Wayne Kerr Electronics

LCR METER

4230

User Manual

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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, or 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 4230 LCR Meter

The 4230 LCR Meter is suitable for the manufacturing environment and provides accurate four-terminal measurements of passive component primary and secondary parameters. Components may be measured over the frequency range 100Hz to 200kHz at a drive level of 50mV to 1V. A switch able 2V DC bias is also available. DC Resistance measurements are performed at a level of 500mV.

Component measurements include: Inductance (L), Capacitance (C), AC Resistance (R), DC Resistance (DCR), Impedance (Z), Admittance (Y), Conductance (G), Quality Factor (Q).

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

- Memory for 127 set-up conditions
- Display of actual measurement values
- Display of the deviation from a user-set nominal value
- Display of measurement results in absolute terms or as the percentage difference from a specified nominal value
- Pass or Fail indication on both primary and secondary component parameters

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 mains 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 on the rear panel above the power inlet connector. The supply voltage setting can be changed by first disconnecting the unit from the power supply and adjusting the switch to read the required voltage. Ensure that the fuse rating is correct:

3A–T for both 230V and 115V operation.

No adjustment is required for variation of supply frequency on installation, but for accurate measurements the line frequency must be selected in the system configuration, see section 4.8.1 System Configuration and 4.8.1.1 Line 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 4230 is intended for use on the bench. The power modules are convection cooled and care must be taken not to restrict any of the air paths.

4. OPERATION

WARNING!

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

This product is capable of having hazardous voltages (greater than 60V) on its terminals in normal use. Appropriate precautions should be taken for safety.

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

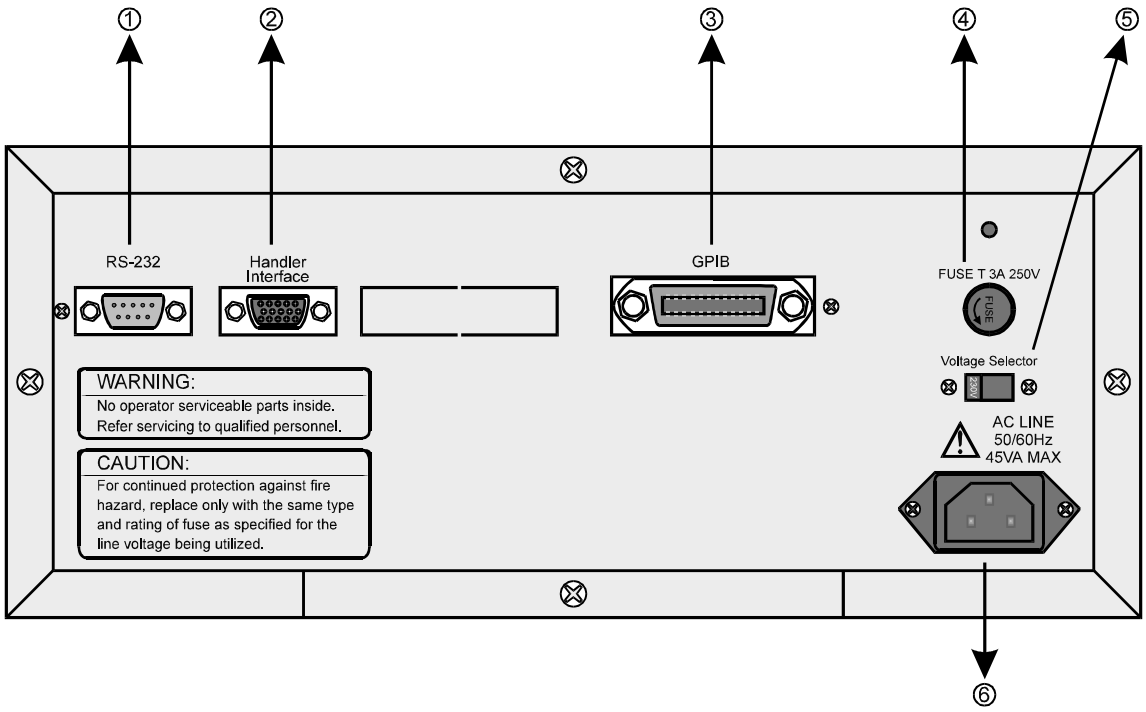

Figure 4-1 Rear Panel

1) RS-232 Port
2) Handler Interface
3) GPIB Interface
4) Fuse (250V/3A)
5) Voltage Selector (115V/230V)
6) AC Mains Power Input (115V/230V)

4.2 The Front Panel

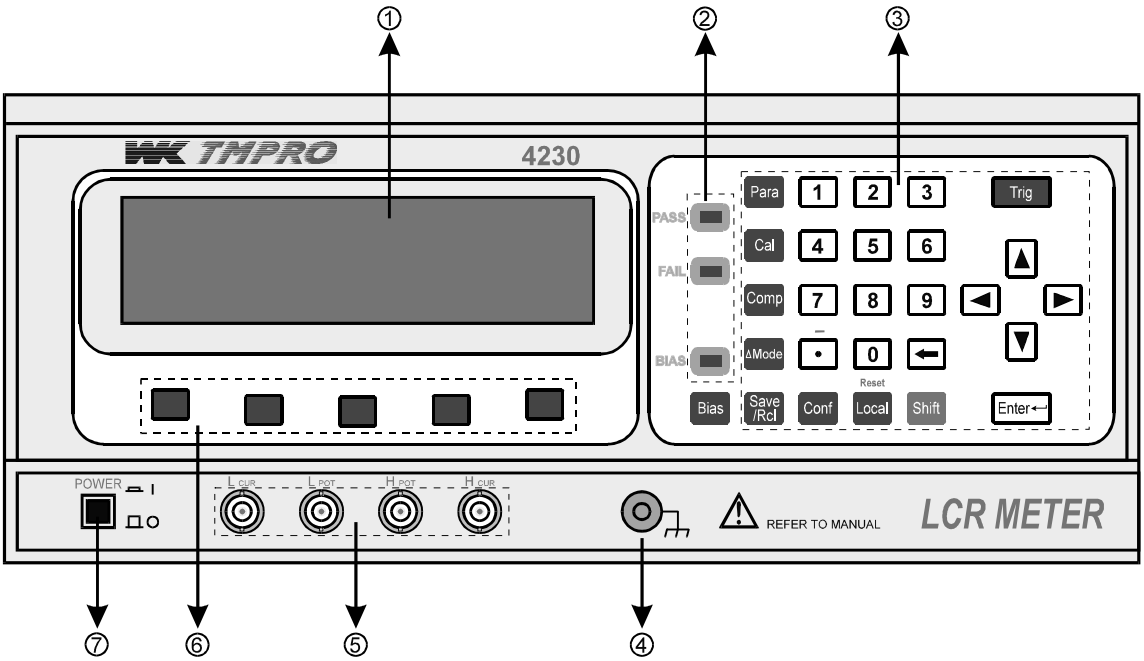

Figure 4-2 Front Panel

1) Display
2) PASS, FAIL and BIAS indicators
3) Numeric Keypad
4) Ground Connector
5) BNC Fixture/Test Lead Connectors
6) Soft Keys
7) Power Switch

4.3 Switching the unit on

With the instrument connected to the correct AC mains power supply, press the front panel POWER switch. The unit will default to the last measurement type selected before the power was switched off. Bias is always off when the unit is powered up.

4.4 Switching the unit off

The power can be switched off at any time without damage to the instrument; however to avoid loss of data the unit should not be switched off while performing a test, or loading/saving a file.

4.5 Indicators

The PASS and FAIL indicators show the result of the last test.

The BIAS indicator lights when the 2V DC Bias is on.

4.6 Measurement Connections

Four BNC connectors are provided on the front panel for connection to the component to be tested. The following Kelvin clip leads and fixtures are available for use with the 4230.

Four-Terminal BNC Kelvin Clips (standard accessory—Part No. AC-6870K1)

General purpose four-terminal measuring leads for conventional components giving good accuracy except for measurement of very small capacitances or very small inductances where the use of a four-terminal component fixture will give more accurate results.

Four-Terminal Component Fixture (optional accessory—Part No. 1JFX-0000C1)

Four-terminal fixture with spring-loaded jaws to accommodate conventional leaded components. This fixture fits directly onto the front panel BNC connectors, removing inaccuracies associated with the movement of test leads. This is especially important when measuring low value inductors. This fixture will give the greatest accuracy for 4-terminal measurements of conventional components.

SMD Tweezers, (optional accessory—Part No. 1EVA40120)

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 open-circuit trim will trim out the residual capacitance of the tweezers.

4.7 Keys

4.7.1 Para

Use to set the primary and secondary measurement parameters to display.

4.7.2 Cal

Allows open- and short-circuit trimming to be carried out at the fixture or test lead jaws.

4.7.3 Comp

Use the **Comp** key to set upper and lower test measurement limits, on one or both parameters, to enable the instrument to indicate Pass or Fail when a component is measured.

4.7.4 ΔMode

Selects deviation display mode. In this mode the instrument displays the measurement with respect to the deviation reference setting.

4.7.5 Save/Rcl

Use the **Save/Rcl** key to save component set-up data to memory, and to recall it from memory.

4.7.6 Conf

Enters the system configuration menu to set up the line frequency, audible warning mode and GPIB address.

4.7.7 Local

Switches between remote (GPIB) and local measurement modes.

4.7.8 Bias

Applies a 2V DC bias voltage to the measurement terminals.

4.7.9 Numeric Keypad

Use for entering characters: 0 – 9, decimal point, minus sign and backspace.

4.7.10 Navigation Keys

The ◄ ► ▲ and ▼ navigation keys are used to move the cursor between fields when using set up keys such as Para and Comp.

4.7.11 Enter

Press to confirm a menu selection.

4.7.12 Trig

Use to trigger a measurement when operating in manual measurement mode.

4.7.13 Soft keys

The soft keys are used to select the corresponding function on the display. The function of the soft keys change according to the mode selected.

4.7.14 Reset

Under normal operation this key should not need to be used. Pressing this key will reset the unit to the default state. Stored files are retained, but the current set-up will be lost.

4.8 Instrument Set-up

4.8.1 System Configuration

To select the System Configuration screen press the front panel **Conf** key to display the current configuration. Press the EXIT soft key to leave System Configuration.

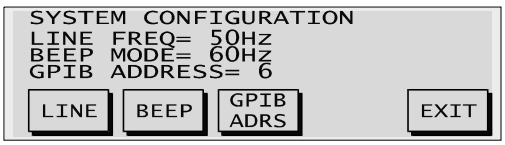

Figure 4-3 System Configuration screen

The following parameters can be set:

Parameter	Description	Range
Line Frequency	The frequency of the AC mains power supply	50Hz; 60Hz
Beep Function	The 'beep' sound that is emitted when a test is passed or failed	OFF; PASS; FAIL
GPIB Address	The address for GPIB operation.	0 – 30

4.8.1.1 Line Frequency

1) Press the front panel **Conf** key.
2) Press the LINE soft key.
3) Select either 50Hz or 60Hz with the appropriate soft key: the instrument will set the selected line frequency and will then start measuring the currently selected parameters (see section 4.8.3 Parameters).

4.8.1.2 Beep Function

1) Press the front panel **Conf** key.
2) Press the BEEP soft key.
3) Select either OFF, PASS or FAIL with the appropriate soft key: the instrument will set the selected beep function and will then start measuring the currently selected parameters (see section 4.8.3 Parameters).

4.8.1.3 GPIB Address

1) Press the front panel **Conf** key.
2) Press the GPIB ADRS soft key.
3) Enter the required GPIB address from the keypad [Range: 0 – 30].
4) Press the front panel **Enter** key: the instrument will set the selected GPIB address and will then start measuring the currently selected parameters (see section 4.8.3 Parameters).

4.8.2 Calibrate Mode

To select the Calibrate Mode screen press the front panel **Cal** key.

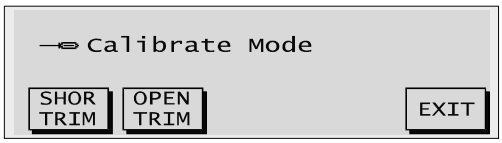

Figure 4-4 Calibrate Mode screen

This function ensures maximum measurement accuracy by setting the measurement reference point at the fixture or test lead jaws to 0mΩ (short circuit trim) and 0µF (open circuit trim).

For maximum measurement accuracy, the short- and open-circuit trims should be performed daily, whenever the measurement frequency is changed, and whenever the test leads or fixture are removed and refitted.

To leave the Calibrate Mode screen, press the EXIT soft key. The instrument will then start measuring the currently selected parameters (see section 4.8.3 Parameters).

4.8.2.1 Short Trim

1) Fit the test leads or fixture to be used.
2) Short the test leads or fixture contacts with a wire shorting link. For maximum measurement accuracy the wire shorting link should be the same gauge and form as the component to be tested.
3) Press the SHOR TRIM soft key from the Calibrate Mode menu: the following screen will be displayed while the instrument measures the short circuit at the test frequency.

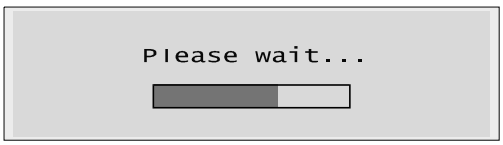

Figure 4-5 Please Wait screen

Note

If the shorting link is not fitted, or if either the shorting link or fixture contacts are dirty, the instrument will not be able to measure the short circuit and the following error will be reported.

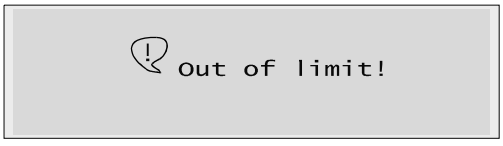

Figure 4-6 Out of Limit error

4.8.2.2 Open Trim

1) Fit the test leads or fixture to be used.
2) Open-circuit the test leads or fixture contacts, that is, remove any component which may be connected.
3) Press the OPEN TRIM soft key: the Please Wait screen shown in Figure 4-5 will be displayed while the instrument measures the open circuit at the test frequency.

Note

If the test fixture contacts are shorted or have a component connected across them, the instrument will not be able to measure the open circuit and the Out of Limit error shown in Figure 4-6 will be reported.

4.8.3 Parameters

Press the front panel **Para** key to select the primary and secondary measurement parameters. A ◄ or ► symbol at the edge of the screen indicates that further parameters are available. Use the ◄ or ► navigation key, as appropriate, to show the other parameters.

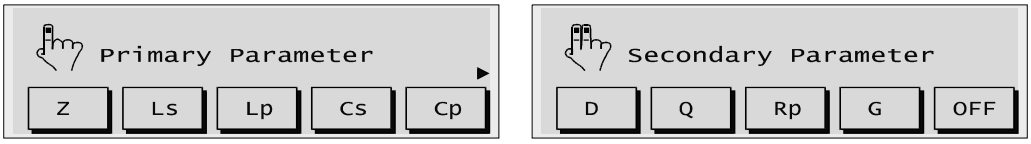

Figure 4-7 Primary and Secondary Parameters

Selection of the primary parameter will limit the available secondary parameter options: see table below.

Primary Parameter	Secondary Parameters available
Z	θ; OFF
Ls	Q; D; Rs; OFF
Lp	Q; D; Rp; G; OFF
Cs	D; Q; Rs; OFF
Cp	D; Q; Rp; G; OFF
R	X; OFF
Y	θ; OFF
G	B; OFF
DCR	—

1) Press the front panel Para key. The Primary Parameter menu will be displayed. To see more parameters, press the ► navigation key.
2) Select the required primary parameter with the appropriate soft key. The Secondary Parameter menu will be displayed.
3) Select the required secondary parameter with the appropriate soft key: the instrument will then start measuring the parameters selected.

4.8.4 Comparator

The comparator screen is used to set measurement limits against which the device under test (DUT) is compared. If the DUT measurement is within the comparator limits set, a Pass result will be indicated by the instrument; if the DUT measurement is outside of the comparator limits, a Fail result will be indicated.

Press the front panel **Comp** key to enter the comparator screen. The soft key values will reflect the parameter and deviation mode settings and may be shown as either absolute units or percentage limits.

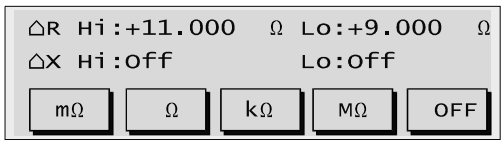

Figure 4-8 Comparison with absolute resistance limits and reactance turned off

To leave the current setting unchanged, use the Enter key or the ◄ ► ▲ ▼ navigation keys to move to the next deviation mode setting.

Either limit may be turned off with the soft key marked 'OFF'.

1) Press the front panel Comp key: the comparator screen will be shown.
2) Use the keypad to type the numeric value of the primary parameter Hi limit, which may be expressed in absolute or percentage limits, depending on the setting.
3) Use the appropriate soft key to select the primary parameter Hi limit unit. If the primary parameter is set to show percentage deviation, then only the percentage (%) soft key will be available. When the required soft key is selected the cursor will move to the primary parameter Lo limit.
4) Type the numeric value of the primary parameter Lo limit.
5) Select the primary parameter Lo limit unit: the cursor will move to the secondary parameter Hi limit.
6) Type the numeric value of the secondary parameter Hi limit.
7) Select the secondary parameter Hi limit unit: the cursor will move to the secondary parameter Lo limit.
8) Type the numeric value of the secondary parameter Lo limit.
9) Select the secondary parameter Lo limit unit: the instrument will then start measuring the currently selected parameters.

4.8.5 Deviation Mode

This function is used to set either absolute measurement units or percentage limits and can be used to set a reference level. For example if the reference level is set to 0, then the instrument will display the measurement value; if the reference level is set to the nominal value of the DUT, then the instrument will display the deviation from the nominal value.

Hence:

Displayed value = Measured value – Deviation Mode reference level

Therefore:

If the Deviation Mode reference level is set at 10Ω and the instrument measures the DUT at 9.947Ω, then the displayed value will be:

9.947 – 10 = –0.053Ω (–53mΩ)

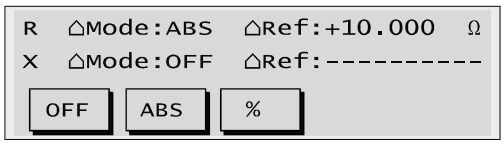

Figure 4-9 Deviation Mode with absolute units for R, a 10Ω reference and X turned off

To leave the current setting unchanged, use the Enter key or the ◄ ► ▲ ▼ navigation keys to move to the next deviation mode setting.

If a deviation mode setting is set to OFF, the reference level setting is not applicable and will be omitted.

1) Press the front panel **ΔMode** key: the deviation mode screen will be shown with the cursor at the primary parameter ΔMode setting
2) Use the appropriate soft key to set the primary parameter to absolute units (ABS), percentage limits (%) or OFF: the cursor will move to the primary parameter reference level setting.
3) Use the keypad to type the numeric value of the reference level, and then press a soft key to set the unit required: the cursor will move to the secondary parameter ΔMode setting.
4) Use the appropriate soft key to set the secondary parameter to ABS, % or OFF: the cursor will move to the secondary parameter reference level setting.
5) Use the keypad to type the numeric value of the reference level, and then press a soft key to set the unit required: the instrument will then start measuring the currently selected parameters.

4.8.6 Trigger

The front panel **Trig** key is used to manually initiate a measurement when the instrument is set to manual trigger mode. Figure 4-10, below, shows the trigger mode setting and trigger mode soft key; the table below outlines the trigger requirements of each trigger mode setting.

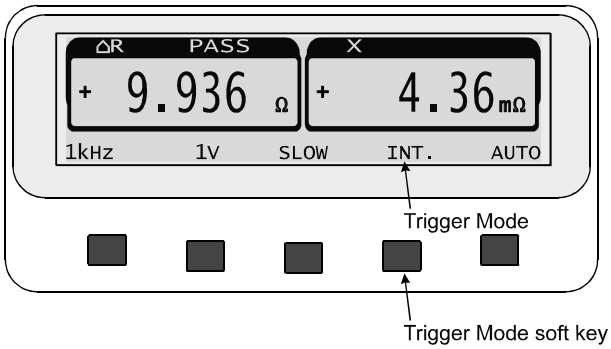

Figure 4-10 The Trigger Mode soft key

Trigger Mode	Description
INT. (internal)	Measurements are automatically triggered.
MAN. (manual)	A measurement is made each time the front panel **Trig** key is pressed.
EXT. (external)	Measurements are triggered by an external signal, for example from the RS-232 port or Handler Interface.
BUS (GPIB bus)	Measurements are triggered via the GPIB bus.

4.8.7 Save/Rcl

Up to 127 different instrument set-up conditions can be saved in the instrument's memory to enable fast recall of the test conditions required for a particular component type.

4.8.7.1 Save

To save an instrument set-up condition to memory:

1) Ensure that the instrument is set-up as required.
2) Press the front panel **Save/Rcl** key: the following screen will be displayed.

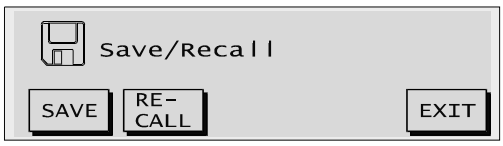

Figure 4-11 Save/Recall

3) Press the SAVE soft key.

4) Enter a number to save the set-up condition [range: 1 – 127], followed by the front panel **Enter** key.

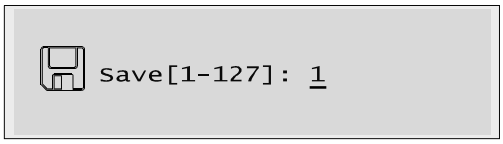

Figure 4-12 Save set-up

NOTE

Any previously saved set-up will be overwritten; therefore you are advised to keep a record of all the saved set-up conditions.

4.8.7.2 Recall

To recall an existing instrument set-up condition from memory:

1) Press the front panel **Save/Rcl** key: the screen shown in Figure 4-11, above, will be displayed.
2) Press the RECALL soft key.
3) Enter the number of the previously saved set-up condition [range: 1 – 127], followed by the front panel **Enter** key: the settings will be applied and the instrument will start measuring using the recalled parameters.

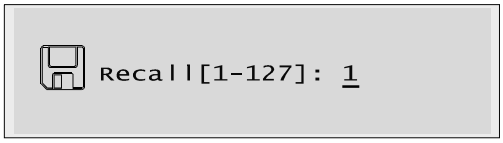

Figure 4-13 Recall set-up

NOTE

If a number is entered for which no saved set-up exists, the following error will be reported.

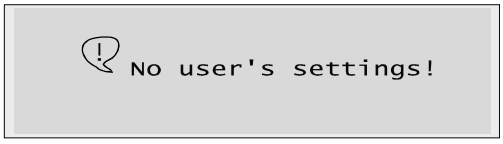

Figure 4-14 Recall error

4.9 Measuring a Component

4.9.1 General

The general procedure for component measurement is shown below. For specific measurement examples see section 4.9.2 Examples.

1) Connect the test leads or fixture to the front panel BNC connectors.
2) Set the required calibration frequency.
3) Press the front panel **Cal** key to enter Calibrate Mode and perform short- and open-circuit trims.
4) Press the EXIT soft key to exit Calibrate Mode: the measurement screen will be displayed.
5) Set up the instrument as required (see section 4.8 Instrument Set-up). If a set-up condition has been saved for the DUT, recall it from memory (see section 4.8.7 Save/Rcl).
6) If necessary, use the measurement screen soft keys to change the measurement parameters, e.g. test frequency, voltage, speed, trigger mode, range.
7) Insert the DUT into the test lead or fixture jaws: if the instrument is set to internal trigger, measurements of the DUT will now be made and displayed on the screen; if the comparator has been set-up (see section 4.8.4 Comparator) the PASS or FAIL indicator will light as appropriate.

4.9.2 Examples

4.9.2.1 Inductance Measurement

1) Connect the test leads or fixture to the front panel BNC connectors.
2) Set the required calibration frequency.
3) Press the front panel **Cal** key to enter Calibrate Mode.
4) Short the test leads or fixture contacts with a wire shorting link, preferably of the same gauge and form as the DUT.
5) Press the SHOR TRIM soft key and wait while the instrument measures the short circuit at the test frequency.
6) Remove the wire shorting link, and with the test leads or fixture contacts open circuit, press the OPEN TRIM soft key and wait while the instrument measures the open circuit at the test frequency.
7) Press the EXIT soft key to exit Calibrate Mode: the measurement screen will be displayed.

NOTE

The short- and open-circuit trims do not need to be done every time a component is measured. For maximum measurement accuracy, they should be performed daily,

whenever the measurement frequency is changed, or whenever the test leads or fixture are removed and refitted.

8) Set up the instrument as required (see section 4.8 Instrument Set-up). If a set-up condition has been saved for the DUT, recall it from memory (see section 4.8.7 Save/Rcl). For this example, the following settings will be used to measure a 470µH inductor.

Parameter	Setting	Information
Primary Secondary	Ls Q	Set with the front panel **Para** key (see section 4.8.3 Parameters)
Primary Hi limit Primary Lo limit Secondary Hi and Lo limits	495µH 445µH Off	Set with the front panel **Comp** key (see section 4.8.4 Comparator)
Primary units Primary deviation Secondary units Secondary deviation	ABS 0µH Off [1] n/a	Set with the front panel **ΔMode** key (see section 4.8.5 Deviation Mode).
Test Frequency Test Voltage Test Speed Trigger Mode Range	10kHz 0.1V SLOW INT. AUTO	Set with the measurement screen soft keys.

9) Connect the DUT to the test leads or fixture contacts: the measurement result will be displayed and the PASS or FAIL indicator will light, as appropriate.

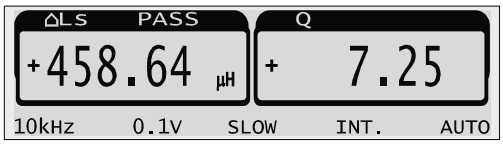

Figure 4-15 Inductance Measurement

4.9.2.2 Resistance Measurement

1) Connect the test leads or fixture to the front panel BNC connectors.
2) Set the required calibration frequency.
3) Press the front panel **Cal** key to enter Calibrate Mode.

[1] The instrument defaults to absolute units.

4) Short the test leads or fixture contacts with a wire shorting link, preferably of the same gauge and form as the DUT.

5) Press the SHOR TRIM soft key and wait while the instrument measures the short circuit at the test frequency.

6) Remove the wire shorting link, and with the test leads or fixture contacts open circuit, press the OPEN TRIM soft key and wait while the instrument measures the open circuit at the test frequency.

7) Press the EXIT soft key to exit Calibrate Mode: the measurement screen will be displayed.

NOTE

The short- and open-circuit trims do not need to be done every time a component is measured. For maximum measurement accuracy, they should be performed daily, whenever the measurement frequency is changed, or whenever the test leads or fixture are removed and refitted.

8) Set up the instrument as required (see section 4.8 Instrument Set-up). If a set-up condition has been saved for the DUT, recall it from memory (see section 4.8.7 Save/Rcl). For this example, the following settings will be used to measure a 10Ω resistor.

Parameter	Setting	Information
Primary Secondary	R X	Set with the front panel **Para** key (see section 4.8.3 Parameters)
Primary Hi limit Primary Lo limit Secondary Hi and Lo limits	11Ω 9Ω Off	Set with the front panel **Comp** key (see section 4.8.4 Comparator)
Primary units Primary deviation Secondary units Secondary deviation	ABS 0mΩ Off [2] n/a	Set with the front panel **ΔMode** key (see section 4.8.5 Deviation Mode).
Test Frequency Test Voltage Test Speed Trigger Mode Range	1kHz 1V SLOW INT. AUTO	Set with the measurement screen soft keys.

[2] The instrument defaults to absolute units.

9) Connect the DUT to the test leads or fixture contacts: the measurement result will be displayed and the PASS or FAIL indicator will light, as appropriate.

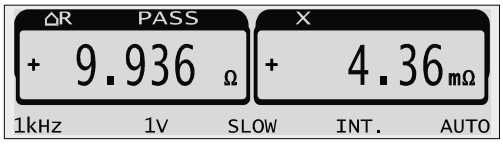

Figure 4-16 Resistance Measurement

4.9.2.3 Impedance Measurement

1) Connect the test leads or fixture to the front panel BNC connectors.
2) Set the required calibration frequency.
3) Press the front panel **Cal** key to enter Calibrate Mode.
4) Short the test leads or fixture contacts with a wire shorting link, preferably of the same gauge and form as the DUT.
5) Press the SHOR TRIM soft key and wait while the instrument measures the short circuit at the test frequency.
6) Remove the wire shorting link, and with the test leads or fixture contacts open circuit, press the OPEN TRIM soft key and wait while the instrument measures the open circuit at the test frequency.
7) Press the EXIT soft key to exit Calibrate Mode: the measurement screen will be displayed.

NOTE

The short- and open-circuit trims do not need to be done every time a component is measured. For maximum measurement accuracy, they should be performed daily, whenever the measurement frequency is changed, and whenever the test leads or fixture are removed and refitted.

8) Set up the instrument as required (see section 4.8 Instrument Set-up). If a set-up condition has been saved for the DUT, recall it from memory (see section 4.8.7 Save/Rcl). For this example, the following settings will be used to measure a complex impedance.

Parameter	Setting	Information
Primary Secondary	Z θ	Set with the front panel **Para** key (see section 4.8.3 Parameters)
Primary Hi and Lo limits Secondary Hi and Lo limits	Off Off	Set with the front panel **Comp** key (see section 4.8.4 Comparator)
Primary units Primary deviation Secondary units Secondary deviation	Off [3] n/a Off n/a	Set with the front panel **ΔMode** key (see section 4.8.5 Deviation Mode).
Test Frequency Test Voltage Test Speed Trigger Mode Range	100kHz 0.25V FAST INT. AUTO	Set with the measurement screen soft keys.

9) Connect the DUT to the test leads or fixture contacts: the measurement result will be displayed, but because there are no comparator test limits set, there will be no PASS or FAIL indication.

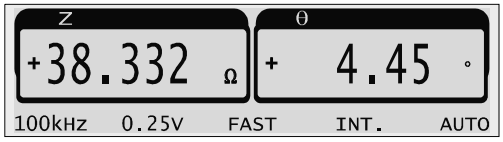

Figure 4-17 Impedance Measurement

4.9.2.4 Capacitance Measurement

1) Connect the test leads or fixture to the front panel BNC connectors.
2) Set the required calibration frequency.
3) Press the front panel **Cal** key to enter Calibrate Mode.
4) Short the test leads or fixture contacts with a wire shorting link, preferably of the same gauge and form as the DUT.
5) Press the SHOR TRIM soft key and wait while the instrument measures the short circuit at the test frequency.
6) Remove the wire shorting link, and with the test leads or fixture contacts open circuit, press the OPEN TRIM soft key and wait while the instrument measures the open circuit at the test frequency.

[3] The instrument defaults to absolute units.

7) Press the EXIT soft key to exit Calibrate Mode: the measurement screen will be displayed.

NOTE

The short- and open-circuit trims do not need to be done every time a component is measured. For maximum measurement accuracy, they should be performed daily, whenever the measurement frequency is changed, and whenever the test leads or fixture are removed and refitted.

8) Set up the instrument as required (see section 4.8 Instrument Set-up). If a set-up condition has been saved for the DUT, recall it from memory (see section 4.8.7 Save/Rcl). For this example, the following settings will be used to measure a 680nF capacitor.

Parameter	Setting	Information
Primary Secondary	Cp D	Set with the front panel **Para** key (see section 4.8.3 Parameters)
Primary Hi limit Primary Lo limit Secondary Hi limit Secondary Lo limit	+20% –20% 0.1 Off	Set with the front panel **Comp** key (see section 4.8.4 Comparator)
Primary units Primary deviation Secondary units Secondary deviation	% 0nF ABS 0	Set with the front panel **ΔMode** key (see section 4.8.5 Deviation Mode).
Test Frequency Test Voltage Test Speed Trigger Mode Range	1kHz 1V SLOW INT. AUTO	Set with the measurement screen soft keys.
BIAS	Off	A 2V DC bias can be switched on and off with the front panel **BIAS** key.

9) Connect the DUT to the test leads or fixture contacts: the measurement result will be displayed and the PASS or FAIL indicator will light, as appropriate.

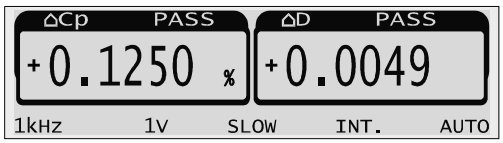

Figure 4-18 Capacitance Measurement

5. GENERAL PURPOSE INTERFACE BUS (GPIB)

5.1 Introduction

The GPIB is a parallel port designed to be used for communication between instruments and control device such as PCs fitted with a suitable interface card. The interface protocol is defined by the IEEE 488.1 standard. Some additional generic capabilities of the listeners and talks are defined by IEEE 488.2. The SCPI standard defines the highest level of command structure including a number of standard commands for all instruments.

5.1.1 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

5.1.2 Changing the GPIB Address

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

The default address for the 4230 is 6 and this may be changed from System Configuration menu as follows:-.

1) Press the **Conf** front panel key**.**
2) Select **GPIB ADRS** using the soft key.
3) Enter the new GPIB address using the numeric keypad,
4) Press the **Enter** key to confirm the change.

The GPIB address is stored in non-volatile memory.

5.2 Returning to Local Mode

Any GPIB command sent to the 4230 will put the instrument into remote mode. Once in remote mode none of the front panel keys will function with the exception of the **LOCAL** key.

To restore control of the instrument to the front panel keyboard press the **LOCAL** key.

5.3 Getting Data from the 4230

There are several GPIB commands that end with a question mark. These commands are called query commands and return data from the 4230.

5.4 Numeric data NR1, NR2, NR3

These three numeric data types are defined in IEEE 488.2

NR1: Integer

e.g. 10

+10

-10

NR2: Fixed point

e.g. 10.1

+10.1

-10.1

NR3: Floating point

e.g. 1.23E+3

12.3E-6

5.5 Control sequence

A Typical control sequence example for 4230 is

1. Set up the 4230.
2. Trigger the measurement.
3. Retrieve the data.

Programming example in the C language:

```
int ud;
char bfr[32];
```

```
ud = ibfind("DEV6");                  // 4230's address is 6
ibwrt(ud, "*RST");                    // Resets the 4230
ibwrt(ud, ":TRIG:SOUR INT");          // Trigger source is internal trigger
ibwrt(ud, ":CALC1:FORM LP");          // Primary parameter is LP
ibwrt(ud, ":CALC2:FORM Q");           // Secondary parameter is Q
ibwrt(ud, ":SOUR:FREQ 10kHZ");        // Test signal frequency is 10kHz
ibwrt(ud, ":SOUR:VOLT 1V");           // Test signal level is 1 volt
delay(500);                           // Wait until the internal trigger is complete
ibwrt(ud, ":FETCH?");                 // Retrieve reading from output buffer
ibrd(ud, bfr);
```

5.6 Status Reporting

5.6.1 Status Byte Register (SBR)

The status byte is used to summarize information from the other status groups. The SBR can be read by the query command *STB? or by performing a serial poll on the instrument.

Bit	Description
7	Operation Status Event Register summary bit.
6	This bit serves two functions, Request Service (RQS) and Master Summary (MSS). RQS If this bit is read in serial polling process, it is treated as the RQS bit and is reset during the serial polling process. MSS If this bit is read by using the *STB? query, it is treated as the MSS bit and its value is not changed after read.
5	Event Summary Bit (ESB). When unmasked by ESE register, this bit will be set whenever the corresponding bit or bits are set in the Event Status Register.
4	Message Available bit (MAV). The output queue has data available to read. This bit is cleared when the data is read.
3	Questionable Status Register Summary bit. This bit is not used and is always 0.
2	Always 0
1	Always 0
0	Always 0

Figure 5-1 Status Byte Register

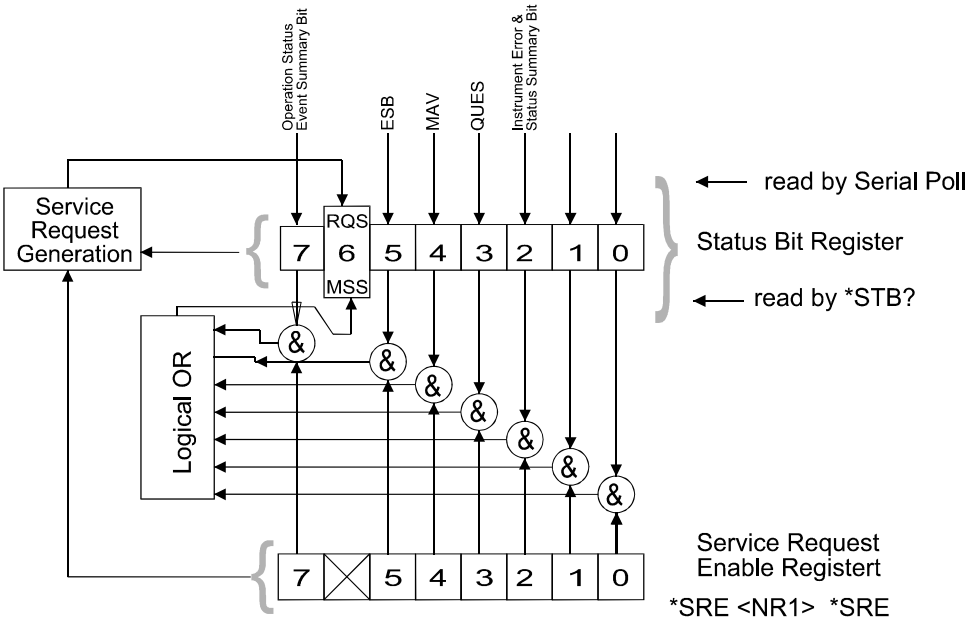

Figure 5-2 Status Byte Register

5.6.2 Service Request Enable Register (SRE)

The SRE register 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 SBR is set. The SRE register is set by the *SRE command and read by the *SRE? command.

5.6.3 Standard Event Status Register (ESR)

The standard 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 (ESB) of the SBR is set to "1".

Bit	Description
7	Power ON bit (PON). This bit is set when the instrument power 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). Error Nos. -100 to -178. This bit is set if the following command errors occur: 1. An IEEE 488.2 syntax error occurred. 2. The device received a Group Execute Trigger (GET) inside a program message.
4	Execution Error (EXE). Error Nos. -211 to -230. This bit is set 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). Error Nos. -310 to -311. This bit is set when any bit is set in the Encoded Message Register.
2	Query Error (QYE). Error Nos. -400 to -440. This bit is set 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). This bit is set when the instrument has completed all selected pending operations before sending the *OPC command.

Figure 5-3 Standard Event Status Register

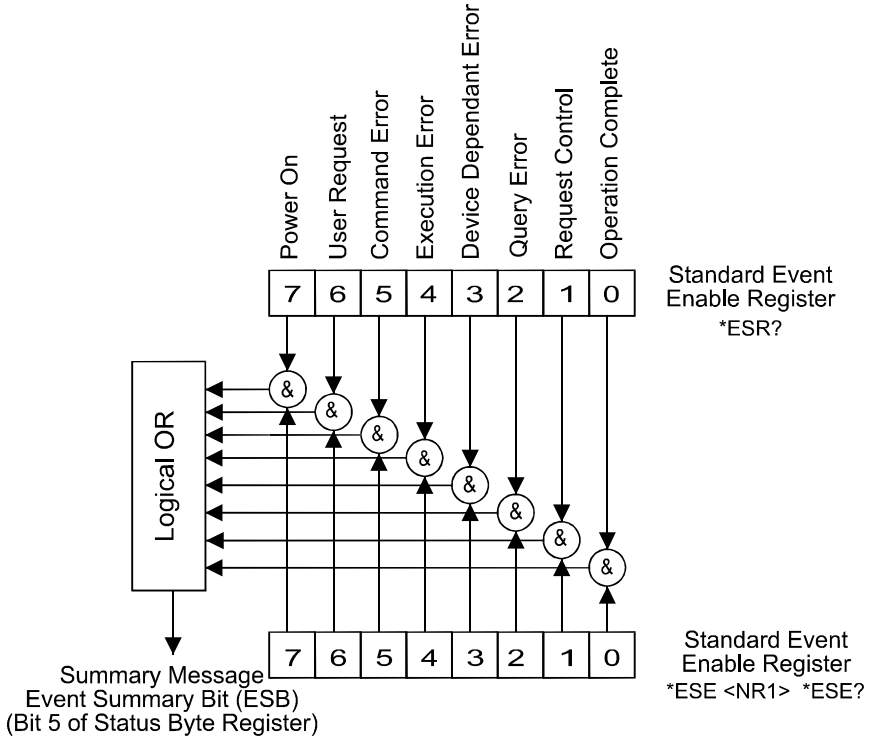

Figure 5-4 Event Status Byte Register

5.6.4 Standard Event Status Enable Register (ESE)

The standard ESE register is a mask determining the conditions in which the standard ESR will set bit 5 of the SBR. It is bit-wise ANDed with the standard ESR and if the result is not zero the ESB (bit 5) of SBR is set. Thus any event affecting the ESR can be made to generate a service request in conjunction with the ESE and SRE. The standard ESE is set by the *ESE command and read by the *ESE? command.

5.6.5 Standard Operation Status Register

The 4230 provides two standard operation status groups. Each group includes a condition register, event register and enable register which can be accessed through the STATus subsystem.

5.6.6 Operation Status Register

The standard operation status group provides information about the state of the measurement system in the instrument.

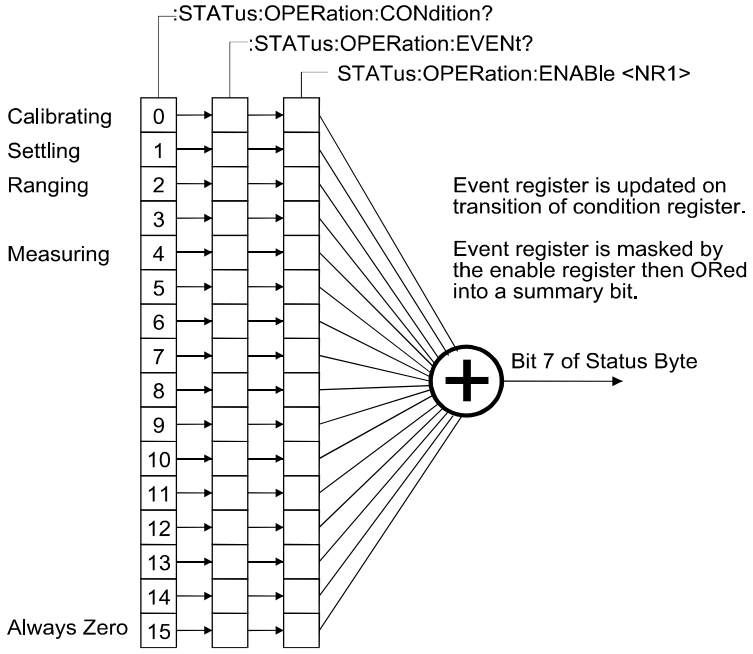

Figure 5-5 Standard Operation Status Group

Bit	Description
15-5	Always 0.
4	This bit is set when the measurement is in progress.
3-1	Always 0
0	This bit is set when the open trim or the short trim is in progress.

Figure 5-6 Operation Status Condition Register

Bit	Description
15-5	Always 0
4	This bit is set when a measurement has been completed.
3-1	Always 0
0	This bit is set when the open trim or the short trim has been completed.

Figure 5-7 Operation Status Event Register

Note: Once the event register's bits are set to 1, the bits are kept at 1 before the data has been read.

5.6.7 Questionable Status Register

The 4230 has no operation to report the event to the questionable status register group, so they are always 0. This register is available to keep consistency with other SCPI compatible instrumentation.

5.7 Command Summary

5.7.1 Common Commands

Command	Name	Description
*CLS	Clear Status	Clears the Status Byte Register and the Standard Event Status Enable Register.
*ESE <numeric val>	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.
*IDN?	Identification Query	Returns the data identifying the instrument. (e.g. the data output will be: 'TMPRO,4230,0,1.0' where the first field is the manufacturer, then the model number, then a zero followed by the software revision number: here represented as Issue 1.0).
*LRN?	Status	Returns 4230 state
*OPT ?	Option Identification Query	Returns the hardware options installed in the instrument. 0 = no options installed, 1=GPIB interface.
*OPC	Operation Complete Command	Sets the 0 (OPC) bit of the Standard Event Status Register when all pending operations are complete.
*OPC?	Operation Complete Query	Always returns 1 as instrument commands are always processed sequentially.
*RCL <numeric val>	Recall	Loads the instrument settings stored in the specified memory locations. 128 memory locations (1-128) are available.
*RST	Reset	Resets the instrument to a default setting. This command is equivalent to a power-up reset. This command has same effect as :SYSTem:PRESet.
*SAV <numeric val>	Save	Saves the instrument settings in the specified memory number. 128 memory locations (1-128) are available.

Command	Name	Description
*SRE <numeric val>	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.
*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.
*TRG	Trigger	Triggers a measurement when the Trigger source is set to BUS, but does not return the results to the controller. This is the same as a GET (Group Execute Trigger) command. Sending the *TRG command when the current trigger mode is not set to the BUS mode will generate an error.
*TST	Self test.	Executes an internal self-test function. Always returns 1.
*WAI	Wait-to-continue	Makes the 4230 wait until all previously sent commands are executed completely.

5.7.2 Operation Status Commands

Refer to section 5.6 for an explanation of the following commands.

Command	Name	Description
:STATus:OPERation:CONDition?	Status Operation Condition Register query.	Returns the content of the condition register of the operation status register group. Reading the register does not clear it.
:STATus:OPERation:EVENt?	Status Operation Event register query	Returns the contents of the event register of the operation status register group.
:STATus:OPERation:ENABle <numeric val>	Status Operation Enable Register	Sets the enable register of the operation status register group.
:STATus:OPERation:ENABle?	Status Operation Enable Register query	Returns the current contents of the enable register of the operation status register group.
:STATus:QUEStionable:CONDition?	Status Questionable Condition Register query	Always returns 0

Command	Name	Description
:STATus:QUEStionable:ENABle <numeric_value>	Status Questionable Enable Register	Sets the enable register of the questionable status register group.
:STATus:QUEStionable:ENABle?	Status Questionable Enable Register query	Returns the enable register of the questionable status register group.
:STATus:QUEStionable:EVENt?	Status Questionable Event Register query	Always returns 0.

5.7.3 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.

5.7.3.1 Command Summary

Command	Summary	Page
:ABORt	Stop all pending GPIB commands.	5–12
:CALCulate1:FORMat	Sets the primary measurement parameter.	5–12
:CALCulate1:FORMat?	Queries the primary measurement parameter	5–13
:CALCulate2:FORMat	Sets the secondary measurement parameter.	5–14
:CALCulate2:FORMat?	Queries the secondary measurement parameter.	5–15
:CALCulate1:LIMit:UPPer	Sets the primary parameter upper limit value.	5–15
:CALCulate1:LIMit:UPPer?	Queries the primary parameter upper limit value.	5–15
:CALCulate1:LIMit:LOWer	Sets the primary parameter lower limit value.	5–16
:CALCulate1:LIMit:LOWer?	Queries the primary parameter lower limit value.	5–16
:CALCulate1:LIMit:UPPer:STATe	Enables/disables the primary parameter upper limit.	5–16
:CALCulate1:LIMit:UPPer:STATe?	Queries if the primary parameter upper limit is enabled.	5–16
:CALCulate1:LIMit:LOWer:STATe	Enables/disables the primary parameter lower limit.	5–17
:CALCulate1:LIMit:LOWer:STATe?	Queries if the primary parameter lower limit is enabled.	5–17
:CALCulate1:LIMit:FAIL?	Returns the comparison result for the primary parameter.	5–17
:CALCulate2:LIMit:UPPer	Sets the secondary parameter upper limit value.	5–17
:CALCulate2:LIMit:UPPer?	Queries the secondary parameter upper limit value.	5–18
:CALCulate2:LIMit:LOWer	Sets the secondary parameter lower limit value.	5–18

Command	Summary	Page
:CALCulate2:LIMit:LOWer?	Queries the secondary parameter lower limit value.	5–18
:CALCulate2:LIMit:UPPer:STATe	Enables/disables the secondary parameter upper limit.	5–18
:CALCulate2:LIMit:UPPer:STATe?	Queries if the secondary parameter upper limit is enabled.	5–19
:CALCulate2:LIMit:LOWer:STATe	Enables/disables the secondary parameter lower limit.	5–19
:CALCulate2:LIMit:LOWer:STATe?	Queries if the secondary parameter lower limit is enabled.	5–19
:CALCulate2:LIMit:FAIL?	Returns the secondary parameter comparison result.	5–19
:CALCulate1:MATH:EXPRession:MODE	Sets the expression used for the primary parameter deviation measurement	5–20
:CALCulate1:MATH:EXPRession:MODE?	Queries the expression used for the primary parameter deviation measurement.	5–20
:CALCulate2:MATH:EXPRession:MODE	Sets the expression used for the secondary parameter deviation measurement.	5–20
:CALCulate2:MATH:EXPRession:MODE?	Queries the expression used for the secondary parameter deviation measurement.	5–21
:CALCulate1:MATH:EXPRession:REFerence	Sets the reference value for the primary parameter deviation measurement.	5–21
:CALCulate1:MATH:EXPRession:REFerence?	Queries the reference value for the primary parameter deviation measurement.	5–21
:CALCulate2:MATH:EXPRession:REFerence	Sets the reference value for the secondary parameter deviation measurement.	5–21
:CALCulate2:MATH:EXPRession:REFerence?	Queries the reference value for the secondary parameter deviation measurement.	5–22
:FETCh?	Returns the measurement data form the output buffer.	5–22
:SENSe:CORRection OPEN	Performs an OPEN circuit correction.	5–22
:SENSe:CORRection SHORt	Performs a SHORT circuit correction.	5–22
:SENSe:CORRection:OPEN:DATA?	Returns the OPEN correction data	5–22
:SENSe:CORRection:SHORt:DATA?	Returns the SHORT correction data	5–23
:SENSe:CORRrction:STATe	Enables the measurement error correction function.	5–23
:SENSe:CORRrction:STATe?	Queries if measurement error correction is enabled.	5–23
:SENSe:APERture	Sets the measurement speed.	5–23
:SENSe:APERture?	Queries the measurement speed.	5–24
:SENSe:RANG:HOLD	Sets the range hold function.	5–24
:SENSe:RANG:HOLD?	Queries whether the range hold function is enabled or disabled.	5–24

Command	Summary	Page
:SOURce:FREQuency	Sets the test signal frequency.	5–25
:SOURce:FREQuency?	Queries the test signal frequency.	5–25
:SOURce:VOLTage	Sets the test signal voltage level.	5–25
:SOURce:VOLTage?	Queries the test signal voltage level.	5–26
:SOURce:VOLTage:BIAS:STATe	Enables the DC bias voltage.	5–26
:SOURce:VOLTage:BIAS:STATe?	Queries whether the internal DC bias voltage is enabled.	5–26
:SYSTem:ERRor?	Queries the GPIB error message in the error queue.	5–28
:SYSTem:KLOCk	Locks or unlocks the front panel keys.	5–28
:SYSTem:KLOCk	Queries if the front panel keys are locked.	5–28
:SYSTem:LFRequency	Sets the power line frequency compensation.	5–28
:SYSTem:LFRequency?	Queries the power line frequency compensation.	5–29
:SYSTem:PRESet	Reset the 4230 to the default state.	5–29
:SYSTem:VERSion	Returns the software version.	5–29
:SYSTem:BEEPer	Sets the audible warning mode.	5–30
:SYSTem:BEEPer?	Queries the audible warning mode.	5–30
:TRIGger	Execute a measurement	5–30
:TRIGger:SOURce	Sets the trigger mode.	5–27
:TRIGger:SOURce?	Queries the trigger mode.	5–27

5.7.3.2 Measurement Commands

MEASUREMENT COMMANDS

:ABORt

The ABORt command resets the trigger system immediately, ignoring all pending GPIB commands.

Parameters:

None.

Response:

None.

:CALCulate1:FORMat {Z|LS|LP|CS|CP|R|Y|G}

Sets the primary measurement parameter. Once the primary measurement parameter has been set, then the system will use the default parameter for the secondary measurement parameter.

Parameters:

Selecting the primary measurement parameter:

:CALCulate1:FORMat Z Impedance

:CALCulate1:FORMat LS Inductance (Series)

:CALCulate1:FORMat LP Inductance (Parallel)

:CALCulate1:FORMat CS Capacitance (Series)

:CALCulate1:FORMat CP Capacitance (Parallel)

:CALCulate1:FORMat R Resistance

:CALCulate1:FORMat Y Admittance

:CALCulate1:FORMat G Conductance.

Response:

None.

MEASUREMENT COMMANDS

:CALCulate1:FORMat?

Queries the primary measurement parameter.

Parameters:

None

Response:

Returns the primary measurement type.

Z Impedance

LS Inductance (Series)

LP Inductance (Parallel)

CS Capacitance (Series)

CP Capacitance (Parallel)

R Resistance

Y Admittance

G Conductance

MEASUREMENT COMMANDS

:CALCulate2:FORMat {PHAS|Q|D|RS|RP|G|X|B|OFF}

Sets the secondary measurement parameter.

Parameters:

Selecting the secondary measurement parameter:

:CALCulate2:FORMat PHAS Phase

:CALCulate1:FORMat Q Quality factor

:CALCulate1:FORMat D Dissipation factor

:CALCulate1:FORMat RS Resistance (Series)

:CALCulate1:FORMat RP Resistance (Parallel)

:CALCulate1:FORMat G Conductance

:CALCulate1:FORMat X Reactance

:CALCulate1:FORMat B Susceptance

:CALCulate1:FORMat Off No Secondary parameter

The following primary and secondary parameter combinations may be set.

Primary	Secondary
Z	PHAS, OFF
LS	Q, D, RS, OFF
LP	Q, D, RP, G, OFF
CS	D, Q, RS, OFF
CP	D, Q, RP, G, OFF
R	X, OFF
Y	PHAS, OFF
G	B, OFF

Response:

None.

MEASUREMENT COMMANDS

:CALCulate2:FORMat?

Queries the secondary measurement parameter.

Parameters:

None

Response:

Returns the secondary measurement parameter.

Θ	Phase
Q	Quality factor
D	Dissipation factor
RS	Resistance (Series)
RP	Resistance (Parallel)
G	Conductance
X	Reactance
B	Susceptance
Off	No Secondary parameter

:CALCulate1:LIMit:UPPer <numeric_val>

Sets the upper limit value of the primary parameter.

Parameters:

The primary parameter upper limit value.

Response:

None

:CALCulate1:LIMit:UPPer?

Queries the upper limit value of the primary parameter.

Parameters:

None

Response:

Upper limit value of the primary parameter in <NR3> format.

MEASUREMENT COMMANDS

:CALCulate1:LIMit:LOWer <numeric_val>

Sets the lower limit value of the primary parameter.

Parameters:

The primary parameter lower limit value.

Response:

None

:CALCulate1:LIMit:LOWer?

Queries the lower limit value of the primary parameter.

Parameters:

None

Response:

Lower limit value of the primary parameter in <NR3> format.

:CALCulate1:LIMit:UPPer:STATe {OFF|ON}

Enables or disables the upper limit for the primary parameter.

Parameters:

:CALCulate1:LIMit:UPPer:STATe OFF Upper limit disabled.

:CALCulate1:LIMit:UPPer:STATe ON Upper limit enabled.

Response:

None

:CALCulate1:LIMit:UPPer:STATe?

Queries the status of the upper limit for the primary parameter

Parameters:

None

Response:

1 Enabled

0 Disabled

MEASUREMENT COMMANDS

:CALCulate1:LIMit:LOWer:STATe {OFF|ON}

Enables or disables the lower limit for the primary parameter.

Parameters:

:CALCulate1:LIMit:LOWer:STATe OFF Lower limit disabled.

:CALCulate1:LIMit:LOWer:STATe ON Lower limit enabled.

Response:

None

:CALCulate1:LIMit:LOWer:STATe?

Queries the status of the lower limit for the primary parameter

Parameters:

None

Response:

1 Enabled

0 Disabled

:CALCulate1:LIMit:FAIL?

Returns the comparison result for the primary parameter.

Parameters:

None

Response:

1 FAIL

0 PASS

:CALCulate2:LIMit:UPPer <numeric_val>

Sets the upper limit value of the secondary parameter.

Parameters:

The secondary parameter upper limit value.

Response:

None

MEASUREMENT COMMANDS

:CALCulate2:LIMit:UPPer?

Queries the upper limit value of the secondary parameter.

Parameters:

None

Response:

Upper limit value of the secondary parameter in <NR3> format.

:CALCulate2:LIMit:LOWer <numeric_val>

Sets the lower limit value of the secondary parameter.

Parameters:

The secondary parameter lower limit value.

Response:

None

:CALCulate2:LIMit:LOWer?

Queries the lower limit value of the secondary parameter.

Parameters:

None

Response:

Lower limit value of the secondary parameter in <NR3> format.

:CALCulate2:LIMit:UPPer:STATe {OFF|ON}

Enables or disables the upper limit for the secondary parameter.

Parameters:

:CALCulate2:LIMit:UPPer:STATe OFF Upper limit disabled.

:CALCulate2:LIMit:UPPer:STATe ON Upper limit enabled.

Response:

None

MEASUREMENT COMMANDS

:CALCulate2:LIMit:UPPer:STATe?

Queries the status of the upper limit for the secondary parameter

Parameters:

None

Response:

1 Enabled

0 Disabled

:CALCulate2:LIMit:LOWer:STATe {OFF|ON}

Enables or disables the lower limit for the secondary parameter.

Parameters:

:CALCulate2:LIMit:LOWer:STATe OFF Lower limit disabled.

:CALCulate2:LIMit:LOWer:STATe ON Lower limit enabled.

Response:

None

:CALCulate2:LIMit:LOWer:STATe?

Queries the status of the lower limit for the secondary parameter

Parameters:

None

Response:

1 Enabled

0 Disabled

:CALCulate2:LIMit:FAIL?

Returns the comparison result for the secondary parameter.

Parameters:

None

Response:

1 Fail

0 Pass

MEASUREMENT COMMANDS

:CALCulate1:MATH:EXPRession:MODE {OFF|ABS|PCNT}

Sets the primary measurement deviation parameter.

Parameters:

:CALCulate1:MATH:EXPRession:MODE OFF Disabled

:CALCulate1:MATH:EXPRession:MODE ABS Absolute deviation

:CALCulate1:MATH:EXPRession:MODE PCNT Percentage deviation

Response:

None

:CALCulate1:MATH:EXPRession:MODE?

Queries the deviation parameter type for the primary measurement.

Parameters:

None

Response:

OFF Disabled

ABS Absolute deviation

PCNT Percentage deviation

:CALCulate2:MATH:EXPRession:MODE {OFF|ABS|PCNT}

Sets the secondary measurement deviation parameter.

Parameters:

:CALCulate2:MATH:EXPRession:MODE OFF Disabled

:CALCulate2:MATH:EXPRession:MODE ABS Absolute deviation

:CALCulate2:MATH:EXPRession:MODE PCNT Percentage deviation

Response:

None

MEASUREMENT COMMANDS

:CALCulate1:MATH:EXPRession:MODE?

Queries the deviation parameter type for the secondary measurement.

Parameters:

None

Response:

OFF Disabled

ABS Absolute deviation

PCNT Percentage deviation

:CALCulate1:MATH:EXPRession:REFerence <numeric_val>

Sets the deviation reference value for the primary measurement.

Parameters:

The reference value for the primary measurement.

Response:

None

:CALCulate1:MATH:EXPRession:REFerence?

Queries the deviation reference value for the primary measurement.

Parameters:

None

Response:

The reference value for the primary measurement in <NR3> format.

:CALCulate2:MATH:EXPRession:REFerence <numeric_val>

Sets the deviation reference value for the secondary measurement.

Parameters:

The reference value for the secondary measurement.

Response:

None

MEASUREMENT COMMANDS

:CALCulate2:MATH:EXPRession:REFerence?

Queries the deviation reference value for the secondary measurement.

Parameters:

None

Response:

The reference value for the secondary measurement in <NR3> format.

:FETCh?

Retrieves the last measurement result from the 4230.

Parameters:

None

Response:

<data1>,<data2>

<data1> Measurement data of the primary parameter in <NR3> format.

<data2> Measurement data of the second parameter in <NR3> format.

:SENSe:CORRection {OPEN|SHORt}

Performs an open or short circuit trim.

Parameters:

:SENSe:CORRection OPEN

:SENSe:CORRection SHORt

Response:

None

:SENSe:CORRection:OPEN:DATA?

Returns the open circuit trim correction data.

Parameters:

None

Response:

Open circuit trim correction in <NR3> format.

MEASUREMENT COMMANDS

:SENSe:CORRection:SHORt:DATA?

Returns the short circuit trim correction data.

Parameters:

None

Response:

Short circuit trim correction in <NR3> format.

:SENSe:CORRrction:STATe {OFF|ON}

Enables or disables the measurement error correction.

Parameters:

:SENSe:CORRrction:STATe OFF Trim values ignored.

:SENSe:CORRrction:STATe ON Measurements corrected using last trim values.

Response:

None

:SENSe:CORRrction:STATe?

Returns the status of the measurement correction facility.

Parameters:

None

Response:

1 Enabled

0 Disabled

:SENSe:APERture {SLOW|MEDium|FAST}

Sets the measurement speed.

Parameters:

:SENSe:APERture SLOW Slowest measurements speed selected.

:SENSe:APERture MEDium Measurement speed set to medium.

:SENSe:APERture FAST Fastest measurement speed selected.

Response:

None

MEASUREMENT COMMANDS

:SENSe:APERture?

Returns the measurement speed.

Parameters:

None

Response:

SLOW Measurement speed set to slow.

MED Measurement speed set to medium.

FAST Measurement speed set to fast.

:SENSe:RANG:HOLD {OFF|ON}

The set measurement range is held or auto ranging is used.

Parameters:

:SENSe:RANG:HOLD OFF Auto ranging is used to select the measurement range.

:SENSe:RANG:HOLD ON The set measurement range is held.

Response:

None

:SENSe:RANG:HOLD?

Returns the range hold setting.

Parameters:

None

Response:

0 Auto ranging is used to select the measurement range.

1 The current measurement range will be used for all measurements.

MEASUREMENT COMMANDS

:SOURce:FREQuency <numeric_val|MAX|MIN>[HZ|K|KHZ]

Sets the test frequency.

Parameters:

:SOURce:FREQuency <numeric_val>	Set test frequency <numeric_val>Hz.
:SOURce:FREQuency <numeric_val>HZ	Set test frequency <numeric_val>Hz.
:SOURce:FREQuency <numeric_val>K	Set test frequency <numeric_val>KHz.
:SOURce:FREQuency <numeric_val>KHZ	Set test frequency <numeric_val>KHz.
:SOURce:FREQuency MAX	Set test frequency 200KHz.
:SOURce:FREQuency MIN	Set test frequency 100Hz.

Response:

None

:SOURce:FREQuency?

Returns the test frequency.

Parameters:

None

Response:

Test frequency in <NR3> format.

:SOURce:VOLTage <numeric_val|MAX|MIN>[V|MV]

Sets the test signal level.

Parameters:

:SOURce:VOLTage <numeric_val>	Set test level <numeric_val>V.
:SOURce:VOLTage <numeric_val>V	Set test level <numeric_val>V.
:SOURce:VOLTage <numeric_val>MV	Set test level <numeric_val>mV.
:SOURce:VOLTage MAX	Set test level 1V.
:SOURce:VOLTage MIN	Set test level 50mV.

Response:

None

MEASUREMENT COMMANDS

:SOURce:VOLTage?

Returns the test signal level.

Parameters:

None

Response:

Test signal level in <NR3> format.

:SOURce:VOLTage:BIAS:STATe {OFF|ON}

Controls the DC bias voltage.

Parameters:

:SOURce:VOLTage:BIAS:STATe OFF Removes the DC bias voltage.

:SOURce:VOLTage:BIAS:STATe ON Applies the DC bias voltage.

Response:

None

:SOURce:VOLTage:BIAS:STATe?

Returns the status for the DC bias voltage.

Parameters:

None

Response:

1 Bias applied

0 Bias removed

:TRIGger

Make a measurement.

Parameters:

None.

Response:

None.

MEASUREMENT COMMANDS

:TRIGer:SOURce {INTernal|MANual|EXTernal|BUS}

Sets the trigger mode.

Parameters:

:TRIGer:SOURce INTernal Internal mode.

:TRIGer:SOURce MANual Manual mode using keyboard

:TRIGer:SOURce EXTernal External mode.

:TRIGer:SOURce BUS Bus mode.

Response:

None.

:TRIGer:SOURce?

Returns the trigger mode.

Parameters:

None

Response:

INT Internal mode.

MAN Manual mode.

EXT External mode.

BUS Bus mode.

5.7.3.3 System Commands

SYSTEM COMMANDS
:SYSTem:ERRor? Returns the GPIB error message in the 4230 error queue. **Parameters:** None **Response:** Error number.
:SYSTem:KLOCk {OFF|ON} Locks or releases the front panel keys. **Parameters:** :SYSTem:KLOCk OFF Front panel keys can be operated by user. :SYSTem:KLOCk ON Front panel keys are locked. **Response:** None
:SYSTem:KLOCk? Returns the status for the front panel keys. **Parameters:** None **Response:** 1 Front panel keyboard locked. 0 Front panel keyboard unlocked.
:SYSTem:LFRequency {50|60} Sets the power line frequency compensation. **Parameters:** :SYSTem:LFRequency 50 Use with 50Hz power line frequency. :SYSTem:LFRequency 60 Use with 60Hz power line frequency. **Response:** None

SYSTEM COMMANDS

:SYSTem:LFRequency?

Returns the setting for power line compensation.

Parameters:

None

Response:

50 50Hz power line.

60 60Hz power line.

:SYSTem:PRESet

Sets the 4230 to the following default states.

Parameter	Default
Test signal frequency	1kHz
Test signal level	1V
Primary parameter	LP
Secondary parameter	Q
Measurement speed	Slow
Trigger mode	Internal
Deviation reference	Cleared
Comparator limits	
Comparator state	OFF
Deviation measurement	
Range hold function	
DC bias state	
Beep mode	
Correction state	No effect
Correction data	
Power line frequency	
GPIB address	
Key lock function	

Parameters:

None

Response:

None

:SYSTem:VERSion?

SYSTEM COMMANDS

Returns the 4230 system software version number.

Parameters:

None

Response:

Version number.

:SYSTem:BEEPer {OFF|PASS|FAIL}

Sets the system audible warning mode when making a comparative measurement.

Parameters:

:SYSTem:BEEPer OFF Audible warning turned off.

:SYSTem:BEEPer PASS Audible warning when comparison passes.

:SYSTem:BEEPer FAIL Audible warning on failure

Response:

None.

:SYSTem:BEEPer?

Returns the audible warning mode set.

Parameters:

None

Response:

OFF Audible warning is turned off.

PASS Audible warning is given when comparison passes.

FAIL Audible warning is given when comparison fails.

5.8 Error Massages

-100 Command error

-101 Invalid character

-102 Syntax error

-103 Invalid separator

-108 Parameter not allowed

-109 Missing parameter

-112 Program nmemonic too long

-113 Undefined header

-115 Unexpected number of parameter

-141 Invalid character data

-160 Block data error

-211 Trigger ignored

-222 Data out of range

-223 Too much data

-224 Illegal parameter value

-410 Query interrupted

-420 Query unterminated

5.9 Programming Examples

5.9.1 Set the Power Line Frequency to 50 Hz

:SYST:LFR 50

5.9.2 Select the Z and Phase Measurement Parameters

:CALC1:FORM Z

:CALC2:FORM PHAS

5.9.3 Select 100 Hz as the Test Signal Frequency

:SOUR:FREQ 100

5.9.4 Select 1V as the Test Signal Level

:SOUR:VOLT 1

5.9.5 Hold the Measurement Range

:SENS:RANG:HOLD ON

5.9.6 Perform Short Circuit Correction

:SENS:CORR SHOR

5.9.7 Set the Measurement Speed to Slow

:SENS:APER SLOW

5.9.8 Save and Recall Instrument Settings

*SAV 10

*RCL 20

5.9.9 Trigger and Retrieve a Measurement

5.9.9.1 Internal Trigger

:TRIG:SOUR INT	(Set internal trigger as trigger source)
delay	(Wait until measurement is complete)
:FETC?	(Retreieve data from 4230 output buffer)

5.9.9.2 Bus Trigger

:TRIG:SOUR BUS	(Set the GPIB bus as trigger source)
*TRG	(Trigger the measurement and retrieve data from buffer)

6. SERIAL BUS (RS-232)

6.1 Protocol

Baud rate: 9600bps

Character length: 8bits
Stop bit: 1bit
Parity: Non-parity
Character: ASCII character

6.2 Serial Port Connections

Function	4230	Controller
RxD	Pin 2	Pin 3
TxD	Pin 3	Pin 2
GND	Pin 5	Pin 5
RTS	Pin 7	Pin 8
CTS	Pin 8	Pin 7

6.3 Commands

All the RS-232 commands and functions are totally the same as the GPIB command except the SRQ function.

The command is terminate by LF Line Feed (ASCII code 10); only the LF is effective as the terminator.

7. SPECIFICATION

7.1 Measurement Parameters

Parameter	Range
| Z | R X	0.01mΩ – 100.00MΩ
| Z | G B	0.0001nS – 1000.0S
Cs Cp	0.01pF – 1F
Ls Lp	0.01μH – 100kH
D	0.0001 – 9.9999
Q	0.1 – 9999.9
θ	–180º – +180º
Δ	–999.99% – 999.99%
DCR	0.01mΩ – 100.00MΩ

7.2 Measurement Speed

Fast	5 measurements per second
Medium	3 measurements per second
Slow	2 measurements per second

7.3 Basic Accuracy

±0.1%

7.4 Comparator Test Mode

Upper and Lower test limits in units and percentage

7.5 Test Signals

Signal	Range
Test Frequency	100Hz to 200kHz
Test Frequency Steps	389
AC Test Voltage	50mV 100mV 250mV 1Vrms
DC Test Voltage	0.5V
Bias Voltage	2V

7.6 Ranging

Auto and Hold

7.7 Trigger

Internal, Manual, External, and Bus

7.8 Display and Indicators

240 x 64 pixel dot matrix LCD

PASS, FAIL and BIAS LED indicators

Internal speaker

7.9 Connections

4-Terminal BNC Guarded Connections

7.10 Error Correction

Open- and Short-circuit trim at test lead or fixture terminals

7.11 Memory

127 instrument set-up conditions can be saved.

7.12 Interfaces

RS-232 port, Handler Interface, GPIB

7.13 Power Supply

Input voltage	90 – 132Vac or 198 – 264Vac (selectable)
Frequency	47 – 66Hz
Power	45VA typical

7.14 Environmental

Installation category	II (in accordance with IEC664)
Temperature range	Operating: 10°C to 40°C
Relative humidity	up to 90% non-condensing
Pollution degree	2 (mainly non-conductive)
Altitude	up to 2000m

7.15 Safety

Complies with the requirements of EN61010-1

7.16 EMC

Immunity	EN61326-1
Emissions	EN55022 Class A

7.17 Mechanical

Height	150mm
Width	320mm
Depth	300mm
Weight	6kg without accessories

7.18 Accessories

4-Terminal BNC Kelvin Clips

4-Terminal Component Test Fixture (optional)

SMD Tweezers (optional)

Power Cord

User Manual

7.19 Ordering Information

Item	Part Number
4230 LCR Meter	1J4230
4-Terminal Component Fixture (optional)	FX-0000C1
SMD Tweezers (optional)	1EVA40120
4-Terminal BNC Kelvin Clips	AC-6870K1

8. MAINTENANCE, SUPPORT AND SERVICES

8.1 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.

8.2 Maintenance

8.2.1 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.

8.2.2 Safety Checks

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

8.2.2.1 Equipment required

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

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

8.2.2.2 Tests

5) **DISCONNECT THE INSTRUMENT FROM THE AC MAINS POWER SUPPLY!**

6) 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.

7) **Ground Bond:** Ensure that 25A DC can flow from exposed metal parts of the unit (not connectors) to ground with an impedance of less than 100mΩ.

8) **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.

8.3 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.

INDEX

T

V