PRECISION MAGNETICS ANALYZER
3260B

User Manual

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Part N° 9H3260B

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CONTENTS

ILLUSTRATIONS

1. SAFETY

1.1 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.

1.2 AC Power Supply

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	N. AMERICAN
LIVE	BROWN	BLACK
NEUTRAL	BLUE	WHITE
GROUND	GREEN/YELLOW	GREEN

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.

Before switching on the equipment, ensure that it is set to the voltage of the local AC power supply.

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.

1.3 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.

1.4 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

Figure 2-1 PMA3260B Precision Magnetics Analyzer

The 3260B Precision Magnetics Analyzer provides 2-terminal or 4-terminal (Kelvin) measurement of inductors and transformers over the frequency range 20Hz to 3MHz. DC resistance measurements are performed at a drive level of 100mV. The drive level for AC measurements can be varied from 1mV to 10V rms. Automatic level control (ALC) can maintain the drive level at the component. During AC measurements the 3260B can supply a DC bias current which is variable between 1mA and 1A and when used with external 3265B DC Bias Units, up to 125A DC bias current is available.

The Telecom function allows insertion loss and return loss of line matching transformers to be derived with user-specified values of terminating resistance or impedance. Damped network components can also be selected, together with a blocking capacitor, if required.

The analyzer's measurement, display and control facilities include:

- spot frequency measurements;
- multi-frequency measurements at a number of user-defined frequencies;
- display of actual measurement values;
- series or parallel resonant frequency;
- bar graph analogue display for easy adjustment of variable components—spot frequency measurements only;
- linear or logarithmic graphical representation of a component or circuit across a user-defined frequency range;
- output of measurement results and graphical display to an Epson-compatible printer;
- sorting of components into bins according to their measured value and/or minor term (option);
- measurement of insulation resistance with a test voltage of up to 500V DC (option);
- demagnetization of coils.

All the above functions can be selected via manual front panel control or remote control via the GPIB interface for fully-automated high-speed testing.

3. INSTALLATION

3.1 AC Line Connections

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	N. AMERICAN
LIVE	BROWN	BLACK
NEUTRAL	BLUE	WHITE
GROUND	GREEN/YELLOW	GREEN

The supply voltage setting can be checked by looking through the transparent window on the rear panel next to the power inlet socket. This can be changed by first disconnecting the unit from the electrical supply, removing the window and adjusting the switch to read the required voltage. Replace the window and ensure that the fuse rating is correct:

230V	1A–T
115V	2A–T

No adjustment is required for variation of supply frequency.

Before connecting the AC power, read the precautions listed under section 1.2—AC Power Supply.

The instrument is not suitable for battery operation.

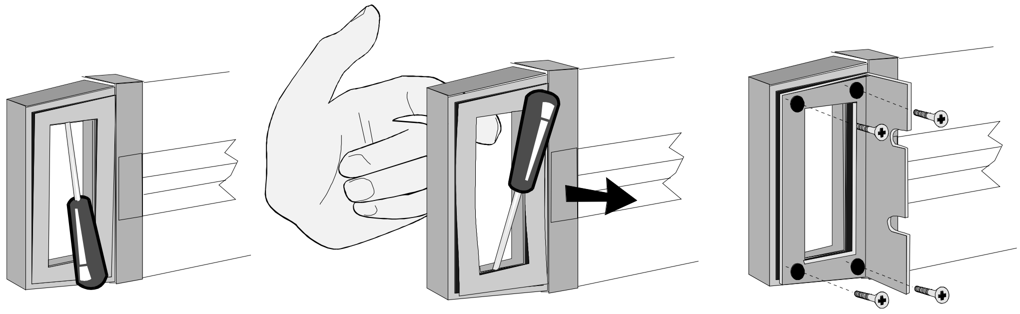
The power switch is located on the left of the front panel.

3.2 Location

The 3260B is intended for use either on the bench or in a rack. The power modules are convection cooled and care must be taken not to restrict any of the air paths.

3.2.1 Rack Mounting

There is a rack mounting kit available as an option 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 Brackets

3.3 Wayne Kerr Electronics Measurement Leads

The 3260B can be used with any of the following Wayne Kerr Electronics leads or fixtures. Except in **HANDLER MODE** (see Figure 5-3 for connections) ensure that the colour-coded plugs are mated correctly with the corresponding panel sockets.

Kelvin Clip Leads (Fine Jaws), Part No. 1EVA40100

General purpose 4-terminal measuring leads for conventional components giving good accuracy except for measurement of very small capacitances or very small inductances where the use of the 4-terminal component fixture, part number 1EV1006, will give more accurate results.

Kelvin Clip Leads ((large jaws), Part No. 1EVA40180

Similar to part number 1EVA40100 but with larger jaws making them more suitable for connection to terminal posts or larger diameter component leads.

Four-Terminal Lead Set, Part No. 1EV1505

600mm screened cable terminated in four crocodile clips at the component end. Not recommended for use above 30kHz.

SMD Tweezers, Part No. 1EVA40120

2-terminal component tweezers for use with surface-mount or leadless components. A cam is incorporated to set the jaw spacing to the width of the component to be tested so that O/C trim will trim out the residual capacitance of the tweezers.

Four-Terminal Component Fixture, Part No. 1EV1006

Remote fixture with sliding jaws to accommodate both axial and radial leaded components. This fixture will give the greatest accuracy for 4-terminal measurements of conventional components. The jaws can be set to the component width for trimming and component measurements can be performed without moving the measuring leads: stable lead positioning is important when measuring low value inductors.

3.3.1 Other Test Leads

Other test leads can be used with the analyzer, provided that they conform to the following connection protocol.

The front-panel BNC sockets are for screened cable connections to the unknown component or test fixture: use good quality 50Ω screened cable, e.g. RG174A/U; cable length should not exceed 2m. In each case, the outer connection provides the screening and the inner is the active connection. Except in **HANDLER MODE** (see Figure 5-3 for connections) the innermost pair of panel connectors carry the signal source (ORANGE) and the current return (RED) signals. The outer pair serve to monitor the actual voltage at the device under test (DUT), excluding any voltage drops arising in the source and return leads. The common ground point should be connected to component guards and/or screens for in-circuit measurements.

The outers of the BNC sockets are not directly connected inside the analyzer, so it is important that the GROUNDS are linked OUTSIDE. For accurate high frequency operation, the leads must be screened and the screens connected close to the DUT.

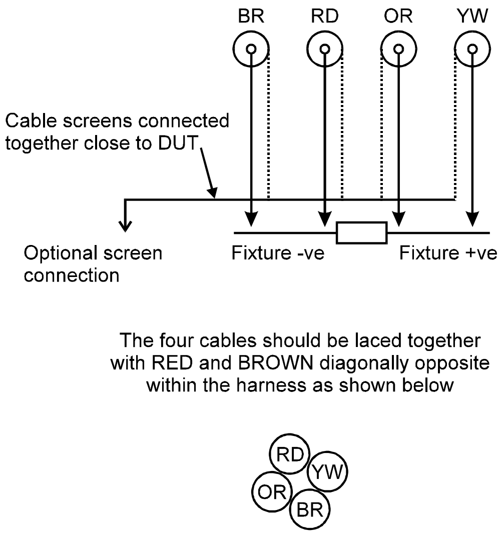


Figure 3-2 4 Terminal Measurement

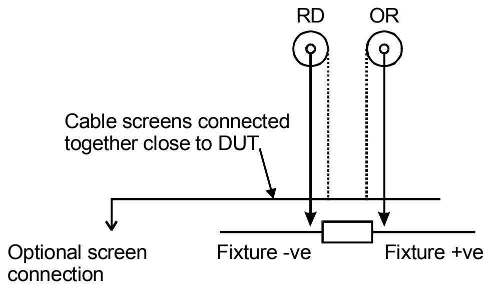


Figure 3-3 2 Terminal Measurement

4. OPERATION

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 DAMAGED.

4.1 The Rear Panel

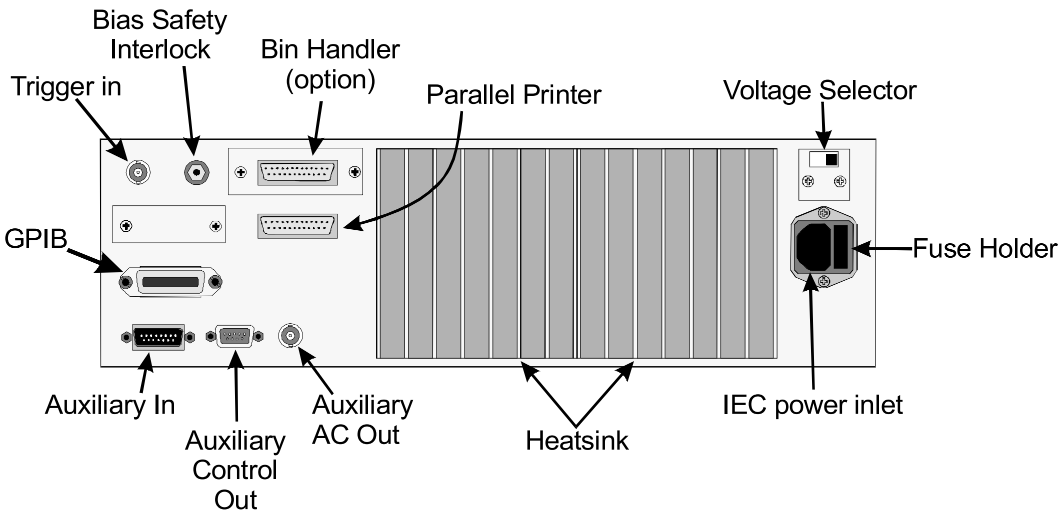


Figure 4-1 The 3260B Rear Panel

4.1.1 Voltage Selector

The instrument can be operated from an AC power source of either 115V or 230V. Before applying AC power to the IEC socket, ensure that the voltage selector switch is set to the voltage of the local AC power supply.

4.1.2 IEC Socket and Fuse Holder

Please read section 1.2—AC Power Supply, before connecting the IEC socket to the AC power source.

4.1.3 Rear Panel Control Connections

Label	Type	Use	Reference
SAFETY INTERLOCK	3 pole 3.5mm jack plug	To protect user against unintentional back emf.	See section 4.1.4
GPIB	Standard GPIB	For remote operation.	Sections 4.1.7 and 4.2.5
TRIGGER IN	BNC	Duplicates action of front panel trigger key.	Section 4.1.5
AUX IN	15-way D-type (male)	For future expansion	Section 4.1.8
AUX CONTROL OUT	9-way D-type (female)	For control of external options.	Section 4.1.9
AUX AC OUT	BNC	For future expansion	Section 4.1.10
PARALLEL PRINTER	25-way D-type (female)	To send results to local printer	Sections 4.1.6, 4.2.6.1, 5.15.2 and 6.2.1.
HANDLER	25-way D-type (male)	OPTIONAL - to interface with bin sorting equipment.	Sections 4.1.11 and 5.9

4.1.4 Safety Interlock

DC bias current is inhibited until the safety interlock circuit is complete. The terminal fixture for the inductor under test should be placed within a housing with an interlocked door controlled by a circuit such as that shown in Figure 4-2 below.

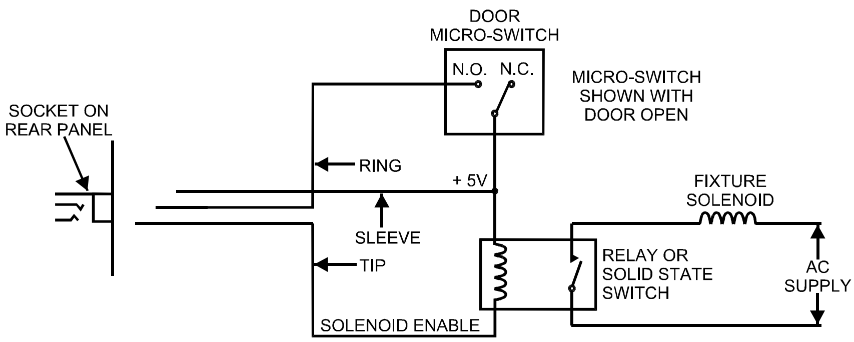


Figure 4-2 Typical Bias Interlock Fixture

Only when the fixture door is closed, and the microswitch therefore made, can DC bias be activated. At this time, the relay is energized, activating an AC supply for a solenoid which can be used to lock the door while bias remains available.

The solenoid drive relay should have a 5V DC coil of resistance not less than 200Ω. Diode coil protection is provided within the bias circuitry.

The door lock is activated when **Bias On** is selected on the instrument. If the door switch or interlock lead is broken, DC bias is inhibited.

Note

If the safety interlock is not required, it is necessary to insert the 3.5mm jack plug, with the ring and sleeve connections linked, into the socket on the back panel. Failure to do this will result in bias being inhibited, and the message, ✷ **Bias Interlock** ✷ being displayed.

4.1.5 External Trigger

The **TRIGGER IN** BNC socket is TTL compatible. 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.

4.1.6 Parallel Printer Connector

Allows the instrument to be connected to an Epson-compatible printer for printing of measurement results and graphs: see sections 5.15.2—Parameters Available when the Graph is Displayed and 6.2.1—Command Summary.

Note:

The printer must be enabled before results can be output to it: enter **Code 30** from the **MAIN MENU** as described in section 4.2.6.1. If printer output is enabled with no printer connected or with the printer power switched off, a message will be displayed and printer output will be disabled. Printer output will also be disabled when the instrument is switched off or goes to remote control. To manually disable the printer output enter **Code 31** from the **MAIN MENU**.

4.1.6.1 Parallel Printer Output

Header

When the printer is enabled, the instrument will print a title, together with the time and date, in the following format:

```
Wayne Kerr 3260B
13:53:17  02 Oct 00
```

Status

Whenever a mode is selected or changed, the status of the selected mode will be printed, for example:

```
2-TERM RESONANCE MODE
```

Test Conditions

A summary of the test conditions will be output whenever the type of test is changed, e.g. from **Rdc Meas** to **AC Meas** in **IMPEDANCE MODE**.

```
AC Meas:
L Q Parallel
1.02Vac  1.0000kHz
DC Bias 0.000 A OFF
Range Auto
Speed Fast
ALC off
```

If, on selecting a mode, the required test type is already selected, press the highlighted key once to obtain this test condition summary.

Measurement Results

Measurement results will be output to the printer in **IMPEDANCE**, **TRANSFORMER, INSULATION** and **BINNING** modes whenever a single-shot test is performed. The value of the frequency, test level or DC bias will be printed if highlighted in the test set up. For example, printing L and Q variation with frequency.

```
400.00 Hz    13.90mH, 12.55
500.00 Hz    13.85mH, 13.12
600.00 Hz    13.79mH, 13.98
800.00 Hz    13.72mH, 14.52
1.0000kHz    13.61mH, 15.07
```

To obtain a print out of test results without the additional parameter, move the test set-up highlight to **Range** or **Speed**.

Binning

A **PRINT** soft key label will be displayed in **BINNING MODE – COUNT** if a printer is connected and printing is enabled (**Code 30** from the **MAIN MENU**).

In **BINNING MODE – SET, Code 34** will print a list of the current bin set-up (the printer must first be enabled by entering **Code 30** from the **MAIN MENU**).

In **BINNING MODE – SORT** and single-shot mode, measurement results and bin numbers will be printed if printing is enabled.

4.1.6.2 Parallel Printer Connector Pin Assignment

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)

Pin	Description	Pin	Description
13	Select		

4.1.7 GPIB Connector

The General Purpose Interface Bus (GPIB) is a parallel port which allows communication between the instrument and other devices such as PCs fitted with a suitable interface card. The GPIB port allows remote control of the instrument for measurement of components and the collection of measurement results. For details of GPIB control and commands see section 6.

Devices should be connected to the instrument using a standard GPIB 24-pin connector assembly with a shielded cable. Use of the standard connector consisting of a plug and receptacle is recommended and should be compatible with the Amphenol and Cinch Series 57 or Amp Champ.

4.1.7.1 GPIB Connector Pin Assignment

Pin	Description	Pin	Description
1	Data Line 1	**13**	Data Line 5
2	Data Line 2	**14**	Data Line 6
3	Data Line 3	**15**	Data Line 7
4	Data Line 4	**16**	Data Line 8
5	EOI (End or Identify)	**17**	REN (Remote Enable)
6	DAV (Data Valid)	**18**	Ground
7	NRFD (Not Ready For Data)	**19**	Ground
8	NDAC (Not Data Accepted)	**20**	Ground
9	IFC (Interface Clear)	**21**	Ground
10	SRQ (Service Request)	**22**	Ground
11	ATN (Attention)	**23**	Ground
12	Screen	**24**	Signal Ground

4.1.8 Auxiliary In

For future expansion.

4.1.9 Auxiliary Control Out

For control of external options, e.g. when using external DC bias current from a 3265B DC Bias Unit, the 3260B **AUX CONTROL OUT** connector is connected to the 3265B **AUX IN** connector using the control link cable supplied with the 3265B DC Bias Unit.

4.1.10 Auxiliary AC Out

For future expansion.

4.1.11 Bin Handler Interface (Option)

For details of how to use the **BINNING MODE – Set**, **– Sort** and **– Count** modes refer to section 5.9—BINNING MODE (Optional).

An external bin handler may be connected via a 25-way D-type connector at the rear of the instrument (see section 4.1.11.5 for bin handler interface pin assignment details). If the option is fitted the instrument will measure a component, sort it into one of the ten bins according to the measurement results and then provide the signals for external bin handling hardware to physically 'bin' the component. The interface supports up to ten external bins and provision is made for external bin handler hardware to trigger a measurement directly.

On power up, the instrument recognizes if the bin handler option is fitted, the $\overline{\text{BUSY}}$ line is taken low, with the $\overline{\text{BDA}}$ and all $\overline{\text{BIN}}$ lines high. Measurements may be triggered by pressing the **Trigger** key on the front panel or taking the external **TRIGGER IN** line low. If a measurement is in progress when the unit is triggered, the current measurement will be aborted and a new measurement started.

If the external trigger is to be used under GPIB control, then the local trigger must be enabled by sending the GPIB command 'LOC-TRIG ON'.

The $\overline{\text{BUSY}}$ line goes low to acknowledge the trigger and also to indicate that the component between its terminals is in the process of being measured and should not be removed until the $\overline{\text{BUSY}}$ line goes high again. The $\overline{\text{BDA}}$ line is the opposite logic level of the $\overline{\text{BUSY}}$ line. The falling edge of the $\overline{\text{BDA}}$ signal indicates that the data on the $\overline{\text{BIN}}$ lines is valid.

In **IMPEDANCE MODE** the Pass/Fail output corresponds to the scale bar **PASS**, **HI** and **LO**. In **MULTI FREQ – Run** mode the Pass/Fail output corresponds to the **PASS**, **FAIL**, **HI** and **LO** results. The Pass/Fail output goes low only when a measurement has passed all set limits, see section 4.1.11.5 for the bin handler interface pin assignment.

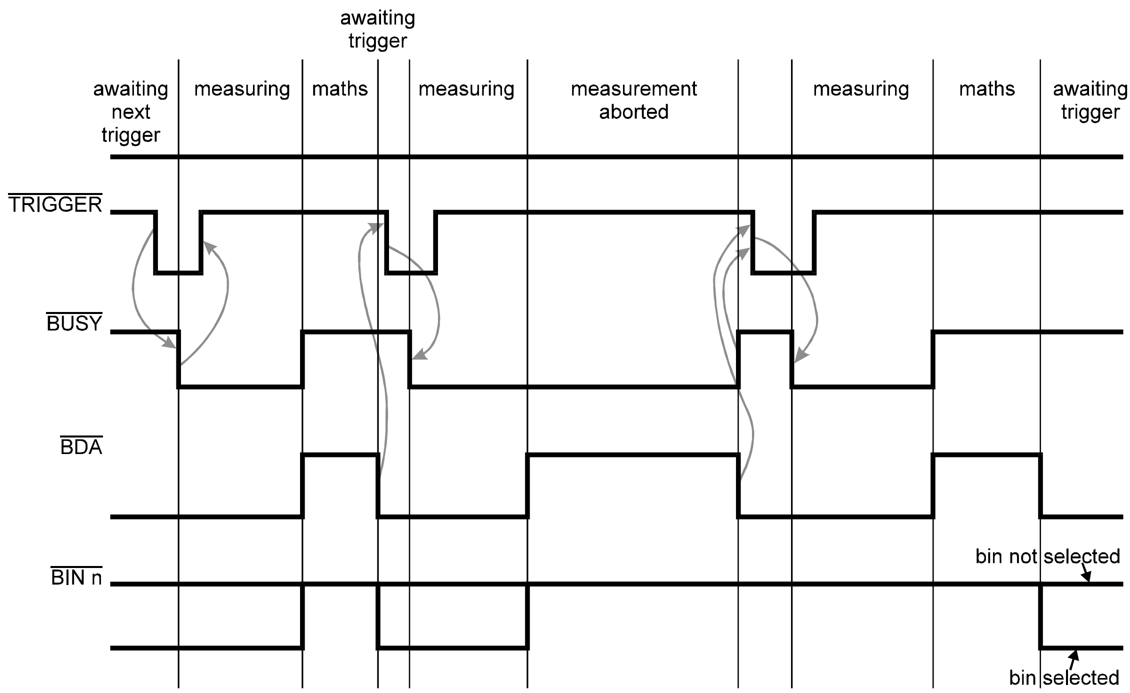


Figure 4-3 Standard Bin Handler Timing

The two output signal lines $\overline{\text{BUSY}}$ and $\overline{\text{BDA}}$ (Bin Data Available) will at any time assume one of four different states:

4.1.11.1 Null State

The null state is defined as $\overline{\text{BUSY}}$ low and $\overline{\text{BDA}}$ high. The instrument enters this state on power-up. When this state is detected by external hardware, it must be assumed that the current signals on the $\overline{\text{BIN}}$ lines are invalid and should be ignored.

4.1.11.2 Ready for Trigger

$\overline{\text{BUSY}}$ is high and $\overline{\text{BDA}}$ is low in this state. All $\overline{\text{BIN}}$ lines will be unchanged. If the previous state was a null then all $\overline{\text{BIN}}$ lines will be high, meaning no bin selected, although $\overline{\text{BDA}}$ suggests that valid bin data is present. When the instrument receives a trigger it will respond by entering the next state.

4.1.11.3 Busy

Both $\overline{\text{BUSY}}$ and $\overline{\text{BDA}}$ are low in this state. The $\overline{\text{BUSY}}$ line goes low to acknowledge the trigger and also to indicate that the component between its terminals is in the process of being measured and should not be removed until the $\overline{\text{BUSY}}$ line goes high again, when the instrument enters the next state.

4.1.11.4 Not Busy

Both $\overline{\text{BUSY}}$ and $\overline{\text{BDA}}$ are high and all $\overline{\text{BIN}}$ lines are set to high in this state. The instrument has finished with the component under test, which may be removed and replaced by the next component. However, the instrument has still to sort the component into the relevant bin and, as the current bin is being updated, all the $\overline{\text{BIN}}$ lines are made invalid.

If the process has been completed without interruption, the instrument will re-enter the 'Ready for Trigger' state waiting to measure the next component. The bin handler hardware should respond to the falling edges of the $\overline{\text{BDA}}$ line and the relevant $\overline{\text{BIN}}$ line, which will occur only when a component has been successfully measured and sorted.

4.1.11.5 Bin Handler Interface Pin Assignment

Pin	Description	Pin	Description
1	Bin 0 select (active low)	18	Bin 9 select (active low)
2	Bin 1 select (active low)	19	Unused
3	Bin 2 select (active low)	20	Unused
4	Bin 3 select (active low)	21	Pass/Fail output (low = Pass)
13	Bin 4 select (active low)	8	Trigger input
14	Bin 5 select (active low)	10	$\overline{\text{BUSY}}$ output
15	Bin 6 select (active low)	5	$\overline{\text{BDA}}$ output
16	Bin 7 select (active low)	7	+5V Supply (<50mA)
17	Bin 8 select (active low)	24	Ground (0v)

4.1.11.6 Signal Levels

Output High: >4V Output Low: <1V

Input High: >3.5V Input Low: <1.5V

Drive capability typically is 10mA sink (low) and 30µA (high).

4.2 The Front Panel

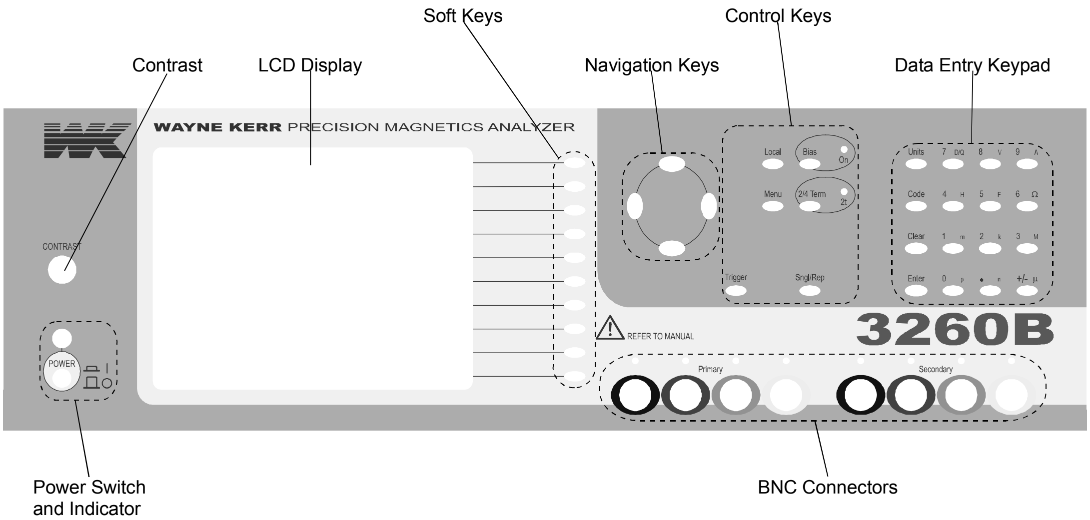


Figure 4-4 The 3260B Front Panel

4.2.1 Switching the Instrument ON

With the instrument connected to the correct AC power supply (see section 3—Installation) press the **POWER** switch. The power indicator will light and the instrument will display the mode and settings selected when the instrument was last switched off (the exception is **Bias** which, for safety reasons, is always OFF when the instrument is powered up).

If the display is too bright or too dark, use the **CONTRAST** control above the power switch to set the contrast level.

If the analyzer had previously been set up for measuring components, testing can recommence after checking the settings and, if applicable, switching the **Bias** back on.

To return to the **MAIN MENU** press the **Menu** control key.

4.2.2 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.

4.2.3 The Soft Keys

The general protocol is that soft keys labelled with **UPPER CASE** letters select the labelled mode and soft keys labelled with **lower case** letters select settings within the current mode.

The functions of the ten soft keys change according to the mode selected. For example, when the **MAIN MENU** is displayed by pressing the **Menu** key, the soft keys relate to the various modes available, e.g. **IMPEDANCE**, **TRANSFORMER**, etc. Once a mode has been selected, the soft keys labelled with small letters select settings within the mode, while the soft keys labelled with capital letters select the labelled modes.

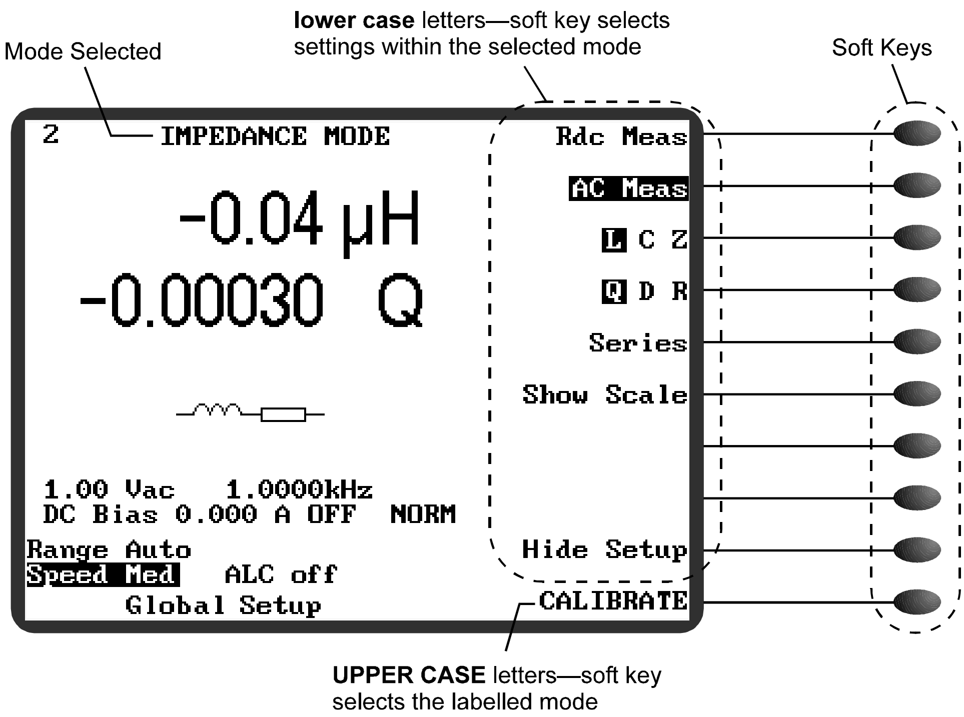


Figure 4-5 The Soft Keys

4.2.4 The Navigation Keys

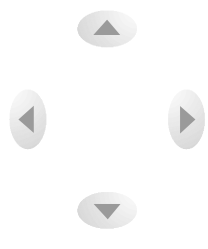


Figure 4-6 The Navigation Keys

When the set up details are showing on the screen (in some modes, there is a soft key which toggles between **Hide Setup** and **Show Setup:** this soft key can be seen in Figure 4-5), the left and right navigation keys, ◀ and ▶, allow each parameter to be selected in turn. When a parameter is selected, the up and down navigation keys, ▲ and ▼, step the numeric value for AC level, frequency and DC Bias: the steps vary according to the value but are always multiples of 1, 2 or 5. Finer frequency steps can be achieved by using the data entry keypad, see section 4.2.6. For other parameters, the ▲ and ▼ navigation keys change the settings, e.g. Auto Range/[fixed range], Slow/Med/Fast/Max, ALC off/on.

4.2.5 The Control Keys

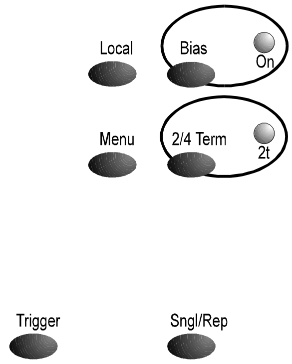


Figure 4-7 The Control Keys

Pressing **Local** restores control to the front panel when the instrument is under GPIB control.

Bias toggles the DC bias current ON and OFF. Before bias can be switched ON, the Bias parameter must be selected with the left and right navigation keys, ◂ and ▸, and a Bias current value entered, either with the up and down navigation keys, ▴ and ▾, or using the data entry keypad: see section 4.2.6. During AC measurements the 3260B can supply a DC bias current which is variable between 1mA and 1A (**DC Bias NORM**) and when used with an external 3265B DC Bias Unit, up to 125A DC bias current is available (**DC Bias BOOST**). Whenever DC bias is on, the message shown below in Figure 4-8 will be displayed at the top of the screen.

Figure 4-8 Bias Safety Hazard Notice

Pressing the **Menu** key displays the **MAIN MENU**, from where each mode of operation can be selected with the soft keys. To select the second page of menu options, press the **Menu** control key again or press the **MORE . .** soft key.

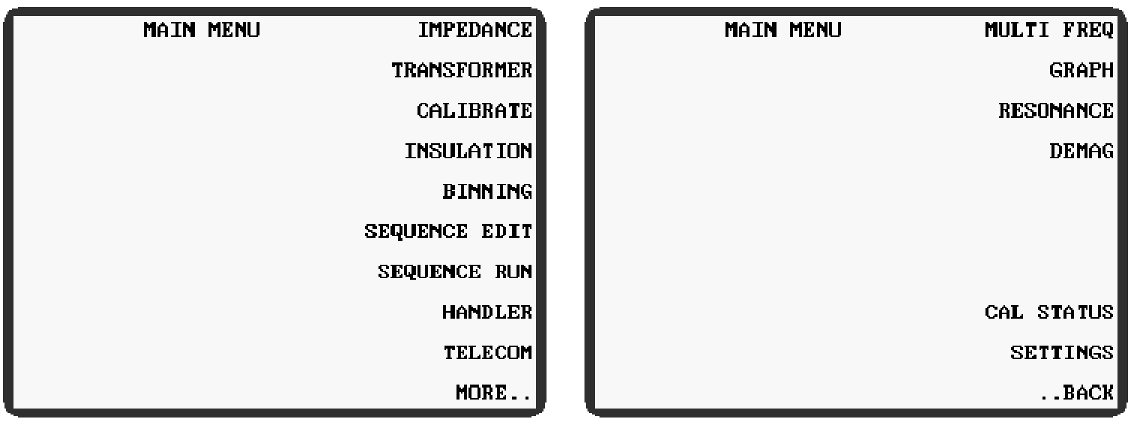


Figure 4-9 The3260B Main Menu (pages 1 and 2)

The **2/4 Term** key selects 2- or 4-terminal measurement. When 2-terminal measurement is selected the associated indicator lights and the display shows **2-TERM… MODE** at the top of the screen. Switching between 2- and 4-terminal mode will require the analyzer to be retrimmed, see section 4.3. 4-terminal measurements are recommended when measuring low impedance devices. Quoted accuracies assume 4-terminal connection whenever the DUT impedance is below 1kΩ.

Sngl/Rep toggles between **Single shot mode** and **Repetitive mode**. When **Sngl/Rep** is pressed the display briefly indicates the mode selected as shown in Figure 4-10 and Figure 4-11 below. Single shot mode is also indicated by the lack of a continuously flashing asterisk (*) in the top left corner of the screen. Conversely, the presence of a continuously flashing asterisk indicates that the instrument is in repetitive mode. The asterisk flashes once every time the instrument makes a measurement.

`Single shot mode`

Figure 4-10 Single Shot Mode

`Repetitive mode`

Figure 4-11 Repetitive Mode

When in single shot mode, the **Trigger** key initiates a single measurement. If it is pressed and held, the analyzer will fall into repetitive measurement mode until the key is released.

4.2.6 The Data Entry Keypad

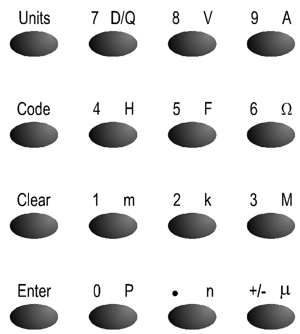


Figure 4-12 The Data Entry Keypad

The data-entry keypad is a multi-function key set permitting manual entry of data values, measurement units and control codes.

The **Units** key must be used prior to keying a unit or multiplier. Where more than one unit is available on a key, e.g. D/Q, pressing the key will display the first unit, pressing the key again will display the second unit. Terminate the units mode with **Enter** to accept the key sequence. Pressing **Clear** will delete the whole key sequence; pressing ◀ will delete the last key press.

An invalid keypad entry may cause the entry line to be cleared and an error message, such as the one shown in Figure 4-13, to be displayed, in which case the existing settings will be preserved; or the nearest available value may be set, accompanied by the error message shown in Figure 4-14.

```
Units mismatched
```

Figure 4-13 Example of an Error Message from an Invalid Keypad Entry

```
Nearest Available
```

Figure 4-14 'Nearest Available' Error Message

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 **-**. For numbers which are positive only, this key is disabled.

4.2.6.1 Keypad Codes

A number of special functions are available by pressing **Code** followed by a valid code number and terminated with **Enter**. The codes shown below are only available in the mode or menu indicated; some are for the use of a service engineer.

MAIN MENU	
Code	**Description**
0.1	Display the character set. Press any key to display more characters, when all characters have been shown, the main menu will be displayed and normal operation can be resumed.
0.4	Test the keyboard.
9.1	Load default values of non-volatile RAM variables, measurement conditions and trim values.
9.2	Clear sequence programs
9.3	Load default values of self-calibration and HF lead compensation data
30	Enable printer output
31	Disable printer output
32	Print factory calibration data

SETTINGS MENU	
Code	**Description**
25	Set the real time clock
34	Print the settings page. Printer must be enabled first—enter code 30 in MAIN MENU.

SEQUENCE EDIT MODE	
Code	**Description**
0.3	DIR command
0.4	Save the working program
0.5	Load a program explicitly

SEQUENCE EDIT MODE	
Code	**Description**
34	Print the full list of the current program. Code 30 must be entered first from the MAIN MENU page.

SEQUENCE RUN MODE	
Code	**Description**
50	Enter single step mode
51	Cancel single step mode
52	Test step failure message disabled
53	Test step failure message enabled
3260	Lock / unlock keyboard

IMPEDANCE, TRANSFORMER AND HANDLER IMPEDANCE MODES	
Code	**Description**
10	Select fine frequency steps
11	Select coarse frequency steps
12	Set global test conditions
13	Set non-global test conditions
18	Single-shot mode
19	Repetitive mode

TRANSFORMER AND HANDLER IMPEDANCE MODES	
Code	**Description**
14	Select turns ratio correction for normal transformer
15	Select turns ratio correction for auto transformer
16	No turns ratio correction applied

BIN SET MODE	
Code	**Description**
10	Select fine frequency steps
11	Select coarse frequency steps
18	Single shot mode
19	Repetitive mode

BIN SET MODE	
Code	**Description**
34	Print the present bin set-up. Code 30 must be entered first from the MAIN MENU page.
40	Store bin set-up at a given location in non-volatile memory.
41	Recall a bin set-up from non-volatile memory.
42	List all the set-up in non-volatile memory.

BIN SORT AND BIN COUNT MODES	
Code	**Description**
18	Single shot mode
19	Repetitive mode

Key Sequence Examples (characters in [ ])

Example 1: Supply the analyzer with a value of 27.39mH

1) Select the following settings in **IMPEDANCE MODE**:

   AC Meas, **L**, **Q**, **Parallel**, **Show Scale**, **%**.

2) Using the ◄ and ► keys, highlight the 'nominal' parameter (underneath the left-hand-side of the scale).

3) Key the following sequence:

[.] [0] [2] [7] [3] [9] [Units] [H] check data entry line is correct, then press [Enter]

or

[2] [7] [.] [3] [9] [Units] [m] [H] [Enter]

If a mistake is made in a key sequence, before pressing **Enter**, press ◄ to delete the last key press or **Clear** to delete the whole key sequence.

Example 2: Set the frequency to 100kHz

1) Using the ◄ and ► keys, highlight the frequency.

2) Key the following sequence:

[1] [0] [0] [0] [0] [0] [Enter]

or

[1] [0] [0] [Units] [k] [Enter]

or

[.] [1] [Units] [M] [Enter]

4.3 Trimming

The purpose of trimming is to eliminate the effects of stray capacitance or series impedance in the connecting leads or fixture.

The trim values are held in non-volatile stores and for most measurements no retrimming is necessary. The exceptions are:

- when the lead set or fixture is changed;
- when the highest possible accuracy is required for measurements of very high or very low impedances;
- when maximum accuracy is required when switching between modes, in which case maximum accuracy will be obtained by trimming from the mode which is to be used for component measurement;
- when the instrument is switched between 4-terminal and 2-terminal operation;
- when the instrument is switched to, or from, **HANDLER MODE**, see section 4.6—Handler Calibration.

Depending on the trim option selected, the analyzer trims by making measurements at a number of frequencies, including the measurement frequency in use when the trim was initiated, 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. Corrections for the Rdc functions are also stored.

For **O/C Trim** the Kelvin clips or fixture jaws should be separated by a distance equivalent to the DUT pin separation.

For **S/C Trim** the connector jaws should be clipped to a piece of wire or a component lead as close together as possible. Do not connect the clips directly together: this does not provide the necessary 4-terminal short circuit and will lead to trim errors.

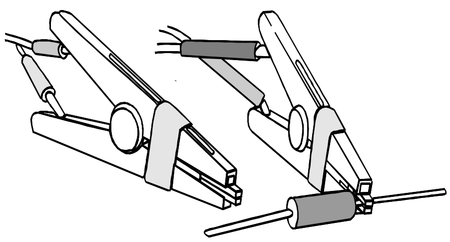


Figure 4-15 Connections for O/C trimming of Kelvin clips

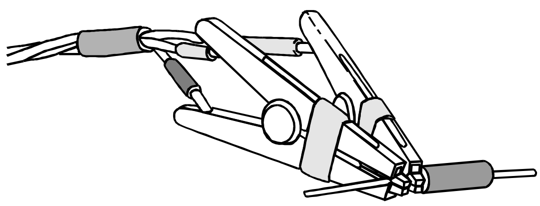


Figure 4-16 Connections for S/C trimming of Kelvin clips

For **HF Lead Compensation** the transfer standard capacitor supplied with the analyzer should be placed in the Kelvin clips or fixture jaws. Both O/C and S/C Trims must be performed before performing HF lead compensation.

4.3.1 Performing an O/C Trim (Pri) or S/C Trim (Pri)

For normal impedance measurements these are the only trims required.

1) Select **CALIBRATE**, either from the **MAIN MENU**, or from a mode which has **CALIBRATE** as an option (in which case pressing the bottommost soft key, which will be labelled with the name of the original mode, e.g. **IMPEDANCE**, **TRANSFORMER**, will return the analyzer to that mode). The analyzer will enter **CALIBRATE MODE**.

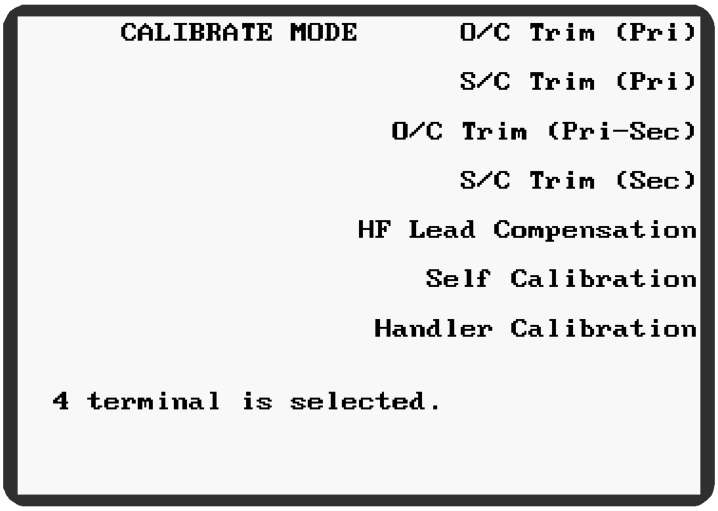


Figure 4-17 Calibrate Mode

2) Select **O/C Trim (Pri)** or **S/C Trim (Pri)**.
3) With the measurement leads connected to the **Primary** BNC connectors, open- or short-circuit the Kelvin clips or fixture jaws as appropriate.
4) Select the trim option required and wait until the analyzer has finished trimming. The trim options are described in section 4.3.1.1.

Note:

If the instrument is switched OFF during the trim, the messages shown in Figure 4-18 and Figure 4-23 will be displayed when the instrument is next switched ON. The component measurement modes will be reset to the default settings and `O/C Trim Error` or `S/C Trim Error` will be displayed at the top of the screen. These messages will only be cleared by performing the appropriate trims. The instrument can be used with the default settings but it is recommended that O/C trim and/or S/C trim is run for full measurement accuracy.

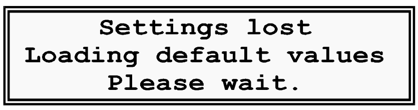


Figure 4-18 Settings Lost

Figure 4-18 will also be displayed when power is removed during other critical routines, such as calibration and data entry.

4.3.1.1 Trim Options

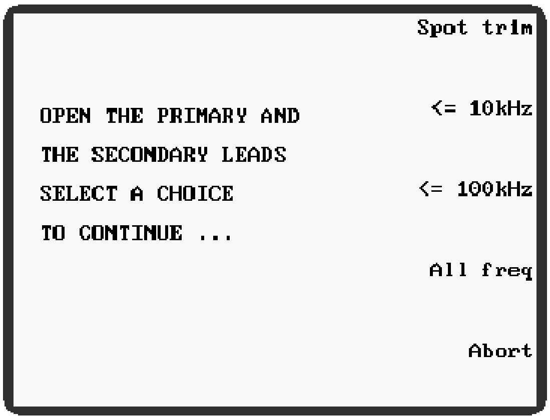


Figure 4-19 O/C Trim (Pri) Options

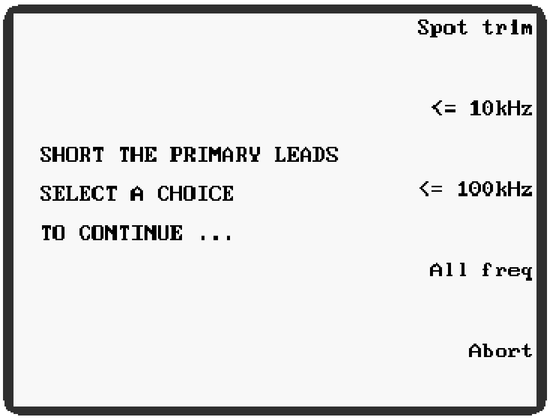


Figure 4-20 S/C Trim(Pri) Options

All freq trims at a number of frequencies, including the frequency set when the trim was initiated. For most measurements made using standard test leads and fixtures this is the normal trim option to use. The other trim options are normally only used in exceptional circumstances, such as when a special test fixture fails O/C or S/C trim at certain frequencies outside of the component test parameters.

Spot trim trims only at the frequency set in the last selected mode.

<= 10kHz trims at a number of frequencies up to and including 10kHz.

<= 100kHz trims at a number of frequencies up to and including 100kHz.

Abort cancels the trim and displays the **CALIBRATE MODE** main screen.

Note:

If, after trimming with an option other than **All freq**, a measurement frequency is selected which is outside of the trim parameters, `O/C Trim Error` or `S/C Trim Error` will be displayed at the top of the screen and no trim corrections will be applied for the frequency selected. The analyzer can be used without trim correction but full measurement accuracy will not be available until the analyzer is retrimmed using an option which covers the new measurement frequency.

4.3.2 Performing an O/C Trim (Pri–Sec)

This trim is required for transformer and insulation measurements. If using Kelvin clip leads, two sets of leads are required.

1) Select **CALIBRATE**, either from the **MAIN MENU**, or from a mode which has **CALIBRATE** as an option (in which case pressing the bottommost soft key, which will be labelled with the name of the original mode, e.g. **IMPEDANCE**, **TRANSFORMER**, will return the analyzer to that mode). The analyzer will enter **CALIBRATE MODE**, shown in Figure 4-17.
2) Select **O/C Trim (Pri–Sec)**.
3) If using two sets of Kelvin clip leads, connect one set of leads to the **Primary** BNC connectors and the other set of leads to the **Secondary** BNC connectors. If using other

measurement leads, connect them to the **Primary** and **Secondary** BNC connectors as appropriate.

4) Open-circuit the Kelvin clips (see Figure 4-15) or fixture jaws.

5) Select the trim option required and wait until the analyzer has finished trimming. The trim options are described in section 4.3.1.1.

WARNING!

If the optional INSULATION MODE is fitted, part of the O/C Trim (Pri–Sec) performs an INSULATION MODE trim. The test connections are at a high voltage during this trim. While high voltage is applied, a message, shown in Figure 4-21 below, will be displayed on the screen. ***To minimize the risk of electric shock, AVOID TOUCHING THE TEST CONNECTIONS during the trimming operation.***

Figure 4-21 High Voltage ON warning

4.3.3 Performing an S/C Trim (Sec)

This trim is required for transformer measurements.

1) Select **CALIBRATE**, either from the **MAIN MENU**, or from a mode which has **CALIBRATE** as an option (in which case pressing the bottommost soft key, which will be labelled with the name of the original mode, e.g. **IMPEDANCE**, **TRANSFORMER**, will return the analyzer to that mode). The analyzer will enter **CALIBRATE MODE**, shown in Figure 4-17.

2) Select **S/C Trim (Sec)**.

3) With the measurement leads connected to the **Secondary** BNC connectors, short-circuit the Kelvin clips (see Figure 4-16) or fixture jaws.

4) Select the trim option required and wait until the analyzer has finished trimming. The trim options are described in section 4.3.1.1.

4.4 HF Lead Compensation

The purpose of HF lead compensation is to eliminate scalar errors which are due to the test leads. These vary with test lead length and become significant at frequencies above 200kHz.

Before performing HF lead compensation, both **O/C Trim (Pri)** and **S/C Trim (Pri)** must be performed using the **All freq** trim option, see section 4.3.1 above.

4.4.1 Performing HF Lead Compensation

1) Select **CALIBRATE**, either from the **MAIN MENU**, or from a mode which has **CALIBRATE** as an option (in which case pressing the bottommost soft key, which will be labelled with the name of the original mode, e.g. **IMPEDANCE**, **TRANSFORMER**, will

return the analyzer to that mode). The analyzer will enter **CALIBRATE MODE**, shown in Figure 4-17.

2) Select the **HF Lead Compensation** soft key.

   The following message will be displayed:

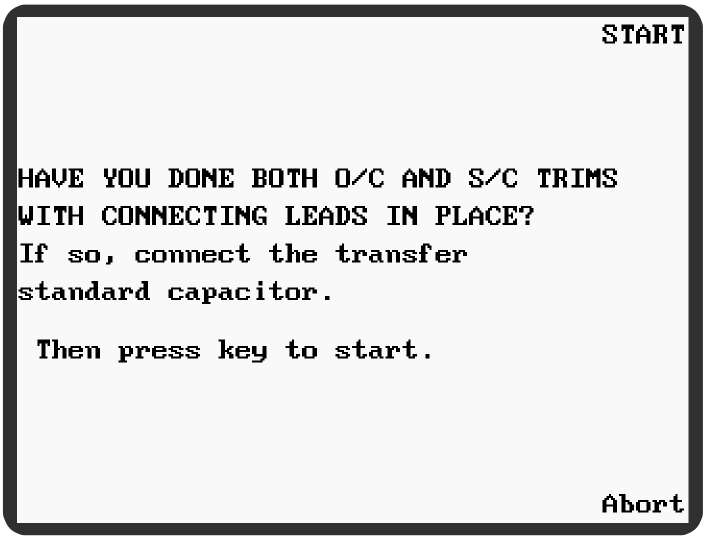


Figure 4-22 HF Lead Compensation

3) Assuming that O/C and S/C trims have already been performed, connect the transfer standard capacitor supplied with the instrument to the Kelvin clips or fixture jaws.

4) Press the **START** soft key. When the **CALIBRATE MODE** main screen is redisplayed, HF lead compensation has finished.

Notes:

1) If the HF lead compensation routine fails for any reason, e.g. a test lead connection error or a power failure during the routine, Figure 4-18 (above) may be displayed when the instrument is next switched ON, and Figure 4-23 will be displayed every time the instrument is switched ON. When component measuring modes are selected, `Calibrate Error` will be displayed at the top of the screen when the measurement frequency is set to 200kHz or above. These messages will only be cleared by successfully performing the HF lead compensation routine preceded, if necessary, by O/C and S/C trims. The instrument can be used with the default settings but it is recommended that the trims are run for full measurement accuracy.

```
HF Lead Compensation data is lost
and default values have been applied.
To maintain full calibration accuracy
above 500kHz, run the HF-Lead-
Compensation routine with the
Transfer Standard capacitor
connected.

Press any key to clear this message.
```

Figure 4-23 HF Lead Compensation Data Lost

2) If the instrument is switched to **HANDLER MODE** and then back to any other mode, `Calibrate Error` will be displayed at the top of the screen when the measurement frequency is set to 200kHz or above. This message will only be cleared, and full measurement accuracy restored, by successfully performing the HF lead compensation routine preceded, if necessary, by O/C and S/C trims.

4.5 Self Calibration

Self calibration is performed to set calibration constants for signal processing elements in the measurement hardware and signal generation system, and to compensate for components which have drifted with time. To maintain full specified accuracy it should be run at least every three months. If it is not run within this period, a reminder will be displayed at power up. This message is shown in Figure 4-24 below.

```
To maintain full calibration accuracy,
the self-calibrate routine should be
run periodically. This calibration is
now due. Allow the instrument to warm
up for at least 30 minutes at its
normal operating temperature before
running this routine.

 Press any key to clear this message.
```

Figure 4-24 Self-Calibration Reminder

4.5.1 Performing Self Calibration

1) Switch on the instrument and allow it to stabilize for at least 30 minutes at a stable ambient temperature.
2) Select **CALIBRATE**, either from the **MAIN MENU**, or from a mode which has **CALIBRATE** as an option (in which case pressing the bottommost soft key, which will be labelled with the name of the original mode, e.g. **IMPEDANCE**, **TRANSFORMER**, will return the analyzer to that mode). The analyzer will enter **CALIBRATE MODE**, shown in Figure 4-17.
3) Select **Self Calibration**.
4) Disconnect all BNC leads from the instrument front panel and select the **Start** soft key. Allow at least 1 minute for the self calibrate routine to run.

When self calibration is finished, the analyzer will return to **CALIBRATE MODE**.

The **Abort** soft key will return the analyzer to **CALIBRATE MODE**.

Note:

If the self calibration routine fails for any reason, e.g. a test lead connection error or a power failure during the routine, or if the self calibration data becomes corrupted, Figure 4-18 (above) may be displayed when the instrument is next switched ON, followed by Figure 4-25, which will be displayed every time the instrument is switched ON. When component measuring modes are selected, `Calibrate Error` will be displayed at the top of the screen. These messages will only be cleared by performing self calibration. The instrument can be used with the default settings but it is recommended that self calibration is run for full measurement accuracy.

```
Calibration data is lost and
default values have been applied.
To restore full calibration accuracy,
run the self-calibrate routine,
preferably after the instrument has
warmed up for at least 30 minutes at
its normal operating temperature.


Press any key to clear this message.
```

Figure 4-25 Calibration Data Lost

4.6 Handler Calibration

In **HANDLER MODE** the front panel connections are reconfigured to make the analyzer compatible with many existing 4-terminal fixtures and scanners. Due to the different lead configuration, O/C trim, S/C trim and HF lead compensation cannot share trim values with other modes. The trim corrections saved by the instrument in **HANDLER CAL MODE** will overwrite those saved in the normal **CALIBRATION MODE**. Therefore, when the instrument is switched from **HANDLER MODE** to any other mode, the instrument's *default* trim settings will be used when measuring components. The instrument can be used with the default settings but it is recommended that the appropriate trims are run for full measurement accuracy. Handler calibration consists of **O/C Trim**, **S/C Trim** and **HF Lead Compensation**.

Notes

1) If the instrument is switched to **HANDLER MODE** and then back to any other mode, `Calibrate Error` will be displayed at the top of the screen when the measurement frequency is set to 200kHz or above. This message will only be cleared, and full measurement accuracy restored, by successfully performing the HF lead compensation routine preceded, if necessary, by O/C and S/C trims.

2) If the instrument is switched to **HANDLER MODE** and then back to any other mode, and is then switched OFF, Figure 4-18 may be displayed when the instrument is next switched ON, and Figure 4-23 will be displayed every time the instrument is switched ON. When component measuring modes are selected, `Calibrate Error` will be displayed at the top of the screen when the measurement frequency is set to 200kHz or above. These messages will only be cleared by successfully performing the HF lead compensation routine preceded, if necessary, by O/C and S/C trims. The instrument can be used with the default settings but it is recommended that the trims are run for full measurement accuracy.

3) **Self Calibration** is also an option from **HANDLER CAL MODE**. This is run without leads or a fixture connected to the instrument front panel and is therefore valid for all modes and all types of tests. The self calibration routine is also available from the normal **CALIBRATION MODE** menu: see section 4.5.

4.6.1 O/C Trim and S/C Trim

O/C Trim and S/C Trim must be run from **HANDLER CAL MODE** for full measurement accuracy when using a compatible 4-terminal fixture or scanner with the instrument.

1) Either:

   a) Select **CALIBRATE** from the **MAIN MENU.** The analyzer will enter **CALIBRATE MODE**, shown in Figure 4-17. Select the **Handler Calibration** soft key. The analyzer will enter **HANDLER CAL MODE**.

   b) Select **CALIBRATE** from **HANDLER MODE** (in which case pressing the bottommost soft key, which will be labelled **HANDLER**, will return the analyzer to **HANDLER MODE**). The analyzer will enter **HANDLER CAL MODE**.

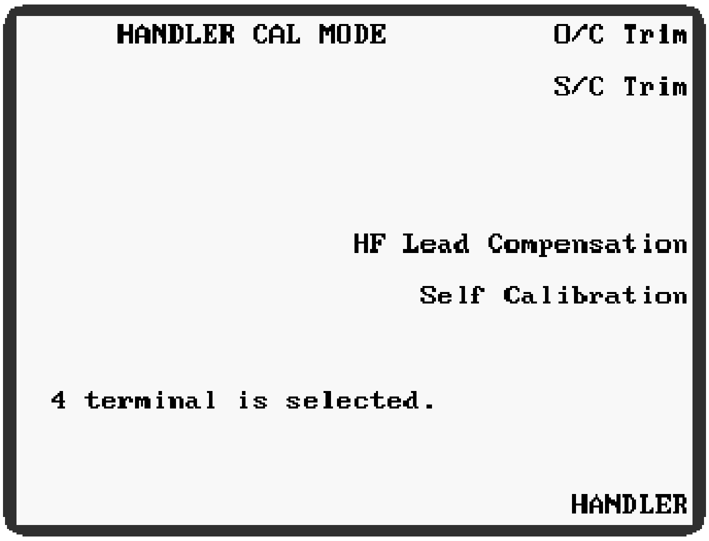


Figure 4-26 Handler Cal Mode

2) Select O/C Trim or S/C Trim.

3) With the fixture/scanner leads connected to the **Primary** and **Secondary** BNC connectors as shown below, open- or short-circuit the fixture/scanner component contacts as appropriate.

Primary BNC Connectors				Secondary BNC Connectors			
Brown	**Red**	**Orange**	**Yellow**	**Brown**	**Red**	**Orange**	**Yellow**
Connect to fixture/scanner leads as shown below (n.c. = no connection)							
n.c.	**Red**	**Orange**	n.c.	n.c.	**Brown**	**Yellow**	n.c.

Figure 4-27 Front Panel BNC Connections for Handler Mode

4) Select the trim option required and wait until the analyzer has finished trimming. The **HANDLER MODE** trim options are described in section 4.6.1.1.

Note

If the instrument is switched OFF during O/C trim or S/C trim, the message shown in Figure 4-18 will be displayed when the instrument is next switched ON, followed by Figure 4-23, which will be displayed every time the instrument is switched ON. The component measurement modes will be reset to the default settings and `O/C Trim Error` or `S/C Trim Error` will be displayed at the top of the screen. Figure 4-28 will be displayed whenever the instrument is switched ON in **HANDLER MODE** after power is interrupted during O/C Trim or S/C Trim. These messages will only be cleared by performing the appropriate trims. The instrument can be used with the default settings but it is recommended that O/C trim and/or S/C trim is run for full measurement accuracy.

```
Handler Factory Cal lost
  Default values used
```

Figure 4-28 Handler Factory Cal Lost Message

4.6.1.1 HANDLER MODE Trim Options

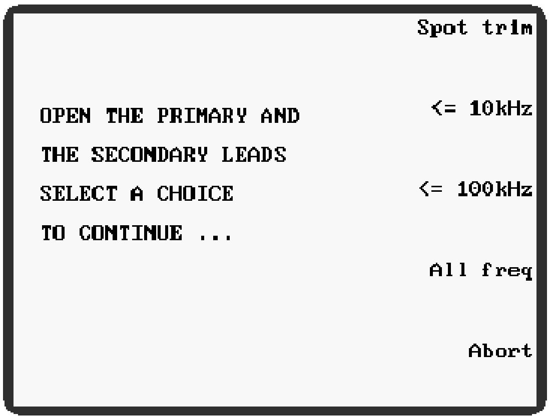


Figure 4-29 HANDLER CAL MODE O/C Trim Options

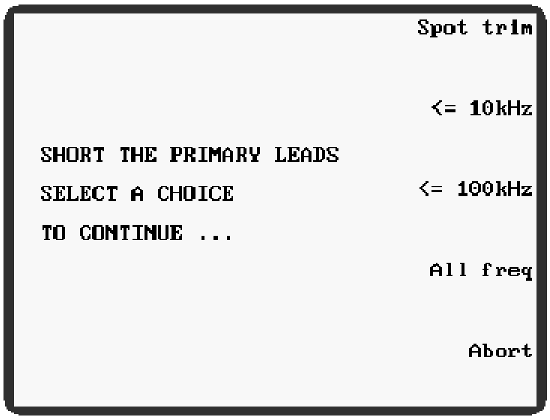


Figure 4-30 HANDLER CAL MODE S/C Trim Options

All freq trims at a number of frequencies, including the frequency set when the trim was initiated. For most measurements this is the normal trim option to use. The other trim options are normally only used in exceptional circumstances, such as when a fixture or scanner fails O/C or S/C trim at certain frequencies outside of the component test parameters.

Spot trim trims only at the frequency set in **HANDLER MODE**.

<= 10kHz trims at a number of frequencies up to and including 10kHz.

<= 100kHz trims at a number of frequencies up to and including 100kHz.

Abort cancels the trim and displays the **HANDLER CAL MODE** main screen.

Note:

If, after trimming with an option other than **All freq**, a measurement frequency is selected which is outside of the trim parameters, `O/C Trim Error` or `S/C Trim Error` will be displayed at the top of the screen and no trim corrections will be applied for the frequency selected. The analyzer can be used without trim correction but full measurement accuracy will not be available until the analyzer is retrimmed using an option which covers the new measurement frequency.

4.6.2 HF Lead Compensation

The purpose of HF lead compensation is to eliminate scalar errors which are due to the test leads and fixture/scanner. These vary with test lead length and become significant at frequencies above 200kHz. Before performing HF lead compensation, both **O/C Trim** and **S/C Trim** must be performed from **HANDLER CAL MODE** using the **All freq** trim option as described in section 4.6.1.

4.6.2.1 Performing HF Lead Compensation

1) Either:

   a) Select **CALIBRATE** from the **MAIN MENU.** The analyzer will enter **CALIBRATE MODE**, shown in Figure 4-17. Select the **Handler Calibration** soft key. The analyzer will enter **HANDLER CAL MODE** (Figure 4-26).

b) Select **CALIBRATE** from **HANDLER MODE** (in which case pressing the bottommost soft key, which will be labelled **HANDLER**, will return the analyzer to **HANDLER MODE**). The analyzer will enter **HANDLER CAL MODE** (Figure 4-26).

2) Select the **HF Lead Compensation** soft key.

The following message will be displayed:

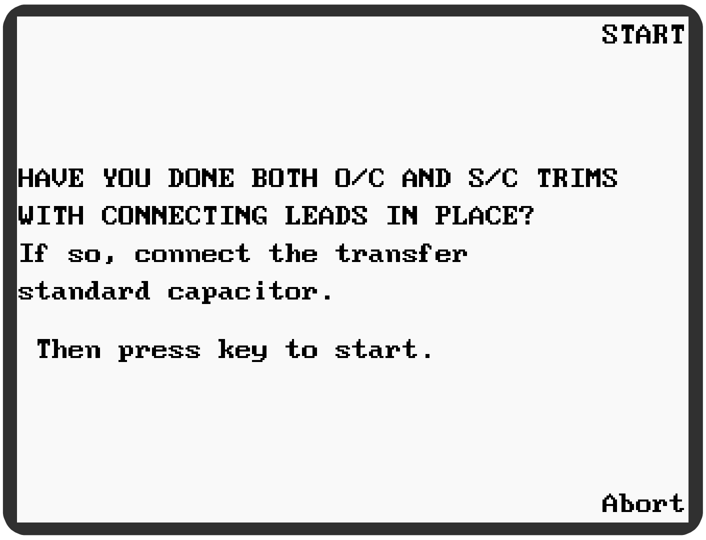


Figure 4-31 HF Lead Compensation

3) Assuming that O/C and S/C trims have already been performed, connect the transfer standard capacitor supplied with the instrument to the fixture or scanner component contacts.

4) Press the **START** soft key. When the **CALIBRATE MODE** main screen is redisplayed, HF lead compensation has finished.

See **Notes** 1) and 2) of section 4.6.

4.7 Measuring a Component in IMPEDANCE MODE

The analyzer should be powered up with the test leads or fixture connected to the front panel **Primary** BNC connectors. If the test leads or fixture have been changed since the analyzer was last used, they should be trimmed as described in section 4.3. If measurements will be made at 200kHz and above, repeat the HF lead compensation as described in section 4.4.1.

The following instructions illustrate the process of measuring a component in **IMPEDANCE MODE**.

1) Press the front panel **Menu** control key. The **MAIN MENU** (Figure 4-9) will be displayed.

2) Press the **IMPEDANCE** soft key. **IMPEDANCE MODE** (Figure 4-32) will be displayed.

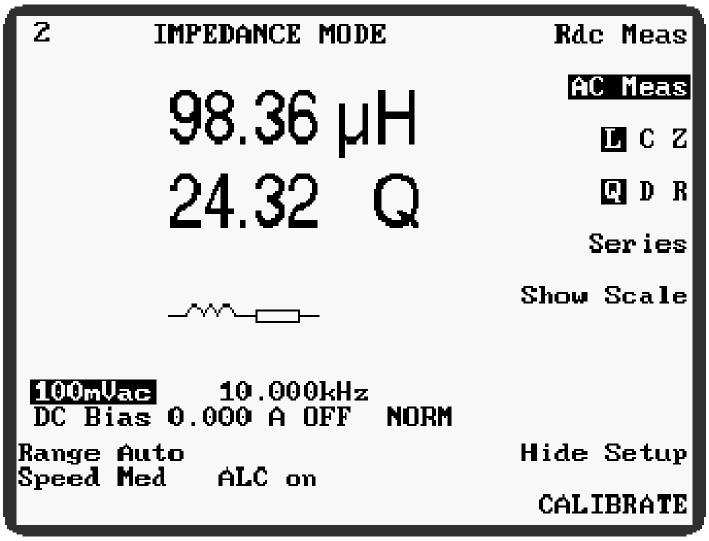


Figure 4-32 Impedance Mode

3) Use the soft keys, shown in Figure 4-4 and Figure 4-5, to set the required measurement parameters: these are described in section 4.7.2 below. Do not exceed the limitations of the component to be measured.
4) Connect the component to be measured to the test leads or fixture.
5) If the analyzer is in **Repetitive mode**, the measured values will be displayed and updated according to the **Speed** setting selected. A continuously flashing asterisk (*) in the top left-hand-corner of the screen indicates that the analyzer is in repetitive mode.
6) If the analyzer is in **Single shot mode**, the front panel **Trigger** key must be pressed to initiate a measurement; alternatively, a suitable trigger pulse may be applied to the **TRIGGER IN** socket on the rear panel, see section 4.1.5. If the **Trigger** key is pressed and held, the analyzer will make repetitive measurements at the **Speed** setting selected until the key is released. When in single shot mode, the asterisk (*) in the top left-hand-corner of the screen only flashes when a measurement is triggered.

4.7.1 Example

This example will take the user through the process of measuring the inductance (L) and quality factor (Q) of a 100µH inductor. 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 test leads or fixture connected to the front panel BNC connectors. If the test leads or fixture have been changed since the analyzer was last used, they should be trimmed as described in section 4.3. If measurements will be made at 200kHz and above, repeat the HF lead compensation as described in section 4.4.1.

1) Press the front panel **Menu** control key. The **MAIN MENU** will be displayed.
2) Press the **IMPEDANCE** soft key. **IMPEDANCE MODE** will be displayed.
3) Ensure that the analyzer is in **Repetitive mode** (if there is no continuously flashing asterisk (*) in the top left-hand-corner of the screen press the front panel **Sngl/Rep** control key—the analyzer will briefly indicate which mode it is entering (shown in Figure 4-10 and Figure 4-11)).

4) Use the soft keys to select the following parameters. Pressing the soft keys will either toggle between two options or, where more than two options are available, scroll through the options from left to right, one option at a time.

   AC Meas
   L
   Q
   Series

5) Using the navigation keys, highlight and set each of the following parameters in turn. Use the and navigation keys to highlight a parameter and the and navigation keys to alter the highlighted parameter setting. Settings may be altered one step at a time, or continuously by holding the navigation key down.

   100mVac
   10.000kHz
   DC Bias OFF set with the front panel **Bias** control key (shown in Figure 4-4 and Figure 4-7)
   NORM can be set to **BOOST** only when a 3265B External Bias Unit is connected
   Range Auto
   Speed Med
   ALC on

6) Connect the component to be measured to the test leads or fixture. The screen will display the measured values of L and Q. The display should be similar to Figure 4-33 below.

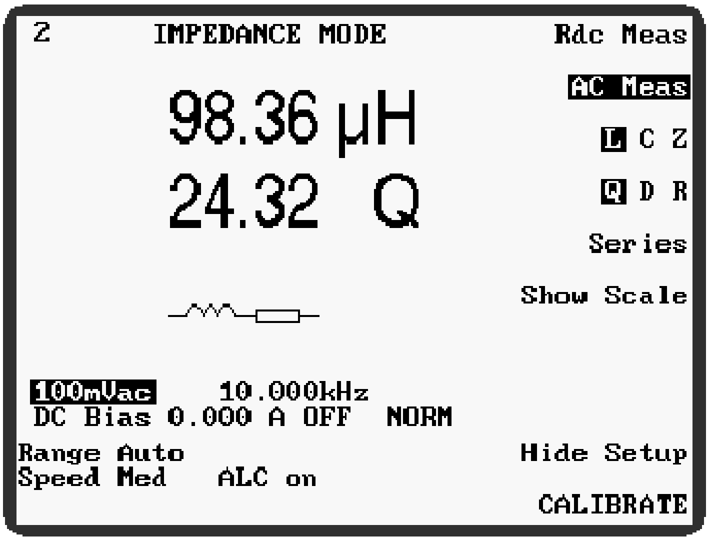


Figure 4-33 Example Display when Measuring the Inductance and Quality Factor of a 100µH Inductor

4.7.2 IMPEDANCE MODE Parameters

The following **IMPEDANCE MODE** parameters are selectable with the ten soft keys to the right of the display.

Rdc Meas

DC measurement of resistors. The drive level is fixed at 100mV (short circuit current 10mA). The only measurement options are range and speed.

AC Meas

Allows AC measurements to be performed at the selected drive level and frequency. The measurement terms and equivalent circuit are set with the next three soft keys.

L C Z

The first measurement term.

When **Z** is selected, the second measurement term is angle (º) and the **Q D R** and **Parallel/Series** soft keys are not appropriate and therefore not shown.

Q D R

The second measurement term.

Parallel/Series

Parallel or **Series** equivalent circuit. This soft key is not available when **Z** is selected: see the narrative on **L C Z** (above).

Show Scale/Hide Scale

Toggles between **Show Scale** and **Hide Scale**. The selection either shows a diagram of the equivalent circuit, i.e. **Parallel** or **Series**, or shows a bar graph representation of either of the measurement terms (selectable by setting the nominal and limits, see **Abs %** below). The bar graph scale can either be used as a quick visual verification that the component is within the limits set, or can be used for adjustment of variable components. When the measurement falls within the centre band the analyzer reports **PASS**; when the measurement falls above or below the centre band the analyzer reports **HI** or **LO**.

Notes:

1) The centre portion of the scale length is proportional to the measured value, but scale compression is used above and below the centre band.
2) If the binning option is fitted, an external output is available to indicate **PASS** or **FAIL**, see sections 4.1.11 and 4.1.11.5 for details.

Abs %

Only available when the bar graph scale is displayed. Toggles between **Abs** and **%**. When **Abs** is selected, absolute Hi and Lo limits (i.e. units of the measured parameter) are displayed. When **%** is selected, a nominal value together with Hi and Lo percentage limits are displayed.

The limits and nominal value (if applicable) must be set using the ◄ and ► navigation keys to highlight each parameter and the data entry keypad to set each value (the use of the data entry keypad is described in section 4.2.6). When in **%** mode, the bar graph scale Hi and Lo limits can easily be set equidistant about the nominal by setting either of the limits then highlighting the other limit and pressing the keypad **Enter** key twice. This mimics the setting of the other limit but with the opposite sign.

Save Nom

Only available when the bar graph scale is displayed. If a standard component exists, it can be connected to the test leads or fixture and measured by the analyzer. Pressing **Save Nom** (when either **abs** or **%** is selected) enters the most recent analyzer measurement of the component as the nominal test value for comparing all subsequent components with against **%** limits.

Notes:

1) To change this function from the first to the second measured parameter (or vice versa), first enter a dummy value with units via the keypad; e.g. to change from L to R, enter [1] [units] [Ω] [Enter] then press the **Save Nom** key.
2) Do not use the **Save Nom** function if the measured value is negative (e.g. an inductor measured above its self resonant frequency).

Show Setup/Hide Setup

Once the measurement parameters have been set, **Hide Setup** can be selected to clear them from the screen. The parameter settings are still valid and will be used for component measurements. The bar graph scale and limits will still be displayed. **Hide Setup** is used primarily to unclutter the display, making it more easily readable. Selecting **Show Setup** will redisplay the parameter settings.

CALIBRATE

Enters **CALIBRATE MODE** which is used for Trimming (section 4.3) and Self Calibration (section 4.5).

The following **IMPEDANCE MODE** parameters are those displayed in the bottom left-hand-corner of the screen, shown in Figure 4-34. They are only visible when **Hide Setup** is NOT SELECTED.

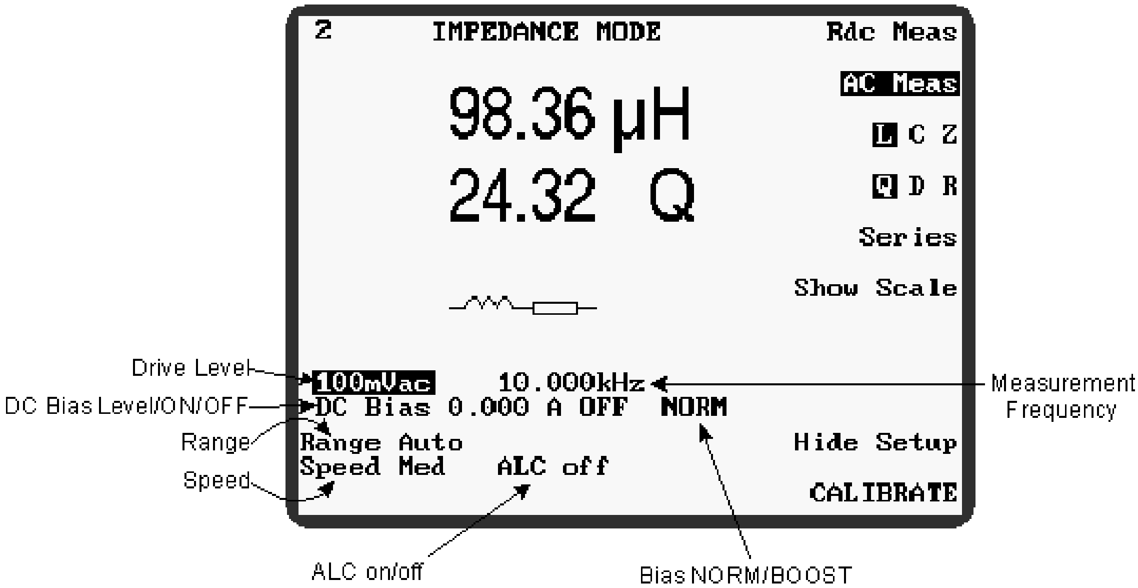


Figure 4-34 Non-Soft Key IMPEDANCE MODE Parameters

Drive Level

Only available when **AC Meas** is selected. Set by highlighting the parameter with the ◄ and ► navigation keys, then altering the setting in pre-determined steps with the ▲ and ▼ navigation keys, or by using the data entry keypad. The range is:

Rdc Meas mode	Drive Level not displayed—Fixed at 100mV (short circuit current 10mA)
AC Meas mode	Variable between: 1mV–10V or 50µA–200mA (appropriate for low impedance components)

See also **ALC**, below

Measurement Frequency

Set by highlighting the parameter with the ◄ and ► navigation keys, then altering the setting in pre-determined steps with the ▲ and ▼ navigation keys, or by finer increments using the data entry keypad. The range is:

20Hz to 3MHz

Fine or coarse frequency steps are available. Coarse steps vary in increments of between 20% and 33%; fine steps vary in increments of 1% or less. Set fine or coarse steps from the **SETTINGS** page—see section 5.18, or use code 10 (fine steps) or code 11 (coarse steps)—see section 4.2.6

DC Bias

The **DC Bias** is turned ON and OFF with the **Bias** control key. Before bias can be turned ON, the level must be set by highlighting the parameter with the and navigation keys, then altering the setting in pre-determined steps with the and navigation keys, or by finer increments using the data entry keypad. 1mA to 1A is available internally (**NORM** mode). With one or more 3265B External Bias Units connected (max 5), the unit may be toggled between **NORM** (internal bias) and **BOOST** (external bias). Up to 25A per 3265B is available in **BOOST** mode. For more information see section 4.2.5.

Range

Toggles between auto range and manual range selection, set by highlighting the parameter with the and navigation keys and altering the setting with the and navigation keys. Auto range automatically selects the most accurate range for the measurement. Circumstances where manual ranging may be more appropriate include:

- measuring non-linear components (auto range may hunt);
- to avoid the short auto range delay, for example when using max speed with an auto handler.

The manual range is set using the data entry keypad. Ranges 1 to 7 are valid. When a manual range is selected, the equivalent measurement range is shown on the display: although range boundaries are impedance values they are converted to appropriate L or C values.

At higher frequencies or reduced levels, availability of the highest or lowest ranges is restricted. If a previously selected range is changed due to a change in drive conditions, the selection will be remembered by the analyzer and reapplied when drive conditions allow it.

Speed

Four measurement speeds are available: **Slow**, **Med**, **Fast** and **Max**. Selecting slower measurement speeds increases the display resolution and decreases measurement noise by averaging. The measurement speed is set by highlighting the parameter with the and navigation keys and altering the setting with the and navigation keys.

The following measurement periods apply for **Rdc Meas** and **AC Meas** ≥100Hz:

Max speed makes measurements at ≈40ms intervals and is intended for automatic sorting under GPIB control.

Fast speed makes measurements at ≈100ms intervals and is intended for non-critical measurements.

Med speed makes measurements at ≈300ms intervals and gives full measurement accuracy.

Slow speed makes measurements at ≈900ms intervals and gives full measurement accuracy, maximum display resolution and enhanced supply frequency rejection.

ALC

ALC (Automatic Level Control) is only available for AC measurements and works in conjunction with the drive level, which has a 50Ω source impedance. It is set by highlighting the parameter with the ◀ and ▶ navigation keys and altering the setting with the ▲ and ▼ navigation keys.

Three ALC options are available: **ALC off**, **ALC on** and **ALC hold**.

When **ALC off** is selected, the analyzer will not try to maintain the drive level at the component. The drive level will therefore be diminished according to the impedance of the component being measured. For example, since the drive level source impedance is 50Ω, measuring a component which has an impedance of 100Ω will reduce the drive level by:

$$\frac{50}{(50+100)} \text{ x } 100\% = 33.3\%$$

The level indicated on the display however, corresponds to the open-circuit voltage or short-circuit current at the test fixture.

When **ALC on** is selected, the analyzer will try to maintain the selected drive level at the component. If, due to the impedance of the component being measured, it is unable to maintain the set drive level, a message such as Figure 4-35 will be displayed at the top of the display. If the drive level is diminished to such an extent that measurement of the component is impossible, Figure 4-36 will be reported instead. This will happen if the measure terminals are short-circuited with voltage drive selected, or if they are open-circuited with current drive selected.

Nearest Level = 9.90V

Figure 4-35 Nearest Drive Level Warning

Cannot Set Level

Figure 4-36 Cannot Set Level Warning

ALC hold is intended for the fastest possible repetitive measurement, either manually or under GPIB control, of components which should have the same impedance value. If, when a representative component is measured with **ALC on**, **ALC hold** is then selected, the drive level voltage is maintained at the drive source. Therefore, the drive level at the fixture jaws will rise when a component is removed and will return to the correct level when a new component of the same impedance is inserted (`Range Error` may be reported at the top of the display with no component in the fixture jaws). The range is also maintained at that used for measuring the representative component. When using **ALC hold** therefore, the analyzer does not spend time computing the correct ALC compensation and range, thus making measurements quicker.

5. ADVANCED OPERATION

This section will provide the user with a guide to:

- front panel connections;
- in-circuit measurements;
- measurement of very small capacitors;
- measurement of very small inductors;
- measurement of iron-cored and ferrite inductors;
- measurement of transformers;
- using the various modes available from the **MAIN MENU**, with the exception of **CALIBRATE MODE** which is covered in sections 4.3 to 4.6, and **IMPEDANCE MODE** which is covered in section 4.7.

5.1 Front Panel Connections

5.1.1 Connection Protocol

The analyzer has two sets of four front panel BNC sockets for screened cable connections to the device under test (DUT). In each case the outer connection provides the screening and the inner is the active connection. The four **Primary** BNC sockets provide screened Kelvin connections for transformer primary or impedance measurements and the four **Secondary** BNC sockets provide Kelvin connections for transformer secondary and bin handler sense connections.

In some cases it may prove more convenient to use leads with crocodile clips or other special terminations. See section 3.3 for a description of the measurement lead sets available from Wayne Kerr Electronics and for details of the connection protocol for manufacturing special test leads.

In all modes except **HANDLER MODE t**he innermost pair of panel connectors carry the signal source (ORANGE) and current return (RED) signals, while the outer pair serve to monitor the actual voltage at the DUT, excluding any voltage drops arising in the source and return leads.

Due to the different lead configuration when in **HANDLER MODE** the innermost pair of **Primary** panel connectors carry the signal source (ORANGE) and current return (RED) signals, while the innermost pair of **Secondary** panel connectors monitor the actual voltage at the DUT, excluding any voltage drops arising in the source and return leads.

The following tables illustrate the connection protocol for use in impedance, transformer and handler modes.

INSTRUMENT	Primary BNC Connectors				Secondary BNC Connectors			
	Brown	**Red**	**Orange**	**Yellow**	**Brown**	**Red**	**Orange**	**Yellow**
LEADS	Brown Sense Low	Red Drive Low	Orange Drive High	Yellow Sense High	not used	not used	not used	not used
leads marked **not used** may be left connected to the analyzer but are not used for the insulation test								

Figure 5-1 Connection Protocol for IMPEDANCE MODE

INSTRUMENT	Primary BNC Connectors				Secondary BNC Connectors			
	Brown	**Red**	**Orange**	**Yellow**	**Brown**	**Red**	**Orange**	**Yellow**
LEADS	Connect one lead set to transformer primary				Connect 2nd lead set to transformer secondary			
	Brown Sense Low	Red Drive Low	Orange Drive High	Yellow Sense High	Brown Sense Low	Red Drive Low	Orange Drive High	Yellow Sense High

Figure 5-2 Connection Protocol for TRANSFORME/TELECOM MODE

INSTRUMENT	Primary BNC Connectors				Secondary BNC Connectors			
	Brown	**Red**	**Orange**	**Yellow**	**Brown**	**Red**	**Orange**	**Yellow**
Connect to fixture/scanner leads as shown below (n.c. = no connection)								
HANDLER	n.c.	Red Drive Low	Orange Drive High	n.c.	n.c.	Brown Sense Low	Yellow Sense High	n.c.

Figure 5-3 Connection Protocol for HANDLER MODE

5.1.2 Two-, Three- and Four-Terminal Connections

For low impedances, the main advantage of four-terminal connections is to reduce the effect of contact resistance *variations* at the DUT. With Kelvin clip leads or the four-terminal component fixture 1EV1006, screened four-terminal connections are made automatically to the DUT.

If the impedance being measured is greater than 1kΩ and contact resistance variation is not a problem, two-terminal connection is adequate, the S/C trim facility being used to remove the effect of series lead impedance. To maintain accuracy when using two-terminal connections, do not plug anything into the BROWN or YELLOW BNC sockets

If the DUT has a large area of metal not connected to either of its terminals (e.g. a screen or core), this should be separately connected to ground using the green clip lead; but if there is a relatively large unscreened conducting surface which *is* connected to one of its terminals (e.g. an air-spaced tuning capacitor), this should be connected to the ORANGE signal source lead to minimize noise pick-up.

Measurement connections to transformers are simplified by providing separate primary and secondary connections. These are automatically reconfigured by the instrument to suit the selected test mode.

The front panel BNC LEDs indicates which BNC connections are active in each case

5.2 In-Circuit Measurements

A component connected into a circuit can usually be measured even when the impedances of other components connected to it are comparable to or less than that of the DUT. This is possible by connecting one side of all such components to the grounded neutral terminal of the analyzer, as shown in Figure 5-4. The components Zd and Zs are connected to ground via the green clip lead when using Wayne Kerr Electronics leads.

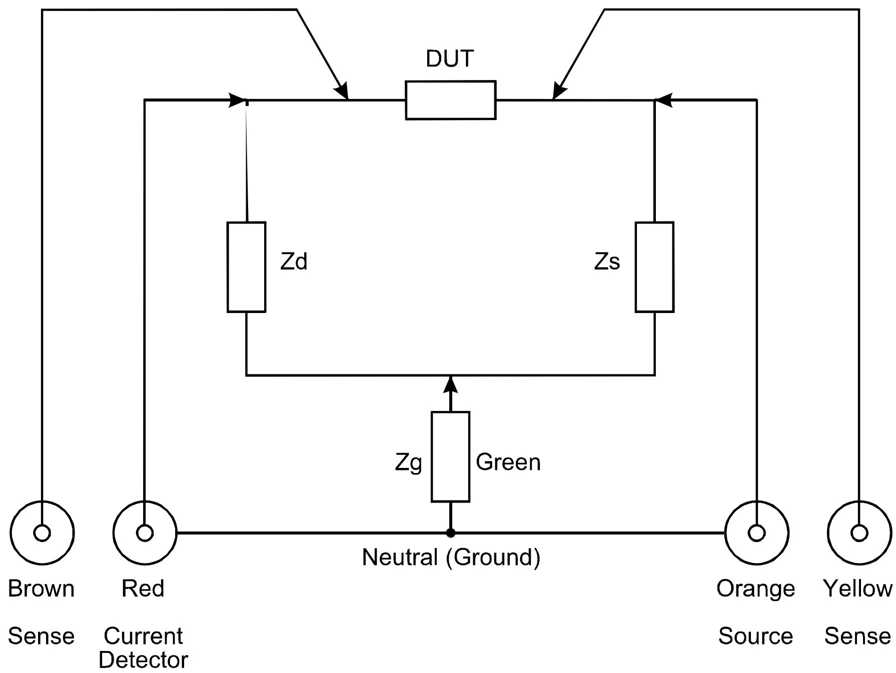
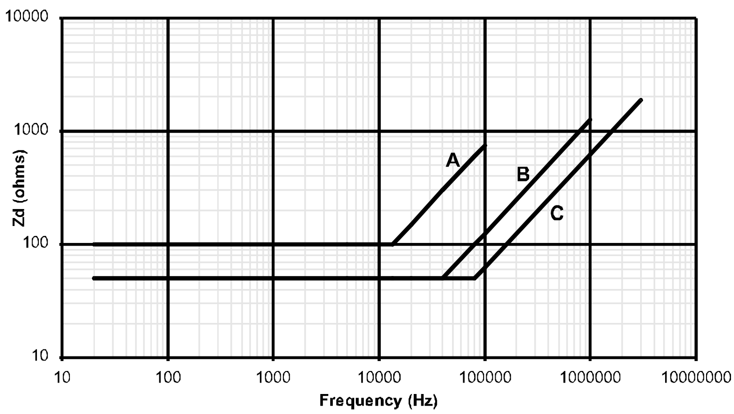


Figure 5-4 In-Circuit Measurements

The presence of Zd introduces a small measurement error, dependant on the frequency and impedance range in use. Figure 5-5 shows the minimum shunt impedance (i.e. R, ωL or ωC) for an additional error (magnitude or phase) not exceeding 1%. Note that when measuring high impedances it may be beneficial to use a drive level greater than 1V or to manually select a lower measurement range (see section 4.7.2—IMPEDANCE MODE Parameters).



Range No	Freq Range	Level ≤1V	Level >1V
7	≤10kHz	Curve A	Curve A
	>10kHz	Curve A	Curve B
6	≤100kHz	Curve A	Curve B
	>100kHz	Curve B	Curve C
5	≤1MHz	Curve B	Curve C
	>1MHz	Curve C	Curve C
1 – 4	All	Curve C	Curve C

Figure 5-5 Effect of shunt loading on current terminal

The main effect of adding Zs alone is to reduce the available drive signal. When measuring high impedances, this effect is dominated by the fixed 50Ω output impedance of the signal source. For example, a shunt resistance of 50Ω may be expected to halve the available output level. When measuring components with an impedance below 50Ω, the degree of reduction will be less. Note that when ALC is turned ON (see section 4.7.2) the displayed level will always correspond to the actual level at the measurement terminals.

When Zd and Zs are connected simultaneously, an additional measurement error occurs due to the impedance of the guard lead (Zg). This error may become significant if the DUT is larger than Zd and Zs, and is given by

$$\text{Error}\,\% = 100 \text{ x } \frac{\text{DUT x Zd}}{\text{Zs x Zd}}$$

At low frequencies Zg is up to 40mΩ for lead types 1EVA40100, 1EVA40180 or 1EV1505. At frequencies above 10kHz the series inductance, which depends to some extent on lead and component positioning, may become significant. For lowest inductance, minimize the area of the loop formed by the Red (current detector) lead, via Zd and the Green lead to neutral. In this case the inductance should not exceed 0.25µH.

Note that at low frequencies (<2kHz) the effective guard resistance can be reduced by a factor of 2:1 or more by returning Zs and Zd directly to the outer of the Red BNC connector. However this technique increases the loop inductance and any benefit is lost at frequencies above 5kHz.

5.3 Measurement of Very Small Capacitors

For best accuracy when measuring small value capacitors it is necessary to perform an O/C trim (see section 4.3.1) at the frequency to be used for the measurement and to ensure that the measurement leads are not moved between the trimming and the measurement. A level of 1V is an optimum value for minimizing lead errors as this is the level used during the trim operation.

When measuring surface-mount or leadless capacitors with the two-terminal SMD tweezers, part no. 1EVA40120, the cam should be used to set the jaw spacing of the tweezers to the width of the DUT when performing the O/C trim so that the residual capacitance of the tweezers is trimmed out.

5.4 Measurement of Very Small Inductors

The analyzer measures the difference between the inductance of S/C trimming and the inductance of the DUT. Stable measurement lead arrangements are essential for low inductance measurements; the use of the four-terminal component fixture, part no. 1EV1006, is recommended for leaded components. When using this fixture, S/C trim (see section 4.3.1) is achieved by placing a wire across the jaws:

a 5cm length of 1mm diameter wire has an inductance of 50nH
a 5cm length of 2mm diameter wire has an inductance of 40nH

The known inductance of the wire used for the S/C trim should be subtracted from the measured DUT inductance.

A similar stable fixture arrangement should be used for four-terminal measurements of surface-mount or leadless components: contact the Wayne Kerr Electronics Applications Department if this kind of fixture is required.

The Q is always low, but self-capacitance is not normally a problem at the analyzer's measurement frequencies. For best inductance measurement results, make the measurement at 200kHz in series configuration. Where possible, make the measurements at an AC level of 100mA which is the level used during trimming.

When an inductor is measured at a frequency much lower than that for which it is designed (e.g. an HF choke tested at AF) it will tend to behave as an inductive resistor. In these circumstances, the inductance measurement accuracy is widened by the factor (1 + 1/Q).

Air-cored coils are particularly susceptible to noise pick up and should be kept well clear of any test equipment that may contain power transformers or display scan circuitry. Also avoid proximity to metal objects which may modify inductor characteristics. Whenever possible, measure at 10kHz. If low frequency measurements are required and trouble persists, use slow measurement speed.

5.5 Measurement of Iron-Cored and Ferrite Inductors

The effective value of iron-cored and ferrite inductors can vary widely with the magnetization, and therefore the level, of the test signal. Ideally, they should be measured at the AC level and frequency of use. When core materials can be damaged by excessive magnetization (for example, some tape heads and microphone transformers), check before connection that the test signal level is acceptable.

Iron-cored inductors, including transformers, are susceptible to disaccommodation arising from electrical, magnetic, mechanical and thermal shock; any of which can produce transient or permanent change in inductance. The effect is worst in un-gapped iron-cored inductors at low drive levels. Since the shocks can be caused by large changes in level of the driving signal, it is advisable to change the drive level in small increments. The transient changes have long recovery time-constants, so successive measurements (at the same conditions) on a shocked inductor, will show unidirectional changing values. The time taken for the overall change of level, will depend on the component itself and the accuracy required..

5.6 Measurement of Transformers

When measuring transformers, two sets of Kelvin clip leads are used: one set is connected to the primary, and the other set to the secondary, of a transformer. 2- or 4-terminal measurement may be selected. Use 4-terminal measurement if the primary impedance is particularly low. If accurate level control is required, select ALC on.

5.7 TRANSFORMER MODE

TRANSFORMER MODE allows seven different transformer parameters to be measured, selectable from the soft keys. The measurement parameters of each type of transformer test are independent of other transformer tests and other measurement modes when the instrument is set to non-global test conditions (see section 5.18—The SETTINGS Page). This allows a single key stroke to restore the preset test conditions of the corresponding test, configure the test connections and trigger a measurement, greatly simplifying complex test procedures. One exception is that **Leakage(Pri)** and **Leakage(Sec)** tests share the same measurement conditions. **INSULATION MODE**, when fitted, can be accessed directly from **TRANSFORMER MODE**.

Two sets of measurement leads are required; see Figure 5-2 for the connection protocol. Active connections depend on the type of transformer test selected and are indicated by the LEDs above the BNC connectors. The general procedure when using **TRANSFORMER MODE** is as follows.

1) Select the **Menu** control key, followed by the **TRANSFORMER** soft key.
2) Connect the measurement leads, see Figure 5-2.
3) Select 2- or 4-terminal measurement.
4) From **TRANSFORMER MODE** select the **CALIBRATE** soft key.
5) Refer to section 4.3 and perform the following trims (not required for **Turns Ratio** measurements).
    a) **O/C Trim (Pri)**
    b) **S/C Trim (Pri)**
    c) **O/C Trim (Pri–Sec)**
    d) **S/C Trim (Sec)**
    e) **HF Lead Compensation** if a test frequency of 200kHz or greater is to be used.
6) Select the **TRANSFORMER** soft key to return to **TRANSFORMER MODE**.
7) Select the transformer test required, e.g. **L + Q (Pri)**, with the appropriate soft key.
8) Change the setup parameters, e.g. **drive level**, **frequency**, as necessary for the test, being careful not to exceed the limitations of the component to be measured.
9) Connect **Primary** and **Secondary** leads to the appropriate transformer windings.
10) If the setup parameters are hidden, press **Show Setup.**
11) If the instrument is set to make repetitive measurements, the measurement will displayed on the screen, otherwise press the **Trigger** control key to initiate a measurement.

5.7.1 Example

This example will take the user through the process of making a 2-terminal measurement of the turns ratio of a transformer. 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 test leads or fixture connected to the front panel BNC connectors according to the connection protocol for transformer mode (see Figure 5-2).

1) Press the front panel **Menu** control key. The **MAIN MENU** will be displayed.

2) Press the **TRANSFORMER** soft key. **TRANSFORMER MODE** will be displayed.

3) Press the **CALIBRATE** soft key and perform the trims listed in section 5.7 paragraph 5). When the trims are complete, press the **TRANSFORMER** soft key to return to **TRANSFORMER MODE**.

4) Ensure that the analyzer is in **Repetitive mode** (if there is no continuously flashing asterisk (*) in the top left-hand-corner of the screen press the front panel **Sngl/Rep** control key—the analyzer will briefly indicate which mode it is entering (shown in Figure 4-10 and Figure 4-11).

5) If the 2/4 Term LED is not lit, press the **2/4 Term** control key. The 2/4 Term LED should light and **2-TERM TRANSFORMER MODE** should be displayed at the top of the screen.

6) Press the **Turns Ratio** soft key.

7) Using the navigation keys, highlight and set each of the following parameters in turn. Use the ◀ and ▶ navigation keys to highlight a parameter and the data entry keypad or ▲ and ▼ navigation keys to alter the highlighted parameter setting. Settings may be altered one step at a time, or continuously by holding the navigation key down.

   100mVac
   10.000kHz
   Ratio: Np/Ns
   Range Auto
   Speed Med
   ALC off

8) Connect the component to be measured to the test leads or fixture. The screen will display the measured value of turns ratio.

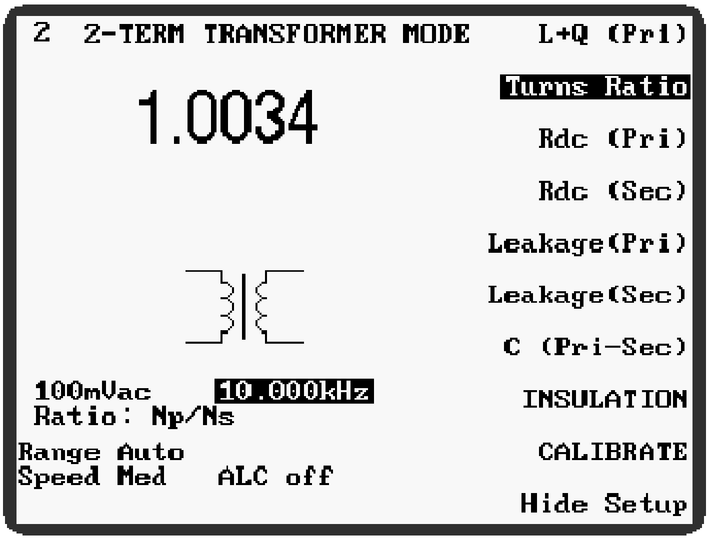


Figure 5-6 Example of Measuring Turns Ratio in TRANSFORMER MODE

5.7.2 TRANSFORMER MODE Parameters

The following **TRANSFORMER MODE** parameters are selectable with the ten soft keys to the right of the display. Parameters which are common to both **TRANSFORMER MODE** and **IMPEDANCE MODE** are described in section 4.7.2—IMPEDANCE MODE Parameters.

L + Q (Pri)

Measures the inductance (L) and quality factor (Q) of the transformer primary winding. The **Equ cct** parameter allows selection of either **Parallel** or **Series** resistance in the transformer primary winding. When **Equ cct** is set to **Auto**, the analyzer makes a measurement of the primary winding resistance and sets series or parallel equivalent circuit according to the following criterion:

Primary winding resistance **>250Ω** = **Parallel** equivalent circuit
Primary winding resistance **<250Ω** = **Series** equivalent circuit

Turns Ratio

Measures the turns ratio of a transformer. Turns ratio can be displayed as **Np/Ns** or **Ns/Np**. When maximum resolution is required, choose the display which is greater than unity. The value displayed is the ratio of measured voltages, hence non-integer results are likely. Trimming and high frequency lead compensation are not required for turns ratio measurements.

A negative reading when measuring turns ratio implies a reverse-connected winding. Check the winding sense convention.

Secondary turns (**Ns**) can be displayed. This requires the primary turns (Np) to be preset via the data entry keyboard. Allowable values of Np are between 0.001 and 10000.

For accurate measurement of turns ratio, software correction can be employed when the primary impedance is high (typically >50Ω). A transparent primary leakage measurement is performed before the turns ratio measurement. Because this involves operating relays inside the 3260B, normal repetitive measurements are disabled with the ratio correction algorithm operating. Ratio correction is NOT automatically performed by the instrument. Instead, the user must set it ON or OFF and define whether the transformer is a normal type (floating secondary) or an auto-transformer (one end grounded) as this affects the loading corrections. This selection is made either from the **SETTINGS** page (see section 5.18), or by using keypad codes 14, 15 and 16 when in **TRANSFORMER MODE** or **HANDLER MODE** (see section 4.2.6.1). If the primary impedance is low, the turns ratio correction should be turned OFF. If a ratio correction option other than OFF is selected, it is displayed when **Turns Ratio** is selected in **TRANSFORMER MODE**.

For step-up transformers, the measured secondary voltage is limited to 10Vrms.

Constant current drive is not provided for turns ratio measurements.

Rdc (Pri) The series DC resistance of the transformer primary winding.

Rdc (Sec) The series DC resistance of the transformer secondary winding.

Leakage (Pri) The series leakage inductance and resistance of the transistor primary winding. Best results will be obtained by short-circuiting the transformer secondary winding(s). A message is displayed to this effect when the mode is initially selected. Leakage (Pri) and Leakage (Sec) tests share the same measurement conditions.

Leakage (Sec) The series leakage inductance and resistance of the transistor secondary winding. Best results will be obtained by short-circuiting the transformer primary winding. A message is displayed to this effect when the mode is initially selected. Leakage (Pri) and Leakage (Sec) tests share the same measurement conditions.

C (Pri–Sec) The capacitance between the transformer primary and secondary windings at the selected voltage and frequency test conditions.

INSULATION Enters **INSULATION MODE**, see section 5.8.

The following **TRANSFORMER MODE** parameters are those displayed in the bottom left-hand-corner of the screen, shown in Figure 5-6. They are only visible when **Hide Setup** is NOT SELECTED.

Drive Level

This parameter is available during measurement of **L + Q (Pri)**, **Turns Ratio**, **Leakage (Pri)**, **Leakage (Sec)**, **C (Pri–Sec)**.

When **Turns Ratio** or **C (Pri–Sec)** is selected, only voltage drive can be set. All other settings listed above will accept either voltage or current drive, set by highlighting the parameter with the and navigation keys, then altering the setting in pre-determined steps with the and navigation keys, or by using the data entry keypad. The range is:

L + Q (Pri); **Leakage (Pri);** **Leakage (Sec).**	1mV–10V At frequencies above 300kHz the maximum current drive is restricted.	50µA–200mA
Turns Ratio; **C (Pri–Sec).**	1mV–10V; no current drive	
Rdc (Pri); **Rdc (Sec).**	Drive Level not displayed—Fixed at 100mV (short circuit current 10mA)	

See also **ALC**, in section 4.7.2—IMPEDANCE MODE Parameters

Equ cct:

Available only for **L + Q (Pri)** measurements. Selectable between **Series**, **Parallel**, or **Auto**. See **L + Q (Pri)**, above.

Ratio

Available only for **Turns Ratio** measurement. Selectable between **Np/Ns**, **Ns/Np** or **Ns Np=*x***, where ***x*** is a value between 0.001 and 10000.

See **Turns Ratio**, above.

5.8 INSULATION MODE (Optional)

Insulation tests can be made between transformer windings, and from each winding to the grounded metal case or shell of the transformer. For each transformer winding, the test voltage is applied to one BNC connector only, as indicated by the front panel LEDs. If 4-terminal operation is selected, this is the BROWN BNC connector (voltage sense low). For 2-terminal operation it is the RED BNC connector (drive current return). The active connections are shown in section 5.8.1—Connections.

The insulation test is a 3-terminal function. If measuring insulation between primary and secondary windings, any leakage to grounded terminals (e.g. the transformer case or shell) will be ignored. The insulation from either winding to grounded terminals may be separately measured, in which case primary to secondary leakage will be ignored. If a measurement of total leakage resistance between windings is required, make no connection to the ground lead (i.e. the green clip lead).

Insulation tests are performed in single-shot mode with the **Trigger** control key being used to initiate each measurement. If the **Trigger** key is pressed and held, the analyzer will make repetitive measurements until the key is released. To minimize the risk of electric shock, high voltages are applied to the test leads only during testing.

WARNING!

AVOID TOUCHING THE TEST CONNECTIONS DURING MEASUREMENT OR TRIMMING OPERATIONS. **Although the current is limited to a safe level, there is a risk of electric shock, especially at 200V and 500V test levels. Unless energy is stored in components, e.g. capacitors, connected to the measurement terminals, the voltage at the measurement terminals will be removed within 0.5 seconds of test completion.**

Unless global measurement conditions are selected (see section 5.18—The SETTINGS Page), the test voltage and other settings may be set differently for each of the three test types.

The insulation test cannot be performed if the test current exceeds 1mA, i.e. if the impedance is too low. This corresponds to a minimum resistance of 100kΩ at 100V, 200kΩ at 200V or 500kΩ at 500V. In this case a message, shown in Figure 5-7, will be displayed.

`Current Too Large`

Figure 5-7 INSULATION MODE: Current Too Large

Note

If the **INSULATION** soft key is pressed when the insulation option is not fitted, the analyzer will report **Unit Not Available** (Figure 5-8).

`Unit Not Available`

Figure 5-8 Unit Not Available

5.8.1 Connections

Except when using a handler or 4-wire scanner, the standard connection protocol for **TRANSFORMER/TELECOM MODE** may be used for all insulation test types. This is shown in Figure 5-2. The tables below show the active connection for each test. Leads marked **not used** may be left connected to the analyzer but are not used for the insulation test.

For operation with a 4-wire scanner the scanner relays should be configured as for turns ratio measurement. During Insulation mode operation, set the instrument to 2-terminal operation. Since a 4-wire scanner is connected to the analyzer with **HANDLER MODE** lead configuration (see Figure 5-3), it is not possible to perform a primary to secondary winding test.

INSTRUMENT	Primary BNC Connectors				Secondary BNC Connectors			
	Brown	Red	Orange	Yellow	Brown	Red	Orange	Yellow
LEADS	not used	**Red Drive Low**	not used	not used	not used	not used	not used	not used

Leads marked **not used** may be left connected to the analyzer but are not used for the insulation test.

Connect the RED lead to the transformer primary, and the GREEN CLIP LEAD to the transformer metal case or shell.

Figure 5-9 Active Connection for 2-TERM INSULATION MODE (Pri–GND)

INSTRUMENT	Primary BNC Connectors				Secondary BNC Connectors			
	Brown	Red	Orange	Yellow	Brown	Red	Orange	Yellow
LEADS	**Brown Sense Low**	not used	not used	not used	not used	not used	not used	not used

Leads marked **not used** may be left connected to the analyzer but are not used for the insulation test.

Connect the BROWN lead to the transformer primary, and the GREEN CLIP LEAD to the transformer metal case or shell.

Figure 5-10 Active Connection for 4-TERM INSULATION MODE (Pri–GND)

INSTRUMENT	Primary BNC Connectors				Secondary BNC Connectors			
	Brown	Red	Orange	Yellow	Brown	Red	Orange	Yellow
LEADS	not used	not used	not used	not used	not used	**Red Drive Low**	not used	not used

Leads marked **not used** may be left connected to the analyzer but are not used for the insulation test.

Connect the RED lead to the transformer secondary, and the GREEN CLIP LEAD to the transformer metal case or shell.

Figure 5-11 Active Connection for 2-TERM INSULATION MODE (Sec–GND)

INSTRUMENT	Primary BNC Connectors				Secondary BNC Connectors			
	Brown	**Red**	**Orange**	**Yellow**	**Brown**	**Red**	**Orange**	**Yellow**
LEADS	not used	not used	not used	not used	**Brown Sense Low**	not used	not used	not used

Leads marked **not used** may be left connected to the analyzer but are not used for the insulation test.

Connect the BROWN lead to the transformer secondary, and the GREEN CLIP LEAD to the transformer metal case or shell.

Figure 5-12 Active Connection for 4-TERM INSULATION MODE (Sec–GND)

INSTRUMENT	Primary BNC Connectors				Secondary BNC Connectors			
	Brown	**Red**	**Orange**	**Yellow**	**Brown**	**Red**	**Orange**	**Yellow**
LEADS	not used	**Red Drive Low**	not used	not used	not used	**Red Drive Low**	not used	not used

Leads marked **not used** may be left connected to the analyzer but are not used for the insulation test.

Connect the **Primary** RED lead to the transformer primary, and the **Secondary** RED lead to the transformer secondary.

Figure 5-13 Active Connections for 2-TERM INSULATION MODE (Pri–Sec)

INSTRUMENT	Primary BNC Connectors				Secondary BNC Connectors			
	Brown	**Red**	**Orange**	**Yellow**	**Brown**	**Red**	**Orange**	**Yellow**
LEADS	**Brown Sense Low**	not used	not used	not used	**Brown Sense Low**	not used	not used	not used

Leads marked **not used** may be left connected to the analyzer but are not used for the insulation test.

Connect the **Primary** BROWN lead to the transformer primary, and the **Secondary** BROWN lead to the transformer secondary.

Figure 5-14 Active Connections for 4-TERM INSULATION MODE (Pri–Sec)

5.8.2 Trimming

For **INSULATION MODE** operation, trimming compensates for any residual leakage current in the test leads or fixture. For maximum accuracy the trimming operation should be performed with the test leads connected to the instrument but isolated from each other.

WARNING!

The test connections are at a high voltage during this trim. While high voltage is applied, a message, shown in Figure 5-15 below, will be displayed on the screen. ***To minimize the risk of electric shock, AVOID TOUCHING THE TEST CONNECTIONS DURING THE TRIMMING OPERATION.***

⚠ High Voltage ON ⚠

Figure 5-15 High Voltage ON warning

When trimming for manual operation:

1) Ensure that the measurement leads/fixture are connected to the analyzer according to the connection protocol shown in Figure 5-2.
2) Ensure 2-terminal or 4-terminal operation is selected as required for subsequent measurements.
3) Carry out **O/C Trim (Pri-Sec)** as detailed in section 4.3.2.

When trimming for HANDLER MODE operation:

1) Ensure that the handler/scanner is connected to the analyzer according to the connection protocol shown in Figure 5-3.
2) Either:
   a) select **Handler Calibration** from **CALIBRATE MODE**;

   or

   b) select **CALIBRATE** directly from **HANDLER MODE**.
3) Select the **Insulation Trim** soft key.
4) Wait until the analyzer has finished trimming.

Notes:

1) The stored trim values will be applied during 2-terminal insulation tests, even if AC impedance and Rdc trimming correspond to 4-terminal operation.
2) The **Insulation Trim** soft key is not available when **CALIBRATE** is selected from **INSULATION MODE**.
3) If **Insulation Trim** is attempted with Kelvin clip leads attached to the analyzer in **HANDLER MODE** configuration, the trim will fail because the RED and BROWN leads are shorted by the Kelvin clip.

5.8.3 Operation

The general procedure when using **INSULATION MODE** is as follows.

1) Select the **Menu** control key, followed by the **INSULATION** soft key.

2) Connect the measurement leads to the analyzer according to the connection protocol detailed in section 5.8.1.
3) Select 2- or 4-terminal measurement.
4) Refer to section 5.8.2 and trim the leads/fixture.
5) Select the insulation test required, i.e. **Pri–Sec**, **Pri–GND** or **Sec–GND**, with the appropriate soft key.
6) If the setup parameters are hidden, press **Show Setup.**
7) Change the setup parameters, i.e. **Level**, **Range** and **Speed**, as necessary for the test.
8) Connect the measurement leads/fixture to the transformer (see section 5.8.1—Connections).
9) Select the measurement unit to display with the **µA MΩ** soft key.
10) Press the **Trigger** control key to initiate a measurement.

5.8.4 Example

This example will take the user through the process of performing all three insulation test types on a transformer. The settings used are examples only and the user may substitute other settings as required. The analyzer should be powered up with two sets of Kelvin clip leads connected to the **Primary** and **Secondary** front panel BNC sockets according to the connection protocol shown in Figure 5-2 .

1) Press the front panel **Menu** control key. The **MAIN MENU** will be displayed.
2) Press the **INSULATION** soft key. **INSULATION MODE** will be displayed.
3) Select either 2- or 4-terminal measurement, as required for subsequent tests, with the 2/4 Term control key. For this example, 4-terminal measurement will be selected.
4) Press the **CALIBRATE** soft key and perform an **O/C Trim (Pri–Sec)**. If necessary refer to section 4.3.2 for trimming details. When the trim is complete, press the **INSULATION** soft key to return to **INSULATION MODE**.

WARNING!

The test connections are at a high voltage during this trim. While high voltage is applied, a message, shown in Figure 5-15 above, will be displayed on the screen. ***To minimize the risk of electric shock, AVOID TOUCHING THE TEST CONNECTIONS DURING THE TRIMMING OPERATION.***

---

5) Press the **Pri–Sec** soft key.
6) Using the **µA MΩ** soft key, ensure that **µA** is highlighted.
7) Using the navigation keys, highlight and set each of the following parameters in turn. Use the ◄ and ► navigation keys to highlight a parameter and the ▲ and ▼ navigation keys to alter the highlighted parameter setting.

Level **500V** this can also be set with the data entry keypad.
Range **Auto**
Speed **Med**

8) Connect the **Primary** BROWN BNC connector to one end of the transformer primary winding. Connect the **Secondary** BROWN BNC connector to one end of the transformer secondary winding. The LEDs above the BROWN BNC connectors should be lit to show that they are the active connections. There should be no other connections to the transformer.

9) Press the **Trigger** control key to initiate the measurement. Figure 5-15, above, will be displayed while high voltage is applied to the measurement terminals and the measurement result will be displayed.

WARNING!

AVOID TOUCHING THE TEST CONNECTIONS DURING MEASUREMENT OPERATIONS. **Although the current is limited to a safe level, there is a risk of electric shock, especially at 200V and 500V test levels. Unless energy is stored in components, e.g. capacitors, connected to the measurement terminals, the voltage at the measurement terminals will be removed within 0.5 seconds of test completion.**

---

10) Press the **Pri–GND** soft key and, if necessary, re-establish the measurement conditions outlined in steps 6) and 7).

11) Connect the **Primary** BROWN BNC connector to one end of the transformer primary winding. Connect the GREEN CLIP LEAD to the transformer metal case or screen The LED above the **Primary** BROWN BNC connector should be lit to show that it is the active connection. There should be no other connections to the transformer.

12) Press the **Trigger** control key to initiate the measurement. Figure 5-15, above, will be displayed while high voltage is applied to the measurement terminals and the measurement result will be displayed.

13) Press the **Sec–GND** soft key and, if necessary, re-establish the measurement conditions outlined in steps 6) and 7).

14) Connect the **Secondary** BROWN BNC connector to one end of the transformer secondary winding. Connect the GREEN CLIP LEAD to the transformer metal case or screen The LED above the **Secondary** BROWN BNC connector should be lit to show that it is the active connection. There should be no other connections to the transformer.

15) Press the **Trigger** control key to initiate the measurement. Figure 5-15, above, will be displayed while high voltage is applied to the measurement terminals and the measurement result will be displayed.

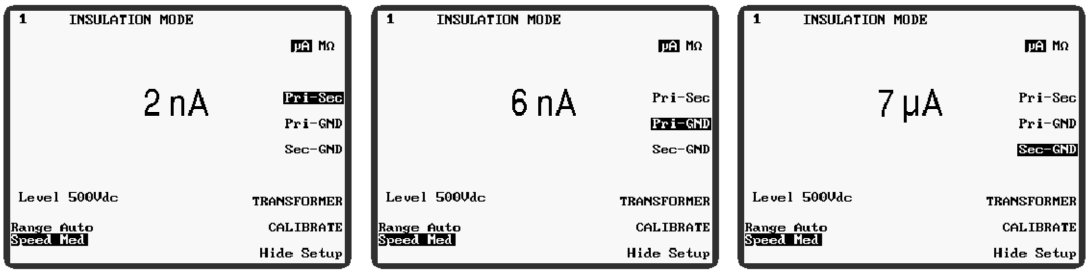


Figure 5-16 INSULATION MODE: display readouts from above example

5.8.5 INSULATION MODE Parameters

The following **INSULATION MODE** parameters are selectable with the soft keys to the right of the display. Parameters which are common to both **INSULATION MODE** and **IMPEDANCE MODE** are described in section 4.7.2—IMPEDANCE MODE Parameters.

µA MΩ

Selects the measurement unit to display, either µA or MΩ. See also **Range**, below.

Pri–Sec

Sets the analyzer to measure leakage current between the transformer primary and secondary windings. Depending on whether the analyzer is set to 2- or 4-terminal measurement, the active connections, shown by the LEDs above the BNC connectors, are either the RED or BROWN BNC connectors respectively. For measurements in this mode, the active **Primary** BNC is connected to one end of the transformer primary winding and the active **Secondary** BNC is connected to one end of the transformer secondary winding.

Pri–GND

Sets the analyzer to measure leakage current between the transformer primary winding and its grounded metal case or screen. Depending on whether the analyzer is set to 2- or 4-terminal measurement, the active connections, shown by the LEDs above the BNC connectors, are the RED or BROWN **Primary** BNC connector and the ground lead, which is the green clip lead when using Wayne Kerr Kelvin clip leads. For measurements in this mode, the active **Primary** BNC is connected to one end of the transformer primary winding and the ground lead is connected to the transformer metal case or screen.

Sec–GND

Sets the analyzer to measure leakage current between the transformer secondary winding and its grounded metal case or screen. Depending on whether the analyzer is set to 2- or 4-terminal measurement, the active connections, shown by the LEDs above the BNC connectors, are the RED or BROWN **Secondary** BNC connector and the ground lead, which is the green clip lead when using Wayne Kerr Kelvin clip leads. For measurements in this mode, the active **Secondary** BNC is connected to one end of the transformer secondary winding and the ground lead is connected to the transformer metal case or screen.

TRANSFORMER Enters **TRANSFORMER MODE** see section 5.7

The following **INSULATION MODE** parameters are those displayed in the bottom left-hand-corner of the screen, shown in Figure 5-16. They are only visible when **Hide Setup** is NOT SELECTED.

Level The DC voltage level used for the insulation test. This parameter is selected with the and navigation keys and is altered with the and navigation keys or with the data entry keypad. Levels of **100V**, **200V** or **500V** are available.

Range Enables manual or auto range to be set. The parameter is highlighted with the or navigation key and toggled between manual and auto range with the or navigation key. When manual ranging is selected, the range is set with the data entry keypad. Because of the low levels of current measured in **INSULATION MODE** only ranges 1 and 2 are valid. Entering a higher range will result in Figure 4-14, above, being displayed and the nearest available range being set. When the analyzer is set to display units of **MΩ,** even though high ohmic values would be expected, manual ranges are still limited to 1 or 2 because the analyzer actually measures the leakage *current* and converts it to ohms before displaying the result.

5.9 BINNING MODE (Optional)

BINNING MODE allows components to be sorted into bins according to their measured value and/or minor term. Bins 0 to 8 contain the sorted components and bin 9 the rejects. Binning is normally done in **Single shot mode** or under GPIB control. Using **Repetitive mode** will disable the **Count** facility, but can be used if this is not required. The measurement conditions and test parameters are independent of other modes when the instrument is set to non-global test conditions (see section 5.18—The SETTINGS Page).

BINNING MODE is divided into three sections: **Set**, **Sort** and **Count**.

5.9.1 BINNING MODE – Set

When **BINNING** is selected from the **MAIN MENU** the analyzer will display the last binning mode used. If **BINNING MODE – Set** is not displayed at the top of the screen, press the **BIN SET** soft key to select it. Figure 5-17 shows the **BINNING MODE – Set** main screen set to measure turns ratio against a nominal of 1 with a drive level of 1V AC and a frequency of 10kHz.

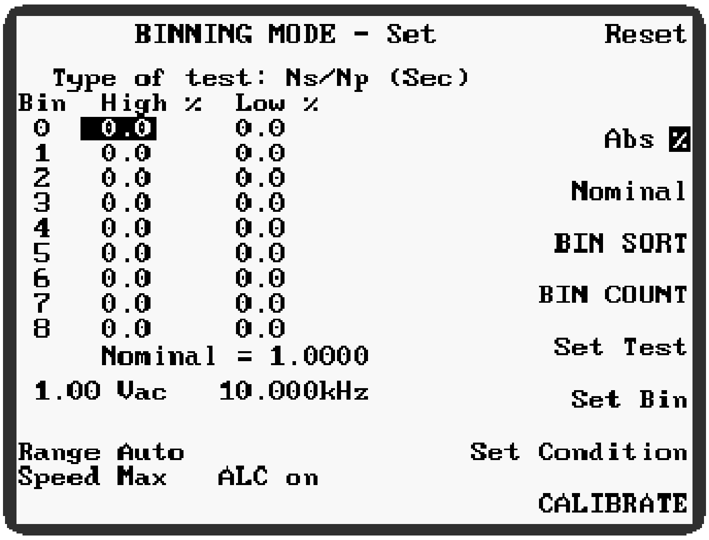


Figure 5-17 BINNING MODE – Set Main Screen

In Figure 5-17 above, the bins are shown ready to receive percentage limits. Absolute limits can be entered by highlighting **Abs** with the **Abs %** soft key. Either nested or stacked limits can be entered. When entering nested limits, the second limit in a row can be entered by highlighting it and pressing the keypad **Enter** key twice. This mimics the setting of the first limit but with the opposite sign. Since the analyzer will accept one set of percentage limits and another set of absolute limits it is possible to enter a set of nested percentage limits and a set of stacked absolute limits, or vice versa. The only limitation to this is that the minor term, when displayed, is common to both percentage and absolute limits.

When using percentage limits, the nominal component value must also be entered by pressing the **Nominal** soft key, then entering the nominal component value with the data entry keypad.

Any limit set to zero is ignored during subsequent sorting. Bins can therefore be set up with no minor term limit.

The minor term limit is a single maximum or minimum value as appropriate, e.g. Q would have a minimum limit, indicated by **Minor Q > x**.

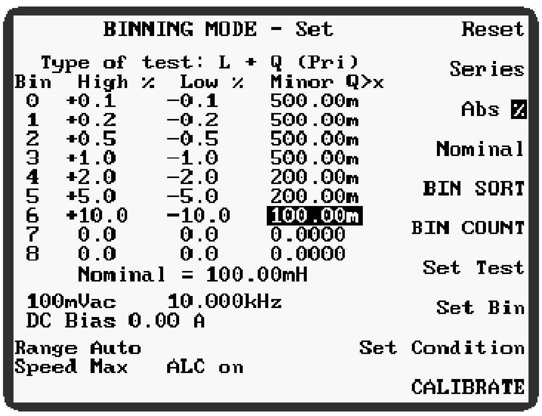


Figure 5-18 BINNING MODE
Nested Percentage Limits

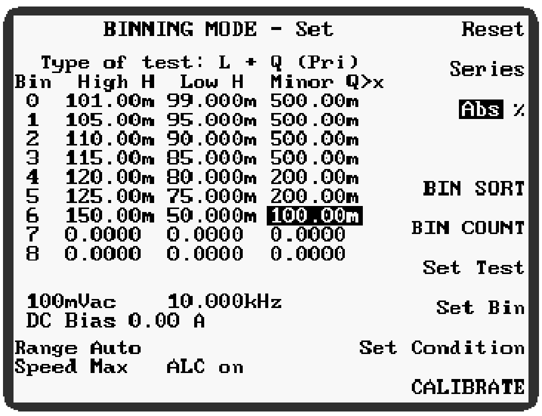


Figure 5-19 BINNING MODE
Stacked Absolute Limits

The example shown in Figure 5-18 above would sort transformers on the basis of their % deviation from primary winding inductance and Q factor. In this case, a transformer with a primary winding inductance of 100mH ±0.5% and a Q factor greater than 0.5 would be sorted into bin 2.

Figure 5-19 is an alternative set-up with stacked limits, sorting the transformers by absolute value. In this case, a transformer with a primary winding inductance of 112mH and a Q factor greater than 0.5 would be sorted into bin 3.

5.9.1.1 BINNING MODE – Set Parameters

Parameters which are common to **IMPEDANCE MODE** are described in section 4.7.2—IMPEDANCE MODE Parameters.

Reset

Resets all bin limits to 0 after displaying a warning message, shown in Figure 5-20 below. Confirm by pressing the **Yes** soft key. Absolute and percentage limits must be reset separately, but since the minor term is common to both, it is reset from either limits mode.

```
Are you sure that you
 want to delete all
  the bin limits?
```

Figure 5-20 BINNING MODE – Set: Reset Warning

Series/Parallel

Only available for tests of: **L + Q (Pri)**, **L + R (Pri)**, **C + D (Pri)**, and **L + R (Sec)**. Selects series or parallel equivalent circuit for measurement of the selected parameters.

Abs %

Toggles between **Abs** and **%**. When **Abs** is selected, absolute Hi and Lo limits (i.e. units of the measured parameter) are displayed. When **%** is selected, a nominal value together with Hi and Lo percentage limits are displayed.

The limits and nominal value must be set using the navigation keys to highlight each parameter, and the data entry keypad to set each value (the use of the data entry keypad is described in section 4.2.6). When in **%** mode, the Hi and Lo limits can be set equidistant about the nominal by setting either of the limits then highlighting the other limit and pressing the keypad **Enter** key twice. This mimics the setting of the first limit but with the opposite sign.

Nominal

This soft key operates only when percentage limits are displayed. The nominal value is displayed below the percentage limits and can be seen, set to 100mH, in Figure 5-18. The nominal is set by pressing the **Nominal** soft key and entering the value using the data entry keypad.

BIN SORT Enters BINNING MODE – Sort: see section 5.9.2.

BIN COUNT Enters BINNING MODE – Count: see section 5.9.3

Set Test Pressing the **Set Test** soft key displays the available measurement options. The required option is highlighted with the ▲ and ▼ navigation keys and selected by pressing the **Enter test** soft key.

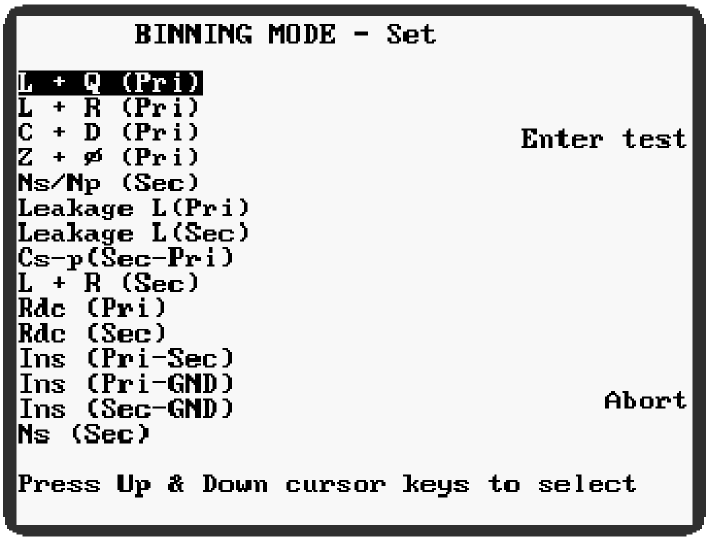


Figure 5-21 BINNING MODE – Set, Measurement Options

Set Bin Moves the cursor, and confines it to, the bin limits area of the screen. The limits are set by highlighting each field using the navigation keys, then entering the limits with the data entry keypad. The ◄ and ► navigation keys move the cursor left and right one step at a time; the ▲ and ▼ navigation keys move the cursor up and down the column. See section 5.9.1 for more information about setting bin limits.

Set Condition Moves the cursor, and confines it to, the test conditions area of the screen (bottom-left-corner). The test conditions are set by highlighting the parameter with the ◄ and ► navigation keys, then altering the setting in pre-determined steps with the ▲ and ▼ navigation keys, or by using the data entry keypad.

CALIBRATE See section 4.3. **Note:** this is not a binning calibration.

Note: If the **BINNING** soft key is pressed when the binning option is not fitted, the analyzer will report **Unit Not Available** (Figure 5-22).

Figure 5-22 Unit Not Available Message

5.9.2 BINNING MODE – Sort

Before sorting components into their respective bins, the bin limits should be set up as described in section 5.9.1—BINNING MODE – Set. When the limits are correctly set up and the screen is displaying the desired limits mode, i.e. absolute limits (**Abs**) or percentage limits (**%**), the **BIN SORT** soft key can be selected from the **BINNING MODE – Set** display.

BINNING MODE – Sort can be performed in Repetitive mode, Single shot mode or under GPIB control; if performed in Single shot mode the **Count** total will be updated in the background (see section 5.9.3). As each component is inserted into the fixture and the measurement made, the bin designation for the measured component is displayed together with the measured value(s). The component may now be placed into the appropriate bin and the next component placed in the fixture ready for sorting.

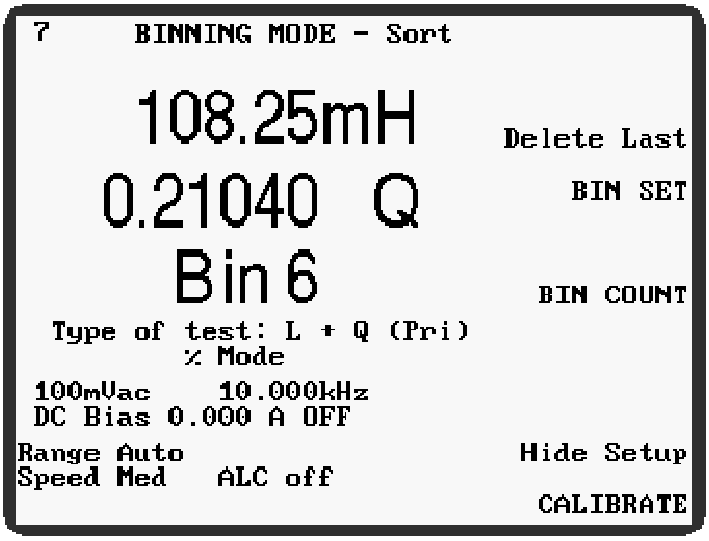


Figure 5-23 BINNING MODE – Sort

5.9.2.1 BINNING MODE – Sort Parameters

Parameters which are common to **IMPEDANCE MODE** are described in section 4.7.2—IMPEDANCE MODE Parameters.

Delete last — If a component is wrongly sorted (e.g. a bad connection to the fixture), pressing the **Delete last** soft key will clear this result from the total. It is only possible to step back one reading.

This soft key appears after a measurement is triggered. Selecting it will display Figure 5-24 below.

```
Delete last result
  Are you sure?
```

Figure 5-24 Delete Last Result Message

Selecting the **Yes** soft key will delete the last result.

BIN SET Enters BINNING MODE – Set: see section 5.9.1.

BIN COUNT Enters BINNING MODE – Count: see section 5.9.3.

CALIBRATE See section 4.3.

5.9.3 BINNING MODE – Count

BINNING MODE – Count can be entered at any time during component sorting by selecting the **BIN COUNT** soft key. Figure 5-25 below shows 9 components sorted into their respective bins.

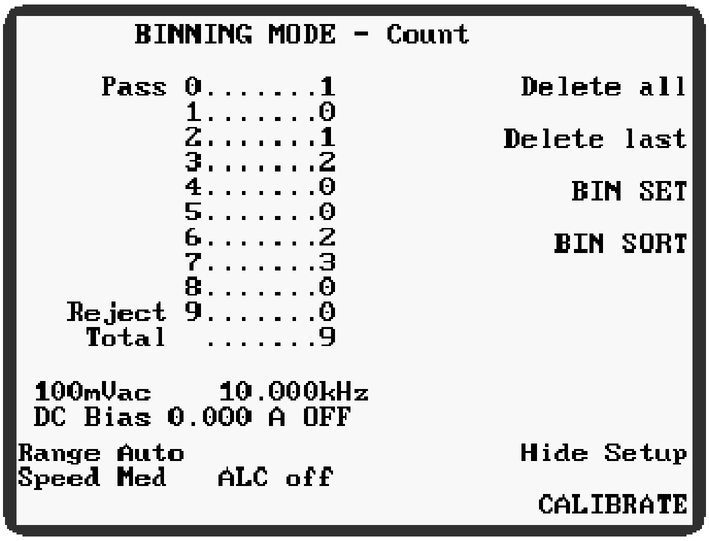


Figure 5-25 BINNING MODE – Count

5.9.3.1 BINNING MODE – Count Parameters

Parameters which are common to **IMPEDANCE MODE** are described in section 4.7.2—IMPEDANCE MODE Parameters.

Delete all Deletes all of the bin counts, resetting them to 0, after a warning message, shown in Figure 5-26 is displayed and is confirmed by pressing the **Yes** soft key.

Figure 5-26 Delete Bin Counts Warning

Delete last If a component is wrongly rejected (e.g. a bad connection to the fixture), pressing the **Delete last** soft key will clear this result from the total. It is only possible to step back one reading.

See also **Delete last** in section 5.9.2.1 above.

BIN SET Enters **BINNING MODE – Set**: see section 5.9.1.

BIN SORT Enters **BINNING MODE – Sort**: see section 5.9.2.

CALIBRATE See section 4.3.

5.10 SEQUENCE EDIT MODE

SEQUENCE EDIT MODE allows a sequence of transformer tests, e.g. on each transformer winding, to be programmed against PASS/FAIL limits for each test. A sequence program can be loaded, viewed and edited in this mode. Programs may have up to 20 steps with up to 100 programs stored in the non-volatile memory of the analyzer. The actual number of programs capable of being stored is dependant on the number of steps within each program. Programs can be selected manually from the front panel or under GPIB control. It is possible to backup and restore programs, e.g. to/from a computer, via GPIB.

A new program should be generated by first copying a previous one (e.g. in the first instance the default program), this can be used as a template and modified to suit requirements. The modified program can then be saved for future use.

The left-hand side of the screen displays the program number and test step list. Test step selection is made by using the ▲ and ▼ navigation keys to scroll through the list. Selecting a test step will display the parameter setup and limits associated with the step which can then be modified using the navigation keys or numeric keypad. The ◀ and ▶ navigation keys are used to select an individual setup parameter or test limit for the selected program test step. Addition, deletion and moving of steps can be carried out using the soft keys on the right-hand side of the screen.

To open **SEQUENCE EDIT MODE** select the **Menu** control key followed by the **SEQUENCE EDIT** soft key. **SEQUENCE EDIT MODE** will be opened with the last selected program displayed, regardless of whether it was selected in **SEQUENCE EDIT MODE** or **SEQUENCE RUN MODE**. If no programs have been saved by the user, the program template, shown in Figure 5-27, will be displayed as program No. 1.

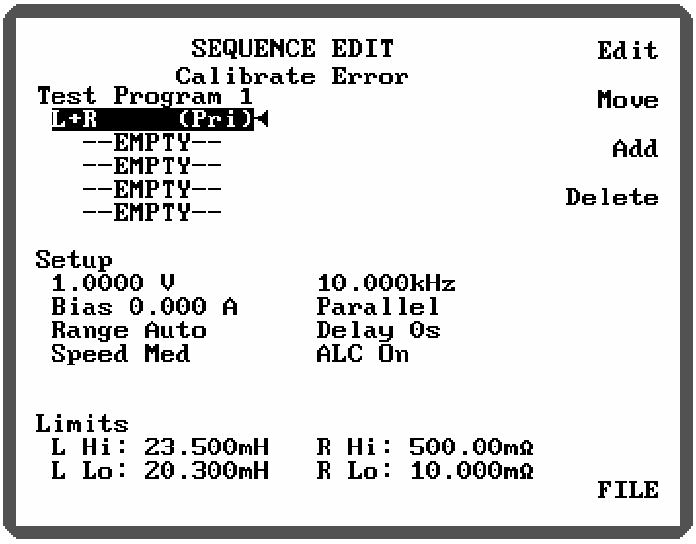


Figure 5-27 SEQUENCE EDIT MODE: Program Template

5.10.1 Sequence Mode Program Files

5.10.1.1 Sequence File Screen

The **SEQUENCE FILE** screen is used to create, load, label, save and delete sequence programs which are stored within the 3260B. To display the **SEQUENCE FILE** screen select **SEQUENCE EDIT MODE** from the main menu and then press the **File** soft key from within the **SEQUENCE EDIT MODE**.

5.10.1.2 Loading an Existing Program

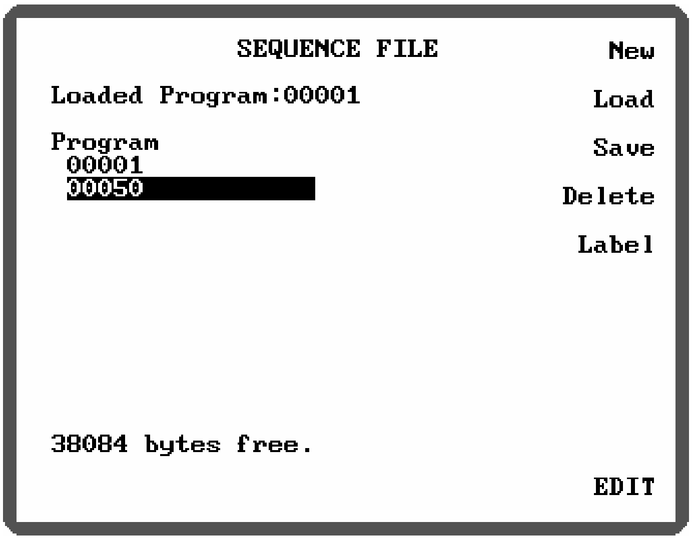


Figure 5-28 SEQUENCE EDIT MODE:Sequence File Screen

1) Display the SE**QUENCE FILE** screen. See section 5.10.1.1 Sequence File Screen.
2) Use the and navigation keys to scroll through the list and press the **Load** soft key when the desired program is highlighted.

3) To return to the **SEQUENCE EDIT MODE** press the **Edit** soft key.

5.10.1.3 Creating a New Program

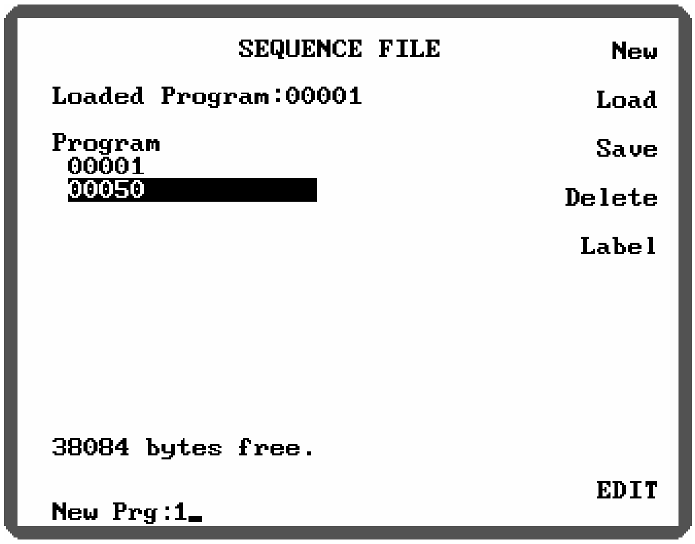


Figure 5-29 SEQUENCE EDIT MODE:New Program

1) Display the SE**QUENCE FILE** screen. See section 5.10.1.1 Sequence File Screen.
2) Select the **New** soft key.
3) Type a unique program number between 1 and 65535, followed by the keypad **Enter** key. A single step test program will be created assigned the number entered.

5.10.1.4 Adding a Program Label

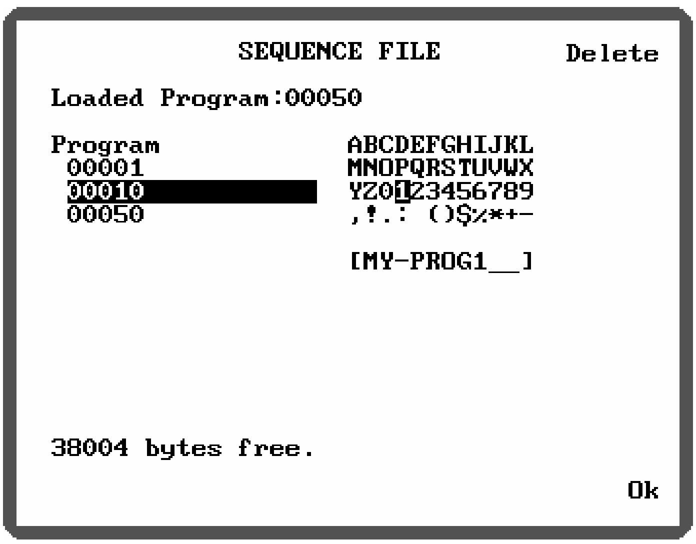


Figure 5-30 SEQUENCE EDIT MODE:Program Label

Any test program may have a label assigned with up to 10 characters.

1) Display the **SEQUENCE FILE** screen. See section 5.10.1.1 Sequence File Screen.
2) Use the ▲ and ▼ navigation keys to scroll through the program list and highlight the program to be labelled.
3) Select the **Label** soft key.
4) Use the navigation keys to select each label character followed by the keypad **Enter** key for confirmation. To cancel the last character entered use the **Delete** soft key.
5) To store the label with the program select the **Ok** softkey.

5.10.1.5 Saving an Existing Program

It is a good idea to regularly save a program during editing.

1) Display the **SEQUENCE FILE** screen. See section 5.10.1.1 Sequence File Screen.
2) Select the **Save** softkey.
3) To overwrite the loaded test file press the **Enter** key on the keypad. Select the **Yes** softkey when prompted to confirm an existing file overwrite or **No** to abort.

5.10.1.6 Copying an Existing Program

1) Display the SE**QUENCE FILE** screen. See section 5.10.1.1 Sequence File Screen.
2) Use the ▲ and ▼ navigation keys to scroll through the list and press the **Load** soft key when the desired program is highlighted.
3) Select the **Save** softkey.
4) Enter a unique program number in the **Save As** field at the bottom of the screen and confirm the program number by pressing the **Enter** key. A label may be added to the program number. See section Adding a Test Program Label.

5.10.1.7 Deleting a Program

1) Display the SE**QUENCE FILE** screen. See section 5.10.1.1 Sequence File Screen.
2) Use the ▲ and ▼ navigation keys to scroll through the program list and highlight the program to be deleted.
3) Select the **Delete** softkey.
4) Program deletion is confirmed by pressing the **Yes** softkey. Abort the deletion process by pressing the **No** softkey.

5.10.2 Sequence Mode Test Program

5.10.2.1 Adding a Test Step

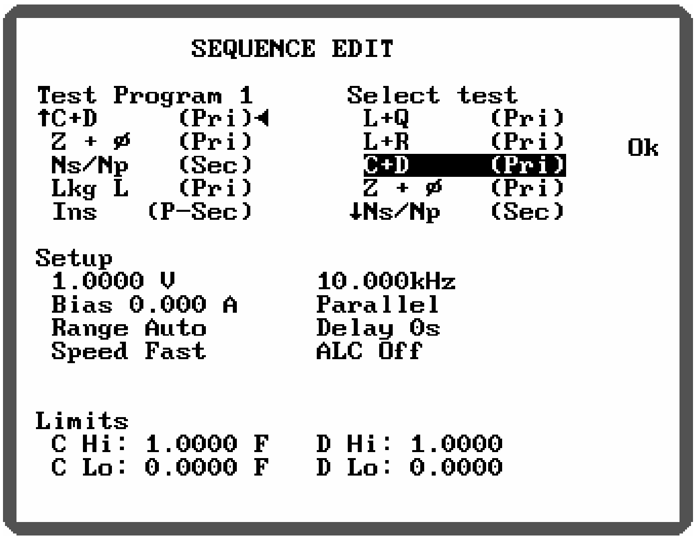


Figure 5-31 SEQUENCE EDIT MODE:Additional Test Step

1) Open the program to be edited. See section 5.10.1.2 Loading an Existing Program.
2) Use the and navigation keys to select the insertion point of the new test step in the test program. The new step will be added to the program after the highlighted test step.
3) Press the **Add** soft key to list the available tests
4) Use the and navigation keys to highlight the type of test to be added.
5) Pressing the **Ok** soft key adds the test step to the program.

Notes:

- New primary winding test steps are always added after the last primary winding test in the list.
- New secondary winding test steps are always added after the last secondary winding test.
- New test steps mimic the settings of the step which was highlighted when the new step was added.

5.10.2.2 Editing a Test Step

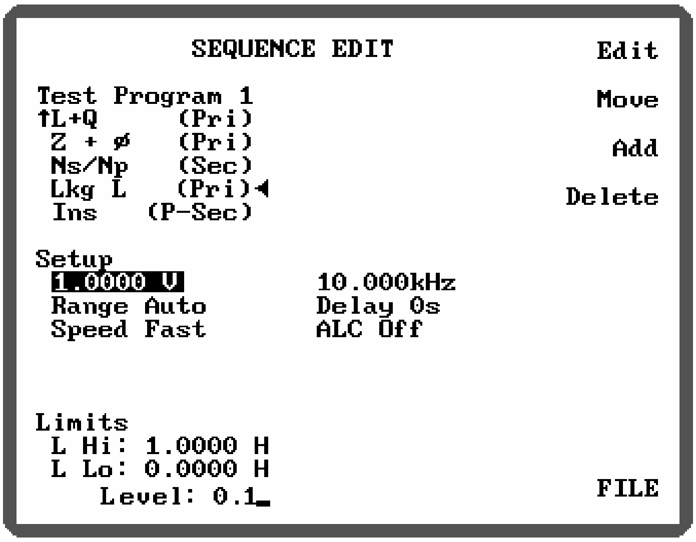


Figure 5-32 SEQUENCE EDIT MODE:Change Test Parameter

1) Open the program to be edited. See section 5.10.1.2 Loading an Existing Program.
2) Use the and navigation keys to highlight the setup or limit parameter to be changed.
3) Parameter settings are modified using the and navigation keys or numeric keypad. Some parameters, e.g. frequency, are changed by entering the new value from the data entry keypad; other parameters, e.g. speed, are changed by repeatedly pressing the keypad **Enter** key to scroll through the available settings.

5.10.2.3 Deleting a Test Step

1) Open the program to be edited. See Section 5.10.1.2 Loading an Existing Program.
2) Use the and navigation keys to highlight the test step to be deleted.
3) Press the soft key labelled **Delete** to remove the highlighted program step from the test program.

5.10.2.4 Moving a Test Step

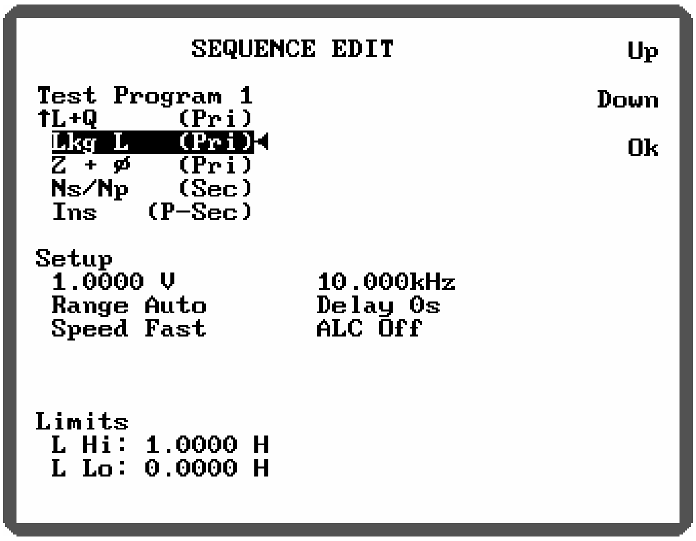


Figure 5-33 SEQUENCE EDIT MODE:Moving a Test Step

1) Open the program to be edited. See section 5.10.1.2 Loading an Existing Program.
2) Use the ▲ and ▼ navigation keys to highlight the test step to be moved.
3) Press the soft key labelled **Move** and use the **Up** and **Down** softkeys to reposition the test step.
4) Complete the move of the test step by pressing the **Ok** softkey.

5.11 SEQUENCE RUN MODE.

To open **SEQUENCE RUN MODE** select the **Menu** control key followed by the **SEQUENCE RUN** soft key. **SEQUENCE RUN MODE** will be opened with the last selected program displayed, regardless of whether it was selected in **SEQUENCE RUN MODE** or **SEQUENCE EDIT MODE**.

5.11.1 Selecting a Program.

The required program is selected using the ▲ and ▼ navigation keys to scroll through the available programs. Pressing the **LIST** soft key will display a list of the available programs.

5.11.2 Program Development.

Entering **code 50** via the data entry keypad will put the analyzer into single step mode so that as a program is run, each program step measurement result is displayed, together with the limits, regardless of PASS/FAIL results. Running a program in this way allows program limits and settling delays to be adjusted while the program is being developed. **Code 50** must be entered after entering **SEQUENCE RUN MODE** and selecting a program, but before running the program. **Code 51** or the next power-up resets the analyzer to repetitive mode.

5.11.3 Running a Program.

Once a program is loaded, see section 5.11.1—Selecting a Program, it is run by pressing the **RUN** soft key. A message, such as that shown in Figure 5-34, will be displayed to prompt connection of the transformer to the measurement leads or fixture. Once this is done, pressing the **Trigger** control key will run the program. As the test progresses, messages will be displayed to prompt connection of secondary windings.

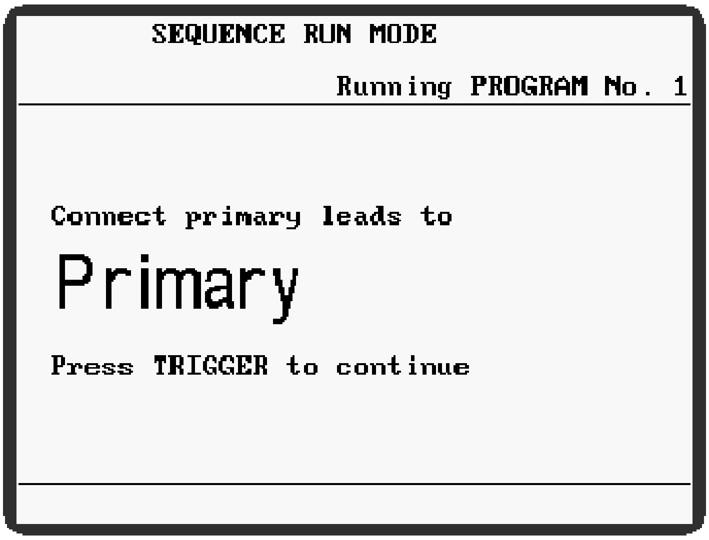


Figure 5-34 SEQUENCE RUN MODE: Connection Prompt

If the transformer passes all test steps, **PASS** will be reported at the end of the test run. Failures are reported on a test-by-test basis, with a failure message, such as that shown in Figure 5-35, reported in each case. When a failure occurs, various options are available.

a) Select the **RETRY** soft key to rerun the failed test step.

b) Press the **Trigger** control key to continue the sequence program.

c) Select the **NEXT TRANSFORMER** soft key to discard any remaining test steps and allow connection of the next transformer to be tested.

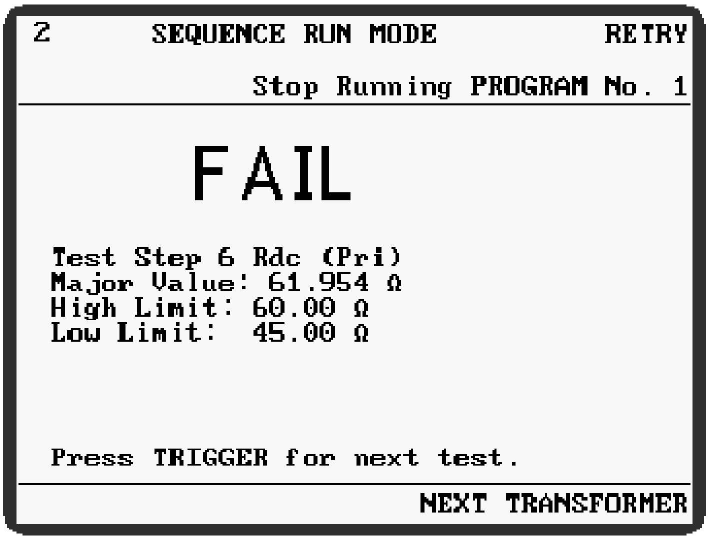


Figure 5-35 SEQUENCE RUN MODE: Failure Message

Selecting the **Stop Running PROGRAM No. *X*** soft key will allow a new sequence program to be selected

5.12 HANDLER MODE

In **HANDLER MODE** the front panel connections are reconfigured to make the analyzer compatible with many existing 4-terminal fixtures and scanners (see Figure 5-3 for the connection protocol for **HANDLER MODE**). The screen layout is similar to **IMPEDANCE MODE** but with the ability to measure turns ratio. The bar graph analogue scale is not available in **HANDLER MODE**.

5.12.1 Use of HANDLER MODE

1) Before any measurements are made using **HANDLER MODE** calibration MUST be carried, see section 4.6—Handler Calibration for information and methods of handler calibration.
2) **Rdc and AC measurements** are performed in the same way as **IMPEDANCE MODE**. See section 4.7—Measuring a Component in IMPEDANCE MODE
3) **Turns ratio measurements** are performed in the same way as **TRANSFORMER MODE**. See section 5.7. Turns ratio measurements in **HANDLER MODE** are made under 2-terminal operation so the effects of measurement lead impedance and transformer shunt impedance cannot be avoided.

5.13 TELECOMS MODE

TELECOMS MODE allows line-matching-transformer insertion loss and return loss to be derived. The user may specify values of source impedance and terminating resistance. A damped network may also be selected with user-specified values and, if required, a DC blocking capacitor in the source line. The pictures below show the three configurations with default component values.

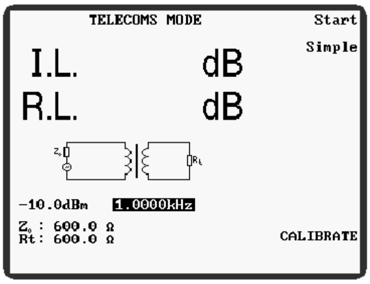


Figure 5-36 TELECOMS MODE: Simple Termination

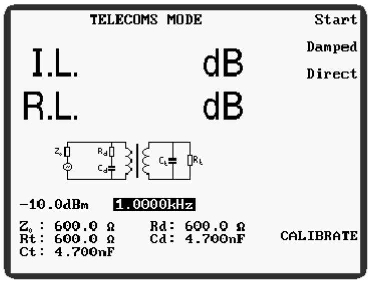


Figure 5-37 TELECOMS MODE: Direct Damped Termination

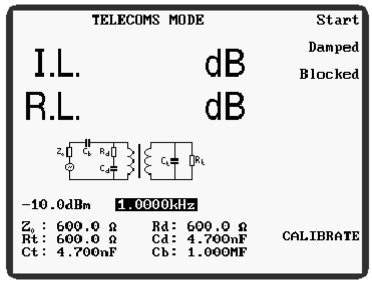


Figure 5-38 TELECOMS MODE: Damped Termination with DC Blocking Capacitor

Two sets of measurement leads are required; see Figure 5-2 for the connection protocol. To meet the specified accuracy, 4-terminal connection must be used. The general procedure when using **TELECOMS MODE** is as follows.

1) Select the **Menu** control key, followed by the **TELECOM** soft key.
2) Connect the measurement leads, see Figure 5-2.
3) Select 4-terminal measurement.
4) From **TELECOMS MODE** select the **CALIBRATE** soft key.
5) Refer to section 4.3 and perform the following trims.
   a) **O/C Trim (Pri)**
   b) **S/C Trim (Pri)**
   c) **O/C Trim (Pri–Sec)**
   d) **S/C Trim (Sec)**
6) Select the **TELECOM** soft key to return to **TELECOMS MODE**.
7) Select the terminating options required..
8) Change the setup parameters as required, i.e. drive level, frequency and terminating component values, being careful not to exceed the limitations of the transformer.
9) Connect **Primary** and **Secondary** leads to the appropriate transformer windings.
10) Press the **Start** soft key to initiate the test. The measured values of insertion loss (I.L.) and return loss (R.L.) will be displayed on the screen.

5.13.1 Example

This example will take the user through the process of measuring the insertion loss and return loss of a line matching transformer. 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 test leads or fixture connected to the front panel BNC connectors according to the connection protocol for transformer/telecom mode (see Figure 5-2).

1) Press the front panel **Menu** control key. The **MAIN MENU** will be displayed.
2) Press the **TELECOM** soft key. **TELECOMS MODE** will be displayed.

3) Press the **CALIBRATE** soft key and perform the trims listed in section 5.13 paragraph 5). When the trims are complete, press the **TELECOM** soft key to return to **TELECOMS MODE**.

4) Using the **Simple/Damped** soft key, select **Damped** termination.

5) Using the **Direct/Blocked** soft key, select **Blocked** termination.

6) Using the navigation keys, highlight and set each of the following parameters in turn. Use the ◀ and ▶ navigation keys to highlight a parameter and the data entry keypad or ▲ and ▼ navigation keys to alter the highlighted parameter setting. Settings may be altered one step at a time, or continuously by holding the navigation key down.

-10.0dBm	(default value)
4.0000kHz	
Z_0 : 600.0 Ω	(default value)
Rt : 600.0 Ω	(default value)
Ct : 4.700nF	(default value)
Rd : 600.0 Ω	(default value)
Cd : 4.700nF	(default value)
Cb : 1.000MF	(default value)

7) Connect the transformer to the test leads or fixture.

8) Press the **Start** soft key. The measured values of insertion loss (I.L.) and return loss (R.L.) will be displayed on the screen.

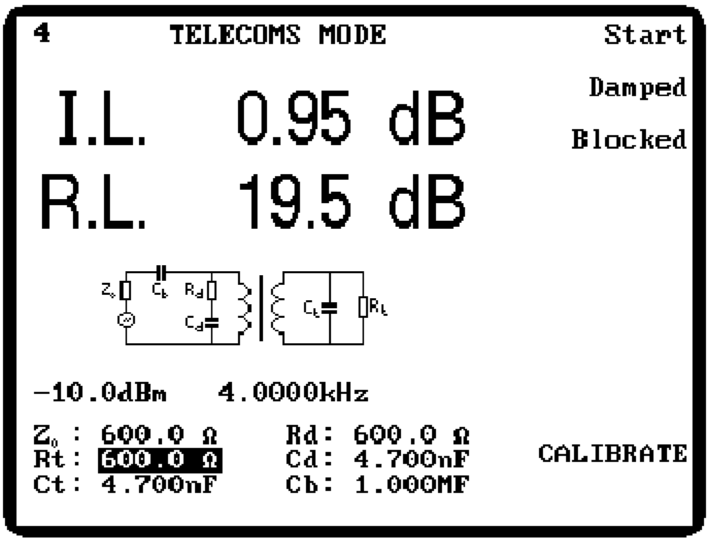


Figure 5-39 Example of Measuring Insertion Loss and Return Loss in TELECOMS MODE

5.13.2 TELECOMS MODE Parameters

The following **TELECOMS MODE** parameters are selectable with the soft keys to the right of the display.

Start When the test conditions have been set and the transformer connected to the test leads or fixture, pressing the **Start** soft key performs a test of Insertion Loss (I.L.) and Return Loss (R.L.).

Simple/Damped

Toggles between **Simple** termination, shown in Figure 5-36, and a **Damped** termination network, shown in Figure 5-37. See also **Direct/Blocked** below.

Direct/Blocked

This soft key becomes available when **Damped** termination is selected (see **Simple/Damped** above). **Direct** termination is shown in Figure 5-37. **Blocked** termination is shown in Figure 5-38 and features a DC blocking capacitor in the transformer signal source.

CALIBRATE

See section 4.3.

The following **TELECOMS MODE** parameters are those displayed in the bottom left-hand-corner of the screen, shown in Figure 5-39.

Drive Level

Set by highlighting the parameter with the and navigation keys, then altering the setting in pre-determined steps with the and navigation keys, or by using the data entry keypad. The range is:

–28.0dBm to 16.0dBm.

Measurement Frequency

Set by highlighting the parameter with the and navigation keys, then altering the setting in pre-determined steps with the and navigation keys, or by finer increments using the data entry keypad. The range is:

100Hz to 20kHz

Fine or coarse frequency steps are available. Coarse steps vary in increments of between 20% and 33%; fine steps vary in increments of 1% or less. Set fine or coarse steps from the **SETTINGS** page—see section 5.18, or use code 10 (fine steps) or code 11 (coarse steps)—see section 4.2.6.1

Z_0

The signal source impedance. The range is:

50.00Ω to 2.000kΩ default = 600.0Ω

Rt

The network terminating resistor. The range is:

50.00Ω to 2.000kΩ default = 600.0Ω

Ct

The network terminating capacitor. Only available when **Damped** termination is selected. The range is:

0.000F to 9.999TF default = 4.700nF

Rd The network source resistance. Only available when **Damped** termination is selected. The range is:

0.000Ω to 9.999TΩ default = 600.0Ω

Cd The network source capacitance. Only available when **Damped** termination is selected. The range is:

0.000F to 9.999TF default = 4.700nF

Cb The signal source DC blocking capacitor. Only available when **Damped** termination is selected and **Direct/Blocked** is set to **Blocked**. The range is:

0.000F to 9.999TF default = 1.000MF

5.14 MULTI FREQ MODE

This mode allows measurement of components at a number of user-defined frequencies. Limits can be turned off or set in absolute or percentage terms and can be different for each defined frequency. When limits are set in percentage terms, a nominal component value must also be entered. **MULTI FREQ** mode is divided into two areas: **MULTI FREQ – Set** and **MULTI FREQ – Run**.

5.14.1 MULTI FREQ – Set

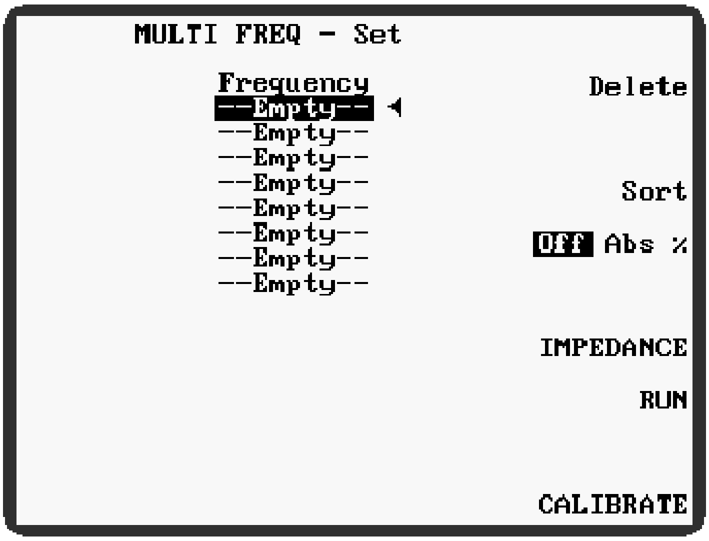


Figure 5-40 MULTI FREQ – Set Display With No Parameters Set up

Up to eight frequencies can be defined by highlighting the frequency, then entering the frequency with the data entry keypad. The and navigation keys scroll through each frequency in turn. Also available, depending upon the setting of the **Off Abs %** soft key, are **High**, **Low** and **Minor** term limits and a **Nominal** parameter. The **High**, **Low, Minor** and

Nominal settings are accessed by pressing either of the ◀ or ▶ navigation keys when one of the frequency settings is highlighted. The **Nominal** value is common to all frequencies but the **High**, **Low** and **Minor** term limits may be different for each frequency set.

Any limit set to zero is ignored when the multi-frequency test is run. Therefore either the major or minor term test may be omitted by setting the appropriate limits to zero.

5.14.1.1 Example

This example will illustrate the procedure for setting **MULTI FREQ** parameters using different limits for each set frequency. The sequence used in this example is not the only way to set the parameters but is intended to familiarize the user with this mode of operation. For this illustration, percentage limits will be used.

1) Enter **MULTI FREQ – Set** mode by pressing the **MULTI FREQ** soft key from the **MAIN MENU**. If **MULTI FREQ – Run** mode is displayed, press the **SET** soft key. If no parameters have previously been set, the display will look like Figure 5-40 above.

2) If the test leads or fixture have been changed since the last time the analyzer was used, press the **CALIBRATE** soft key and perform the following trims with reference to sections 4.3 and 4.4.1. When finished, press the **MULTI FREQ** soft key to return to **MULTI FREQ – Set** mode.

   O/C Trim (Pri)
   S/C Trim (Pri)
   HF Lead Compensation

3) Use the **Off Abs %** soft key to highlight **%**. This sets the display ready to accept percentage limits.

4) Press the **IMPEDANCE** soft key. This will return the instrument to **IMPEDANCE MODE** where the appropriate measurement parameters must be set prior to running a **MULTI FREQ** test. Enter the parameters required for the test. For this example they are set to:

   AC Meas
   L
   Q
   Parallel
   1.00Vac
   1.0000kHz—this will be the first set frequency in **MULTI FREQ – Set** mode
   DC Bias 0.000 A OFF
   NORM
   Range Auto
   Speed Med
   ALC off

   Note: Where a component is to be measured over a wide frequency range, setting **Range** to **Auto** is recommended.

   When the measurement parameters have been set, press the **RETURN** soft key to return the instrument to **MULTI FREQ – Set** mode.

5) Highlight the first frequency, shown highlighted in Figure 5-40 (the and navigation keys scroll through each frequency in turn) and enter the required frequency with the data entry keypad.

6) Highlight and enter the next frequency. Continue to highlight and enter up to eight frequencies in this way. This example will enter frequencies of 1kHz, 3kHz, 10kHz, 30kHz, 100kHz, 300kHz and 1MHz.

7) With the first (top) frequency highlighted, press either of the or navigation keys until the **Nominal** parameter is highlighted (if using absolute limits there is no nominal parameter). Enter the **Nominal** value with the data entry keypad; for this example the nominal will be set to 100µH.

8) Still using the and navigation keys, highlight the **High** limit then enter the required limit with the data entry keypad. For this example all the limits will be set to ±10%, though they could be set to different values for each frequency. Highlight the **Low** limit and enter the required limit. Pressing the **Enter** key twice will echo the **High** limit but with the opposite sign.

9) Highlight the **Minor** term with the and navigation keys and enter the required value. Note that the **Minor** term limit is either an upper or lower limit depending on what the parameter is (e.g. <D, >Q). For this example the Q term will be set to >2 at 1kHz, i.e. anything more than or equal to 2 will pass the minor term parameter and anything below 2 will fail.

10) Press the navigation key: the ◄ symbol will move down and point to the second frequency (3kHz in this example). Note that the limits showing at the bottom of the screen change as each frequency is selected in turn. Using the and navigation keys highlight and set the **High**, **Low**, and **Minor** limits for the second frequency. Press the navigation key again and the ◄ symbol will point to the third frequency and the limits for the third frequency can be set. Continue in this way until the limits have been set for each frequency. The limits set in this example are as follows:

Frequency	**High Limit (L)**	**Low Limit (L)**	**Minor Term Limit (Q)**
1kHz	10%	-10%	>2
3kHz	10%	-10%	>5
10kHz	10%	-10%	>20
30kHz	10%	-10%	>50
100kHz	10%	-10%	>50
300kHz	10%	-10%	>50
1MHz	10%	-10%	>50

These limits can be read back by selecting each frequency in turn.

Figure 5-41 shows the display when set to 30kHz in the example above.

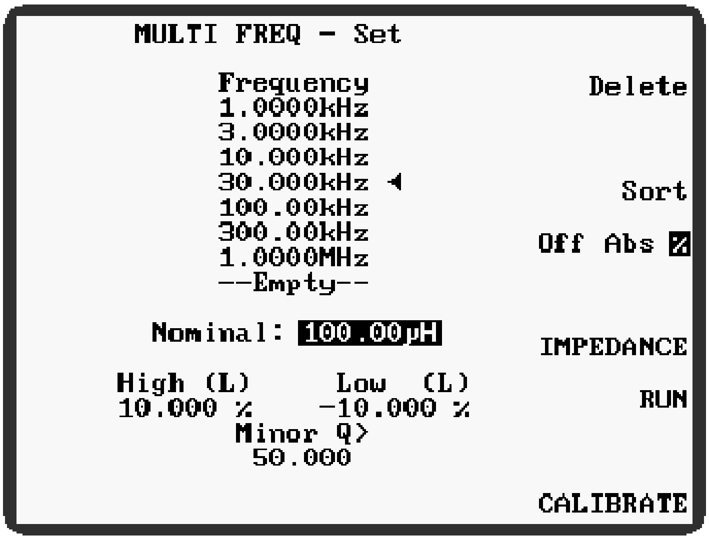


Figure 5-41 MULTI FREQ – Set Display Example

5.14.1.2 MULTI FREQ – Set Parameters

Parameters which are common to **IMPEDANCE MODE** are described in section 4.7.2—IMPEDANCE MODE Parameters.

Delete

The **Delete** soft key will delete the frequency which the ◄ symbol is pointing to. Before deleting the frequency a message, shown in Figure 5-42, will be displayed and must be acknowledged with either the **Yes** or **No** soft key.

Figure 5-42 Delete Frequency Message

Sort

If the frequencies entered were not in sequence, pressing the **Sort** soft key will sort them into ascending order. Pressing **Sort** again toggles the frequency sequence, i.e. the top frequency becomes the bottom frequency and vice versa. The limits will stay with the frequency they relate to.

Off Abs %

Switches between no limits, absolute limits or percentage limits. When set to **Off**, no nominal value or limits are displayed, but any previously selected values will be retained in memory.

When **Abs** is selected, **High**, **Low** and **Minor** term limits are displayed.

when **%** is selected the **Nominal** value together with **High**, **Low** and **Minor** term limits are displayed.

The nominal and limits are set as described in the example above. Nominal and limit values for **MULTI FREQ – Set** mode are independent of those set in any other mode.

IMPEDANCE

Enters **IMPEDANCE MODE** so that measurement parameters may be set up or changed. When the correct measurement parameters are set, the **RETURN** soft key returns the instrument to **MULTI FREQ – Set** mode.

RUN

Enters **MULTI FREQ – Run** mode: see section 5.14.2.

5.14.2 MULTI FREQ – Run

Before a multi-frequency test can be run it must be set up as described in section 5.14.1. Pressing the **RUN** soft key from **MULTI FREQ – Set** mode enters **MULTI FREQ – Run** mode. When first entering this mode the screen will look similar to Figure 5-43 which shows **MULTI FREQ – Run** mode entered after setting **MULTI FREQ – Set** mode according to the example in section 5.14.1.1.

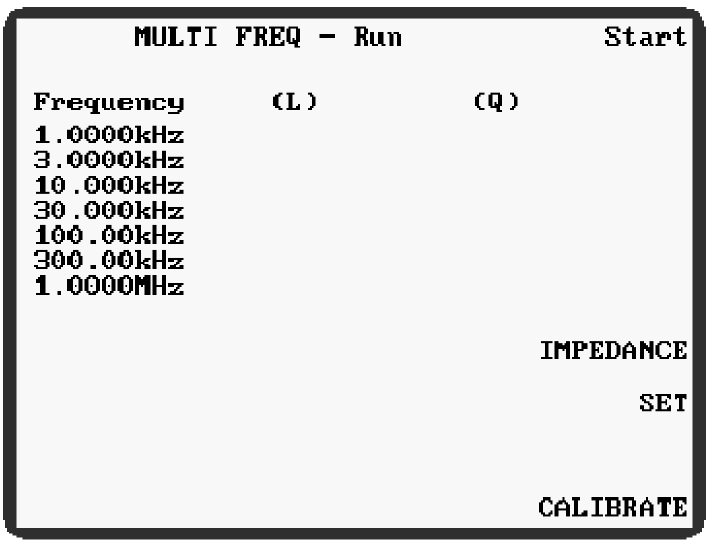


Figure 5-43 Initial MULTI FREQ – Run Display (from example in section 5.14.1.1)

When the **Start** soft key or the **Trigger** key is pressed, the analyzer will measure the component at the frequencies and measurement parameters previously set and the measurement values will be displayed. If either **Abs** or **%** was selected in **MULTI FREQ – Set** mode, the analyzer will report **PASS**, **FAIL, HI** or **LO** according to the table below. Figure 5-44 shows the results of running the multi-frequency test set up in section 5.14.1.1.

PASS	Major *and* minor terms are within the limits set.
FAIL	Major *and* minor terms are outside of the limits set.
HI (X), e.g. HI D, HI C	The parameter indicated is above the upper limit.
LO (X), e.g. LO L, LO Q	The parameter indicated is below the lower limit.

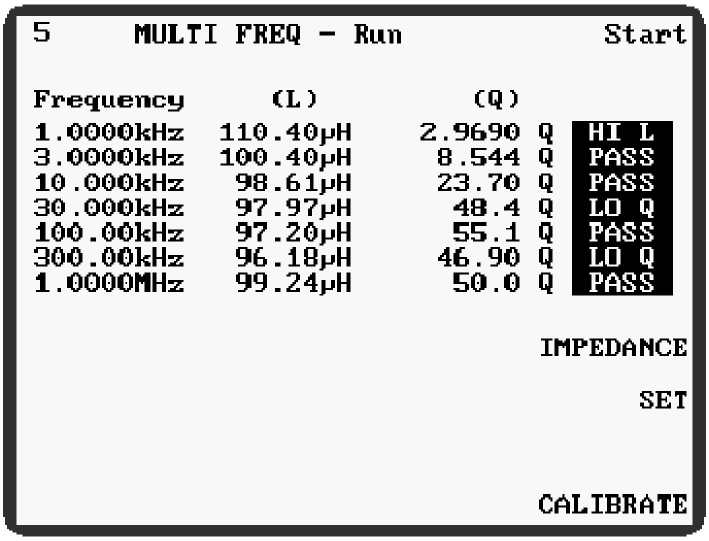


Figure 5-44 MULTI FREQ – Run

When the bin handler option is fitted, the bin handler Pass/Fail output corresponds to the PASS, FAIL, HI and LO results. The Pass/Fail output goes low only when a measurement has passed all set limits, see section 4.1.11.5 for the bin handler interface pin assignment.

5.15 GRAPH MODE

GRAPH MODE allows both major and minor term component or circuit characteristics to be viewed in graphical form (linear or logarithmic) across a user-defined frequency range. Only one term can be viewed at a time but it is possible to rapidly toggle between the major and minor term views. The major term graph may be in absolute units, or as a percentage from a nominal value. The vertical axes for both the major and minor term may be pre-defined by the user. After plotting the graph, the **FIT** function may be used to autoscale either vertical axis for the best available resolution. Other functions within **GRAPH MODE** can be used to find resonance and to identify the highest peak and lowest trough across the frequency range. A marker is displayed with the graph and can move along the graph outline and give x and y coordinate readouts. Results can be printed to an Epson-compatible printer if required, after entering **Code 30** from the **MAIN MENU**.

When first entering **GRAPH MODE** from the **MAIN MENU**, the **GRAPH MODE – Set** screen is displayed (Figure 5-45) which defines the parameters necessary to plot the graph.

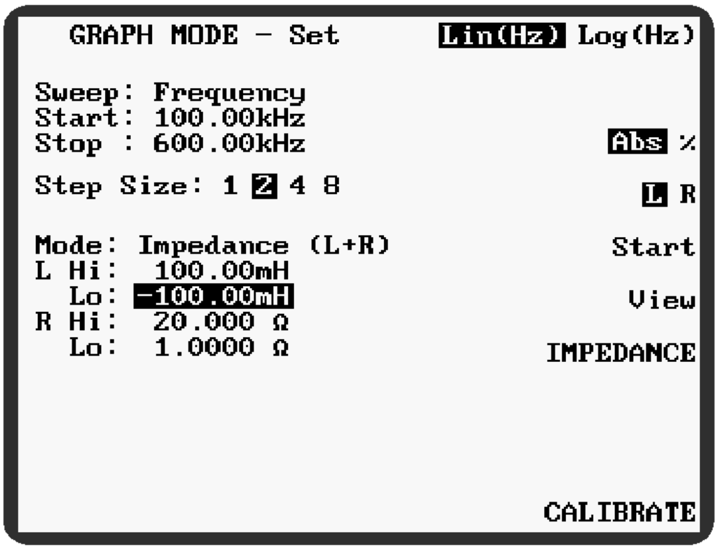


Figure 5-45 GRAPH MODE – Set

Figure 5-45 shows **GRAPH MODE** set up to plot a graph of inductance against frequency on a linear scale between 100kHz and 600kHz with the limits set in absolute terms.

5.15.1 GRAPH MODE – Set Parameters

Parameters which are common to **IMPEDANCE MODE** are described in section 4.7.2—IMPEDANCE MODE Parameters.

Lin(*unit*) Log(*unit*) — Toggles between **Lin(*unit*)** and **Log(*unit*)** to set either linear or logarithmic horizontal scale, where *unit* is the unit of the **Sweep** parameter (see **Sweep**, below).

Lin(Z) Log(Z) — This soft key is displayed only when **Log(*unit*)** is selected (above) and when **Mode** is set to **Impedance (Z+θ)**. It allows selection of Lin or Log vertical scale, allowing log/log graphs to be plotted. Note that negative or zero scale limits cannot be plotted on a log scale. Both limits must be set to positive values before pressing **Start**, or a warning message will be displayed.

Sweep — The **Start** and **Stop** settings for the graph, which are set by highlighting each in turn with the ◀ and ▶ navigation keys, then entering the value with the data entry keypad. When **Sweep** is highlighted the ▲ and ▼ navigation keys are used to set the **Sweep** parameter to **Frequency**, **Bias**, **Bias (Boost)** or **Drive Level**.

Step Size

The **Step Size** is the number of LCD display pixels used for a single point along the graph. The higher the number selected, the coarser the graph but the more quickly it is plotted. Set by highlighting **Step Size** with the and navigation keys, then select from **1 2 4 8** with the and navigation keys.

Mode

When the **Mode** parameter is highlighted with the and navigation keys, it may be toggled between **Impedance…** mode or **Transformer…** mode parameters (see **Major/Minor Term Select**, below) with the and navigation keys. Once this selection is made, the expected **Hi** and **Lo** limits for the y axis of the graph may be highlighted with the and navigation keys and the values entered with the data entry keypad. If percentage limits are selected, a **Nominal** value must also be entered: no units are necessary, this will always match the major term selection.

Abs %

This soft key toggles between **Abs** and **%** (major term only). When **Abs** is selected, absolute **Hi** and **Lo** limits (i.e. units of the measured parameter) are displayed. When **%** is selected, a **Nominal** value together with **Hi** and **Lo** percentage limits is displayed.

The limits and nominal value (if applicable) must be set using the and navigation keys to highlight each parameter and the data entry keypad to set each value.

Note: The **Abs %** soft key is not available when the vertical scale is logarithmic.

Major/Minor Term Select

This soft key toggles between either of the measurement terms selected in **IMPEDANCE MODE** or **TRANSFORMER MODE** depending on whether the **Mode** parameter is set to **Impedance…** or **Transformer…**. The graph will be plotted according to whichever of these terms is highlighted.

Start

When all parameters have been set up, pressing the **Start** soft key will plot the graph.

As the graph is being plotted, a progress marker at the bottom of the screen shows how complete the graph is and the speed of the marker gives an indication of how long the graph will take to plot. If the graph is progressing too slowly, perhaps because too small a **Step Size** has been selected, it can be aborted by pressing and *holding* the **Abort** key.

Notes:

1) If the range is manually selected and the component characteristics take the graph outside the boundaries of the selected range, that portion of the graph will not be plotted.
2) If incorrect y axis settings are selected, no graph will be seen even though the progress marker will indicate that a graph is being plotted: the graph will actually be 'plotted' outside of the display area. The display can be corrected by using the **FIT** autoscale function, or by pressing the **RETURN** soft key and selecting more appropriate limits.
3) An error message shown at the top of the screen indicates that the error occurred somewhere on the sweep.
4) The graph is plotted using the full measurement resolution.

View

When the graph has been plotted and **GRAPH MODE – Set** has been reselected with the **RETURN** soft key, **View** can be used to redisplay the last graph plotted by the analyzer.

IMPEDANCE
or
TRANSFORMER

Enters **IMPEDANCE MODE** or **TRANSFORMER MODE** according to the **Mode** selected (see **Mode**, above) so that measurement parameters may be set up or changed. When the correct measurement parameters are set, the **RETURN** soft key returns the instrument to **GRAPH MODE – Set**.

5.15.2 Parameters Available when the Graph is Displayed

FUNCTION

Pressing **FUNCTION** temporarily crops the graph to display other soft keys available. These are shown indented below:

VIEW

Pressing **VIEW** hides the available soft keys and displays the whole graph.

FIT

The **FIT** soft key replots the graph, auto scaling the vertical axis for the best available resolution. This may be done separately for both major and minor terms.

TOGGLE When a graph is plotted on the major or minor term, the other term is automatically stored in the background and the **TOGGLE** soft key can be used to toggle between the two graphical displays.

RESONANCE Enters **RESONANCE MODE**. See section 5.16.

PEAK Aligns the marker with the highest peak in the set frequency range.

DIP Aligns the marker with the lowest trough in the set frequency range.

NOM>MK Replots the graph with the marker position set as the component nominal value. To aid positioning of the marker, its position in both axes is shown at the bottom of the screen. It is moved with the and navigation keys. When **GRAPH MODE – Set** is re-entered with the **RETURN** soft key, the **Nominal** and **Hi/Lo** limits will reflect the replotted graph.

PRINT Prints the graph on an Epson-compatible printer after entering **Code 30** from the **MAIN MENU**.

RETURN Returns the analyzer to **GRAPH MODE – Set**.

Note

If the DUT exhibits high Q resonances, the graph function may miss the peak or trough due to quantized frequency steps. For accurate values at resonance, use the **RESONANCE** function.

5.15.3 Example

This example will illustrate the procedure for using **GRAPH MODE** and is intended to familiarize the user with this mode of operation. For this example a linear scale will be used to plot inductance over the frequency range of 100kHz to 600kHz.

1) Enter **GRAPH MODE – Set** by pressing the **GRAPH** soft key from the **MAIN MENU**.
2) Highlight the **Sweep** parameter with the or navigation key, then using the and navigation keys set it to **Frequency**.
3) Highlight the **Start** frequency with the or navigation key and enter the required frequency with the data entry keypad. For this example **100kHz** will be entered.
4) Highlight the **Stop** frequency with the or navigation key and enter the required frequency with the data entry keypad. For this example **600kHz** will be entered.
5) Highlight **Step Size** with the or navigation key, then use the and navigation keys to select **1 2 4** or **8**. For this example **2** is selected.
6) Highlight the **Mode** parameter with the or navigation key, then using the and navigation keys set it to **Impedance…**.

7) Press the **IMPEDANCE** soft key. This will display **IMPEDANCE MODE** where the appropriate parameters must be set prior to plotting the graph. Enter the parameters required for the test. For this example they are set to:

   AC Meas
   L
   R
   1.00Vac
   1.0000kHz—this setting will be overridden when the graph is plotted
   DC Bias 0.000 A OFF NORM
   Range Auto
   Speed Med
   ALC off

   When the measurement parameters have been set, press the **RETURN** soft key to return the instrument to **GRAPH MODE– Set**.

8) Highlight the **L** and **R Hi** and **Lo** limits with the or navigation key, then set each in turn with the data entry keypad. For this example they will be set to:

   L Hi: 100.00m
   Lo: -100.00m
   R Hi : 20.000Ω
   Lo : 1.000Ω

9) Use the **Lin(Hz) Log(Hz)** soft key to highlight **Lin(Hz)**.

10) Use the **Abs %** soft key to highlight **Abs**.

    The screen should now look like Figure 5-45.

11) If necessary, press the **CALIBRATE** soft key and perform the appropriate trims for the **Mode** selected. See section 4.3 for details of the trim procedure.

12) Connect the component to the test leads or fixture.

13) Press the **Start** soft key. A graph will be plotted showing the component characteristics using the measurement parameters and frequency range set (Figure 5-46).

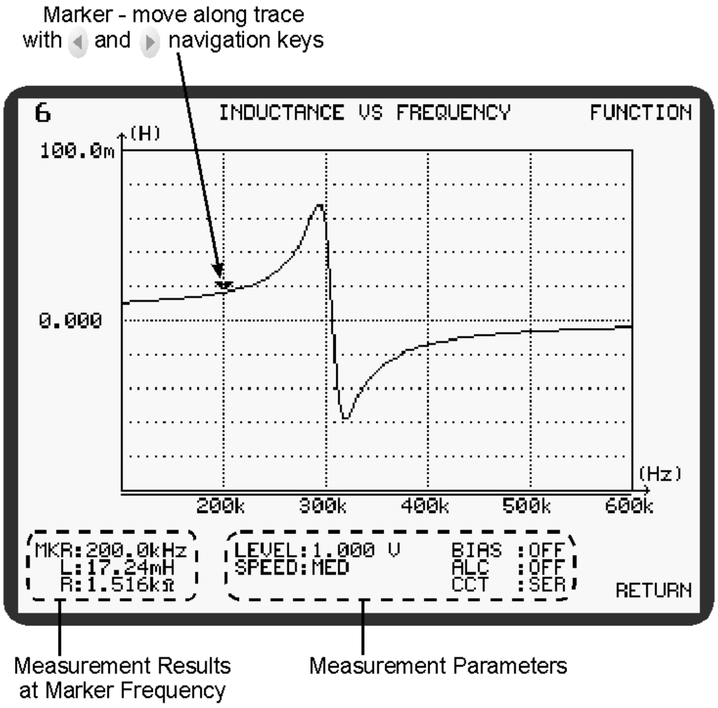


Figure 5-46 Graph Plotted From Example

14) By stepping the marker along the graph with the and navigation keys, the measurement result and frequency can be seen at the marker position in the bottom-left corner of the screen.

15) Pressing the **FUNCTION** soft key will display the other soft key functions available. These are described in section 5.15.2—Parameters Available when the Graph is Displayed

5.16 RESONANCE MODE

RESONANCE MODE identifies and analyses either series or parallel resonances in the component under test. These are typically caused by the self-inductance of capacitors or the self-capacitance of inductors respectively. For analysis purposes, the equivalent circuits shown below are assumed.

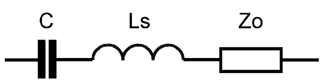


Figure 5-47 Series Equivalent Circuit

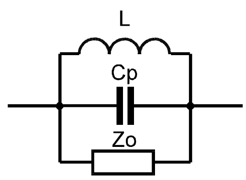


Figure 5-48 Parallel Equivalent Circuit

At the selected resonant frequency, the capacitive and inductive reactances are equal and opposite, giving a measured impedance that is purely resistive. By making measurements above and below this frequency, the exact resonant characteristics are found by interpolation. For resonances with reasonably high Q factors, accurate results are returned for the resonant frequency (fo), self inductance (Ls) or self capacitance (Cp). The Q value and effective resistance at resonance (Zo) are also indicated.

For simple components, where the above models are valid, the series or parallel frequency obtained will also correspond to the minimum or maximum impedance point. The results may not be valid for more complex components, especially those exhibiting more than one resonance.

Before initiating a resonance search, enter values for the Start and Stop frequencies corresponding to the range in which resonance is expected to occur. The search process will complete more quickly if close limits are entered. The search will be performed at the AC test level specified in **IMPEDANCE MODE,** but other test parameters will be selected automatically and need not be specified.

Start the search by pressing the **Find Series** or **Find Parallel** soft key. If a resonance is found, the results will appear after a few seconds, as shown in Figure 5-50. With the **Find Series** or **Find Parallel** label highlighted, a further search may be initiated by pressing the **Trigger** key. Alternatively, press the soft key again.

If the resonance lies outside the frequency range of the analyzer, it is possible to use an extrapolated search, but the results will be at a reduced accuracy. If no resonance is detected within the specified frequency limits, Figure 5-51 will be displayed and must be acknowledged with either the **Yes** or **No** soft key. Answering **Yes** will cause the analyzer to look for a resonance at frequencies up to 2:1 beyond the limits. For best accuracy, always adjust the limits and repeat if this is possible. Accuracy of extrapolated results is undefined, as it is not possible to verify the validity of the circuit model. If no resonance is detected, or if the **No** soft key was pressed, the analyzer will report **Resonance not found.**

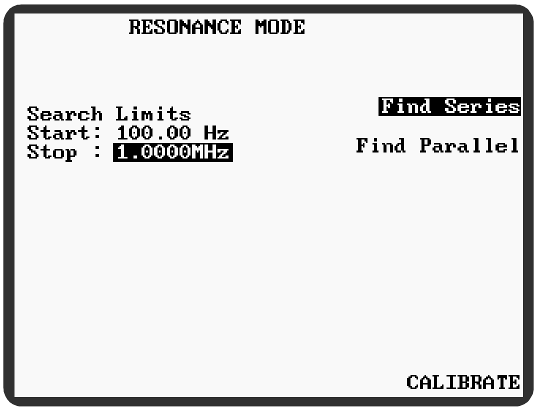


Figure 5-49 RESONANCE MODE

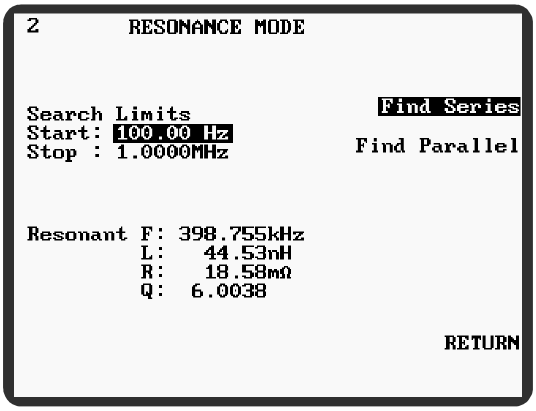


Figure 5-50 RESONANCE MODE Results

Figure 5-50 shows the result of a series resonant frequency search on a 10µF capacitor with the bandwidth search limits set to 100Hz and 1MHz.

Figure 5-51 Resonance Not Found Message

5.17 DEMAG MODE

DEMAG MODE is used for demagnetizing coils. Enter values for **Frequency** and **Start Level**, then press the **Start** soft key. First the coil is saturated by applying the set **Frequency** at the **Start Level**. The coil is then demagnetized by slowly reducing the level to zero.

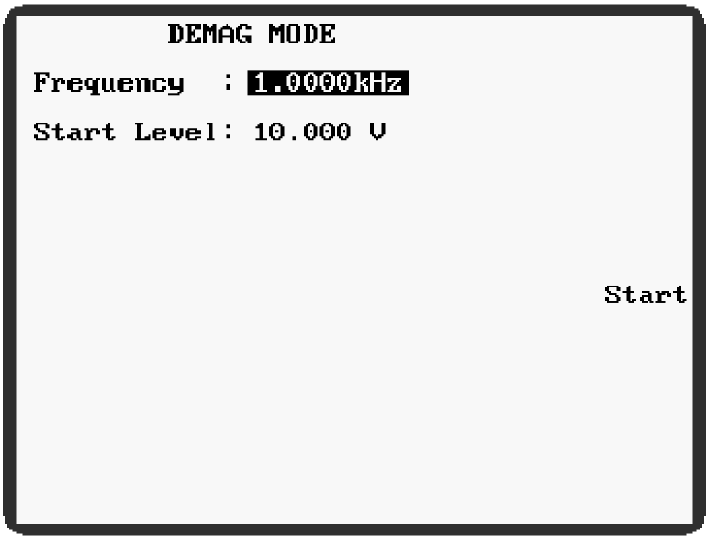


Figure 5-52 DEMAG MODE

5.17.1 DEMAG MODE Parameters

Frequency

Set by highlighting the parameter with the and navigation keys, then altering the setting in pre-determined steps with the and navigation keys, or by finer increments using the data entry keypad. The range is:

20Hz to 3MHz

Start Level

Set by highlighting the parameter with the and navigation keys, then altering the setting in pre-determined steps with the and navigation keys, or by using the data entry keypad. The range is:

1mV to 10V

At frequencies above 300kHz the maximum start level is restricted.

5.18 The SETTINGS Page

The **SETTINGS** page, shown in Figure 5-53, is displayed by pressing the **SETTINGS** soft key from the **MAIN MENU**. **J** indicates that an option is fitted.

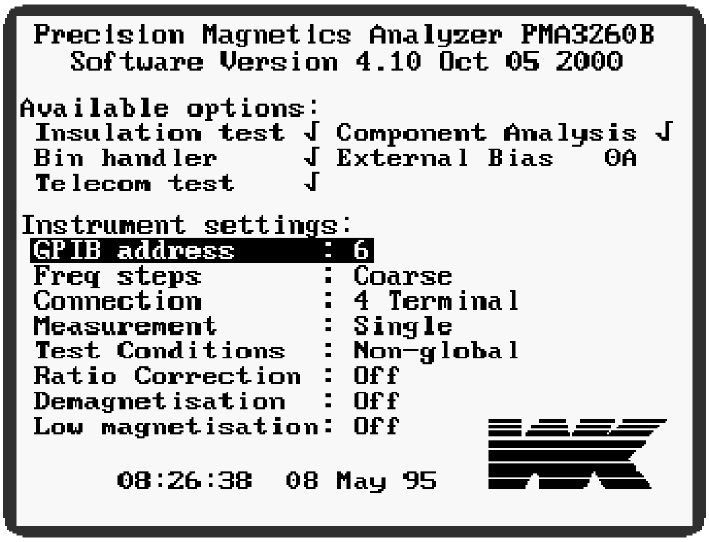


Figure 5-53 The SETTINGS Page

There are eight parameters which may be altered from within the settings page: **GPIB address**, **Freq steps**, **Connection**, **Measurement**, **Test Conditions**, **Ratio Correction, Demagnetisation**, **Low Magnetisation**.

5.18.1 The SETTINGS Page Parameters

GPIB Address

The analyzer's default GPIB address is 6. This may be changed by highlighting the **GPIB address** parameter with the and navigation keys, then altering the address with the or navigation keys or the data entry keypad. Allowable addresses are 0 to 30 inclusive.

Freq Steps

This sets the frequency steps used when the measurement frequency is altered using the navigation keys. Two options are available: **Coarse** or **Fine**. Set by highlighting the **Freq steps** parameter with the and navigation keys, then using the or navigation keys to toggle between the two choices. With **Coarse** steps selected, the frequency steps are 33% or less; with **Fine** steps selected, the frequency steps are 1% or less.

Even with **Coarse** frequency steps selected, the data entry keypad can be used to set the measurement frequency with the maximum possible resolution and accuracy.

Connection

Toggles the analyzer between 2- and 4-terminal operation by highlighting the **Connection** parameter with the and navigation keys, then using the or navigation keys to toggle between the two choices.

Alternatively, the **2/4 Term** control key can be used to switch between 2- and 4-terminal operation (see section 4.2.5).

Note:

1) When 2-terminal measurement is selected the **2/4 term** control key indicator will light and the display will show **2-TERM …MODE** at the top of the screen**.**
2) The leads will require retrimming when switching from 4- to 2-terminal measurement or vice versa.

Measurement

Toggles the analyzer between **Single shot mode** and **Repetitive mode** operation. Set by highlighting the **Measurement** parameter with the and navigation keys, then using the or navigation keys to toggle between the two choices.

Alternatively, the **Sngl/Rep** control key can be used to select either single shot or repetitive mode (see section 4.2.5).

Test Conditions

Toggles the analyzer between **Global** and **Non-global** test conditions. With **Global** set, any parameter, e.g. drive level, frequency, set in one mode of operation, is automatically reflected in all other modes. For example if the **IMPEDANCE MODE** frequency is set to 300Hz, the **TRANSFORMER MODE** frequency will automatically be changed to 300Hz too. With **Non-global** set, the parameters in each mode may be set independently of the parameters in all other modes. Set by highlighting the **Test Conditions** parameter with the and navigation keys, then using the or navigation keys to toggle between the two choices.

Ratio Correction

Sets the ratio correction to **Off**, **Normal transformer** or **Auto transformer** during transformer ratio measurements. Set by highlighting the **Ratio Correction** parameter with the and navigation keys, then using the or navigation keys to select the setting required.

When measuring the turns ratio of transformers with a floating secondary winding, the ratio correction should be set to **Normal transformer** or **Off**. If the primary impedance is low, it is highly recommended to turn ratio correction **Off**. When measuring the turns ratio of auto transformers (transformers with a common connection between one end of the primary and secondary windings) the ratio correction should be set to **Auto transformer**.

Demagnetisation

This is a global setting. With **Demagnetisation** set **On**, components measured using AC primary settings, i.e. **L**, **Q**, **C**, **D**, **Z**, **R**, in **IMPEDANCE MODE** and **L+Q (Pri)** in **TRANSFORMER MODE**, will be demagnetized, using the settings in **DEMAG MODE**, before the component measurement is performed. The demagnetization function will only occur when measurements are performed in single-shot mode. When the analyzer is set to make repetitive measurements, the **Demagnetisation** function is disabled.

Low Magnetisation

Sometimes, when connecting a component to the measurement terminals, the connection coincides with a signal peak from the analyzer which may saturate the component. This situation can be avoided by setting **Low Magnetisation On**. This global setting shorts the analyzer's terminals while the component is connected to the measurement leads/fixture. When a single-shot measurement is performed, by pressing the **Trigger** key, the short is removed and the measurement made. When the measurement has been made, the short is reapplied to the analyzer terminals, allowing removal of the component without the risk of saturation at this point. When the analyzer is set to make repetitive measurements, the **Low Magnetisation** function is disabled

5.19 The CAL STATUS Page

The **CAL STATUS** page, shown in Figure 5-54, is displayed by pressing the **CAL STATUS** soft key from the **MAIN MENU**.

In the **Calibration status** area, **✓** indicates that the named calibration has been performed and is valid. **x** indicates that the named calibration has not been performed or is not valid.

The **Trim status** area shows the trims that have been performed and which conditions were used for trimming. The **Trim** column lists the possible trims. The **Freq** column displays **No trim**, **Spot trim** or **All freq** to show the kind of trim performed. The **Spot** column shows **None** of no trim has been performed. If a spot trim is performed, the **Spot** column shows the frequency the spot trim was performed at. If the trim was performed with the **All freq** setting, the **Spot** column shown the frequency set in **IMPEDANCE MODE** when the trim was performed; the analyzer trims at this frequency, in addition to the normal trim frequencies, when an **All freq** trim is performed. The **Connect** column shows **4-term** or **2-term**, depending on whether the trim was performed in 2- or 4-terminal mode.

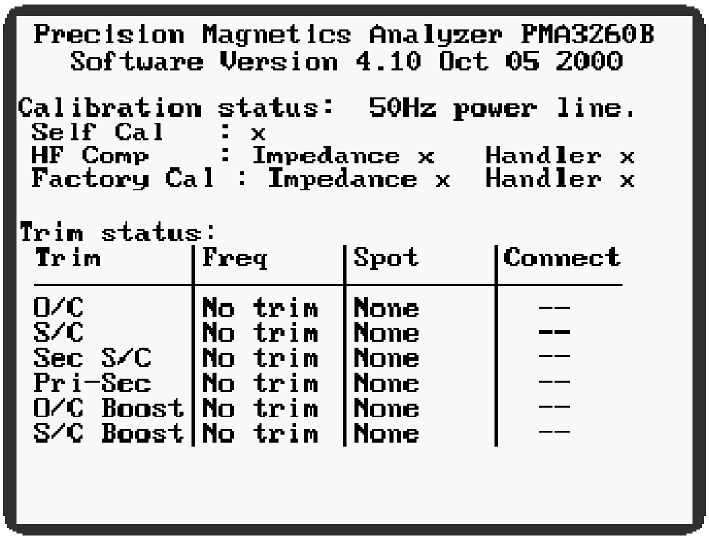


Figure 5-54 The CAL STATUS Page

6. GENERAL PURPOSE INTERFACE BUS (GPIB)

6.1 GPIB Control

6.1.1 Introduction

The GPIB is a parallel port designed to be used for communication between instruments (listeners) and control devices (talkers) such as PCs fitted with a suitable interface card. The interface protocol is defined by the IEEE488.1 standard. Some additional generic capabilities of the listeners and talkers are defined by IEEE488.2. The SCPI standard defines the highest level of command structure including a number of standard commands for all instruments.

6.1.2 Interface Specification

The IEEE 488.1 bus standard and the IEEE 488.2 code standard are fully supported. The command set has also been designed to the SCPI standard.

The IEEE 488.1 functions supported

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

6.1.3 Changing GPIB Address

Each instrument on the GPIB requires a unique address, this can be set to any address in the range 0 to 30.

The default address is 6. This may be changed from the **SETTINGS** page, as follows:

1) From the **MAIN MENU** select **SETTINGS.**
2) Highlight the settings page **GPIB address** parameter with the ▲ and ▼ navigation keys.
3) Alter the address with the ◀ or ▶ navigation keys or the data entry keypad.

The GPIB address is stored in non-volatile memory.

6.1.4 Message Syntax

A GPIB message is made up of one or more commands. Commands can be separated into two groups, **common commands** and **subsystem commands**. The available common commands are defined by IEEE488.2 and are primarily concerned with the instrument's GPIB configuration, e.g. reading error registers and identifying the instrument. The subsystem commands are the higher level commands that follow the SCPI guidelines and are concerned with setting up the instrument functions, e.g. changing the frequency and drive level.

6.1.4.1 Message structure

Messages are sent to the instrument as ASCII character strings. The structure of these strings can be seen in Figure 6-1. When interpreting the strings the instrument is not case-sensitive.

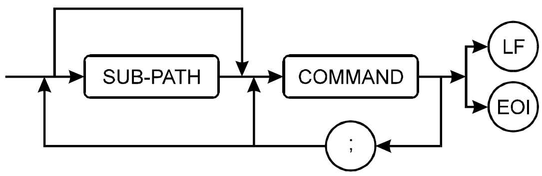


Figure 6-1 GPIB Message Structure

The path command prefix allows access to commands in the SCPI command tree. Using this approach greatly simplifies GPIB programming by allowing related commands to be grouped together. The next part of the string is the command itself which has the structure shown in Figure 6-2. Multiple commands can be sent in one message by separating them with a semicolon (maximum length 256 bytes). The terminator indicates the end of the command string to the instrument: this can be the sending of the line-feed character (ASCII 0Ah) and/or the assertion of the EOI handshake line on the GPIB bus.

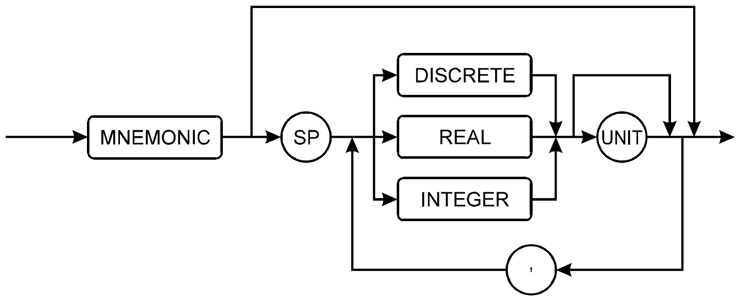


Figure 6-2 GPIB Command Structure

Each instrument command begins with a mnemonic that describes the required action, e.g. `FREQ` for changing the frequency.

If the command requires a parameter, then the next character should be a white space character (ASCII 20h), although any character in the range 00h-20h can be used with the exception of line-feed (ASCII 0Ah).

The parameter itself can take one of three forms depending on the command:

1) Discrete data

   This includes words like `ON`, `OFF` and `ABS`.

2) Real Number

   A floating point number that can be in engineering format or a number with a multiplier suffix K (kilo-), M (mega-) or G (giga-).

   For example:

   ```
   FREQ 1000.0
   FREQ 1E+3
   FREQ 0.1E4
   FREQ 1k
   ```

   are all valid ways of setting a frequency of 1kHz.

3) Integer

   A single integer number. Often used to indicate a Boolean state.

   For example:

   ```
   RANGE 1
   ```

   will select range 1.

If invalid data is supplied then a command error will be generated. If data is supplied but the instrument is not able to apply the setting, an execution error will be generated. If the instrument is unable to exactly comply with the command and can only apply the nearest available, a device specific error is generated. Details of these error codes can be found in Figure 6-6.

6.1.4.2 Hierarchical Commands

As described in the previous section, SCPI uses a command tree to simplify device programming. This structure is similar to the directory structure used on most computers. To access a specific command in a specific mode the user must supply the ‘path’ to reach that particular command within the tree.

When the unit is powered up the initial path is ‘root’ which is the top level from which all paths must start.

Note that common commands (which by convention always start with the ‘*’ character) are not part of the tree and can be accessed regardless of the current path.

So to select the impedance measurement function in deviation mode, the path must describe the command tree as below:

```
ROOT
└► DEViation
    └► FUNCtion
        └► Z
```

The ‘:’ character is used as the path separator so the command string will be:

```
:DEV:FUNC:Z
```

Note that the string starts with ‘:’. This tells the instrument to start from the ‘root’ path. Whenever a terminator is reached (line-feed and/or EOI) the path is reset to the root path, so each new GPIB command string must state the full path in order to work correctly, for example:

To set a measurement frequency of 1kHz at a level of 1.0V, the following string can be used:

```
:IMP:FREQ 1k;LEV 1.0V <line-feed>
```

Or it can be expressed as two separate commands:

```
:IMP:FREQ 1k <line-feed>
:IMP:LEV 1.0 <line-feed>
```

However, the following will not work as the second command will be run from the ‘root’ path, not the measurement path which was required:

```
:IMP:FREQ 1k <line-feed>
LEV 1.0            <line-feed>
```

Summary: The following are the rules for negotiating the command hierarchy

- On power-up or reset, the current path is set to the root.
- Message terminator, line-feed (ASCII 0Ah) or EOI, sets the current path to the root.
- When a colon is the first character of a command, it specifies that the next command mnemonic is a root level command.
- When a colon is placed between two path mnemonics, the current path is moved down one level in the command tree if the path name is valid.
- A semicolon separates two commands in the same message without changing the current path.
- If a command requires more than one parameter, the separate adjacent parameters must be specified using a comma. Commas do not affect the current path.
- Common commands, such as *RST, *RCL, are not part of the tree. An instrument interprets them in the same way, regardless of the current path setting.

Other syntax rules

- Commands will be executed in the order in which they appear in the string.
- A command string can contain any number of ‘query commands’: the response will contain the replies to each query separated by a semicolon.
- Only commands available in the selected mode will be accepted. Otherwise, an Execution Error will be generated. For example, AC frequency cannot be set if Rdc type of test is selected
- Either full or abbreviated forms of the device specific commands will be accepted. The abbreviated form is indicated by upper case letters in section 6.2.
- Device specific commands have the same effect as pressing the equivalent front panel key and can be expected to interact with any other instrument settings in the same way.

6.1.5 Data Output

6.1.5.1 Output Syntax

For each query which generates an output response, a Response Message Unit (RMU), will be generated. This consists of a string of numbers or alphanumeric characters; if more than one RMU is generated they will be delimited with a semicolon. The terminator, line-feed and EOI asserted indicates the end of data output. All characters will be upper case.

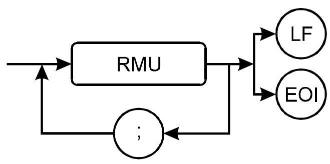


Figure 6-3 GPIB Data Output

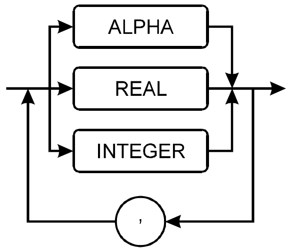


Figure 6-4 GPIB RMU Structure

6.1.5.2 Multiple Items

Some commands will generate an RMU containing more than one item of data (e.g. TRIG will generate a first and second result). In this case, each item of response data will be separated by a comma. Note that the maximum number of characters that can be output is 256, any data beyond this will be lost.

If the command string contained multiple queries then the response will contain multiple RMUs, each of which will be separated by a semicolon.

6.1.5.3 Numeric Format

The format of numeric results will correspond to that used for the instrument display, with the engineering multiplier (if any) replaced by an equivalent 10's exponent. If the FAST-GPIB mode is being used then numbers will be output in a raw engineering format.

6.1.6 Status Reporting

6.1.6.1 Status byte

The status byte is used to summarize information from the other status groups. It is shown in Figure 6-5, which conforms to IEEE 488.2 and SCPI. The status byte can be read by the query command *STB? or by performing a serial poll on the instrument (these two are identical although the point at which the RQS bit can be cleared is slightly different).

BIT	Meaning True = '1'
7	Operation Status Event Register summary bit. This bit is true when measurement or trimming etc., is in progress
6	RQS – ReQuest for Service. When the bit in the Service Request Enable mask is set with the corresponding bit in the status register true, this will trigger a service request to the controller. MSS – Master Summary Status bit. The version of the request for service bit which appears in the Status Byte.
5	ESB – Event Summary Bit. When unmasked by the ESE register, this bit will be set whenever the corresponding bit or bits are set in the Event Status Register.

BIT	Meaning True = ‘1’
4	MAV – Message available. The output queue has data to be read.
3	A summary bit from Questionable Data. This bit is not used, so is always 0.
2	This is a summary bit of error and instrument status messages. True if any new status information is available.
1	Always 0.
0	Always 0.

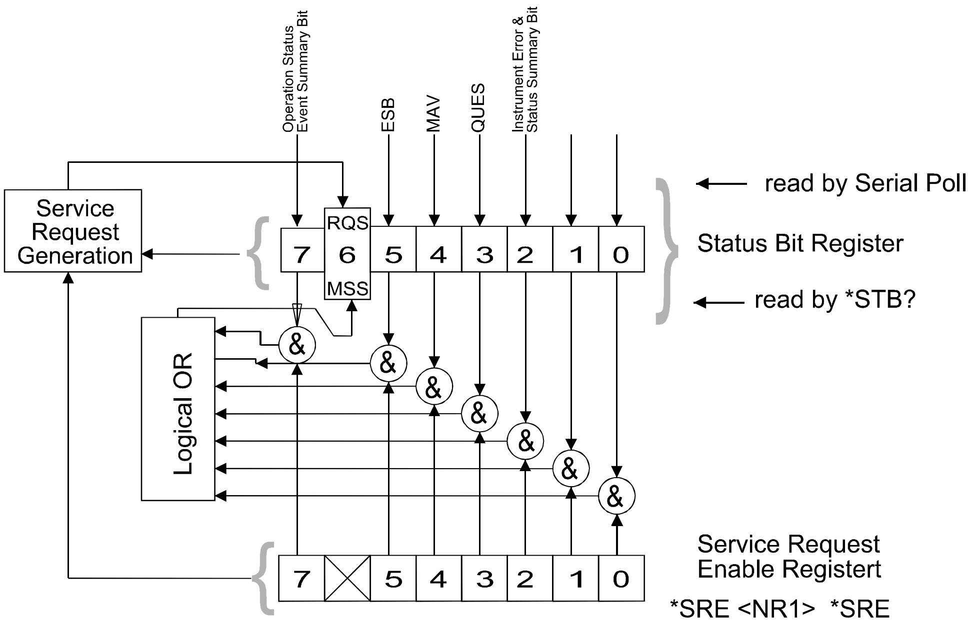


Figure 6-5 Status Byte Register

6.1.6.2 Service Request Enable Register

The service request enable register (SRE) is a mask determining the conditions in which the SBR will generate a service request. It is bit-wise ANDed with the SBR and if the result is not zero then bit 6 of the SBR is set (see Figure 6-5). The SRE is set by the *SRE command and read by the *SRE? command.

6.1.6.3 Standard Event Status Register

The standard event status register (ESR) contains the 8 bits of the operation status report which is defined in IEEE 488.2. If one or more event status bit is set to '1' and their enable bits are also '1', bit 5 (called ESB) of the status register byte is set to '1'.

Each bit of the standard event status register is shown below.

BIT	Name	Meaning (True = '1')
7	Power On (PON)	True when the instrument power supply has been turned OFF and then ON since the last time this register was read.
6	User Request (URQ)	Not used. Always 0.
5	Command Error (CME)	True if the following command errors occur: An IEEE 488.2 syntax error occurred. The device received a Group Execute Trigger (GET) inside a program message.
4	Execution Error (EXE)	True when a parameter following a header of a GPIB command was evaluated by the instrument as being outside of its legal input range or is otherwise inconsistent with the instrument's capabilities.
3	Device Dependent Error (DDE)	True when any bit is set in the Encoded Message Register.
2	Query Error (QYE)	True when attempting to read data from the output buffer in which no data was present, or when the data was lost.
1	Request Control (RQC)	Not used. Always 0.
0	Operation Complete (OPC)	True when the instrument has completed all selected pending operations before sending the *OPC command

Figure 6-6 Standard Event Status Register

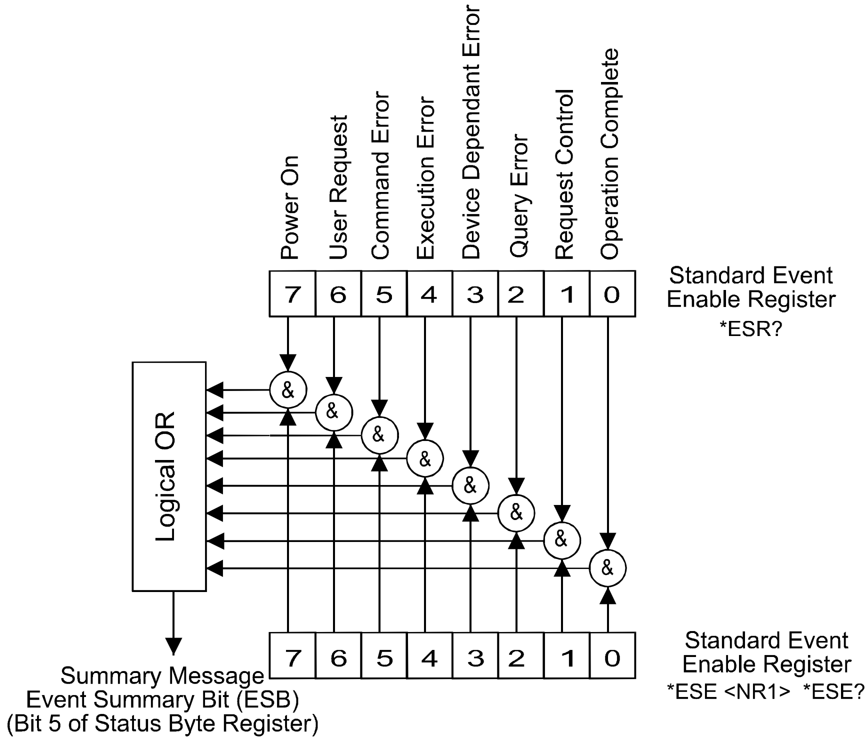


Figure 6-7 Event Status Byte Register

6.1.6.4 Event Status Enable Register

The event status enable register (ESE) is a mask determining the conditions in which the ESR will set bit 5 of the SBR. It is bit-wise ANDed with the ESR and if the result is not zero then ESB (bit 5) of the SBR is set (see Figure 6-7). Thus any event affecting the ESR can be made to generate a Service Request in conjunction with the ERE and the SRE.

The event status enable is set by the *ESE command and read by the *ESE? command.

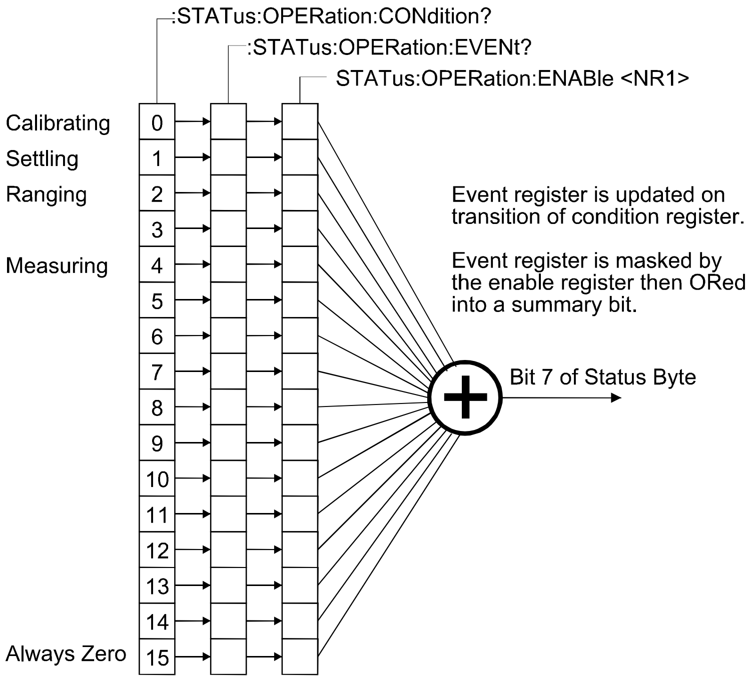


Figure 6-8 Standard Operation Status Group

6.1.6.5 Standard Operation Status Group

The standard operation status group provides information about the state of the measurement systems in the instrument. This status group is accessed through the STATus subsystem. Standard operation status includes a condition register, event register, and an enable register. Figure 6-8 illustrates the structure of standard operation status.

6.1.6.6 Standard Operation Status Condition Register

This is a 16-bit register gathering information about the state of the measurement systems in an instrument. According to SCPI recommendation, we define:

BIT	Meaning (True = ‘1’)
0	Calibrating bit which is true when S/C trimming, O/C trimming, or calibrating is in progress, and otherwise reset.
4	Measuring bit which is true when measurement is in progress, and otherwise reset.

Other bits are unused and are 0.

6.1.6.7 Standard Operation Status Event Register

This is a 16-bit register; each event bit in the event register corresponds to a condition bit in the standard operation status condition register. According to SCPI recommendation, we define:

BIT	Meaning (True = '1')
0	True when S/C trimming, O/C trimming, or calibration measurement is completed.
4	Set true when single shot measurement is completed.

Other bits are uncommitted and are always 0.

6.1.6.8 Encoded Message Register

All front panel warnings and messages can be monitored over the GPIB. There are also several extra flags, otherwise hidden, that are of interest to the bus user.

The encoded message query command returns a string of 8 hexadecimal digits. Each digit represents 4 different errors or their combinations.

The encoded message format is as follows:

D7 D6 D5 D4 D3 D2 D1 D0

D0 indicates range or trim errors

bit0 = Range Error

bit1 = S/C Trim Error

bit2 = O/C Trim Error

bit3 = Calibrate Error

D1 is reserved for future expansion.

D2 indicates errors related to ALC operations.

bit0 = CANNOT SET LEVEL

bit1 = Reserved

bit2 = ALC HELD

bit3 = Reserved

D3 indicates errors related to data entry.

bit0 = Nearest Available

bit1 = Units Mismatched

bit2 = Connection Error

bit3 = Reserved

D4 is reserved.

D5 represents errors related to voltage Bias.

bit0 = Bias overload, Bias Turned Off

bit1 = Reserved

bit2 = Reserved

bit3 = Reserved

D6 is reserved.

D7 is reserved.

Any of the above messages will set bit 2 of the Service Request Register. If ‘Range Error’ or ‘Connection Error’ occurs, pseudo-measurement results ‘999.9E+15, 999.9E+15’ or ‘999.9E+15’ will be produced dependent on the measurement function.

6.1.7 Common Commands

Common commands are listed below. Their detailed description will be given later.

Command	Name	Description
*CLS	Clear Status	Clears the Event Status Register and associated status data structure.
*ESE <NR1>	Event Status Enable	Sets the Event Status Enable Register to the value of the data following the command.
*ESE?	Event Status Enable Query	Returns the current contents of the Standard Event Status Enable Register as an integer in the range 0 to 255.
*ESR?	Event Status Register Query	Returns the current contents of the Standard Event Status Register as an integer in the range 0 to 255. It also clears ESR.
*SRE <NR1>	Service Request Enable	Sets the Service Request Enable Register to the value following the command. The register is set except that bit 6 is ignored.

Command	Name	Description
*SRE?	Service Request Enable Query	Returns the current contents of the Service Request Enable Register as an integer in the range 0 to 63 and 128 to 255.
*STB?	Status Byte Query	Returns the current contents of the Status Byte with the Master Summary bits as an integer in the range 0 to 255. Bit 6 represents Master Summary Status rather than Request Service.
*IDN?	Identification Query	Returns the data identifying the instrument. (e.g. the data output will be: 'WAYNE KERR,3260B,0,1.0' where the first field is the manufacturer, then the model number, then a zero and the software revision number: here represented as Issue 1.0).
*RST	Reset	Resets the instrument to a default setting. This command is equivalent to a power-up reset.
*TRG	Trigger	Triggers a direct measurement, but does not return the results to the controller. This is the same as a GET (Group Execute Trigger) command.
*OPT	Option Identification Query	Returns the hardware options installed in the instrument.
*OPC	Operation Complete Command	Sets the OPC bit of the ESR register.
*OPC?	Operation Complete Query	Always returns 1 as instrument commands are always processed sequentially.
*WAI	Wait-to-continue	Command has no effect as commands are processed sequentially.

6.1.8 Standard Operation Status Commands

Refer to section 6.1.6 for an explanation of the following commands.

Command	Description	Query
	Read Status Operation Condition register.	:STATus:OPERation:CON?
	Read Status Operation Event register	:STATus:OPERation:EVENt?
:STATus:OPERation:ENABle <NR1>	Set Status Operation Enable Register	

6.2 Device-Specific Commands

The sub-system commands are grouped in different modes similar to the local operation. The recommended discipline to control the instrument under GPIB is to select the mode and the type of test first, then change the measurement conditions. Trying to change measurement conditions which are not in the present mode and type of test will be rejected and return an error flag.

6.2.1 Command Summary

Command	Summary	Page
:IMPedance	Select impedance mode/path.	6–23
IMP:TEST	Select test sub-path within impedance mode.	6–23
:IMP:TEST:AC	Select AC measurement.	6–23
:IMP:TEST:RDC	Select Rdc measurement.	6–23
:IMP:TEST?	Impedance test query.	6–24
:IMP:TRIGger	Trigger an AC or Rdc measurement.	6–24
:IMP:FREQuency <real>	Set frequency of AC measurement.	6–24
:IMP:FREQuency?	Frequency query.	6–24
:IMP:LEVel <real>	Set the AC drive level.	6–25
:IMP:LEVel?	Drive level query.	6–25
:IMP:DRIVE?	Test level drive type query.	6–25
:IMP:BIAS <disc>	Control internal and external bias drive.	6–26
:IMP:BIAS-STATus?	Bias status query.	6–26
:IMP:SPEED <disc>	Select measurement speed.	6–26
:IMP:SPEED?	Speed query.	6–26
:IMP:RANGE <disc>	Select auto-ranging or range-hold on range N.	6–27
:IMP:RANGE?	Measurement range query.	6–27
:IMP:ALC <disc>	Select the state of Automatic Level Control.	6–27
:IMP:ALC?	ALC status query.	6–27
:IMP:EQU-CCT <disc>	Select equivalent circuit.	6–28
:IMP:EQU-CCT?	Equivalent circuit query.	6–28
:IMP:FUNC: C, L, Z, Q, D, or R	Select first or second AC measurement function.	6–28
:IMP:FUNC:MAJOR?	First AC function query.	6–29
:IMP:FUNC:MINOR?	Second AC function query.	6–29

Command	Summary	Page
:IMP:SCALE <disc>	Select the state of the scale bar.	6–30
:IMP:SCALE?	Scale status query.	6–30
:IMP:NOMinal <real>	Set nominal value for scale.	6–30
:IMP:NOMinal?	Nominal query.	6–30
:IMP:LIMIT <disc>	Set percentage or absolute scale limits.	6–31
:IMP:LIMIT?	Limit type query.	6–31
:IMP:HIgh-LIMit <real>	Set scale high limit.	6–31
:IMP:HIgh-LIMit?	High limit query.	6–31
:IMP:LOw-LIMit <real>	Set scale low limit.	6–32
:IMP:LOw-LIMit?	Low limit query.	6–32
:TRANsformer	Enter Transformer mode / path.	6–33
:TRAN:TEST:Primary-LQ	Select Primary L+Q measurement.	6–33
:TRAN:TEST?	Transformer test query	6–33
:TRAN:TEST:RATIO	Select Ratio measurement.	6–34
:TRAN:TEST:Primary-RDC	Select Primary Rdc measurement.	6–34
:TRAN:TEST:Secondary-RDC	Select Secondary Rdc measurement.	6–34
:TRAN:TEST:Primary-LEakage	Select Primary Leakage measurement.	6–34
:TRAN:TEST:Secondary-LEakage	Select Secondary Leakage measurement.	6–35
:TRAN:TEST:Capacitance	Select interwinding capacitance measurement.	6–35
:TRAN:TRIGger	Trigger a specified type of measurement and return results.	6–35
:TRAN:FREQuency <real>	Set frequency.	6–36
:TRAN:FREQuency?	Frequency query.	6–36
:TRAN:LEVel <real>	Set AC level	6–36
:TRAN:LEVel?	AC level query.	6–36
:TRAN:SPEED <disc>	Select measurement speed.	6–37
:TRAN:SPEED?	Measurement speed query.	6–37
:TRAN:RANGE <disc>	Select measurement range condition for transformer tests.	6–37
:TRAN:RANGE?	Measurement range query.	6–37
:TRAN:ALC <disc>	Select the state of Automatic Level Correction.	6–38
:TRAN:ALC?	ALC status query.	6–38
:TRAN:FUNC:NS/NP	Select the display of Turns Ratio Ns/Np measurement.	6–38
:TRAN:FUNC:NP/NS	Select the display of Turns Ratio Np/Ns measurement.	6–39

Command	Summary	Page
:TRAN:FUNC:NS <real>	Select the display of Turns Ratio Ns measurement with Np = x.	6–39
:TRAN:FUNC:MAJOR?	Major term query.	6–38
:TRAN:FUNC:NP?	Np query	6–39
:TRAN:EQU-CCT <disc>	Select equivalent circuit.	6–40
:TRAN:EQU-CCT?	Equivalent circuit query.	6–40
:TRAN:RATio-CORRection <disc>	Select the type of transformer for turns ratio correction.	6–40
:TRAN:RATio-CORRection?	Ratio correction query.	6–40
:INSulation	Select Insulation mode / path.	6–41
:INS:PRImary-SECondary	Select Primary to Secondary insulation measurement.	6–41
:INS:PRImary-GND	Select Primary to ground insulation measurement.	6–41
:INS:SECondary-GND	Select Secondary to ground insulation measurement.	6–41
:INS:LEVel <integer>	Set insulation test level.	6–42
:INS:LEVel?	Insulation test level query.	6–42
:INS:DISPlay <disc>	Select display µA or MΩ.	6–42
:INS:TRIGger	Trigger the insulation test and return results.	6–42
:BINning	Select binning mode / path.	6–43
:BINning:SET	Select BIN SET mode.	6–43
:BINning:SORT	Select BIN SORT mode.	6–43
:BINning:COUNT	Select BIN COUNT mode.	6–43
:BINning:NOMinal <real>	Set binning mode nominal.	6–44
:BINning:NOMinal?	Nominal query.	6–44
:BINning:LIMIT <disc>	Select absolute or relative bin limits.	6–44
:BINning:LIMIT?	Limit query.	6–44
:BINning:BIN <integer>	Select a bin to manipulate.	6–45
:BINning:BIN?	Bin number query.	6–45
:BINning:HIgh-LIMit <real>	Set high limit.	6–45
:BINning:HIgh-LIMit?	High limit query.	6–45
:BINning:LOw-LIMit <real>	Set low limit.	6–45
:BINning:LOw-LIMit?	Low limit query.	6–45
:BINning:MINOR <real>	Set minor term limit if it is applicable on the selected test.	6–46

Command	Summary	Page
:BINning:MINOR?	Minor term query.	6–46
:BINning:DEL-ALL	Reset all the bin counters in BIN COUNT mode.	6–46
:BINning:SAVE <integer>	Save the present setup in a store.	6–46
:BINning:LOAD <integer>	Load a set of bin limits from non-volatile memory.	6–47
:BINning:TRIG	In BIN SORT or BIN COUNT mode, trigger a measurement and return results.	6–48
:BINning:DEL-LAST	Decrement by 1 in the most recent bin counter in BIN COUNT mode.	6–48
:BINning:RES?	Return the counts from all the bin counters.	6–48
:SEQuence	Select Sequence mode / path.	6–49
:SEQ:PROGram <integer> <contents>	Upload a sequence program to the instrument.	6–49
:SEQ:PROGram? <integer>	Program query. Download a sequence program from the instrument.	6–49
:SEQ:DELete <integer>	Delete a sequence program.	6–49
:SEQ:RUN <integer>	Run a sequence program.	6–50
:SEQ:RESult?	Sequence result query	6–50
:SEQ:LIST?	Returns a list of the sequence programs stored in the analyzer.	6–50
:SEQ:CLR	Clears all the sequence programs stored in the analyzer.	6–50
:HANdler	Select handler mode / path.	6–51
:HAN:TEST:RDC	Select Rdc measurement.	6–51
:HAN:TEST?	Impedance test query.	6–51
:HAN:TEST:AC	Select AC measurement.	6–51
:HAN:TEST:RATIO	Select Turns Ratio measurement.	6–51
:HAN:FREQuency <real>	Set frequency.	6–52
:HAN:FREQuency?	Frequency query.	6–52
:HAN:LEVel <real>	Set drive level.	6–52
:HAN:LEVel?	Returns the test level of the currently selected test.	6–52
:HAN:BIAS <disc>	Set the bias condition.	6–53
:HAN:BIAS?	Bias level query.	6–53
:HAN:BIAS-STATus?	Bias the current bias status.	6–53
:HAN:SPEED <disc>	Select measurement speed.	6–54
:HAN:SPEED?	Measurement speed query.	6–54
:HAN:RANGE <disc>	Select auto-ranging or range-hold.	6–54

Command	Summary	Page
:HAN:RANGE?	Range query. Returns measurement range in integer.	6–54
:HAN:ALC <disc>	Select the state of Automatic Level Correction.	6–55
:HAN:ALC?	ALC status query.	6–55
:HAN:EQU-CCT <disc>	Select equivalent circuit.	6–55
:HAN:EQU-CCT?	Equivalent circuit query.	6–55
:HAN:FUNC:L, C, Z, Q, D, R	Select major and minor terms.	6–56
:HAN:FUNC:MAJOR?	Major term query.	6–57
:HAN:FUNC:MINOR?	Minor term query.	6–57
:HAN:FUNC:NS/NP	Select the display of Turns Ratio Ns/Np measurement.	6–57
:HAN:FUNC:NP/NS	Select the display of Turns Ratio Np/Ns measurement.	6–57
:HAN:FUNC:NS <real>	Select the display of Turns Ratio Ns measurement with Np = x.	6–58
:HAN:FUNC:NP?	Np query.	6–58
:HAN:CLRLCD	Clear the LCD Display	6–58
:HAN:XCURSOR <integer>	Set X cursor pixel position.	6–58
:HAN:YCURSOR <integer>	Set Y cursor pixel position.	6–59
:HAN:DISP-SMALL <string>	Display string in small characters.	6–59
:HAN:DISP-LARGE <string>	Display string in large characters.	6–59
:HAN:RATio-CORRection <disc>	Select the type of transformer for turns ratio correction.	6–60
:HAN:RATio-CORRection?	Transformer turns ratio correction query.	6–60
:TELecom	Select telecommunications transformer test mode / path.	6–61
:TELecom:FREQuency <real>	Set the telecom test frequency.	6–61
:TELecom:FREQuency?	Query the telecom test frequency.	6–61
:TELecom:NETwork	Set the damping network state.	6–61
:TELecom:NETwork?	Query the damping network state.	6–61
:TELecom:BLOCK	Turn on and off the blocking capacitor in the damping network.	6–62
:TELecom:Z0 <real>	Set the telecom test line impedance value.	6–62
:TELecom:Z0?	Query the telecom test line impedance.	6–62
:TELecom:Rt <real>	Set the telecom test termination resistor value.	6–62
:TELecom:Rt?	Query the telecom test termination resistor.	6–62
:TELecom:Ct <real>	Set the telecom test termination capacitor value.	6–63

Command	Summary	Page
:TELecom:Ct?	Query the telecom test termination capacitor.	6–63
:TELecom:Cd <real>	Set the telecom test damping network capacitor value.	6–63
:TELecom:Cd?	Query the telecom test damping network capacitor.	6–63
:TELecom:Rd <real>	Set the telecom test damping network resistor value.	6–63
:TELecom:Rd?	Query the telecom test damping network resistor.	6–63
:TELecom:Cb <real>	Set the telecom test blocking capacitor value.	6–64
:TELecom:Cb?	Query the telecom test blocking capacitor.	6–64
:MULTI	Select multi-frequency mode / path.	6–65
:MULTI:SET	Switch to the multi-frequency set-up page.	6–65
:MULTI:RUN	Switch to the multi-frequency run page.	6–65
:MULTI:TEST	Select the frequency step to edit.	6–65
:MULTI:TEST?	Return the number of the frequency that is currently being edited.	6–65
:MULTI:FREQuency <real>	Set the frequency for the currently selected step.	6–66
:MULTI:FREQuency?	Returns the frequency of the currently selected multi-frequency step.	6–66
:MULTI:HIgh-LIMit <real>	Set the higher test limit of the currently selected step.	6–66
:MULTI:HIgh-LIMit?	Returns the high limit value of the currently selected multi-frequency step.	6–66
: MULTI:LOw-LIMit <real>	Set the lower test limit of the currently selected step.	6–67
: MULTI:LOw-LIMit?	Returns the low limit value of the currently selected multi-frequency step.	6–67
: MULTI:MINor <real>	Set the minor test limit of the currently selected step.	6–67
: MULTI:MINor?	Returns the minor limit value of the currently selected step.	6–67
:MULTI:NOMinal <real>	Set the multi-frequency nominal value.	6–67
:MULTI:NOMinal?	Returns the multi-frequency nominal value.	6–67
:MULTI:LIMIT <disc>	Selects absolute or percentage limits checking.	6–68
:MULTI:LIMIT?	Returns the current limits checking mode.	6–68
:MULTI:DEL	Removes the current frequency.	6–68
:MULTI:SORT <disc>	Sorts the current frequency list into the required order.	6–69
:MULTI:TRIGger	Starts a run of multi-frequency measurements.	6–69
:MULTI:RES? <integer>	Query the result of the selected frequency step.	6–69
:GRAPH	Select graphing mode / path.	6–70

Command	Summary	Page
:GRAPH:StarT <real>	Set the start frequency for the sweep.	6–70
:GRAPH:StarT?	Returns the start frequency of the sweep.	6–70
:GRAPH:StoP <real>	Set the stop frequency for the sweep.	6–70
:GRAPH:StoP?	Returns the stop frequency of the sweep.	6–70
:GRAPH:LOGF <disc>	Selects the frequency scale type.	6–71
:GRAPH:LOGF?	Returns the current frequency scale type.	6–71
:GRAPH:LOGY <disc>	Selects the measurement scale type.	6–71
:GRAPH:LOGY?	Returns the current measurement scale type.	6–71
:GRAPH:LIMIT <disc>	Selects absolute or relative plotting.	6–72
:GRAPH:LIMIT?	Returns the current graph plotting mode.	6–72
:GRAPH:MarKer?	Returns the first and second measurement from the current marker position.	6–72
:GRAPH:MarKerF <real>	Move the marker to the frequency nearest the supplied value.	6–73
:GRAPH:MarKerF?	Returns the current marker frequency.	6–73
:GRAPH:MAJor-LOw <real>	Set the Y-axis start point for the first measurement type.	6–73
:GRAPH:MAJor-LOw?	Query the current Y-axis start point for the first measurement type.	6–73
:GRAPH:MAJor-HIgh <real>	Set the Y-axis stop point for the first measurement type.	6–74
:GRAPH:MAJor-High?	Query the current Y-axis stop point for the first measurement type.	6–74
:GRAPH:MINor-LOw <real>	Set the Y-axis start point for the second measurement type.	6–74
:GRAPH:MINor-LOw?	Query the current Y-axis start point for the second measurement type.	6–74
:GRAPH:MINor-HIgh <real>	Set the Y-axis stop point for the second measurement type.	6–75
:GRAPH:MINor-High?	Query the current Y-axis stop point for the second measurement type.	6–75
:GRAPH:NOMinal <real>	Set the nominal value for use when graphs are being plotted in percentage mode.	6–75
:GRAPH:NOMinal?	Returns the current graph nominal.	6–75
:GRAPH:TERM <integer>	Set which measurement will be shown/viewed.	6–76
:GRAPH:TERM?	Query the current measurement selection.	6–76
:GRAPH:STEP <integer>	Select the number of pixels between each measured point on the graph.	6–76

Command	Summary	Page
:GRAPH:STEP?	Query the current step size for the plot.	6–76
:GRAPH:SET	Go to the graph mode set-up page.	6–77
:GRAPH:VIEW	Redraw the graph.	6–77
:GRAPH:FIT	Fit the Y-axis scale to the current measurement data.	6–77
:GRAPH:TRIG	Start plotting a graph with the current settings.	6–77
:GRAPH:PEAK	Move the marker to the highest point on the current graph.	6–78
:GRAPH:DIP	Move the marker to the lowest point on the current graph.	6–78
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IMPEDANCE MODE

:IMPedance

Select impedance mode.

Parameters:

None.

Response:

None.

:IMP:TEST

Select test sub-path within impedance mode.

Parameters:

None.

Response:

None.

:IMP:TEST:AC

Select AC measurement.

Parameters:

None.

Response:

None.

:IMP:TEST:RDC

Select Rdc measurement.

Parameters:

None.

Response:

None.

IMPEDANCE MODE

:IMP:TEST?

Measurement test query.

Parameters:

None.

Response:

0 AC measurement type.

1 Rdc measurement type.

:IMP:TRIGger

Trigger a measurement using the current settings.

Parameters:

None.

Response:

For AC measurements the response will be the first and second measurements separated by a comma.
Example: `68.860E-9 , 13.0E+6`

For Rdc measurements the response will be a single measurement result.
Example: `6.2295E+3`

:IMP:FREQuency <real>

Set the frequency of AC measurements.

Parameters:

The required frequency in Hertz. The unit suffix ‘Hz’ is optional.

Example:

```
:IMP:FREQ 1k
:IMP:FREQ 1000 Hz
:IMP:FREQ 1E3
```

are all equivalent commands and set the test frequency to 1kHz.

Response:

None.

:IMP:FREQuency?

Returns the current AC test frequency.

Parameters:

None.

Response:

Returns the current test frequency in engineering format.

Example: +.10000000E+04

for a test frequency of 1kHz.

IMPEDANCE MODE

:IMP:LEVel <real>

Set the AC drive level.

Parameters:

For AC tests supply the required drive level in either Volts or Amps.

Example: `:IMP:LEV 1.2V`

`:IMP:LEV 1E-2A`

will select drive levels of 1.2V and 10mA respectively.

Response:

None.

:IMP:LEVel?

Returns the AC drive level.

Parameters:

None.

Response:

Returns the current test level in engineering format.

Example: +.20000000E-01

for a test level of 20mV.

:IMP:DRIVE?

Test level drive type query.

Parameters

None

Response

0 Current drive

255 Voltage drive

IMPEDANCE MODE

:IMP:BIAS <disc>

Set the voltage bias condition.

Parameters:

`ON`	Turn on bias.
`OFF`	Turn off bias.
`INT`	Select internal bias.
`EEXT`	Select external bias.

Example: `:IMP:BIAS INT`

`:IMP:BIAS ON`

will select internal bias and turn it on.

Response:

None.

:IMP:BIAS-STATus?

Returns the current bias status.

Parameters:

None.

Response:

Returns bias status in two integers delimited by a comma:

First integer:	0 Bias OFF.
	1 Bias ON.
Second integer:	0 Internal bias.
	1 External bias.

Example: `1,0`

would indicate that internal voltage bias is turned on.

:IMP:SPEED <disc>

Select the required measurement speed.

Parameters:

`MAX`	Maximum speed.
`FAST`	Fast speed.
`MED`	Medium speed.
`SLOW`	Slow speed.

Example: `:IMP:SPEED SLOW`

will select slow speed for measurements.

Response:

None.

:IMP:SPEED?

Returns the current test speed.

Parameters:

None.

Response:

Returns the test speed as an integer according to the table:

`0`	Maximum
`1`	Fast
`2`	Medium
`3`	Slow

Example: `1`

indicates that Fast measurements are selected.

IMPEDANCE MODE

:IMP:RANGE <disc>

Select the measurement range condition for AC and Rdc tests.

Parameters:

The following parameters are valid:

`AUTO` Auto-ranging.

`HOLD` Hold current range.

`1 to 7` Range 1 to 7

Example: `:IMP:RANGE 1`

`:IMP:RANGE AUTO`

will select range 1 and auto-ranging respectively.

Response:

None.

:IMP:RANGE?

Measurement range query

Parameters:

None.

Response:

Returns the measurement range as an integer according to this table:

`0` Auto-ranging.

`1-7` Current measurement range.

Example: `0`

indicates that auto ranging is selected.

:IMP:ALC <disc>

Select the state of Automatic Level Control for AC tests.

Parameters:

The following parameters are valid:

`ON` ALC on.

`OFF` ALC off.

`HOLD` Hold current ALC level.

Example: `:IMP:ALC OFF`

will turn off ALC.

Response:

None.

:IMP:ALC?

Automatic Level Control status query.

Parameters:

None.

Response:

Returns the ALC state according to this table:

`0` OFF.

`1` ON.

`2` HELD.

Example: `2`

indicates that ALC is currently held.

IMPEDANCE MODE

:IMP:EQU-CCT <disc>

Select the equivalent circuit type for AC tests.

Parameters:

The following parameters are valid:

`SER`	Series equivalent circuit.
`PAR`	Parallel equivalent circuit.

Example: `:IMP:EQU-CCT SER`

will select series equivalent circuit.

Response:

None.

:IMP:EQU-CCT?

Equivalent circuit query.

Parameters:

None.

Response:

Returns the equivalent circuit flag according to this table:

`0`	Parallel.
`1`	Series.

Example: `0`

indicates that parallel equivalent circuit is selected.

:IMP:FUNC:C, L, Z, Q, D, R

Select first or second AC measurement function.

Parameters

Selecting first measurement:

`:IMP:FUNC:C`	Capacitance.
`:IMP:FUNC:L`	Inductance.
`:IMP:FUNC:Z`	Impedance.

Selecting second measurement:

`:IMP:FUNC:Q`	Quality factor.
`:IMP:FUNC:D`	Dissipation factor.
`:IMP:FUNC:R`	Resistance.

Note that selecting Z as the first measurement will force the second measurement to be Angle. This does not change the equivalent circuit flag setting.

Example: `:IMP:FUNC:C;D`

will select C+D measurements.

Response

None

IMPEDANCE MODE

:IMP:FUNC:MAJOR?

First AC function query.

Parameters:

None.

Response:

Returns the measurement type according to this table:

`0` Inductance.

`1` Capacitance

`2` Impedance.

Example: `2`

indicates that the first measurement is impedance (Z).

:IMP:FUNC:MINOR?

Second AC function query (non-polar measurements).

Parameters:

None.

Response:

Returns the measurement type according to this table:

`0` Q-Factor.

`1` D-Factor.

`2` Resistance.

Example: `1`

indicates that the second measurement is dissipation factor (D). Note that if the first measurement is polar (Z), this query will return the last non-polar setting.

IMPEDANCE MODE

:IMP:SCALE <disc>

Show/Hide the scale bar.

Parameters:

The following parameters are valid:

`ON` Show scale.

`OFF` Hide scale.

Example: `:IMP:SCALE OFF`

will turn off the scale.

Response:

None.

:IMP:SCALE?

Returns the current status of the scale bar.

Parameters:

None.

Response:

Returns scale setting according to this table:

`0` Scale hidden.

`1` Scale visible.

Example: `0`

indicates that the scale is currently hidden.

:IMP:NOMinal <real>

Set the scale bar nominal value.

Parameters:

The required nominal value. If a unit is supplied it must that of either the first or second measurement otherwise the unit mismatch error will be set. If no unit is supplied the current nominal unit will be used.

Examples:

`:IMP:NOMINAL 1e-6F`
will set a nominal of 1uF.

`:IMP:NOMINAL 0.47e-5`
will set a nominal of 4.7uF

Response:

None.

:IMP:NOMinal?

Returns the scale bar graph nominal value.

Parameters:

None.

Response:

Returns the nominal in engineering format.

Example: `+.10000000E-01`

would indicate a nominal of 10mH if the first nominal unit is Henrys.

IMPEDANCE MODE

:IMP:LIMIT <disc>

Select absolute or percentage scale bar limits.

Parameters:

The following discrete parameters are valid:

`ABS` Absolute limits.

`PERC` Percentage limits.

Example: `:IMP:LIMIT PERC`

will select percentage limits.

Response:

None.

:IMP:LIMIT?

Returns the current scale bar limits type.

Parameters:

None.

Response:

Returns the scale bar limits according to this table:

`0` Absolute scale.

`1` Percentage scale.

Example: `0`

indicates that the scale bar currently has absolute limits.

:IMP:HIgh-LIMit <real>

Set the percentage scale bar high limit.

Parameters:

The required high limit. No unit should be supplied: the nominal unit is used.

Example: `:IMP:HI-LIM 5.0`

will set a high limit of +5.0% of nominal.

Response:

None.

:IMP:HIgh-LIMit?

Returns the current scale bar percentage high limit.

Parameters:

None.

Response:

The current high limit in engineering format.

Example: `+.25000000E+01`

indicating a high limit of +2.5% of nominal.

IMPEDANCE MODE

:IMP:Low-LIMit <real>

Set the percentage scale bar low limit.

Parameters:

The required low limit. No unit should be supplied: the nominal unit is used.

Example: `:IMP:LO-LIM -5.0`

will set a low limit of -5.0% of nominal.

Response:

None.

:IMP:LOw-LIMit?

Returns the current scale bar percentage low limit.

Parameters:

None.

Response:

The current low limit in engineering format.

Example: `-.20000000E+01`

indicating a high limit of -2.0% of nominal.

TRANSFORMER MODE

:TRANSformer

Enter Transformer mode / path.

Parameters

None.

Response

None.

:TRAN:TEST:Primary-LQ

Select Primary L+Q measurement.

Parameters

None.

Response

None.

:TRAN:TEST?

Transformer test query.

Parameters

None.

Response

0	P-LQ
1	Ratio
2	P-RDC
3	S-RDC
4	P-LE
5	S-LE
6	C

TRANSFORMER MODE

:TRAN:TEST:RATIO

Select ratio measurement.

Parameters

None.

Response

None.

:TRAN:TEST:Primary-RDC

Select Primary Rdc measurement.

Parameters

None.

Response

None.

:TRAN:TEST:Secondary-RDC

Select Secondary Rdc measurement.

Parameters

None.

Response

None.

:TRAN:TEST:Primary-LEakage

Select Primary Leakage measurement.

Parameters

None.

Response

None.

TRANSFORMER MODE

:TRAN:TEST:Secondary-LEakage

Select Secondary Leakage measurement.

Parameters

None.

Response

None.

:TRAN:TEST:Capacitance

Select interwinding capacitance measurement.

Parameters

None.

Response

None.

:TRAN:TRIGger

Trigger a specified type of measurement and return results.

Parameters

None.

Response

The measurement result as displayed. Multiple results (L + Q, Leakage) will be separated by commas.

Example: `5.0E + 0`

would indicate a turns ratio of 5:1.

TRANSFORMER MODE

:TRAN:FREQuency <real>

Set frequency of test selected.

Parameters

The required test frequency in Hertz. The unit suffix ‘Hz’ is optional. Suffix multipliers K, M, G may be used.

Example: `:TRAN:FREQ 1k`

`:TRAN:FREQ 1000 Hz`

`:TRAN:FREQ 1E3`

are all equivalent commands and set the test frequency to 1kHz.

Response

None

:TRAN:FREQuency?

Frequency query.

Parameters

None

Response

Return the current test frequency in Hz as floating point number.

Example: `2.50E2`

for a test frequency of 250Hz.

:TRAN:LEVel <real>

Set AC level of test selected.

Parameters

Supply the required level in either Volts or Amps. If no suffix is stated, the previous type of drive is set.

Note:

Current drive is not available in Turns Ratio tests.

Example: `:TRAN:LEV 1.2V`

`:TRAN:LEV 1E-2A`

will select levels of 1.2V and 10mA respectively.

Response

None.

:TRAN:LEVel?

Returns the test level of the currently selected test type.

Parameters:

None.

Response:

Returns the current test level in engineering format.

Example: `+.20000000E-01`

for a test level of 20mV.

TRANSFORMER MODE

:TRAN:SPEED <disc>

Select the required measurement speed.

Parameters:

MAX	Maximum speed.
FAST	Fast speed.
MED	Medium speed.
SLOW	Slow speed.

Example: `:TRAN:SPEED SLOW`

will select slow speed for measurements.

Response:

None.

:TRAN:SPEED?

Measurement speed query.

Parameters:

None.

Response:

Returns the test speed as an integer according to the table:

0	Maximum
1	Fast
2	Medium
3	Slow

Example: `1`

indicates that Fast measurements are selected.

:TRAN:RANGE <disc>

Select measurement range condition for transformer tests.

Parameters:

The following parameters are valid:

AUTO	Auto-ranging.
HOLD	Hold current range.
1 to 7	Range 1 to 7

Example: `:TRAN:RANGE 1`

`:TRAN:RANGE AUTO`

will select range 1 and auto-ranging respectively.

Response:

None.

TRAN:RANGE?

Measurement range query.

Parameters:

None.

Response:

Returns the measurement range as an integer according to this table:

0	Auto-ranging.
1-7	Current measurement range.

Example: `0`

indicates that auto ranging is selected.

TRANSFORMER MODE

:TRAN:ALC <disc>

Select the state of Automatic Level Control.

Parameters:

The following parameters are valid:

`ON`	ALC on.
`OFF`	ALC off.
`HOLD`	Hold current ALC level.

Example: `:TRAN:ALC OFF`

will turn off ALC.

Response:

None.

:TRAN:ALC?

Automatic Level Control status query.

Parameters:

None.

Response:

Returns the ALC state according to this table:

`0`	OFF.
`1`	ON.
`2`	HOLD.

Example: `2`

indicates that ALC is currently held.

:TRAN:FUNC:NS/NP

Select the display of Turns Ratio Ns/Np measurement.

Parameters

None.

Response

None

:TRAN:FUNC:MAJOR?

Major term query.

Parameters

None.

Response

`0`	`Ns/Np`
`1`	`Np/Ns`
`2`	`Ns`

Example: `0`

indicates that the transformer test is set to Ns/Np.

TRANSFORMER MODE

:TRAN:FUNC:NP/NS

Select the display of Turns Ratio Np/Ns measurement.

Parameters

None.

Response

None

:TRAN:FUNC:NP?

Np query.

Parameters

None.

Response

Returns the value of Np as floating point number.

:TRAN:FUNC:NS <real>

Select the display of Turns Ratio Ns measurement.

Parameters

<real> is decimal numeric data to specify the number of turns of Np.

Example: `:TRAN:FUNC:NS 1`

will set Np to 1 turn.

Response

None

TRANSFORMER MODE

:TRAN:EQU-CCT <disc>

Select the equivalent circuit type for transformer tests.

Parameters:

The following parameters are valid:

`SER` Series equivalent circuit.

`PAR` Parallel equivalent circuit.

`AUTO` Sets series or parallel equivalent circuit according to the resistance of the primary winding, as follows:

>250Ω = Parallel
<250Ω = Series

Example: `:TRAN:EQU-CCT SER`

will select that series equivalent circuit.

Response:

None.

:TRAN:EQU-CCT?

Equivalent circuit query.

Parameters:

None.

Response:

Returns the equivalent circuit status according to this table:

`0` Parallel.

`1` Series.

2 AUTO

Example: `0`

indicates that parallel equivalent circuit is selected.

:TRAN:RATio-CORRection <disc>

Select the type of transformer for turns ratio correction.

Parameters

The following parameters are valid:

`OFF` Normal transformer with low primary impedance.

`NORM` Normal transformer with primary impedance >50Ω.

`AUTO` Auto transformer (common connection between one end of primary and secondary windings)

Response

None.

:TRAN:RATio-CORRection?

Ratio correction query.

Parameters:

None.

Response

Returns the turns ratio correction status according to this table:

`0` `OFF`

`1` `NORM`

`2` `AUTO`

Example: `0`

indicates that turns ratio correction is OFF.

INSULATION MODE

:INSulation

Select Insulation mode / path.

Parameters

None

Response

None

:INS:PRImary-SECondary

Select Primary to Secondary insulation measurement.

Parameters

None

Response

None

:INS:PRImary-GND

Select Primary to ground insulation measurement.

Parameters

None

Response

None

:INS:SECondary-GND

Select Secondary to ground insulation measurement.

Parameters

None

Response

None

INSULATION MODE

:INS:LEVel <integer>

Set insulation test level.

Parameters

<integer> is decimal integer data which can be 100, 200 or 500.

Example: `:INS:LEV 500`

will set the insulation test level to 500V.

Response

None

:INS:LEVel?

Insulation test level query.

Parameters

None

Response

Returns the test level in volts as integer number 100, 200 or 500.

:INS:DISPlay <disc>

Select display µA or MΩ.

Parameters

UA or MOHM.

Example: `:INS:DISP UA`

will set the analyzer to display µA.

Response

None

:INS:TRIGger

Trigger the insulation test and return results.

Parameters

None

Response

The test result in engineering format.

Example: `5E + 7`

would indicate an insulation resistance of 50MΩ.

BINNING MODE

:BINning

Select one of the previously worked binning modes / binning command path.

Parameters:

None.

Response:

None.

:BINning:SET

Select BIN SET mode.

Parameters:

None.

Response:

None.

:BINning:SORT

Select BIN SORT mode.

Parameters:

None.

Response:

None.

:BINning:COUNT

Select BIN COUNT mode.

Parameters:

None.

Response:

None.

BIN SET MODE

:BINning:NOMinal <real>

Set binning mode nominal if Bin Set percentage mode is selected.

Parameters:

The required bin nominal value. No unit is required: the measurement mode unit is used.

Example `:BIN:NOM 68e-9`

will set a nominal value of 68nF.

Response:

None.

:BINning:NOMinal?

Nominal query.

Parameters:

None.

Response:

Returns the nominal in engineering format.

Example: `0.68E-07`

would indicate a nominal of 68nF if the measurement is capacitance

:BINning:LIMIT <disc>

Set percentage or absolute mode.

Parameters:

The following discrete parameters are valid:

`ABS`	Absolute limits.
`PERC`	Limits as a percentage of nominal.

Example: `:BIN:LIMIT PERC`

will set the test limits to a percentage of the nominal value.

Response:

None.

:BINning:LIMIT?

Limit query.

Parameters:

None.

Response:

`0`	Absolute limits.
`1`	Percentage limits.

Example: `1`

indicates that components will be tested against limits that are a percentage of the nominal value.

BIN SET MODE

:BINning:BIN <integer>

In BIN SET, select a bin (bin 0 to bin 8) to manipulate.

Parameters:

An integer in the range 0 to 8.

Example: `:BIN:BIN 3`

will select bin 3 for editing.

Response:

None.

:BINning:BIN?

Bin number query.

Parameters:

None.

Response:

Returns the present bin.

Example: `5`

indicates that the settings for bin number 5 are those currently being edited.

:BINning:HIgh-LIMit <real>

Set high limit.

Parameters:

The required high limit. <real> is decimal numeric data. No suffix is allowed.

Example: `:BIN:HI-LIM 10.0`

will set a high limit of 10% when percentage limits are selected.

Response:

None.

:BINning:HIgh-LIMit?

High limit query.

Parameters:

None.

Response:

Returns high limit value as a floating point number.

Example: `0.50E + 0`

indicates a high limit of +5% when percentage limits are selected.

:BINning:LOw-LIMit <real>

Set low limit.

Parameters:

<real> is decimal numeric data. No suffix is allowed.

Example: `:BIN:LO-LIM -10.0`

will set a low limit of -10% when percentage limits are selected.

Response:

None.

:BINning:LOw-LIMit?

Low limit query.

Parameters:

None.

Response:

Returns low limit value as a floating point number.

Example: `-.50000000E+01`

indicates a high limit of -5% when percentage limits are selected.

BIN SET MODE

:BINning:MINOR <real>

Set minor term limit if it is applicable on the selected test.

Parameters:

<value> is decimal numeric data. No suffix is allowed.

Example: `:BIN:MINOR 1.0`

will set a low limit of 1.0 for the minor test.

Response:

None.

:BINning:MINOR?

Minor term query.

Parameters:

None.

Response:

Returns low limit value as a floating point number.

Example: `.10000000E+01`

indicates a minor limit of 1.0.

:BINning:DEL-ALL

Reset all the bin counters in BIN COUNT mode.

Parameters:

None.

Response:

None.

:BINning:SAVE <integer>

In BIN SET mode, save the present setup in non-volatile memory.

Parameters:

The memory store to use in the range 1 to 99.

Example: `:BIN:SAVE 2`

will save the current bin limits to memory store number 2.

Response:

None.

BIN SET MODE

:BINning:LOAD <integer>

Load a set of bin limits from non-volatile memory.

Parameters:

The memory store to use in the range 1 to 99.

Example: `:BIN:LOAD 1`

will load the set-up currently stored in memory number 1.

Response:

None.

BIN SORT AND BIN COUNT MODES

:BINning:TRIG

In BIN SORT or BIN COUNT mode, trigger a measurement and return results.

Parameters:

None.

Response:

In BIN SORT mode both the measurement result and the bin number are returned.

Example: `14.235E-6 , 5.820 ; 3`

where the first two numbers are the measurement and the number after the semicolon is the sorted bin.

In BIN COUNT mode only the result bin is returned.

Example: `3`

indicating that the component met the characteristics of bin 3.

:BINning:DEL-LAST

Decrement by 1 in the most recent bin counter in BIN COUNT mode.

Parameters:

None.

Response:

None.

:BINning:RES?

Return the counts from all the bin counters.

Parameters:

None.

Response:

The cumulative counts of all the bins 0 to 8, the reject bin and the total number of components tested are returned in comma delimited form.

Example: `4, 3, 2, 6, 3, 7, 8, 2, 5, 1, 34`

indicating a total of 34 components tested with 1 reject and bins 0 through 8 containing 4, 3, 2, 6, 3, 7, 8, 2, 5 components respectively.

SEQUENCE MODE

:SEQuence

Select Sequence mode / path.

Parameters

None

Response

None

:SEQ:PROGram <integer> <contents>

Upload a sequence program to the instrument.

Parameters

The program will be stored in the analyzer with the program number <integer>, 0 to 65535.

<contents> conforms to the IEEE488.2 and SCPI 'Definite Length Block Response Data'.

Response

If the program number already exists, an Execute Error will be generated.

:SEQ:PROGram? <integer>

Program query. Download a sequence program from the instrument.

Parameters

The program stored in the analyzer with the program number <integer>, 0 to 65535, is sent to the controller if it exists.

Example: `:SEQ:PROG? 23`

will download program number 23 to the controller.

Response

If the program number does not exist an Execute Error will be generated.

:SEQ:DELete <integer>

Delete a sequence program.

Parameters

The program stored in the analyzer with program number <int>, 0 to 65535, will be deleted without warning if it exists.

Example: `:SEQ:DEL 65`

will delete the analyzer sequence program number 65 (if it exists). NO WARNING WILL BE GIVEN!

Response

If the program number does not exist an Execute Error will be generated.

SEQUENCE MODE

:SEQ:RUN <integer>

Run a sequence program.

Parameters

The program stored in the analyzer with program number <int>, 0 to 65535, will be loaded and run if it exists.

Example: `:SEQ:RUN 43`

will run program number 43 (if it exists).

Response

If the program number does not exist an Execute Error will be generated.

:SEQ:RESult?

Sequence result query.

Parameters

None

Response

Returns the result of the sequence executed as an integer as follows:

`0` `FAIL`

`1` `PASS`

Example: `0`

would indicate that the last sequence program run failed.

:SEQ:LIST?

Returns a list of the sequence programs stored in the analyzer.

Parameters

None

Response

The program numbers separated by commas.

:SEQ:CLR

Clears all the sequence programs stored in the analyzer.

WARNING: This GPIB command will clear ALL the sequence data in the analyzer, use with caution!

Parameters

None

Response

None

HANDLER MODE

:HANdler

Select handler mode / path.

Parameters

None

Response

None

:HAN:TEST:RDC

Select Rdc measurement.

Parameters

None

Response

None

:HAN:TEST?

Impedance test query.

Parameters

None

Response

2	Turns Ratio
1	Rdc
0	AC

:HAN:TEST:AC

Select AC measurement.

Parameters

None

Response

None

:HAN:TEST:RATIO

Select Turns Ratio measurement.

Parameters

None

Response

None

HANDLER MODE

:HAN:FREQuency <real>

Set frequency.

Parameters

The required test frequency in Hertz. The unit suffix 'Hz' is optional. Suffix multipliers K, M, G may be used.

Example: `:HAN:FREQ 1k`

`:HAN:FREQ 1000 Hz`

`:HAN:FREQ 1E3`

are all equivalent commands and set the test frequency to 1kHz.

Response

None

:HAN:FREQuency?

Frequency query.

Parameters

None

Response

Return the current test frequency in Hz as floating point number.

Example: `2.50E2`

for a test frequency of 250Hz.

:HAN:LEVel <real>

Set AC drive level.

Parameters

Supply the required level in either Volts or Amps. If no suffix is stated, the previous type of drive is set.

Example: `:HAN:LEV 1.2V`

`:HAN:LEV 1E-2A`

will select levels of 1.2V and 10mA respectively.

Response

None.

:HAN:LEVel?

Returns the test level of the currently selected test.

Parameters:

None.

Response:

Returns the current test level in engineering format.

Example: `+.20000000E-01`

for a test level of 20mV.

HANDLER MODE

:HAN:BIAS <disc>

Set the bias condition.

Parameters:

`ON`	Turn on bias.
`OFF`	Turn off bias.
`INT`	Select internal bias drive.
`EEXT`	Select external bias drive.

Example: `:HAN:BIAS INT`

`:HAN:BIAS ON`

will select internal bias and turn it on.

Response:

None.

:HAN:BIAS?

Bias level query.

Parameters

None

Response

Returns the bias as a floating point number.

:HAN:BIAS-STATus?

Returns the current bias status.

Parameters:

None.

Response:

Returns bias status in two integers delimited by a comma:

First integer:	0 Bias OFF.
	1 Bias ON.
Second integer:	0 Internal bias.
	1 External bias.
Example:	`1,0`

would indicate that internal bias is turned on.

HANDLER MODE

:HAN:SPEED <disc>

Select the required measurement speed.

Parameters:

`MAX` Maximum speed.

`FAST` Fast speed.

`MED` Medium speed.

`SLOW` Slow speed.

Example: `:HAN:SPEED MAX`

will select maximum speed for measurements.

Response:

None.

:HAN:SPEED?

Measurement speed query.

Parameters:

None.

Response:

Returns the test speed as an integer according to the table:

`0` Maximum

`1` Fast

`2` Medium

`3` Slow

Example: `1`

indicates that Fast measurements are selected.

:HAN:RANGE <disc>

Select the required measurement range.

Parameters:

The following parameters are valid:

`AUTO` Auto-ranging.

`HOLD` Hold current range.

`1 to 7` Range 1 to 7

Example: `:HAN:RANGE 1`

`:HAN:RANGE AUTO`

will select range 1 and auto-ranging respectively.

Response:

None.

:HAN:RANGE?

Range query.

Parameters:

None.

Response:

Returns the measurement range as an integer according to this table:

`0` Auto-ranging.

`1-7` Current measurement range.

Example: `0`

indicates that auto ranging is selected.

HANDLER MODE

:HAN:ALC <disc>

Select the state of Automatic Level Correction.

Parameters:

The following parameters are valid:

`ON`	ALC on.
`OFF`	ALC off.
`HOLD`	Hold current ALC level.

Example: `:HAN:ALC OFF`

will turn off ALC.

Response:

None.

:HAN:ALC?

ALC status query.

Parameters:

None.

Response:

Returns the ALC state according to this table:

`0`	OFF.
`1`	ON.
`2`	HOLD.

Example: `2`

indicates that ALC is currently held.

:HAN:EQU-CCT <disc>

Select the equivalent circuit type for AC tests.

Parameters:

The following parameters are valid:

`SER`	Series equivalent circuit.
`PAR`	Parallel equivalent circuit.

Example: `:HAN:EQU-CCT SER`

will select series equivalent circuit.

Response:

None.

:HAN:EQU-CCT?

Returns the currently selected equivalent circuit.

Parameters:

None.

Response:

Returns the equivalent circuit flag according to this table:

`0`	Parallel.
`1`	Series.

Example: `0`

indicates that parallel equivalent circuit is selected.

HANDLER MODE

:HAN:FUNC:L, C, Z, Q, D, R

Select major and minor terms.

Parameters

Selecting first measurement:

`:HAN:FUNC:L`	Inductance.
`:HAN:FUNC:C`	Capacitance.
`:HAN:FUNC:Z`	Impedance.

Selecting second measurement:

`:HAN:FUNC:Q`	Quality factor.
`:HAN:FUNC:D`	Dissipation factor.
`:HAN:FUNC:R`	Resistance.

Note that selecting Z as the first measurement will force the second measurement to be Angle. This does not change the equivalent circuit flag setting.

Example: `:HAN:FUNC:L;Q`

will select L+Q measurements.

Response

None

HANDLER MODE

:HAN:FUNC:MAJOR?

Major term query.

Parameters:

None.

Response:

Returns the measurement type according to this table:

`0` Inductance.

`1` Capacitance

`2` Impedance.

Example: `2`

indicates that the major term is impedance (Z).

:HAN:FUNC:MINOR?

Minor term query.

Parameters:

None.

Response:

Returns the measurement type according to this table:

`0` Q-Factor.

`1` D-Factor.

`2` Resistance.

Example: `1`

indicates that the minor term is dissipation factor (D). Note that if the first measurement is polar (Z), this query will return the last non-polar setting.

:HAN:FUNC:NS/NP

Select the display of Turns Ratio Ns/Np measurement.

Parameters

None.

Response

None

:HAN:FUNC:NP/NS

Select the display of Turns Ratio Np/Ns measurement.

Parameters

None.

Response

None

HANDLER MODE

:HAN:FUNC:NS <real>

Select the display of Turns Ratio Ns measurement.

Parameters

<value> is decimal numeric data to specify the number of turns of Np.

Example: `:HAN:FUNC:NS 1`

will set Np to 1 turn.

Response

None

:HAN:FUNC:NP?

Np query.

Parameters

None.

Response

Returns the value of Np as floating point number.

:HAN:CLRLCD

Clear the LCD Display.

Parameters

None

Response

None

:HAN:XCURSOR <integer>

Set X cursor pixel position.

Parameters

An integer in the range 0 to 319.

Example: `:HAN:XCURSOR 20`

will set the X cursor position 20 pixels from the left of the LCD screen.

Response

None

HANDLER MODE

:HAN:YCURSOR <integer>

Set Y cursor pixel position.

Parameters

An integer in the range 0 to 239.

Example: `:HAN:YCURSOR 60`

will set the Y cursor position 60 pixels from the top of the LCD screen.

Response

None

:HAN:DISP-SMALL <string>

Display string in small characters at current cursor position.

Parameters

Any alphanumeric character may be used within the string. Upper case characters only.

Example: `:HAN:DISP-SMALL THIS IS A LOWER CASE STRING`

will display 'this is a lower case string' at the current cursor position.

:HAN:DISP-LARGE <string>

Display string in large characters at current cursor position.

Parameters

Any alphanumeric character may be used within the string. Upper case characters only.

Example: `:HAN:DISP-LARGE THIS IS AN UPPER CASE STRING`

will display 'THIS IS AN UPPER CASE STRING' at the current cursor position.

HANDLER MODE

:HAN:RATio-CORRection <disc>

Select the type of transformer for turns ratio correction.

Parameters

The following parameters are valid:

`OFF`	Normal transformer with low primary impedance.
`NORM`	Normal transformer with primary impedance >50Ω.
`AUTO`	Auto transformer (common connection between one end of primary and secondary windings)

Response

None.

:HAN:RATio-CORRection?

Ratio correction query.

Parameters:

None.

Response

Returns the turns ratio correction status according to this table:

`0`	`OFF`
`1`	`NORM`
`2`	`AUTO`

Example: `0`

indicates that turns ratio correction is OFF.

TELECOMS MODE

:TELecom

Select telecommunications transformer test mode / path.

Parameters:

None

Response:

None

:TELecom:FREQuency <real>

Set the telecom test frequency.

Parameters:

The required frequency in Hertz.

The unit descriptor ‘HZ’ is optional.

Example: `:TEL:FREQ 1E3 HZ`

set the telecom test frequency to 1kHz.

Response:

None.

:TELecom:FREQuency?

Query the telecom test frequency.

Parameters:

None.

Response:

The test frequency in engineering format.

Example: `+.80000000E+03`

indicating a test frequency of 800Hz.

:TELecom:NETwork

Set the damping network state.

Parameters:

The required state.

ON or OFF

Example: `:TEL:NET ON`

turns on the damping network.

Response:

None.

:TELecom:NETwork?

Query the damping network state.

Parameters:

None

Response:

0 = Network is OFF

1 = Network is ON

TELECOMS MODE

:TELecom:BLOCK

Turn on and off the blocking capacitor in the damping network.

Parameters:

The required state.

ON or OFF

Example: `:TEL:BLOCK OFF`

turns off the damping network.

Response:

None.

:TELecom:Z0 <real>

Set the telecom test line impedance value.

Parameters:

The required value in Ohms.

Example: `:TEL:Z0 600`

sets the line impedance to 600Ω.

Response:

None.

:TELecom:Z0?

Query the telecom test line impedance.

Parameters:

None.

Response:

The line impedance in engineering format.

Example: `+.60000000E+03`

indicating a line impedance of 600Ω.

:TELecom:Rt <real>

Set the telecom test termination resistor value.

Parameters:

The required resistor value in Ohms.

Example: `:TEL:RT 500`

sets the termination resistor to 500Ω.

Response:

None.

:TELecom:Rt?

Query the telecom test termination resistor.

Parameters:

None.

Response:

The termination resistor value in engineering format.

Example: `+.450000000E+03`

indicating a termination of 450Ω.

TELECOMS MODE

:TELecom:Ct <real>

Set the telecom test termination capacitor value.

Parameters:

The required capacitor value in Farads.

Example, `:TEL:CT 1E-9`

sets the termination capacitor to 1nF.

Response:

None.

:TELecom:Ct?

Query the telecom test termination capacitor.

Parameters:

None.

Response:

The termination capacitor value in engineering format.

Example, `+.470000000E-10`

indicating a termination of 47pF.

:TELecom:Cd <real>

Set the telecom test damping network capacitor value.

Parameters:

The required capacitor value in Farads.

Example: `:TEL:CD 47E-10`

sets the damping capacitor to 4.7nF.

Response:

None.

:TELecom:Cd?

Query the telecom test damping network capacitor.

Parameters:

None.

Response:

The damping capacitor value in engineering format.

Example: `+.470000000E-9`

indicating a damping capacitor value of 470pF.

:TELecom:Rd <real>

Set the telecom test damping network resistor value.

Parameters:

The required resistor value in Ohms.

Example: `:TEL:RD 560`

sets the damping resistor to 560Ω.

Response:

None.

:TELecom:Rd?

Query the telecom test damping network resistor.

Parameters:

None.

Response:

The damping resistor value in engineering format.

Example: `+.15000000E+03`

indicating a damping resistor value of 150Ω.

TELECOMS MODE

:TELecom:Cb <real>

Set the telecom test blocking capacitor value.

Parameters:

The required capacitor value in Farads.

Example: `:TEL:CB 47E-6`

sets the damping capacitor to 47µF.

Response:

None.

:TELecom:Cb?

Query the telecom test blocking capacitor.

Parameters:

None.

Response:

The capacitor value in engineering format.

Example: `+.220000000E-04`

indicating a blocking capacitor value of 22µF.

MULTI-FREQUENCY MODE

:MULTI

Select multi-frequency mode.

Parameters:

None.

Response:

None.

:MULTI:SET

Switch to the multi-frequency set-up page.

Parameters:

None.

Response:

None.

:MULTI:RUN

Switch to the multi-frequency run page.

Parameters:

None.

Response:

None.

:MULTI:TEST

Select the frequency step to edit.

Parameters:

The frequency number in the range 0 to 7.

Example: `:MULTI:TEST 0`

will select the top frequency for editing

Response:

None.

:MULTI:TEST?

Return the number of the step that is currently being edited.

Parameters:

None.

Response:

The frequency number in the range 0 to 7.

Example: `7`

would indicate the last frequency is selected for editing.

MULTI-FREQUENCY MODE

:MULTI:FREQuency <real>

Set the frequency for the currently selected step.

Parameters:

The required frequency in Hertz. The unit suffix ‘Hz’ is optional.

Example: `MEAS:FREQ 1k`

will set the selected frequency to 1kHz

Response:

None.

:MULTI:FREQuency?

Returns the frequency of the currently selected multi-frequency step.

Parameters:

None.

Response:

Returns the current test frequency in engineering format.

Example: `+.10000000E+04`

for a test frequency of 1kHz.

:MULTI:HIgh-LIMit <real>

Set the higher test limit of the currently selected step.

Parameters:

The required higher limit.

example: `:BIN:HI-LIM 10.0`

will set a high limit of 10% when percentage limits are selected.

Response:

None.

:MULTI:HIgh-LIMit?

Returns the high limit value of the currently selected step.

Parameters:

None.

Response:

The high limit value in engineering format.

Example: `+.50000000E+01`

indicates a high limit of +5% when percentage limits are selected.

MULTI-FREQUENCY MODE

: MULTI:LOw-LIMit <real>

Set the lower test limit of the currently selected step.

Parameters:

The required lower limit.

Example: `:BIN:LO-LIM -10.0`

will set a low limit of -10% when percentage limits are selected.

Response:

None.

: MULTI:LOw-LIMit?

Returns the low limit value of the currently selected step.

Parameters:

None.

Response:

The low limit value in engineering format.

Example: `-.50000000E+01`

indicates a high limit of -5% when percentage limits are selected.

: MULTI:MINor <real>

Set the minor test limit of the currently selected multi-frequency step.

Parameters:

The required limit.

Example: `:BIN:MINOR 1.0`

will set a low limit of 1.0 for the minor test.

Response:

None.

: MULTI:MINor?

Returns the minor limit value of the currently selected step.

Parameters:

None.

Response:

The minor limit value in engineering format.

Example: `.10000000E+01`

indicates a minor limit of 1.0.

:MULTI:NOMinal <real>

Set the multi-frequency nominal value.

Parameters:

The required nominal value, no unit is required: the measurement mode unit is used.

Example `:MULTI:NOM 33e-9`

will set a nominal value of 33nF.

Response:

None.

:MULTI:NOMinal?

Returns the multi-frequency nominal value.

Parameters:

None.

Response:

Returns the nominal in engineering format.

Example: `+.68000002E-07`

would indicate a nominal of 68nF if the measurement is capacitance.

MULTI-FREQUENCY MODE

:MULTI:LIMIT <disc>

Selects absolute or percentage limits checking.

Parameters:

The following discrete parameters are valid:

`OFF` No limits.

`ABS` Absolute limits.

`PERC` Limits as a percentage of nominal.

Example: `:MULTI:LIMIT PERC`

will set the test limits to a percentage of the nominal value.

Response:

None.

:MULTI:LIMIT?

Returns the current limits checking mode.

Parameters:

None.

Response:

`0` No limits.

`1` Absolute limits.

`2` Percentage limits.

Example: `1`

indicates that components will be tested against limits that are a percentage of the nominal value.

:MULTI:DEL

Removes the current frequency.

Parameters:

The frequency number in the range 0 to 7

Example: `MULTI:DEL 0`

will delete the top frequency.

Response:

None.

MULTI-FREQUENCY MODE

:MULTI:SORT <disc>

Sorts the current frequency list into the required order.

Parameters:

The required sort order.

`UP` Ascending frequency.

`DOWN` Descending frequency.

Example: `MULTI:SORT UP`

will sort the frequencies in ascending order.

Response:

None.

:MULTI:TRIGger

Starts a run of multi-frequency measurements.

Parameters:

None.

Response:

None.

:MULTI:RES? <integer>

Query the result of the selected frequency step.

Parameters:

The frequency number in the range 0 to 7

Response:

The first and second result separated by a comma, if the result is being checked against limits (absolute or percentage) the PASS/FAIL flag will prefix the result.

Examples: `1, +.68898363E-07, +.72168059E-04`
would indicate a pass result on a 68nF capacitor.

`+.68898363E-07, +.72168059E-04`
would be the result if limits were not being checked.

GRAPH MODE

:GRAPH

Select graphing mode.

Parameters:

None.

Response:

None.

:GRAPH:StarT <real>

Set the start frequency for the sweep.

Parameters:

The required frequency in Hertz. The unit suffix ‘Hz’ is optional.

Example: `:GRAPH:ST 1k`

will set the start frequency to 1kHz.

Response:

None.

:GRAPH:StarT?

Returns the start frequency of the sweep.

Parameters:

None.

Response:

Returns the start frequency in engineering format.

Example: `+.10000000E+05`

for a start frequency of 10kHz.

:GRAPH:StoP <real>

Set the stop frequency for the sweep.

Parameters:

The required frequency in Hertz. The unit suffix ‘Hz’ is optional.

Example: `:GRAPH:SP 100k`

will set the stop frequency to 100kHz.

Response:

None.

:GRAPH:StoP?

Returns the stop frequency of the sweep.

Parameters:

None.

Response:

Returns the stop frequency in engineering format.

Example: `+.125000000E+06`

for a start frequency of 125kHz.

GRAPH MODE

:GRAPH:LOGF <disc>

Selects the frequency scale type.

Parameters:

The required scale type:

`ON` Logarithmic scale.

`OFF` Linear scale.

Example: `GRAPH:LOGF ON`

will select the logarithmic frequency scale.

Response:

None.

:GRAPH:LOGF?

Returns the current frequency scale type.

Parameters:

None.

Response:

The current scale type:

`1` Logarithmic scale.

`0` Linear scale.

Example: `0`

would indicate that the linear frequency scale is selected.

:GRAPH:LOGY <disc>

Selects the flag for the measurement scale type.

Parameters:

The required scale type:

`ON` Logarithmic scale.

`OFF` Linear scale.

Example: `GRAPH:LOGY ON`

will select the logarithmic scaling of the Y-axis (available for Z, Y only).

Response:

None.

:GRAPH:LOGY?

Returns the flag for the measurement scale type.

Parameters:

None.

Response:

The current scale type:

`1` Logarithmic scale.

`0` Linear scale.

Example: `1`

would indicate that logarithmic scaling of the Y-axis will be used if Z or Y is selected.

GRAPH MODE

:GRAPH:LIMIT <disc>

Selects absolute or relative plotting.

Parameters:

The following discrete parameters are valid:

`ABS`	Absolute plot.
`PERC`	Plot as a percentage of nominal.

Example: `:GRAPH:LIMIT ABS`

will select plotting of the absolute measurement result.

Response:

None.

:GRAPH:LIMIT?

Returns the current graph plotting mode.

Parameters:

None.

Response:

`0`	Absolute plotting.
`1`	Percentage plotting.

Example: `1`

indicates that the graph will be plotted with the results calculated as a percentage of the nominal value.

:GRAPH:MarKer?

Returns the first and second measurement from the current marker position.

Parameters:

None.

Response:

The results in engineering format, separated by a comma.

Example: +.10666955E-06, +.11760951E+01

GRAPH MODE

:GRAPH:MarKerF <real>

Move the marker to the frequency nearest to the supplied value.

Parameters:

The required frequency in Hertz. The unit suffix ‘Hz’ is optional.

Example: `GRAPH:MKF 10k`

will move the marker to the point nearest to 10kHz.

Response:

None.

:GRAPH:MarKerF?

Returns the current marker frequency.

Parameters:

None.

Response:

Returns the marker frequency in engineering format.

Example: `+.100000000E+04`

for a marker frequency of 1kHz.

:GRAPH:MAJor-LOw <real>

Set the Y-axis minimum for the first measurement type on the graph.

Parameters:

The required start value.

Example: `:GRAPH:MAJ-LO 10.0`

will set the minimum to 10.

Response:

None.

:GRAPH:MAJor-LOw?

Query the current Y-axis minimum for the first measurement type.

Parameters:

None.

Response:

The current minimum in engineering format.

Example: `+.95000006E-04`

would indicate that the Y-axis will start at 95µF for example.

GRAPH MODE

:GRAPH:MAJor-HIgh <real>

Set the Y-axis maximum for the first measurement type on the graph.

Parameters:

The required maximum value.

Example: `:GRAPH:MAJ-HI 1000.0`

will set the end point to 1k.

Response:

None.

:GRAPH:MAJor-High?

Query the current Y-axis maximum for the first measurement type.

Parameters:

None.

Response:

The current maximum in engineering format.

Example: `+.105000006E-03`

would indicate that the Y-axis will stop at 105µF for example.

:GRAPH:MINor-LOw <real>

Set the Y-axis minimum for the second measurement type.

Parameters:

The required minimum value.

Example: `:GRAPH:MIN-LO 0.0`

will set the minimum to zero.

Response:

None.

:GRAPH:MINor-LOw?

Query the current Y-axis minimum for the second measurement type.

Parameters:

None.

Response:

The current minimum in engineering format.

Example: `+.100000000E-01`

would indicate that the Y-axis will start at 1Ω for example.

GRAPH MODE

:GRAPH:MINor-HIgh <real>

Set the Y-axis maximum for the second measurement type on the graph.

Parameters:

The required maximum.

Example: `:GRAPH:MAJ-HI 100.0`

will set the end point to 100Ω for example.

Response:

None.

:GRAPH:MINor-High?

Query the current Y-axis maximum for the second measurement type.

Parameters:

None.

Response:

The current maximum in engineering format.

Example: `+.100000000E+02`

would indicate that the Y-axis will stop at 10Ω for example.

:GRAPH:NOMinal <real>

Set the nominal value for use when graphs are being plotted in percentage mode.

Parameters:

The required nominal value, no unit is required: the unit of the first measurement type is used.

Example `:GRAPH:NOM 150e-12`

will set a nominal value of 150pF.

Response:

None.

:GRAPH:NOMinal?

Returns the current graph nominal.

Parameters:

None.

Response:

Returns the nominal in engineering format.

Example: `+.15000000E-09`

would indicate a nominal of 150pF for example.

GRAPH MODE

:GRAPH:TERM <integer>

Set which measurement will be shown/viewed.

Parameters:

The following values are valid:

1 Plot 1st measurement.

2 Plot 2nd measurement.

Response:

None.

:GRAPH:TERM?

Query the current measurement selection.

Parameters:

None.

Response:

`1` 1st measurement.

`2` 2nd measurement.

Example: `2`

would, for example, indicate that the Angle measurement would be displayed if the selected measurements were Z+Angle.

:GRAPH:STEP <integer>

Select the number of pixels between each measured point on the graph.

Parameters:

The following values are valid:

Value	Step Size	
1	1	(Slowest, Most accurate)
2	2	
3	4	
4	8	(Fastest, Most interpolated)

Example: `GRAPH:STEP 3`

would set the plot to take a measurement at every 4 pixels on the graph and interpolate between them.

Response:

None.

:GRAPH:STEP?

Query the current step size for the plot.

Parameters:

None.

Response:

The step size in pixels.

Example: `4`

would indicate that a measurement will be taken every 4 pixels when the graph is plotted.

GRAPH MODE

:GRAPH:SET

Go to the graph mode set-up page.

Parameters:

None.

Response:

None.

:GRAPH:VIEW

Redraw the graph. This command is useful for viewing the graph after switching between the two measurements, without plotting the graph again fully. Otherwise the display would be left in the set-up page.

Parameters:

None.

Response:

None.

:GRAPH:FIT

Fit the Y-axis scale to the current measurement data.

Parameters:

None.

Response:

None.

:GRAPH:TRIG

Start plotting a graph with the current settings.

Parameters:

None.

Response:

None.

GRAPH MODE

:GRAPH:PEAK

Move the marker to the highest point on the current graph.

Parameters:

None.

Response:

None.

:GRAPH:DIP

Move the marker to the lowest point on the current graph.

Parameters:

None.

Response:

None.

:GRAPH:PRINT

Print the current graph on an Epson compatible printer.

Parameters:

None.

Response:

None.

GRAPH MODE

:GRAPH:TEST <disc>

Set the test type.

Parameters

The required test type:

1 Impedance
2 Transformer

Example: `:GRAPH:TEST 2`

will select transformer measurements.

Response

None.

:GRAPH:TEST?

Query the test type.

Parameters

None.

Response

The required test type:

1 Impedance
2 Transformer

:GRAPH:TYPE <disc>

Set the sweep parameter.

Parameters

The required sweep type:

1 Frequency
2 Level
3 Internal Bias
4 External Bias (BOOST)

Example: `:GRAPH:TYPE 1`

will select a frequency sweep.

:GRAPH:TYPE?

Query the sweep parameter.

Parameters

None.

Response

The selected sweep parameter:

1 Frequency
2 Level
3 Internal Bias
4 External Bias

RESONANCE MODE

:RESOnance

Enter resonance mode / path.

Parameters:

None.

Response:

None.

:RESOnance:StarT <real>

Set the start frequency for the search.

Parameters:

The required frequency in Hertz. The unit suffix 'Hz' is optional.

Example: `:RESO:ST 1k`

Would set the search to start at 1kHz.

Response:

None.

:RESOnance:StarT?

Returns the start frequency of the search.

Parameters:

None.

Response:

Returns the start frequency in engineering format.

Example: `+.10000000E+05`

For a start frequency of 10kHz.

:RESOnance:StoP <real>

Set the stop frequency for the search.

Parameters:

The required frequency in Hertz. The unit suffix 'Hz' is optional.

Example: `:RESO:SP 1k`

Would set the search to stop at 1kHz.

Response:

None.

:RESOnance:StoP?

Returns the stop frequency of the search.

Parameters:

None.

Response:

Returns the stop frequency in engineering format.

Example: `+.10000000E+05`

For a stop frequency of 10kHz.

RESONANCE MODE

:RESOnance:EQU-CCT <disc>

Select the equivalent circuit type for resonance search.

Parameters:

The following parameters are valid:

`SER` Series resonance.

`PAR` Parallel resonance.

Example: `:RESO:EQU-CCT SER`

will select the series resonance search.

Response:

None.

:RESOnance:EQU-CCT?

Returns the currently selected equivalent circuit.

Parameters:

None.

Response:

Returns the equivalent circuit state according to this table:

`0` Parallel.

`1` Series.

Example: `0`

indicates the parallel resonance search circuit is selected.

:RESOnance:TRIG

Begin a resonance search.

Parameters:

None.

Response:

Returns the resonant frequency, capacitance, inductance, resistance and Q all separated by commas.

Example: +.77534195E+06, +.47321000E-05, +.89043000E-08,
+.19562000E-02, +.221748E+02

indicating a resonant frequency of 775.342kHz with equivalent series values at resonance of 4.7321µF, 8.904nH, 1.956mΩ and a Q value of 22.175.

DEMAG MODE

:DEMAG

Select demagnetization mode / path.

Parameters:

None.

Response:

None.

:DEMAG:FREQuency <real>

Set demagnetization frequency

Parameters

The required frequency in Hz.

Example: `:DEMAG:FREQ 100`

will set a de-magnetization frequency of 100Hz.

Response

None.

:DEMAG:FREQuency?

Demagnetization frequency query.

Parameters

None.

Response

Returns the demagnetization frequency in engineering format.

Example: `+.10000000+03`

for a frequency of 100Hz.

:DEMAG:LEVel <real>

Set the demagnetization initial level.

Parameters

The required level in volts or amps.

Example: `:DEMAG:LEV 2.0V`

`:DEMAG:LEV 0.02A`

will select drive levels of 2V and 20mA respectively.

:DEMAG:LEVel?

Demagnetization level query

Parameters

None.

Response

Returns the demagnetization level in engineering format.

Example: `+.10000000+01`

for a level of 1V.

DEMAG MODE

:DEMAG:TRIG

Start demagnetization

Parameters

None.

Response

None.

CALIBRATE MODE

:CAL

Select calibrate mode / path.

Parameters:

None.

Response:

None.

:CAL:OC-TRIM <integer>

Perform open circuit trimming.

Parameters:

The required trim type.

`1` Spot trim.

`2` Up to 10kHz.

`3` Up to 100kHz.

`4` All frequency.

Example: `:CAL:OC-TRIM 4`

would perform an open circuit trim across the whole frequency range of the unit.

Response:

None.

CALIBRATE MODE

:CAL:SC-TRIM <integer>

Perform short circuit trimming.

Parameters:

The required trim type.

1 Spot trim.

2 Up to 10kHz.

3 Up to 100kHz.

4 All frequency.

Example: `:CAL:SC-TRIM 1`

would perform a short circuit trim at the current frequency.

Response:

None.

:CAL:HF-CAL

Perform HF lead compensation.

Parameters:

None.

Response:

None.

:CAL:SELF-CAL

Perform self-calibration; disconnect all BNCs from the instrument terminals before using this command.

Parameters:

None.

Response:

None.

CALIBRATE MODE

:CAL:RES?

Returns the result of the most recent trim or calibration performed.

Parameters:

None.

Response:

The trim flag:

`1` Calibration passed.

`0` Calibration failed.

Example: `1`

would indicate that the last trim or calibration was successful.

ROOT COMMANDS

:TRIGger

Trigger a measurement in the current mode.

Parameters:

None.

Response:

The measurement result depending on the mode.

:LOC-TRIG <disc>

Select local trigger condition. When local trigger is ON the trigger button on the front panel can be used to take a measurement, all other functions being under remote control.

Parameters:

`ON` Enable local trigger.

`OFF` Disable local trigger.

Example: `:LOC-TRIG ON`

will allow triggering from the front panel.

Response:

None.

:LOC-TRIG?

Query the local trigger condition.

Parameters:

None.

Response:

The local trigger flag:

`1` Local trigger enabled.

`0` Local trigger disabled.

ROOT COMMANDS

:REPeat <disc>

Enable repetitive measurements when unit is returned to local control.

Parameters:

The required state:

`ON` Repetitive

`OFF` Single shot

Example: `REP ON`

will set the unit to repetitive mode when it is returned to local control.

Response:

None.

:Repeat?

Query trigger status.

Parameters:

None.

Response:

The selected trigger mode.

`0` Single shot

`1` Repetitive

Example: 1

would indicate that the instrument will begin repetitive measurements when returned to local control.

:TERMinal <integer>

Select 2 or 4 terminal measurements.

Parameters:

The required mode:

`2` 2-Terminal.

`4` 4-Terminal.

Example: `:TERM 4`

will select 4 terminal measurement.

Response:

None.

:TERMinal?

Query the current terminal setting.

Parameters:

None.

Response:

The current setting:

`2` 2-Terminal.

`4` 4-Terminal.

Example: `:TERM 4`

will select 4 terminal measurement.

ROOT COMMANDS

:SETUP <disc>

Select set-up view ON and OFF. GPIB commands that change the test settings will be slightly faster with the set-up display off.

Parameters:

The required mode:

`ON` Show set-up.

`OFF` Hide set-up.

Example: `:SETUP OFF`

will turn off the set-up display.

Response:

None.

:SETUP?

Query the current set-up mode.

Parameters:

None.

Response:

The set-up condition:

`1` Set-up displayed.

`0` Set-up hidden.

Example: `1`

would indicate that the set-up is visible.

:FAST-GPIB <disc>

Select fast GPIB mode, in this mode all measurement results are returned in a raw unformatted format and without displaying the result. Measurement time is reduced when using this mode.

Parameters:

The required mode:

`ON` Enable fast GPIB.

`OFF` Disable fast GPIB.

Example: `:FAST-GPIB ON`

will turn on fast GPIB operation.

Response:

None.

:FAST-GPIB?

Query fast GPIB mode.

Parameters:

None.

Response:

The current fast GPIB setting:

`1` Fast GPIB operation.

`0` Normal GPIB operation.

Example: `1`

would indicate that fast GPIB is selected.

ROOT COMMANDS

:MODE?

Query the currently selected operating mode.

Parameters:

None.

Response:

The current mode:

0	Main menu
1	Impedance
2	Transformer
3	Calibrate
4	Insulation
5	Binning
6	Sequence Edit
7	Sequence Run
8	Handler
9	Telecoms
10	Multi Freq
11	Graph
12	Resonance
13	Demag
14	Cal Status
15	Settings

Example: `1`

would indicate that Impedance Mode is selected.

ROOT COMMANDS

:DUMP-BMP

Returns the display as a windows compatible bitmap. The data conforms to IEEE 488.2 or SCPI ‘Indefinite Length Arbitrary Block Response Data’.

Parameters:

None.

Response:

None.

:DE-MAG <disc>

Set demagnetization function state.

Parameters

The required demagnetization state:

`ON` Enable demagnetization function.
`OFF` Disable demagnetization function.

Example: `:DE-MAG ON`

will turn on the demagnetization function.

Response

None.

:DE-MAG?

Query demagnetization status.

Parameters

None.

Response

The selected demagnetization status.

0 `OFF`
1 `ON`

:LO-MAG <disc>

Set low magnetization function state.

Parameters

The required low magnetization state:

`ON` Enable low magnetization function.
`OFF` Disable low magnetization function.

Example: `:LO-MAG ON`

will turn on the low magnetization function.

Response

None.

:LO-MAG?

Query low magnetization status.

Parameters

None.

Response

The selected low magnetization state:

0 OFF
1 ON

6.3 Example Programs

The following examples are written for Microsoft QuickBasic 4.5 running on a PC with a National Instruments GPIB controller. The programs are short and can be readily converted to another language/platform as their function is primarily to illustrate the use of the instrument GPIB commands.

Example 1:

Simple identification query, use this program to establish that the GPIB configuration is correct.

Example 2:

Simple measurement program. This program triggers a single AC measurement and displays the result.

Example 3:

Simple querying example. This program interrogates the instrument and display the current values for a number of AC measurement settings.

Example 4:

Multi-frequency example for AC tests. This program sets up a 4-measurement multi-frequency test and displays the results from a single trigger.

Example 5:

Performs a graphical sweep of impedance from 20-400kHz and finds the lowest impedance value. It also takes a screenshot of the graph to a file.

6.3.1 Example 1

```
' ***************************************************************
'
' Program 1 : Simple GPIB operation check Version 1.0
'
' Platform : QuickBasic 4.5
'
' Description :
'
' This program will ask the instrument to identify itself.
' It assumes the instrument is called 'WK' in the National
' Instruments configuration.
'
' ***************************************************************

' $INCLUDE: 'QBDECL.BAS' ' National Instruments include file.

buf$ = SPACE$(200) ' Buffer for GPIB response.

CLS ' Clear the screen

CALL IBFIND("WK", wk%) ' Look for 'WK'

IF wk% < 0 THEN ' Check that the id was found.
 PRINT "Identifier 'WK' not found"
 PRINT "Please check your configuration."
 END
END IF

CALL IBCLR(wk%) ' Clear the device.
IF IBSTA% < 0 THEN ' Check for a problem.
 PRINT "Error clearing instrument"
 PRINT "Please check you configuration."
 END
END IF

CALL IBWRT(wk%, "*IDN?") ' Request identification.
IF IBSTA% < 0 THEN ' Check for a problem.
 PRINT "Error writing to instrument"
 PRINT "Please check that the instrument"
 PRINT "is powered, set to the correct"
 PRINT "GPIB address and the cable is"
 PRINT "securely connected."
 END
END IF

CALL IBRD(wk%, BUF$) ' Read the response.
IF IBSTA% < 0 THEN ' Check for a problem.
 PRINT "Error reading from instrument"
 PRINT "Please check the device configuration"
 END
END IF

PRINT buf$ ' Display the response.

END           ' The end.
```

6.3.2 Example 2

```
' **************************************************************
'
' Program 2 : Simple Measurement Version 1.0
'
' Platform : QuickBasic 4.5
'
' Description :
'
' This program will set-up and run a single Z+Angle measurement
' on a component.
' This program assumes that the GPIB configuration is correct
' enough to be able to run example program 1 correctly.
'
' **************************************************************
' $INCLUDE: 'QBDECL.BAS' ' National Instruments include file.
CLS ' Clear the screen.

' Initialise the GPIB
CALL IBFIND("WK", wk%) ' Look for 'WK'.
CALL IBCLR(wk%) ' Clear the device.

' Select the required operating mode
CALL IBWRT(wk%, ":IMP") ' Go to measurement mode.
CALL IBWRT(wk%, ":IMP:FUNC:Z") ' Select Z+Angle.

' Set-up measurement conditions.
' Level = 100mV Freq = 10kHz
' Alc = Off Speed = Medium
' Range = AUTO Bias = Off
CALL IBWRT(wk%, ":IMP:LEVEL 0.1; FREQ 1E4; ALC OFF; SPEED MED")
CALL IBWRT(wk%, ":IMP:RANGE AUTO; BIAS OFF")

' Perform the measurement.
buf$ = SPACE$(200) ' Prepare buffer for GPIB response.
CALL IBWRT(wk%, "TRIG") ' Trigger a measurement.
CALL IBRD(wk%, buf$) ' Read in the response.
buf$ = LEFT$(buf$, ibcnt% - 1) ' Remove trailing characters.

' The next piece of code extracts the numbers from
' the response so that they can be manipulated.
first = VAL(LEFT$(buf$, INSTR(buf$, ",") - 1))
second = VAL(RIGHT$(buf$, LEN(buf$) - INSTR(buf$, ",") - 1))

' Display the final result.
PRINT " Z = "; first
PRINT "Angle = "; second

END ' The end.
```

6.3.3 Example 3

```
DECLARE FUNCTION GPIBQuery$ (id%, Query$)
' ************************************************************
'
' Program 3 : Querying the instrument state Version 1.0
'
' Platform : QuickBasic 4.5
'
' Description :
'
' This program will use queries to find out the current settings
' of the unit.
' This program assumes that the GPIB configuration is correct
' enough to be able to run example program 1 correctly.
'
' ************************************************************
' $INCLUDE: 'QBDECL.BAS' ' National Instruments include file.
CLS ' Clear the screen.

' Initialise the GPIB
CALL IBFIND("WK", wk%) ' Look for 'WK'.
CALL IBCLR(wk%) ' Clear the device.

' Select the required operating mode
CALL IBWRT(wk%, ":IMP") ' Go to measurement mode.
CALL IBWRT(wk%, ":IMP:FUNC:AC") ' Select AC measurements.

' Start querying
alc = VAL(GPIBQuery$(wk%, ":IMP:ALC?")) ' Query the ALC setting.
freq = VAL(GPIBQuery$(wk%, ":IMP:FREQ?")) ' Query the AC frequency.
level = VAL(GPIBQuery$(wk%, ":IMP:LEV?")) ' Query the AC level.
range = VAL(GPIBQuery$(wk%, ":IMP:RANGE?")) ' Query the range.
speed = VAL(GPIBQuery$(wk%, ":IMP:SPEED?")) ' Query the speed.

' Print the status of the major settings.
PRINT "AC Frequency ="; freq; "Hz" ' Print the AC frequency.

PRINT "AC Drive level ="; level; "V" ' Print the AC level.

PRINT "AC Range ="; ' Print the AC range.
IF range = 0 THEN
 PRINT " AUTO"
ELSE
 PRINT range
END IF

PRINT "ALC = "; ' Print the ALC condition.
IF alc = 0 THEN
 PRINT "OFF"
ELSE
 PRINT "ON"
END IF

PRINT "SPEED = "; ' Print the test speed.
SELECT CASE speed
 CASE 3
       PRINT "SLOW"
 CASE 2
       PRINT "MEDIUM"
 CASE 1
       PRINT "FAST"
 CASE 0
```

```
        PRINT "MAX"
END SELECT

END ' The end.

' This function sends the supplied query to the instrument
' and reads back the reply and strips the trailing characters
FUNCTION GPIBQuery$ (id%, Query$)
 buf$ = SPACE$(80) ' Initialise the buffer.
 CALL IBWRT(id%, Query$) ' Query the level
 CALL IBRD(id%, buf$) ' Read in the response.
 GPIBQuery$ = LEFT$(buf$, ibcnt% - 1) ' Remove trailing characters.
END FUNCTION
```

6.3.4 Example 4

```
DECLARE FUNCTION GPIBQuery$ (id%, Query$)
' ***************************************************************
'
' Program 4 : Multi-frequency mode Version 1.0
'
' Platform : QuickBasic 4.5
'
' Description :
'
' This program sets up and runs a simple 4 frequency measurement
' in Multi-frequency mode
'
' ***************************************************************
' $INCLUDE: 'QBDECL.BAS' ' National Instruments include file.
CLS ' Clear the screen.

' Initialise the GPIB
CALL IBFIND("WK", wk%) ' Look for 'WK'.
CALL IBCLR(wk%) ' Clear the device.

' Set-up the AC test parameters
CALL IBWRT(wk%, ":IMP") ' Measurement mode
CALL IBWRT(wk%, ":IMP:FUNC:AC") ' Select AC measurements.
CALL IBWRT(wk%, ":IMP:FUNC:C;D") ' Select C+D measurements.

' Go to multi-frequency mode
CALL IBWRT(wk%, ":MULTI") ' Multi-frequency mode
CALL IBWRT(wk%, ":MULTI:SET") ' Multi-frequency set-up

' Set-up frequency steps
CALL IBWRT(wk%, ":MULTI:TEST 0; FREQ 1k") ' Step 1
CALL IBWRT(wk%, ":MULTI:TEST 1; FREQ 2k") ' Step 2
CALL IBWRT(wk%, ":MULTI:TEST 2; FREQ 5k") ' Step 3
CALL IBWRT(wk%, ":MULTI:TEST 3; FREQ 10k") ' Step 4

CALL IBWRT(wk%, ":MULTI:LIMIT OFF") ' No limit checking
CALL IBWRT(wk%, ":MULTI:RUN; TRIG") ' Go to RUN mode and start

PRINT GPIBQuery(wk%, ":MULTI:RES? 0") ' Get result 1
PRINT GPIBQuery(wk%, ":MULTI:RES? 1") ' Get result 2
PRINT GPIBQuery(wk%, ":MULTI:RES? 2") ' Get result 3
PRINT GPIBQuery(wk%, ":MULTI:RES? 3") ' Get result 4

END ' The end!

' This function sends the supplied query to the instrument
' and reads back the reply and strips the trailing characters
FUNCTION GPIBQuery$ (id%, Query$)
 buf$ = SPACE$(80) ' Initialise the buffer.
 CALL IBWRT(id%, Query$) ' Query the level
 CALL IBRD(id%, buf$) ' Read in the response.
 GPIBQuery$ = LEFT$(buf$, ibcnt% - 1) ' Remove trailing characters.
END FUNCTION
```

6.3.5 Example 5

```
DECLARE FUNCTION GPIBQuery$ (id%, Query$)
' ***************************************************************
'
' Program 5 : Graph mode Version 1.0
'
' Platform : QuickBasic 4.5
'
' Description :
'
' This program sets up and plots a graph of the characteristic
' of a 4.7uF capacitor.
' At the end it takes a screenshot which is in windows bitmap
' format (.BMP) and can be viewed in MS Paint (Win 9X).
'
' ***************************************************************
' $INCLUDE: 'QBDECL.BAS' ' National Instruments include file.
CLS ' Clear the screen.

' Initialise the GPIB
CALL IBFIND("WK", wk%) ' Look for 'WK'.
CALL IBCLR(wk%) ' Clear the device.
CALL IBTMO(14) ' 30 Second timeout for graph drawing.

' Set-up the AC test parameters
CALL IBWRT(wk%, ":IMP") ' Measurement mode.
CALL IBWRT(wk%, ":IMP:FUNC:AC") ' Select AC measurements.
CALL IBWRT(wk%, ":IMP:FUNC:Z") ' Plot impedance.
CALL IBWRT(wk%, ":IMP:SPEED MAX") ' As fast as possible.

CALL IBWRT(wk%, ":GRAPH") ' Enter GRAPH mode.
CALL IBWRT(wk%, ":GRAPH:ST 20;SP 400k") ' Sweep 20Hz-500kHz.
CALL IBWRT(wk%, ":GRAPH:LOGY ON; LOGF ON") ' Log-Log plot.
CALL IBWRT(wk%, ":GRAPH:TERM 1") ' Plot Z.
CALL IBWRT(wk%, ":GRAPH:STEP 2") ' Step size 4.
CALL IBWRT(wk%, ":GRAPH:MAJ-LO 1e-3") ' Y start 1mOhm.
CALL IBWRT(wk%, ":GRAPH:MAJ-HI 1k") ' Y stop 1kOhm.
CALL IBWRT(wk%, ":GRAPH:TRIG;FIT") ' Plot the graph and fit scale.
CALL IBWRT(wk%, ":GRAPH:DIP") ' Find the low point.

' Take a screenshot.
PRINT "Taking screenshot."
CALL IBWRT(wk%, "DUMP-BMP") ' Request data.
CALL IBRDF(wk%, "GRAPH.BMP") ' Read to file.
PRINT "Done!"

END ' The end!

' This function sends the supplied query to the instrument
' and reads back the reply and strips the trailing characters
FUNCTION GPIBQuery$ (id%, Query$)
 buf$ = SPACE$(80) ' Initialise the buffer.
 CALL IBWRT(id%, Query$) ' Query the level
 CALL IBRD(id%, buf$) ' Read in the response.
 GPIBQuery$ = LEFT$(buf$, ibcnt% - 1) ' Remove trailing characters.
END FUNCTION
```

7. SPECIFICATION

7.1 Measurement Functions

Any of the following parameters may be measured and displayed.

7.1.1 IMPEDANCE MODE

DC Resistance

AC Parameters

Series or Parallel Equivalent Circuit: C+R, C+D, C+Q, L+R, L+D, L+Q

Polar Form: Z + angle

7.1.2 HANDLER MODE

DC Resistance

AC Parameters

Series or Parallel Equivalent Circuit: C+R, C+D, C+Q, L+R, L+D, L+Q

Polar Form: Z + angle

7.1.3 TRANSFORMER MODE

DC Resistance:

Primary or Secondary Windings.

AC Parameters:

Primary L+Q

Primary Leakage Inductance

Secondary Leakage Inductance

Interwinding Capacitance (Pri-Sec)

Turns Ratio:

Np/Ns, Ns/Np and Ns with Np entered before measurement.

7.1.4 RESONANCE MODE

Frequency, L, R and Q for series or parallel circuits.

Results may be extrapolated if resonance is not found within frequency range specified.

7.1.5 DEMAGNETISATION MODE

Enables a component to be demagnetized.

7.1.6 INSULATION MODE (Option)

Pri-Sec, Pri-Gnd, Sec-Gnd.

7.1.7 BINNING MODE

L + Q (Pri)
L + R (Pri)
L + R (Sec)
C + D (Pri)
Z + θ (Pri)
Ns/Np (Sec)
Leakage L (Pri)
Leakage L (Sec)
Cs-p (Sec-Pri)
Rdc (Pri)
Rdc (Sec)
Ns (Sec)
Ins (Pri-Sec)—requires Insulation Option
Ins(Pri-GND)—requires Insulation Option
Ins(Sec-GND)—requires Insulation Option

7.1.8 SEQUENCE MODE

L + Q (Pri)
L + R (Pri)
L + R (Sec)
C + D (Pri)
Z + θ (Pri)
Ns/Np (Sec)
Ns (Sec)
Leakage L (Pri)
Leakage L (Sec)
Cs-p (Sec-Pri)
Rdc (Pri), Rdc (Sec)
Ins (Pri-Sec)—requires Insulation Option
Ins(Pri-GND)—requires Insulation Option
Ins(Sec-GND)—requires Insulation Option

7.1.9 LF TELECOM (Option)

Simple Insertion and Return Loss (derived)

Damped Insertion and Return Loss (derived)

7.2 Additional Measurement Facilities

7.2.1 2/4 Terminal

Measurements may be made in two- or four-terminal mode, with selection via a front panel key.

7.2.2 Transformer Ratio Correction

Ratio measurement correction is available for normal or auto transformers to improve accuracy when winding resistance is high.

7.2.3 Low Magnetization Measurement

Any AC measurement may be made using a low magnetization measurement option. Measurements made will be slower than normal but changes to the characteristics of the device under test, due to magnetization, will be minimized.

7.2.4 Measurement Speeds

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

7.2.5 Repeat Measurement

Measurements may be made in single-shot or repetitive measurement modes, selected using a front panel key.

7.2.6 Frequency Steps

Coarse or fine frequency steps are available.

7.3 Test Conditions

7.3.1 Measurement Range

R 0.01mΩ to >2GΩ *

L 0.1nH to >1000H *

C 5fF to >1F *

* Varies with measurement speed

7.3.2 Frequency (AC Measurements)

Accuracy of selected frequency ±0.01%.

Coarse step mode: 20, 25, 30, 40, 50, 60, 80, 100, 120, 150, 200 repeated in each decade.

Fine step mode: >1800 frequencies between 20Hz and 3MHz with increments ≤1% over entire range.

7.3.3 Drive Level

Source impedance: 50Ω

1mV to 10V rms into open circuit

50µA to 200mA rms into short circuit

ALC ensures level at DUT is ±2%, ±1mV of set voltage or ±2% ±0.1mA of set current

7.3.4 DC Bias Current (Impedance modes only)

1mA to 1A from internal DC bias supply over the full temperature range.

Accuracy of set current ±2% ±0.25mA

Voltage compliance 20V minimum.

Safety interlock provision.

7.3.5 Insulation (Option)

Selectable test voltages of 100, 200 or 500V DC.

For user safety, short circuit current is limited to <2mA.

Test voltage accuracy: ±1%.

7.3.6 LF Telecom (Option)

Frequency Range:	100Hz to 20kHz
Drive Level Setting:	-28dBm to +16dBm (0.1dBm steps)
Line Impedance (Zo):	50Ω to 2000Ω
Secondary Termination:	50Ω to 2000Ω
Damping Components:	4 digit accuracy

7.4 Basic Accuracy

The following applies for medium or slow speeds, drive level 1V or 20mA.

Accuracy reduces for lower drive levels, or frequencies outside the quoted range.

At fast speed the same accuracy applies, except at 100Hz or for component values within 10:1 of the range limits quoted.

7.4.1 Rdc

0.2Ω to 500kΩ 0.5%

7.4.2 L, R, Z, C

Refer to the accuracy chart

7.4.3 Dissipation Factor (D)

$\pm A_d (1 + D^2)$ where A_d = (% accuracy)/100.

Varies with frequency and option chosen

7.4.4 Quality Factor (Q)

$A_L (Q + 1/Q)$ where A_L = measurement accuracy.

Varies with frequency and option chosen

7.4.5 Insulation (Option)

For leakage currents 0.5µA to 1mA ±5%

Corresponding resistance range at 500V = 500kΩ to 1GΩ

7.4.6 Insertion Loss (LF Telecom Option)

0 to 3dB ±0.1dB

3 to 6dB ±0.2dB

7.4.7 Return Loss (LF Telecom Option)

Specification applies if both Zo and Rt ≥150Ω.

Return loss accuracy is not guaranteed above 10kHz.

Uncertainties are doubled for Zo or Rt values down to 50Ω.

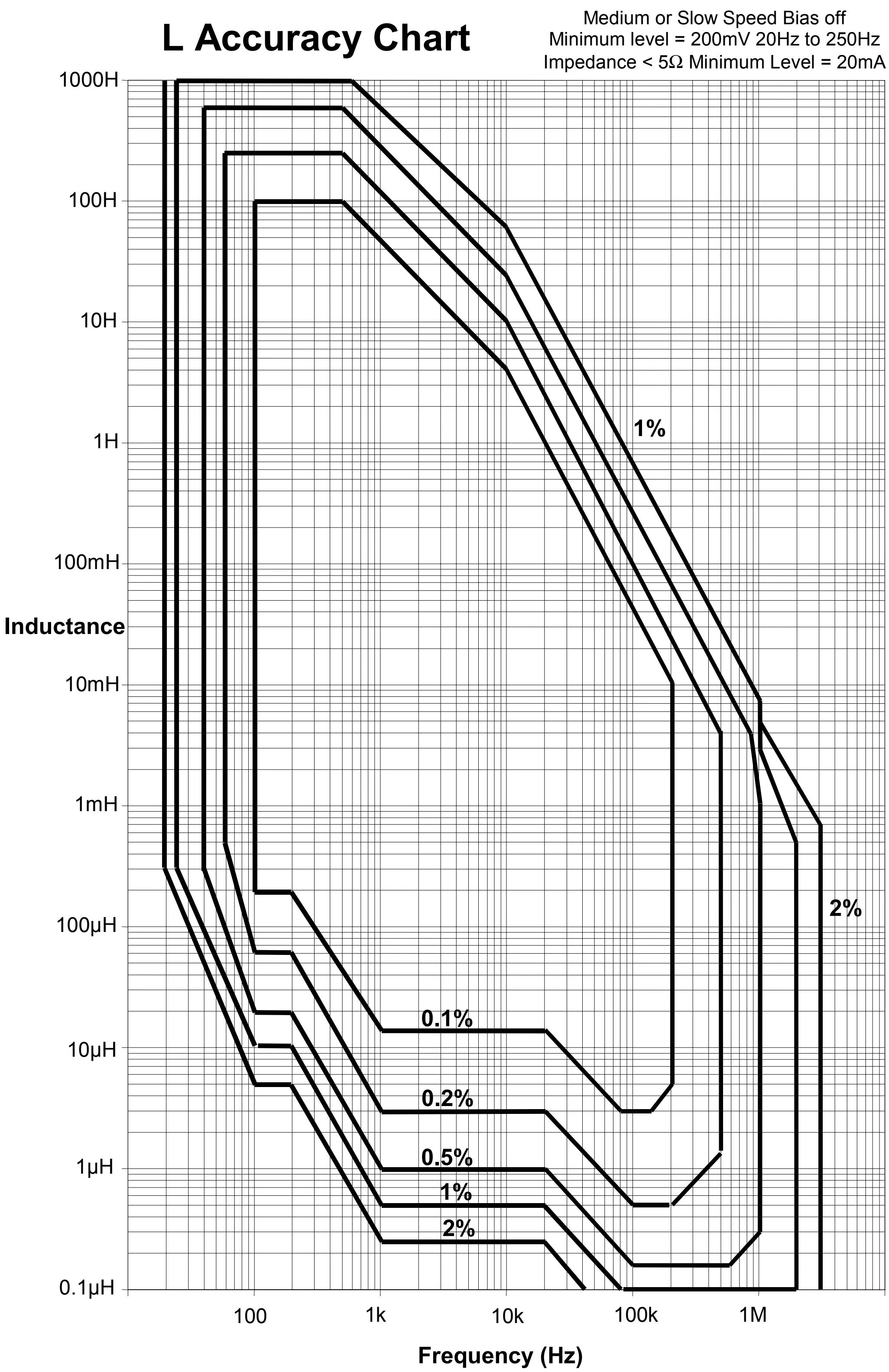
Frequency Range 200Hz to 5KHz

0 to 40dB	±1dB
Up to 45dB	±2dB
Up to 50dB	±3dB

Frequency Range 100 to 200Hz, or 5kHz to 10kHz

0 to 35dB	±2dB

7.4.8 Accuracy Chart



7.5 General Data

7.5.1 Power Supply

Input Voltage	115V AC ±10% or 230V AC ±10% (selectable)
Frequency	50/60Hz
VA rating	100VA
Input fuse rating	115V operation: 2AT
	230V operation: 1AT
	The input fuse is in the fuse holder drawer integral to the IEC input connector.

7.5.2 Display

High contrast black and white LCD module 320 x 240 dot with CFL back lighting and manual contrast control. Visible area 115 x 86mm. Viewing angle 45°.

7.5.3 Measurement Connections

8 front panel BNC sockets.

Selectable 2- or 4-wire (Kelvin) measurements with screen at ground potential.

Separate terminals for primary and secondary connections.

Indication of active sockets.

7.5.4 Remote Control (Option)

Designed to GPIB (IEEE 488.2) and SCPI 1992.0.

7.5.5 Binning Interface (Option)

25-way D-type connector on rear panel provides dedicated output lines for each bin, with busy and data ready handshake lines, separate pass/fail output that operates with the bar graph function, and a trigger input. Outputs are 0 to 5V nominal with ≥10mA current sinking capability. Trigger input is via contact closure or a negative logic edge (logic high = 4 to 5V).

7.5.6 Printer Output

Centronics parallel printer port on rear panel allows printing of test conditions, measurement results and graphical display.

7.5.7 Environmental Conditions

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

Installation Category

II (in accordance with IEC664)

Temperature Range

Storage	-40°C to +70°C
Operating	0°C to 40°C
Full Accuracy	15°C to 35°C

Relative Humidity

Up to 80% non-condensing.

Pollution Degree

2 (mainly non-conductive)

Altitude

Up to 2000m

7.5.8 Safety

Designed to meet the requirements of EN61010-1.

7.5.9 EMC

Complies with EN50081-1, EN50082-1 generic emissions and immunity standards by meeting with the requirements of EN55022, IEC801.2, EN801.3 & IEC 801.

7.5.10 Mechanical

Height	150mm (6")
Width	440mm (17⅜")
Depth	520mm (20½")
Weight	11kg (24lb 4oz)

7.5.11 Accessories Supplied

AC power cable 2m.
User Manual.

7.5.12 Options and Accessories

Binning
Insulation Test
A range of test leads and fixtures
Rack mounting kit.

8. THEORY REFERENCE

8.1 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	

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

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

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

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

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

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

8.3 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.

8.4 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.

9. MAINTENANCE, SUPPORT AND SERVICES

9.1 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.

9.2 Maintenance

9.2.1 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.

9.2.2 Safety Checks

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

9.2.2.1 Equipment required

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

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

9.2.2.2 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.

9.3 Support and Service

In the event of difficulty, or apparent circuit malfunction, it is advisable to contact the service department 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
www.waynekerrtest.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
email: service@wayne-kerr.co.uk
www.waynekerrtest.com

Asia

Microtest
14F-6, No.79, Hsin Tai Wu Road, Sec. 1,
Hsi-chih, Taipei 221, Taiwan, R.O.C.
Tel: +886-2-2698-4104
Fax: +886-2-2698-0716
Email: wksales@microtest.com.tw
www.waynekerrtest.com

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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