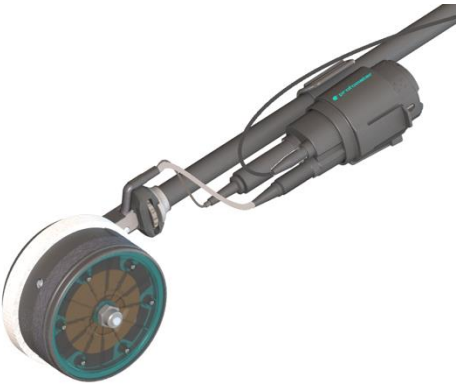
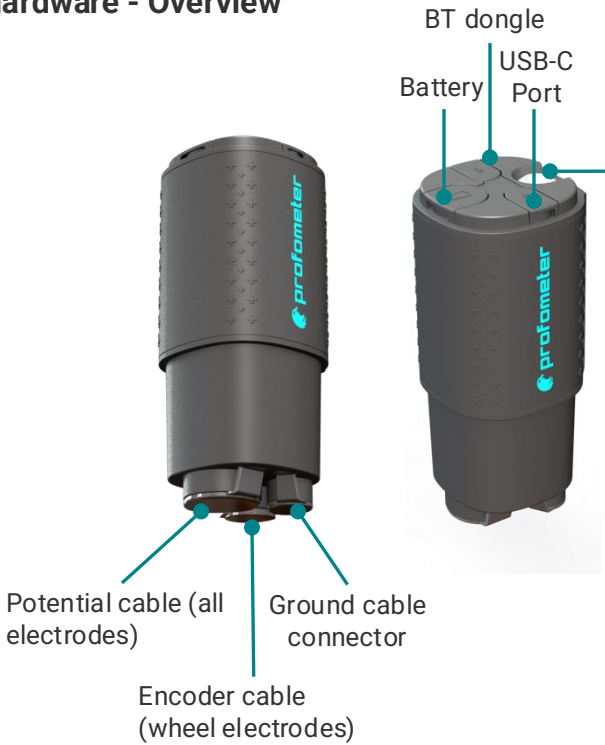
profometer

PM8500



Quick Reference

Hardware - Overview



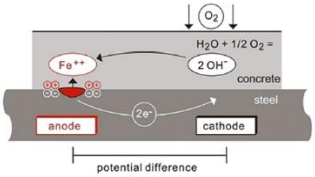
Device ON/OFF	
Medium push (3s)	Power ON
Medium push (3s)	Power OFF
Taking out the Battery	Reboot device

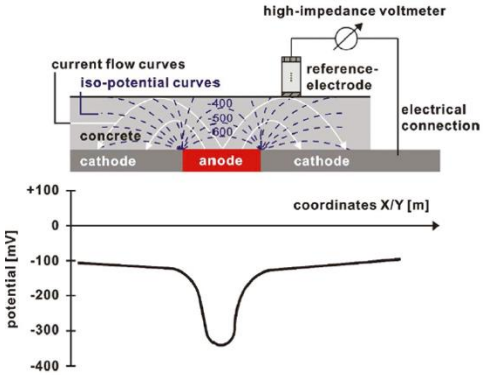
LED - Behaviour

LED Verhalten	
Battery Status – While turning on the device	Green: single quick blink: >20%
	Red: single quick blink: <20%
Turn on, awaiting Bluettoh connection	Green Solid
Connected. Review Mode • Paused • Stopped	Blue Solid
While measuring (rod/wheels)	Blue Blinking
Turn Off	No changes on LED during first 1 sec, then Red Solid countdown during 1 sec
Errors	
Device in boot loader mode	Red-Green Alternate Blinking

Measurement Principle

Half Cell Potential





- Under normal conditions reinforcement steel is protected from corrosion by a thin, passive film of hydrated iron oxide
- This passive film is decomposed due to the reaction of the concrete with atmospheric carbon dioxide (CO2, carbonatation), or by the penetration of substances aggressive to steel, in particular chlorides.
- At the anode, ferrous ions (Fe++) are dissolved, and electrons are set free. These electrons drift through the steel to the cathode, where they form hydroxide (OH-) with the generally available water and oxygen. This principle creates a potential difference that can be measured by the half-cell method.
- The basic idea of potential measurement is to measure the potentials at the concrete surface. For this purpose, a Cu/CuSO4 reference electrode (with a known potential) is connected via a high-impedance voltmeter to the steel reinforcement and is moved in a grid over the concrete surface.

Typical Reference Values

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Half Cell Potential

- Typical orders of magnitude (for information only) for the half-cell potential of steel in concrete measured against a Cu/CuSO4 reference electrode are in the following range (RILEM TC 154-EMC)

RILEM TC 154-EMC	
Water saturated concrete without O2	-1000 to -900 mV
Moist, chloride contaminated concrete	-600 to -400 mV
Moist, chloride free concrete	-200 to +100 mV
Moist, carbonated concrete	-400 to +100 mV
Dyr, carbonated concrete	0 to +200 mV
Dry, non-carbonated concrete	0 to +200 mV

- Probability of corrosion rises with low (negative) potentials. Active corrosion can be expected at locations where a negative potential is surrounded by increasingly positive potentials. I.e. locations with a positive potential gradient. Potential differences of around +100mV within a 1m distance, together with negative potentials, can be a clear indication of active corrosion
- The actual potential absolute value (corrosion threshold) may vary on different structures.
- ASTM C 876-09 suggests two different thresholds:

ASTM C 876-09	
90% probabiliy of corrosion	< -350mV
Uncertain	-350 to -200 mV
90% probability of no corrosion	> -200mV

External Factors

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Half Cell Potential

Moisture
Moisture has a large effect on the measured potential leading to more negative values

Cover
The potential becomes more positive with increasing concrete cover. Very low concrete cover can lead to more negative potentials which would seem to indicate high levels of corrosion

Electrical resistivity
Low electrical resistivity leads to more negative potentials and the potential gradients become flatter – coarse grid is needed.
High electrical resistivity leads to more positive potentials and potential gradients become steeper – fine grid is needed.

Temperature
High temperature will cause concrete resistivity to be lower and low temperature will cause concrete resistivity to be higher

O_2

Oxygen content
With decreasing oxygen concentration and increasing pH-value at a steel surface its potential becomes more negative

Preliminary operations

Prepare the electrodes

Rod Electrode: Remove the cap with the wooden plug and soak it into water for about an hour to allow the wood to saturate and swell.

Wheel Electrode: The wooden plug is not intended to be removed. Immerse the wheel in water for an hour to allow the water to soak into the plug. Only the wheels should be immersed, therefore, please remove them from the telescopic rod before soaking.

The felt hoops and the felt hoop connector must be saturated before measuring. In normal use, the thin felt is on the side of the wooden plug.

Copper Sulphate*

Prepare the saturated solution by mixing **40 units by weight of copper sulphate with 100 units by weight of distilled water**. Add an additional teaspoon of copper sulphate crystals into the electrode.

The electrode should be filled as completely as possible with a **minimum of air** in the compartment. This ensures that the solution is in contact with the wooden plug even when measuring in an upwards direction.

Connect to rebar

The ground cable must be **connected to the reinforcement**. The connection should be made with the **least possible resistance**.
The connection should be **tested for continuity**. This requires at least one other point of the reinforcement to be exposed and to check the resistance between the two with an Ohmmeter - **not more than 1 Ω** above the resistance of the cable used.
A secure connection can be also obtained by drilling a 25 mm hole into the concrete above the rebar, then drill a 4 mm hole into the rebar and insert a self tapping screw with attached lead into the hole in the steel

*When handling copper sulphate be careful to take note of the safety instructions on the packaging

Preliminary operations

Coated surfaces

It is not possible to make a measurement through an electrically isolating coating (e.g. an epoxy resin coating, sealing sheets or asphalt layers.)

It is possible to make a measurement through thin dispersion coatings, however this can cause a small shift of the potentials. To do this, potentials should be measured at a few locations

- in the first place through the coating and
- with the coating removed

If there is no alteration of the potential, or if a shift of the potential can be compensated by a correction (e.g. ΔV = ± 50 mV), then a measurement can be made directly on the coating. If not, then the coating must be removed before making the measurement.

Pre-moistening

The contact between the pore solution of the concrete and the probe can be impaired by a dried out concrete skin. This can greatly increase the electrical resistivity of the concrete.

It is recommended to moisten the surface approximately 10 to 20 minutes before carrying out the measurement.

If this is not possible, it must be ensured that the sponge on the Rod Electrode or the felt hoops on the wheel electrode are sufficiently moistened. In this case, when making a measurement, the probe must be held against the surface until a stable end value is reached. This is only possible with the Rod Electrode.

In the case of the wheel electrode with its continual automatic measurement, it is not possible to monitor whether or not the measured value is stable. Therefore, it is recommended to pre-moisten the surface in sections and to measure in intervals of a few minutes.

Maintenance and Cleaning

To guarantee consistent, reliable and accurate measurements, the instrument should be calibrated on a yearly basis. The customer may, however, determine the service interval based on his or her own experience and usage.

- Do not immerse the instrument in water or other fluids.
- Keep the housing clean at all times.
- Wipe off contamination using a moist and soft cloth.
- Do not use any cleaning agents or solvents.
- Do not open the housing of the instrument yourself.

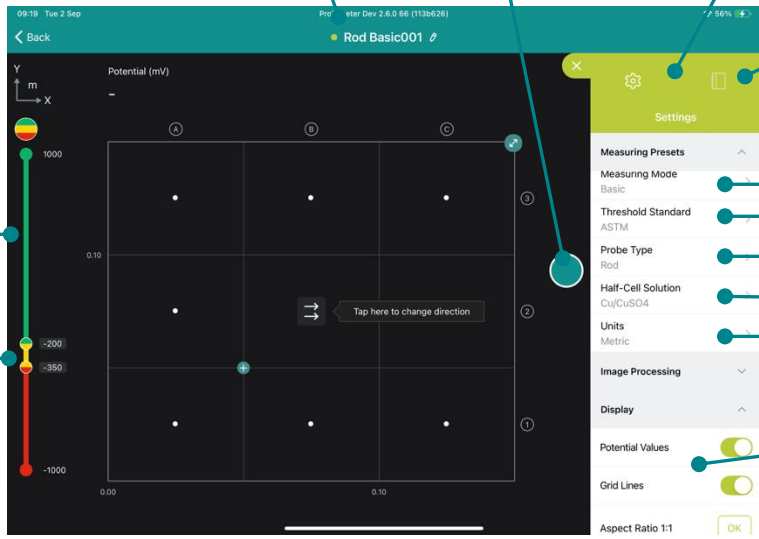
Rod Electrode

- Unscrew the two caps, wash with water and carefully clean the inner side of the tube.
- Clean the copper rod using emery cloth.
- Refill the electrode with copper sulphate

Wheel Electrode

- Remove the felt hoops and wash in lukewarm water.
- Remove the plastic filling screw and pour the copper sulphate solution into a container. (This can be reused)
- Flush out several times with water.
- Dissolve 1-part citric acid in 10 parts hot water and half fill the wheel.
- Replace the filling screw.
- Leave for 6 hours, shaking occasionally.
- Pour out the citric acid solution (no special disposal procedure is required) and flush out several times with water.
- Refill the electrode with copper sulphate solution.
- Replace the felt hoops. The felt hoop connector must be in place between the dampening nozzle and the wooden plug of the wheel electrode.
- When not in use, store the wheel electrode with the wooden plug facing upwards.

Settings – Rod Electrode Basic



Settings – Rod Electrode Advanced

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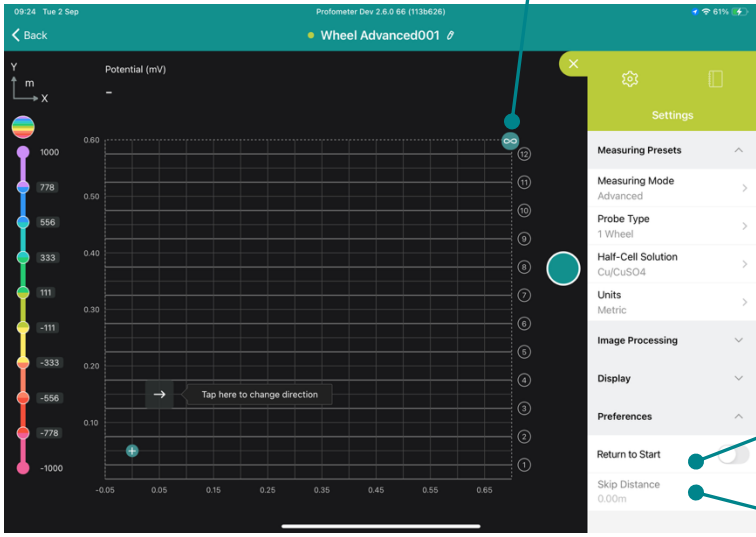
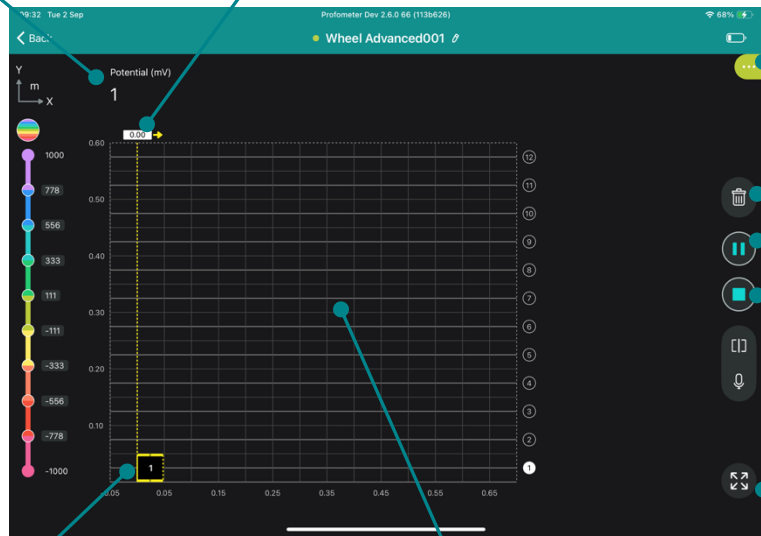
Settings – Wheel Electrode Advanced



Scanning - Measuring Screen

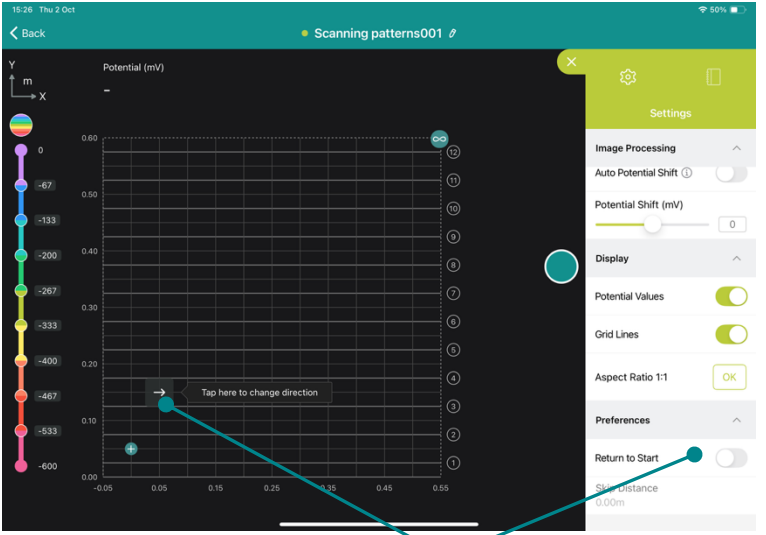


Scanning Flexibility

profometer

Function	Comments
Scan with a fixed grid or a flexible grid	
Scan horizontally or vertically	
Scan forwards or negative	
Return to start for each new line or scan in an S-pattern	Switch between pattern modes during a scan (Flexible grid only)
Select any cell and continue scanning from there	Can be used to fill in missing cells or to overwrite existing data. (Flexible grid only)
Start a scan from any corner	Made possible by capability to select any cell and scan from there in a positive or negative direction (Flexible grid only)
Set and maintain zoom level while scanning	
Skip a preset distance	
Open a saved scan and continue scanning from any cell	

Set the Scanning Pattern



Set the scanning pattern with a combination of these two settings

Scanning Patterns

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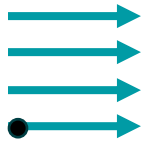
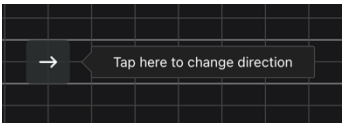
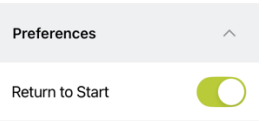
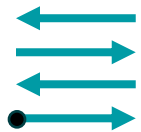
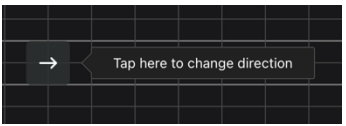
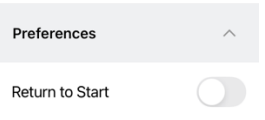


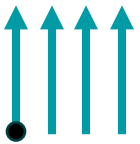


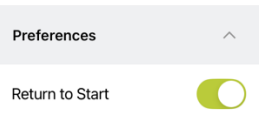


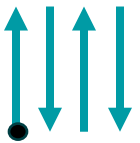


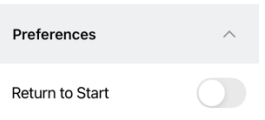




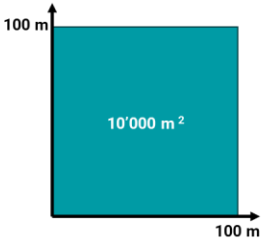


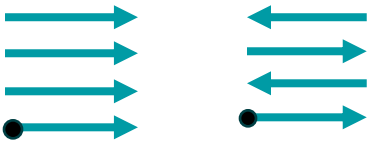




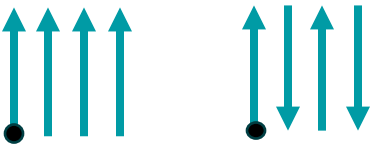


Scanning Limits – Fixed Grid



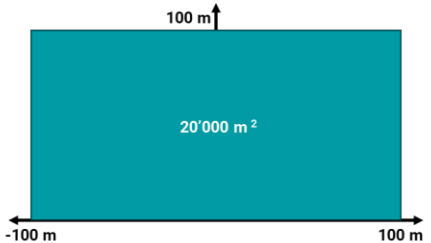


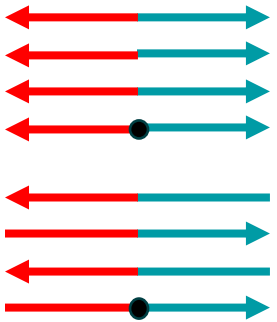
Horizontal Scanning Patterns



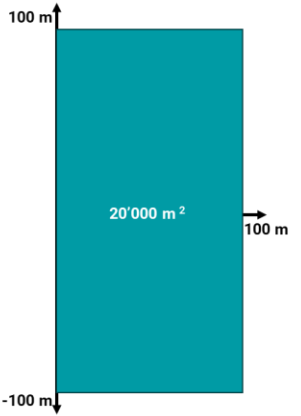
Vertical Scanning Patterns

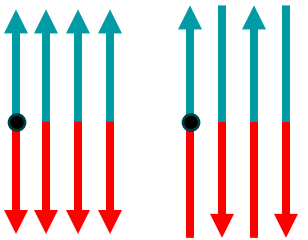
Scanning Limits – Flexible Grid





Horizontal Scanning Patterns

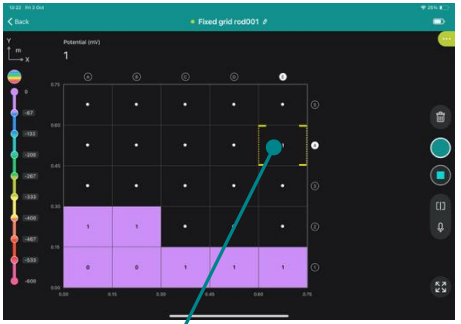




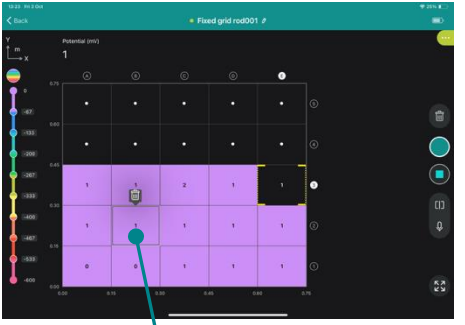
Vertical Scanning Patterns

Fixed Grid Scanning

- Choose the scanning pattern
- On saving a measurement the next cell defined by the scanning pattern becomes the active cell
- Double tap on any free cell (no data recorded) to make this active cell
- Long press on any cell with data to delete the contents of the cell
- Easy skip can also be used in the fixed grid



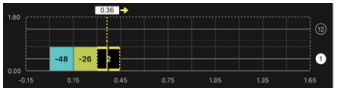
Double tap on any empty cell to make it the active cell



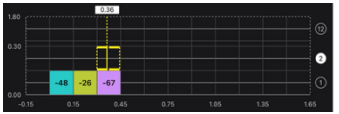
Long press on any cell to delete the contents

Flexible Grid Scanning – Resume from any cell

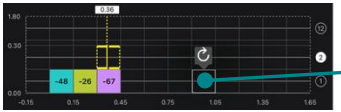
- The flexible grid allows the user to resume a scan from any cell
- It is also possible to open a saved scan and resume scanning from any cell
- The chosen cell can be an empty cell – e.g. for avoiding obstacles or for dealing with irregular shaped scans
- The chosen cell can be a cell which already has data – In this case the data will be overwritten as the scan continues



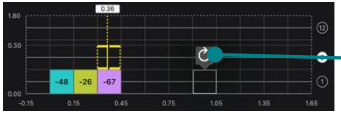
Ongoing Scan



Step 1
Stop the scan
Active cell jumps to the next line

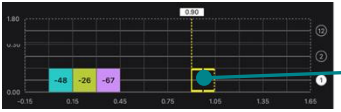


Step 2
Long press in the cell you wish to jump to and release

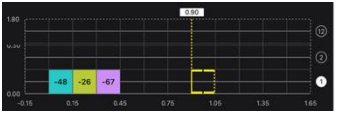


Step 3
Tap on resume symbol to make this the active cell

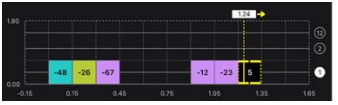
Resume from any cell continued



The chosen cell is now the active cell



Step 4
Resume the scan

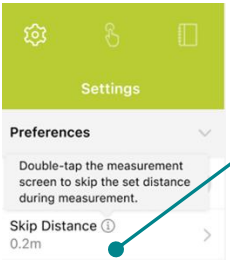


Step 5
Continue scanning

Flexible Grid Scanning – Easy skip

- Easy skip allows the user to predefine a skip distance and quickly jump this distance while scanning
- This function is also available in fixed grid scanning
- Set the easy skip distance in “preferences”. Note this can only be set while scanning.
- Double tap on the measurement screen to jump the preset distance.
- The scan is stopped. Move the wheel electrode to the new position (e.g. beyond the obstacle)
- Start the scan again and continue measuring

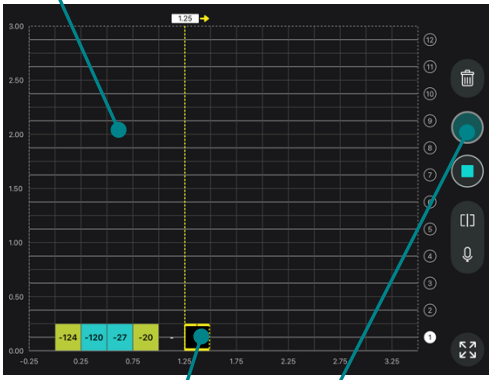
Ongoing Scan



Step 1
Set the Skip Distance

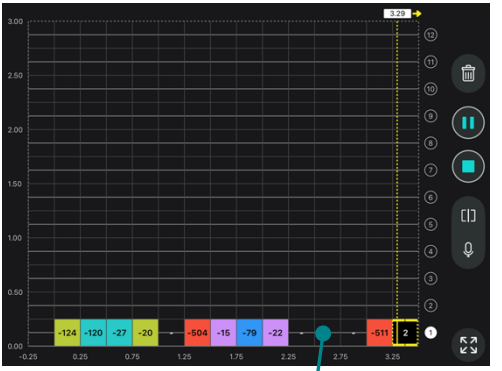
Easy Skip continued

Step 2
Double tap anywhere in the measurement grid to activate easy skip



Step 3
Continue scanning

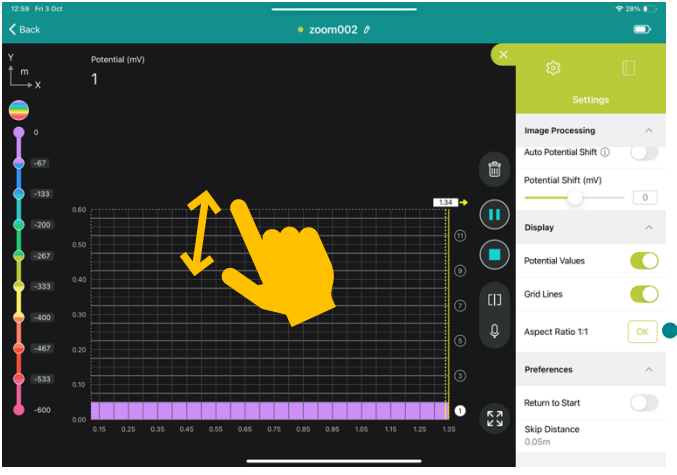
Measurement position jumps to the new position defined by the skip distance



Double tap multiple times without restarting the scan to activate the skip distance multiple times

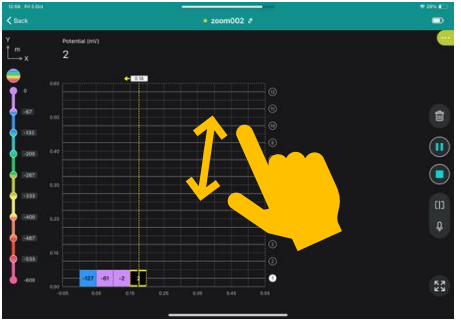
Scanning Flexibility – Zoom While Scanning

- The zoom level can be adjusted while scanning as desired by pinching with two fingers in the measurement grid
- The new zoom level is maintained until adjusted again
- Zooming out beyond a certain level will mean that the potential values can no longer be displayed
- The 1:1 display can be reset at any time by tapping on the button in the settings

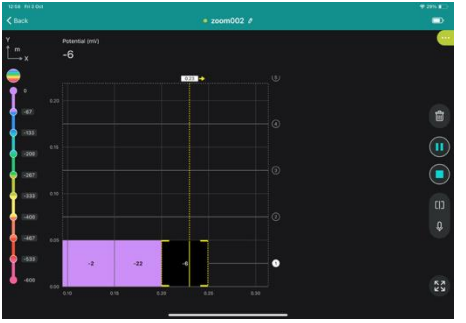


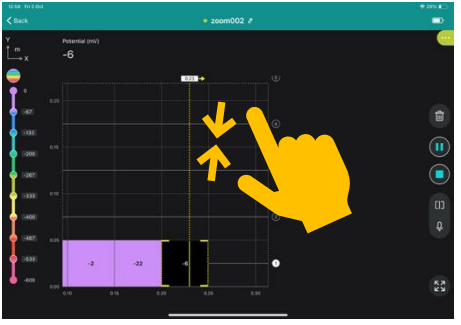
Tap to restore 1:1 aspect ratio

Scanning Flexibility – Zoom While Scanning

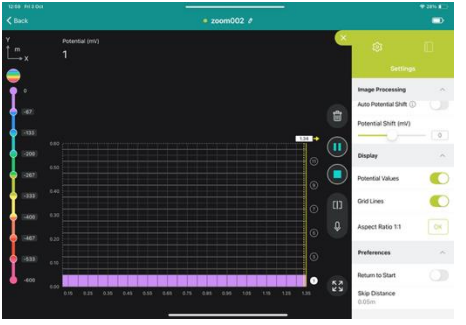


Zoom in



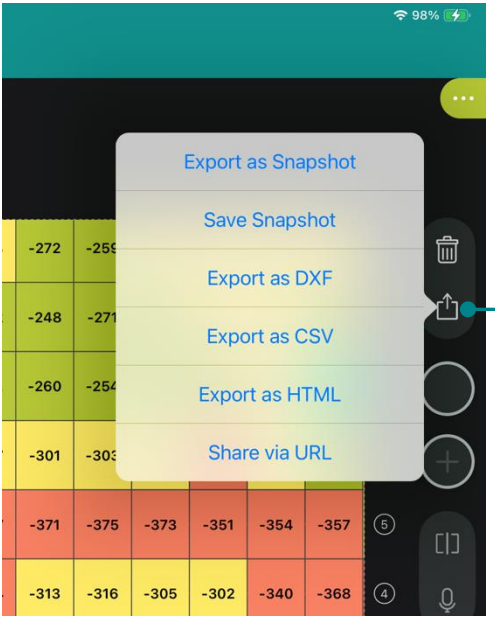


Zoom out



Review Screen

Export Formats



Select the export format

Summary of Data Export Formats

Format	Explanation
Export snapshot	Creates a .PNG image of the current iPad display along with a CSV file containing user info, measurement settings, statistical data and measurement data that can be opened with spreadsheet software (e.g. EXCEL)
Save Snapshot	Creates a .PNG image of the current iPad display that is sent to the logbook
Export as DXF	Creates a file in DXF format that can be viewed and scaled with suitable software, e.g. Autocad, for alignment with construction drawings
Export as CSV	Creates a CSV file that can be opened with spreadsheet software (e.g. EXCEL)
Export as HTML	Creates a link that enables the logbook of the scan to be viewed on the Workspace viewing portal
Share via URL	Sharing a URL creates a link to the measurement file that can be opened by anyone who has a Screening Eagle ID and the Profometer app

View Modes

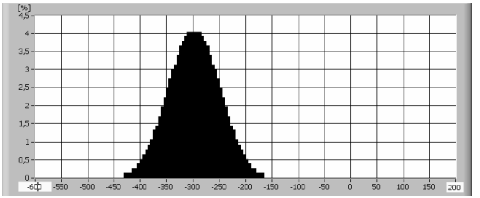
- Swipe down with two fingers to switch between one view and the next

Potential Map

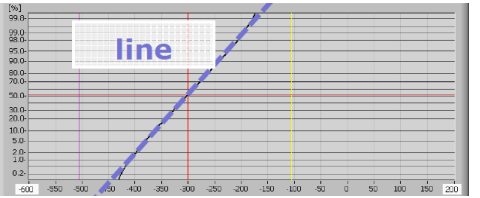
Measurement Statistics

Chipping Graph

Corrosion Analysis Basic Theory

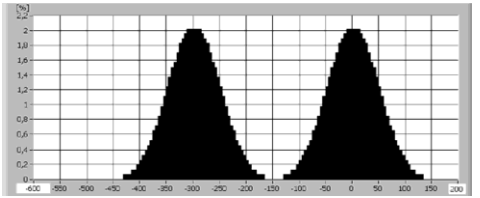


Frequency Histogram

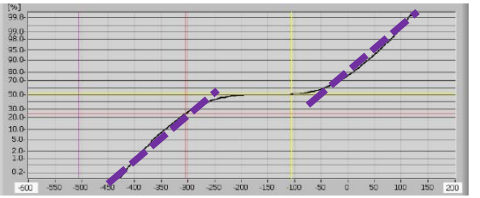


Cumulative Frequency

If all of the measurements collected were made on corroding steel, then we would obtain a normal distribution centered around a negative potential and the cumulative frequency plot would be a straight line.



Frequency Histogram



Cumulative Frequency

If we have two distinct populations – e.g. Half of the measurements are made only on corroding steel and the other half are made on steel that is only passive, we will obtain two normal distributions, the first centered on a negative potential, the second centered around a higher potential. The cumulative frequency plot would be two distinct straight lines.

Statistics View - Corrosion Analysis Tools

Frequency Histogram **Cumulative Frequency**

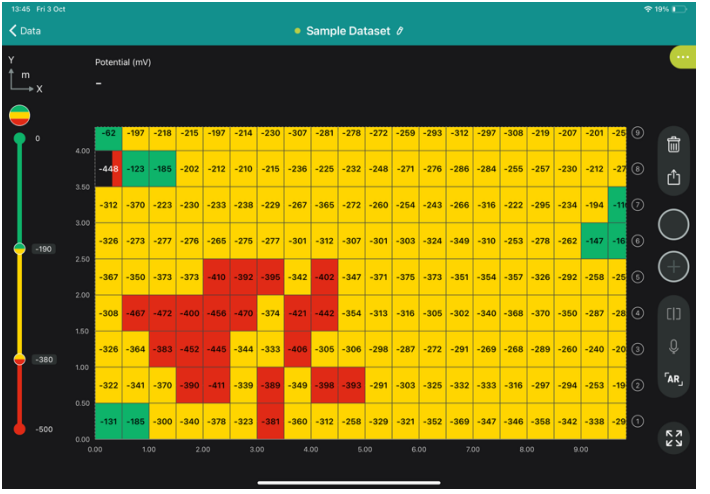
On real structures the populations will overlap.
The cumulative frequency graph is used to identify the straight-line sections which indicate the passive and corrosive thresholds.
It is always advised to make an opening in the concrete at locations with these potentials to verify the analysis

Chipping Graph

The Chipping Graph View provides an area mapping of the measured potential values with a fixed green/yellow/red color palette referring to the thresholds set in the Cumulative Frequency View.

An immediate overview is then provided discriminating the actively corroding areas (red) from the passive areas (green) and the uncertain regions (yellow).

This view can be superimposed on the surface structure using augmented reality

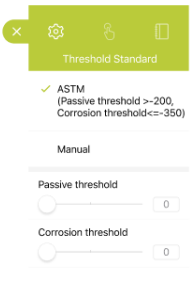


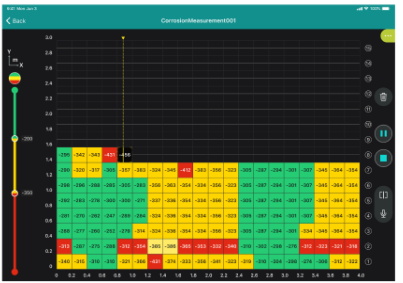
Basic Mode

The Basic Mode shows directly the Chipping Graph at the same time as the measurement is done.

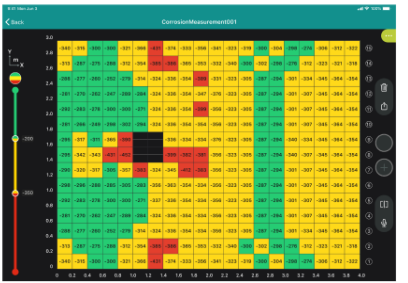
For that purpose, the threshold limits have to be preset:

- Manually
- Selecting the limits defined in the ASTM C876-09, Appendix X1, assigning a 90% probability of corrosion ongoing to the areas more negative than -350 mV, and a 90% probability of no corrosion to the areas more positive than -200 mV.





Measure Mode



Review Mode

profometer

SWISS MADE

For more information on the product use of the product,
please refer to the Profometer PM8500 documentation

It is available for download on

www.screeningeagle.com/en/products/profometer-pm8500

profometer

ASIA-PACIFIC
Proceq Asia Pte Ltd.
1 Fusionopolis Way
Connexis South Tower #20-02
Singapore 138632
T +65 6382 3966

CHINA
Proceq Trading Shanghai Co., Limited
Room 701, 7th Floor, Golden Block
407-1 Yishan Road, Xuhui District
200032 Shanghai | China
T +86 21 6317 7479

EUROPE
Proceq AG
Ringstrasse 2
8603 Schwerzenbach
Zurich | Switzerland
T +41 43 355 38 00

UK
Screening Eagle UK Limited
Bedford i-lab, Stannard Way
Priory Business Park
MK44 3RZ Bedford
London | United Kingdom
T +44 12 3483 4645

MIDDLE EAST AND AFRICA
Proceq Middle East and Africa
Sharjah Airport International
Free Zone | P.O.Box: 8365
United Arab Emirates
T +971 6 5578505

USA, CANADA & CENTRAL AMERICA
Screening Eagle USA Inc.
14205 N Mopac Expressway Suite 533
Austin, TX 78728 | United States

Screening Eagle USA Inc.
117 Corporation Drive
Aliquippa, PA 15001 | United States
T +1 724 512 0330

SOUTH AMERICA
Proceq SAO Equipamentos
de Mediçao Ltda.
Rua Paes Leme 136
Pinheiros, Sao Paulo
SP 05424-010 | Brasil
T +55 11 3083 3889