Locator 3s
Phasec 2s
Phasec 2d

Technical Reference and Operating Manual

Ident No. 40DH04

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Subject to change without notice.

1 Unpacking and Preparing for Operation 1-1

2 Introduction to Controls / Basic Operation 2-1

Unpacking and Preparing for Operation **1**

GE Inspection Technologies Manuals provide functional information about a particular instrument or group of instruments. However, proper set-up and use of this equipment and the performance of electromagnetic tests requires familiarity with factors which are beyond the scope of Owners Manuals. These factors include the following:

❚ Selection of appropriate cables, probes, fixtures, mechanical handling equipment and other accessories.

❚ Selection of proper test frequency, test mode and other test settings.

❚ Preparation of the test surface.

❚ Characteristics of the test material for example: conductivity, hardness, permeability, geometry, magnetic properties, heat treatment etc.

❚ Environmental factors such as temperature humidity, dust and electrical interference.

❚ Any individual factors that will depend on the particular test object or test being performed.

It is therefore imperative that operators are properly trained in both general procedure for eddy current testing and in the set up and execution of the particular test to be performed. It is the responsibility of the instrument user to ensure that test operators are trained to a sufficiently high standard, suitable equipment is used in the correct manner and that any test variables which may affect specific tests are taken into account. Similarly, compliance with standards such as ASTM, ASNT, API, ASME, BS,EN etc., as well as the observance of any test procedure specified by any government, manufacturer or other regulating authority is the responsibility of the user.

Periodic calibration, cleaning and maintenance may be necessary to ensure proper operation of the equipment. Environmental conditions and regularity of use should be considered when determining the frequency of such checks, then this should be observed.

Incidents such as physical shock, immersion in liquid and exposure to damaging environments such as excessive heat, moisture, dirt or dust can adversely affect equipment performance. The equipment must be examined for damage and recalibrated after any such incident. Do not use any product which you know or suspect to be faulty.

EC Declaration of Conformity

We

GE Inspection Technologies, Ltd
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St Albans Hertfordshire AL1 5HL
United Kingdom

declare under sole responsibility that all production issue versions of the Eddy Current Flaw Detectors Locator 3s, Phasec 2s and Phasec 2d meet the intent of Directive 89/336/EEC for Electromagnetic Compatibility.

Compliance tested to:

EN 50081-1 Emissions

EN 50082-1 Immunity

Manufacturer address

The instruments are manufactured by:

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The instruments are manufactured according to state-of-the-art methods using high-quality components. Thorough in-process inspections or intermediate tests and a quality management system certified to DIN EN ISO 9001 ensure an optimum quality of conformance of the instrument.

Should you nevertheless detect an error on your instrument, switch the instrument off. Inform your local GE Inspection Technologies Service or Distributor and describe the error in as much detail as possible.

Keep the shipping container for any repairs possibly required which cannot be made on the spot.

If there is anything special that you would like to know about the use, handling, operation and specifications of the instruments, please contact your nearest GE Inspection Technologies representative.

1.1   Checking Supplied Equipment

The instrument is available with a wide range of accessories. Check that the contents of your shipment match all the items listed on the packing note. If any items are missing please contact your supplier immediately.

1.2   Basic Knowledge

As a general rule, effective use of eddy current equipment for new applications requires the following:

❚ An understanding of the principles of eddy current testing, particularly aspects which may limit detectability of flaws such as depth of penetration and the way in which different probe configurations respond to different flaw types.

❚ An understanding of other NDT and inspection procedures which may be appropriate or which may be required to verify results.

❚ Knowledge of the application, i.e. the way in which the part being tested is manufactured or stressed in use and the probable flaw mechanisms.

❚ Existing applications require a good working knowledge of the equipment to be used plus a written technique to be followed in performing the inspection.

1.3   Key Features of the Instrument

The instrument has been designed to be extremely rugged and robust, whilst also avoiding risk of damage to the surrounding environment. For this reason plastics and rubbers have been used to avoid scratching or denting of precision surfaces, whilst all connectors are flush with the surface to avoid any scratch hazard. All parts of the unit are secured so as to avoid a Foreign Object Damage (FOD) hazard. For this reason connectors are locked from the inside of the case and there are no parts that can become disconnected.

The instrument is available in three different configurations. The following table outlines the major differences and similarities.

	Locator 3s	**Phasec 2s**	**Phasec 2d**
Keypad colour	Light Grey	Blue	Red
Number of Frequencies	1	1	2
Frequency Range	10 Hz – 10 MHz	10 Hz – 10 MHz	10 Hz – 10 MHz
Conductivity Mode	✓	✓	✓
Rotary Mode		✓	✓
VGA Output	✓	✓	✓
Analog Outputs	2	2	2
12 Way Probe Connector	✓	✓	✓
7 Way Auxillary Connector	✓	✓	✓

1.4   Power Sources

Connect the instrument to the power source. This will depend on the configuration of Phasec 2s purchased and can be an advanced lithium-ion battery, AA cells or connection to an AC supply via the charger/eliminator unit. For information on these options see Chapter 7, Power Sources and Battery Management.

1.5   Positioning the Instrument

Instrument is a versatile, lightweight unit that is designed for operation in a wide range of environments. A variety of accessories is available for setting the unit in the optimal position for operator use including tripods and other camera accessories. These can be secured to the instrument using the camera thread provided on the lower edge (see Fig). Ensure any screw is not longer than 8 mm or it may damage the enclosure. The thread type is ¼" BSF.
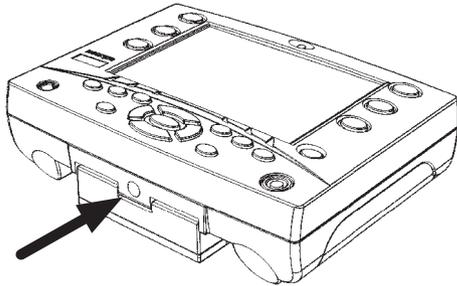
☞ **Note**

The instrument has designed to be rugged, splash resistant and also resistant to dirt and dust ingress. The unit is rated to IP64. However, it should not be considered drop proof or water proof, and care should be taken to position it to prevent damage due to falling or immersion in water.

The instrument has high grip rubber handles on the rear of the unit and these are intended to prevent sliding of the unit when placed on inclined smooth surfaces. Care should be taken to keep the rear of the instrument clean to prevent scratching of the surface. Avoid placing the instrument on contaminated surfaces where it might pick up abrasive particles.

1.6   Switching the Instrument On and Off

Once a suitable power source has been connected to the instrument the unit can be switched on by a single press of **on/off** button.

The unit will then display the welcome screen momentarily, followed by the operating screen.

A short press of **on/off** button switches the backlight on and off.

The unit can be switched off by pressing and holding **on/off** button for more than 2 seconds.

Introduction to Controls / Basic Operation **2**

2.1   Introduction to Instrument Controls

All operating controls are available on the front panel of the instrument. The most frequently used controls (**balance**, **clear** and **freeze**) are located vertically beside the screen. These buttons are duplicated on either side to allow both left handed and right handed operation.

These keys have two functions. The short press function is as indicated by the light writing on the dark background (i.e. Balance, Clear, Freeze). The second functions are invoked by a long press and are as indicated by the dark writing on the light ellipse (i.e. Automatic Liftoff selection, Clear Reference Trace and Keyboard Lock). These are positioned to be most accessible during operation (see 2.2 for further information).

All the controls required for adjustment of operating settings are based along the lower edge of the screen. Softkeys are engraved with **F1** to **F6** for ease of reference.
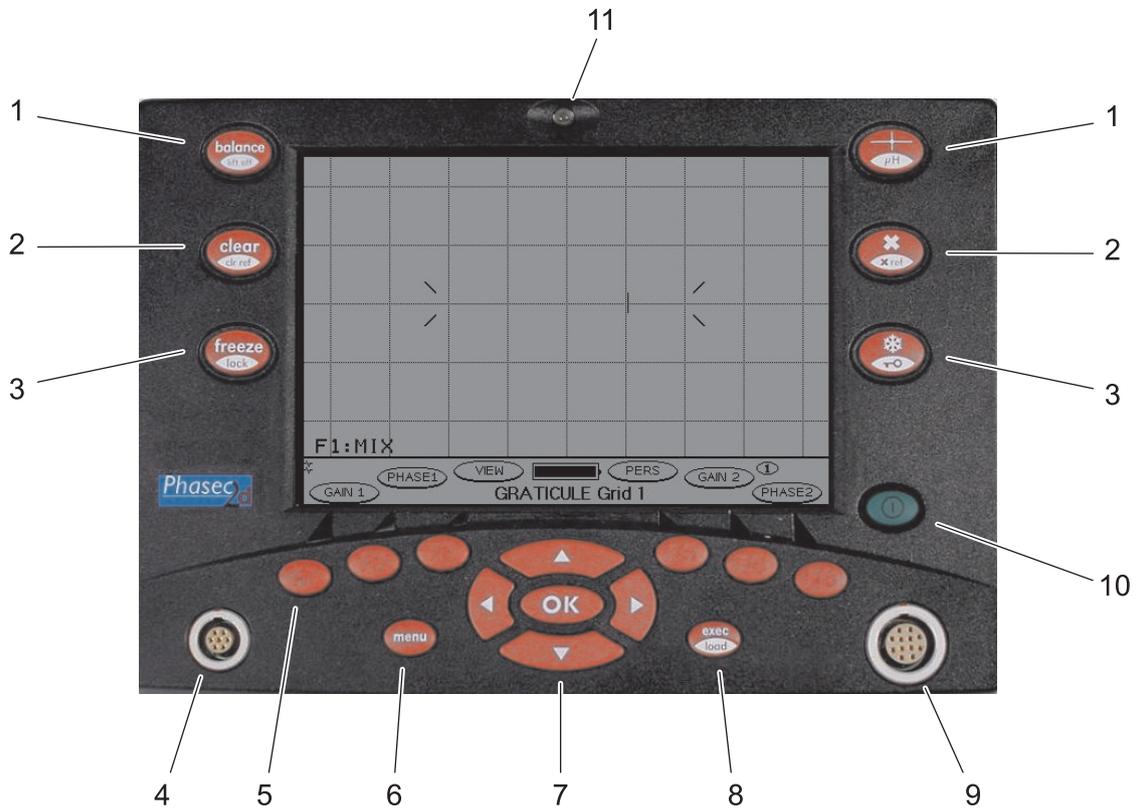
1 Balance Button

2 Clear Button

3 Freeze Button

4 7 Way connector for RS232 connection and XY analogue output

5 User Programmable Softkey Button (1 of 6)

6 Menu Screen Button

7 Cursor and OK Buttons for Menu Selection

8 Exec Button

9 12 Way Connector for Probe Connection

10 ON and Off button (short presses select backlight level)

11 Alarm LED

Instrument operating screen
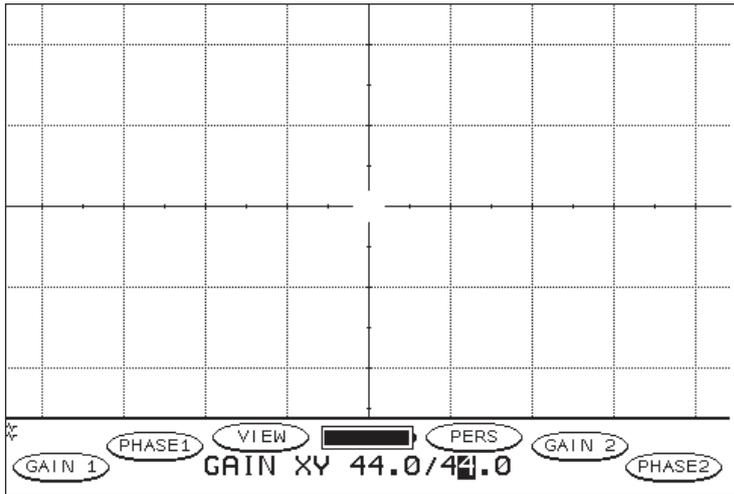
Instrument Normal menu screen
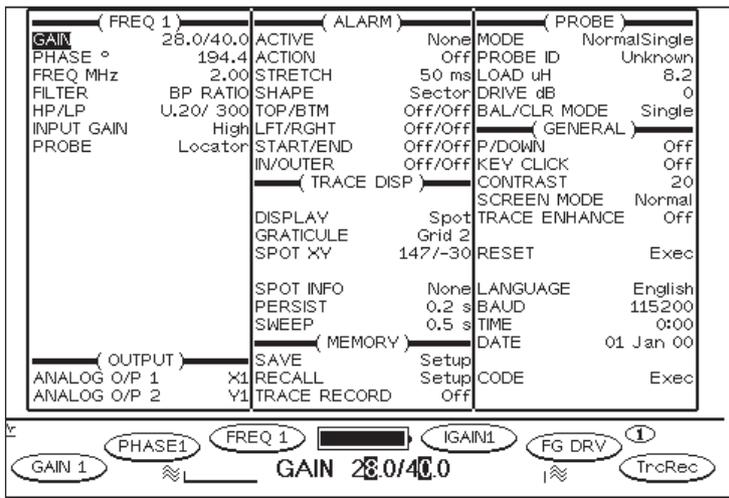
The menu screen shows all the settings available for the instrument. For this reason some variables that are not necessarily being used (e.g. alarm settings) will still be visible in the menu view.

2.2   Overview of button functions

Button	Function	Description
	balance	Returns the spot to its set position on the operating screen. A long press automatically sets the phase angle for lift-off.

In NormalDual Mode they can be made to Balance both working spots, or can be split to control left and right spots individually (see BAL/CLR Mode). |
| | clear | Clears active trace data left on screen as a result of long (or permanent) persistence. A long press will erase traces that have been recalled from memory.

In NormalDual Mode they can be made to Clear both working spots, or can be split to control left and right spots individually (see BAL/CLR Mode). |
| | freeze | Freezes the active trace in its current position (useful for saving traces).

A long press locks the keypad (see 2.14). |
| | menu | Switches between the operating screen and the menu screen. |
| | OK | Selects menu items in the menu screen. Switches between softkey items in the operating screen. |
| | exec | Toggles the cursor between updating compound variables such as Alarm Boundaries, XY Gain and High Pass and Low Pass Filters.

Executes menu actions such as entering Save or Recall, activates alarm parameters, activates the required menu language, and starts the Trace Recorder.

A long press performs the automatic load selection when in absolute mode. |
| | cursors up down left right | Navigates around the menus and changes values. For some menu items (such as GAIN, ALARM TOP, BOTTOM etc) left and right cursor have large increments, whilst up and down have fine increments. |
| | on/off | Short press switches the unit on. Long press switches the unit off.

Short presses switch the back light on and off. |

2.3   Changing Settings using Menus and Cursors

To change settings on the instrument the following general guidelines apply. There are some special cases explained in the relevant sections.

▌ The **menu** button switches to the menu screen.

▌ Use cursors to move to the relevant menu field.

▌ Use **OK** to highlight the setting.

▌ Use cursors to change the setting.

☞ **Note**

Press **exec** to move between overall settings and individual settings for composite variables such as Gain, High and Low Pass filters and Alarm Boundaries.

Alternatively the operator can switch back to the operating screen once the **menu** item has been highlighted by pressing **menu**. The variable will now be displayed on the operating screen. At this point it can be adjusted using the cursors.

2.4   Setting the Operating Language

The instrument can be set to operate in a range of languages. Available languages are English, French, German, Spanish and Portuguese. Use the cursor up button to move through the available languages. When the required language has been selected press **exec** to activate the selection. This instantly updates the menu in the chosen language.

2.5   Setting the Time and Date

Setting the time and date will enable all stored traces and settings to have accurate date and time information stored with them.

To set the time:

– Press **menu** to enter the menu screen.

– Using cursors move to the third menu column.

– Move to the **TIME** item.

– Press **OK** to highlight the menu item.

– Use cursors, left/right to select the time component to change.

– Use cursors, up/down to set the time.

– Once this has been completed press **menu** to return to the operating screen.

To set the date:

– Press **menu** to enter the menu screen.

– Using cursors move to the third menu column.

– Move to the **DATE** item.

– Press **OK** to highlight the menu item.

– Use cursors, left/right to select the Day, Month or year that requires changing.

– Use cursors, up/down to change the item.

– Press **OK** to update the **DATE** item.

2.6   Switching the Backlight On and Off

For operation in low light environments the instrument has an inbuilt LED backlight.

A short press on the **on/off** button will switch the backlight on.

Operating the unit with the backlight switched on will increase the battery power consumption.

In conditions of high ambient lighting it may not be evident if the backlight is on or not. For this reason a candle icon is provided in the lower right hand area of the operating screen when the backlight is active.

☞ **Note:**

When the unit is switched on, the backlight will be set to the state that it was in when the unit was switched off.

2.7   Setting the Display Contrast level

the instrument has a variable display contrast setting to allow the user to set the contrast to the optimum for the ambient lighting and temperature. Range is from 1 to 32.

Step to **CONTRAST** in the third column. To change the setting use the cursor buttons.

A further feature is the **SCREEN MODE** menu item, which allows the user to invert the screen to white display on a black background or select VGA output mode (please see Accessories for required adapter).

☞ **Note**

Changes in temperature may cause a change in the characteristics of the LCD display. In this case the contrast control should be used to compensate for this effect.

If an operator has problems viewing the menu screen then the unit should be switched off. When switching back on again the operator should press **F4** to automatically set to a contrast value of 4, or **F6** to set to a contrast setting of 28. This should be pressed when the splash screen is displaying.

2.8   Trace Enhance

When the **TRACE ENHANCE** feature has been selected to **On**, the on screen signal is thickened to aid viewing.

2.9   Setting the Automatic Power Down function

The instrument is provided with a selectable power down function. This switches off the unit after a predetermined period of inactivity. Settings are **Off**, **5**, **10**, **15** or **20** minutes. This function will preserve battery life in situations when the equipment is not in constant use. To vary this move to the **P/DOWN** menu item.

☞ **Note**

When the unit closes down due to the Automatic Power Down function all settings will be preserved and will be restored when the unit is switched back on. However, the mode that the unit starts back up in will depend on the probe leads connected.

2.10   Graticules – Spot Mode

A suitable graticule for the inspection can be selected from a choice of four different types. This applies to spot mode only. If Timebase mode is chosen then an automatic graticule (AUTO) is displayed that resizes relative to the sweep setting.

NONE – A clear graticule with cross-hairs for identifying the origin:
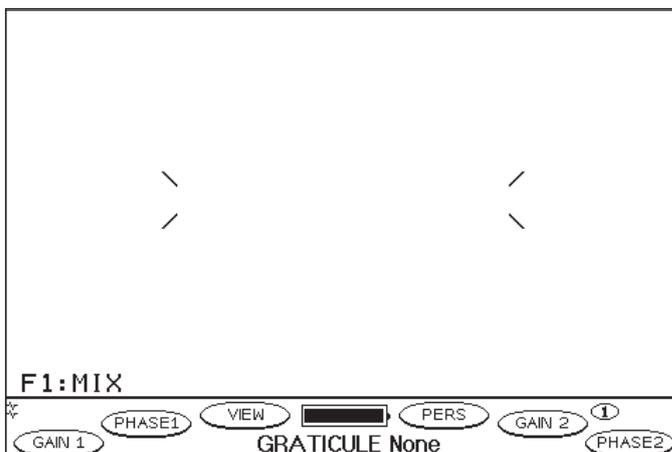
GRID 1 – A square graticule with X and Y positions marked at 20%:
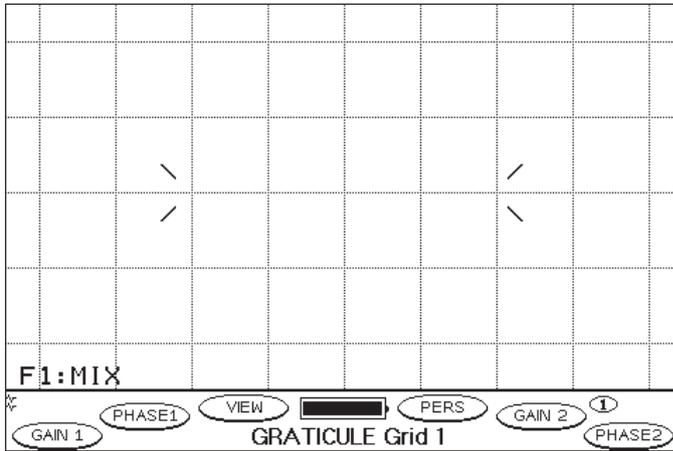
GRID 2 – A square graticule with X and Y positions marked at 10%:
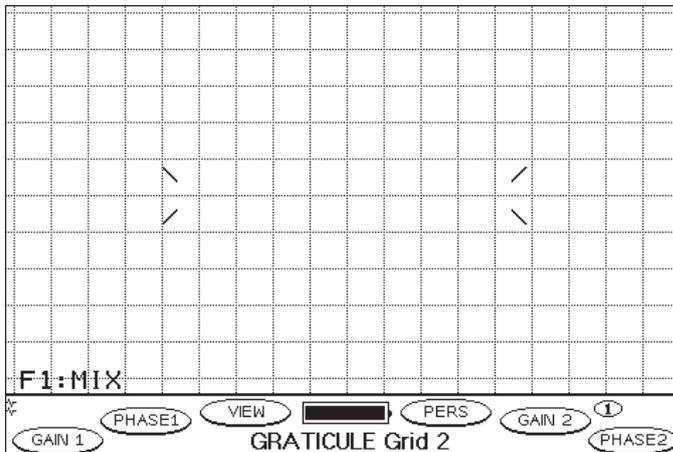
POLAR – a circular style graticule:
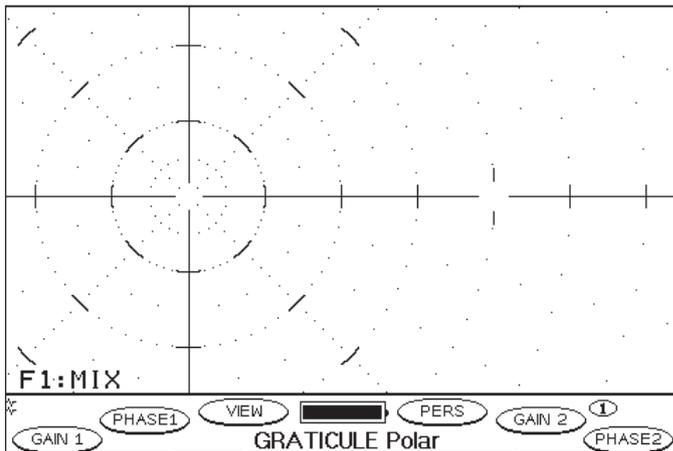
2.11 Selecting Graticule Type

Select the **GRATICULE** menu field. Use the cursors to step through the options. Press **OK** to select the required option.

2.12 Selecting Key Click

Audio feedback from the unit can be selected so that even when operating the unit in heavy gloves an operator will be able to determine whether a key press has been successful.

Set to **KEY CLICK** to either **ON** or **OFF**.

2.13 Defining User Programmable Softkeys

Each of the six softkeys on the front panel of the instrument can be allocated to any setting as required by the operator.

Press **menu** to enter the **menu** screen. Use the cursor buttons to step to the required menu item. When it is highlighted press the **OK** button to highlight the item value and then hold the required function key.

After 2 seconds the menu field is allocated to the on-screen softkey location.

☞ Note

The item value must be selected using the **OK** button in order to be programmed to a softkey.

Press **menu** to return to the operating screen.

Pressing a softkey will bring up the associated item value for adjustment by the cursor buttons.

To clear a softkey press **menu** to enter the menu screen and hold the softkey for two seconds whilst on the **menu** screen, when a menu item is NOT selected.

To use the second set of programmable soft keys (the Utility Set) press **F1** when on the **menu** screen in order to page between the two softkey sets.

2.14   Using Pre-Programmed Softkeys

For three frequently used operations, Spot position, Box Gate Alarm, and Sector Alarm there is easy access to these settings via the pre-programmed softkeys.

There is also a Utility set of softkeys which displays frequently used softkeys.

①	Utility Set 1 This can be programmed by the user. As a default these settings are GAIN, PHASE 1, FREQ 1, H/LP 1 (high Pass and Low Pass Filters), TrcRec (Trace Recorder) and DISPL (Display type).
②	Utility Set 2 Can be programmed by the user as a second set by pressing F1 when in the menu mode. As a default these settings are FREQ1, PROBE (probe type e.g. absolute, bridge etc.) SAVE (for Saving settings) and RECALL (for recalling settings).
▣	Box Alarm ACTIVE, ACTION, SHAPE, STRETCH, TB (Top and Bottom), LR (Left and Right).
▽	Sector Alarm ACTIVE, ACTION, SHAPE, STRETCH, SE (Start and End), IO (Inner and Outer).
⊕	XY Position PERS (persistence), SWEEP, GRAT (graticule), DISPL (Display Type) and SPOT (Spot XY position).

To cycle through the above softkey sets repeatedly press **OK** whilst on the operating screen. An icon on the right hand side of the display indicates which softkey mode the instrument is in.

☞ **Note:**

These settings apply to Normal Single mode only, they are different for Normal Dual Mode, Rotary and Conductivity modes.

Another press on **OK** will revert to user programmed softkeys and the icon will disappear. A long press on **OK** at any time will revert to the first set of user programmed keys.

2.15 Keyboard Lock

To prevent accidental key presses changing the settings, the keyboard can be locked. This prevents the operation of all menu keys.

Balance, **clear** and **freeze** will continue to remain active when the keyboard is locked.

The keyboard lock is invoked by a long press on **freeze**.

A key icon appears on the display to indicate that the keyboard lock is active.

The keyboard lock is removed by a long press on **freeze**.

2.16 Understanding the Different Modes

The instrument is a multi-capability unit that effectively contains four separate instrument modes. In the menu screen the operator can switch the mode by selecting **MODE** and changing to the required mode using the cursors.

The modes will also automatically change when either a rotary or conductivity probe is attached using an autodetection function.

The unit defaults to the last mode it was used in, unless a rotary or conductivity probe is attached to the unit. The user can put the instrument into any mode required by stepping to the **MODE** item in the **PROBE** section of the menu. Select which mode is required with the **OK** and cursor buttons, and press exec to switch modes. Pressing **OK** will escape from the selection process.

2.17 Normal Single Mode (all instruments)

Normal Single mode is effectively the general purpose mode, and covers a wide variety of applications, from sub-surface corrosion inspection (generally using low frequencies) to surface crack detection and inspection of thin-section items (generally using higher frequencies), with a wide variety of probes such as Absolute, Bridge, Weld Inspection, Spot Face, Reflection etc. More details can be found in Chapter 3.

2.18   Conductivity and Coating Thickness Mode (all instruments)

The Conductivity mode is used for the conductivity measurement of non-ferrous metals. This measurement can be very useful for detecting heat damage or other material change. Measurement of conductivity is used for the accurate calculation of effective depth of penetration. In addition there is a graph indicating the thickness of non-conductive layers on the top of metal surfaces. This can be used for paint thickness and insulation evaluations etc. This functionality is outlined in Chapter 4.

2.19   Rotary Mode (only Phasec 2s and Phasec 2d)

The Rotary mode is the mode in which the unit supports rotary probe drive units, primarily used for the inspection of holes in structures, such as fastener or lightening holes. The unit is capable of powering rotary probes from the unit, and can support scanner speeds of up to 3000 RPM. This functionality is outlined in Chapter 5.

2.20   Normal Dual Mode(only Phasec 2d)

The Normal Dual mode is the mode in which the unit is able to drive a single probe at two separate frequencies, or drive a single probe in two modes (e.g. absolute and differential simultaneously). This functionality is described in Chapter 6.

Operation in Normal Single Mode **3**

👉 **Note**

For the following instructions it is assumed that the operator is familiar with the method of changing variables described in 2.3 - Changing Settings using Menus and Cursors.

3.1   Connecting a Probe

A very wide range of eddy current probes may be used with the instrument. They may be connected directly by an appropriate cable or via adapters in the case of probes made for other instruments. The primary probe connector on the instrument is the 12 way Lemo connector on the right hand side of the front panel.

For existing absolute probe cables terminated in a BNC cable a Lemo 12 way to BNC adapter is available (PRN 40A002). For other probes, please see Chapter 10, Accessories.

3.2   Selecting Probe Type

Probe type will depend on the inspection, taking into consideration the flaws that are being inspected for. Flaw geometry, as well as material type and depth of penetration required will determine what kind of probe is required. Once this probe has been selected the instrument can be set to match the connected probe type.

It is important to understand that probes are configured as a choice of EACH of the following elements:

❚ Absolute or Differential

❚ Bridge or Reflection

❚ Shielded or Unshielded

With some eddy current instruments the probe must be hardwired into the configuration required. However the instrument can drive probes in a variety of ways. For this reason it is often possible to use a differential probe as an absolute probe.

This flexibility allows for different configurations with a single probe, however care must be taken to ensure that the effects of each configuration are understood by the operator.

Probe type can be set to Locator, Absolute, Bridge or Reflection.

Locator mode is a dedicated mode that is designed to match the impedance of all absolute Locator probes at 100 Ohms.

The Absolute mode is for Absolute probes with an impedance of 50 Ohms.

For Absolute or Differential probes intended for bridge operation the setting should be Bridge.

For driver/pick-up probes the Reflection setting probe should be used.

3.3   Frequency

The instrument has a wide range of selectable frequencies between 10 Hz to 10 MHz. Select **FREQUENCY** from the menu. The frequencies available are in the following ranges

❚ Between 10 Hz and 99.5 Hz in 0.5 Hz steps

❚ Between 100 Hz and 995 Hz in 5 Hz steps

❚ Between 1 kHz and 9.95 kHz in 50 Hz steps

❚ Between 10 kHz and 99.5 kHz in 500 Hz steps

❚ Between 100 kHz and 995 kHz in 5 kHz steps

❚ Between 1 MHz and 10 MHz in 50 kHz steps

Correct frequency selection is critical for a good inspection and is dependent on the flaw type, the probe used and the depth of penetration required.

To rapidly step through the frequency ranges the left and right cursors can be used, by stepping to the end of the frequency and repeating the key press, the frequency will step in orders of magnitude.

Many probes are supplied with a fixed frequency stated as their operating frequency. However it is possible to carry out an effective inspection using a different frequency to the stated nominal. As a rule of thumb the probes can be used up to three times higher or lower than its "center" frequency. However this should be validated by the use of test blocks to ensure the effectiveness of the probe.

3.4   Selecting a Balance Load - Absolute and Locator Probes

The instrument has a series of internal balance loads to balance Absolute and Locator probes. Attach a suitable probe and go to the operating screen.

Press and hold **exec** for approximately 2 seconds, until the auto load detect process starts.

The instrument will select a suitable load in order to balance the absolute probe. If the operator wishes to override the selection then this can be performed by going to the Load item on the menu screen.

3.5   Balancing the Probe - All Probe Types

The probe should be placed on a known good section of material and balance pressed. If the probe cannot be balanced the message **BALANCE FAILED** will be displayed. A failed balance may be for a variety of reasons:

❚ Incorrect probe selection (see 3.2)

❚ Incorrect frequency selection (see 3.3)

❚ Input Amplifier saturated, i.e. Input Gain too high (see 3.7)

❚ Incorrect Load selection for absolute probe (see 3.4)

❚ Probe worn or damaged, or lead damaged (check equipment)

3.6   Automatic Lift-Off Compensation

An automatic facility is provided to rotate the lift-off signal so that it moves from the balance point horizontally to the left of the screen (for most applications this is the accepted position).

To perform this procedure place the probe on known good metal of the type to be inspected.

Press and hold **balance** for 2 seconds.

The unit will balance. When the unit displays **LIFT PROBE** the probe should be re-moved from the surface of the metal. The unit will automatically rotate the phase of the lift-off signal so it is set to the 9 o'clock position.

If the **LIFT PROBE** message shows for more that 2 seconds after you have lifted the probe then automatic lift-off compensation has failed. If this occurs, please see reasons for balance failure in section 3.5. Also, the gain may need to be increased so that the lift-off signal is greater then one half screen height.

3.7   GAIN XY

The instrument has both composite and independent X and Y gain that are controlled from the **GAIN XY** menu item. This allows fine setting of the impedance plane display. The unit allows simultaneous increase or decrease of the gain setting by using the **GAIN XY** function and pressing left/right cursors for 10 dB adjustment and up/down for 1 dB adjustment. Pressing the **exec** button steps from composite setting to setting just the X value. A subsequent press selects the Y value and another press on **exec** returns it to composite setting.

This independent gain allows extremely fine attenuation of the signals properties to give the best separation of lift-off signal from the flaw signal.

3.8   Manual Phase Adjustment

Select **PHASE** from the menu. Highlight the **PHASE** setting using **OK**, and select the required digit using the left/right cursors, and increase or decrease using up/down cur-sors.

This feature allows rotation of the signal so that flaw indications can be presented in the clearest possible fashion, and is useful for ensuring that non flaw signals do not trigger alarms.

Convention is that the lift-off signal (i.e. the signal that displays when the probe is lifted off the surface of the material) is set in the "9 o'clock" position.

Phase is adjustable from 0 to 359.9 degrees in steps of 0.1, 1, 10 or 100 degrees as re-quired.

3.9   Overview of Filters

Filters are used to reduce or eliminate unwanted signals. High pass filters reduce low frequency components of signals and Low pass filters reduce high frequency components. The frequency of the two sets of filters should not be set so that there is no gap between them or the inspection bandwidth will be reduced to zero (i.e. no signal).

The gap between the filters can be set as a band pass filter. The instrument allows the user to relocate this band in the frequency cutoff spectrum by employing the Band Lock setting feature (see 3.13).

3.10   High Pass Filters

The High Pass filter reduces low frequency components such as product vibration, geometry and temperature drift changes. If the probe does not traverse a crack quickly the unit may treat it as a slowly varying signal and the indication will be reduced.

A typical application for the high pass filter would be to remove low speed rotation signals from a rotating probe system. The frequency of the noise from these sources is lower than the wanted defect signal.

High pass filters can be used effectively during hand scanning where there are slowly changing effects but care should be exercised to move the probe at a constant speed. Settings greater than 10 Hz may be unsuitable for hand scanning. For tests with a rotating component higher settings may be appropriate.

Select **HP/LP** from the Menu.

Use **exec** to select just the High Pass filter setting.

Use cursors to change the value.

The DC setting indicates that no low frequency signals are being filtered.

Standard High Pass filter settings available are (in Hz):

▌ DC

▌ Ultra filters 0.01 Hz to 0.5 Hz steps (6 steps)

▌ 1 Hz to 9.95 Hz in 0.05 Hz steps (180 steps)

▌ 10 to 99.5 Hz in 0.5 Hz steps (180 steps)

▌ 100 to 995 Hz in 5 Hz steps (180 steps)

▌ 1 kHz to 1.2 kHz in 50 Hz steps (4 steps, Normal Mode)

▌ 1 kHz to 1.95 kHz in 50 Hz steps (20 steps, Rotary Mode)

Ultra filters are special low frequency filters that are controlled by the lift-off signal to give improved signal display.

☞ **Note:**

HP settings can not be moved higher than the currently set LP setting. If it does not appear possible to select some of these settings, check that the LP filter is set to higher than the desired HP filter setting.

3.11   Ultra Filters

The Ultra filter is a special form of the High Pass filter. ULTRA is a filter setting that removes the effect of very long timebase signals, and will reduce or remove the effect of long term drift of the balance point. This has a range of timebases that it averages over so that different scanning speeds etc. can be compensated.

However, it has been designed so that rapid and/or large movements of the spot from the balance point will not be compensated. This stops the spot from rebalancing to the centre when the probe has been taken off the surface of the metal, for example. Ultra filters are indicated by a **U** prefix before the value.

3.12   Low Pass Filters

The Low Pass filter reduces and eliminates rapid signal changes such as electrical noise. If a discontinuity or flaw is traversed quickly with a probe, a low pass filter unit will treat it as a rapidly changing signal and the indication will be reduced. The filter setting is sometimes a compromise between acceptable noise and ability to respond to fast flaw signals.

Select **LOPASS** from the Menu.

Use the cursor pad to change the value.

▮ 3 to 9.95 Hz in 0.05 Hz steps (140 steps)

▮ 10 to 99.5 Hz in 0.5 Hz steps (180 steps)

▮ 100 to 995 Hz in 5 Hz steps (180 steps)

▮ 1 kHz to 1.5 kHz in 50 Hz steps (11 steps, Normal Mode)

▮ 1 kHz to 2.0 kHz in 50 Hz steps (21 steps, Rotary Mode)

3.13   Filter Indication Bar

The user can use the Filter Indication bar on the Operating screen to clearly see how the High Pass and Low Pass filters are interacting in order to provide a band pass.

This facility can alert the operator to the fact that filters may have been set in too restrictive a way. This can help troubleshoot situations where the operator is not seeing signals that might be expected.

The figure indicates filter settings that will allow all signals through, indicated by the continuous solid bar and filter settings that restrict a lot of signals getting through.

Filter Bar – Wide
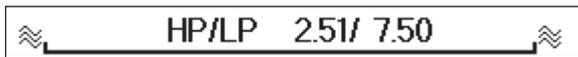
Filter Bar – Narrow
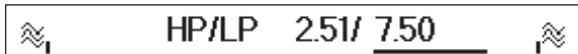
3.14   Filter Setting

Variations in test frequency will result in the operator wanting to move the high and low pass filter settings simultaneously. This can be achieved through the use of the Filter 1 setting. This item has two possible settings, **BP RATIO** and **BP LOCK**. This filter function is most useful for rotary inspections where variations in RPM will require changes to both high and low pass filters.

BP LOCK – This maintains the gap between hi and low pass filters as a fixed amount. For example if the low pass is set at 700 Hz and Hi Pass at 400 Hz then incrementing either will always result in a 300 Hz band being maintained between the two. This setting should be used if a specific Band is required for an inspection, irrespective of rotary probe RPM.

RATIO – This maintains a band between Hi Pass and Low Pass filters that is proportional to the original setting position, so as the operator reduces either the Hi or Low Pass setting, the Band Pass will reduce, likewise as the Hi or Low Pass are increased so the size of the band will increase. This mode gives the most consistent filter performance when Rotary probe RPM is varied, as the higher the RPM, the wider a band pass filter needs to be in order to display the same signal characteristics as at lower RPM speeds. The ratio setting removes the need for the operator to manipulate both hi and low pass filters when changing speed.

☞ **Note**

This setting only applies when both HP and LP filter settings have been highlighted for simultaneous update from the **HP/LP** menu item. Use **exec** to select this.

3.15   PROBE

This function allows the selection of the probe configuration. See 3.2 for a full explanation.

3.16   PROBE ID

This allows the user to manually select a rotary probe drive supplied from manufacturers other than GE Inspection Technologies, and will only work when in Rotary mode. Probe drives currently supported are Rohmann and Zetec. See 5.5 for full details.

3.17   LOAD

This allows the manual selection of Load for balancing absolute probe operation. A long press on the **exec** will automatically select the most appropriate balance load. The following table gives approximate inductances for a range of probes.

Load	Description	Example Product Reference Numbers
8.2 µH	Locator 2 MHz probes, Defectometer probes with adapter 29A010	122P1A, 352P1A, 106P4, 206P4, 304P24
22 µH	Broad band and some Phasec probes	130P2, 5P21
47 µH	Locator 500 kHz probes	121P1A, 351P1A, 105P4
82 µH	Broad Band and some Phasec probes	5P22, 5P262, 130P3
120 µH	Locator 200 kHz probes, probes for ED520 and compatibles	120P1A, 350P1A, 104P4, 204P4, 308P24

3.18   INPUT GAIN

The sensitivity of the probe can be increased by switching the **INPUT GAIN** from Low (+0 dB) to High (+14 dB). This increases the signal level input from the probe, but for some probe types and materials this may cause problems with balancing (see 3.5). Changing this will affect the overall system gain level (shown by **GAIN XY**).

☞ **Note**

If the instrument repeatedly fails to balance set Input Gain to Low.

3.19   Probe Drive

The level at which the probe is driven can also be varied by using the **DRIVE dB** menu item. This can be set to −8 db, 0 dB and +8 dB. This has significant advantages for fine control of the signal to noise level attainable, but may cause problems in certain setups with saturation. If the unit fails to balance this level should be reduced as a check.

3.20   RECALL function

– To recall a trace move to **RECALL** menu field, press **OK** and select **TRACE**.

– Press **exec** to enter the Recall screen (see Fig. 3.3).

– To move to the location use **DN/F6** to move down and **UP/F5** to move up.

– To leave the dialogue without recalling press **exec**.

– To clear the location without leaving the dialogue press **DEL/F2**.

– To recall the trace press **RECALL/F1**. To exit, press **exec**.

– To recall a **SETUP** repeat the steps above but ensure **RECALL** is set to **SETUP**.

– To clear the reference trace from the screen press and hold **clear**.

☞ Note

When a trace is recalled, the graticule that was used when the trace was stored will be recalled and displayed for as long as the reference trace is displayed. A flashing icon is used to indicate to the user that other selected graticules cannot be selected whilst this is the case.

RECALL menu

```
┌─────────────────────────────────────────────────────────┐
│                                                           │
│                                                           │
│  ┌──┬───────┬───────────────────────────┬──────────┬───────┐ │
│  │Nº│M:Type │Name                       │Date      │Time   │ │
│  │01│N:Full │SCRATCH 2MHZ 106P4         │──────────│─────  │ │
│  │02│N:Full │WELD SCAN                  │──────────│─────  │ │
│  │03│N:Full │700P16A  5KHZ 3 LAYER CRF  │──────────│─────  │ │
│  │04│N:Full │700P16A COR PITS 2 LAYER   │──────────│─────  │ │
│  │05│R:Full │7-32 HOLE                  │──────────│─────  │ │
│  │06│R:Full │1-2  HOLE                  │──────────│─────  │ │
│  │07│?:Empty│                           │          │       │ │
│  │08│?:Empty│                           │          │       │ │
│  │09│?:Empty│                           │          │       │ │
│  │10│?:Empty│                           │          │       │ │
│  └──┴───────┴───────────────────────────┴──────────┴───────┘ │
│                                                           │
│  ─────────────────────────────────────────────────────── │
│         ( DEL )   (        ) ▇▇▇▇▇ (        ) ( Up )       │
│  (RECALL)   ≈     RECALL Setup        ≈      ( Dn )        │
└─────────────────────────────────────────────────────────┘
```

Recalled Trace with flashing reference trace icon indicated

3.21   SAVE function

– To save a trace first create the trace on screen.

– Press **freeze** to freeze the display.

– Go to **SAVE** and select **TRACE**. Press **exec** to enter the Save screen.

The instrument will move to the next empty storage space.

☞ **Note**

If a trace or setting has been saved then the instrument will automatically duplicate the previous saved item and add an incremental character to help the operator name subsequent traces rapidly. If the automatic name is not required it can be immediately cleared with a single press of the **F2/Clear** softkey.

– To move to a new storage space press **UP/F5** and **DN/F6** to move up and down the list. The operator can name the file using the alphanumeric box.

– Use the cursors to navigate to the correct letter and press **OK** to accept each letter.

– Any mistakes in the file name can be corrected by moving the cursor to the correct point by using **</F3** and **>/F4**. Once the file has been named press **SAVE/F1** to exit the field. To leave the menu without saving back changes, simply press **exec**.

– To save setups repeat the steps above but ensure **SAVE** is set to **SETUP**.
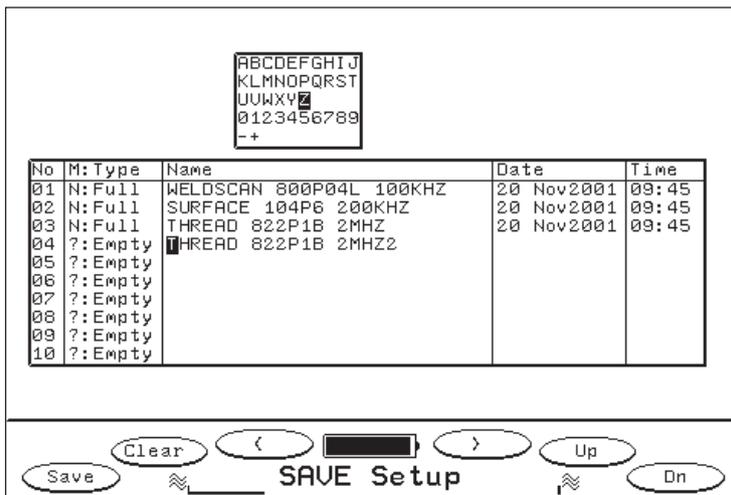
3.22   Saving and Recalling in Different Modes

Traces and setups can be stored in either Normal Single, Normal Dual or Rotary mode but cannot be recalled in a mode that they were not created in. The Save and Recall dialogs indicate this by the letters under the column MT. If the Trace or Setting has NS: before it then it was created in the Normal Single mode, ND: indicates Normal Dual mode and RS: indicates Rotary Single mode.

Attempting to recall a trace or setting not created in the specific mode will result in the error message MODE INCOMPATIBLE : CANNOT RECALL being displayed.

3.23   Allocating Trace and Setup Permissions

The Trace and Setup Files have four different Type statuses; Empty, Full, Lock and User. To access these settings, select **RECALL**, **Setup/Trace** and press **exec**.

The status can be read from the Type column on the Recall screen (the second column).

'Empty' indicates that no data has been stored in the location.

'Full' indicates that data has been stored in the location. This is the default data Type.

'Lock' prevents the user from accidentally deleting the file when recalling the data.

'User' enables an operator to recall the Trace or Setup when in User mode (See 7.12). When the instrument is in User mode no other Traces or Setups can be recalled.

– To change the data type go to the required data location via the recall screen (see 3.16). Press the **OK** button. The data type will change to **User**. A further press will change to **Lock**.

– To return the Type to **Full**, go to the setting on the **RECALL** menu, and make sure the data is showing **LOCK**. Press the **FREEZE** button and it will return to **FULL**.

– Press **menu** to return to the menu.

☞ **Note**

When saving large traces the unit may automatically allocate a subsequent Save slot to cope with all the data. In this case the user will see that the type is indicated as **Extra**. This can only be cleared by deleting the saved trace above.

3.24   Trace Recorder

The instrument has the facility to record up to 65 seconds of trace and to play it back when in Normal Single mode, allowing the optimal set-up of gain levels and alarm gates, among other items. In Rotary Single and Normal Dual mode up to 32 seconds of events can be recorded.

This feature allows the operator to concentrate on good scanning of the test piece in the first instance, and then to focus fully on the instrument in order to optimise settings.

– To operate the trace recorder mode move to the **TRACE RECORD** item in the menu and select **On**.

– Press **exec** to activate the recorder. A new set of function keys will appear.
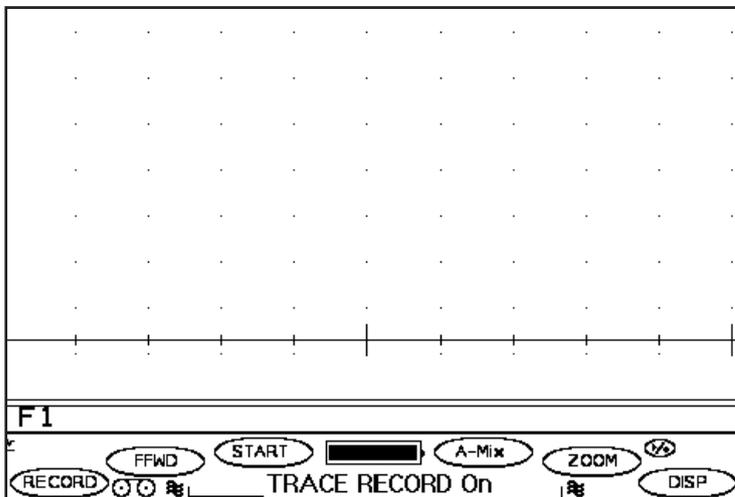
– Pressing **OK** the operator can move through the Softkeys as before.

The operator must ensure that the correct **FREQUENCY**, **PROBE TYPE**, **LOAD** (if applicable) and **INPUT GAIN** are selected before starting the recording. These items cannot be changed when playing back as they are fundamental to the data captured. The system indicates that these are locked (i.e. they cannot be changed) by displaying a key item alongside them in the menu.

When the operator is ready to scan then the **RECORD** Softkey can be pressed, and the trace recorder will start. The operator can choose to record for the maximum amount of time or can simply press the **PLAY/F1** Softkey to start replaying the recorded signal.

During recording, the bar is displayed at the bottom of the screen and the solid area indicates how much of the available storage area has been used. A flashing bar indicates that the storage area is full and only the last 32 seconds (in Normal mode) of data is stored.

When the signal is replayed a bar at the bottom will be displayed, the black area indicating which element of the recorded trace is being displayed.

The operator can focus on a specific area of the replayed trace by pressing **START/F3** and moving the point using the cursors to locate the start point for the clip, pressing **END/F3** and moving the point using the cursors to locate the end point for the clip, and then pressing **ZOOM/F5** to move in. Excessive zoom can be corrected by re-pressing **ZOOM/F5** to step back through previous zoom levels. **DISP/F6** allows the user to toggle between XY display and YT mode.

In Normal Single mode **FFWD/F2** allows the user to play the clip at four times normal speed, pressing **F2** again returns the replay speed to normal. In Rotary Single and Normal Dual modes the data will fast forward at two times normal speed.

Whilst in the trace recorder mode, the operator can press **OK** as normal to scroll through the programmable key sets, and can use **menu** to access the menu as usual.

To end a trace recorder session, press **clear** at any stage.

☞ **Note:**

The **AUTOMIX** function on key **A-Mix/F4** can only be operated in Dual mode.

3.25   An Overview of Alarms

To switch on the alarm functions **ACTIVE** has to be set to a valid setting (**F1** for Normal Single and RotarySingle, and **F1**, **F2** or **MIX** for Normal Dual). The **Alarm** menu field shows the settings of alarms shapes that are currently selected in the **SHAPE** dialog.

Alarm Menu showing different Alarm types

─────(ALARM)─────	─────(ALARM)─────	─────(ALARM)─────
ACTIVE None	ACTIVE F1	ACTIVE F1
ACTION Off	ACTION Tone&Frze	ACTION Tone&Frze
STRETCH 50 ms	STRETCH 50 ms	STRETCH 50 ms
SHAPE Box	SHAPE Box	SHAPE Sector
TOP/BTM Off/Off	TOP/BTM 19/-19	TOP/BTM Off/Off
LFT/RGHT Off/Off	LFT/RGHT -30/-4	LFT/RGHT Off/Off
START/END Off/Off	START/END Off/Off	START/END 0/60
IN/OUTER Off/Off	IN/OUTER Off/Off	IN/OUTER 7/20
Off	Box	Sector

There are two types of alarm: **BOX** and **SECTOR**. An alarm condition can be indicated through the LED and Sounder and also by freezing the display. To select which action is required it can be selected from **ACTION** as **None**, **Tone**, **Freeze** or **Tone&Frze**. To improve audibility, the Alarm may be stretched to lengthen the audible alert. An alarm can be switched off by setting **ACTIVE** to **None**.

☞ Notes:

Only one type of alarm can be active at a time, and if **ACTIVE** is set to **None** no alarms will appear, even if settings appear on the menu screen.

If **ACTIVE** is set to **None** it will not be possible to access the **ACTION** menu item, or **TOP/BTM**, **LFT/RGHT**, **START/END**, **IN/OUTER**.

In Normal Dual mode the alarm will not be displayed if the display channel that it is active on (**F1**, **F2** or **Mix**) is not selected for display from the **VIEW** menu item.

3.26   Box Gate Alarms

To set a box go to **SHAPE** and select **Box**.

– Press menu to return to the operating screen.

– Press **OK** until the BOX Pre-Programmed Softkeys appear (see 2.12).

– Press **TB1** to call up the **TOP/BTM** dialogue.

– Repeat for **LR1** and **LFT/RGHT**.

If the balance point is inside the box then an alarm condition will be created when the working point goes outside the BOX. If the balance point is outside of the BOX alarm then the alarm will indicate when the working point goes inside the BOX.
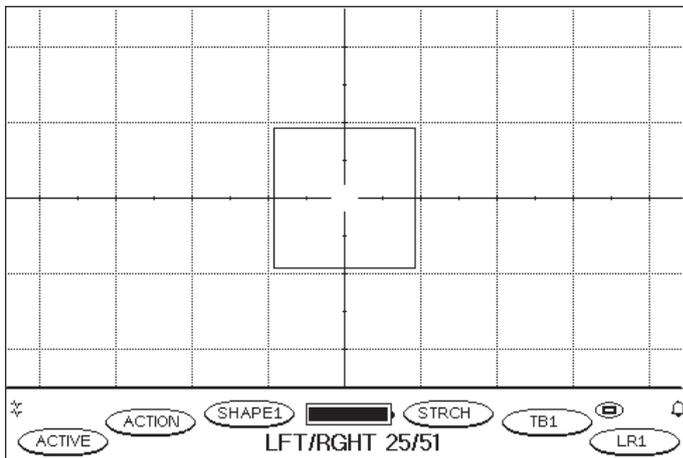
3.27   Sector Alarms

The sector alarm has the same versatility as the box alarm, and works on a similar principle.

–   To set a Sector Alarm go to **Alarm Shape** on the Menu and select **Sector**.

–   Press **menu** to return to the operating screen.

–   Press **OK** until the Sector Pre-Programmed Softkeys appear (see 2.12).

–   Select **IO** for Inner/Outer values and **SE** for Left/Right values.
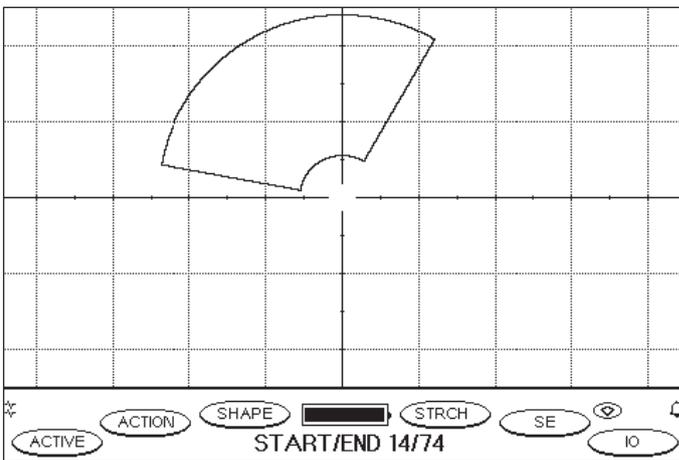
3.28   STRETCH

This setting allows the alarm to be stretched for 50 msecs, 100 msecs, 500 msecs, 1 second, 5 seconds and 10 seconds. This function is relevant where a short alarm might be missed but it is important to note that several flaws close together will not be resolved if the alarm stretch is too long.

3.29   ALARM ACTION

This setting controls action of the unit upon detecting an alarm condition. The permissible selections are **None**, **Tone**, **Freeze**, and **Tone&Frze**.

Tone emits a beep when the gate is triggered, and **Freeze** stops the trace at that point.

Tone&Frze allows **Tone** and **Freeze** to be used at the same time.

3.30   DISPLAY

Display type can be selected between **SPOT**, **TIMEBASE**, **WATERFALL**, **BAR XY** and **BAR**.

SPOT mode (or XY display) is the display mode used for the majority of non-rotary applications. This displays both the X and Y components of the impedance plane.

TIMEBASE mode (or YT display) is the mode in which the Y component is represented against time. In this mode some of the menu items are not valid, such as X:Y ratio, Graticule, and Sector Alarm. However these items are still displayed and can be modified. The T component (time) can be changed by changing the **SWEEP** variable below.

WATERFALL mode can be used in either non or rotary mode. In non-rotary application it can be used as extended Timebase. In rotary mode the Waterfall is synchronised to the rotation of the drive.

BAR XY mode is used for non-rotary applications. In this mode there is a split screen display; one display has a vertical Bar which, shows the Y amplitude of the signal and the other display is **SPOT** (see above)

BAR mode is used for non-rotary applications. Its display has a vertical Bar which, shows the Y amplitude of the signal.

3.31   GRATICULE

Depending on how the display mode (above) is set. This gives a choice of **Grid 1**, **Grid 2**, **Polar** or **none** in **Spot display mode**, it is fixed when in timebase mode, and fixed when in Waterfall display mode.

3.32   SPOT X/Y

The position of the spot can be adjusted to define the origin. This only applies when **DISPLAY** is set to **SPOT**. When the spot position is altered the graticules move automatically to indicate the origin point on screen. If the graticule is set to **NONE** there are cross hairs to indicate the origin.

The cross-hairs allow the operator to observe if the balance point has drifted or moved due to an artefact or material condition.

The spot positions are indicated in terms of percentage position, relative to X and Y axes.

Zero X and Zero Y are indicated as the middle of the left hand side of the screen. This allows the user to easily set up the unit in terms of percentage screen deflection relative to the display.

To move spot position whilst on the operating screen use the Spot Position Pre-Programmed Softkeys (see 2.12).

3.33   SPOT INFO

The location of the working spot on screen can be displayed by switching the **SPOT INFO** item to on by selecting it as **CH1**. This will then display a dialog box on screen that gives a numerical representation of the spot position. This can be useful for metal sorting applications and similar. When the freeze button is hit, the values in the box will also be frozen.

3.34   PERSIST

This function sets the time for which data is retained on the display before it is refreshed. When set to permanent the data on the screen remains until the **Clear** button is pressed. The persistence values are set to match the Sweep values above so that the trace can persist for one full traverse of the screen.

Settings available are (in seconds): 0.1, 0.2, 0.5, 1.0, 1.5, 2.0, 5.0, 10.0, 15.0, 20.0, Permanent.

3.35   SWEEP

Sweep applies only when **TIMEBASE** has been selected. This varies the time that it takes the spot to move across the major division on screen.

Settings available are (in seconds):
0.1, 0.2, 0.5, 1.0, 1.5, 2.0, 5.0, 10.0, 15.0, 20.0, 50.0.

3.36   Output Functions

The instrument has a provision for outputting Analogue X and Y signals, which could be used on an external plotter or data logger. To enable this function the unit should be connected to the external device using the 7 way lemo connector.

The X and Y outputs are always available, so there is no need to configure the device to output them (see chapter 10 for details of pin outs).

Operation in Conductivity Mode **4**

4.1   Basics of Conductivity

Conductivity of metals is commonly measured in two sets of units. In the SI system the unit of conductivity is MS/m (reciprocal ohm-meter). Conductivities of metals at ambient temperature are typically in the range of 1 to 60 MS/m.

For convenience metal conductivities are often expressed as a percentage of the conductivity of a standard sample of copper – the International Annealed Copper Standard (IACS). 100% IACS corresponds to 58 MS/m. Note that since this 'pure' copper standard was established in 1913 pure copper now often has a conductivity greater than 100% IACS.

The instrument measures the conductivity of non-magnetic metals and alloys in the range 0.8 to 110.0 % IACS. It uses the Eddy Current technique for measuring the conductivity of materials in % IACS, or MS/m, (set this in **CONDUCTIVITY** on the menu).

It is important to understand that eddy current measurement is essentially a 'skin' effect. The eddy current field intensity is greatest at the surface and decreases exponentially with depth. The depth at which the field strength reduces to 1/e (37 %) of its surface value is referred to as the 'standard depth of penetration'. This depends primarily on the operating frequency and the conductivity of the metal.

It is generally considered that materials of thickness greater than 3 standard depths of penetration can be measured without any correction factors being required.

For example at 60 kHz this figure (the "effective depth of penetration") is around 0.05" (1.25 mm) in Aluminium Alloys (conductivity approximately 35% IACS) and 0.32" (8 mm) in Titanium alloy, (conductivity approximately 1% IACS). At 500 kHz the corresponding values are 0.02" (0.5 mm) and 0.11" (2.8 mm).

Care must also be taken when measuring non-homogeneous materials, for example materials which have been surface heat-treated, clad or plated, or where the surface is rough or corroded. Measurements at different frequencies will give different results due to the different distribution of energy within layers of different conductivity. Care must be taken to always measure such materials at the same frequency (usually 60 kHz).

4.2   The Effect of Temperature on Conductivity

The conductivity of a material can change with temperature, but is normally specified at 20 degrees Celsius. For the best accuracy, the instrument, material to be tested, probe, and calibration standards should always be at the same temperature, close to 20 °C.

4.3   Lift-off Compensation

Other key factors are coating thickness/lift-off and material curvature.

Measurements can be made through layers of paint or other non-conductive coatings up to a thickness of 0.020" (0.5 mm) with the 12.7 mm probe.

4.4   Measurement on Curved Surfaces

Use on curved surfaces requires some caution, with concave surfaces the effect is primarily lift-off and the instrument will compensate up to the point where the spacing of the centre of the probe from the material becomes excessive. With convex surfaces the indicated conductivity will decrease as the radius decreases. Correction tables are required for radii below approximately 3" (75 mm).

4.5   Setting up for Conductivity and Coating Thickness Inspection

To use the instrument for Conductivity measurement requires the following:

❚ Instrument

❚ Standard 60 kHz Probe (PRN 47P001) and Cable (PRN 33A170)

❚ Conductivity standards of known value (PRN 33A136 or equivalent)

Before switching on, plug the lead into the 12 way Lemo socket on the front of the unit. Switch the unit on. The operator should see a splash screen displayed that has the word **Conductivity** on. After a short pause the Conductivity Operating Screen will be displayed.
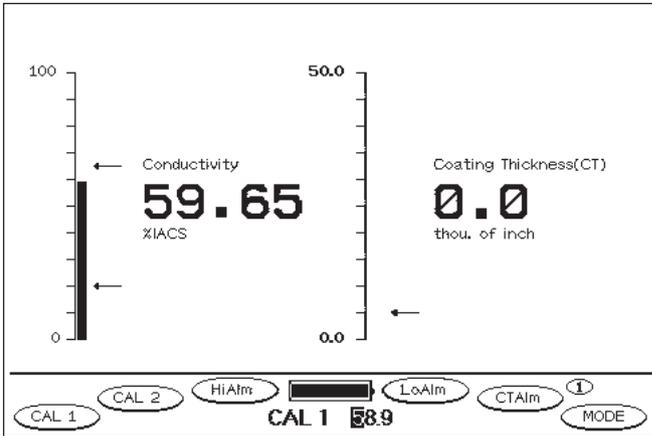
The screen above shows the two elements of the Conductivity operating mode.

On the left the screen displays the conductivity reading, in the units as set on the Menu page. An arrow adjacent to the bar indicates the limits set. On the right is the display for Lift-off. Again this bar graph is calibrated in the units set by the operator on the menu screen, in this case under DIMS (an abbreviation for Dimensions).

– Press **menu** to show the Conductivity Menu Screen.
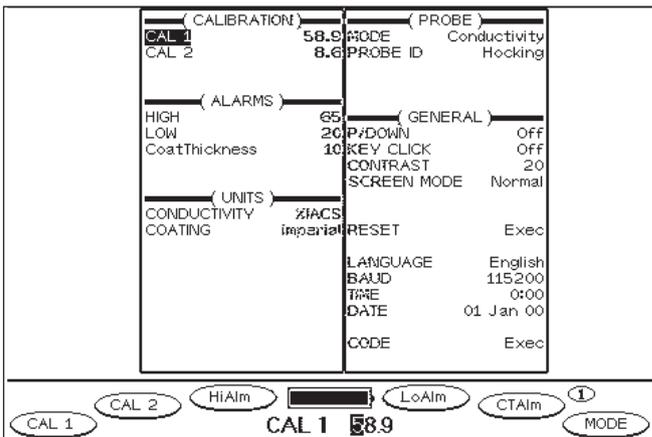
– Go to the **UNITS** item in the menu. Using the cursors, change the conductivity units to match those in which the blocks are calibrated. The **CAL 1** setting should be the higher value of the two.

– Use the cursors to select the **CAL 1** menu item. Adjust the figures to match the value of standard 1 on the Calibration Block set. Recommended value 58 – 59 %IACS.

– Repeat the process to set **CAL 2** to the value of standard 2 on the Calibration Block set. Recommended value 8 – 9 %IACS.

– Adjust other parameters as desired.

– Press **menu** again to return to the Conductivity Operating Screen.

4.6 Calibration for Conductivity Measurement

– Press **balance** to start the setting process. The following message will appear:
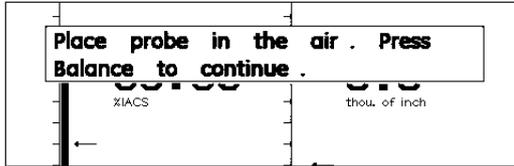
– Move the probe to a position that is well away from any material (at least 10 cm) and press **balance** again. The following message will appear:
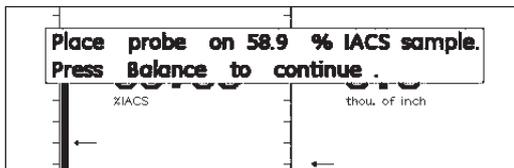
☞ **Note**

58.90 represents the value for **CAL 1**.

– Place the probe on the Calibration sample that has been set up as sample 1 and press **balance** again. The following message should appear:
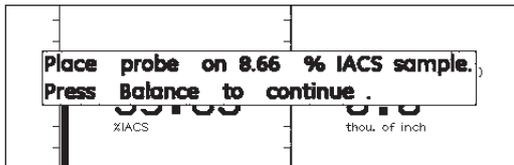
☞ **Note**

8.66 represents the value for **CAL 2**.

– Place probe on the calibration sample that has been set up as sample 2 and press **balance** again. If the calibration has been carried out successfully a message will appear stating **Setup succesfull**. The instrument is ready to perform conductivity measurements.

4.7 Measuring Conductivity and Coating Thickness

Guidelines for successful operation:

▋ For accurate measurement of conductivity the surface coating thickness should not exceed 0.25 mm (0.010 inches).

▋ The surface to be measured should be flat, or of the same curvature as the calibration standards. Where curved surfaces must be measured, additional error may be introduced.

▋ Measurement close to edges and on thin materials may give erroneous results. Check on a known consistent material to establish the influence of these effects.

▋ The coating thickness function does not require further calibration, it should be accurate to better than 10% of the displayed value on base materials having a conductivity between approximately 15% and 100% IACS.

4.8 Error messages

If the lift-off is greater than 1.250 mm (0.0500 inches) Coating Thickness will be displayed as "+++" and the conductivity will be shown as zero.

On Ferrous (Magnetic) materials the Conductivity will be displayed as 'Fe', on ambiguous materials such as copper coated steel coins, it will be displayed as '??'.

VALUE OUT OF RANGE – The instrument is unable to perform a reading within range. This error is usually followed by THE SEQUENCE WILL RESTART. This error may occur for a number of reasons.

▋ If the set values do not correspond with the standards

▋ If a probe is not attached

▋ If the cable is damaged

Operation in Rotary Single Mode **5**
(Phasec 2s and Phasec 2d only)

5.1   Basics of Rotary Inspection

The Rotary inspection is an automated form of inspection that gives the operator an increased Probability of Detection (POD) of flaws compared to a manual hole inspection. The reason for this is that in a single insertion and withdrawal of the probe from a hole the scanning element passes over the material surface many more times in comparison. In addition the instrument has a sample frequency of 16 kHz for Rotary mode, compared to the 4 kHz sample frequency in Normal mode.

When one of the recommended GE Inspection Technologies probe drives is plugged in the instrument, software will automatically recognise the type of drive being used, and will set a number of parameters to appropriate values.

In addition the instrument can be connected (via appropriate leads) to competitors equipment. Because often competitors equipment does not have enough connections to allow intelligent recognition, the instrument has been designed with the ability to characterise the unit to obtain the best possible performance from the unit. However selection of rotary mode with competitors rotor units connected has to be carried out manually.

The AutoDetection facility of the instrument means that a rotary probe can be attached when the unit is off or on, and the unit will automatically detect its presence and switch to the correct mode. Connect the drive using a suitable cable and plug in a suitable probe of the correct diameter for the holes to be inspected.

For ease of operator training the Rotary Menu is broadly the same as the Normal Menu (see Chapter 3). However there are several specific differences between this mode and the Normal Menu screen which are outlined below.

Rotary Mode Menu Screen

5.2   Frequency Range

The frequency range in Rotary Mode is from 10 kHz to 2 MHz which covers the standard range for Rotary probe inspections.

5.3   RPM Range

The instrument allows instrument based control of suitable rotary probe drive units from 600 to 3000 RPM. Most other eddy current units only allow drive at a single fixed speed, so if the operator is using a legacy probe drive unit, reference should be made to the documentation to obtain the optimum drive speed.

5.4   Initial Setup

– Press the switch on the side of the drive to start rotation.

– Place the probe into a clear area of the test block hole and balance, verify that no significant response is seen on screen.

– Move the probe so that it rotates in the notched region of the hole.

– Rotate phase so that the indication from the notch is vertical.

– Switch **DISPLAY** to **Timebase** menu using the cursor keys and **OK** key as before. Display will now show an angular representation as shown.

– Select the first set of programmable soft keys and optimize filters for best signal to noise ratio.

– Set filters as explained in 5.7. When used with a GE Inspection Technologies probe drive the unit will "learn" to compensate for drag, so when setting up the probe it should be dragged slightly on the test block hole so that the unit can always maintain optimum speed.

– Select alarms if desired (e.g. top 20 and bottom 20).

5.5   PROBE ID

The instrument has the ability to Autodetect when a GE Inspection Technologies rotary gun has been connected and will automatically go to the appropriate settings for that unit. However, when connecting to other manufacturers units there is the option of moving to the **Probe ID** menu item and selecting the correct manufacturers identity. This is then implemented using the **exec** button.

This is necessary as not all manufacturers support the wide range of rotational speeds and other features of the drive. See Paragraph 5.10 for further details.

5.6   Graticules – Timebase Mode

Graticules in SPOT are the same as in Normal mode. However, extra graticules are available in timebase as depicted below.
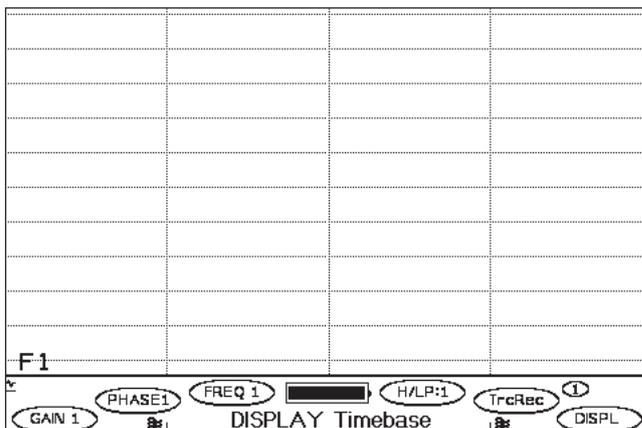
5.7   Filters in Rotary Mode

The filter functionality of the unit is extended in Rotary mode. Proper filtering is essential in rotary inspection due to the high level of mechanical and electrical noise generated by such an inspection. Conducting such an inspection without filters will result in an extremely noisy trace, and would make the detection of cracks very difficult.

The instrument allows independent manipulation of Hi and Low Pass filters, as well as the use of the Band Lock function which allows rapid repositioning of the filter depending on RPM. See 3.14 for further details.

A significant advantage of the GE Inspection Technologies rotary probe drives is that the instrument employs a control loop to ensure that the gun is running at the stated RPM. This differs from other systems as a constant voltage or constant current drive will slow down when drag is placed upon the probe (for example from the hole walls). If the drive does slow down then filters that have been optimised for a non-drag environment will now be eliminating useful data.

The filters available in rotary mode are up to 2.0 kHz in Low Pass and 1.95 kHz in High Pass mode. See Chapter 9 for full specifications.

5.8   Guidelines regarding Rotary Inspection

The various types of drives available from GE Inspection Technologies are programmed with relevant parameters, such as type, serial number and allowable speeds. When the drive is switched off the display is instantaneously frozen (before the drive slows down), this allows easy saving of traces.

Filter frequencies are proportional to speed, e.g. 100 Hz and 750 Hz at 1500 RPM will give approximately the same results with the same diameter probe as 200 Hz and 1.5 kHz at 3000 RPM.

5.9   Maximum Probe Sizes for Rotary Inspection

The following table gives an indication for the maximum practical size of probes at different rotary speeds. The information was established by measuring the response on a 12.1 mm diameter hole with a 3000 rpm speed. Reducing the Low Pass Filter to 900 Hz resulted in the amplitude of the signal reduced by 6 dB from that at 2 kHz. This was then scaled up to get the max hole diameter.

RPM	Max Diameter (mm)
3000	26.9
2500	32.3
2000	40.3
1500	53.8
1000	80.7
600	134.4

5.10   Rotary Drive Units from Other Manufacturers

The instrument has a facility to support the Rotary Drive units supplied by other manufacturers. Due to the design of these units not all the advanced functions available on the GE Inspection Technologies Rotary Drive units will be available, as some of the units have only a single rotary speed, or no provision for automatic freeze.

The products currently supported are as follows:

❚ Rohmann Mini and Standard Drive (ID Rohmann1) – requires lead 40A101

❚ Staveley RA16 Rotary Drive (ID Staveley) – requires lead 40A103

❚ Zetec Standard Drive (ID Zetec1) – requires lead 40A102

❚ Zetec Incrementing Drive (ID Zetec 2)– requires lead 40A102

The unit automatically recognises when a GE Inspection Technologies unit has been connected to it, and will switch to the required mode. However, in order to attach another Manufacturers probe the relevant lead (see above) is required. Once the lead has been attached to the drive, the 12 way Lemo connector end should be inserted into the unit when it is switched on. The instrument will then Autodetect the fact that a rotary drive has been attached and will switch mode to Rotary.

The operator should press menu and select the Probe ID menu item. Use the cursors to move through the options Rohmann1, Zetec1, Zetec2 and Staveley as they correspond with the list above.

Once the desired Rotary Probe drive type has been selected press exec to activate the drive.

👉 **Note:**

If the user subsequently selects another type of Rotary Probe ID with out disconnecting the lead then the instrument will not supply power in order to prevent damage to either the instrument or the Rotary Probe Drive.

⚠ **Caution**

The operator is responsible for ensuring that the Rotary Probe drive is compatible with the types listed above. The different units have significantly different power schemes and damage to the unit may occur if the correct setting is not selected. If in doubt, contact your local distributor or GE Inspection Technologies direct.

Operation in Normal Dual Mode 6
(Phasec 2d only)

6.1   Basics of Dual Frequency Mode Inspection

The Normal Dual mode allows a wide range of inspection that greatly increase the potential of the eddy current unit. On the instrument the dual mode is operated using a single input for the probe, but the eddy current channel can be split in two and manipulated. There are two main ways that the unit can be used.

❚ As a simultaneous two frequency inspection through a single probe

❚ Driving a single probe in two different configurations e.g. differential and absolute mode simultaneously.

The instrument allows much more than just setting the frequency to two separate values simultaneously. Once the signal is in the instrument it can be manipulated in a number of ways.

Normal Dual Menu Screen

```
┌──────(FREQ 1)──────┬──────(ALARM)──────┬──────(PROBE)──────┐
│GAIN XY1 40.0/40.0  ACTIVE       None MODE      NormalDual
│PHASE1 °      262.0 ACTION        Off PROBE ID    Unknown
│FREQ1 kHz      35.0 STRETCH     50 ms LOAD uH         1.3
│FILTER1   BP RATIO  SHAPE          Box DRIVE dB         0
│HP/LP1    DC/ 300   TOP/BTM    Off/Off BAL/CLR MODE   Both
│INPUT GAIN1    High LFT/RGHT   Off/Off ──────(GENERAL)──────
│PROBE1      Bridge  START/END  Off/Off P/DOWN         Off
│──────(FREQ 2)──────IN/OUTER   Off/Off KEY CLICK      Off
│GAIN XY2 38.6/35.4  ──(TRACE DISP)── CONTRAST          20
│PHASE2 °      313.0 VIEW      F1:Mix SCREEN MODE Normal
│FREQ2 kHz      25.0 DISPLAY      Spot TRACE THICKEN   Off
│FILTER2   BP RATIO  GRATICULE   Polar
│HP/LP2    DC/ 300   SPOT XY      48/0 RESET          Exec
│INPUT GAIN2    High SPOT DUAL    128/0
│PROBE2      Bridge  SPOT INFO    None LANGUAGE     English
│──────(MIX)──────   PERSIST     0.2 s BAUD         115200
│GAINMIX   5.0/ 5.1  SWEEP       0.5 s TIME         0:00
│PHASEMIX °    220.0 ──(MEMORY)── DATE        01 Jan 00
│──────(OUTPUT)──────SAVE        Setup
│ANALOG O/P 1   Xmix RECALL      Setup CODE          Exec
│ANALOG O/P 2   Ymix TRACE RECORD Exec
└────────────────────────────────────────────────────────┘
  ☆
     (PHASE1)  (VIEW) [■■■■   ]  (PERS) (GAIN 2)
 (GAIN 1)        GAIN XY1 40.0/40.0       (PHASE2)
```

6.2   Switching to Normal Dual Mode

The instrument has been designed so that if an application has been setup in single frequency mode, and then another frequency needs to be added the settings from the single frequency can be instantly transferred.

– In order to do this select the **Mode** menu item and press **OK**.

– Select **Normal Dual** using the cursor keys and press **exec**.

The unit will switch to Normal dual mode, and a dialog will be presented. This will ask "Copy Current FREQ 1 settings to new mode? Press Exec to accept or OK to decline."

6.3   Dual Frequency Operation – manual method

The instrument is able to test at two simultaneous frequencies, and provides a mixing channel which allows unwanted variables to be suppressed. Setting up a two frequency test requires a good sample of the product in which the artefact which needs mixing out can be simulated. In this situation the unit should be set up to have the **VIEW** menu item set to **F1:F2**. **FREQ1 PROBE** and **FREQ2 PROBE** should be set to the same configuration. **FREQ1** and **FREQ2** should be set to different frequencies (these frequencies are dependant on the material under test, but a multiple of 5 between **F1** and **F2** is a good general starting point).

The probe should be run over a good section of the material, with the artefact present. The signal given as a result should be adjusted so that **F1** represents **F2** as closely as possible by manipulating gain and phase.

☞ **Note**

The instrument also allows independent manipulation of filters and input gain to give maximum control.

Once the F1 and F2 signals have been mixed, the **VIEW** should be changed to **F1:MIX**. When the probe is run over the artefact there should be little or no indication as the mix of the two channels should eliminate this.

If a flaw is present near or under the artefact it should be visible on the mix channel.

6.4   Dual Frequency Operation – Using Automix

The use of the Automix function requires operation of the Trace Recorder feature (see 3.24). The artefact requiring mixing should be recorded with the **FREQ1** and **FREQ2** set up as indicated in paragraph 6.3 above.

Once a representative trace has been recorded, select a section of the playback in which the trace is shown at its best. Press **A-Mix/F4** to invoke the Automix functionality. The best available mix will be represented in the **MIX** display (see 6.6. below). In some situations the software may not be able to calculate an Automatic mix, and the process should be followed as indicated above.

6.5   Manipulating the Mix Channel

The Gain and Phase of the Mix Channel can be manipulated by using the **MIX** section of the menu. This allows a standard screen deflection to be applied, or for a flaw indiucation to be set at, or near, the vertical.
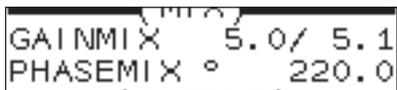
```
GAINMIX    5.0/ 5.1
PHASEMIX °    220.0
```

6.6   Dual Frequency Display

The display options for Dual frequency mode are very similar to Normal Single mode. However if the graticule is set to None in Spot mode, then the location of the two display channel origins are identified by to distinct cursors, as shown below;
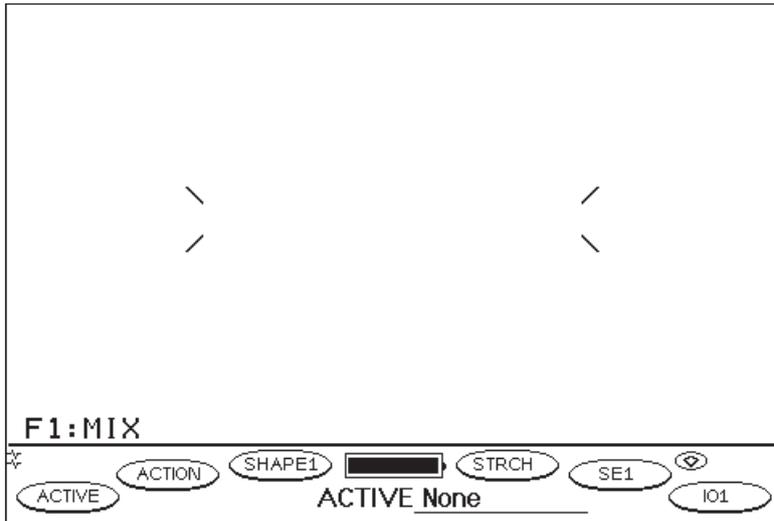
These spot positions can be individually manipulated. The left hand cursor is identified as SPOT XY and the right hand position is SPOTF2 XY.

6.7   Balance and Clear Mode

The **balance** and **clear** buttons on the front panel of the instrument can be set to operate to both traces, or split so that the left hand **balance** and **clear** buttons apply to **Spot XY** and the right hand **balance** and **clear** buttons apply to **SpotF2 XY**. This is set by the **BAL/CLR MODE** button being set to either **Both** or **Split**. This menu item can be found in the **PROBE** section.

6.8   Outputs in Dual Frequency Mode

The dual frequency mode allows the user to choose required analog outputs from X1, Y1, X2, Y2, Xmix and Ymix.

Power Sources and Battery Management **7**

7.1   Removing and installing the battery pack

The instrument has a variety of power options. The various choices all use the same method of connecting to the unit as outlined below:
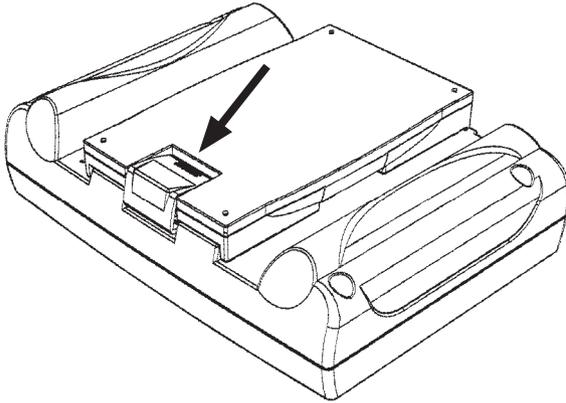
– Place the instrument face down on a soft, clean surface.

– Press down on the battery release clip as indicated above.

– Roll the battery pack away from the unit.

– Installation is the reverse process.

7.2   Battery charger/eliminator

The battery charger/eliminator should be connected an AC supply using an appro-priately terminated plug. The adapter is able to switch to power supplies that are in the range of 90 to 264 VAC, and 47 to 440 Hz. Once the unit has been connected the mains switch on the side of the unit should be switched on.
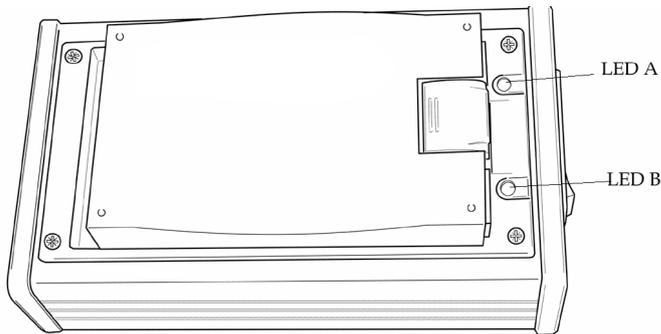
The charger has automatic safety protection to ensure that it will only charge the Lithi-um-ion battery pack supplied for the instrument, and will not charge the AA/eliminator pack if it is placed on the unit.

☞ Note

The charger/eliminator unit will continue to supply to instrument even when recharging a lithium-ion battery.

To charge the Lithium-ion battery pack place the battery on top of the unit in exactly the same way as described in 7.1.
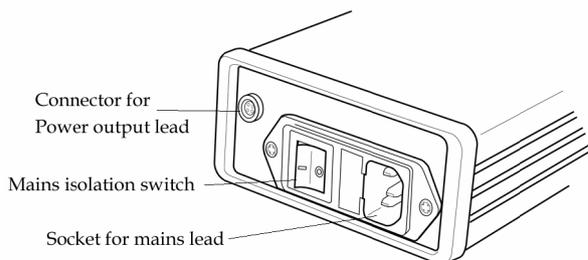
Different conditions of the battery charger and Lithium-ion battery pack are indicated in the table below.

Condition	LED A	LED B
Temperature OK	Solid Green	
Temperature too high to charge	Solid Red	
Temperature too low to charge	Solid Orange	
Incorrect Battery Type		Flashing Red
Battery charging		Flashing Green
Battery charged		Solid Green
Battery not full after 3 hours		Solid Red
Pre-Charge failed		Solid Orange
Battery not detected		No light
Unknown battery, pre-charging for 1 minute		Flashing Red/Orange
Problem with power supply	Flashing Orange	Flashing Orange

The charger/eliminator pack has two modes of operation, Pre-charge and fast charge which are determined automatically depending on battery condition and are not user selectable.

The unit interrogates Lithium-ion packs when they are placed on the unit. If the unit has discharged to a very low level then the unit initiates a pre-charge routine that trickle charges the pack until it is ready to accept the fast charge. In the case of extremely discharged packs this process can take up to 90 minutes.

If LED A is not green then the battery will not be charging. LED B may still flash green to indicate it is in the battery charge cycle, but the unit will wait for the pack and charger to stabilise before starting to charge.

For packs in normal use the pre-charge is not necessary and the unit can start on a fast charge routine immediately.

Using the fast charge the pack can be supplied with enough charge in 30 minutes to provide over 3 hours of operation. If the battery illuminates LED B as a solid red, see section 7.4 "Battery Not Full" Indication.

⚠ **CAUTIONS**

▌ AS THE UNIT USES HIGH CURRENTS WHEN IN FAST CHARGE MODE THE UNIT WILL GET WARM. IT IS IMPORTANT THAT THE COOLING SLOTS IN THE SIDE OF THE BATTERY CHARGER/ELIMINATOR UNIT ARE KEPT CLEAR FROM OBSTRUCTION.

▌ ENSURE THAT THE UNIT IS NOT EXPOSED TO DIRT OR FLUID AS THIS MAY DAMAGE THE UNIT.

▌ HIGH VOLTAGES ARE PRESENT INSIDE THE UNIT. AS WITH ALL POWER SUP-PLIES CARE MUST BE TAKEN IN HANDLING AND THE UNITS MUST NEVER BE OPENED BY NON-AUTHORISED PERSONNEL.

7.3   Lithium-ion battery pack

A Lithium-ion battery pack is available for the instrument. The fully enclosed design means that there are no user serviceable parts.

Lithium-ion batteries offer the highest possible energy density for the minimum size and weight. The fully charged cells provide sufficient energy for 6 hours continuous use without the backlight or 4 hours with backlight on.

A significant advantage of this technology over other secondary battery technologies is that unlike NiCad or NiMH cells there is no requirement for cycling or deep discharging the batteries. Lithium-ion does not suffer from memory effects, therefore it is possible to top up batteries as required without losing battery capacity.

This battery technology has several levels of protection to ensure safety for the operator and equipment. However as with all forms of battery power care must be taken in handling these units.

☞ **Note**

The contacts are contained in a in a moulded feature on the pack providing barriers between the contacts and reducing the likelihood of inadvertent short circuit. Nevertheless the batteries should be handled with care, shorting the contacts may cause the cell protection to operate and render the pack useless. If it is suspected that the battery contacts have been shorted then the pack must be returned to a battery charger/eliminator unit. Placing the pack on the unit will allow the intelligent management system to establish whether the pack is useable or not.

The battery charge indicator on the screen will only work with the Lithium ion pack. If the AA/eliminator pack is attached then the battery charge indicator will not display a remaining charge indicator.

Charging of the Lithium-ion battery pack should only be performed using the instrument battery charger eliminator (39a005).

7.4 "Battery Not Full" Indication

A solid red LED B indicates that the battery has not fully charged in three hours. This may have happened for a number of valid reasons, such as requiring a lengthy pre-charging routine due to deep discharge or high ambient temperatures. In nearly all cases the battery will be OK to operate. To validate this, place the battery on the instrument and switch on. If the battery charge indicator shows full, or nearly full, then the battery is fine. However if the instrument battery charge indicator shows a low charge level even after two hours on the recharger then the Lithium-ion unit should be returned for service at the next convenient time.

7.5 Battery charge indicator (Lithium-ion only)

The instrument indicates the battery charge of Lithium-ion packs when they are operated on the unit. The indication of charge remaining can alter with change in ambient temperature, use of backlight and inspection frequency, amongst others. This indication will not work with the AA pack. The unit will give a fill on the battery graphic on screen to indicate approximate remaining charge. When the battery charge icon approaches the empty state the operator is advised to save the settings and replace/recharge the battery.

7.6   AA battery/eliminator pack

The AA battery/eliminator pack has two functions.

It is able to take standard dry cell AA batteries when required. The operator can use rechargeable technology AA cells such as NiCad or NiMH and recharge on a proprietary frame.

Connector for
Power output lead
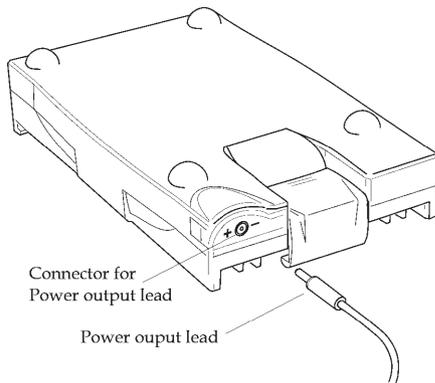
Power ouput lead

It connects the charger/eliminator unit to the instrument by the Power Output lead as illustrated.

Power output lead
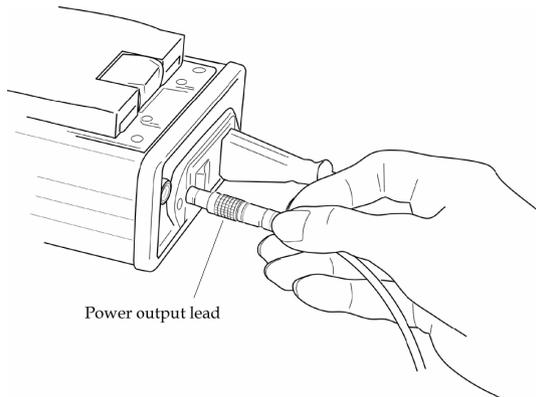
7.7   Placing cells in the AA battery/eliminator pack

–   Remove the AA battery eliminator pack from the instrument.

–   Remove the pack cover by gently pulling the tabs located at the middle of the pack on either side.
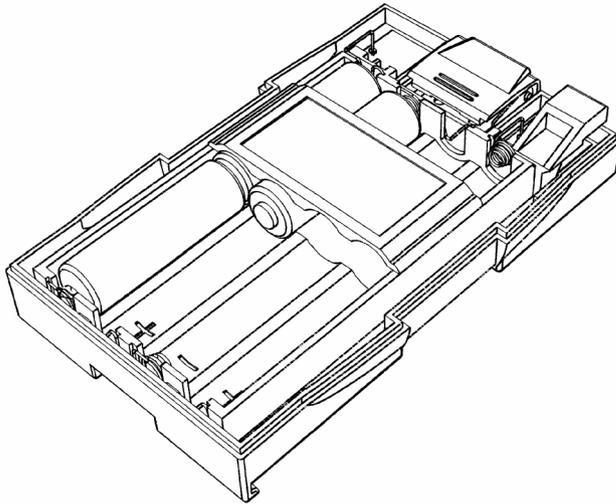
–   Place 8 AA cells in the polarity indicated by the pack.

–   Replace cover by snap-fitting over the base.

⚠ CAUTION

DO NOT USE A MIXTURE OF RECHARGEABLE AND ALKALINE CELLS. DO NOT USE CELLS THAT HAVE DIFFERENT AMP HOUR RATINGS. DO NOT MIX CELLS OF DIFFERENT CHARGE LEVELS.

7.8   Resetting the Instrument

The instrument may be reset by selecting the menu item **RESET**, press **OK** and then press **exec**.

⚠ **Caution**

These actions may result in damage to the software of the unit.

A dialogue box will appear as illustrated below;

▌ Total Reset   F1

▌ Default   F2

▌ Continue   F3

TOTAL RESET reboots the unit and takes unit back to factory settings, losing all traces, settings and other setup data.

DEFAULT will reset standard factory settings but will attempt to maintain traces and settings if possible.

CONTINUE maintains stored locations and unit settings.

Press **CONTINUE/F3** to continue. This will start the unit in a normal manner without re-setting any of the variables in the unit. However the user must check both the settings menu, and the stored traces and settings to check for evidence of corruption which would invalidate further operations. This will be evident by file locations reported as full that have no apparent data, and corrupted data labels etc.

If data corruption is evident then the unit should be switched off.

When the unit is switched back on the operator should press and hold the **F5** button.

This will bring up the reset menu, and depending on the perceived level of corruption either TOTAL RESET or DEFAULT should be implemented.

Removal of the battery and replacement whilst the instrument is powered up will cause the instrument to revert to the settings prior to the last correct power down.

Supervisor PC **8**

8.1   Overview of Supervisor PC

The instrument is supplied with Supervisor PC. This is a program that is capable of up-loading and downloading traces and settings and documenting inspections. It can also be used for remote control of the unit via serial commands. Full details of the operation of this software is available on the CD ROM supplied with it.

Routine Care and Maintenance **9**

9.1   Care and maintenance

The instrument is a product of superior design requiring minimum user maintenance.

The suggestions below will help you fulfil any warranty obligations and will keep the instrument fully functional for many years.

❚ Keep it dry. Precipitation, humidity and most liquids contain minerals that will damage electronic circuits.

❚ Do not store in hot or extremely cold areas. Extreme temperatures can shorten the life of electronic devices, damage batteries and warp or melt plastics.

❚ Do not attempt to open it. Non-expert handling of the device may damage it.

❚ Do not drop, knock or shake it. Rough handling could break internal circuit boards.

❚ Do not use harsh chemicals, cleaning solvents or strong detergents to clean it. Wipe it with a soft cloth slightly dampened in a mild soap-and-water solution.

❚ Do not paint it. Paint can clog the keypad, connectors and battery latching. This will prevent proper operation.

9.2   Long term storage

As with all battery technologies the lithium-ion battery pack has a shelf life. This means that if the battery pack is left for a long period (greater than 12 months) there is a risk that the voltages inside the unit may drop to a level at which permanent damage to the pack may occur, thus rendering it inoperable.

If the unit is to be left in long term storage the following precautions should be followed:

❚ Ensure that the storage area is clean and dry. For optimum protection it is recommended that the instrument is stored at Room Temperature (i.e. 20° C).

❚ Make sure that the battery is fully charged and place the battery on the rear of Instrument.

❚ It is recommended that all settings and traces are saved and archived on computer using the Supervisor PC program as described in Chapter 8.

❚ Ensure that the instrument is switched off.

❚ Visually inspect all items for signs of physical damage.

❚ Pack the instrument and accessories in a protective case and place the Instrument kit in a location where it will not be subjected to physical shock or exposed to potentially damaging substances.

❚ Every 3 months the instrument should be removed from storage. The lithium-ion battery pack should be removed and charged.

❚ When the battery is fully charged place the lithium-ion back on the instrument.

Specifications **10**

Mode Selection

Automatic (via appropriate cables)

Rotary Mode (Phasec 2s and Phasec 2d only) detected via Cable
(PRN 33A103 for GE Inspection Technologies Rotary drives)

Rotary Mode (Phasec 2s and Phasec 2d only) detected via Cable
(PRN 40A101 for Rohmann Rotary drives)

Conductivity Mode detected via Cable
(PRN 33A170 for GE Inspection Technologies 60 kHz probe)

Normal mode is the default mode

Frequencies (Normal Mode)

Between 10 Hz and 99.5 Hz in 0.5 Hz steps

Between 100 Hz and 995 Hz in 5 Hz steps

Between 1 kHz and 9.95 kHz in 50 Hz steps

Between 10 kHz and 99.5 kHz in 500 Hz steps

Between 100 kHz and 995 kHz in 5 kHz steps

Between 1 MHz and 10 MHz in 50 kHz steps

Frequencies (Rotary Mode, Phasec 2s and Phasec 2d only)

Between 10 kHz and 99.5 kHz in 0.5 kHz steps

Between 100 kHz and 995 kHz in 5 kHz steps

Between 1 MHz and 2 MHz in 50 kHz steps

Frequency (Conductivity and Lift-off Mode)

60 kHz

Overall Gain

8 dB – 96 dB

Input Gain

Selectable 0 or +14 dB

Drive dB

Selectable −8 dB − 0 dB − +8 dB

X and Y Gain

Adjustable together or as independent axes 0.0/74.0 − 74.0/0.0 dB
in 0.1, 1 or 10 dB steps

Phase

0 − 359.5 Degrees in 0.1, 1, 10 or 100 Degree steps.

Probe Compatibility

Selectable   Locator - Absolute 100 ohm input

Absolute - Absolute 50 ohm input

Bridge (50 ohm Impedance)

Reflection (Driver 2V peak to Peak, 20 ohm Minimum input impedance)

Minimum Sensitivity

Instrument readily detects a flaw $0.1 \times 0.2 \times 0.5$ (w × d × h) using a 2 MHz Shielded probe.

Internal Balance Loads

1.3, 8.2, 22, 47, 82, 120 µH

Balance Load Selection

Automatic or Manual

Balance

Push-button automatic

Lift-off Compensation

Automatic, with Phase rotation to 9 o'clock position, or manual

Filters

High Pass	DC
	Ultra filters 0.01 Hz to 0.5 Hz steps (6 steps)
	1 Hz to 9.95 Hz in 0.05 Hz steps (180 steps)
	10 to 99.5 Hz in 0.5 Hz steps (180 steps)
	100 to 995 Hz in 5 Hz steps (180 steps)
	1 kHz to 1.2 kHz in 50 Hz steps (4 steps, Normal Mode)
	1 kHz to 1.95 kHz in 50 Hz steps (20 steps, Rotary Mode)
Low Pass	3 to 9.95 Hz in 0.05 Hz steps (140 steps)
	10 to 99.5 Hz in 0.5 Hz steps (180 steps)
	100 to 9 95 Hz in 5 Hz steps (180 steps)
	1 kHz to 1.5 kHz in 50 Hz steps (11 steps, Normal Mode)
	1 kHz to 2.0 kHz in 50 Hz steps (21 steps, Rotary Mode)

Display size

Total Viewable 115 × 78 mm

Trace Area 115 × 65

Display Type

Impedance-Plane display on LCD with LED Backlight protected by hard-coated Acrylic window, Pixel pitch 0.2 mm, Useable in ambient lighting from 100 Lux to 7000 Lux

Display Resolution

480 × 320 pixels

Display Contrast

Adjustable in 32 steps

Backlight

Selectable by a short press on the On/Off button.

Video Modes

Normal or inverted, (white text on a black background) to allow user choice of background.

VGA

Screen Flip

Allows 180 degree rotation of operating screen by a long press on F6. This allows easy presentation of screen traces when many people are gathered around the unit.

Graticules-Definitions

Selectable – Dependant on mode

The grid arrangement allows easy reading of the screen trace height and position, as it presents the screen in regular divisions.

Normal Mode, Spot Display

Grid 1 – Divisions at 20% of full screen height

Grid 2 – Divisions at 10% of full screen height

Polar   – Major divisions at 30 degrees, minor divisions at 15 degrees.

None   – Crosshairs to indicate the balance point only

Rotary Mode, Timebase Display

Grid 1 – Y axes at 90 degrees of rotation

Grid 2 – Y axes at 45 degrees of rotation

Grid 3 – Y axes at 20 degrees of rotation

None   – no graticules

Display Modes

Selectable – Spot (X, Y), Timebase (Y/T), Waterfall, Bar, Bar:XY

Timebase Sweep (Normal Mode Only)

Selectable – 0.1, 0.2, 0.5, 1.0, 1.5, 2.0, 5.0, 10.0, 15.0, 20.0 and 50.0 s.

☞ **Note:**

In Rotary mode the sweep of the screen corresponds to a full 360 rotation of the probe.

Trace Persistence

Selectable – 0.1, 0.2, 0.5, 1.0, 1.5, 2.0, 5.0, 10.0, 15.0 and 20.0 s and permanent.

Spot Position

Adjustable over trace display area . Displayed in terms of screen percentage.

Alarm Type

X and Y levels	Adjustable from 10% to 90% full screen height.
Box	Adjustable – Left, Right, Top, Bottom
Sector	Adjustable – Start, End, Inner, Outer

Alarm Signals

Audio Tone, Visual flashing LED and freeze on alarm

Alarm Tone

Selectable on off using Alarm Action menu item.

Alarm Stretch

Selectable – 50 mS, 100 mS, 500 mS, 1 Sec, 5 Secs, 10 Secs.

Conductivity

The unit is capable of measuring electrical conductivity of materials in the range from 1 to 110% IACS. The unit uses a constant operating frequency of 60 kHz for conductivity measurement.

Coating Thickness

A non-conductive coating on a non-ferrous substrate can be measured up to 1.00 mm (0.050 inches) thick.

User Restricted Modes

'Supervisor Mode' – all functions and adjustments are available at all times.

'User Mode' – limited functions and stored programmes available as selected in the 'Supervisor' mode

User Controls

Dedicated Tactile buttons for:- Balance, Erase, Freeze large buttons each side for operation by gloved hand

Exec, Menu, OK

On/Backlight Off

Cursor keys for rapid navigation through menu items and settings

'Soft Keys' Six User-Programmable front panel buttons

☞ **Note**

Keys are arranged for operation by either left or right hand

Menu Screen

Menu allows all settings to be allocated, saved in memory and recalled. 'Frozen' traces may similarly be saved, named and recalled as required.

Memory Size

Storage for 50 settings (of all settable parameters) plus up to 50 traces.

Language

Selectable – English, French, German, Spanish, Portuguese

Key Click

Selectable – On, Off.

Keyboard Lock

Selectable – On/Off.

Deactivates all buttons (except balance, clear, freeze and power buttons) to avoid inadvertent operation.

Clock

Time and Date up to Year 2099

Power Sources

Clip-on sealed Lithium Ion battery pack, securely retained by S/S clip, Gold plated connectors

Clip-on 'AA Cell' battery pack (non IP rated)

Plug in Charger/Battery Eliminator (non IP rated)

Charge Endurance

6 hours with backlight OFF, 4.5 hours with backlight ON. Battery consumption will increase with the use of low frequency inspection and rotary inspection.

☞ **Note**

Batteries at temperatures below 0 °C have reduced capacity.

Charge Indicator

Permanently on-screen, shows proportion of battery charge remaining. Does not operate when used with the AA battery cell case as there are significant uncertainties when reading AA battery levels.

Auto Power Down

Selectable – 5, 10, 15, 20 minutes from last 'keystroke', or OFF

Safety Power-Down

Instrument switches off automatically when battery charge is very low to avoid degraded operation and protect battery pack.

Charger/Battery Eliminator

An 'Intelligent' charger monitors the battery condition and optimises safe recharging. Automatic voltage selection between 90 and 264 VAC, 47 – 440 Hz.

☞ **Note**

Not IP rated.

Recharge time

Batteries receive sufficient charge for 3 hours operation in 30 minutes.

Standard full charge takes 3 hours.

Pre-charge may take up to 90 minutes (see Section 6.2).

☞ **Note**

No gases are released during charging or discharging.

Software

Supervisor PC, a Windows based program, allows connection to an external PC for control, setting up, data transfer and printing (Requires Cable PRN 40A024).

This software allows either the individual download of settings and traces, or the complete backup of an instrument, and then simple upload of all settings and traces. This feature is ideal for applications such as "fleet" programming, where the same instrument settings have to be applied to many different units, or where the operator wishes to save different characters of the unit.

Serial Interface

Standard RS 232, full Duplex.

Analogue Output

X and Y analogue signals are always "available" via the 7 way output connector. An alarm output is also available as a switch closure. Analogue output scaled at 0.2 V per division with Grid 2 in use.

Baud Rate

Selectable – 9600, 19200, 57600, 115200, 230400, and 345600 Baud

Size

192 mm × 140 mm × 55 mm, (7.6 × 5.5 × 2.2 inches) including Lithium Ion battery pack.

Weight

0.94 kg (2 lbs) Including Lithium Ion battery

Temperature Range

Operation from 0 °C to +40 °C

Storage from −33 °C to +71 °C

☞ **Note**

Prolonged exposure to temperatures over 50 °C will reduce battery life.

Enclosure

Rated to IP 64, Resistant to short term immersion and/or splash or wipe contact with a wide range of substances including:

Avtur/FSII (F34), Avcat (F44), JP8+100

Avgas, 100LL, F18, Diesel, Petrol, Synthetic and mineral based oils, Lotoxane

Tactile moulded rubber grips for non-slip on smooth angled surfaces

Tripod Mount

The enclosure features a standard camera tripod mounting point.

Conformance

CE marked. The instrument and accessories conform to appropriate Standards, including EEC Directive 89/336/EEC and 73/23/EEC.

These standards apply when used with appropriate leads and accessories.

Connectors

Probe – 12 way fixed socket, Lemo Size 2B

Auxiliary – 7 way fixed socket, Lemo Size 1B

☞ **Note**

Sockets are different sizes to prohibit incorrect connection of cables.

Sockets are secured from rear to reduce risk of Foreign Object Damage.

Probe (12 way Lemo) connections

Pin No.	Function
1	FG0V
2	FGO/P
3	+VB
4	Motor–
5	Motor+
6	0VD
7	Diff+
8	Diff–
9	ENC
10	Gunsw/sck
11	Gun sda
12	Gunalarm
	0V

Auxiliary (7 way Lemo) connections

Pin No.	Instrument
1	0v
2	Analog O/P 1 (X)
3	Analog O/P 2 (Y)
4	Alarm
5	RX
6	+5v
7	TX
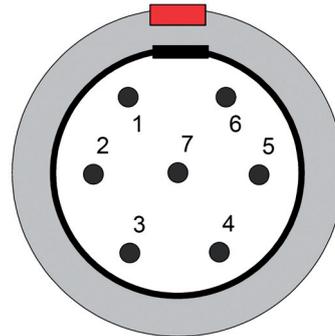
Accessories **11**

PRN	Description
40I003	Phasec 2d, Portable Eddy Current Flaw Detector
33A100	Miniature Rotating Probe Drive
33A103	Lead, for GE Inspection Technologies drive units 33A106 and 33A100, 2 m long
33A120	Adapter for Lemo 12 way to 2 × BNC Socket
33A121	Adapter, short, for Leads with Jaeger connectors
33A130	Lead, for GE Inspection Technologies reflection probes, 12 way Lemo to 4 way Lemo
33A132	Lead for GE Inspection Technologies bridge probes
33A136	Conductivity Standard
33A170	Conductivity Lead (with Autodetect function)
39A023	Output Power lead for Charger/Eliminator to instrument
39A030	Lithium-ion battery pack
39A031	AA/Battery eliminator pack
39A035	Battery Charger/Eliminator Unit
39A039	Tripod stand for instrument
39A040	Lightweight operating handle for instrument
40A142	Soft Pouch for storage
39A043	Rugged Polycarbonate Transit case
40DH04	Owners Manual
40A101	Lead to support Rohmann rotary drives, 12 way Lemo to 8 way Fischer
40A102	Lead to support Zetec rotary drives, 12 way Lemo to 8 way Lemo
40A103	Lead to support Staveley rotary drives, 12 way Lemo to 8 way Burndy
47P001	60 kHz Conductivity probe
39A040	Instrument Lightweight Operating Handle
40A041	Instrument Case, Splashproof
40A001	Lead, for standard Locator probes, 1.5 m long
40A200	VGA Output adapter 15 way D type Socket

PRN	Description
40A002	Adapter, short for BNC leads
40A003	Adapter, short 12 Way Connector to BNC
40A007	Adapter, short, for Defectometer probes with integral leads, 290 mm long
40A025	Lead, for connection of X and Y Output to Chart recorder or similar
40A026	Lead, unconnected ends for custom connection of Auxiliary Socket
40A060	Adapter, for connection of Zetec Miz 21A style Bridge probe
40A061	Adapter, for connection of Zetec Miz 21A style Reflection probe
40A038	Instrument Communication Software (requires 40A024)
40A024	Lead for Supervisor PC/RS232 Interface Lead
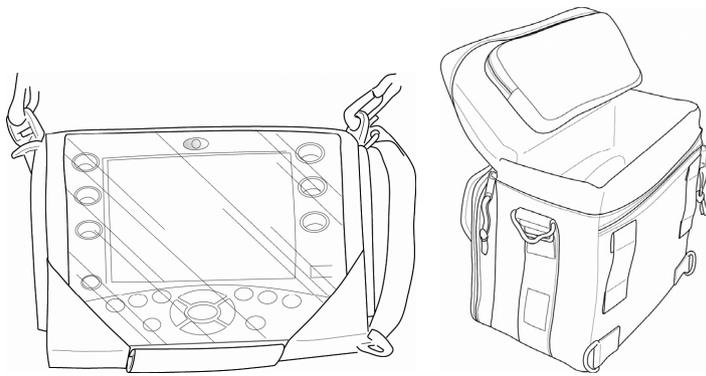
Instrument in 40A041 Splashproof case and 40A142 Soft Pouch for storage
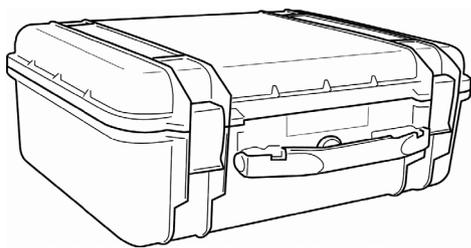
39A043 Rugged Transit Case

Glossary 12

A

ABSOLUTE PROBE

A probe where only one coil is used to test the material. A balancing coil may be present in the instrument or within the probe body. For the instrument the nominal impedance is 50 ohms. Also see Locator.

AC

An abbreviation for alternating current as used in the domestic power supply and eddy current probe excitation.

ALPHANUMERIC

Indicating either alphabetic letters or numerals.

AMPLIFICATION

This is a measure of the increase in level of the probe signal before a representation of it appears on the display. On the menu, it is also described as Gain and is usually measured in dB. E.g. +6 dB = 2× gain, −6 dB = 1/2× gain, +20 dB = 10× gain and −20 dB = 1/10× gain.

B

BALANCE LOAD

An inductance added to the instruments input circuit to allow the use of absolute single coil probes. The value of the inductance should equal that of the absolute probe. Also see HENRY and INDUCTANCE.

BALANCING

This facility allows steady or dc signals from a probe, or probe/material combination, to be cancelled out. The visual effect is that after balancing has occurred the display is set at zero or a preset reference point.

BAUD

Baud Rate is the number of bits of information transmitted in one second.

BRIDGE

A probe connection where there are two coils connected so that the signal is compared between them.

C

CURRENT

Is the measure of the amount of electrical charge flowing in a conductor in unit time. Unit of measurement the Ampere (A)

D

dB

An abbreviation for decibels, a logarithmic measure of gain or attenuation. See AMPLI-FICATION.

DC

An abbreviation for direct current as supplied by a battery.

DEFECT

An imperfection in material composition.

DIFFERENTIAL

A differential probe is one that has two detection coils arranged such that equal signals detected by both coils are cancelled out. This gives much less drift and noise than an absolute probe. May be Bridge or Reflection connected.

DIGITAL

Digital or logic circuitry operates in incremental steps and switches between two voltage levels (commonly 0 V and +5 V). A microprocessor consists of digital circuitry.

DSP

Digital Signal Processor. A specialised type of microprocessor, it is optimized for high speed processing of digitized signals, used for phase rotation, filtering, mixing etc.

E

EARTH

A local connection between a circuit or device and the earth which is at zero potential.

EDDY CURRENT

These are the currents that are created in a conductive material when changing magnetic fields intersect the conductor e.g. by bringing a coil carrying an alternating current near to the conductive material. Commonly used to describe the Non-Destructive testing method exploiting this phenomena.

EC

An abbreviation for Eddy Current.

ET

Electro-magnetic testing. An alternative term used in the USA for Eddy Current Testing.

F

f, Freq.

Abbreviation for Frequency. Unit Hertz (Hz).

FILTER

Is an electronic device for limiting frequency range. Filters are often described as high, low or band pass.

FLAW

An imperfection in material composition e.g. a crack.

FREQUENCY

For an alternating current signal, frequency is a measure of the number of full cycles occurring every second (measured in Hertz).

G

GAIN

See AMPLIFICATION

GROUND

An alternative word for EARTH, a local connection between a circuit or device and the earth which is at zero potential.

GROUNDING

The act of connecting to ground.

H

HERTZ

Unit of frequency. Abbreviated to Hz.

Hz

Abbreviation for Hertz. 1 kHz = one thousand Hz and 1 MHz = one million Hz.

I

IMPEDANCE

Circuits that have resistive and reactive components (capacitance and inductance are reactive components) are said to give an impedance to the flow of current. Impedance is normally dependent on frequency.

INDUCTANCE

Inductance is a measure of the voltage required to cause current to change at a given rate in a coil of wire. Measured in Henrys. Usually in micro-henries (millionths of a Henry) = μH.

L

LED

Abbreviation for light emitting diode.

LCD

Abbreviation for Liquid Crystal Display.

Li-Ion

Abbreviation for Lithium Ion battery technology. Offering high charge density, zero memory effect and greater charge cycle life. Also see NiMH and NiCd. State of the art technology.

LIFT-OFF

The signal caused when a probe is lifted from the test specimen surface. Can refer to movement or the actual spacing.

LIFT-OFF COMPENSATION

Setting the phase of the signal caused by lift-off to the 9 o'clock direction from the balance point in order to ensure that defect signals in the Y axis are relatively free of this effect.

LOCATOR PROBE

As in Locator Probe. This is an absolute probe but to be compatible with the Locator UH the nominal impedance is 100 ohm. This means that the operating frequency for a Locator Probe when set to Absolute Probe Mode is half that when set to Locator Probe Mode e.g. 2 MHz probe may be used at 1 MHz in absolute probe mode. See Absolute Probe.

N

NDE

Abbreviation for NON DESTRUCTIVE EVALUATION.

NDT

Abbreviation for NON DESTRUCTIVE TESTING.

NiCd or NICAD

Abbreviation for Nickel-Cadmium technology batteries. Well known for suffering from the memory effect, where the energy storage capability is reduced if the battery is not discharged fully before recharging. Oldest of battery technology used in portable equipment.

NiMH

Abbreviation for Nickel Metal Hydride battery technology. Successor to NiCd giving no memory effect at the cost of a higher self discharge rate.

NOISE

Unwanted signals which appear on the display. Much of the design work for an eddy current instrument is involved with minimising electronic noise (both external and internal) in order to improve the signal to noise ratio.

P

PROBE

This is the name given to hand held eddy current sensors. See also ABSOLUTE, LOCATOR, DIFFERENTIAL, BRIDGE and REFLECTION.

R

REFLECTION

A probe connection where there is a primary and secondary windings. The secondary output is connected so as to give a small output. May be differential or absolute.

RS232

A serial communications protocol for transferring data between computers and other devices.

S

SKIN EFFECT

The tendency for alternating current to flow near the surface of a conductor.

SKIN DEPTH

The average depth at which an eddy current is considered to flow (37% of the current density at the surface) and decreases exponentially with depth. Higher frequencies, relative permeability (magnetism) and conductivity result in less skin depth.

T

THRESHOLD

A limit which indicates that the signal from a defect is sufficient to cause concern.

TRAIN

To train an instrument is to set the phase angle to optimum for the sample under test (term used on Locator UH). The equivalent of Auto Lift-Off on the instrument.

Serial Commands **13**

Channel 1 Gain

set xy1 123 456   Gain1X = 12.3 dB, Gain1Y = 45.6 dB

inq xy1   123   456

ask xy1   X 12.3 dB : Y 45.6 dB

Range: 0 to 74.0

☞ **Note**

Gains are set by entering the required value multiplied by 10. Thus to set 30.0 db a number of 300 is used.

Channel 2 Gain

set xy2 123 456   Gain2X = 12.3 dB, Gain2Y = 45.6 dB

inq xy2   123   456

ask xy2   X 12.3 dB : Y 45.6 dB

Range: 0 to 74.0

☞ **Note**

Gains are set by entering the required value multiplied by 10. Thus to set 30.0 db a number of 300 is used.

Channel 1 Phase

set phase1 123.4   123.4 degrees

inq phase1   1234

ask phase1   123.4 deg

Range: 0 to 359.9

Channel 2 Phase

set phase2 123.4   123.4 degrees

inq phase2   1234

ask phase2   123.4 deg

Range: 0 to 359.9

Channel 1 Frequency

set freq1 10.5 KHz   10.5 KHz

inq freq1   8297

ask freq1   10.5 KHz

☞ **Notes**

Frequency is set by entering the required value including the decimal place and the range, e.g. set freq1 23.0 KHz = 23.0 KHz.

The 8297 response from "inq" is due to the number being in the following format:

8297 decimal is 0x2069 hex

The top 4 bits – represented by '3' – is the range.

The remaining bits represent the frequency.

Range: 10.0 Hz – 10 MHz

Channel 2 Frequency

set freq2 10.5 KHz   10.5 KHz

inq freq2   8297

ask freq2   10.5 KHz

☞ **Note**

See notes for Channel 1.

Range: 10 Hz – 10 MHz

Channel 1 Filter (frequencies)

set h/lp:1 U.05 1000

inq h/lp:1	0.03 1000.00
ask h/lp:1	HP u.05 Hz : LP 1000.00 Hz

set h/lp:1 10.0 300

inq h/lp:1	10.00 300.00
ask h/lp:1	HP 10.00 Hz : LP 300.00 Hz

set h/lp:1 DC 300

inq h/lp:1	0.00 300.00
ask h/lp:1	HP DC Hz : LP 300.00 Hz

Range: dc, u.01, u.02, u.05 u.10, u.20, u.50, 1.0 to (Low Pass – 1 least significant digit)

☞ **Note**

The final version will incorporate a flexible token interpretation that can parse the decimal point and non-significant zeros and characters within the set process.

E.g. set h/lp:1 U.05 1000.56 0.03 1000.56

☞ **Note**

The ultra ranges are represented in the inq query in the following manner:

U.01 : 0.01

U.02 : 0.02

U.05 : 0.03

U.10 : 0.04

U.20 : 0.05

U.50 : 0.06

Channel 2 Filter (frequencies)

set h/lp:2 U.05 1000

inq h/lp:1   0.03 1000.00

ask h/lp:1   HP U.05 Hz : LP 1000.00 Hz

set h/lp:2 10 300

inq h/lp:1   10.00 300.00

ask h/lp:1   HP 10.00 Hz : LP 300.00 Hz

set h/lp:2 DC 300

inq h/lp:2   0.00 300.00

ask h/lp:2   HP   DC Hz : LP 300.00 Hz

Range: dc, u.01, u.02, u.05 u.10, u.20, u.50, 1.0 to (High Pass + 1 least significant digit)

☞ **Note**

See note for Channel 1 Filter (frequencies).

Channel 1 Filter (type)

set filt1 bp ratio

inq filt1   0

ask filt1   BP RATIO

Range: bp ratio, bp lock

Channel 2 Filter (type)

set filt2 bp lock

inq filt2   1

ask filt2   BP LOCK

Range: bp ratio, bp lock

Probe ID

set id 0

inq id   0

ask id   unknown

Channel 1 Probe

set probe1 reflection

inq probe1   2

ask probe1   Reflection

Range: absolute, bridge, reflection, locator

Channel 2 Probe

set probe2 bridge

inq probe2   1

ask probe2   Bridge

Range: absolute, bridge, reflection, locator

Gain Mix

set gainmx 10.1 18.0

inq gainmx   101 180

ask gainmx   X 10.1 dB : Y 18.0 dB

Range: −180 to +180

☞ **Note**

See note for Channel 1 Gain.

Phase Mix

set phasem 234.1

inq phasem   2341

ask phasem   234.1 deg

Range: 0 to 359.9

☞ **Note**

See note for Channel 1 Phase.

Analog O/P 1

set op:1 X1

inq op:1   0

ask op:1   X1

Range: x1, y1, x2, y2, xmix, ymix

Analog O/P 2

set op:2 ymix

inq op:2   5

ask op:2   Ymix

Range: x1, y1, x2, y2, xmix, ymix

Active

set active f1

inq active   1

ask active   F1

Range: none, f1, f2, mix

Alarm box top/bottom

set tb1 10 20

ask tb1   T1 10 : B1 20

inq tb1   10 20

Alarm box left/right

set lr1 10 20

ask lr1   L1 10 : R1 20

inq lr1   58 68

Alarm sector start/end

set se1 0 60

ask se1   S1 0 : E1 60

inq tb1   0 60

Alarm sector inner/outer

set io1 7 20

ask io1   I1 7 : O1 20

inq tb1   7 20

Action

set action tone

inq action   2

ask action   Tone

☞ **Note**

Action cannot be set if Active is set to "None".

Range: Tone&frze, none, tone, freeze

Stretch

set strch 500 ms

inq strch	2
ask strch	500 ms

Range: 50 ms, 100 ms, 500 ms, 1 s, 5 s, 10 s

Channel 1 Input Gain

set igain1 low

inq igain1	0
ask igain1	low

Range: low, high

☞ **Note**

See note for Channel 1 Gain.

Channel 2 Input Gain

set igain2 high

inq igain2	1
ask igain2	high

Range: low, high

☞ **Note**

See note for Channel 1 Gain.

Shape

set shape1 sector

inq shape1	1
ask shape1	sector

Range: box, sector

View

set view f2

inq view   1

ask view   F2

Range: f1, f2, mix, f1:f2, f1:mix, mix:f2

Display

set disply spot

inq disply   0

ask disply   Spot

Range: spot, timebase, waterfall, yt:xy

Graticule

set grat polar

inq grat   2

ask grat   polar

Range: grid 1, grid 2, grid 3 (rotary timebase only), polar, none

Spot XY

set spot 23 -10

inq spot   23 -10

ask spot   X 23 : Y -10

Range: X 0 to 177, Y -50 to 50

SpotDual

set spotd	23 -10
inq spotd	23 -10
ask spotd	X 23 : Y -10

Range: X 0 to 177, Y -50 to 50

Spot information

set spinfo CH1	
ask spinfo	CH1
inq spinfo	1

Software version

inq softver	165= 1.00,prb=00.13,kyd=00.03,dsp=01.00,enc=00.00
ask softver	165= 1.00,prb=00.13,kyd=00.03,dsp=01.00,enc=00.00

Spot Info

set spotinfo none	
inq spotinfo	0
ask spotinfo	none

Range: none, f1, f2

Persistance

set pers permanent	
inq pers	6
ask pers	permanent

Range: 0.1s, 0.2 s, 0.5 s, 1.0 s, 5.0 s, 10.0 s, 15.0 s, permanent

Sweep

set sweep 1.0 s

inq sweep   3

ask sweep   1.0 s

Range: 0.1s, 0.2 s, 0.5 s, 1.0 s, 2.0 s, 5.0 s, 10 s, 20 s, 50 s

Save

set save setup

inq save   0

ask save   setup

Range: Setup, trace

Recall

set recall setup

inq recall   0

ask recall   setup

Range: Setup, trace

Mode

set mode Normal dual

inq mode   1

ask mode   normal dual

Range: normalsingle, normal dual, rotarysingle, conductivity

Load

set load 8.2

inq load   1

ask load   8.2

Range: 1.3, 8.2, 22, 47, 82, 120

Drive

set fgdrive +8

inq fgdrive   2

ask fgdrive   +8

Range: −8, 0, +8

Balance/Clear

set balclr both

inq balclr   0

ask balclr   both

Range: both, split, single

Mode

set mode normal dual

inq mode   1

ask mode   NormalDual

Range: Normal single, normal dual, rotary single, conductivity

Power Down

set p/down off

inq p/down   0

ask p/down   off

Range: off, 5 min, 10 min, 15 min, 20 min

Key Click

set keyclk on

inq keyclk   0

ask keyclk   on

Range: on, off

Contrast

set ctrast 20

inq ctrast   20

ask ctrast   20

Range: 0 to 32

Screen Mode

set vidmod invert

inq vidmod   1

ask vidmod   invert

Range: normal, invert

Trace Enhance

set trcenh on

inq trcenh   1

ask trcenh   on

Range: off, on

Language

set lang English

ask lang   English

inq lang   0

Range: English, French, German, Spanish, Portugués, Chinese, Japanese

☞ **Note**

Portugués is difficult to set serially as it contains an accented character.

The ask query will give a strange response in some languages as the text contains accented characters.

Baud

set baud 9600

ask baud   115200

inq baud   3

Range: 9600, 19200, 57600, 115200, 230400, 345600

☞ **Note**

This remote command must be used with caution as changing this will cause the connected terminal program to be unable to communicate until the terminal is reset to the new baud rate.

Time

set hm 10:25

inq hm   10 25

ask hm   10:25

Date

set date 12 aug 03

inq date   12 7 3

ask date   12 Aug 3

Rotary Frequency

set freq1 10 khz

ask freq1   10 KHz

inq freq1   8292

Range: 10 kHz to 2 MHz

Rotary RPM

set rpm 1500

inq rpm   2

ask rpm   1500

Range: 600, 1000, 1500, 2000, 2500, 3000

Calibration Block 1

set cal1 59.65

ask cal1	59.65
inq cal1	172985

👉 **Note**

The return from Inq has to be divided by 2900 to get the value in %IACS.

Range: 40.00 to 110.0

Calibration Block 2

set cal2 8.88

ask cal2	8.88
inq cal2	25752

👉 **Note**

The return from Inq has to be divided by 2900 to get the value in %IACS.

Range: 1.00 to 30.00

Conductivity High Alarm

set hialm 50

ask hialm	50
inq hialm	50

Range: (Low Alarm + 2) to 110

Conductivity Low Alarm

set loalm 40

ask loalm	40
inq loalm	40

Range: 0 to (High Alarm – 2)

Conductivity Coating Thickness Alarm

set ctalm 25

ask ctalm   25

inq ctalm   25

Range: 5 to 100

Conductivity Units

set cond %iacs

ask cond   %IACS

inq cond   0

Range: %iacs, ms/m

Conductivity Dimensions

set ctunit imperial

ask ctunit   imperial

inq ctunit   0

Range: imperial, metric

Remote Key Responses

This is the serial support for key presses. In other words the UP, DOWN, LEFT, RIGHT, MENU etc keys can now be simulated from the serial port.

Serial commands	Action
„key up"	Up arrow
„key down"	Down arrow
„key left"	Left arrow
„key right"	Right arrow
„key menu"	**menu** key
„key ok"	**OK** key
„key exec"	**exec** key
„key f1"	**F1** key
„key f2"	**F2** key
„key f3"	**F3** key
„key f4"	**F4** key
„key f5"	**F5** key
„key f6"	**F6** key
„key bal"	Left **balance** key
„key clr"	Left **clear** key
„key frz"	Left **freeze** key
„key lbal"	Long left **balance** key
„key lclr"	Long left **clear** key
„key lfrz"	Long left **freeze** key
„key lf1"	Long **F1** key
„key lf2"	Long **F2** key
„key lf3"	Long **F3** key
„key lf4"	Long **F4** key
„key lf5"	Long **F5** key
„key lf6"	Long **F6** key
„key lexec"	Long **exec** key
„key rbal"	Right **balance** key
„key rclr"	Right **clear** key
„key rfrz"	Right **freeze** key
„key lrbal"	Long right **balance** key
„key lrclr"	Long right **clear** key
„key lrfrz"	Long right **freeze** key
„key lok"	Long **OK** key