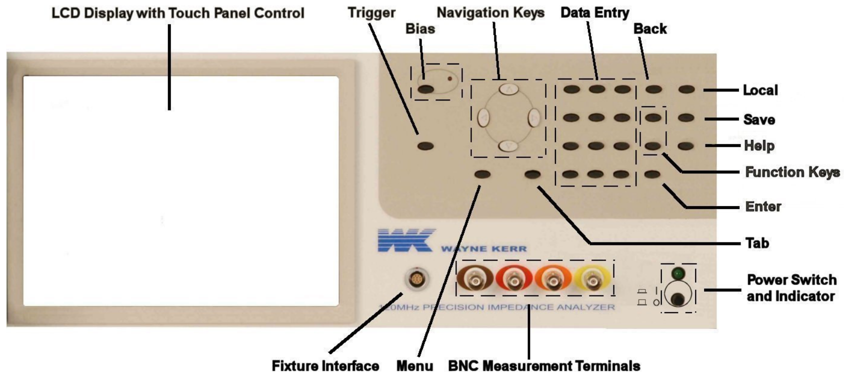


Figure 4-1 The Front Panel

Switching the Instrument ON

With the instrument connected to the correct AC power supply (see chapter 3—Installation) press the **POWER** switch. The power indicator will light, the bias indicator will flash and after running the start up routine the instrument will display Meter Mode.

Switching the Instrument OFF

The power can be switched OFF at any time without damage to the instrument, but to avoid losing trim and calibration data, the instrument should be switched OFF when it is in a quiescent state rather than when it is running a routine, e.g. trimming, calibration or data entry.

Touch Panel Interface

It is recommended that the instrument is controlled using the LCD display touch panel interface.

Use the stylus supplied to select instrument modes, functions and measurement parameters. Select the parameter to be modified by lightly touching the LCD screen with the point of the stylus and the screen will respond by displaying the new setting.

The item selected by the stylus only becomes active when the stylus is lifted off the touch screen. To cancel a selection while the stylus is still touching the screen, drag the stylus to an inactive part of the screen, and the lift off the stylus.

Note:

Do not use a pen with the nib exposed as the ink may damage or obscure the display.

The instrument front panel navigation, data entry and control keys may be used as alternative to the touch panel interface for many of the instrument functions.

The Navigation Keys

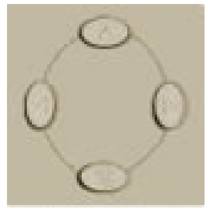


Figure 4-2 The Navigation Keys

The navigation keys can be used in place of the touch screen display or mouse to move around the screen.

Measurement Keys

Figure 4-3 Measurement Control Keys

Trigger

When in single shot mode, the Trigger key initiates a single measurement. If it is pressed and held, the analyzer will continue to make measurements until the key is released.

Bias

The Bias key applies DC bias to the AC measurement signal if a DC bias option (/D1) is fitted.

Control Keys

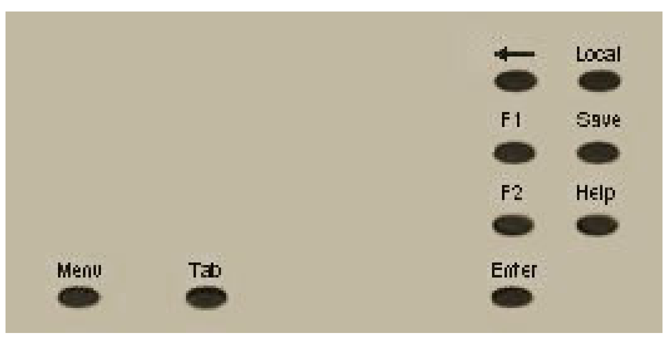


Figure 4-4 Control Keys

Menu

Displays or hides the File, Mode or Display menu items.

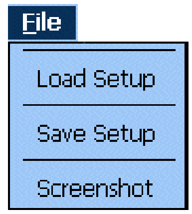


Figure 4-5 File Menu Items

Tab

Selects the next menu, test parameter or option.

←

Deletes the last entered character when the screen data input keypad is displayed.

F1 and F2

Menu specific functions

Enter

Confirm data entry when the screen data input keypad is displayed.

Save

Saves the instrument set-up.

Help

Displays the instrument type and the software revision instrument

Local

Restores control to the front panel when the instrument is under external (GPIB) control.

Data Entry Keypad

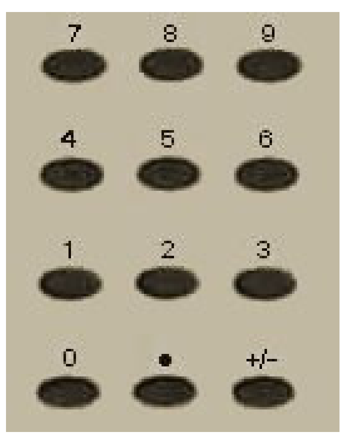


Figure 4-6 The Data Entry Keypad

The data-entry keypad is a multi-function key set permitting manual entry of data values when the appropriate screen data input keypad is displayed.

The **+/-** key may be used before or after a value to change its sign. If the key is pressed more than once, the value will toggle between **+** and **-**.

Key Sequence Example (characters in [ ])

The ← key may be used to delete the last entered key.

Set the frequency to 12.340kHz

1) Select the displayed frequency command button using the stylus, or external mouse. (The frequency button always displays the frequency previously set). The input drive frequency data input keypad will be displayed.
2) Key in the following sequence:

[1] [2] [3] [4] [0] [Enter]

An external keyboard and mouse may be used as an alternative to the touch panel display.

Fixture Interface

For future expansion.

Operation Overview

The 6500P series of High Frequency LCR Meters features a touch screen display which enables the instrument to be controlled by selecting menu items, measurement parameters and control functions directly from the displayed image. It is recommended that a stylus always be used when controlling the instrument using the touch screen interface. Alternatively the instrument may be controlled using the front panel keypad or external keyboard and /or mouse.

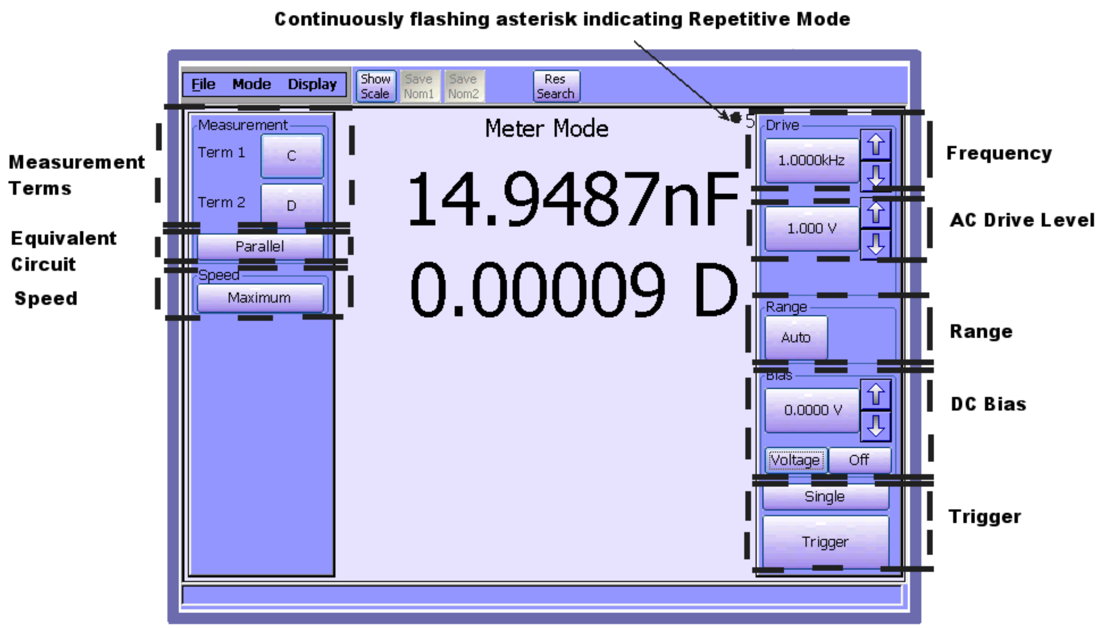


Figure 4-7 Typical Display

Settings can be saved independently using the **Save** command from the **File** drop-down menu.

These settings can then be recalled using the **Load** command from the **File** drop-down menu

Measuring a Component

The following instructions illustrate the process of measuring a component in Meter mode. For a full description of instrument measurement procedures see Chapters 6.

1J1011 Component Fixture

Figure 4-8 1J1011 Component Fixture

Example

This example will take the user through the process of measuring the capacitance and dissipation factor of a capacitor. The settings used are examples only and the user may substitute other settings, subject to the limitations of the component to be measured.

The analyzer should be powered up with the 1J1011 fixture connected to the front panel BNC sockets. Ensure that all the BNC connections are tightened correctly. If the fixture has been changed since the analyzer was last used then it will be necessary to trim the instrument as described in the Chapter 5 - Trimming & High Frequency (HF) Compensation

For this example it is assumed that the instrument will be controlled using the touch screen interface and a stylus will be used to change instrument settings.

1) From the **Measurement** control panel section of the screen select **'Term 1'.** The **Select test parameter** option menu will be displayed. Select **'C', t**he menu will close and the **Term 1** measurement parameter will indicate **'C'**. Select **'Term 2'** and set the parameter to **'D'**.

2) Ensure that the Equivalent Circuit parameter is set to **'Parallel'**. The Equivalent Circuit parameter toggles between the Series and Parallel options.

   Parallel

3) Using the **Speed, Drive and Range** screen control panels set each of the following parameters in turn. To increment or decrement the numeric value of a parameter use the up and down screen icons. Alternatively a numeric data entry keypad may be displayed by selecting the current parameter value on the screen. Select each digit of the desired value from the displayed keypad followed by the unit multiplier or **'OK'** to complete data entry.

   Speed Medium
   Frequency 1.5000 kHz
   Level 1V
   Range Auto

4) Open both fixture jaws using the circular jaw adjusters. Place the component to be measured in to the fixture ensuring that each lead of the component is between each pair of fixture jaws. Lightly tighten the fixture jaw adjusters.

5) Ensure that the analyzer is in **Repetitive mode. I**f there is no continuously flashing asterisk (*) in the top right-hand-corner of the central measurement results section of the screen change the trigger mode command button from **'Single'** to **'Repetitive'**. Note in Repetitive mode the **'Trigger'** command button will be disabled which is indicated by the command label becoming grey in colour.

6) The screen will display the measured values of C and D. The display should be similar to Figure 4-7

5. TRIMMING & HIGH FREQUENCY (HF) COMPENSATION

The section describes the procedures for Trimming and High Frequency Compensation.

CHAPTER CONTENTS

ILLUSTRATIONS

Overview

The instrument is supplied with a 1J1011 Component Fixture. The Trim and HF Compensation values stored in the instrument when it is first shipped apply uniquely to this fixture. The Trim and HF Compensation procedures should only be required when the fixture is changed; when cable accessories are used; or when the highest accuracy is required for measurements of very high or very low impedance devices.

Trims and HF Compensation are applied to both measurement modes.

Trimming and HF Compensation are accessed from the **Mode**, **Calibration** menu.

The instrument can hold three sets of values for both the Trims and HF Compensation. The characteristics of each of these values are listed below:-

Trim	User	Volatile	Read/Write
	User	Non-volatile	Read/Write
	Factory	Non-volatile	Read Only
HF Compensation	User	Volatile	Read/Write
	User	Non-volatile	Read/Write
	Factory	Non-volatile	Read Only

Volatile calibration values are lost when the unit is turned off; non-volatile values are saved and recalled at power up.

Read/Write values can be set and deleted by the user. Read only values cannot be deleted.

The following table illustrate how the instrument applies the various types of trim/compensation values.

'F'are factory values which have been determined (using the 1J1011 fixture supplied) during the final calibration procedure before the unit is shipped.

'U' are user values which are determined when the Trim and HF Calibration procedures are performed by the user to suit a specific measurement set-up.

'X' is no data

Instrument State	**Values used**	**Type**	**Volatile/Non-volatile**	**Calibration Status**
1. Instrument as supplied		✕	User Volatile	No calibration errors
	✓	F	User Non-volatile	
		F	Factory Non-volatile	
2. Instrument after trim or HF Compensation (new values stored as User Volatile)	✓	U	User Volatile	No calibration errors
		F	User Non-volatile	
		F	Factory Non-volatile	

3. Instrument after trim or HF Compensation and 'Save' (new values copied to User Non-volatile)	✓	U	User Volatile	No calibration errors
		U	User Non-volatile	
		F	Factory Non-volatile	
4. State 3 after instrument is turned off and back on (User Volatile values lost so User Non-Volatile values used)		✗	User Volatile	No calibration errors
	✓	U	User Non-volatile	
		F	Factory Non-volatile	
5. Any state after 'Clear' pressed (User Volatile & User Non-volatile values deleted)		✗	User Volatile	Calibration errors:
		✗	User Non-volatile	Cal error [O/C]Factory,
	✓	F	Factory Non-volatile	[S/C]Factory,[HF]Factory
6. After State 5, then 'Save' pressed (Factory Non-volatile values copied to User Non-Volatile)		✗	User Volatile	No calibration errors
	✓	F	User Non-volatile	
		F	Factory Non-volatile	

If at anytime the user is unsure of the validity of the calibration (Trim and HF compensation) the factory set values can be restored by pressing 'Clear' then 'Save' in both the Trim and the HF Compensation boxes. This will leave a warning message at the bottom of the screen, which can be cleared by powering the instrument off then on. These values are valid only for the 1J1011 fixture supplied with the instrument.

Trimming

The analyzer trims by making measurements at a number of frequencies, and storing the corrections for each. If the measurement frequency is changed the analyzer automatically applies a new correction value by interpolation of the stored values.

For **O/C Trim** remove any components and lightly tighten the fixture jaw adjusters.

For **S/C Trim** open both fixture jaws using the circular jaw adjusters. Place a suitable short circuit (supplied by user) in the fixture ensuring that it is between the appropriate fixture jaws and that it does not touch the fixture body. Lightly tighten the fixture jaw adjusters.

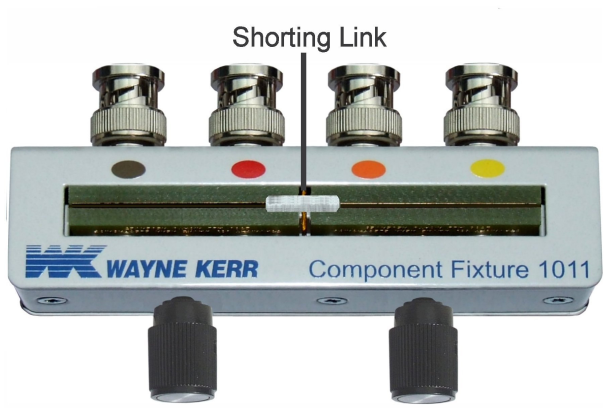


Figure 5-1 Component Fixture 1J1011 Short Circuit Trim

Open and Short Circuit Trims.

1) Select **Calibrate** from the **Mode** menu. The analyzer will display the **Calibration** form.
2) Open - or short-circuit the fixture jaws as appropriate.
3) Select **Open Circuit** or **Short Circuit**
4) Wait until the analyzer has finished trimming.
5) If these trim values need to be saved press 'Save'. If they are temporary the instrument will use these values until the unit is turned off.

High Frequency (HF) Compensation

HF compensation is used to compensate for fixture/cable characteristics at high frequencies. The unit is supplied with HF Compensation values stored suitable for the actual 1J1011 fixture supplied with the instrument. If a different 1J1011 fixture or a different type of fixture, e.g. 1J1012 or 1J1014 SMD fixture is connected to the instrument, it will be necessary to perform a new HF Compensation.

Valid Open and Short circuit trims must be carried out prior to performing HF Compensation.

1) Select **Calibrate** from the **Mode** menu.
2) Select **High Frequency Compensation**.
3) Insert the 100R transfer standard into fixture jaws.
4) Select **OK** – the HF Compensation routine will start.
5) When requested by the instrument remove the 100R transfer standard and fit the 100pF transfer standard and select **OK** – the HF Compensation routine will continue.
6) When requested by the instrument remove the 100pF transfer standard and fit the 10pF transfer standard and select **OK** – the HF Compensation routine will continue to its end. Note for lower frequency units the 10pF standard is not used.
7) If these compensation values need to be saved press '**Save**' (and the values are saved as User Non-volatile). If they are only required temporarily, the instrument will use these values until the unit is turned off (User Volatile).

Note:

Trims and HF Compensation serve two different functions. Trims remove residual impedances in the fixture and cabling, which generally appear as a measurement offset.

HF Compensation removes errors due to cable length (including those inside the fixture) which generally appear as scalar errors. This type of error cannot be removed by trimming.

6. METER MODE

This chapter describes using the Meter Mode to make single and repetitive measurements.

CHAPTER CONTENTS

ILLUSTRATIONS

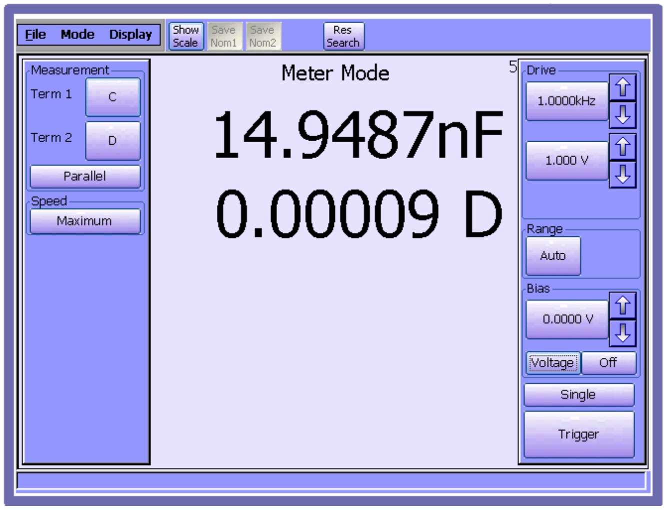


Figure 6-1 Typical Display

The 6500P High Frequency LCR Meter operates in Meter Mode, which provides a traditional LCR meter interface. This allows single or repetitive measurements with two measurement terms displayed as absolute or deviation from a preset nominal. Absolute or relative scale bars may be displayed which compare each measurement to nominal and limit values. The Wayne Kerr 6500B Precision Impedance Analyzer series also offers Analysis Mode which displays measurements graphically against frequency, AC drive level or DC Bias. Please contact your local Wayne Kerr Sales Office or distributor for further details of the 6500B series.

A resonance search facility enables the series or parallel resonance of a component to be accurately established.

Twenty instrument set-ups may be saved in instrument memory enabling component test set-up conditions to be instantly recalled. Additional set-ups can be saved to the USB memory.

The screenshot facility provides the ability to save the displayed screen image to a USB memory attached to one of the rear panel mounted USB interfaces.

Mode Menu

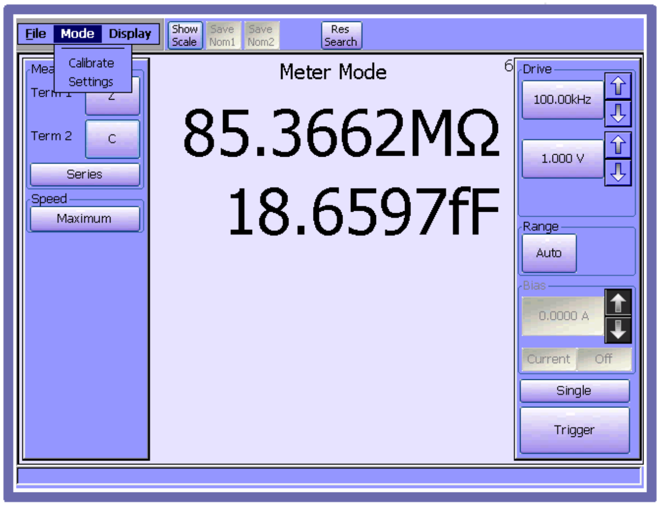


Figure 6-2 Mode Menu

Calibrate

See Chapter 5 -Trimming & High Frequency (HF) Compensation.

Settings

To set the Date, Time, instrument GPIB or LAN address, calibrate the Touch Screen or enable the DC Bias function (when fitted), see Chapter 8 -Settings.

File Menu

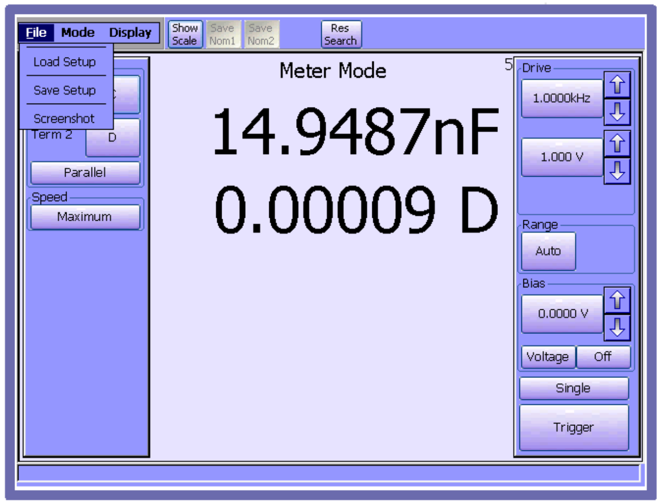


Figure 6-3 File Menu

The File menu enables set-up information to be saved or recalled from internal or external memory. A screenshot facility enables a bit map representation of the displayed screen to be saved to external memory to enable a representation of the screen to be transferred to a PC.

Internal Memory

The instrument has 20 internal non-volatile memory locations which may be used to store instrument setups. The memory locations are accessible from the **Load Set-up** and **Save Set-up** file menu options.

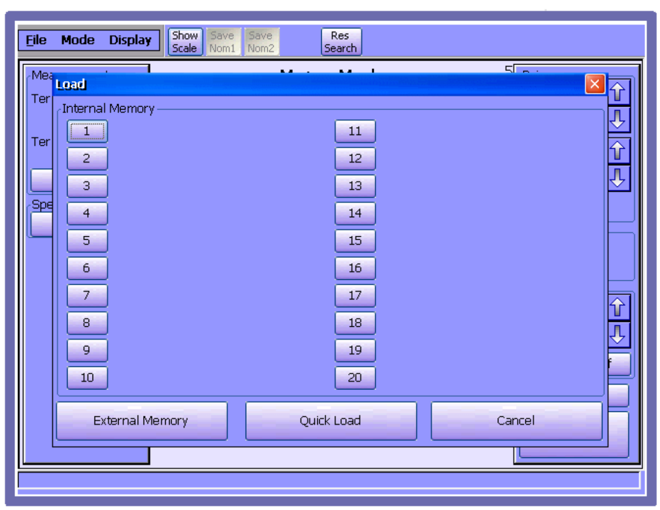


Figure 6-4 Internal Memory Locations

External Memory

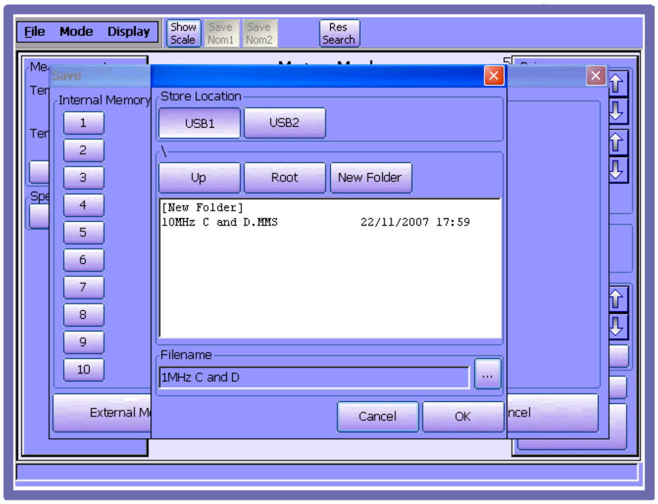


Figure 6-5 Set-up External File location

Selection of **Screenshot** or the **External Memory** command button from **Load Set-up or Save Set-up** displays the External File form.

External files may be saved to the USB memory plugged into either of the USB ports on the instrument back panel. **USB1** and **USB2** select the memory if more than one USB memory is connected.

The 6500 series instruments use a file system that is organised as a hierarchy or tree, with the root folder containing all other folders that have been created using the **New Folder** button. Use the **Root** command button to display all folders created and files stored within the root (top) level folder. Selecting a folder with the stylus will display the contents including any sub folders created. The **Up** button returns to the previous folder level.

Folders screenshots and set-up files are named using the Alpha Numeric Screen Interface, which is accessed by pressing the **File Name Entry** key.

Alpha Numeric Screen Interface

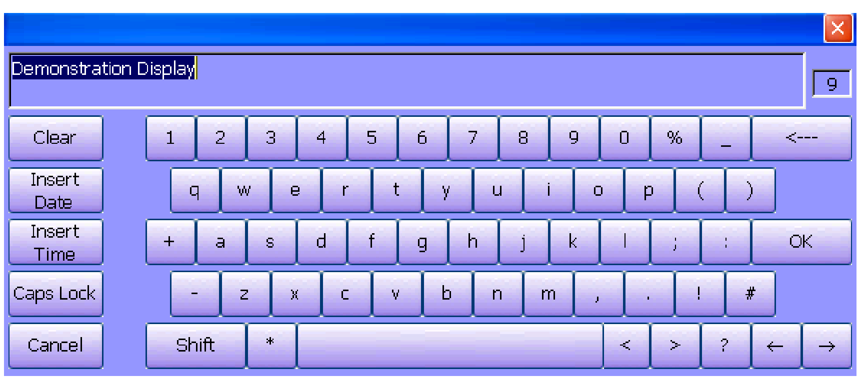


Figure 6-6 Screen Data Entry Keypad

The screen data entry keypad is a full alpha numeric keypad typically displayed when defining file names. The instrument date and time short cut keys enable test results to be chronologically identified while still enabling other text to be included. See Chapter 8 - Settings for guidance on adjusting the instrument date and time.

Upper or lower case characters may be selected with the number of remaining characters which can be entered displayed to the right of the entered text box. Note that the keys available and the maximum number of characters will vary depending on the data being entered.

Use ‘OK’ to complete data entry.

Save Set-up

Stores the instrument set-up to one of twenty memory locations in the instrument non-volatile memory or to an external USB memory. All measurement parameters and display mode settings are stored together with the last measurement results. The bias option settings are saved but the bias will not be applied when the set-up is loaded.

Internal Memory

To save the instrument set-up, select the memory location to be used (1 – 20) and enter the label to be associated with the instrument set-up. Select ‘OK’ to terminate label entry and store the settings. The label entered may have the time and date added using the data entry keypad.

Quick Save

The Quick Save facility is useful when the instrument settings need to be quickly saved and do not need to be associated with a particular component or set of test results. The Quick Save set-up data is held in the instrument non-volatile memory and is loaded when the instrument is powered up.

Load Set-up

Loads the instrument set-up from one of 20 internal stores or from external USB memory. All current measurement parameters and display mode settings are over written together with the last measurement results. The bias option settings are loaded but the bias will not be applied.

Quick Load

The Quick Load facility loads the last instrument set-up stored using ‘Quick Save’ in the ‘Save Set-up’ menu.

Screenshot

The screen image is saved, in .BMP format, to a USB memory attached to one of the USB ports on the rear panel. Use the on screen data entry keypad or external keyboard to set the filename. The display resolution is 640 x 480 pixels.

Display Menu

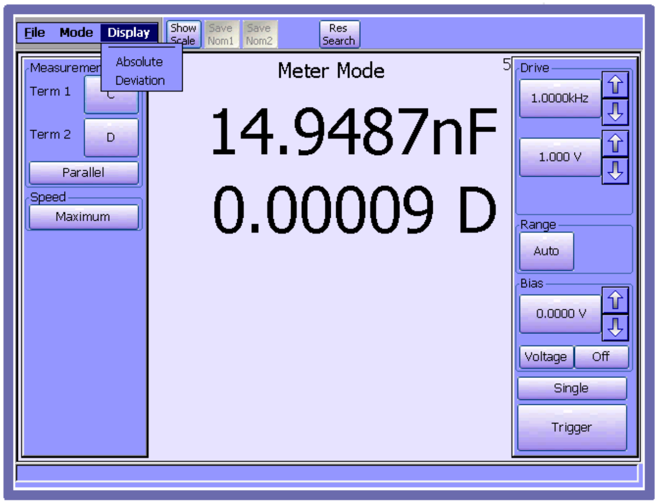


Figure 6-7 Display Menu

Absolute

Displays component measurements as absolute values.

Deviation

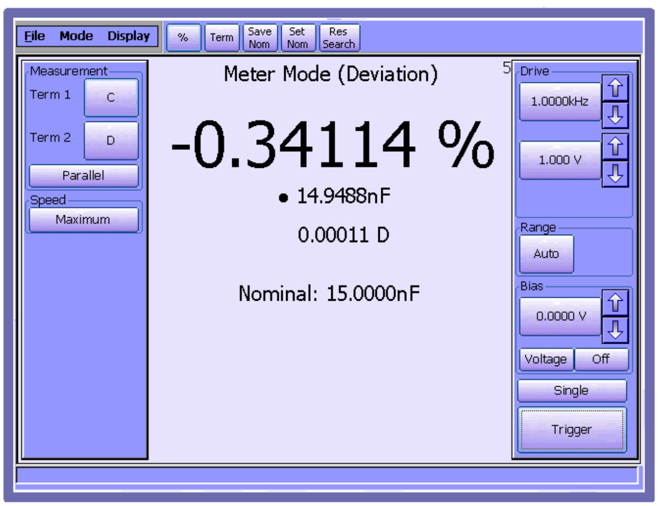


Figure 6-8 Deviation Display Option

Instrument readings are referenced to nominal values. Nominal values may be entered by testing a component followed by ‘Save Nom’ or the measurement term selected and the nominal value entered using the on screen numeric date entry keypad.

The deviation from the nominal value may be expressed as a percentage, ppm or absolute by using the deviation option button. Percentage mode is useful where components are being characterised to a limits specified in percentage terms. Use the Term 1 or Term 2 command buttons to select the measurement to be monitored.

The black circle to the left of the Term 1 or Term 2 measurement identifies whether the deviation is calculated for Term 1 or Term 2.

Making a Measurement

Measurement

AC Function

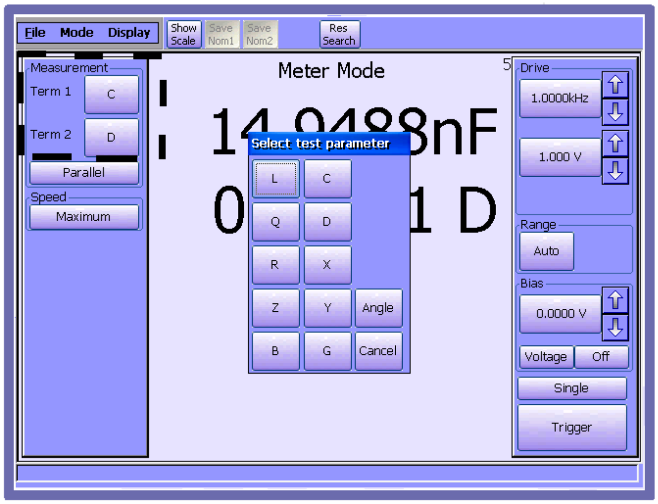


Figure 6-9 Test Parameter Selection

Each measurement displays two terms, which may be set to any one of the available functions. Select 'Term1' or 'Term2' followed by the function required from 'select test parameter'.

Equivalent Circuit

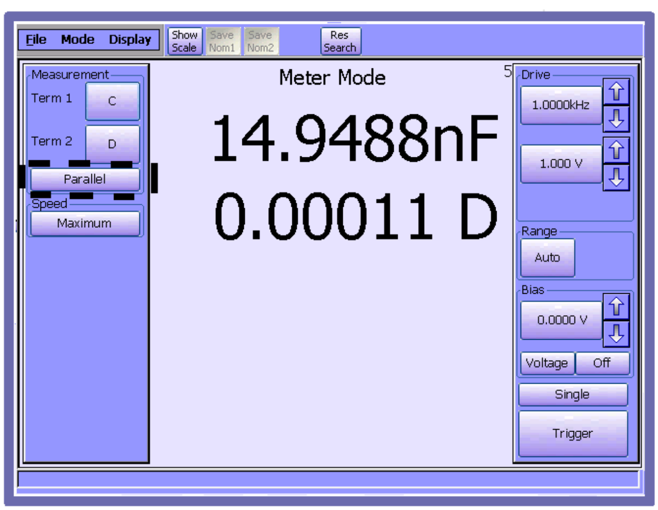


Figure 6-10 Equivalent Circuit Selection

The equivalent circuit, 'Series' or 'Parallel, is displayed on the button. Simply select the button to change the option.

Speed

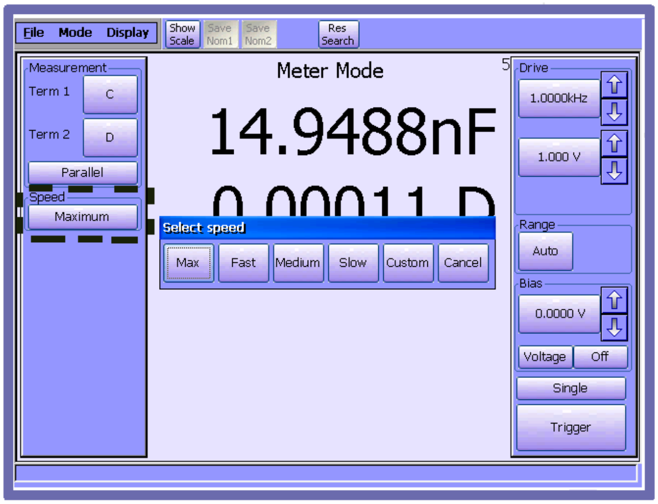


Figure 6-11 Speed Selection

The 'Speed' command button enables the time taken to make a measurement to be varied. The greatest measurement accuracy will be achieved when the speed is set to Slow. Five speed options are available, Max, Fast, Medium, Slow and Custom.

The selected measurement speed is always displayed. To change the speed select the 'Speed' command button and from the speed submenu select the required speed.

Selection of the 'Custom' speed option allows for user defined measurement speeds to enhance noise performance and repeatability. Max = 1, Fast = 10, Medium = 30, Slow = 100 are the equivalent settings for the standard speeds.

AC Drive

Frequency

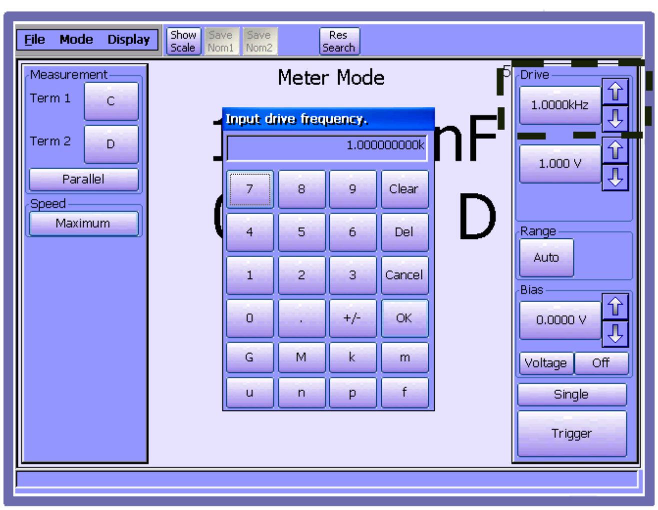


Figure 6-12 Frequency Entry

The measurement frequency may be set by using the or screen icons which increment or decrement the set value or set to a specific frequency using the on screen numeric date entry keypad. To access the numeric date entry keypad select the displayed frequency. Enter the desired frequency followed by any unit multipliers and ‘OK’. To retain the existing frequency select ‘Cancel’.

AC Drive Level

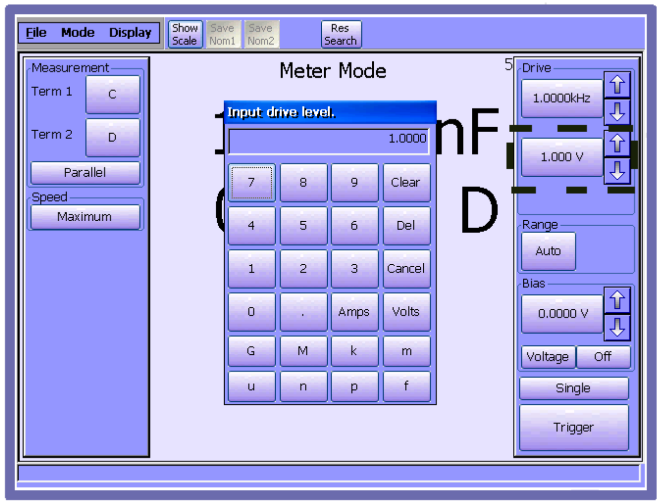


Figure 6-13 Set AC Drive Level

The icon may be used to increment and the icon to decrement the set AC drive level. To set a specific level select the button showing the set level and using the on screen numeric date entry keypad enter the desired value followed by any numeric data multipliers. Terminate drive level entry by selecting ‘Volts’or ‘Amps’, or ‘Cancel’ if the existing drive level is to be retained.

Range

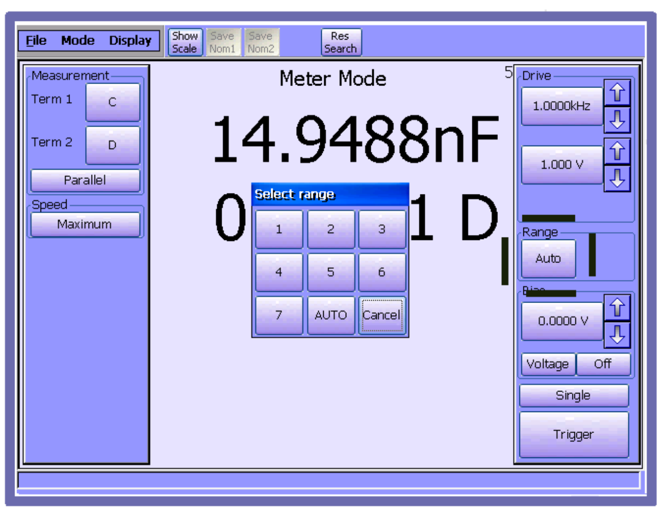


Figure 6-14 Measurement Range Entry

The instrument has seven measurement ranges. If the ‘Auto’ option is chosen then during the next measurement the instrument will select the most appropriate range and display the set range in the top right hand corner of the screen measurement results window. The range selected is dependant on the impedance of the Device Under Test (DUT) and the measurement frequency.

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

Figure 6-15 Measurement Ranges

Generally ‘Auto’ should be used. The exception to this is when DC Bias current (option /D1) is being used with a high impedance DUT. It may be necessary to reduce the range in order to obtain a valid (i.e. not O/R) reading.

DC Bias (Option)

See Chapter 7 - DC Bias Operation. When no DC Bias is fitted, this section of the display will be grey on the screen and inactive.

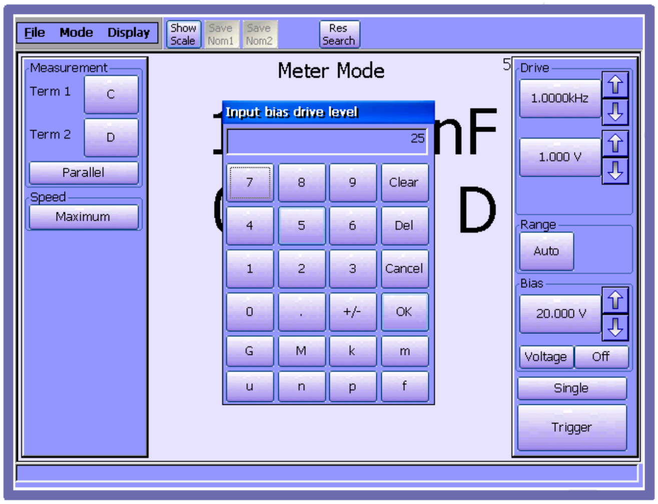


Figure 6-16 DC Bias

Trigger a Measurement

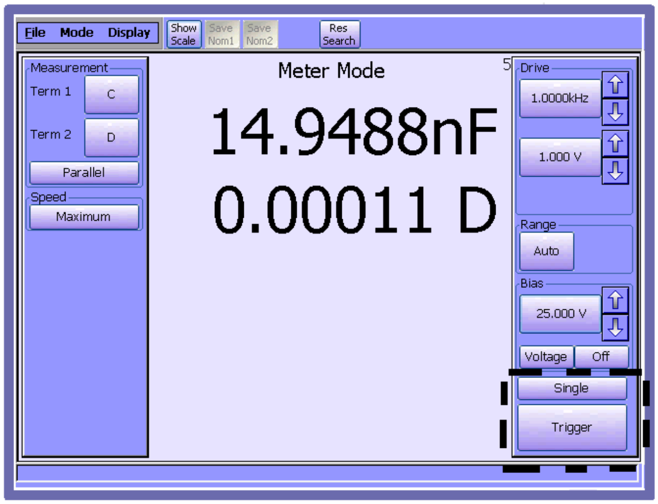


Figure 6-17 Trigger a Measurement

The instrument has two trigger modes, ‘Single’ and ‘Repetitive’. To change the mode, toggle the on screen trigger mode command button.

Single

Individual measurements may be made using the front panel keyboard Trigger button or the on screen ‘Trigger’ command button. Single shot measurement mode is available when the trigger mode command button displays ‘Single’.

Repetitive

Repetitive or continuous measurements may be made by setting the on screen trigger mode command button to ‘Repetitive’. The instrument will continue to make measurements until the trigger mode is toggled to ‘Single’.

Limit Scale

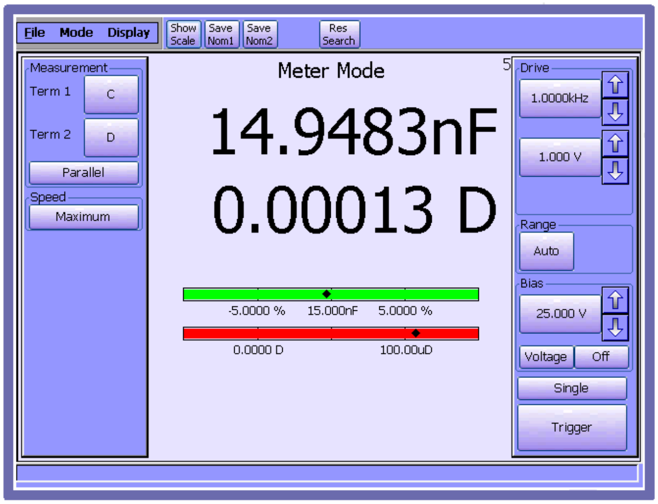


Figure 6-18 Scale Bars

The instrument can indicate the difference between the last component measurement and preset limits. For each measurement Term the last result may be displayed as a horizontal bar, red in colour if outside the set limits or green if the measurement is within the limits. Within the bar, a marker indicates the measurement relative to the set limits.

The scale may be enabled and the scale mode selected, for each measurement term, using the 'Scale Bar Settings' dialogue box accessed by selecting 'Show Scale'.

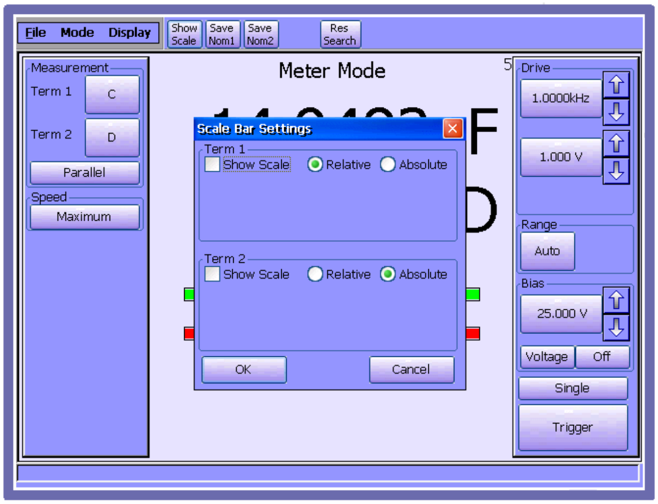


Figure 6-19 Scale Bar No Scales Selected

Relative and Absolute Limits

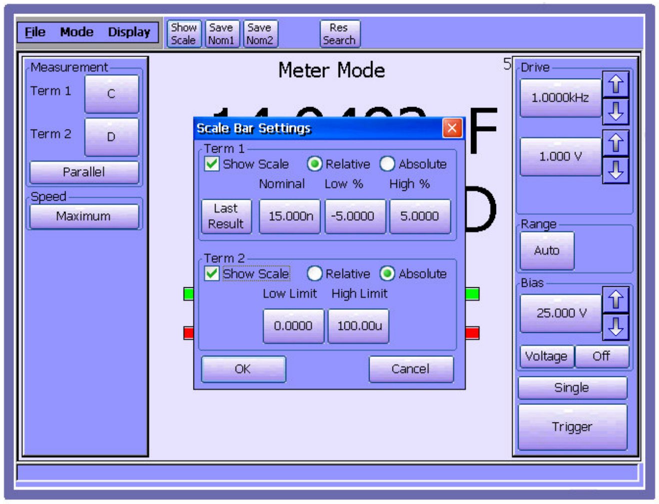


Figure 6-20 Scale Bar Relative or Absolute Options

For each measurement term the scale may be individually enabled and the scale mode set to ‘Relative’ or ‘Absolute’.

The Relative mode compares the measurement term result with a nominal value; the limits are entered as a percentage of the nominal value. The nominal value may be the previous measurement or a subsequent measurement entered using the appropriate ‘Save Nom’ command button.

In Absolute mode the measurement is compared to preset Low and High limits. Each limit is set by selecting the corresponding limit command button and entering the value using the on screen numeric date entry keypad.

Save Nominal

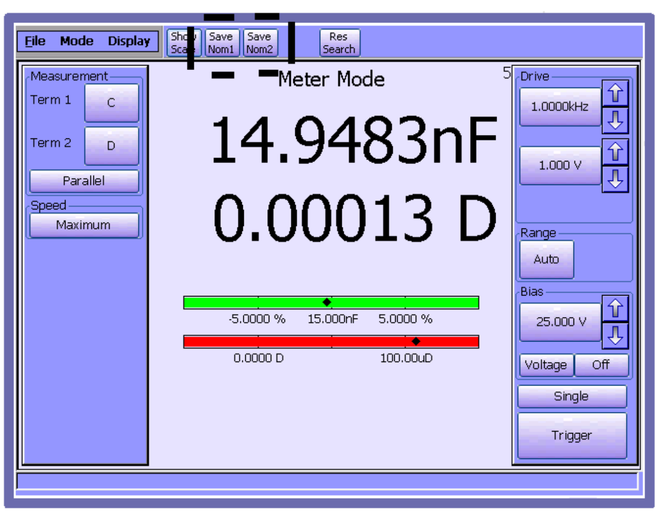


Figure 6-21 Scale Bar Save Nominal

Resonance Search

Resonance Search uses a binary search technique over a frequency range specified by the user in order to locate a DUT (Device Under Test) resonance. It calculates the resonant frequency as well as the equivalent circuit values and the Q value. The user specifies the frequency range in which the resonance is thought to lie and the type of resonance to be found (i.e. series or parallel). The resonant frequency is taken as being the point at which the phase is zero.

Note: This technique can only find a single resonance within the user defined frequency range. It will not find the resonant frequency of a device such as a crystal or a ceramic resonator. These devices have both a series resonance and a parallel resonance. In order to establish either of these, the frequency range set must either start or finish at a frequency, which lies between the series and parallel resonance.

Frequency Range

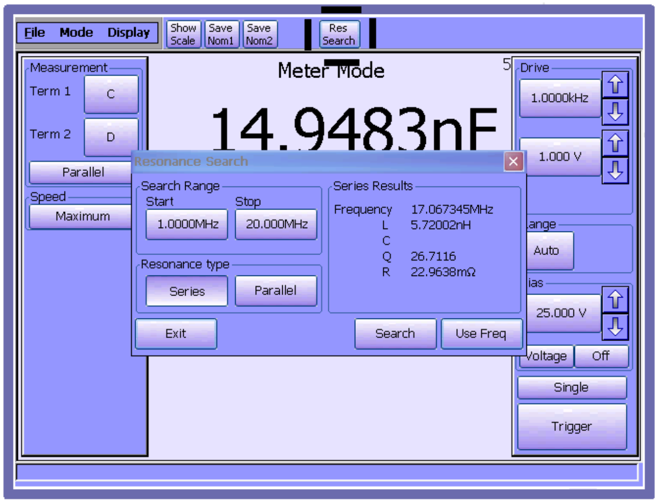


Figure 6-22 Resonance Search Parameter Setting

The frequency range should be chosen such that only one resonance lies in the range. If more than one resonance exists in the chosen frequency range, the function will return 'no resonance found'.

Resonance Type

Select the type of resonance to be found. The main resonance of a capacitor will typically be 'Series'. The main resonance of an inductor will typically be 'Parallel'

Search

Press 'Search' to initiate the search. The progress bar indicates the status of the search.

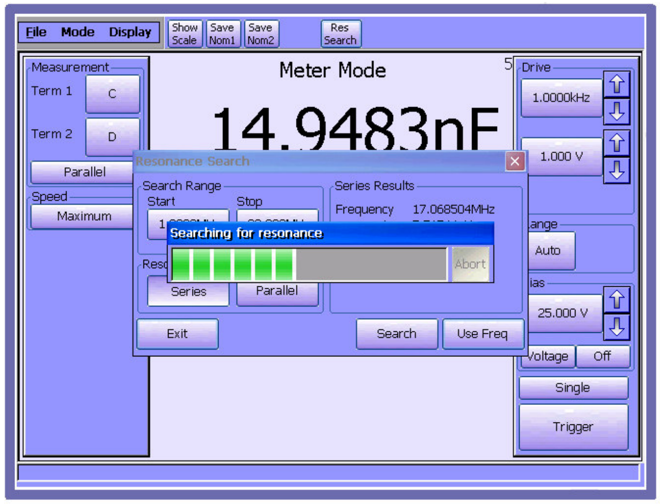


Figure 6-23 Searching for Resonance

When the search is complete, the resonant frequency and equivalent circuit values (if found) are displayed.

Use Freq

'Use Freq' exits resonance search mode and sets the frequency of Meter Mode to the resonant frequency.

Exit

Exits resonance search and returns to Meter Mode.

7. DC BIAS OPERATION

This chapter describes how to use the dc bias options.

CHAPTER CONTENTS

General

DC Bias allows a DC level to be applied to the DUT while a measurement is being performed. Depending on the option fitted this can be a DC voltage or a DC current. DC voltages can be applied to capacitors and DC currents can be applied to inductors or resistors.

The /D1 option allows a DC bias voltage between 0V and +40V, or a DC bias current between 0A and +100mA, to be applied to the DUT.

When the /D1 Voltage/Current option is fitted, the DC bias interlock plug on the rear panel is required. See Chapter 3 -Installation.

The positive terminal for the DC bias is the Yellow BNC connector on the front panel, and the right hand terminal on the 1J1011 fixture.

Bias is enabled/disabled either by using the front panel '**Bias**' key, or by the touch screen '**Bias**' buttons.

If the bias controls are greyed out it there is no bias option is fitted.

DC Voltage (/D1 option)

When a DC voltage is applied to a capacitor, a charging current is required to charge the capacitor to the required voltage. If this current is large enough to prevent a measurement then the 'Charging' message will appear.

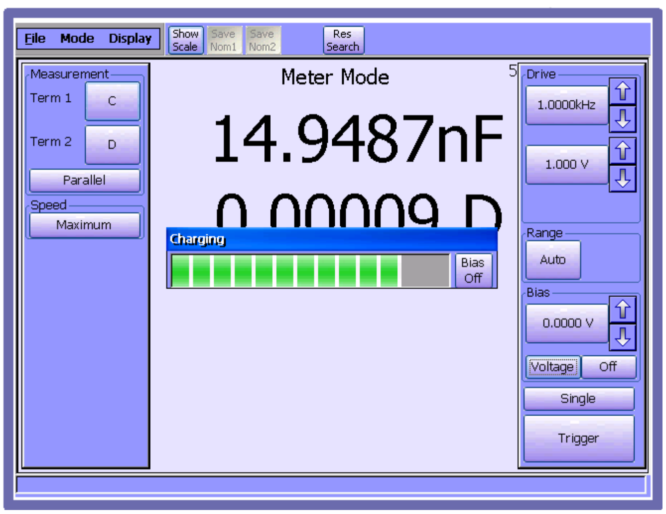


Figure 8-1 DC Bias Charging

This message will stay until one of the three following conditions is met:-

1) The required DC voltage has been reached. The dialog will close and measurements can be triggered.
2) The user presses the 'Bias off' button. The DUT will be discharged back to 0V
3) The charging timeout is exceeded, which can occur for 2 reasons:-

a) The capacitance is too large

b) The capacitor has a very high leakage current which will prevent ac measurements being made.

Note that resistors cannot be tested with voltage bias. To test resistors use bias current to achieve the desired voltage across the DUT. For example, to achieve 2V across a 1kΩ resistor set the current to 2mA.

DC Current (/D1 option)

The DC Current source is a true constant current source, which will set the DUT current to the required level irrespective of the DUT resistance, as long as the dc voltage drop across the DUT does not exceed 45V. If it exceeds this value then the ‘Excess Volt Drop’ message will be displayed. In this case the DC bias level may not be achieved and the error message will be cleared after about 10 seconds if the user does not reduce the bias current level.

Note: Excess Volt Drop does not damage the instrument, it just means that the required current level cannot be achieved.

Meter Mode

In Meter mode simply select Voltage or Current (if the option is available). Then set the level.

Enable/disable the bias using the On/Off touch screen button or the front panel Bias button. The front panel red LED being illuminated and the Bias Warning message at the top of the screen indicates bias enabled.

8. SETTINGS

This chapter describes how to set the time and date and calibrate the touch screen interface.

CHAPTER CONTENTS

ILLUSTRATIONS

Settings Menu

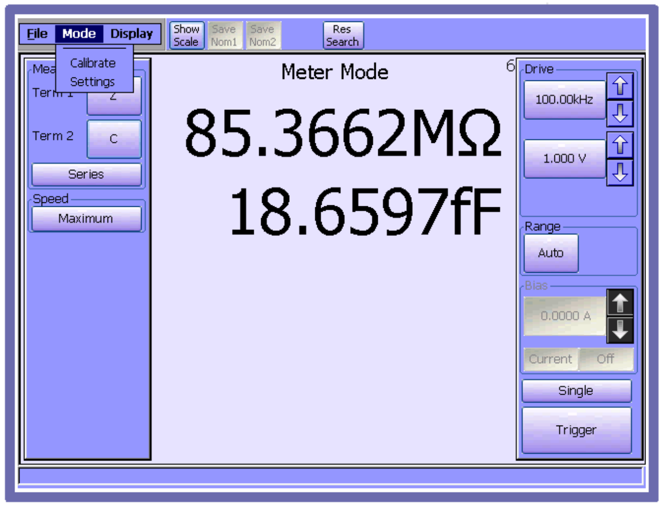


Figure 8-1 Mode Menu

The settings menu is accessible from the Mode menu.

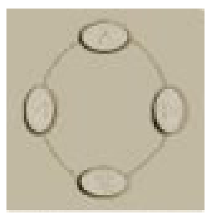


Figure 8-2 Navigation Keys

Press the menu key and using the navigation keys highlight the Mode menu Settings item. Use the Enter key to display the Settings menu.

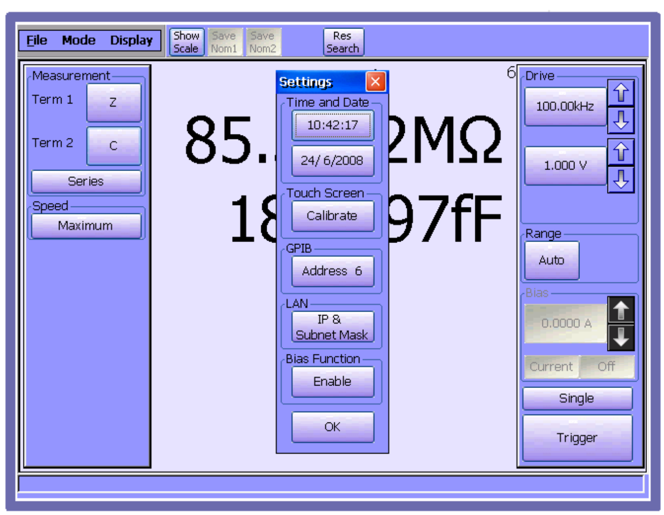


Figure 8-3 Settings Menu

Setting the Time

Figure 8-4 Time Entry

Select the button displaying the time on the settings menu and enter the hours, in 24 hour format, using the on screen keypad. Terminate the entry with OK and then enter the minutes and seconds completing each entry with OK. When the time entry has been completed the Time button on the Settings menu will show the adjusted time.

Note that the time displayed will not show any leading zeroes. For example, 08:06:03 will be displayed as 8: 6: 3.

Setting the Date

Figure 8-5 Date Entry

Select the button displaying the date on the settings menu and enter the day using the on screen keypad. Terminate the entry with OK and then enter the month and year completing each entry with OK. When the time entry has been completed the Date button on the Settings menu will show the revised date in dd/mm/yyyy format.

Touch Screen Calibration

The touch screen alignment may be calibrated by running the touch screen panel calibration procedure. Select the Calibrate button from the Settings menu using the stylus, navigation keys or external mouse to highlight the button followed by the Enter key on the front panel.

Figure 8-6 Touch Screen Calibration Display

The touch screen calibration screen displays twenty five crosses in turn, each cross corresponding to a section of the display. The crosses initially appear red in colour and flashing. Place the stylus point in the centre of the red cross. Hold the stylus in this position until the cross turns to green, then the next cross will appear. Complete the process for all twenty five crosses to calibrate the touch screen.

The yellow bar at the bottom of the screen indicates the time left to position the stylus point at the centre of a cross. When the bar reaches the right side of the screen the calibration utility will time out returning to the Settings menu.

Setting the GPIB Address

The default GPIB address for the instrument is 6. To set an alternative address, from the Settings menu select the GPIB command button and enter the desired address. Valid GPIB addresses are in the range 1 to 31.

Note that the instrument GPIB address is set to the entered address immediately.

Setting the LAN Address

Contact your Network Administrator before connecting the instrument to your Network.

To enable the instrument for LAN operation, the user must set the IP Address and the Subnet Mask. Select the LAN IP & Subnet Mask button. Highlight the IP Address and use the front panel keypad to enter the IP Address in WWW.XXX.YYY.ZZZ format e.g. 192.168.10.250 (default). Select the Subnet Mask field and enter the Subnet Mask Value in WWW.XXX.YYY.ZZZ format e.g. 255.255.255.0 (default). Press ‘OK’. This will save the LAN settings.

Bias Function

This feature is only available when the DC Bias option is fitted to the instrument.

When Enable is selected, the DC Bias can be applied to the DUT by pressing the On/Off touch screen button or the front panel Bias button. See Section 7 – DC Bias Operation for full details.

When Disable is selected and the front panel Bias button is pressed, a message will appear on the screen saying that the DC Bias has been disabled and that it can be enabled from the Settings Page.

This feature is intended to be used if the user wants to prevent the operation of the DC Bias by a single key press, which may occur by accident.

9. BINNING MODE

Separate document.

10. REMOTE CONTROL

The 6500P series of instruments may be remotely controlled using the General Purpose Interface Bus (GPIB) or a Local Area Network (LAN). This chapter describes the interface specification and the command structure for both forms of remote instrument control.

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ILLUSTRATIONS

TABLES

GPIB Interface

Introduction

The General Purpose Interface Bus (GPIB) is a parallel port designed to be used for communication between instruments and control devices such as PCs fitted with a suitable interface card.

The GPIB interface is used where relatively local control and data logging of an instrument is required. For extended operating distance and a reduction in computer costs consider using the industry standard LAN (Ethernet IEEE802.3) control port.

Interface Specification

The IEEE 488.1 bus standard and the IEEE 488.2 code standard are fully supported. The structure of the command set broadly follows the SCPI standard.

SH1	Full source handshake
AH1	Full acceptor handshake
T6	Basic talker, serial poll, no talk only, untalk if MLA
TE0	No talker with secondary addressing
L4	Basic listener, no listen only, unlisten if MTA
LE0	No listener with secondary addressing
SR1	Full service request
DC1	Full device clear
RL1	Full remote/local compatibility
PP0	No parallel poll
DT1	Full device trigger compatibility
C0	No controller

Table 10-1 IEEE 488.1 Supported Functions

GPIB Address

Each instrument on the GPIB bus requires a unique address within the range 1 to 16.

The default address for this instrument is 6 and is stored in non-volatile memory. This may be changed in the **Settings** page found in the **Mode** menu. See chapter 8 - Settings for more details.

Remote Programming

Remote Messages and Commands

A remote message is made up of one or more commands. Remote commands are divided into two groups.

- Common commands – These commands query/change the instrument's status, e.g. querying the status groups or identifying the instrument.
- Subsystem commands – These commands are used to query/control the instrument's function, e.g. to change frequency or perform measurements.

Command Strings

Command strings are the basic form of communication with the instrument. Command strings can contain one or more individual commands. A semicolon is used to separate multiple commands within one command string. The linefeed character and/or asserting EOI *(GPIB only)* terminates the string. Once a string has been received all the commands it contains are executed in the order that they occur within the string from left to right. Command strings are not case sensitive.

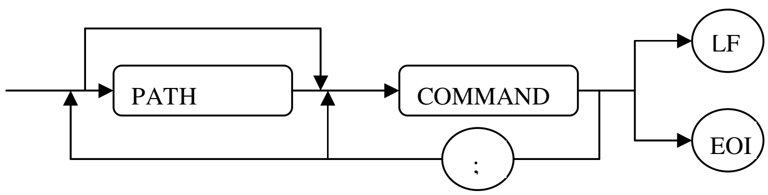

Figure 10-1 Remote Message Structure

Example:

Set the frequency and level in meter mode:

```
:METER:LEVEL 0.5;:METER:FREQ 1E4<lf>
```

Paths

Subsystem commands are accessed via a command path. Paths group the instrument commands into related categories to ease programming. The paths are defined in a tree structure:

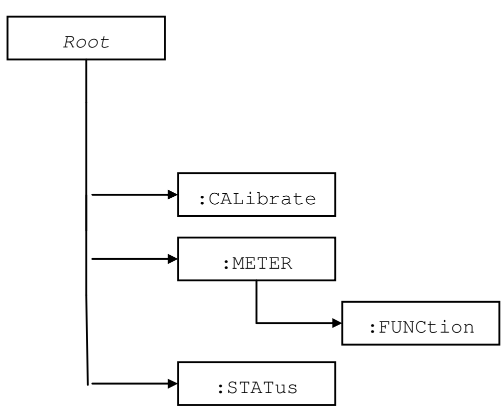

Figure 10-2 Command Paths

Command Structure

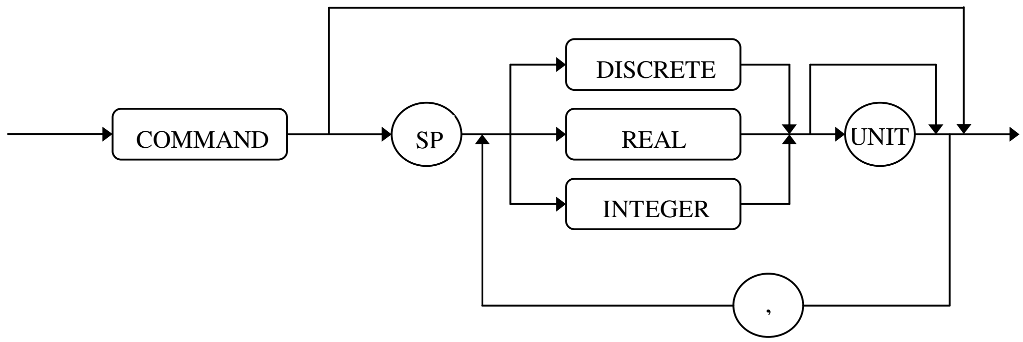

Figure 10-3 GPIB Command Structure

Examples

Discrete parameter: `:METER:BIAS-STAT ON`

Real parameter: `:METER:FREQ 1.2E6`

Data Output

Data is returned from the instrument as an ASCII character string that is terminated with a line feed character.

Output Syntax

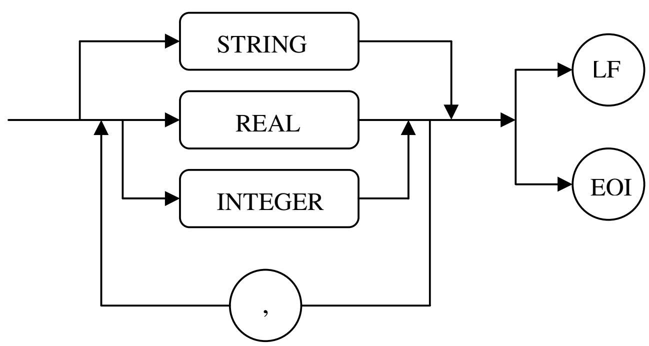

Figure 10-4 Remote Data Output

Examples

String data: `IMPEDANCE vs. FREQUENCY`

Real data: `1.344517e+005`

Integer data: `2`

Multiple data: `9.243736e+002, 4.748015e+004`

Real Data Errors

Real data may be output from the instrument containing a leading '#' character. This indicates that the instrument encountered a numerical error while processing the previous GPIB command. This error is usually caused by submitting a query for an instrument parameter which has not been set or a measurement not completed.

Status Groups

Bit	Name	Description
0	**OPC**	Operation Complete: Not used, commands are processed sequentially.
1	**RQC**	Not used.
2	**QYE**	Not used.
3	**DDE**	Device Dependant Error
4	**EXE**	Execution Error: Command could not be processed, ie parameter out of range.
5	**CME**	Command Error: Command not understood, ie syntax error.
6	**URQ**	Not used.
7	**PON**	1 if the instrument has been powered down since the last read, 0 otherwise.

Table 10-2 Standard Event Group

Bit	Name	Description
0	**Calibrating**	Set when calibration in progress.
1-2	**Settling**	Not used.
3	**Sweeping**	Set when sweeping.
4	**Measuring**	Set when measuring.
5-14	**-**	Not used.
15	**Always Zero**	Always Zero.

Table 10-3 Standard Operation Status Group

Bit	Name	Description
0-2		Not used.
3	**QUE**	Not used.
4	**MAV**	Message available in output queue.
5	**ESB**	Standard Event group summary bit.
6	**RQS**	Service Request.
7	**OPR**	Standard Operation group summary bit.

Table 10-4 Status Group

Group summary bits are set when the value of the group register masked with the value of the enable register (logical AND) is not zero (logical OR).

RQS is set when the value of the Status Group masked with the value of the Status Group Enable register (logical AND) is not zero (logical OR).

RQS being set will generate a GPIB service request *(GPIB only)*.

Common Commands

Common Commands

Standard Event

*ESE

Set the value of the Standard Event Enable group.

(See **Status Groups** section).

Parameter

The Standard Event Enable group value as an integer.

Response

None.

*ESE?

Query the Standard Event Group enable mask.

Parameter

None.

Response

The value of the Standard Event enable group as an integer

*ESR?

Query the value of the Standard Event group.

Parameter

None.

Response

The Standard Event group value as an integer

Instrument Identification

*IDN?

Query the instrument identification.

Parameter

None.

Response

The instrument identification string in the form:

Manufacturer, Model, 0, Software Revision.

Example

```
WAYNE KERR, 6530P, 0, 2.110
```

Common Commands

Options Fitted to the Instrument

*OPT?

Query the instrument options.

Parameter

None.

Response

A comma separated list of options, D1 = /D1 option fitted, 0 = not fitted.

Position	Option
D1	/D1dc bias

Status Byte

*SRE (GPIB only)

Set the value of the Status Byte Enable group. (See **Status Groups** section).

Parameter

The Status Byte Enable group value as an integer.

Response

None.

*SRE? (GPIB only)

Query the Status Byte Enable group.

Parameter

None.

Response

The value of the Status Byte Enable group as an integer.

*STB?

Query the status byte group.

NB This group can also be read by a GPIB serial poll *(GPIB only)*.

Parameter

None.

Response

The value of the Status Byte group as an integer.

Common Commands

Trigger a Measurement

*TRG

Trigger a measurement.

Parameter

None.

Response

Mode dependant.

Status Commands

Status (:STATUS)
OPERation:ENABle Set the value of the Standard Operation Status group enable register. **Parameter** The value of the register as an integer **Response** None.
OPERation:EVENt? Query the Standard Operation Group event register, this register latches transitions of the condition register. **Parameter** None. **Response** The value of the register as an integer.
OPERation:CONDition? Query the value of the Standard Operation Group register. **Parameter** None. **Response** The value of the register as an integer.

Meter Mode

Meter Mode (:METER)

DC Bias

BIAS

Set the output level of the selected bias source.

Parameter

The required output level as a real.

Response

None.

Example

Set 100mA bias current:

```
:METER:BIAS-TYPE CUR
:METER:BIAS 0.1
```

BIAS?

Query the bias source level.

Parameter

None.

Response

The bias source output level as a real number.

BIAS-STATe

Change the state of the selected bias source.

Parameter

ON	Turn bias on.
OFF	Turn bias off.

Response

None.

Example

Turn bias on:

```
:METER:BIAS-STAT ON
```

BIAS-STATe?

Query the state of the selected bias source.

Parameter

None.

Response

0	Bias is off.
1	Bias is on.

BIAS-TYPE

Select the bias source.

Parameter

VOLtage	Voltage bias.
CURrent	Current bias.

Response

None.

Example

Select voltage bias:

```
:METER:BIAS-TYPE VOL
```

BIAS-TYPE?

Query the selected bias source.

Parameter

None.

Response

0	Current bias.
1	Voltage bias.

Meter Mode (:METER)

Deviation Mode Measurement Display

DEViation-TERM

Select the measurement result to use for deviation display.

Parameter

1	First result.
2	Second result.

Response

None.

DEViation-TERM?

Query the deviation display measurement term

Parameter

None.

Response

1	First result.
2	Second result.

DEViation-TYPE

Set the deviation display type.

Parameter

ABSolute	Absolute deviation.
PERCentage	Percentage deviation.
PPM	Parts-per-million deviation.

Response

None

DEViation-TYPE?

Query the deviation display type.

Parameter

None

Response

Absolute deviation.

Percentage deviation.

Parts-per-million deviation.

Display Format

DISPlay

Select the meter mode display format.

Parameter

ABSolute	Absolute display.
DEViation	Deviation display.

Response

None

DISPlay?

Query the meter mode display format.

Parameter

None.

Response

Absolute display.

Deviation display.

Meter Mode (:METER)

Drive Type – Signal Source

DRIVE?

Query the signal source drive type.

Parameter

None.

Response

0	Voltage drive.
1	Current drive.

Equivalent Circuit

EQU-CCT

Select the equivalent circuit.

Parameter

SER	Series circuit.
PAR	Parallel circuit.

Response

None.

EQU-CCT?

Query the equivalent circuit.1`

Parameter

None.

Response

0	Series circuit.
1	Parallel circuit.

Frequency

FREQuency

Set the signal source output frequency.

Parameter

The frequency as a real number.

Response

None.

Example

Set 1MHz signal source frequency.

```
:METER:FREQ 1E6
```

FREQuency?

Query the signal source output frequency

Parameter

None.

Response

The signal source output frequency as a real number

Meter Mode (:METER)

Functions L, C, Q, D, R, X, Z, Y, θ, B, G

FUNC:1

FUNC:2

Select 1st or 2nd result measurement property.

Parameter

L	Inductance.
C	Capacitance.
Q	Q-factor.
D	D-factor.
R	Resistance
X	Reactance.
Z	Impedance.
Y	Admittance.
θ	Angle.
B	Susceptance.
G	Conductance.

Response

None.

Example

Set Term 1 to Capacitance and Term 2 to D-factor

```
:METER:FUNC:1 C;2 D
```

FUNC:1?

FUNC:2?

Query the 1st or 2nd result measurement property.

Parameter.

None.

Response

0	Inductance.
1	Capacitance.
2	Resistance.
3	Impedance.
4	Admittance.
5	Reactance.
6	Conductance.
7	Susceptance.
8	Q-factors.
9	D-factor.
10	Angle.

Meter Mode (:METER)

Level – Signal Source Output

LEVEL

Set the signal source output level.

Parameter

The drive level as real number followed by the drive type suffix if required:

V	Voltage drive.
A	Current drive.

Response

None.

Example

Set 1V voltage drive.

```
:METER:LEVEL 1V
```

Set 100mA current drive.

```
:METER:LEVEL 0.1A
```

LEVEL?

Query the signal source output level.

Parameter

None.

Response

The signal source drive level.

Use **DRIVE?** to query the drive type.

Nominal Level – Deviation Mode

NOMinal

The required deviation mode nominal value.

Parameter

The nominal value as a real number.

Response

None.

Example

Set 10uH nominal value.

```
:METER:NOM 1E-5
```

NOMinal?

Query the deviation mode nominal.

Parameter

None.

Response

The deviation mode nominal value as a real number.

Meter Mode (:METER)

Range – Instrument Measurement Range

RANGE

Select the measurement ranging setting.

Parameter

AUTO	Auto-range.
1	Range 1
2	Range 2
3	Range 3
4	Range 4
5	Range 5
6	Range 6
7	Range 7

Response

None.

RANGE?

Query the measurement ranging settings.

Parameter

None.

Response

The value returned is the set range prior to making a measurement. Auto-range always returns 0 regardless of the range used for the measurement.

0	Auto-range
1	Range 1
2	Range 2
3	Range 3
4	Range 4
5	Range 5
6	Range 6
7	Range 7

Scale Bar

SCALE1-HIgh <real>

SCALE2-HIgh <real>

Set the 1st or 2nd result scale bar high limit.

Parameter

The required limit as a real number.

Response

None.

SCALE1-HIgh?

SCALE2-HIgh?

Query the 1st or 2nd result scale bar high limit.

Parameter

None.

Response

The limit as a real number.

Meter Mode (:METER)	
SCALE1-Low <real> **SCALE2-Low** <real> Set the 1st or 2nd result scale bar low limit. **Parameter** The required limit as a real number. **Response** None.	**SCALE1-LOw?** **SCALE2-LOw?** Query the 1st or 2nd result scale bar low limit. **Parameter** None. **Response** The limit as a real number.
SCALE1-SAVENOMinal **SCALE2-SAVENOMinal** Set the 1st or 2nd result scale bar nominal value to the 1st result measurement value. **Parameter** None. **Response** None	**SCALE1-NOMinal?** **SCALE2-NOMinal?** Query the 1st or 2nd result scale bar nominal value. **Parameter** None. **Response** The nominal value as a real number..
SCALE1-TYPE **SCALE2-TYPE** Select the 1st or 2nd result scale bar display type. **Parameter** **ABSolute** Absolute **RELative** Relative(%). **Response** None.	**SCALE1-TYPE?** **SCALE2-TYPE?** Query the 1st or 2nd result scale bar type. **Parameter** None. **Response** The result 1 scale bar display type. Absolute. Relative.

Meter Mode (:METER)

SHOW-SCALE1

SHOW-SCALE2

Set the 1st or 2nd result scale bar visibility.

Parameter

OFF	Scale bar off.
ON	Scale bar visible.

Response

None.

SHOW-SCALE1?

SHOW-SCALE2?

Query the 1st or 2nd result scale bar visibility.

Parameter

None.

Response

The result 1 scale bar state.

0	Scale bar off.
1	Scale bar visible.

Speed of Measurement

SPEED

Set the measurement speed.

Parameter

MAXimum	Maximum speed.
FAST	Fast speed.
MEDium	Medium speed.
SLOW	Slow speed.
<integer>	Custom speed

Response

None.

SPEED?

Query the measurement speed.

Parameter

-4	Maximum speed.
-3	Fast speed.
-2	Medium speed.
-1	Slow speed.
1-256	Custom speed.

Response

None.

Trigger a Measurement

Meter Mode (:METER)

TRIGger

Trigger a measurement.

Parameter

None.

Response

The measurement results as comma delimited real numbers.

Example

Trigger a meter mode measurement.

```
:METER:TRIG
```

Reply:

```
9.246517e+002, 1.184251e-003
```

Calibration

Calibrate (:CAL)	
Open Circuit Trim	
OC-TRIM Perform an open circuit trim. **Parameter** None. **Response** The trim result. **1** Trim passed. **0** Trim failed.	**OC-TRIM?** Query the trim status. **Parameter** None. **Response** The trim status. **1** Trim valid. **0** Trim invalid.
Short Circuit Trim	
SC-TRIM Perform a short circuit trim. **Parameter** None. **Response** The trim result. **1** Trim passed. **0** Trim failed.	**SC-TRIM?** Query the trim status. **Parameter** None. **Response** The trim status. **1** Trim valid. **0** Trim invalid.

11. SPECIFICATIONS

This chapter details the nominal specification for the 6500P series.

CHAPTER CONTENTS

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

Measurement Parameters

Any of the following parameters can be measured and displayed.

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).

Equivalent Circuit

Series or Parallel.

Test Conditions

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

For all models:	Accuracy of set frequency:	±0.005%
	Frequency step size:	<1mHz

AC Drive

Drive Level (AC Measurements)

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

Signal source impedance: 50Ω nominal

Internal DC Bias /D1 (Optional)

Current

DC bias 0 to +100mA.

DC Bias Current	Resolution	Accuracy
1 – 10mA	0.1mA	±1% ±1uA
10 – 100mA	1mA	±1% ±10uA

Voltage

DC bias 0 to +40V

DC Bias Voltage	Resolution	Accuracy
0 – 4V	5mV	±1% ±5mV
4 – 12V	10mV	±1% ±10mV
12 – 40V	35mV	±1% ± 35mV

Measurement Speeds

Four preset 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

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

Resistance / Reactance (R / X)

±0.05% *

Conductance / Susceptance (G / B)

±0.05% *

Capacitance (C)

±0.05% *

Inductance (L)

±0.05% *

Dissipation Factor (D)

±0.05% $(1+D^2)$*

Quality Factor (Q)

±0.05% (Q+1/Q)*

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

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

Internal Hardware Ranges

The impedance of the Device under Test (DUT) and the measurement frequency determine the hardware range used internally. 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

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.

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.

Set-up Data

Up to 20 instrument set-ups may be locally stored. Additional set-ups may be stored on the external USB memory.

General

Power Supply

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

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.

Printer Output

HP-PCL compatible graphics printing

Ethernet direct print

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

GPIB Remote Control

Designed to GPIB IEEE-488.2 and SCPI 1992.0.

External Trigger In

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

Universal Serial Bus (USB)

Two Universal Serial Bus Interfaces

USB 1.0 compliant

VGA External Monitor

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

Local Area Network (LAN)

10/100-BASETX Ethernet controller.

RJ45 connector

Mouse interface

Standard USB or PS/2 mouse port. Touch screen remains enabled with the mouse.

Keyboard interface

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

Mechanical

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

Environmental Conditions

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

Temperature Range

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

Relative Humidity

Up to 80% non-condensing.

Altitude

Up to 2000m.

Installation Category

II in accordance with IEC664.

Pollution Degree

2 (mainly non-conductive)

Safety

Complies with the requirements of EN61010-1.

EMC

Complies with EN61326 for emissions and immunity.

12. THEORY REFERENCE

Outlined in this chapter are the abbreviations used in this manual and the 6500 series instruments.

The formulae section documents the derivation of the measurement parameters.

CHAPTER CONTENTS

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	

Formulae

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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.

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.

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

13. MAINTENANCE, SUPPORT AND SERVICES

Consult this chapter if the instrument requires calibration or maintenance. Service centre addresses are given at the end of the chapter.

CHAPTER CONTENTS

Guarantee

The equipment supplied by Wayne Kerr Electronics is guaranteed against defective material and faulty manufacture for a period of twelve months from the date of dispatch. In the case of materials or components employed in the equipment but not manufactured by us, we allow the customer the period of any guarantee extended to us.

The equipment has been carefully inspected and submitted to comprehensive tests at the factory prior to dispatch. If, within the guarantee period, any defect is discovered in the equipment in respect of material or workmanship and reasonably within our control, we undertake to make good the defect at our own expense subject to our standard conditions of sale. In exceptional circumstances and at the discretion of the service manager, a charge for labour and carriage costs incurred may be made.

Our responsibility is in all cases limited to the cost of making good the defect in the equipment itself. The guarantee does not extend to third parties, nor does it apply to defects caused by abnormal conditions of working, accident, misuse, neglect or wear and tear.

Maintenance

Cleaning

The body of the equipment can be cleaned with a damp lint-free cloth. Should it be required, weak detergents can be used. No water must enter the equipment. Do not attempt to wash down internal parts.

Safety Checks

Each year the equipment should be given a simple safety check.

Equipment required

25A ground bond tester (e.g. Megger PAT 2)

Insulation tester @ 500V DC (e.g. Megger BM 7)

Tests

1) **DISCONNECT THE INSTRUMENT FROM THE AC POWER SUPPLY!**
2) Inspect the unit and associated wiring for damage e.g. dents or missing parts which might impair the safety or function of the equipment. Look for any signs of overheating or evidence that objects might have entered the unit.
3) **Ground Bond:** Ensure that 25A DC can flow from exposed metal parts of the unit (not BNC connector outers) to ground with an impedance of less than 100mΩ.
4) **Insulation Test:** Connect the Live and Neutral of the power cable together and test the insulation between this point and the ground at 500V DC. Readings greater than 1MΩ are acceptable.

Service Centres

In the event of difficulty, or apparent circuit malfunction, it is advisable to contact the service centre or your local sales engineer or agent (if overseas) for advice before attempting repairs.

For repairs and recalibration it is recommended that the complete instrument be returned to one of the following:-

USA

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

Tel: +781 938 8390
Fax: +781 933 9523
Email: sales@waynekerr.com
service@waynekerr.com

UK

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
service@wayne-kerr.co.uk
www.waynekerrtest.com

Europe

Wayne Kerr Europe
Märkische Str. 38-40
58675 Hemer
Germany
Tel: +49 (0)2372 557870
Fax: +49 (0)2372 5578790
Email: info@waynekerr.de
service@waynekerr.de

Asia

Wayne Kerr Asia
A604 Pengdu Building,
Guimiao Road,
Nanshan District,
Shenzhen, Guangdong
China
Tel: +86 755 26523879
Fax: +86 755 26523875
Email: sales@waynekerr.com
service@waynekerr.com

India

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FF-73, Amrit Plaza Commercial Complex
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Taiwan

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When returning the instrument please ensure adequate care is taken with packing and arrange insurance cover against transit damage or loss. If possible re-use the original packing box.

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