Elcometer 331

Concrete Covermeter

Model SH · Model TH

Operating Instructions

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The Elcometer 331 Concrete Covermeter has been tested in accordance with EU regulations governing Electro-magnetic compliance and it meets the required directives.

Note: Readings may be affected if the unit is operated within a radio frequency electromagnetic strength of greater than 3 V/m.

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A copy of this Instruction Manual is available for download on our Website via www.elcometer.com/downloads.

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Thank you for your purchase of this Elcometer 331 Concrete Covermeter. Welcome to Elcometer.

Elcometer are world leaders in the design, manufacture and supply of inspection equipment for concrete and coatings.

Our concrete inspection products include a comprehensive range of concrete, and civil engineering inspection equipment. Our coatings products cover all aspects of coating inspection, from development through application to post application inspection.

The Elcometer 331 Concrete Covermeter is a world beating product. With the purchase of this Covermeter you now have access to the worldwide service and support network of Elcometer. For more information visit our website at www.elcometer.com

1 ABOUT YOUR COVERMETER

The Elcometer 331 Concrete Covermeter is a handheld Covermeter for fast and accurate location, orientation and measurement of concrete reinforcement bars (high tensile steel or stainless steel). Your Covermeter can also be used in half-cell mode to help assess the potential for corrosion of the reinforcement bars.

<div align="center">

Locate   •   Identify orientation

Measure depth of cover   •   Measure diameter   •   Measure half-cell potential

</div>

The Covermeter is available in five versions:

- Model B (entry level)
- Model BH (entry level with half-cell potential measurement)
- Model SH (intermediate level with half-cell potential measurement)
- Model TH (data logging with half-cell potential measurement)
- Model THD (data logging with half-cell potential measurement and stainless steel reinforcement bar detection)

This manual describes the operation of the **Elcometer 331 Model SH and Model TH**.

All versions of the Covermeter feature an easy-to-use menu-driven graphical interface which guides the user during setup of the Covermeter and during measurement.

A range of fully interchangeable search heads and half-cell probes is available to suit your requirements. Search heads include a keypad which allows remote operation of the Covermeter. See "Search heads" on page 55 for full details.

Your Covermeter is packed in cardboard and plastic packaging. Please ensure that this packaging is disposed of in an environmentally sensitive manner. Consult your Local Environmental Authority for further guidance.

To maximise the benefits of your new Elcometer 331 Concrete Covermeter please take some time to read these Operating Instructions. Do not hesitate to contact Elcometer or your Elcometer supplier if you have any questions.

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ABOUT YOUR COVERMETER

1.1 Features

Feature	B	BH	SH	TH	THD	Page
			Elcometer 331 Model			
Menu-driven backlit graphical user interface	✓	✓	✓	✓	✓	9
3 sizes of search head + borehole probe	✓	✓	✓	✓	✓	55
Weather proof to IP65	✓	✓	✓	✓	✓	
International standard bar size database in memory	✓	✓	✓	✓	✓	25
Multiple languages	✓	✓	✓	✓	✓	11
Automatic bar size estimate	✗	✗	✓	✓	✓	26
Additional orthogonal bar size calculation	✗	✗	✓	✓	✓	27
Locate mode	✓	✓	✓	✓	✓	34
Under Cover mode - alerts user when cover is below minimum	✗	✗	✓	✓	✓	35
Maxpip™ mode - for fast identification of reinforcement bar layout	✗	✗	✓	✓	✓	35
Memory - up to 10 linear batches, up to 1000 readings in each batch	✗	✗	✓	✗	✗	40
Memory - multiple linear and grid batches, up to 240 000 readings	✗	✗	✗	✓	✓	40
Text fields for input of user data in each batch	✗	✗	✓	✓	✓	41
Date and time stamping	✗	✗	✗	✓	✓	41
Statistical analysis of readings and batches	✗	✗	✓	✓	✓	37
Alarm if reading is outside limits	✗	✗	✓	✓	✓	36
Transfer readings and statistics to a computer	✗	✗	✓	✓	✓	52
CoverMaster® software for batch setup, data transfer and reporting	✗	✗	✓	✓	✓	53
Half-cell potential measurement	✗	✓	✓	✓	✓	31
Plot mode	✗	✗	✗	✓	✓	49
Stainless steel reinforcement bar detection and measurement	✗	✗	✗	✗	✓	-
Upgradeable	✗	✗	✓	✗	✗	62

Note: *Features described in these instructions apply to all models unless otherwise indicated in the text.*

1.2 What this box contains

- Elcometer 331 Model SH or Model TH Concrete Covermeter
- Search head[a] connecting cable
- Rechargeable battery pack and battery charger
- Earphone
- Shoulder strap
- CD containing CoverMaster® software
- Data transfer cable
- Plastic carrying case
- Operating instructions

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a. Search head (and half-cells) must be ordered separately. See "Accessories" on page 64 for full details of search heads and half-cell kits.

2
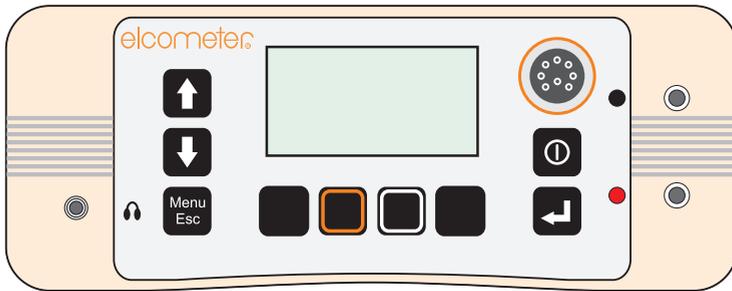
Figure 1. Elcometer 331 Concrete Covermeter

1.3 Standards

The Elcometer 331 Concrete Covermeter can be used in accordance with the following National and International Standards: BS1881:204, ASTM C876, DGZfP:B2, DGZfP:B3, TR60, UN110174

1.4 Conventions in these instructions

A simple menu structure helps you get the most from your Covermeter - see "The menus" on page 13. There are many references to this menu structure in these instructions.

As an example, the LANGUAGE option which is in SETUP from the MAIN MENU would be shown in these instructions as:

☞ MENU / SETUP / LANGUAGE

These instructions include images of Elcometer 331 screens with units set to millimetres (mm). Similar screens will be seen when the Covermeter is set to inches.

2 QUICK-START

To configure the Covermeter quickly and start taking readings:

For an overview of your Covermeter menus and functions, see pages 13 to 17.

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3 GETTING STARTED

This section of the instructions is intended for first-time users of the Covermeter. It contains essential information about batteries, assembling the Covermeter, the controls and the display. At the end of this section you will be ready to take readings.

3.1 The power supply

Your Covermeter is powered by a rechargeable Lithium-Ion[b] battery pack which can be charged inside or outside the Covermeter.

One battery pack is supplied with the Covermeter. To increase productivity on site, Elcometer recommends that you purchase a spare battery pack which can be charged while you are using your Covermeter. To order an additional battery pack (see "Accessories" on page 64), contact Elcometer or your local Elcometer supplier.

Charging the batteries

The rechargeable battery must be fully charged before using the Covermeter for the first time. Use only the charger supplied with your Covermeter to charge the battery. Use of any other type of charger is a potential hazard, may damage your Covermeter and will invalidate the warranty. Do not attempt to charge any other batteries with the supplied charger.

Always charge the battery indoors. To prevent overheating, ensure that the charger is not covered.

1. Referring to Figure 2, unscrew the retaining screw (1) and open the interface access cover (2) on the rear of the Covermeter.
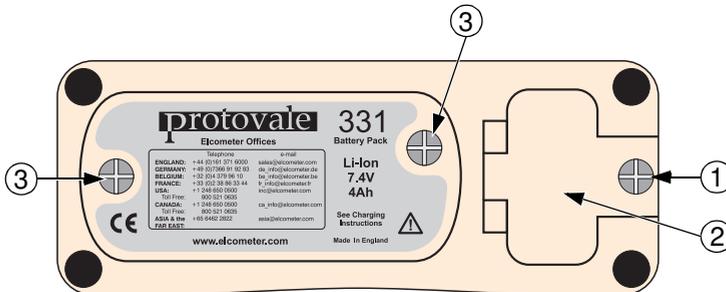
Figure 2. Covermeter rear panel

2. Connect the lead from the charger into the socket marked 'Charger Input' behind the interface access cover (Figure 3).

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b.   The Covermeter is **not** designed to operate using dry cell batteries.

The Covermeter will automatically switch off when the lead from the charger is connected.

(battery in the Covermeter)	(battery removed)

Figure 3. Charging the batteries

3. Plug the charger supplied into the mains supply. The LED indicator on the charger will glow orange.
4. Leave the gauge charging for at least 4 hours. The LED indicator changes colour from orange to green when charging is complete.
5. When charging is complete, disconnect the charger from the mains supply before removing the lead from the Covermeter.

To remove the battery pack for charging outside the Covermeter, unscrew the two battery pack retaining screws (Figure 2, item 3) at the rear of the Covermeter and slide out the battery pack. To charge the battery once it has been removed, connect the lead from the charger into the socket on the battery pack (Figure 3).

Warning: Do not allow metallic objects to come into contact with the battery terminals; this may cause a short circuit and result in permanent damage to the battery.

Warning: Do not attempt to connect the supply side of the battery charger to generators or any other medium to high power source other than the single phase 50 Hz AC mains outlet supplied from an approved and safe mains switchboard. Connection to other supply sources such as generators or inverters may have the potential to damage the charger, the battery and/or the gauge, invalidating warranty.

Battery condition indicator

The state of charge of the battery is shown by a symbol on the display:

Symbol	Battery charge/action required
	70% to 100%
	40% to 70%
	20% to 40%
	10% to 20%, charging recommended
	<10%, Covermeter beeps every 10 seconds and symbol flashes - immediate charging required
	5 loud beeps, Covermeter switches off automatically

3.2 Fitting search heads

The Covermeter **must be switched off** when search heads are fitted or removed.

Connect the search head to the Covermeter using the supplied connecting cable. The connecting cable is fitted with a metal screw-type connector at each end. To fit a connector, align the keyway, push the connector into place and then tighten the metal collar.

A range of search heads is available for your Covermeter - see "Search heads" on page 55 for full details. The search head icon on the reading screen indicates the type of search head connected to the Covermeter:

⊞▬	Narrow pitch
⊞▬	Standard
⊞▬	Deep cover
⟵▭▭▭	Borehole probe - set to forward-looking operation
⟰▭▭▭	Borehole probe - set to sideways-looking operation

The Covermeter must be zeroed after a search head has been fitted and after changing between high-tensile and stainless modes - the display will show PLEASE ZERO and the ZERO softkey will flash to remind you.

The metal and plastic bracket on the outside of the main unit is a storage clip for standard and narrow pitch search heads. The bracket provides a convenient place to store the search head while the Covermeter is not in use.

Figure 4. Search head storage clip

3.3 Identifying search heads

The four search head types are one of two physical sizes. The Narrow Pitch and Standard heads are in a small package which fits in the rails on the top of the instrument. The Deep Cover and THD

search heads are larger and do not fit in the rails. Each head is fitted with a label which identifies its type for ease of recognition. The software also shows an indication of the search head type as indicated in section 3.2.

3.4 Fitting half-cell probes

Connect the probe and cables as shown in Figure 5. The search head can be left connected to the gauge at the same time as the half-cell probe, however for ease of use it is recommended that the search head is removed and stored in the carry case.

Black cable
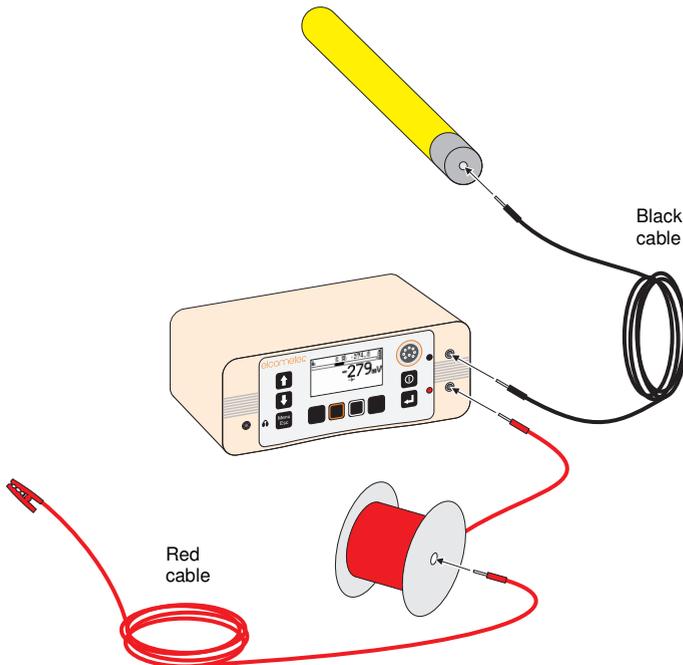
Red cable

Figure 5. Fitting half-cell probe and cables

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3.5 The controls

All functions of the Covermeter can be controlled using the keypad on the main unit. There are two types of keys on the keypad; fixed function keys and 'soft' keys (Figure 6)..

Scrolls up/down through menus and lists of values

Increases/ decreases alphanumeric values

Increases/ decreases sensitivity in locate mode

Switches the Covermeter on or off

Selects menu items

Toggles tick boxes on/off

Confirms values entered on display

Adds reading to statistical analysis

Adds reading to batch (if batch is open)

Accesses menus

Escapes from menus

Discards values entered on display

The function of these 'soft' keys varies and is defined by symbols and text on the screen

Figure 6. Covermeter main keypad

Search head keypad

The keys on the search head mimic the functions of some of the keys on the main unit.

The function of the [enter ↵] key and the [menu/esc] key is identical to the corresponding keys on the main unit.

The function of the [scroll up s zero 0] and [scroll down t size] keys depends upon whether the reading screen is displayed or not.

Selects menu items

Toggles tick boxes on/off

Confirms values entered on display

Adds reading to statistical analysis

Adds reading to batch (if batch is open)

Zeros the Covermeter (only when the display shows the reading screen)

Scrolls up through menus and lists of values

Increases numerical values

Bar size selection (only when the display shows the reading screen)

Scrolls down through menus and lists of values

Decreases numerical values

Accesses menus

Escapes from menus

Discards values entered on display

Figure 7. Search head keypad

3.6 Switching the Covermeter on and off

Note: Before switching the Covermeter on for the first time read *"Selecting a language" on page 11.*

To switch the Covermeter on, press [**⏻**].

To switch the Covermeter off, press and hold [**⏻**] for two seconds. The Covermeter will beep, two single tones followed by a double tone, and will then switch off.

The Covermeter includes an automatic switch off feature which will help to extend the battery life (time between charges). The automatic switch off time can be set to OFF, 5, 6, 7, 8, 9 or 10 minutes.
☞ MENU / SETUP / AUTO SWITCH OFF

A countdown timer is displayed on the screen 60 seconds before the Covermeter automatically switches off. The timer counts down from 60 to 0 to warn you that the Covermeter is about to switch off. Press any key while the countdown timer is displayed to cancel automatic switch off.

3.7 The display

Take some time to familiarise yourself with the information shown on the display of your Covermeter. The display shows:
- Welcome information
- Measurement information
- Menus to configure the Covermeter and control functions
- Help and miscellaneous information

When the Covermeter is switched on an opening (welcome) information screen[c] may be displayed briefly before the main reading screen appears.

The information shown depends upon whether you are taking measurements, reviewing readings or setting up the Covermeter.

The main screen displayed (while you are taking measurements) is the Reading Screen.

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c.   The opening (welcome) screen can be disabled.

     ☞ MENU / SETUP / OPENING SCREEN.
     Customised welcome screens can be created on a PC and downloaded into the gauge - see "Personalised welcome screen" on page 61.

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Reading screen (when measuring depth of cover)
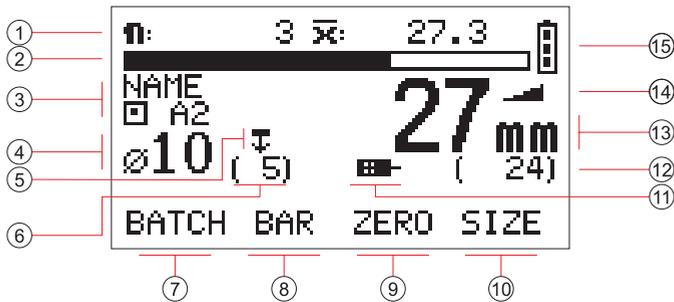
1. Statistics (37)
2. Signal strength indicator bar (18)
3. Batch name/Cell coordinates (40)
4. Bar size/number - input by user (25)
5. Reading out of limits indicator (36)
6. Bar size - Autosize estimate (26)
7. Batch softkey (45)
8. Bar softkey

9. Zero softkey
10. Size softkey
11. Search head type (6)
12. Depth of cover - Autosize estimate (26)
13. Depth of cover (22
14. Sensitivity/Maxpip™/Under Cover (33)
15. Battery condition indicator (5)

Refer to page numbers in brackets ( ) for more information.

Reading screen (when measuring half-cell potential)
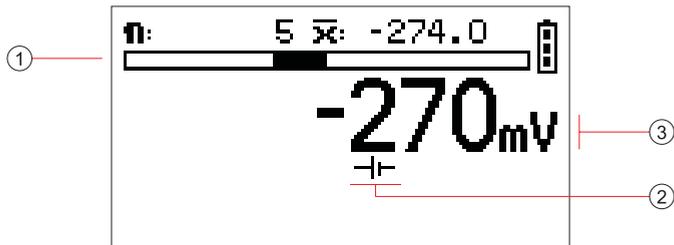
1. Half-cell potential - bar graph (zero at centre)
2. Half-cell reading indicator
3. Half-cell potential - numerical

Symbols

A wide range of symbols is used on the display. The meaning of all these symbols is stored in the Covermeter.
☞ MENU / ABOUT / HELP

LCD contrast

Adjust the contrast of the display to suit lighting conditions.
☞ MENU / SETUP / LCD CONTRAST

Backlight

The display includes a backlight which illuminates the display for 10 seconds after any key is pressed and during measurements. Switch the backlight on or off as required. Switching the backlight off will increase battery life.

☞ MENU / BACKLIGHT

Time and date (Model TH only)

The time and date can be displayed on the top line of the reading screen.

☞ MENU / SETUP / DISPLAY / SHOW TIME

3.8 Selecting a language

Your Covermeter has a number of built-in languages. When the Covermeter is switched on for the first time after dispatch from the Elcometer factory the display will show the language selection screen (Figure 8).

```
 DEUTSCH      2.1
▶ENGLISH      1.5
 ESPAÑOL      1.8
 FRANÇAISE    1.9
 ITALIANO     1.9
 NEDERLANDS   1.9
 SVENSKA      1.6
```

Figure 8. Language selection screen

At first switch on

1. Press [⇧] or [⇩] to locate language required.
2. Press [⏎] to activate the selected language.

The Covermeter operates in the new language until changed.

At any time

1. Switch Covermeter off.
2. Press and hold left hand softkey.
3. Press [⏻] to switch on Covermeter.

    The display will show the language selection screen with the current language highlighted by the cursor.

4. Release left hand softkey.
5. Press [⇧] or [⇩] to locate language required.
6. Press [⏎] to activate the selected language.

Alternatively, select a language at any time.

☞ MENU / SETUP / LANGUAGE

3.9 Computer interface

Your Covermeter is fitted with an RS232 interface. The interface is located under the interface access cover at the rear of the Covermeter - see Figure 2 and Figure 3 on page 4.

This 5-pin RS232 interface is used with the data transfer cable to connect the Covermeter to the RS232 port[d] of a computer. When the Covermeter is connected to a computer you can:

•   Download personalised screens to the Covermeter (see "Personalised welcome screen" on page 61).

•   Transfer measurement data to a PC or printer (see "Transferring readings to a computer" on page 52).

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d. An RS232 to USB transfer cable is available which allows you to connect your Covermeter to a USB port on your computer. For ordering information, see "Accessories" on page 64.

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3.10 Using the earphone

To use the earphone, plug the connector into the 3.5 mm socket marked ⌒ on the front of the Covermeter. Replacement earphones are available as an optional accessory - see "Accessories" on page 64.

3.11 Zeroing the Covermeter

This action is requested by the Covermeter whenever it is switched on with a search head attached, when a cover batch is opened, on entering orthogonal SIZE mode, and periodically thereafter (at least once every 10 minutes). The user can choose to zero the instrument at any time.

If zeroing is required, the cover display is blanked, the user is prompted, and no further readings can be entered until zeroing is completed.

To zero the Covermeter, hold the search head in the air well away from any metal and press the ZERO softkey. Zeroing is complete when the ZERO softkey indicator stops flashing. Sometimes more than one press of the ZERO softkey will be required; this is quite normal.

When a half-cell probe is attached to the instrument, zeroing is not required.

4 THE MENUS

To access the menus press the MENU softkey. To return to the reading screen quickly, press and hold the MENU softkey.

SET THRESHOLD
COVER   50mm
HALFCELL   -250mV

LOW LIMIT
LOW LIMIT ON
LOW LIMIT   50mm

HIGH LIMIT
HIGH LIMIT ON
HIGH LIMIT   150mm

SET DATE FORMAT
DD/MM/YYYY
MM/DD/YYYY

BAUD RATE
1200
2400
4800
9600
14400
19200

PLOT OPTIONS
GREYSCALE MIN/MAX
GREYSCALE LIMITS
THRESHOLD VIEW
SET THRESHOLD

SELECT STATS
NO. OF READINGS
MEAN
STD DEVIATION
COEF OF VARIAT'N
LOWEST READING
HIGHEST READING
UNDER RANGE
BELOW LIMIT
ABOVE LIMIT
OVER RANGE
BLANK

SOUND MODE
LOCATE
MAXPIP
UNDER COVER

UNITS
COVER
TEMPERATURE

LIMITS
LOW LIMIT
HIGH LIMIT

CLOCK
TIME/DATE
SET DATE FORMAT

OUTPUT   9600
BAUD RATE
RS232 BIT IMAGE
RS232 PLAIN TEXT

DISPLAY
SHOW TIME
STATS ON LCD
SHOW AUTOSIZE INFO

DATA LOGGER
EXIT BATCHING
OPEN NEW BATCH
OPEN EXISTING BATCH
CLONE BATCH
REVIEW BATCH
PLOT BATCH
PLOT OPTIONS
EDIT BATCH TAGS
DELETE BATCH
DELETE ALL BATCHES
FREE MEMORY

STATISTICS
ENLARGE STATS
CLEAR STATS
SELECT STATS

INSTRUMENT MODE
COVER
HALFCELL

PRINT/OUTPUT
SINGLE BATCH
ALL BATCHES
CURRENT STATISTICS

SETUP
SOUND MODE
UNITS
LIMITS
CLOCK
OUTPUT
DISPLAY
BEEP VOLUME
LANGUAGE
AUTO SWITCH OFF
OPENING SCREEN
LCD CONTRAST

ABOUT
GAUGE INFORMATION
PROBE INFORMATION
CONTACT
HELP

RESET
INTL GAUGE
USA GAUGE

MENU
DATA LOGGER
BACKLIGHT
STATISTICS
INSTRUMENT MODE
PRINT/OUTPUT
SETUP
ABOUT
RESET

SHADED AREAS
- MODEL TH ONLY -

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4.1 MENU

DATA LOGGER . . . . Opens Data logger menu . . . . See 4.2 DATA LOGGER
BACKLIGHT. . . . . Toggles the display backlight on or off
STATISTICS . . . . Opens Statistics menu . . . . See 4.3 STATISTICS
INSTRUMENT MODE . . . . . . Opens Instrument mode menu . . . . See 4.4 INSTRUMENT MODE
PRINT/OUTPUT. . . . . Opens Print/output menu . . . . See 4.5 PRINT/OUTPUT
SETUP . . . . Opens Setup menu . . . . See 4.6 SETUP
ABOUT. . . . . Opens About menu . . . . See 4.7 ABOUT
RESET . . . . Opens Reset menu . . . . See 4.8 RESET

Note: *When Backlight is on, the display is illuminated for approximately 30 seconds after any key is pressed and during measurements.*

4.2 DATA LOGGER

EXIT BATCHING . . . . Switches off data logger
OPEN NEW BATCH . . . . Opens a new memory batch and starts data logger
OPEN EXISTING BATCH . . . Opens existing memory batch and starts data logger
CLONE BATCH . . . . Creates a clone of an existing memory batch and starts data logger
REVIEW BATCH . . . . Opens an existing memory batch for viewing of readings
PLOT BATCH[e]. . . . . Plots batch readings on the display
PLOT OPTIONS[f] . . . . Sets plot options . . . . See 4.9 PLOT OPTIONS
EDIT BATCH TAGS. . . . . Opens an existing memory batch for editing of tags
DELETE BATCH . . . . Deletes one memory batch
DELETE ALL BATCHES . . . . Deletes all memory batches
FREE MEMORY . . . . Displays amount of free memory (%)

See "Batching/Data logging" on page 40

4.3 STATISTICS

ENLARGE STATS . . . . Displays statistics in a larger font size
CLEAR STATS. . . . . Resets to zero all statistical values
SELECT STATS. . . . . Opens Select stats menu . . . . See 4.10 SELECT STATS

See "Statistics" on page 37

4.4 INSTRUMENT MODE

COVER . . . . Sets the instrument to measure depth of cover
HALFCELL. . . . . Sets the instrument to measure half-cell potential

4.5 PRINT/OUTPUT

SINGLE BATCH. . . . . Prints or outputs to PC a single memory batch
ALL BATCHES. . . . . Prints or outputs to PC all memory batches
CURRENT STATISTICS . . . . Prints or outputs to PC the current statistics

See "Transferring readings to a computer" on page 52

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e.   'Plot batch' - available on Elcometer 331 Model TH only.
f.   'Plot options' - available on Elcometer 331 Model TH only.

4.6 SETUP

SOUND MODE . . . . Opens Sound mode menu . . . . See 4.11 SOUND MODE
UNITS . . . . Opens Units menu . . . . See 4.12 UNITS
LIMITS . . . . Opens Limits menu . . . . See 4.13 LIMITS
CLOCK[g] . . . . Opens Clock menu . . . . See 4.14 CLOCK
OUTPUT . . . . Opens Output menu . . . . See 4.15 OUTPUT
DISPLAY . . . . Opens Display menu . . . . See 4.16 DISPLAY
BEEP VOLUME . . . . Use Scroll keys to select beep volume 0 (off) to 5 (maximum)
and then press Enter
LANGUAGE . . . . Use Scroll keys to select menu language and then press enter
AUTO SWITCH OFF . . . . Use Scroll keys to select auto switch off time, 5 to 10 minutes
or off and then press Enter
OPENING SCREEN . . . . Press Enter to toggle the opening screen on or off
LCD CONTRAST . . . . Use Scroll keys to select LCD contrast, 0 to 8 and then press Enter

4.7 ABOUT

GAUGE INFORMATION . . . . Press Enter to display technical information about the
Covermeter
PROBE INFORMATION . . . . Press Enter to display technical information about the search
head
CONTACT . . . . Press Enter to display Elcometer offices worldwide and
(if programmed) Supplier contact details
HELP . . . . Press Enter to display an explanation of all the symbols
used on the display

4.8 RESET

INTL GAUGE . . . . Press Enter to Reset Covermeter to International settings[h]
(DD/MM/YYYY date format, metric units, etc.)
USA GAUGE . . . . Press Enter to Reset Covermeter to USA settings[i]
(MM/DD/YYYY date format, imperial units, etc.)

Note: The Covermeter will display a Yes/No confirmation screen before reset is activated.

4.9 PLOT OPTIONS[j]

GREYSCALE MIN/MAX . . . . Sets plot greyscale between the minimum and maximum readings
in the batch
GREYSCALE LIMITS . . . . . . Sets plot greyscale between the minimum and maximum limits in
the batch
THRESHOLD VIEW . . . . Sets plot to white, or black below an adjustable threshold
SET THRESHOLD . . . . Opens Set threshold menu . . . . See 4.17 SET THRESHOLD

See "Plot options" on page 50

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g. 'Clock' - available on Elcometer 331 Model TH only.
h. International settings can also be activated at switch on:
Press and hold third softkey ■■◉■ and switch on gauge.
i. USA settings can also be activated at switch on:
Press and hold fourth softkey ■■■◉ and switch on gauge.
j. 'Plot options' - available on Elcometer 331 Model TH only.

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4.10 SELECT STATS

NO. OF READINGS . . . . Press Enter to toggle on or off
MEAN. . . . . Press Enter to toggle on or off
STD DEVIATION . . . . Press Enter to toggle on or off
COEF OF VARIAT'N . . . . Press Enter to toggle on or off
LOWEST READING. . . . . Press Enter to toggle on or off
HIGHEST READING . . . . Press Enter to toggle on or off
UNDER RANGE. . . . . Press Enter to toggle on or off
BELOW LIMIT . . . . Press Enter to toggle on or off
ABOVE LIMIT. . . . . Press Enter to toggle on or off
OVER RANGE . . . . Press Enter to toggle on or off
BLANK[k] . . . . Press Enter to toggle on or off

Note: Only two statistics from the above list can be toggled to 'on' at the same time.

4.11 SOUND MODE

LOCATE. . . . . Press Enter to toggle on or off
MAXPIP . . . . Press Enter to toggle on or off
UNDER COVER. . . . . Press Enter to toggle on or off

Note: Locate cannot be toggled to 'on' at the same time as either Maxpip™ or Under Cover.

> **See "Sound mode/Detection mode" on page 33**

4.12 UNITS

COVER . . . . Press Enter, use Scroll keys to select units (mm/inch) and then
press Enter
TEMPERATURE . . . . Press Enter, use Scroll keys to select units (°C/°F) and then
press Enter

4.13 LIMITS

LOW LIMIT. . . . . Opens Low limit menu. . . . . See 4.18 LOW LIMIT
HIGH LIMIT . . . . Opens High limit menu . . . . See 4.19 HIGH LIMIT

4.14 CLOCK[l]

TIME/DATE . . . . Use Scroll keys and Left/Right softkeys to set time and date
and then press Enter
SET DATE FORMAT . . . . Opens Set date format menu . . . . . See 4.20 SET DATE FORMAT

4.15 OUTPUT

BAUD RATE. . . . . Opens Baud rate menu . . . . See 4.21 BAUD RATE
RS232 BIT IMAGE . . . . Press Enter to toggle on or off
RS232 PLAIN TEXT. . . . . Press Enter to toggle on or off

Note: RS232 Bit Image and RS232 Plain Text cannot be toggled to 'on' at the same time.

> **See "Transferring readings to a computer" on page 52**

---

k. 'Blank' - available on Elcometer 331 Model TH only.
l. 'Clock' - available on Elcometer 331 Model TH only.

4.16 DISPLAY

SHOW TIME[m] . . . . Press Enter to toggle on or off
STATS ON LCD . . . . Press Enter to toggle on or off
SHOW AUTOSIZE INFO. . . . Press Enter to toggle on or off

Note: *Time and Stats cannot both be toggled to 'on' at the same time.*

4.17 SET THRESHOLD[n]

COVER . . . . Press Enter, use Scroll keys to adjust value and then press Enter
HALFCELL . . . . Press Enter, use Scroll keys to adjust value and then press Enter

  See "Plot options" on page 50

4.18 LOW LIMIT

LOW LIMIT ON . . . . Press Enter to toggle on or off
LOW LIMIT . . . . Use Scroll keys to adjust low limit and press Enter

  See "Setting limits" on page 36

4.19 HIGH LIMIT

HIGH LIMIT ON . . . . Press Enter to toggle on or off
HIGH LIMIT . . . . Use Scroll keys to adjust high limit and press Enter

  See "Setting limits" on page 36

4.20 SET DATE FORMAT[o]

DD/MM/YYYY . . . . Press Enter to toggle on or off
MM/DD/YYYY . . . . Press Enter to toggle on or off

4.21 BAUD RATE

1200. . . . . Select using Scroll keys and press Enter to select
2400. . . . . Select using Scroll keys and press Enter to select
4800. . . . . Select using Scroll keys and press Enter to select
9600. . . . . Select using Scroll keys and press Enter to select
14400. . . . . Select using Scroll keys and press Enter to select
19200. . . . . Select using Scroll keys and press Enter to select

---

m. 'Show time' - available on Elcometer 331 Model TH only.
n. 'Set threshold' - available on Elcometer 331 Model TH only.
o. 'Set date format' - available on Elcometer 331 Model TH only.

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5 LOCATING REINFORCEMENT BARS

This section describes how to set up and use your Covermeter to locate reinforcement bars.

5.1 Before you start

• *Are you using the correct search head?*
  See "Search heads" on page 55.

5.2 To locate a single layer of reinforcement bars

1. Connect the search head to the Covermeter.
2. Switch on the Covermeter.
3. Ensure the instrument is set to Cover mode.

   ☞ MENU / INSTRUMENT MODE / COVER

```
     INSTRUMENT MODE
►COVER             ⊢⊷○
 HALFCELL          ─╫─
```
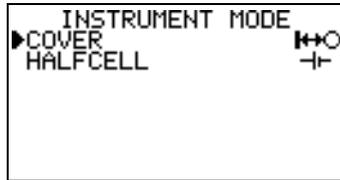
4. Zero the Covermeter.
5. Set sound mode to 'locate' - ☞ MENU / SETUP / SOUND MODE / LOCATE[p].
6. Adjust sensitivity - see "Adjusting sensitivity" on page 34.
7. Align the search head parallel to the reinforcement bars being sought.
8. Maintain the alignment of the search head and move the search head across the search area (Figure 9).
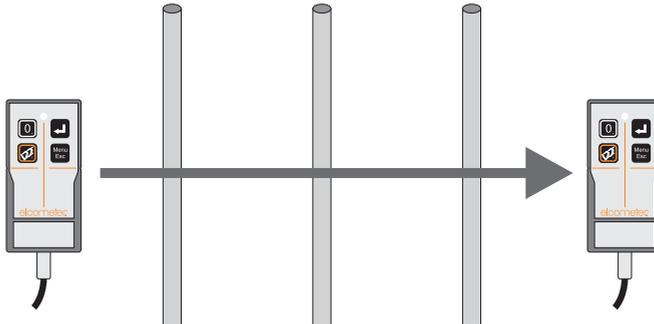
Figure 9. Align search head and scan across bars

When the search head is approaching a reinforcement bar:

• The Covermeter will start to emit a sound which will increase in pitch as the search head moves closer to the bar.

---

p. Although Locate Mode is specified here, other Sound/Detection modes are available - see "Sound mode/ Detection mode" on page 33 for further details.

- The signal strength indicator bar on the display will increase in length.
- The depth of cover on the display will show a number.
- The LED on the search head will start to glow.

The search head is aligned directly over a reinforcement bar when:

- The pitch of the sound is at its highest.
- The signal strength indicator bar is at its maximum.
- The depth of cover is at its minimum.
- The LED is glowing at its most intense.

9. Record the position of the reinforcement bar (using chalk or similar).

5.3 To locate two layers of reinforcement bars

Layers of reinforcement bars are typically orientated at right angles to each other. To locate individual layers of reinforcement bars, carry out the procedure in section 5.2 for each layer.

If the bars in the two layers are of similar size (Figure 10):

Search for the nearer layer first; it gives a stronger signal, and is least influenced by the other bars. Then search for the second layer, this time scanning the head in lanes between the previously located positions of the first layer of bars.

- The first scan locates the nearer (top) layer.
- The second scan locates the second (bottom) layer.
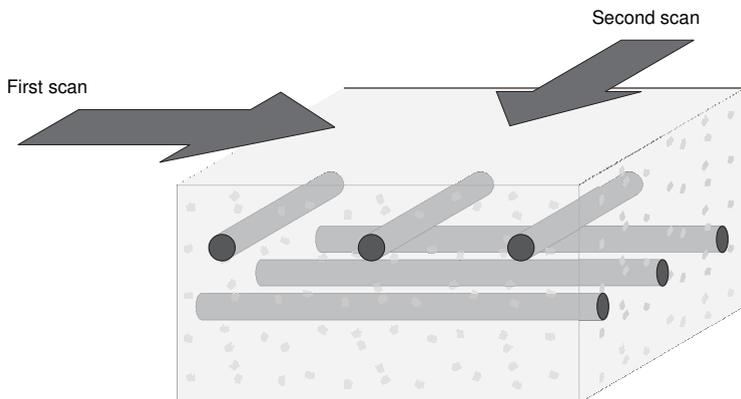
Figure 10. Scanning layers of bars of equal size

If the bars in the nearer layer are thin compared with those in the deeper layer (Figure 11):

Search for the deeper layer first; it gives a stronger signal, and is least influenced by the other bars. Then search for the nearer layer, this time scanning the head in lanes between the now-known positions of the deeper layer of bars.

- The first scan locates the second (bottom) layer.

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• The second scan locates the nearer (top) layer.
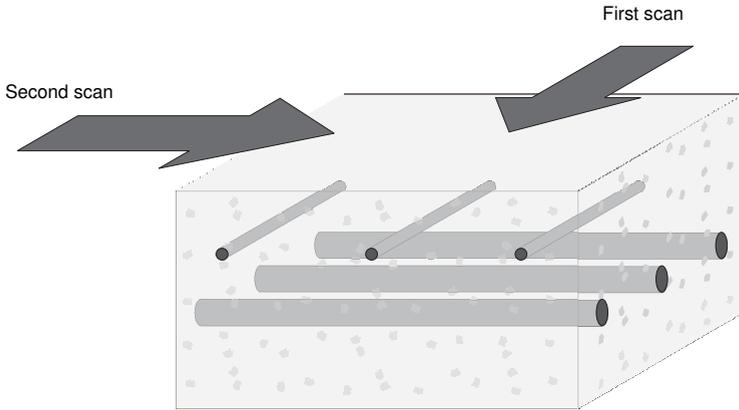
Figure 11. Scanning layers of bars of different size

(This situation is typical of a nearer layer consisting of relatively thin tie-wires or stirrups, and the deeper layer consisting of much larger main structural bars.)

5.4 To determine the orientation of a reinforcement bar

1. Locate the position of the reinforcement bar - see "To locate a single layer of reinforcement bars" on page 18.
2. Hold the search head over the bar. Move the search head side-to-side and rotate the head clockwise/anti-clockwise until the signal is at a maximum (Figure 12).

    When the signal is at its maximum, the search head is aligned parallel with the reinforcement bar.
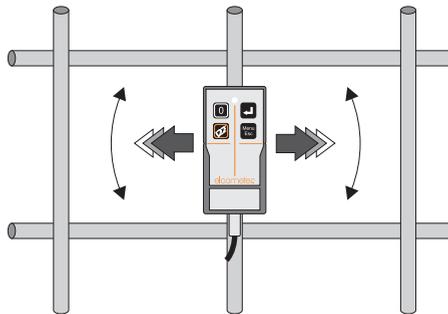
Figure 12. Determining orientation of a reinforcement bar

5.5 Practice

Because your Covermeter is unaffected by the nature of the material covering the reinforcing bars, the easiest way to practice location and orientation technique is to use uncovered bars which you

can see. A block of wood or plastic 20 mm to 45 mm thick can be held between the search head and the bars to simulate the depth of concrete cover.

Start from the simplest situation, a single straight bar, and progress through parallel bars, lapped bars, and crossing bars. As you develop skill and confidence with uncovered bars, move on to locating bars in more realistic situations.

5.6 Surface mapping

When you are locating layers of reinforcement bars it is good practice to 'map' the concrete surface in a systematic manner. The following steps describe a mapping technique which can be used to locate two layers of reinforcement bars at right angles to each other.

1. Hold search head horizontally.

    Scan up and down to locate (predominantly) horizontal bars.
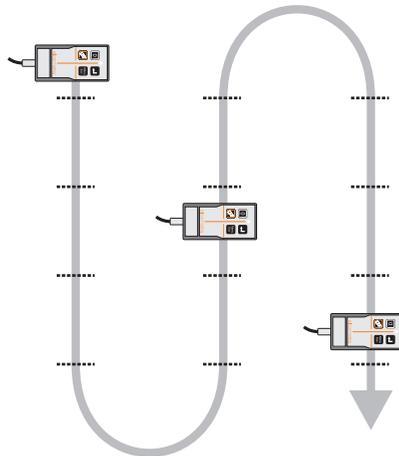
2. Hold search head vertically.

    Scan from side to side between horizontal bars to locate vertical bars.
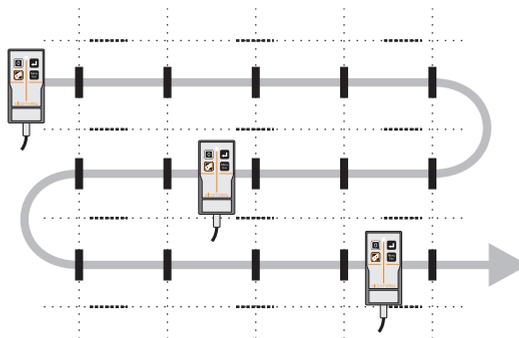
Note: *In some situations, it will be more appropriate to scan first for the vertical bars and then the horizontal bars.*

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6 MEASURING DEPTH OF COVER

This section describes how to set up and use your Covermeter to measure the depth of cover over reinforcement bars.

6.1 Before you start

- *Are you using the correct search head?*
  See "Search heads" on page 55.

- *Do you require statistics?*
  See **"Statistics" on page 37**.

- *Do you want to save readings in memory?*
  See **"Batching**/**Data logging" on page 40**.

- *What units of measurement do you want to use?*
  See "SETUP" on page 15.

6.2 Procedure

1. Connect the search head to the Covermeter.
2. Switch on the Covermeter.
3. Ensure the instrument is set to Cover mode.

   ☞ MENU / INSTRUMENT MODE / COVER

   ```
        INSTRUMENT MODE
   ▶COVER            ▮←○
    HALFCELL          ┼┠
   ```

4. Select bar diameter - see "Selecting bar size" on page 25.
5. Zero the Covermeter.
6. Set sound mode to 'locate' - ☞ MENU / SETUP / SOUND MODE / LOCATE[q].
7. Adjust sensitivity - see "Adjusting sensitivity" on page 34.
8. Locate the reinforcement bar using the sound, the LED and the display as indicators.

   The reading of cover is continuously updated on the display in large digits. If AutoSize is switched on (☞ MENU / SETUP / DISPLAY / SHOW AUTOSIZE INFO), smaller bracketed readings show the estimate of the bar size (autosize) and the corresponding depth of cover. If the autosize calculation cannot be performed because the signal is too small (cover too great), the autosize and autosize depth of cover readings are blanked (the display shows '--').

9. Compare the bar diameter with the autosize bar diameter. If the two numbers are significantly different, stop depth of cover measurement and measure the bar size using the Orthogonal method - see "Measuring size of reinforcement bars (orthogonal)" on page 27.

---

q. Although Locate Mode is specified here, other Sound/Detection modes are available - see "Sound mode/ Detection mode" on page 33 for further details.

10. If the bar diameter and the autosize bar diameter correspond and you are satisfied that the search head is directly over the reinforcement bar, either move on to the next bar or press [↵].

6.3 What happens when you press Enter [↵]

1. The cover reading is entered into the current statistical analysis.
2. If a batch is open, the reading is saved into a memory location.

   The Covermeter will then advance (scroll) to the next memory location. When the last memory location of a row in a grid[r] is reached, the Covermeter will advance to the first memory location of the next row (Figure 13). When the final memory location in a grid or linear batch is filled, the Covermeter closes the batch and exits batching.

   Refer to "The BATCH softkey" on page 45 for information on how to navigate around a batch and review, delete, overwrite and skip memory locations while you are taking readings.

3. The Covermeter will beep:

   Model SH:
   • Single beep - reading taken.
   • Triple beep - reading taken in last memory location of the batch.
   • Triple beep[s] (higher pitch) - reading taken is outside limits if limits have been set (✏ MENU / SETUP / LIMITS).

   Model TH:
   • Single beep - reading taken.
   • Double beep - reading taken in last memory location of a row in a grid.
   • Triple beep - reading taken in last memory location of the grid.
   • Triple beep[t] (higher pitch) - reading taken is outside limits if limits have been set (✏ MENU / SETUP / LIMITS).

	A	B	C	D	E	F
1	*	*	*	*	*	**
2	*	*	*	*	*	**
3	*	*	*	*	*	***
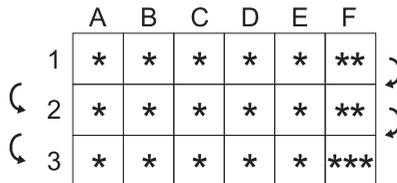
Figure 13. Beeps (*) and scrolling on a 6x3 grid batch

---

r. Grid batches - available on Elcometer 331 Model TH only.
s. The LED in the search head will also flash to indicate an 'out of limits' reading.
t. The LED in the search head will also flash to indicate an 'out of limits' reading.

6.4 Accuracy

The reading of cover will only be accurate if all the following conditions are satisfied:

- The instrument has been zeroed.
- The search head is over the centre-line of the bar.
- The search head is parallel to the bar.
- The search head is not over, or near, any other bars which might affect the reading[u].
- The manually entered bar size has been confirmed as being accurate by comparing with the autosize estimate.

If the reinforcement bar is too deep to measure successfully (over-range), the depth of cover will be displayed as infinite (Figure 14).

Figure 14. Depth of cover over-range (infinite)

---

u. If reinforcement bars are too close together to measure with the standard search head, try using the narrow pitch search head. See "Accessories" on page 64 for ordering details.

7 SELECTING BAR SIZE

The dimensions of reinforcement bars are stored within the Covermeter. The dimensions are grouped into four standard series; Metric, Imperial, ASTM/Canadian and Japanese.

To select bar size, display the reading screen and press the BAR softkey to access Bar Size selection:

• To select bar size, press the SERIES softkey. Use [⇧] or [⇩] to select the appropriate series (Metric, Imperial, ASTM/Canadian or Japanese). Press [⏎] to accept the bar series and then use [⇧] or [⇩] to adjust the bar size. Press [⏎] to accept the bar size and return to the Reading Screen.

Metric			Imperial			ASTM/Canadian			Japanese	
Bar size	**Diam. (mm)**		**Bar size**	**Diam. (inch)**		**Bar size**	**Area (mm^2)**		**Bar size**	**Diam (mm)**
5	5		#2	0.250		10M	100		6	6
5.5	5.5		#3	0.375		15M	200		10	10
6	6		#4	0.500		20M	300		13	13
7	7		#5	0.625		25M	500		16	16
8	8		#6	0.750		30M	700		19	19
9	9		#7	0.875		35M	1000		22	22
10	10		#8	1.000		45M	1500		25	25
11	11		#9	1.125		55M	2500		29	29
12	12		#10	1.250					32	32
14	14		#11	1.375					35	35
16	16		#12	1.500					38	38
18	18		#13	1.625					41	41
20	20		#14	1.750					44	44
22	22		#15	1.875					48	48
25	25		#16	2.000					51	51
28	28		#18	2.250					57	57
32	32									
36	36									
40	40									
44	44									
50	50									

The bar sizing functions of the Covermeter will display any measured bar size to the nearest size in the selected series.

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8 AUTOSIZING

Your Covermeter includes AutoSize - a feature which automatically calculates an estimate of the size of a reinforcement bar and the depth of cover. The autosize estimated values are displayed on the reading screen in a small font size alongside standard readings.

Bar size   Depth of cover

Figure 15. Autosize bar size estimate and depth of cover

You do not need to configure anything to use autosize; just switch it on and off as required.

✍ MENU / SETUP / DISPLAY / SHOW AUTOSIZE INFO

The values of bar size and depth of cover provided by autosize are **estimates only** and are independent of the value of bar size you have entered.

The autosize bar size estimate is typically used as a check that the value of bar size entered manually is accurate. If the two values are significantly different, you should use the orthogonal SIZE feature to determine accurately the bar size - see "Measuring size of reinforcement bars (orthogonal)" on page 27.

When the search head is not directly over a reinforcement bar, the autosizing values are meaningless and should be ignored.

If the signal is too small the autosize and autosize cover readings are blanked (-- displayed).

In congested situations, autosizing will tend to over-estimate bar diameter, correctly reflecting the fact that there is a greater mass of metal present than a single bar. Nevertheless, autosizing will continue to give an essentially correct value for the cover.

In the case of lapped bars, autosizing will typically show double the true diameter of a single bar, but the correct cover, which is generally the desired result.

9 MEASURING SIZE OF REINFORCEMENT BARS (ORTHOGONAL)

Although the Covermeter includes the AutoSize feature (see page 26), a separate 'orthogonal' SIZE function is included for accurate measurement of bar size.

The orthogonal SIZE function is intended to be used to determine the diameter of a (single) reinforcement bar. Although the associated cover will also be displayed, this function is not intended to be used for scanning areas.

Orthogonal sizing can be performed at greater depths than the AutoSize function.

The following sections describe how to use the SIZE function.

9.1 Before you start

•   *Are you using the correct search head?*
    See "Search heads" on page 55.

•   *What units of measurement do you want to use?*
    See "SETUP" on page 15.

9.2 Procedure

1.   Connect the search head to the Covermeter.
2.   Switch on the Covermeter.
3.   Ensure the instrument is set to Cover mode.

☞ MENU / INSTRUMENT MODE / COVER

```
        INSTRUMENT MODE
 ▶COVER                  ⊢↔○
  HALFCELL               ⊣⊢
```
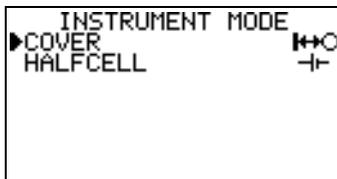
4.   Zero the Covermeter.
5.   Set sound mode to 'locate' - ☞ MENU / SETUP / SOUND MODE / LOCATE.
6.   Press the SIZE softkey. The display will show:

```
    ORTHOGONAL SIZE

       HEAD PARALLEL

       THEN PRESS  ↵
```
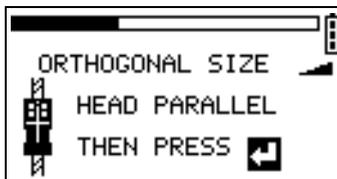
7.   Adjust sensitivity - see "Adjusting sensitivity" on page 34.
8.   Locate the exact position and orientation of the reinforcement bar using the sound, the LED and the display as indicators - see "Locating reinforcement bars" on page 18.

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MEASURING SIZE OF REINFORCEMENT BARS (ORTHOGONAL)

9. Position the search head parallel and in line with the reinforcement bar (Figure 16). The sound/signal will be at a maximum.
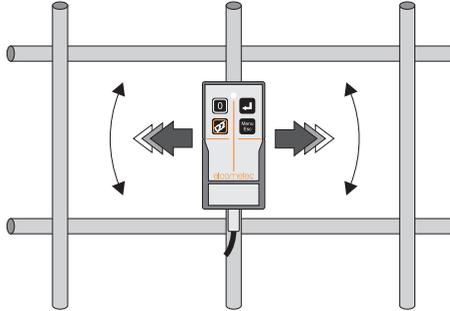
Figure 16. Search head parallel and in line with bar

10. Press [↵]. The display will show:
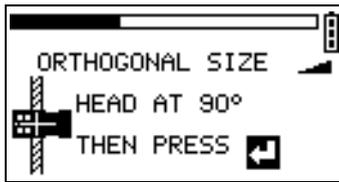
11. Rotate the search head until it is at 90° (orthogonal) to the bar. Use the notches in the sides of the search head and the line across the top of the search head to aid alignment (Figure 17). The sound/signal will be at a minimum when the search head is aligned at 90° to the bar and the notches/line are in line with the bar.
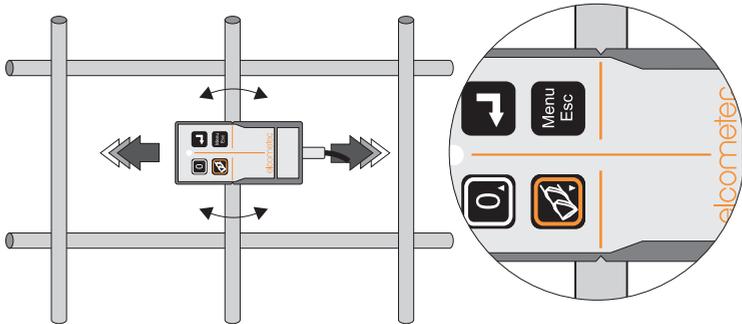
Figure 17. Search head aligned at 90°

12. When the search head is aligned correctly with the reinforcement bar, press [↵].
    The Covermeter will display a depth of cover and a bar size.

13. If you are satisfied with the bar size, press [⏎] to set the Covermeter to use this size. If you are not satisfied with the bar size, press [menu/esc] to return to the reading screen without making any changes.

If the orthogonal size calculation fails (e.g. because of incorrect search head positioning or because the bar is too deep), an error is reported with the option to retry the procedure.

9.3 Accuracy

In common with all bar-sizing methods, the orthogonal SIZE function is sensitive to errors in search head positioning and also to the proximity of neighbouring bars (the pitch of the bars).

The net result of the error-generating influences listed below is that the estimated bar size (and cover) will be too high. Hence the displayed result should be taken as an upper limit, never as a lower limit.

Head-positioning

When taking the parallel reading (Figure 16), the search head should be getting the maximum possible signal from the bar; any misalignment of the search head in either angle or position can only reduce this signal.

When taking the orthogonal reading (Figure 17), the search head should be getting the minimum possible signal from the bar; any misalignment of the search head in either angle or position can only increase this signal.

Therefore, either form of positioning error will always result in the diameter being over-estimated (and so too will be the cover).

Neighbouring bars

Any other metal within range of the search head will increase both the (orthogonal and parallel) readings by an unknown amount, but not necessarily the same for both readings. In practice, since the orthogonal signal is the weaker of the two, it is more susceptible to 'interference', and so the estimated diameter will probably again be too high.

Although, in normal use, transverse bars have comparatively little effect on the cover obtained, these same transverse bars will have a serious effect on this bar-sizing method: when the search head is rotated to take the orthogonal reading, the signal from the bar under investigation decreases, but the signal from any nearby transverse bars increases. Again, the result is a (possibly significant) over-estimation of bar diameter. In particular, orthogonal sizing should never be attempted over the crossing-point of transverse bars.

Neighbouring parallel bars, whilst not causing such drastic effects as transverse ones, should nevertheless be taken into consideration. When the search head is rotated to the orthogonal position, such bars will become nearer to the ends of the search head than they were to its sides.

Welded mesh

Orthogonal sizing should not be attempted on welded mesh fabric; the orthogonal reading will receive an additional signal from the rectangular loop of bars. This will result in a gross over-estimate of bar-size (or even the 'SIZE MODE ERROR' message).

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9.4 Reducing errors when orthogonal sizing

This technique improves the accuracy of orthogonal sizing of bars where the nearest parallel bars appear to be adequately distant, but the transverse bars are closer together[v]. This situation is illustrated in Figure 18 where position **X** is the measurement position.

Transverse bars are close together
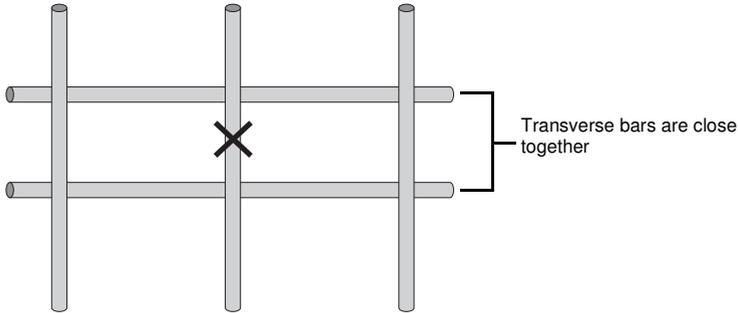
Figure 18. Measurement position

The technique involves zeroing the Covermeter with the search head held close to the concrete:

1. Hold the search head in contact with the concrete surface. The centre of the search head should be in the centre of the space between the bars as shown in Figure 19.
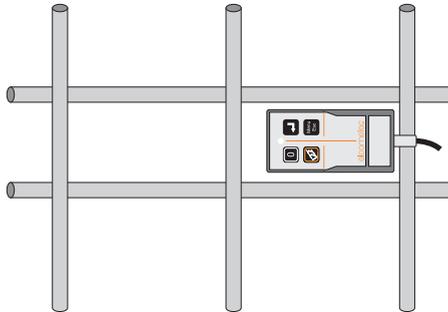
Figure 19. Zeroing

2. Press the ZERO softkey to zero the Covermeter.
3. Move the search head to the measurement position and then carry out orthogonal sizing as previously described in section 9.2 on page 27.

The aim of this technique is to subtract the 'background metal' signal; but it only provides an estimate of that background. As a result, it tends to over-compensate for the errors and therefore may result in an under-estimate of bar size (and cover).

Nevertheless, comparison with results from orthogonal sizing conducted with a standard zeroing technique can be used to get a slightly pessimistic estimate of the probable error (or degree of confidence) in the result.

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v.   In this situation, accuracy may also be improved by using a Narrow Pitch search head.

10 MEASURING HALF-CELL POTENTIAL

Your Covermeter is capable of measuring half-cell potential - an electrochemical technique commonly used to assess the severity of corrosion in reinforced concrete structures. When set to half-cell mode, your Covermeter acts as a voltmeter which measures the potential difference between the steel reinforcement in the concrete structure and a reference electrode (the half-cell) placed on the surface of the concrete.

Half-cell readings can be stored in memory in batches in the same way as readings of cover.

10.1 Before you start

*   *Are you using the correct half-cell probe?*
    See "Half-cell probes" on page 59.

*   *Do you require statistics?*
    See **"Statistics" on page 37**.

*   *Do you want to save readings in memory?*
    See **"Batching/Data logging" on page 40**.

10.2 Procedure

1. Use the Covermeter to locate a reinforcing bar.
2. Expose the bar, e.g. by drilling through the cover using a large drill.
3. Drill a small diameter hole into the bar suitable for attachment of the positive (red) cable using a screw or lead plug.
4. Mark out a grid on the concrete. Measurements will be taken at the intersection points of the grid. Typical grid spacing is 1 m x 1 m, however this may be reduced if localised corrosion is suspected. If the measured half-cell potential between two adjacent positions differs by more than 100 mV, it is recommended that the grid spacing is reduced.
5. If necessary, use tap water to wet the whole of the test area, or just the measurement positions.
6. Connect the red cable and extension reel between the exposed reinforcing bar and the red terminal on the Covermeter (Figure 20). Connect the black cable between the probe and the black terminal on the Covermeter.
7. Switch on the Covermeter.
8. Ensure the instrument is set to Half-cell mode

    ☞ MENU / INSTRUMENT MODE / HALFCELL
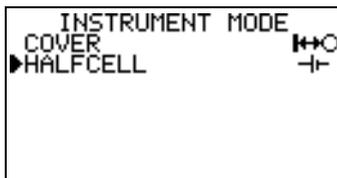
9. Remove the end cap from the probe and store the cap safely.
10. Press the electrode against the concrete surface.
11. View the reading of half-cell potential on the display.
12. If you are satisfied with the reading, either move on to the next measurement location or press Enter [↵].

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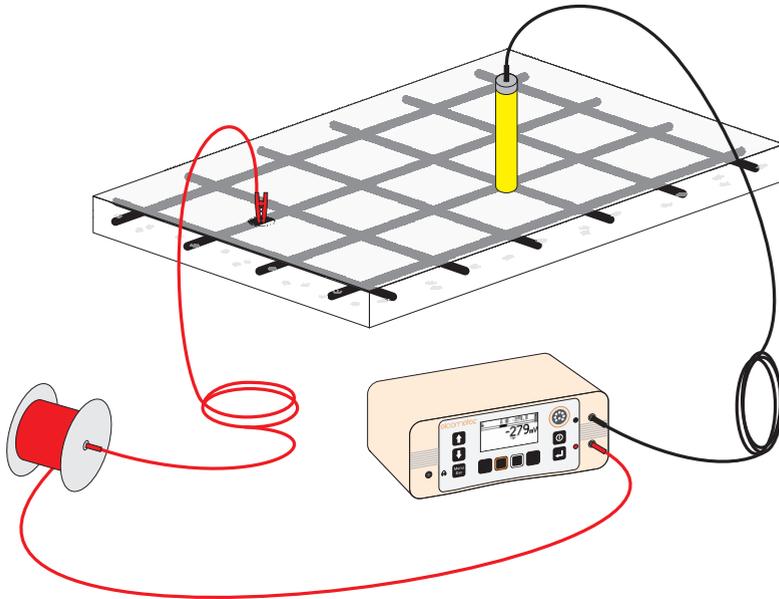
Figure 20. Typical instrument configuration for half-cell measurements

10.3 What happens when you press Enter [⏎]

1. The half-cell potential reading is entered into the current statistical analysis.
2. If a batch is open, the reading is saved into a memory location.

    The Covermeter will then advance (scroll) to the next memory location. When the last memory location of a row in a grid[w] is reached, the Covermeter will advance to the first memory location of the next row (Figure 13). When the final memory location in a grid or linear batch is filled, the Covermeter closes the batch and exits batching.

    Refer to "The BATCH softkey" on page 45 for information on how to navigate around a batch and review, delete, overwrite and skip memory locations while you are taking readings.

3. The Covermeter will beep:

    Model SH:
    • Single beep - reading taken.
    • Triple beep - reading taken in last memory location of the batch.
    • Triple beep (higher pitch) - reading taken is outside limits[x] if limits have been set (✍ MENU / SETUP / LIMITS).

    Model TH:

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w. Grid batches - available on Elcometer 331 Model TH only.
x. Typically, a low limit will be applied at the threshold that would indicate corrosion e.g. -350 mV. Any readings lower (more negative) than this would then cause an alarm and be tagged as below limit in the statistics and/ or the batch.

- Single beep - reading taken.
- Double beep - reading taken in last memory location of a row in a grid.
- Triple beep - reading taken in last memory location of the grid.
- Triple beep (higher pitch) - reading taken is outside limits[y] if limits have been set (☞ MENU / SETUP / LIMITS).

	A	B	C	D	E	F
1	*	*	*	*	*	**
2	*	*	*	*	*	**
3	*	*	*	*	*	***

Figure 21. Beeps (*) and scrolling on a 6x3 grid batch

10.4 Measuring cell-to-cell rather than cell-to-bar

In some instances it will not be possible to make a direct connection to a reinforcing bar. In this situation it is common practice to use two half-cell probes connected to the inputs of the Covermeter. One probe is fixed in position on the concrete surface and the other probe is moved over the surface. In this way the surface can be 'mapped'.

Using this method, the absolute value of the reinforcing bar to concrete half-cell will not be measurable, however changes from one point on the surface to the next can be measured and interpreted.

11 SOUND MODE/DETECTION MODE

Note: The settings in Sound Mode are applicable to measurement of concrete cover only - they have no affect when measuring half-cell potential.

Your Covermeter indicates the presence of a reinforcement bar visually and audibly:

- The **DISPLAY** indicates the presence of a reinforcement bar in the form of a signal strength indicator bar and a depth of cover reading.
- The **LED** on the search head starts to glow as the search head is brought near a reinforcement bar. The intensity of the LED increases as the search head gets closer to the bar.
- Although the display and the LED indications are important, it is likely that you will also rely upon the **SOUND** emitted by the internal speaker. This is the main indication of the presence of a reinforcement bar.

---

y.   Typically, a low limit will be applied at the threshold that would indicate corrosion e.g. -350 mV. Any readings lower (more negative) than this would then cause an alarm and be tagged as below limit in the statistics and/ or the batch.

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Your Covermeter has three sound/detection modes; Locate, Maxpip™ and Under Cover.
☞ MENU / SETUP / SOUND MODE

SOUND MODE	
LOCATE	☐
MAXPIP	☐
UNDER COVER	☐

11.1 Locate

In this mode, the pitch of the sound from the Covermeter increases as the search head gets closer to a bar.

Sound volume can be adjusted - ☞ MENU / SETUP / BEEP VOLUME

The apparent volume of the sound can also be adjusted by changing the sensitivity setting.

Adjusting sensitivity

The sensitivity setting is indicated by the variable wedge-shaped symbol on the display. To increase the sensitivity, press [⇧]. To decrease the sensitivity, press [⇩].
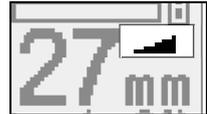
Typically, set the sensitivity to produce a slow 'clicking' sound in the absence of metal. With the sensitivity set at this level you will be able to differentiate quickly between bars of the same size located at different depths.

If the sensitivity is optimised, the pitch of the sound will consistently give a good guide to the extent of cover; shallower-than-average bars will produce a clearly noticeable, more intense sound, which will draw your attention to such bars. However, if the sensitivity has been adjusted to an arbitrary level, the necessary degree of consistency may not be achieved.

To improve audible resolution when locating closely spaced reinforcement bars it may be beneficial to reduce the sensitivity below the optimum level described in the previous paragraphs.

It is also possible to reduce sensitivity deliberately so that bars of adequate cover are not indicated, but bars of shallower cover are. You may find this technique to be a simpler and quicker method (albeit somewhat less precise) than the Under Cover mode described later; but please note that both methods share the same disadvantage that they only indicate bars with shallow cover, but do not confirm the presence of bars with adequate or deeper cover.

During a search the sound from the speaker and the brightness of the LED may reach their maximum level before the signal has reached its maximum. If this occurs, reduce the sensitivity until the sound and LED are again responding readily to changes.

Note: Reducing the sensitivity does not reduce the overall sensitivity of the instrument, but will reduce the sound and LED indications to zero when the search head is removed from the region of high signal strength. This may cause deeply covered bars to be missed.

If the sensitivity is reduced to the minimum setting, the locate sound is muted (indicated by a crossed-out loudspeaker symbol on the screen).

The sensitivity setting only affects the locate sound and the brightness of the LED on the search head; it does not affect the cover measurement or the size measurement.

11.2 Maxpip™

This is an alternative method of locating the centre of each reinforcement bar. In this mode, an audio 'pip' is given each time the middle of a reinforcement bar is detected as the surface is scanned.

An icon on the main measurement display indicates that Maxpip™ mode is active. When Maxpip™ mode is active, the normal locate sound is suppressed.

In practice, since it is not possible to be sure that you have reached maximum signal until the signal has started to decrease again, the pip always occurs just after you have passed the actual position of the bar, and this inevitable lag varies with scanning speed. Therefore the Locate mode is far superior for audible location.

11.3 Under Cover

Under Cover mode enables you to set a minimum depth of cover. In this mode, the Covermeter will signal a continuous alarm sound if the depth of cover of the reinforcement bar is less than the minimum.

An icon on the main measurement display indicates that Under Cover mode is active. When Under Cover mode is active, the normal locate sound is suppressed.

The Lower Limit (from the LIMITS menu) is used as the Under Cover threshold.

When Under Cover mode is active, the Low Limit is displayed and activated and may be adjusted. If Low Limit is switched off (☞ MENU / SETUP / LIMITS / LOW LIMIT), Under Cover mode will be switched off also.

Under Cover mode cannot be selected at the same time as Locate mode.

Maxpip™ and Under Cover modes can both be used simultaneously. When Locate mode is selected, Maxpip™ and Under Cover mode will both be switched off.

A bar of larger size than expected (rather than a bar at shallower cover) may trigger the Under Cover alarm; however, having drawn your attention, you will be able to see from the autosize information on the display just what is under the search head.

Note that although the Under Cover mode is a useful feature, it has some limitations which should not be ignored. Probably the most important, is that it will not distinguish between;

• a bar which is correctly present at more than minimum cover, and
• a bar which is completely missing!

Similarly, a bar (or tie-wire) at just less than minimum cover, but of smaller diameter than that set, may also fail to signal.

It is worth noting that this is not the only way of rapidly recognising reinforcement bars with less than the usual amount of cover. "Locate" on page 34 describes how the ordinary sound signal will give a noticeably more intense sound whenever the search head passes over a reinforcement bar which is shallower than its neighbours. This is possibly a simpler way of drawing your attention to rogue reinforcement bars without the need to use the Under Cover mode.

12 SETTING LIMITS

Low and High limits can be set by the user to monitor whether depth of cover or half-cell potential is within specifications.

☞ MENU / SETUP / LIMITS

LOW LIMIT	
LOW LIMIT ON	☐
LOW LIMIT	mm/mV

HIGH LIMIT	
HIGH LIMIT ON	☐
HIGH LIMIT	mm/mV

Set the limit value and toggle the tick box to switch the limit on or off.

Limits for cover and for half-cell potential are stored in separate memory locations within your Covermeter and are therefore retained as the mode is switched between cover and half-cell.

With limits switched on, when you take a reading which is within the limits, the Covermeter will beep once. When you take a reading which is outside the limits, the Covermeter will beep three times to warn you of an out-of-limit reading.

When limits are switched on, any readings taken which are outside a limit are indicated on the reading screen by an arrow icon; ⬆ or ⬇.
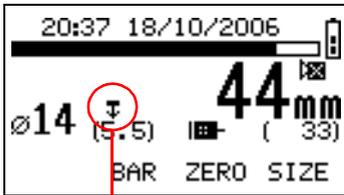
Reading is less than lower limit   Reading is greater than upper limit
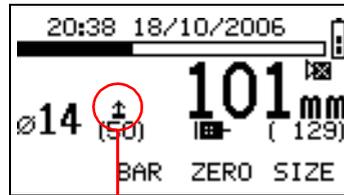
When batching is switched on and limits are switched on, readings in a batch which are outside the limits are marked as follows:

- Down arrow icon ⬇ if the reading is below the low limit.
- Up arrow icon ⬆ if the reading is above the high limit.

13 STATISTICS

Your Covermeter has a Statistics feature which calculates and displays a statistical analysis of readings as they are taken.

Statistics values are also calculated for the readings within a batch and these values are stored in the batch.

To enter a reading into the statistical analysis while you are taking measurements, press [✍].

Table 1: Calculated statistics values

η	Number of Readings	The running value for the number of readings taken in a group.
X̄	Mean	The average of a group of readings; the sum of the individual readings divided by the number of readings.
σ	Standard Deviation	A statistical measure of the spread of values in a group of readings.
CV%	Coefficient of Variation	The standard deviation divided by the mean for a group of readings, expressed as a percentage.
↓ılı	Lowest Reading	The value of the lowest reading taken in a group.
↓ılı	Highest Reading	The value of the highest reading taken in a group.
≪	Under range	The number and percentage of readings under range.
⊻ / ‹	Low limit	The number and percentage of readings below the low limit.
⊦·⊦	Within limits	The number and percentage of readings within limits.
⬆ / ›	High limit	The number and percentage of readings above the high limit.
∞	Over range	The number and percentage of readings over range (or infinite).
⌞ ⌟	Blank readings	Number and percentage of blank readings (skipped/not recorded/ deleted).

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STATISTICS

Over range, under range and blank[z] readings are not included in the calculation of mean, standard deviation, coefficient of variation, lowest reading and highest reading (neither are they counted in number of readings taken).

To access statistics, open the Statistics menu.
☞ MENU / STATISTICS

```
┌─────────────────────────────┐
│         STATISTICS          │
│                             │
│  ENLARGE STATS              │
│  CLEAR STATS          □     │
│  SELECT STATS               │
│                             │
└─────────────────────────────┘
```
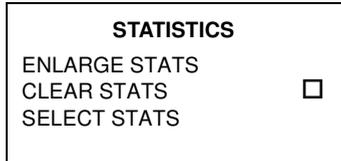
13.1 Viewing statistics

Statistics values can be viewed in a number of ways:

• As you are taking measurements, any two of the statistics values in Table 1 on page 37 can be displayed on the reading screen.
  ☞ MENU / SETUP / DISPLAY / STATS ON LCD
• At any point while taking measurements, any two or all of the statistics values can be displayed in enlarged format.
  ☞ MENU / STATISTICS / ENLARGE STATS
• When a batch has been created, statistics values for the batch can be displayed on the reading review screen.
  ☞ MENU / DATA LOGGER / REVIEW BATCH

13.2 Enlarge stats

Displays the chosen statistical values as double-height characters (Figure 22). Press ALL and use [⇧] and [⇩] to view all statistical values. Press [menu/esc] to return to the Reading Screen.

```
┌─────────────────────────────┐
│   η:   7                     │
│   x̄:  47.5                   │
│                             │
│   ALL                       │
└─────────────────────────────┘
```
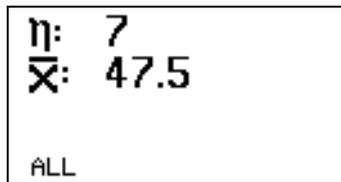
Figure 22. Enlarged statistics

13.3 Clear stats

Resets to zero all statistical values. Press YES to confirm or NO to cancel. Clear stats is not available while a batch is open[aa].

---

z. 'Blank readings' - Elcometer 331 Model TH only.
aa. Opening a new or existing batch will also cause all current statistical values to be reset to zero.

13.4 Select stats

Allows the user to choose which statistics values are displayed on the reading screen during measurement.

Use [⇑] and [⇓] to move the cursor and press [✍] to select or deselect the statistics values.

Only two statistics values can be selected and displayed on the reading screen at the same time. To view all statistics values choose:

✍ MENU / STATISTICS / ENLARGE STATS / ALL

On Elcometer 331 Model TH, the selected statistics values will only be displayed on the reading screen if the display of time and date is not selected:

✍ MENU / SETUP / DISPLAY / SHOW TIME

Note: *'Blank' - Elcometer 331 Model TH only.*

SELECT STATS	
NO. OF READINGS	☐
MEAN	☐
STD DEVIATION	☐
COEF OF VARIAT'N	☐
LOWEST READING	☐
HIGHEST READING	☐
UNDER RANGE	☐
BELOW LIMIT	☐
ABOVE LIMIT	☐
OVER RANGE	☐
BLANK	☐

14 BATCHING/DATA LOGGING

Your Covermeter includes internal memory which can be used to save depth of cover and half-cell readings. Use this memory to save your readings as you take them; this will help to increase your productivity on site and reduce the need to rely on paper and pen to record your results.

All readings saved into the memory of your Covermeter are stored in 'batches'. Typically, a single batch is used to store readings from a particular area or location on a site.

There are two types of batch; 'linear' and 'grid'. Which type of batch you can use depends upon the model of Covermeter you have:

• Elcometer 331 Model SH - linear batches only
• Elcometer 331 Model TH - linear *and* grid batches

Users of Model SH Covermeters can create linear batches only. Users of Model TH Covermeters must define whether a batch is to be in linear (▭▭▭▭▭) or grid (▦) format when the batch is first opened (created).

14.1 Linear batches

A linear batch of memory locations is similar to a single row or column of cells on a spreadsheet:

30	33	29	28	35	30	30	27	28	31	33

Maximum number of readings in a linear batch: 1000

Maximum number of linear batches: 10 (Model SH Covermeters)
200 (Model TH Covermeters)

14.2 Grid batches

Note: *The instructions given in this section (14.2) apply to Elcometer 331 Model TH only. Users of Elcometer 331 Model SH can upgrade their instrument to model TH to gain this functionality - contact Elcometer or your local supplier for details.*

Grid batches are typically used when you are surveying large areas of concrete.

A grid batch of memory locations is similar to the grid of cells marked out by the rows and columns of a spreadsheet:

	A	B	C	D	E	F	G	H	I	J	K	L
1	30	33	30	27	28	31	33	35	32	30	30	
2	29	27	28	31	33	35	32	30	30	27	28	
3	30	27	28	31	33	35	32	28	30	27	28	
4	35	27	28	31	33	35	32	30	29	27	28	
5												

Maximum size of a grid batch: 255 rows x 255 columns

Maximum number of grid batches: 1000

Maximum total number of readings: 240 000

Memory locations in a grid batch are referred to by their column letter and row number, for instance A1, F4, etc.

Grid batches are typically used to save readings when surveying a large area of concrete:

• On the concrete, mark out a pre-defined grid of squares, typically of 0.5 m pitch. This is an arbitrary grid which does not necessarily align with the reinforcement bars.

- Use the Covermeter to locate and measure the minimum area of cover within each grid cell, or the cover to the reinforcement bar nearest to each grid-point, depending upon your survey procedures.
- Store the results in a grid batch corresponding to the grid of squares (press [⏎] to enter a reading while the batch is open).
- If required, create a separate batch *of the same name* configured for half-cell and store corresponding half-cell potential measurements for each location. This allows the batches to be grouped for production of reports which combine cover and half-cell readings using CoverMaster® software - see "CoverMaster software" on page 53.

14.3 What does a batch contain?

Each batch stores three types of information:
- header fields (information entered by the user - see below)
- readings (entered automatically by the 331 as you are taking measurements)
- statistics (entered automatically by the 331 as you are taking measurements)

Table 2: Batch contents

Symbol	Symbol meaning	Typical contents	Entered by User	Entered by 331
▢	Batch name[a]	001-1 or Survey-01	✓	
⊢●⊣ ⊣⊢	Batch type (Cover or half-cell)	⊢●⊣	✓	
▦	Batch format (▦ or ▭)	▦	✓	
nx	Number of columns (nx)	10 (only displayed for ▦ batches)	✓	
ny	Number of rows (ny)	10 (only displayed for ▦ batches)	✓	
n	Number of readings taken (n)	96		✓
▪	Site	Humber Bridge	✓	
+	Location	North Pier	✓	
✛	Area	AA/123/4-001	✓	
⊓	Grid spacing (size of each grid square)	500 mm	✓	
⌀	Bar size/diameter	18 mm	✓	
✳	Batch creation date/time	09:30 17/01/06		✓
⬅	Batch update date/time	14:15 19/01/06		✓
⤓	Low limit	20 mm	✓	
⬆	High limit	35 mm	✓	

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Table 2: Batch contents

Symbol	Symbol meaning	Typical contents	Entered by	
			User	**331**
⊟	Half-cell type	CU/CUSO4 AG/AGCL	✓	
▭	Temperature	20°C	✓	
▰	Engineer	M. Smith	✓	
⚏	Customer	Highways Department	✓	
↓ᵢₗₗ	Lowest reading			✓
↓ₗₗᵢ	Highest reading			✓
⊠	Mean			✓
σ	Standard deviation			✓
x (y%) < z mm	Number and percentage of readings below the lower limit, together with the limit value (if any).			✓
x (y%) ·¦·	Number and percentage of readings within limits.			✓
x (y%) > z mm	Number and percentage of readings above the upper limit, together with the limit value (if any).			✓
x (y%) ⬚	Number and percentage of blank readings (if any).			✓
x (y%) <<	Number and percentage of under-range readings (if any), together with the lowest measurable cover for the current bar size and search head.			✓
x (y%) ∞	Number and percentage of over-range (infinite) readings (if any), together with the highest measurable cover for the current bar size and search head.			✓
≡	Notes	Survey top only	✓	
The following additional symbols may be seen on the reading review screen:				
《	The reading is under range (not measurable)			✓
⬇	The reading is less than the low limit			✓
⬆	The reading is greater than the high limit			✓
∞	The reading is over range (not measurable)			✓
-	Blank reading (memory location is empty) - *Model TH only*			✓

a. Two batches are permitted to have the same name provided they are of different types. This feature can be used to associate cover and half-cell surveys of the same area on the PC during analysis using Covermaster software. If a new batch is created with a name and type matching an existing batch, the instrument beeps and returns to the name editing screen.

Note: Column, rows and grid spacing - Elcometer 331 Model TH only.

14.4 Saving your readings in memory

To use the memory you will need to understand how to use the Data Logger.

☞ MENU / DATA LOGGER

To use a batch of memory it is first necessary to open (create) a batch - see 14.6 below. Once the batch has been opened you can then save your readings into that batch as you take them.

To save a reading when a batch is open, press [✍].

You may exit batching at any time; once you exit batching (and hence the Covermeter is not data logging), readings will no longer be saved.

☞ MENU / DATA LOGGER / EXIT BATCHING

The following sections describe how to configure and use the Data Logger.

DATA LOGGER
EXIT BATCHING
OPEN NEW BATCH
OPEN EXISTING BATCH
CLONE BATCH
REVIEW BATCH
PLOT BATCH
PLOT OPTIONS
EDIT BATCH TAGS
DELETE BATCH
DELETE ALL BATCHES
FREE MEMORY

14.5 Exit batching

Switches off batching (the data logger). No further readings are saved, the display reverts to the reading screen and the BATCH softkey disappears.

14.6 Open new batch

Opens (creates) a new memory batch.

The Covermeter uses the most recently created batch as a template for the new batch. The batch name is based upon the alphanumeric value of the last batch created, but all other header fields are left blank - see "What does a batch contain?" on page 41.

1. Enter information in the header fields (including the batch name) as required[ab] - see "How to enter information into batch header fields" on page 47.
2. When you are happy with the details you have added or changed, press ▱ to create the batch. The display switches to the reading screen and then starts batching (the BATCH softkey appears on the reading screen).
3. Zero the Covermeter if requested.

14.7 Open existing batch

Opens an existing memory batch.

1. Use Left/Right softkeys [⬅➡] to scroll to the required batch.

ab. If a new batch is created with a name matching an existing batch, the instrument beeps and returns to the name editing screen.

2. Press [⟳] to select the batch. When the batch has been opened, the display switches to the reading screen and then starts batching (the BATCH softkey appears on the reading screen). Readings in the existing batch can then be amended, deleted and added.
3. Zero the Covermeter if requested.

14.8 Clone batch/Copy batch information

Creates a clone (a copy) of an existing memory batch.

Cloning a batch allows the contents of an existing batch to be copied (everything is copied except for the readings). Cloning is typically used on site to create new batches without having to re-enter batch header details such as the name of the site, the engineer, the customer, etc.

When the new batch has been created by pressing ▱, the display switches to the reading screen and then starts batching (the BATCH softkey appears on the reading screen).

1. Use Left/Right softkeys [⟵⟶] to scroll to the batch you want to clone.
2. Press [⟳] to select the batch.
3. Adjust information in the header fields as required (you must give the batch a name[ab] which does not already exist) - see "How to enter information into batch header fields" on page 47.
4. Press ▱ to create the clone.
5. Zero the Covermeter if requested.

14.9 Review batch

Opens any existing memory batch for viewing of batch header information, readings and statistics. Also allows individual readings to be deleted.

1. Use Left/Right softkeys [⟵⟶] to scroll to the batch you want to review.
2. Press [⟳] to select batch.
3. Review readings using the scroll keys to move around the contents of a batch.

   Press and hold the Shift softkey [⇧⇩] and then press any of the Scroll keys to jump quickly to the start or end of line of readings.

   Press [⟳] to toggle between;
   • REVIEW BATCH - shows header fields and statistics, and
   • depth of cover readings.

   To delete a reading[ac] press the Delete softkey [✎].
4. Press [menu/esc] once to select another batch (using [⟵⟶]), press [menu/esc] again to return to the Data Logger menu.

As you scroll between batches using the Left/Right softkeys [⟵⟶], the same page of information is shown for each batch. This feature makes it particularly easy to identify, for example, batches from a particular customer/location, or batches with readings outside limits.

A bracketed asterisk [*] next to the batch name indicates that this is the batch currently open (if any).

A complete list of the information given on a review batch screen is given in "What does a batch contain?" on page 41.

---

ac. When readings are removed (either over-written or deleted) from a very large batch, some statistics values may be replaced by a '-' until the batch is recalculated. To force a batch to be recalculated, exit batching (MENU / DATA LOGGER / EXIT BATCHING) and then re-open the batch (MENU / DATA LOGGER / OPEN EXISTING BATCH). Invalid statistics (PLEASE WAIT) will be shown on the display while the recalculation takes place.

14.10 Plot batch[ad]

See "Plotting batches" on page 49

14.11 Plot options[ae]

See "Plotting batches" on page 49

14.12 Edit batch tags

Same as 'Review batch' but allows editing of some of the batch contents.

A moveable cursor is shown next to any entries which can be modified. Pressing Enter opens that tag for editing.

14.13 Delete batch

Deletes one memory batch.

1. Use Left/Right softkeys [←→] to scroll to the batch you want to delete.
2. Press [✍] to delete batch.

   The Covermeter displays a confirmation screen.
3. Press Yes to confirm deletion, No to cancel.

14.14 Delete all batches

Deletes all batches from the Covermeter and stops batching.

1. The Covermeter displays a confirmation screen.
2. Press Yes to confirm deletion, No to cancel.

14.15 Free memory

Displays the amount of free memory (%) and then returns to the reading screen after 2 seconds.

14.16 The BATCH softkey

The BATCH softkey provides rapid access to the readings in a batch as you are taking them.

The BATCH softkey is only displayed on the reading screen when a batch is open.

Once the BATCH softkey has been pressed, you can then;

• scroll around the contents of a batch,
• review, delete and overwrite readings,
• skip memory locations (TH models only),
• and then return to the reading screen ready to take more measurements in the same batch.

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ad. 'Plot batch' - Elcometer 331 Model TH only.
ae. 'Plot options' - Elcometer 331 Model TH only.

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BATCHING/DATA LOGGING

Pressing BATCH displays the Reading Review Screen.

REVIEW readings using the scroll keys to move around the contents of a batch.

Press and hold the Shift softkey [⇧⇩] and then press any of the Scroll keys to jump quickly to the start or end of line of readings.

When you have finished reviewing, press [⏎] to return to the reading screen at the current memory location or press [menu/esc] to return to the reading screen at the original memory location.

Figure 23. Grid reading review screen (TH models only)

DELETE readings by pressing the Delete softkey [✎]. Press Yes to confirm deletion or No to cancel.

When you have finished deleting, press [⏎] to return to the reading screen at the current memory location or press [menu/esc] to return to the reading screen at the original memory location.

You can **OVERWRITE** any of the readings.

1. Use the scroll keys to move to the reading you want to overwrite.
2. Press [⏎].

   The display switches to the reading screen.
3. Take a new measurement and press [⏎] to enter reading.
4. Press Yes to confirm overwrite or No to cancel.

Figure 24. Linear batch reading review screen

SKIP OVER memory locations in a grid batch (TH models only) using the scroll keys to move around the contents of the batch. This facility is useful when surveying in a grid around obstructions. The memory locations in the vicinity of the obstructions can be skipped over and left blank. When you are ready to return to the reading screen, press [⏎].

14.17 How to enter information into batch header fields

You can enter information into the header fields when you first open (create) a new batch or clone a batch and when editing batch tags.

There are two methods of entering information into the header fields of a batch;

• use the keypad on the Covermeter, or

• use a computer and then transfer the information to the Covermeter using CoverMaster® software - see "CoverMaster software" on page 53.

Which method you use depends upon your circumstances. Typically, on a large measuring project, the best method is to design batches on your computer and then transfer the information to the Covermeter. The keypad can be used on site for minor changes and the addition of notes, etc. during cloning or editing of a batch.

Entering information using the keypad

Text and numbers can be entered into header fields using the Covermeter keypad. The function of the keys is shown below:

1. Scrolls up through alphanumeric characters.

2. Scrolls down through alphanumeric characters.

3. Moves cursor left. Hold down to delete a character.

4. Select character set[af] (abc, ABC, 123, #$!, etc.)

5. Moves cursor right. Hold down to insert a character.

6. Enters text into header field. Press Yes to confirm or No to continue editing.
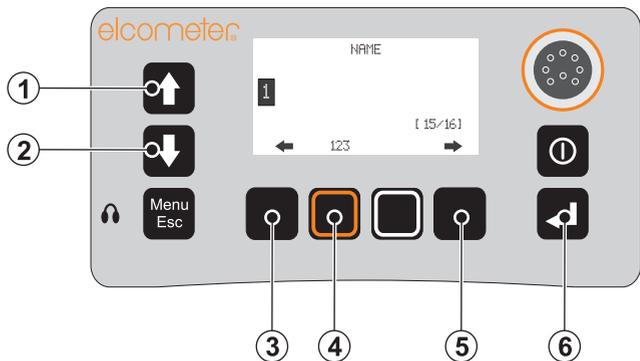
To delete an alphanumeric character, press and hold key 3.

To insert an alphanumeric character, press and hold key 5.

The screen displays the number of spare characters remaining in the field and the maximum total number of characters allowed.

The text fields can be entered/displayed using up to 256 different character codes. These include European accented characters and a few additional accented vowels used in the Chinese phonetic Pinyin system. When the Japanese language is selected, the European characters codes are substituted to represent the phonetic Katakana symbols which are shown at double-height.

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af. The following symbols are not permitted in the Batch Name field because they are illegal in Windows filenames: \/:*?\"<>|. They may be used in the other alphanumeric fields.

15 A TYPICAL SURVEY (USING GRID BATCH MEMORY)

This section leads you step-by-step through taking measurements, saving cover and half-cell readings in batches and producing a report. The instructions are for a model TH; users of a model SH will be limited to linear batches only.

1. Mark out your survey area (in this example a 14 x 14 grid).
2. Fit the search head to your Covermeter, switch on and set Instrument Mode to Cover.
3. Create a new 14 x 14 grid batch for cover and name it '001'.
4. Measure the depth of cover over the entire survey area and record the cover measurements in the batch created at step 3 (press Enter [⏎] to store a reading in the batch).
5. Fit the half-cell probe and cables and then set Instrument Mode to Halfcell.
6. Create another 14 x 14 grid batch, this time for half-cell. *Give the batch the same name as the cover batch* (in this example, '001').
7. Measure the half-cell potential over the entire survey area and record the measurements in the batch created at step 6 (again, press Enter [⏎] to store a reading in the batch).

You now have two batches in your Covermeter, each of the same name ('001') - one containing cover measurements, the other containing half-cell potential measurements.

8. Connect your Covermeter to a PC and download the two batches using CoverMaster software - see "Transferring readings to a computer" on page 52.
9. You can now produce a 'Topographic combined' or 'Topographic overlay' report which shows cover and half-cell potential on one easy-to-read report.
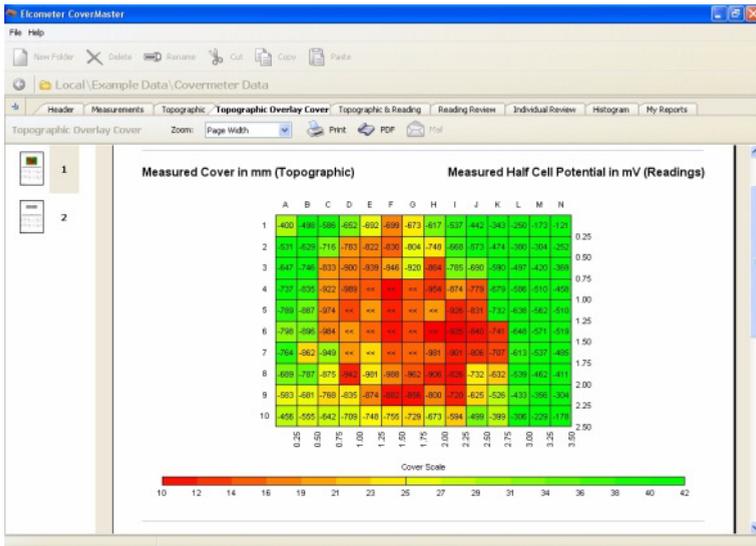
16 PLOTTING BATCHES

Note: The instructions given in this section (16) apply to Elcometer 331 Model TH only. Users of Elcometer 331 Model SH can upgrade their instrument to model TH to gain this functionality - contact Elcometer or your local supplier for details.

Your Covermeter can plot on its display a 'map' of the readings in a batch. Use this feature to locate potential trouble spots quickly and easily.

The map can be plotted in pseudo greyscale or in black and white:

Greyscale: The lowest (worst) readings are displayed as dark regions on the map; the highest readings as light regions. 16 levels of greyscale indicate readings between these extremes.

Black and white: A threshold value is set by the user. All readings below the threshold are displayed as black; all readings above the threshold are displayed as white.

In both instances, blank and over-range readings are shown as white and under-range readings are shown as black. To select greyscale or black and white, see "Plot options" on page 50.

16.1 Plot batch

☞ MENU / DATA LOGGER / PLOT BATCH
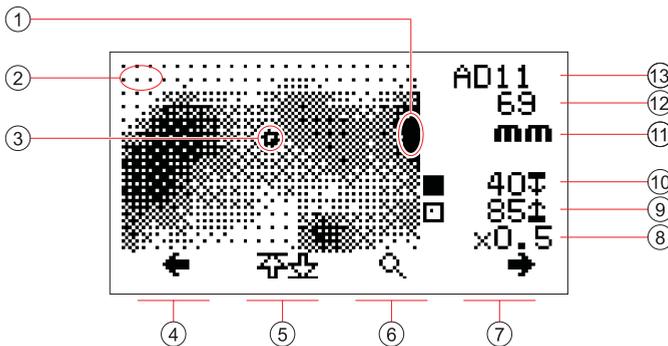
Figure 25. Typical greyscale plot (of concrete cover)

1. Dark area (✖) - potential trouble spot
2. Light area (✔)
3. Cursor position
4. Cursor scroll[ag] left
5. Shift scroll[ah]
6. Zoom[ai] (0.5x, 1x, 2x, 4x magnification)
7. Cursor scroll right

8. Zoom level
9. Upper limit
10. Lower limit/Threshold
11. Units
12. Concrete cover/Voltage
13. Batch memory location

---

ag. To scroll up or down, use the up [⇧] and down [⇩] keys.
ah. Press with cursor scroll keys to jump to end or start of row/column
ai. When a batch is first plotted, the initial zoom is set automatically to the highest level that allows the whole batch to be seen (or to x0.5 if the batch does not fit on the display at minimum zoom).

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Use the arrows to scroll the cursor around the plot; as the cursor moves the current memory location and reading are shown at the top right of the display. Large batches will scroll when the cursor reaches the edge of the display.

Use the Zoom softkey to zoom in to areas of interest.

Press [☞] at any time to view a key of the greyscale levels.

16.2 Plot options

Use this menu to select how readings will be displayed on the plot.

☞ MENU / DATA LOGGER / PLOT OPTIONS

```
┌────────────────────────────────┐
│        PLOT OPTIONS            │
│ GREYSCALE MIN/MAX        □     │
│ GREYSCALE LIMITS         □     │
│ THRESHOLD VIEW           □     │
│ SET THRESHOLD                  │
└────────────────────────────────┘
```

Greyscale min/max

• Black is set to the minimum reading in the batch.
• White is set to the maximum reading in the batch.
• Readings between the minimum and maximum are indicated by decreasing levels of grey.

Greyscale limits

• Black is set to the batch low limit.
• White is set to the batch high limit.
• Readings between the low and high limits are indicated by decreasing levels of grey.

   (To set limits, see **"Setting limits" on page 36**.)

If limits have not been set, the minimum and maximum readings in the batch will be used and this option will show the same plot as 'Greyscale min/max'.

Threshold view

A threshold value is set by the user. All readings below the threshold are displayed as black; all readings above the threshold are displayed as white.

Set threshold

Set threshold values for cover (in mm or inches) and for half-cell (in mV), as required.

The thresholds are applied to all batches and are independent of any other limits which may be set.
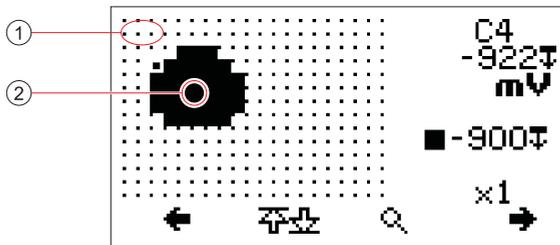
Figure 26. Typical threshold plot (of half-cell potential)

1. Light area (✓) - readings are above threshold value
2. Black area (✗) - readings are below threshold value

17 MEASURING WELDED MESH AND JOINED BARS

The procedures for locating and measuring depth of cover of welded mesh and joined bars are similar to those for reinforcement bars as described in sections 5, 6 and 9 (pages 18 to 24 and 27 to 30). This section highlights the additional factors which must be considered when measuring welded mesh or joined bars.

When searching for isolated reinforcing bars, the Covermeter induces eddy currents within the individual bars. Welded mesh reinforcements however create current loops which produce additional strong signals.

When searching for welded mesh reinforcements, it is common to encounter three levels of signal:

Very strong signals

Very strong signals are obtained when the search head is across the centre bar of a double or 'figure-of-eight' loop. These locations must not be used for cover measurements.
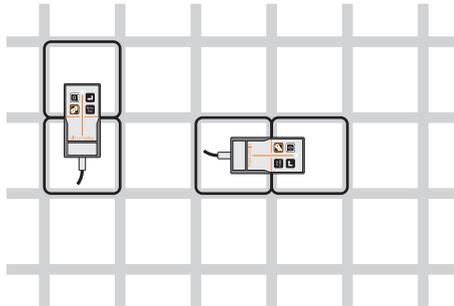
Figure 27. Strong signals at centre of 'figure-of-eight'

Minimum strength signals

Minimum signals are obtained when the search head is over the centre of a single loop.
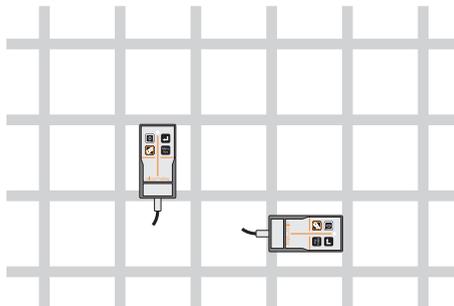
Figure 28. Minimum strength signals at centre of single loop

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Ordinary strength signals

Ordinary strength signals are obtained when the head is accurately aligned with the middle of a side. Only this type of signal is suitable for measuring depth of cover.
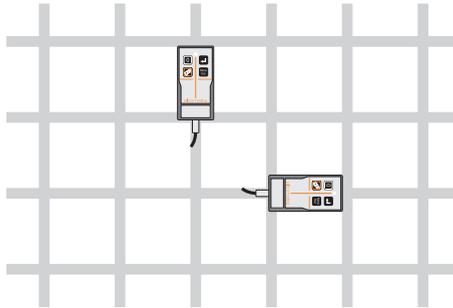
Figure 29. Ordinary strength signals from middle of one side of a loop

Note: The Orthogonal Sizing function (page 27) must not be attempted on welded mesh fabric - the bars are too close together for reliable measurement.

18 TRANSFERRING READINGS TO A COMPUTER

You can transfer statistics and readings data from the memory of your Covermeter to a computer. The data can then be used in reports, analysed to produce graphs, etc.

Connect your Covermeter to a computer, using the cable supplied - see "Connecting the data transfer cable" on page 55.

There are two methods of transferring statistics and readings:

*   Print/output
*   CoverMaster® software (to store, analyse and report)

18.1 Print/output

Use the PRINT/OUTPUT function of the Covermeter to output data over the RS232 interface direct to a printer or to communications software such as Hyperterminal.

Choose between outputting a single batch, all batches or just the current statistics.

☞ MENU / PRINT/OUTPUT / SINGLE BATCH
☞ MENU / PRINT/OUTPUT / ALL BATCHES
☞ MENU / PRINT/OUTPUT / CURRENT STATISTICS

Note: Before you use PRINT/OUTPUT, you must first select the correct output baud rate and output format.

☞ MENU / SETUP / OUTPUT

Baud Rate. This can be set at values from 1200 to 19200. The default value is 9600 baud.

RS232 Bit Image. Toggle tick box to activate/deactivate. All images and characters are output as bit-maps. This allows printing on the Elcometer Miniprinter (see "Accessories" on page 64).

RS232 Plain Text. Toggle tick box to activate/deactivate. The Covermeter sends standard ASCII characters from the Courier New font set[aj]. This allows printing on RS232 printers and data transfer to a PC using software such as HyperTerminal.

18.2 CoverMaster software

CoverMaster[®] software supplied on the CD enclosed with the gauge is designed specifically for your Covermeter. CoverMaster[®] is powerful but easy-to-use software which simplifies setting up and using your Covermeter:

- Design batch templates on your PC and download these to your Elcometer 331 Covermeter, ready for use on site.
- Download cover and half-cell readings data from your Covermeter to the CoverMaster[®] data management system.
- Keep your survey notes, inspection reports, photographs and all your other inspection information in one place - CoverMaster[®].
- Create accurate and professional reports configured to allow your data to be understood easily at all levels.
- Create PDF versions of your reports and e-mail direct from CoverMaster[®].

For complete instructions on how to install and use CoverMaster[®] software, please refer to the separate instructions supplied with the software.

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aj. When RS232 Plain Text is selected the following languages will be output as English: Chinese, Japanese.

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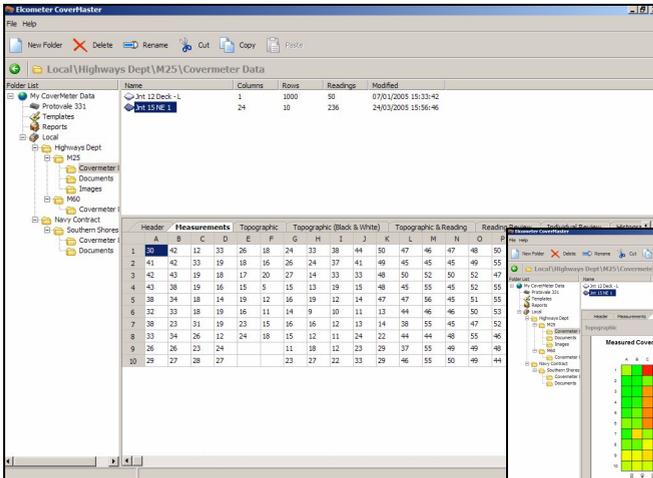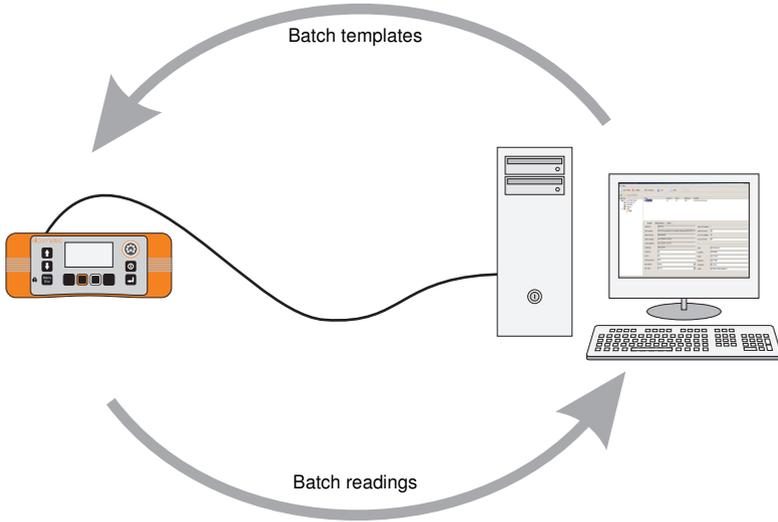
CoverMaster® interface showing reading data
(measurements)
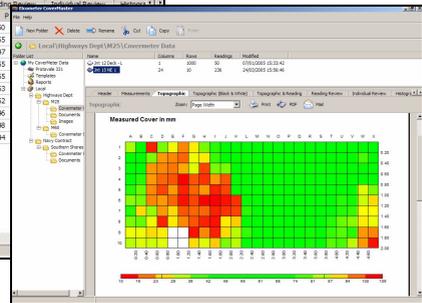
CoverMaster® interface showing
topographical representation of the same
reading data

Figure 30. Use CoverMaster® to link your Covermeter to a computer
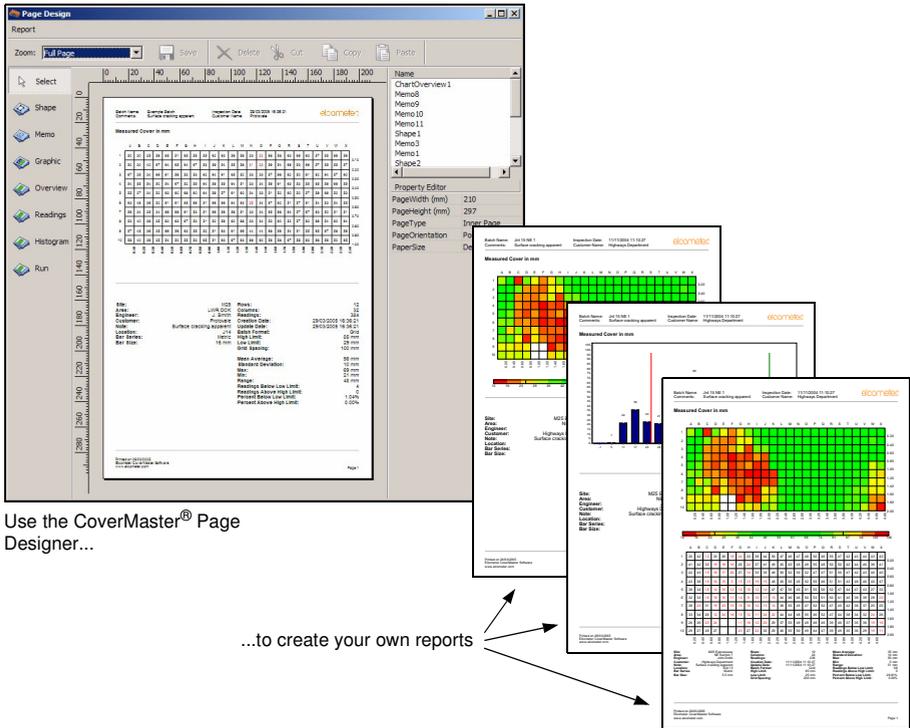
Use the CoverMaster® Page Designer...

...to create your own reports

Figure 31. Produce professional reports[ak] direct from CoverMaster®

18.3 Connecting the data transfer cable

1. Plug the 9-pin female D-type connector on one end of the data transfer cable into the COM port on the PC (an RS232 to USB transfer cable is available which allows you to connect your Covermeter to a USB port on your computer - see "Accessories" on page 70 for ordering details).
2. Plug the 5-pin connector on the other end of the data transfer cable into the RS232 connector at the rear of the Covermeter located under the access cover - see "Computer interface" on page 11.
3. Switch on the Covermeter and ensure that the Reading Screen is displayed.

19 SEARCH HEADS

Four types of search head are available for your Covermeter; Standard, Narrow Pitch, Deep Cover and Borehole Probe. To order any of these search heads see "Accessories" on page 64.

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ak. The illustrations in Figure 30 and Figure 31 show a grid batch. Grid batches are only available on Model 'T' Covermeters. Model 'SH' Covermeters can save up to 10 linear batches.

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All search heads are fully interchangeable. Changing from one type of search head to another is quick and easy; simply switch off the Covermeter, swap search heads, switch on again and zero the Covermeter.

| Narrow Pitch | Standard | Deep Cover | Borehole Probe |
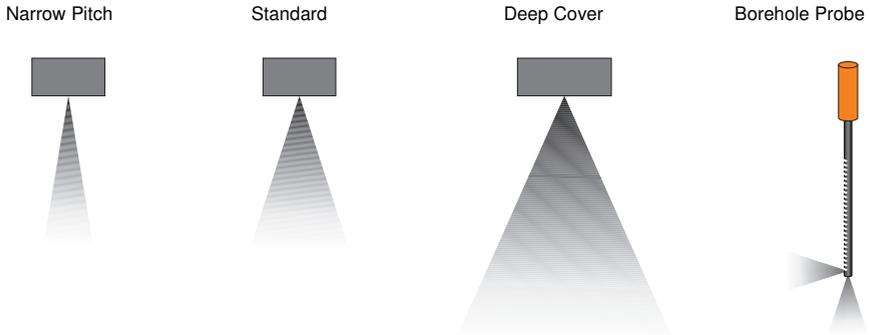
Figure 32. Search head search fields

Use the **Narrow Pitch** search head when the reinforcement bars are close together, i.e. when the pitch of the reinforcement bars is narrow.

Use the **Deep Cover** head to measure depth of cover over reinforcement bars deep within the structure. Because the Deep Cover search head only resolves bars if they are adequately spaced (centre-to-centre pitch more than about 1½ times their cover), for covers shallower than 70 mm, the Standard search head should be used in preference.

Note: *Orthogonal sizing is not possible when the Covermeter is set to detect stainless steel and the SIZE function is therefore removed from the reading screen when this bar grade is selected.*

Borehole Probe

The Borehole Probe is used to locate reinforcement bars, tendon ducts and other metallic objects in the vicinity of holes drilled into concrete. The probe will also measure depth of cover over a limited range, making it ideal when attempting to drill through a structure without making contact with reinforcement bars or tendon ducts. The Borehole Probe is available in two lengths; 400 mm (16") and 1000 mm (40").

The Borehole Probe has two search fields; forwards looking and sideways looking. Readings can be taken looking forward from the end of the probe or looking sideways (at right angles to the axis of the probe) - Figure 33. A switch[al] on the handle controls which search field is active.

---
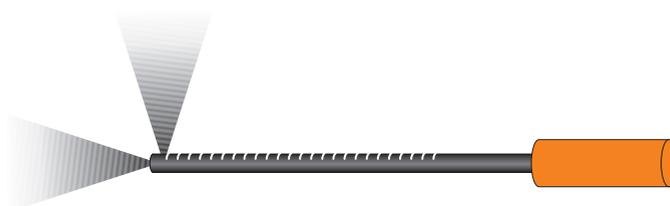
al.   Whenever the position of the switch is changed, the Covermeter must be zeroed.

Figure 33. Borehole probe search fields

The body of the probe has a scale marked every 10 mm (0.5") along its length. Use this scale to measure the depth of reinforcement bars located to one side of the hole. The scale indicates distance from the centre of the sideways looking sensor in the probe. To measure the depth of the borehole, add 15 mm (0.6") to the reading taken from the scale.

The sideways looking search field is located on the side of the Borehole Probe marked with the scale.

Note: Orthogonal sizing is not possible with the Borehole Probe and the SIZE function is therefore removed from the reading screen when this type of probe is connected to the Covermeter.

To scan for reinforcement bars to the side of the borehole: Set the switch to the sideways looking position and move the Borehole Probe into the drilled hole, slowly rotating the probe through 360° (Figure 34 overleaf).

To scan for reinforcement bars or ducts in line with (in front of) the end of the borehole: Set the switch to the forward looking position and push the Borehole Probe into the drilled hole slowly.
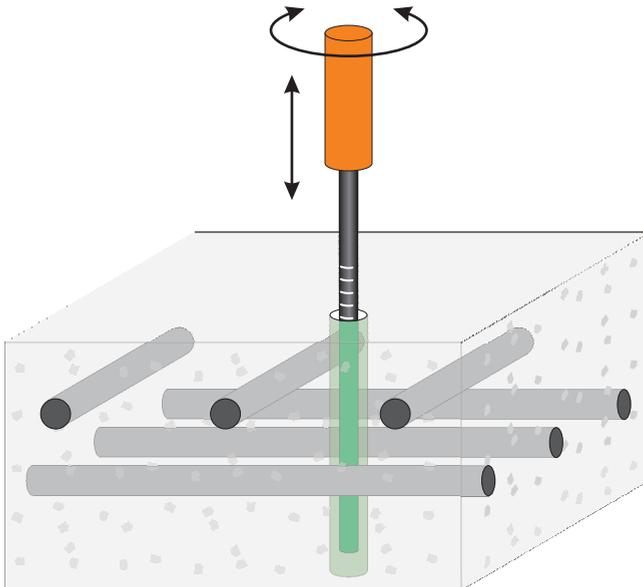
Figure 34. Scanning a borehole

19.1 Search head extension arm

This optional accessory allows the operator simple access to areas normally requiring ladders or scaffolding. The search head extension arm reduces the need to kneel down and allows the user to scan bridge decks and floor areas from a standing postion.

The extension arm is only suitable for use with the standard and narrow pitch search heads. See "Accessories" on page 64 for ordering information.

20 HALF-CELL PROBES

Two types of half-cell probe are available for your Covermeter. The probes can be easily identified by colour:

- Copper-Copper Sulphate (Cu-CuSO$_4$): Yellow
- Silver-Silver Chloride (Ag-AgCl):   Blue

20.1 Wetting your probe

For your probe to function properly the ceramic sensing end (the electrode) must be wet. To get a good wet electrode, just place the electrode in tap water for two to three minutes; this will usually be sufficient to keep the sensor going all day. Keeping the plastic end cap on the sensor when it is not being used will also help to keep the electrode wet. During periods of extended storage, place a small amount of water in the end cap before pushing the cap onto the probe.

20.2 Care of your probe and cables

The probes do not require any maintenance; they do not need recharging and are sealed for life. Any mud or grit should be removed from the electrode by swirling the electrode back and forth in a container of warm, soapy water and then brushing with a wet rag. The soapy water will not harm or contaminate the electrode.

Always check that the connecting cables are free of damage such as cuts and tears in the sheathing before use.

The Copper-Copper Sulphate half-cell probe is intentionally filled with a reserve of saturated Cupric Sulfate solution combined with solid Cupric Sulfate crystals to ensure a minimum 10-year design life.

Under certain circumstances a very small percentage of this reserve can leach out from the ceramic sensing tip of the half-cell producing crystals as shown in the photograph.

This does not affect the performance of the cell. The crystals should be removed by washing in distilled water.

20.3 Temperature

Do not allow the probe to freeze. Although freezing will not damage your probe, it will be impossible to obtain reliable measurements while in this state. All measurements are affected by temperature; if you take two readings in identical conditions, one in the summer at 29°C (85°F) and the other in the winter at 1°C (34°F), the half-cell potential readings will be different.

Each probe is tested at 25°C to be within ±10 mV of a standard Calomel reference cell. The following values relative to a standard Calomel cell are used as the test limits during manufacture:

	Lower limit	Reference value for Calomel	Upper limit
Copper-Copper Sulphate (Cu-CuSO$_4$)	+50 mV	+60 mV	+70 mV
Silver-Silver Chloride (Ag-AgCl)	-50 mV	-40 mV	-30 mV

20.4 Shelf life

Your probe does not degrade when stored.

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21 ERROR MESSAGES

Under certain conditions the Covermeter will display error messages (Figure 35). These messages are normally cleared by pressing any one of the softkeys. The cause of the error will be indicated by the message and should be corrected before proceeding.

Table 3: Error messages

Error message	Causes	Action to take
#1 - PROBE	Search head-to-gauge communication failure.	Remove search head and refit. If error persists, return to Elcometer*.
#2 - PROBE	Corrupt data output from probe.	Try new search head. If error persists, return to Elcometer*.
#3 - PROBE	Internal error.	Return to Elcometer*.
#4 - PROBE	Search head power supply fault.	Remove probe. If error persists, the Covermeter is faulty. If error clears, the probe is faulty. Return faulty part to Elcometer*.
#5 - PROBE	Internal error.	Remove search head and refit. If error persists, return to Elcometer*.
PROBE UNSUPPORTED	Old Covermeter software does not support new search head.	Return to Elcometer* for software upgrade.
PROBE CHANGED	Probe has been changed and is not compatible with current batch.	Change to probe used when batch was created.
VALUE TOO LARGE	Numerical error.	Switch Covermeter off then on again. If error persists contact Elcometer.
CLOCK	Internal error.	Return to Elcometer*.
LANGUAGE MEMORY	Software error.	Return to Elcometer*.

* Contact Elcometer or your Elcometer Supplier to arrange return.
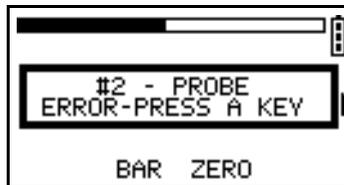
Figure 35. Example error message - search head not connected

22 PERSONALISED WELCOME SCREEN

A personalised welcome screen can be designed on a computer and then downloaded into the Covermeter.

Screen dimensions are 128 pixels x 64 pixels. The welcome screen is typically used to personalise the Covermeter with a logo, serial number, user name, etc. This is the first screen displayed when the Covermeter is switched on.

22.1 Creating the screen

1. Download Elcometer 'Welcome Screen Wizard' software. This software is available free of charge from the downloads section of the Elcometer website, www.elcometer.com
2. Connect Covermeter to PC using Data Transfer Cable.
3. Switch on the Covermeter.
4. Ensure that the reading screen is displayed.
5. Run 'Welcome Screen Wizard' software and follow the on-screen instructions.

22.2 Deleting the screen

1. Run the 'Welcome Screen Wizard' software.
2. Click 'Next'.
3. Select 'Create a new screen setup'.
4. Click 'Next'.
5. Select 'Disabled'.
6. Click 'Next'.

Follow the remaining on-screen instructions to delete the welcome screen.

23 STORAGE

This Covermeter incorporates a Liquid Crystal Display (LCD). If the display is heated above 50°C (120°F) it may be damaged. This can happen if the Covermeter is left in a car parked in strong sunlight.

Always store the Covermeter in its case when it is not being used.

24 MAINTENANCE

You own one of the finest covermeters in the world. If looked after, it will last a lifetime.

Regular calibration checks over the life of the Covermeter are a requirement of quality management procedures, e.g. ISO 9000, and other similar standards. For checks and certification contact Elcometer or your Elcometer supplier.

The Covermeter does not contain any user-serviceable components. In the unlikely event of a fault, the Covermeter should be returned to your Elcometer supplier or directly to Elcometer. The warranty will be invalidated if the gauge has been opened.

Contact details can be found:

*   Stored in the Covermeter (MENU / ABOUT / CONTACT).
*   On the outside cover of these operating instructions.
*   At www.elcometer.com

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25 UPGRADING YOUR COVERMETER

Users of the Elcometer 331 model SH can upgrade their instrument to a model TH.

Upgrading your Covermeter will provide you with the following additional features:

- Memory of over 240 000 readings in multiple linear and grid batches
- Grid batches as well as linear batches
- Date and time stamping of measurements
- Plot on the display of the Covermeter a 'map' of the readings in a batch for quick and easy identification of potential trouble spots in a survey

Upgrading of your Covermeter must be carried out by Elcometer or your local Elcometer supplier.

For more information or to arrange to have your Covermeter upgraded, contact Elcometer, your Elcometer supplier or visit www.elcometer.com

26 TECHNICAL DATA

26.1 Performance[am]

Standard search head

Range:	40 mm (1.6") bar:	17 mm to 100 mm (0.65" to 4")
	8 mm (0.3") bar:	9 mm to 75 mm (0.35" to 3")
Accuracy:	up to 65 mm (2.6") depth:	±2 mm (0.1")
	over 70 mm (2.8") depth:	±3%
Pitch resolution:	16 mm (#5) diameter bar at 50 mm (2") depth of cover; pitch ≥ 75 mm (3")	

Narrow Pitch search head

Range:	40 mm (1.6") bar:	9 mm to 75 mm (0.35" to 3")
	8 mm (0.3") bar:	5 mm to 55 mm (0.2" to 2.2")
Accuracy:	up to 45 mm (1.75") depth:	±1 mm (0.05")
	over 50 mm (2") depth:	±2 mm (0.1")
Pitch resolution:	10 mm (#3) diameter bar at 30 mm (1.2") depth of cover; pitch ≥ 55 mm (2.15")	

Deep cover search head

Range:	40 mm (1.6") bar:	50 mm to 200 mm (2" to 8")
	8 mm (0.3") bar:	25 mm to 150 mm (1" to 6")
Accuracy[an]:	up to 65 mm (2.6") depth:	±2 mm (0.1")
	over 70 mm (2.8") depth:	±3%
Pitch resolution:	16 mm (#5) diameter bar at 100 mm (4") depth of cover; pitch ≥ 125 mm (5")	

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am. All performance figures have been obtained when using Elcometer reference rebars of standard diameter at room temperature.

an. Accuracy figures for the deep cover search head are obtained once the operating temperature has stabilised (after 10 minutes continuous use of the search head).

Half-cell mode

Range: -999 mV to +999 mV

Accuracy: ±5 mV

Half-cell probes

Stability: 10 mV with 3 µA load

26.2 Physical

Weight (including Deep head search head):   1.6 kg (3.5 lb)

Dimensions (including search head and lead):   230 mm x 130 mm x 125 mm
(9" x 5.1" x 4.9")

Operating temperature[ao]:   0°C to 50°C
(32°F to 120°F)

Case: High impact ABS

26.3 Power supply

Internal rechargeable Lithium Ion battery[ap].

Fuse rating of charger: 3 A

Battery life: Up to 32 hours continuous use without backlight. Up to 20 hours with backlight.

27 RELATED EQUIPMENT

Elcometer produces a wide range of concrete and coatings inspection equipment. Users of the Elcometer 331 Concrete Covermeter may also benefit from the following Elcometer products:

•   Elcometer Adhesion and Bond Strength Testers
•   Elcometer Concrete Crack Microscopes
•   Elcometer Concrete Moisture Meters
•   Elcometer Concrete Test Hammers

For further information contact Elcometer, your Elcometer supplier or visit www.elcometer.com

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ao. Operation outside these limits depends upon climatic conditions.
ap. Battery packs must be disposed of carefully to avoid environmental contamination. Please consult your local environmental authority for information on disposal in your region. Do not dispose of the battery pack in a fire.

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28 ACCESSORIES

Your Covermeter is complete with all the items required to get started.

The following optional accessories are available from Elcometer, or your Elcometer supplier. To place an order please quote the sales part number which follows the description of each accessory.

Rechargeable battery pack:	TW33119038
Search head - Standard:	TW33119124-1A
Search head - Narrow Pitch:	TW33119124-2A
Search head - Deep Cover:	TW33119171A
Search head - borehole probe, 400 mm (metric):	TW33119223-1A
Search head - borehole probe, 1000 mm (metric):	TW33119223-2A
Search head - borehole probe, 16" (imperial):	TW33119223-3A
Search head - borehole probe, 40" (imperial):	TW33119223-4A
Search head extension arm (for narrow pitch and standard search heads):	TW33119222
Search head connecting cable (for extension arm):	TW33119201
Search head connecting cable (curly)	TW33119199
Earphone:	TW99912220
Calibration check block:	TW33119218
Data transfer cable[aq] (Covermeter to PC):	T99916217
RS232 to USB transfer cable:	T99916716
CoverMaster$^{®}$ Software	TW33119221
Elcometer 331 Model SH to TH upgrade	TW33119684
Half-cell probe kit, Copper-Copper Sulphate (Cu-CuSO4): (probe, 2 x connecting cables, 1 x 25 m cable reel, carry case)	TW331CUKIT
Half-cell probe kit, Silver-Silver Chloride (Ag-AgCl): (probe, 2 x connecting cables, 1 x 25 m cable reel, carry case)	TW331AGKIT
Half-cell probe cable reel, extendable to 100 m, with carry handle:	TW33119683

Calibration certificate

Certificates traceable to National Standards including UKAS and NIST are available on request.

Calibration Certificates are issued for a specific gauge/search head combination and are not interchangeable. Calibration Certificates must be requested at the time of order, or alternatively, the gauge and search head must be returned to Elcometer for certification.

Calibration Certificates cannot be issued retrospectively.

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aq. A 9-pin to 25-pin adapter may be required for certain PC RS232 ports.

29 INDEX

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