



PM8500

Profometer Corrosion
User Manual



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This document contains important information on the safety, use and maintenance of Proceq products. Read through this document carefully before the first use of the instrument. Observe the safety and warning notes in this documentation and on the product. This is a prerequisite for safe working and trouble-free operation.

Symbols used

- This icon signals important information, specifications, proper working procedure and measures to avoid data loss, damage, or destruction of the instrument.
- This note signifies a warning about dangers to life and limb if the apparatus is handled improperly. Observe these notes and be particularly careful in these cases. Also inform other users on all safety notes. Besides the notes in this instruction manual the generally applicable safety instructions and regulations for prevention of accidents must be observed.

Limitation of use

The instrument is only to be used for its designated purpose as described herein.

- Replace faulty components only with original replacement parts from Proceq.
- Accessories should only be installed or connected to the instrument if they are expressly authorized by Proceq. If other accessories are installed or connected to the instrument, then Proceq will accept no liability and the product guarantee is forfeited.

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- Failure to use the instrument in accordance with its designated use as described in the product documentation.
- Incorrect performance check for operation and maintenance of the instrument and its components.
- Failure to adhere to the instructions dealing with the performance check, operation and maintenance of the instrument and its components.
- Unauthorised modifications to the instrument and its components.
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Damages during carriage

On receipt of the goods, check for any visible damages on the packaging. If it is undamaged, you may sign the receipt of the goods. If you do suspect by visual inspection that damage has occurred, make a note of the visible damage on the delivery receipt and request the courier to countersign it. Moreover, the courier service must be held responsible for the damage in writing.

If a hidden damage is discovered while unpacking, you have to inform and hold the courier liable immediately in the following way: "When opening the parcel we had to notice that ... etc." This superficial checking of the goods has to be done within the time limit set by the carrier, which is normally 7 days. However, the period could vary depending on the courier. Hence, it is recommended to check the exact time limit when receiving the goods.

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Should the device be transported again, it must be packaged properly. Preferably use the original packaging for later shipments. Additionally, use filling material in the package to protect the device from any shock during carriage.

Safety notes and hints

- All maintenance and repair work which is not explicitly permitted and described in the present manual shall only be carried out by **Proceq SA** or your authorized service center, failure to comply voids warranty.
- **Proceq SA** refuses all warranty and liability claims for damages caused by usage of the product in combination with **non-original accessories**, or accessories from 3rd party suppliers.
- Never immerse the device in water or other liquids: **Danger of short circuit!**
- Never leave the product under direct sun exposure. Always store the product in its carrying case.

For the operation of the product all local safety regulations apply.

1 Introduction

Profometer PM8500 is a high-quality instrument used to measure the likelihood of corrosion using the half-cell potential method.

The product consists of:

- the PM8500 sensor unit,
- the electrodes (rod, one wheel or four wheel),
- the Profometer iOS app,
- and the Screening Eagle Workspace platform.



Figure 1: PM8500 System

The PM8500 sensor can be used in the following configuration:

- Wirelessly connected sensor via low power Bluetooth to the iPad, which runs the Profometer app. Given mobile data connectivity (Wi-Fi or mobile network), the pm app automatically and safely stores all measurements on the Screening Eagle Workspace.

1.1 Scope of this document

This document is the user manual for all products of the PM8500 Product family.

1.2 Product versions

To be able to use the functionality of the pm app, a software license is required.

The following license is currently available:

- Profometer PM8500 License

1.3 Product applications

In general, two measurement types can be differentiated:

- Measuring with a pre-defined fixed grid up to 100 x 100 m which is the only option for the rod electrode
- Measuring with a flexible grid up to +/- 100 x 100 m with the wheel electrodes



PM8500

	Fixed Grid	Flexible Grid	
Rod Electrode Scan small areas: columns, beams, footings...	100 x 100 m ² ✓		50 m ² / hour
One Wheel Electrode Scan bigger vertical and overhead areas: walls, roofs...	100 x 100 m ² ✓	+/- 100 x 100 m ² ✓	450 m ² / hour
Four Wheel Electrode Scan big horizontal areas: slabs, parking garages, bridge decks...	100 x 100 m ² ✓	+/- 100 x 100 m ² ✓	1800 m ² / hour

1.4 Scope of Delivery

Please refer to the Quick Start Guide provided in the standard delivery and available in download section of the product webpage.

2 Measurement Principle

2.1 Corrosion and 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), or by the penetration of substances aggressive to steel, in particular chlorides from de-icing salt or salt water.

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.

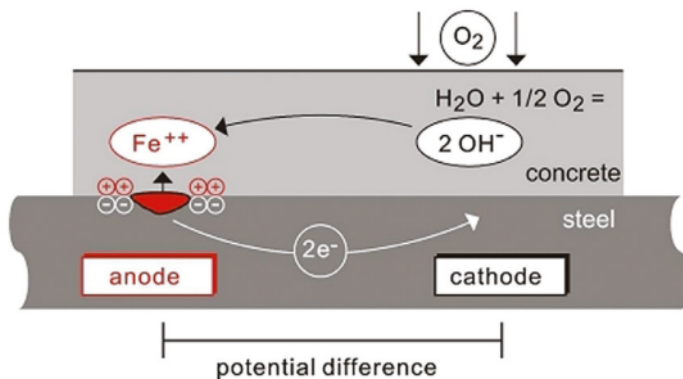


Figure 2: Principle of steel corrosion in concrete with oxygen availability.

The basic idea of the potential field measurement is to measure the potentials at the concrete surface, to get a characteristic picture of the state of corrosion of the steel surface within the concrete. For this purpose, a reference electrode is connected via a high-impedance voltmeter to the steel reinforcement and is moved in a grid over the concrete surface.

The reference electrode of PM8500 system is a Cu/ CuSO₄ half-cell. It consists of a copper rod immersed in a saturated copper sulphate solution, which maintains a constant, known potential.

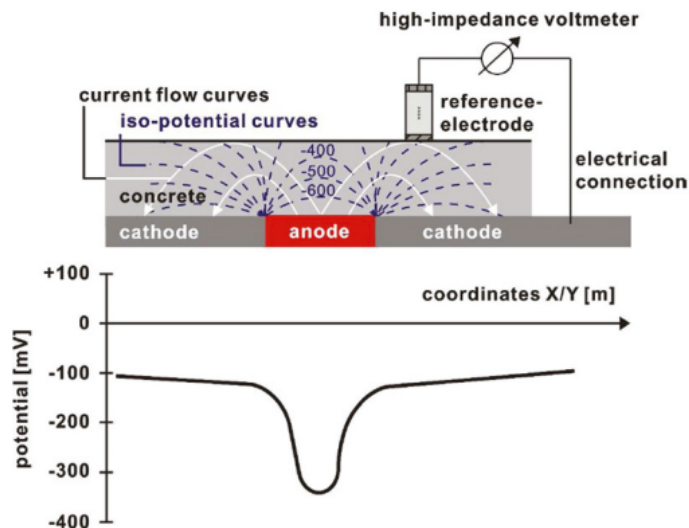


Figure 3: Measuring principle.

2.2 Typical Potential Range

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):

water saturated concrete without O ₂	-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
dry, carbonated concrete	0 to +200 mV
dry non-carbonated concrete	0 to +200 mV

In general terms the 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 measurement area, together with negative potentials can be a clear indication of active corrosion.

The actual potential absolute value (corrosion threshold) below which active corrosion can be expected may vary significantly on different structures. It is however useful to mention the thresholds suggested by ASTM C 876-22b, 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, judging uncertain the behavior in the regions in between the two thresholds. Be sure to note the conditions stated by ASTM as to the applicability of these threshold values.

2.3 Factors affecting the potential measurement

Provided that the corrosion conditions are equal (chloride content or carbonation of the concrete at the steel surface) the main influences upon the half-cell potentials are:

Moisture

See the chart above for moist, carbonated concrete and dry, carbonated concrete. Moisture has a large effect on the measured potential leading to more negative values.

Concrete cover thickness (Measure with PM8000 and PM8000 Pro)

The potential that can be measured at the surface becomes more positive with increasing concrete cover. Variations in the concrete cover can cause deviations in the measurements. Very low concrete cover can lead to more negative potentials which would seem to indicate high levels of corrosion. Therefore, it is advisable to make concrete cover measurements along with the half-cell measurements.

Electrical resistivity of the concrete (Measure with Resipod)

Low electrical resistivity leads to more negative potentials that can be measured on the surface and the potential gradients become flatter. In this case the measurement grid for potential measurements may be coarser, as the risk of undetected anodic areas with flatter gradients becomes lower. However, as the resolution between corroding and passive areas is reduced, this may lead to an overestimation of the actively corroding surface area.

High electrical resistivity leads to more positive potentials that may be measured on the surface and potential gradients become steeper. In this case the measuring grid must be made finer, to be able to locate an anode with a very steep gradient. However, the mere potentials may be misinterpreted as passive areas when only considering the absolute value of the potential.

Temperature

The main effect of temperature on potential measurements is given by its influence on the electrical resistivity. High temperature will cause concrete resistivity to be lower and low temperature will cause concrete resistivity to be higher; the resulting effect on potential value is as described in the previous paragraph "Electrical resistivity of the concrete".

In order to measure the potential, there must be a contact between the probe and the electrolytes in the pore system of the concrete. Therefore, a measurement below the freezing point is not recommended and can lead to incorrect readings.

Oxygen content at the reinforcement

With decreasing oxygen concentration and increasing pH-value at a steel surface its potential becomes more negative. In certain cases of concrete components with a high degree of water saturation, low porosity and/or very high concrete cover and thus low oxygen supply, the potential at the steel surface may be highly negative even though no active corrosion is taking place. Without checking the actual corrosion state this may lead to misinterpretation of the potential data.

2.4 Application limits of the potential measurement technique

The potential field measurement even with a coarse grid delivers good results for chloride induced corrosion. This type of corrosion is typified by pitting developing into troughs. Corrosion due to carbonation is typified by the development of smaller macro-elements and is only possible to determine by using a very fine grid if at all.

Corrosion of pre-stressed steel reinforcement is not possible to detect if it is located within a protective tube.

The potential field measurement alone offers no quantitative conclusions about the rate of corrosion. Empirical studies have shown that there is a direct relationship between the corrosion rate and the electrical resistivity. However, corrosion rate readings are of limited value as the rebar corrosion rate varies considerably with time. It is more reliable to work with corrosion readings taken over a period of time.

3 PM8500 Operation

3.1 Preliminary Operations

3.1.1 Prepare the electrode(s)

Rod Electrode

Before filling, remove the cap with the wooden plug and soak it in 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 well before you intend to use it to allow water to soak into the plug. The felt hoops and the felt hoop connector should be saturated with water before measuring.

In the wheel electrodes you will find two compartments. One is for water, that will moisten the felt hoops during the measurement. The other one should be filled with the copper sulphate solution.

Copper Sulphate (Rod and Wheel)

Prepare the saturated solution by mixing 40 units by weight of copper sulphate with 100 units by weight of distilled water. To ensure that the solution remains saturated, add an additional teaspoonful 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.



NOTE! When handling copper sulphate be careful to take note of the safety instructions on the packaging.

3.1.2 Selecting the correct grid and marking the surface

One method is to use a relatively large grid for a first estimate, e.g., 0.50 x 0.50 m up to a max of 1.0 x 1.0 m. Suspect areas can be further investigated using a finer grid (e.g., 0.15 x 0.15 m), to identify the extent of the surface that will require corrective maintenance.

Vertical elements usually require a smaller grid (e.g., 0.15 x 0.15 m). The same applies to slender elements, for which the grid will be defined by the geometry, (e.g., steps, beams, and joints etc.).

For large horizontal surfaces (parking decks, bridge decks etc.) a grid of 0.25 x 0.25 m to 0.5 x 0.5m is typically sufficient.

It is recommended to mark out a grid on the surface corresponding to the grid you wish to use.

For small areas where point measurements will be made with the Rod Electrode this can be done by using a tape or by drawing the grid on the element.

For large areas such as parking and bridge decks the wheel electrode is preferable. The integrated path measurement ensures the correct grid in the direction of measurement. To

ensure the correct grid between parallel measurement paths marks can be drawn on the surface. Please note the 4-Wheel Electrode ensures a stable parallel grid and requires less marks to be drawn on the surface.

3.1.3 Choosing the appropriate electrode

Depending on the surface under test, it is necessary to choose which type of electrode will be employed.

For small areas or areas that are difficult to access, the small and light Rod Electrode will typically be used.

For more accessible horizontal, vertical, or overhead surfaces, it is much faster to use the 1-Wheel Electrode.

For large horizontal surfaces, the 4-Wheel Electrode is recommended for the reason of the significantly faster automatic measurement in a pre-defined grid.

3.1.4 Connect to the reinforcement.

The ground cable must be connected to the reinforcement of the surface to be measured. This is usually done by chiseling or drilling down to the reinforcement.

In some cases, it may be possible to use existing building elements that are connected to the reinforcement (e.g., water pipes, earth points). The connection to the reinforcement should be made with the least possible resistance. To this end it may be beneficial to grind the reinforcement (e.g., using an angle grinder) and to connect the cable with welding tongs.

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.

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. The connections should be situated as far as possible in opposing corner areas of the surface under test. The measured resistance should not be more than 1 Ω above the resistance of the cable used.

3.1.5 Sensor Unit overview

Keys - Overview

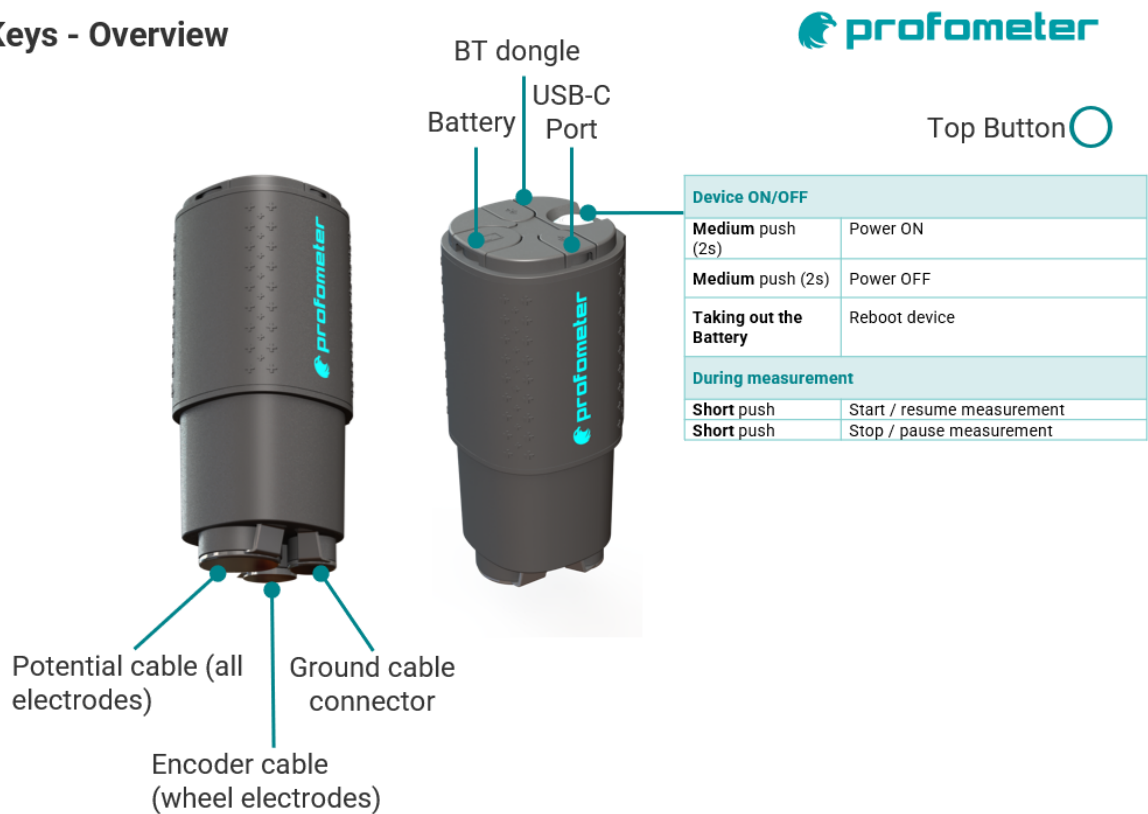


Figure 4 : PM8500 Sensor Unit: Keys Overview

LED - Behaviour

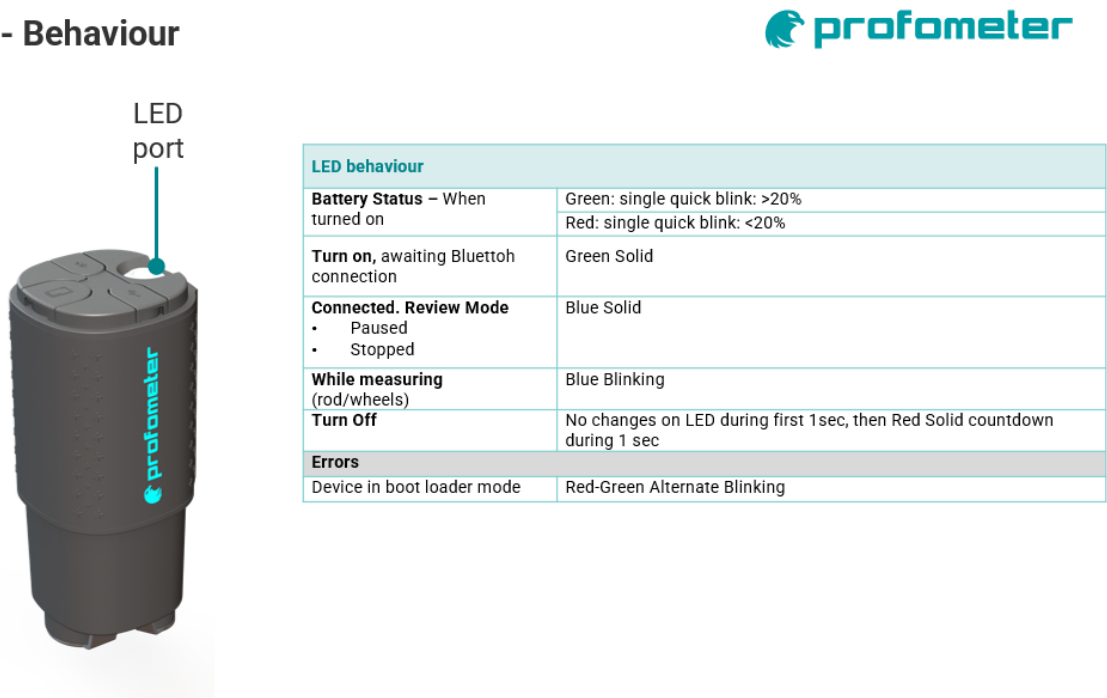


Figure 5 : PM8500 Sensor Unit: LED behavior

3.1.6 Connecting the electrode cables with the sensor unit

Rod Electrode:

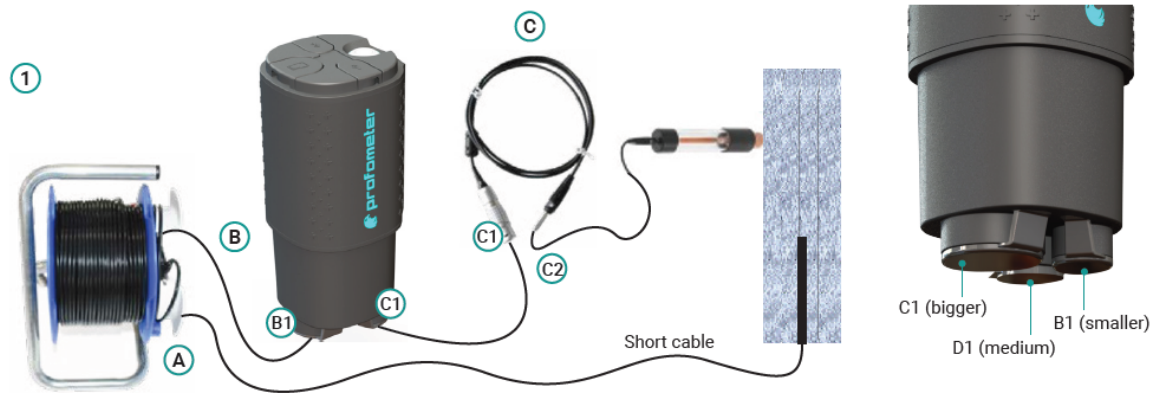


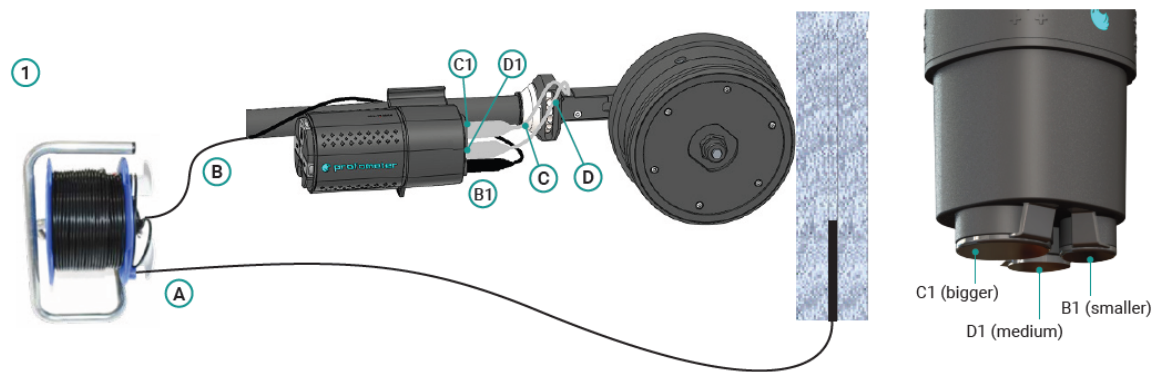
Figure 6 : PM8500 Rod electrode cabling set up

- a Connect the clamp of the ground cable (A) with the exposed rebar
- b Connect the ground cable (B) to the sensor using B1 plug
- c Connect the rod cable (C) to the sensor using C1 plug and to the electrode using C2 plug



Figure 7 : PM8500 Rod electrode cabling set up

One Wheel and Four-Wheel Electrode:



- a Connect the clamp of the ground cable (A) with the exposed rebar
- b Connect the ground cable (B) to the sensor using B1 plug
- c Connect the potential cable (C) and the encoder cable (D) to the sensor using C1 and D1 plugs



Figure 8 : PM8500 One wheel electrode cabling set up

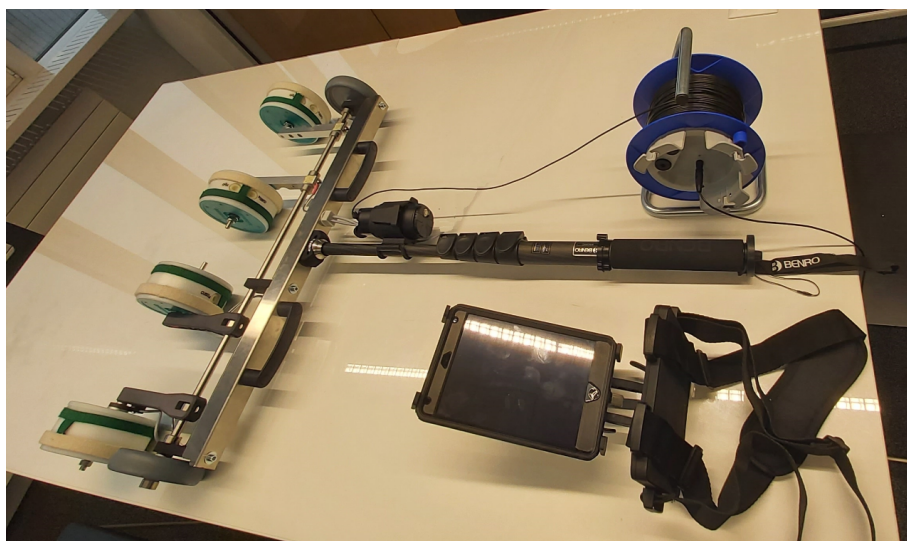


Figure 9 : PM8500 Four-wheel electrode cabling set up

3.1.7 How to mount the sensor on the harness

PM8500 includes a chest harness to carry the iPad for hands-free operation.

This harness can also be used to mount the sensor unit when using the rod electrode. To do so, place the sensor unit in the universal holder and connect the inner clamp to the harness belt.

If you do not want to use the iPad harness, you can always clip the holder to your trouser pocket, or belt.

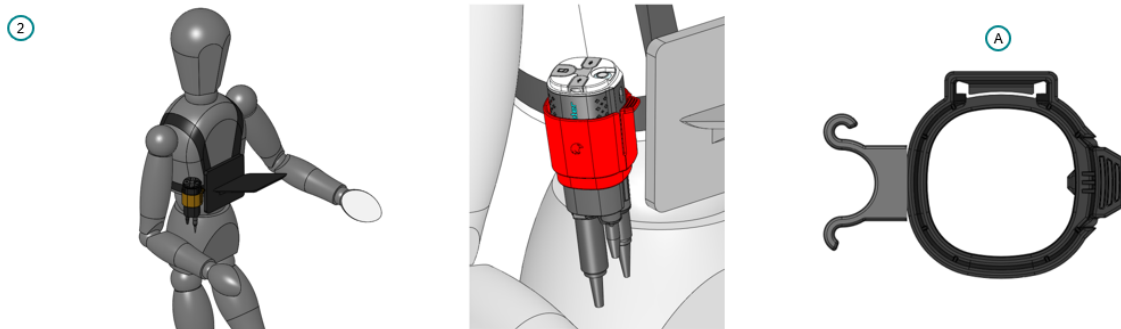


Figure 10 : PM8500 Universal Holder for Sensor Unit

Should you be using the one wheel or the four-wheel electrode, you can mount the universal holder to the telescopic rod.

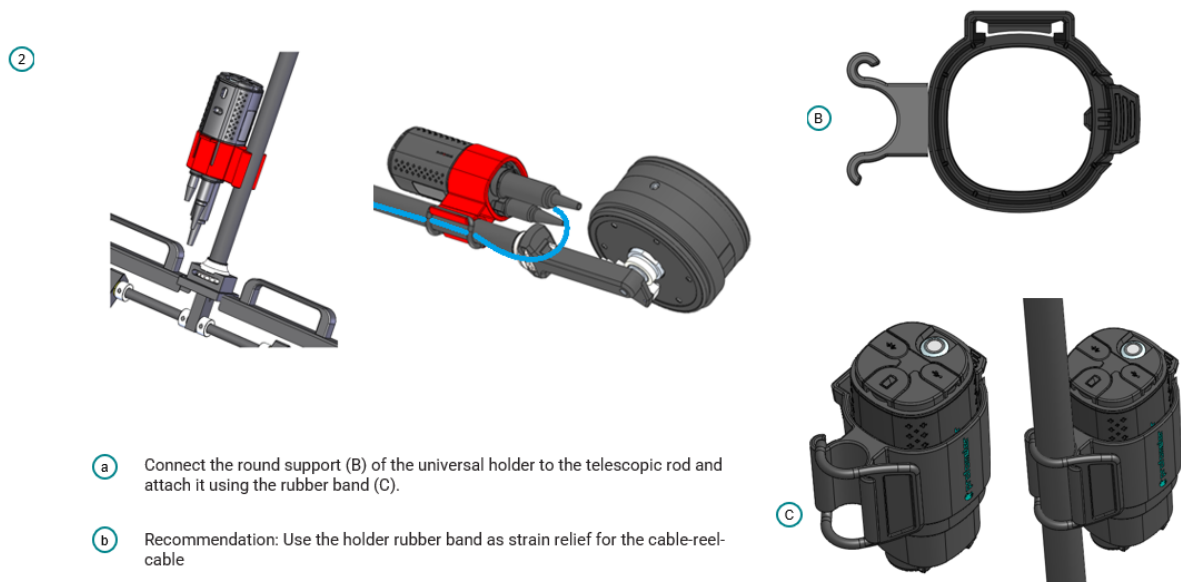


Figure 11 : PM8500 Universal Holder for Wheel Electrodes

3.1.8 How to mount the telescopic rod on the one wheel and four-wheel electrode

A telescopic rod is provided in the one wheel and the four-wheel kit.

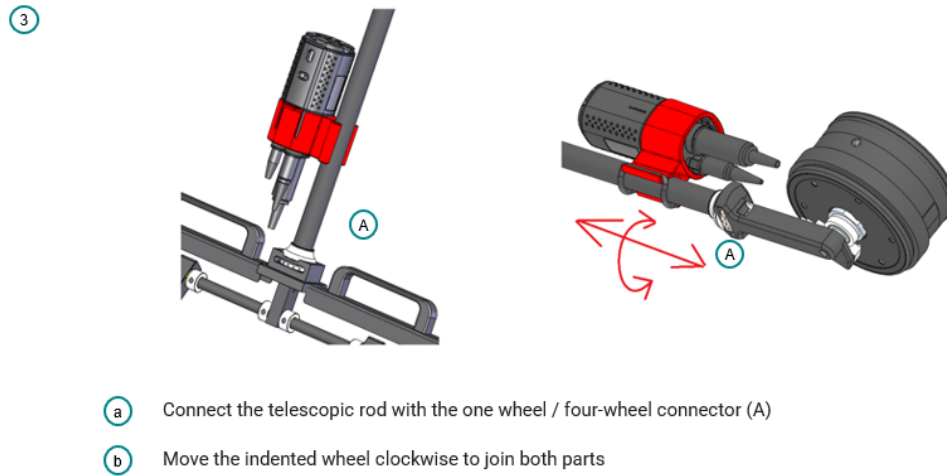


Figure 12 : PM8500 Telescopic Rod

3.1.9 How to mount the Ball-Joint Accessory together with the one-wheel electrode and the telescopic rod

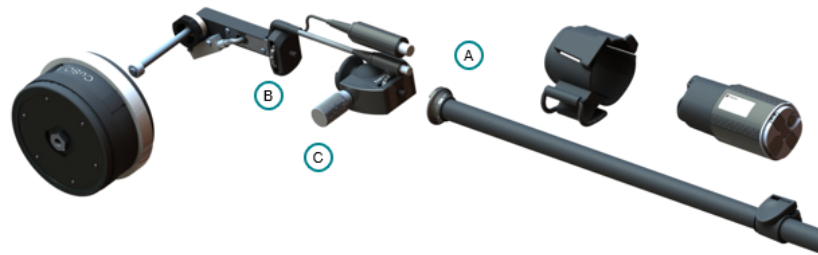
The ball joint is an optional accessory which is not included in the standard one-wheel kit.

It is used for adjusting the angle between the wheel and telescopic rod, for instance, when measuring horizontally near the bottom of a wall.



Figure 13 : PM8500 Ball Joint Accessory

6



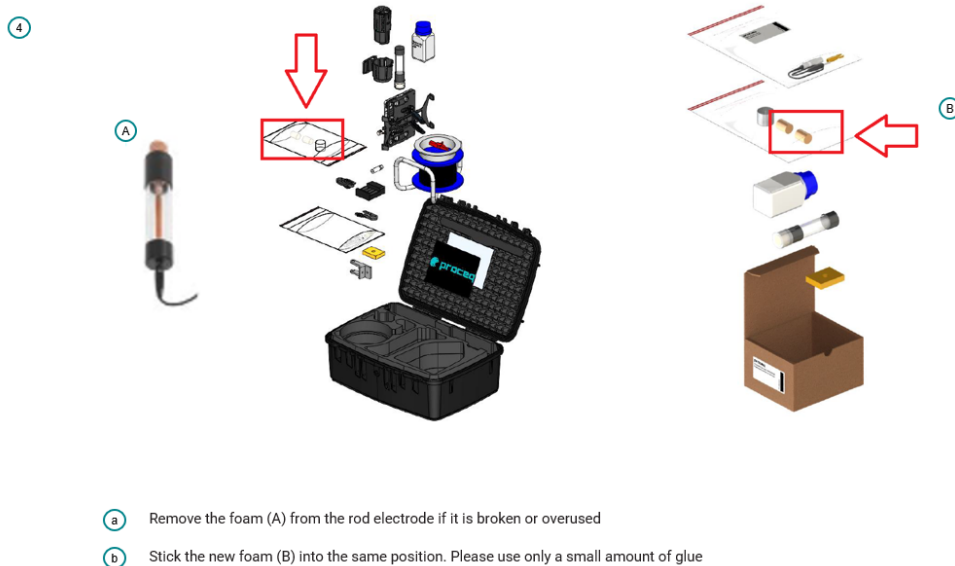
- a Connect the telescopic rod with the ball joint accessory by rotating the indented ring clockwise (A)
- b Connect the one-wheel electrode with the ball joint accessory by rotating the indented ring clockwise (B)
- c Use the ball adjuster (C) to move freely your one-wheel electrode position in a range of 360°. Please be aware of the position of the cables and the sensor unit.

Figure 14 : PM8500 Ball Joint Accessory connection with telescopic rod and one-wheel electrode

3.1.10 How to replace the sponge of the rod electrode

The rod electrode uses a foam insert to enable a good electrical connection to the concrete surface. This foam may deteriorate over time, so replacement units are provided in the standard kit.

Replacing a deteriorated foam is very easy as follows:



- a Remove the foam (A) from the rod electrode if it is broken or overused
- b Stick the new foam (B) into the same position. Please use only a small amount of glue

Figure 15 : PM8500 Rod Electrode: Foam replacement

3.1.11 How to change the distance between the wheels of a 4-wheel electrode

The four-wheel electrode allows the user to set the wheel spacing from 150mm to 250mm.

This is a very useful feature as this distance is fully customizable. 150mm is recommended when a more refined grid is needed. 250mm is recommended for large surfaces.

All of the tools required to do this are included in the four-wheel kit.

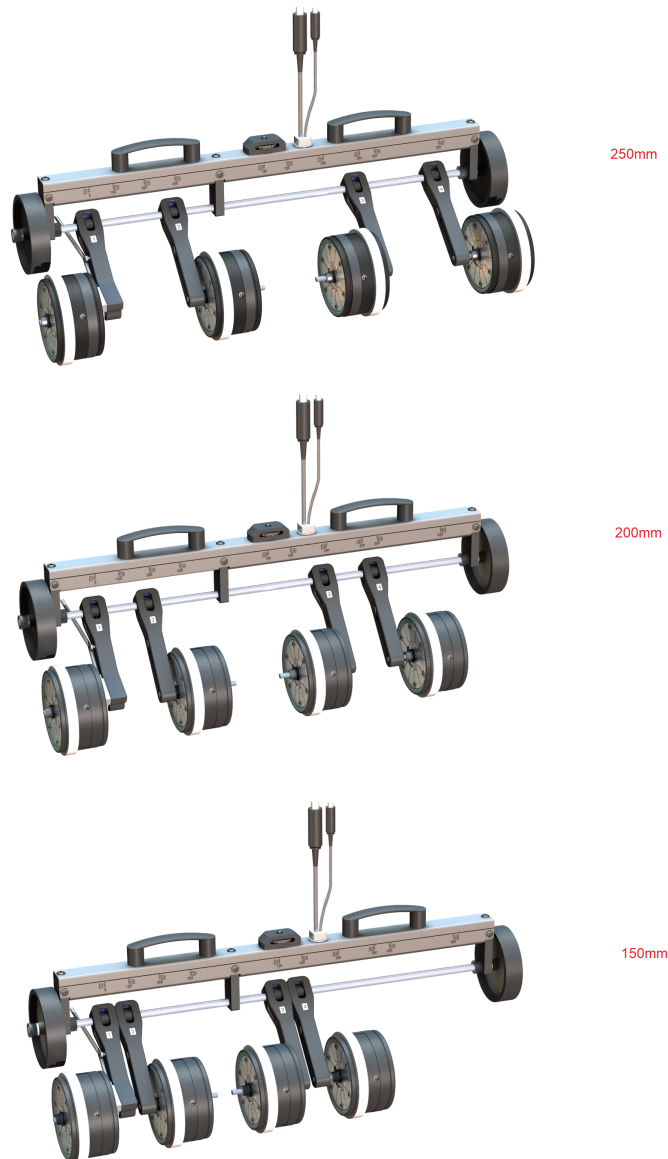


Figure 16 : PM8500 Four Wheel Electrode: 150, 200 and 250mm spacing options

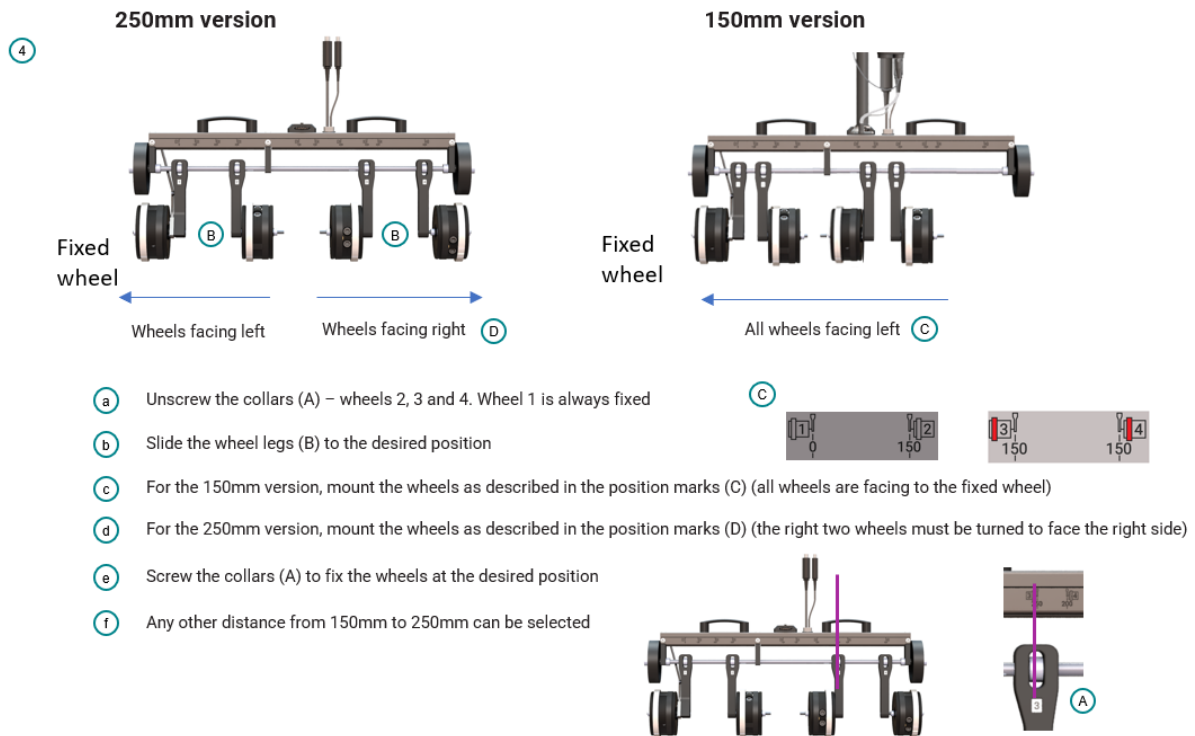


Figure 17 : PM8500 Four Wheel Electrode. Wheel spacing set up

3.1.12 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, that are often used, for example on the walls and ceiling of underground car parks, however this can cause a small shift of the potentials.

It is always necessary to check whether a measurement can be made through a coating. To do this, potentials should be measured at a few locations:

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

If possible, areas with largely varying potentials should be chosen. If there is no alteration of the potential, or if a shift of the potential can be compensated by a correction (e.g., $\rho V = \pm 50$ mV), then a measurement can be made directly on the coating. If not, then the coating must be removed before making the measurement.

3.1.13 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 therefore 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. (If the surface is dry at the beginning of the measurement, it must be moistened by the sponge on the probe so a stable value will not be present initially.) This is only possible with the Rod Electrode.

When using the rod electrode it is also possible to set an “Auto Save Delay” time in preferences. A typical value is 1.5 s. After this interval the measured value will be saved automatically and you can move to the next measurement location.

Proceq provides an additional sponge that connects to the rod electrode to increase the overall surface contact area, to prevent testing immediately above a large aggregate. This is required by some guidelines.

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.

3.2 Starting a measurement

3.2.1 Download the Profometer App and Create Eagle Account

The app can be downloaded free of charge from the Apple Store. To do so, you need to have a compatible iPad with a minimum version of iOS installed. (See the most recent information for compatible iPads at Screening Eagle website).



Figure 18 : PM8500 Profometer App: Download Link

Once the app is downloaded, the user needs to create a Screening Eagle account. Should you already have an Eagle ID, please log in.

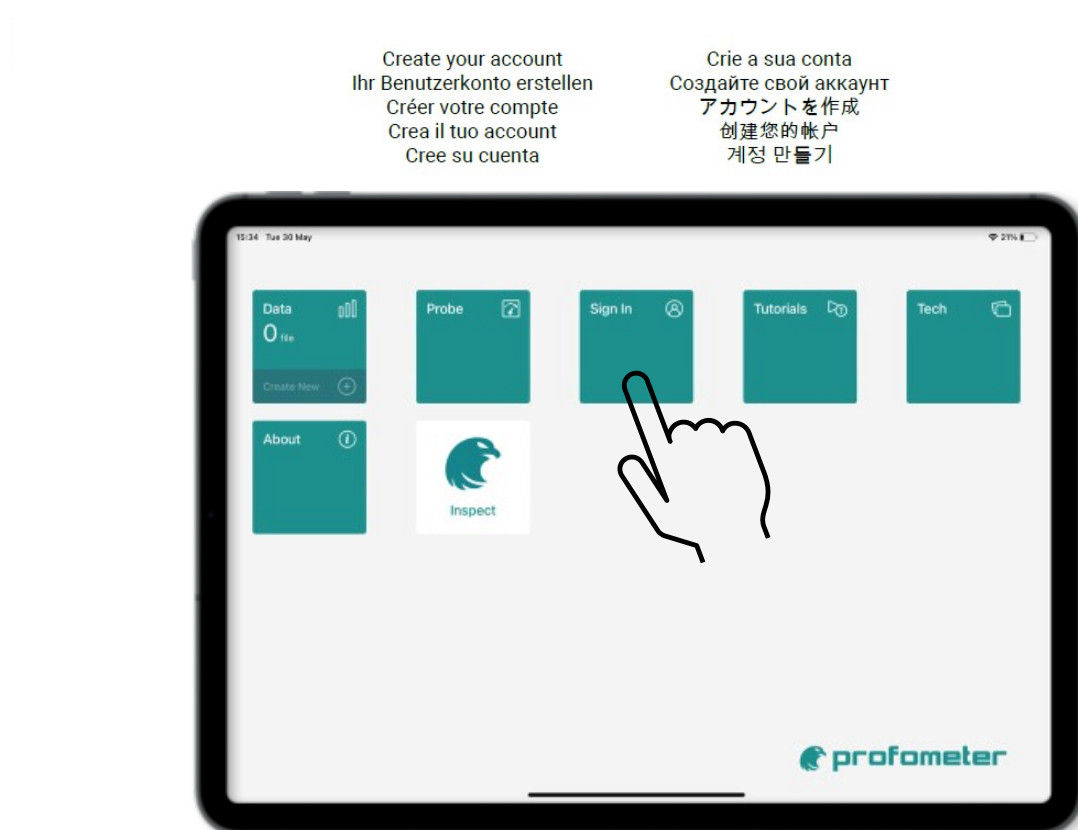


Figure 19 : PM8500 Profometer App: Signing and logging in

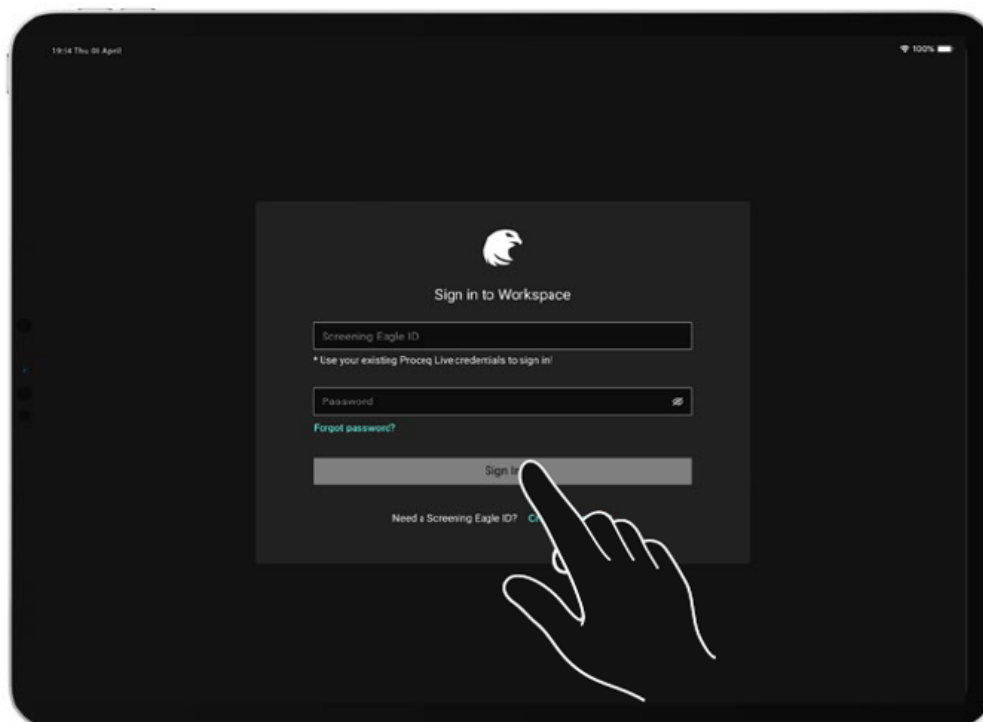


Figure 20 : PM8500 Profometer App: Signing and logging in

3.2.2 Turning the device on and off

Press the button for 2 seconds until the LED turns solid green. To turn it off, press it also for 2 seconds until the LED turns off.



Figure 21 : PM8500 Sensor Unit: Turn on and off

3.2.3 Connect the sensor unit to the Profometer App

The PM8500 sensor unit uses Bluetooth wireless connectivity to be paired with the iPad.

Just select the “Probe” icon, and then click “Connect” when you find your sensor unit.



Figure 22 : PM8500 Profometer App: connecting the probe

3.2.4 Create a new file and start your first measurement

Click “Create New” to start a new measurement:

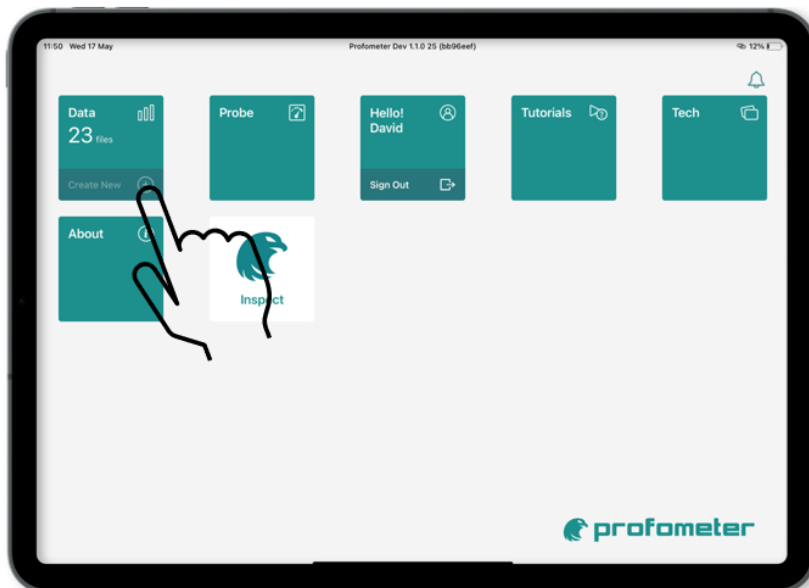


Figure 23 : PM8500 Profometer App: creating new measurement

3.3 Profometer App Overview

3.3.1 Quick overview

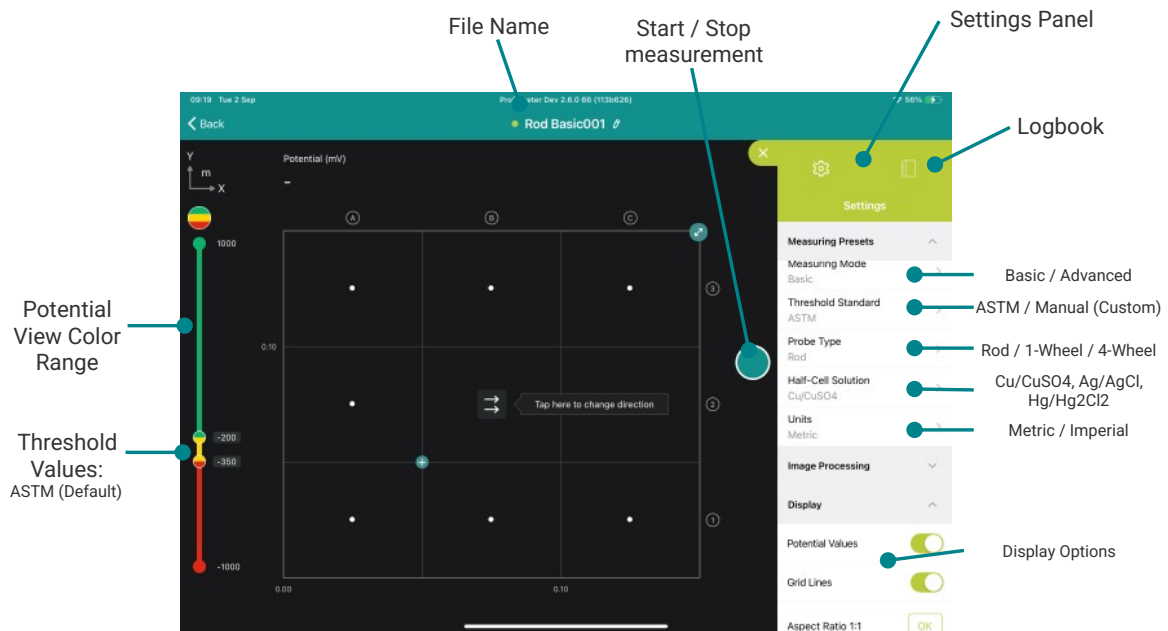


Figure 24 : Settings Rod Electrode Basic

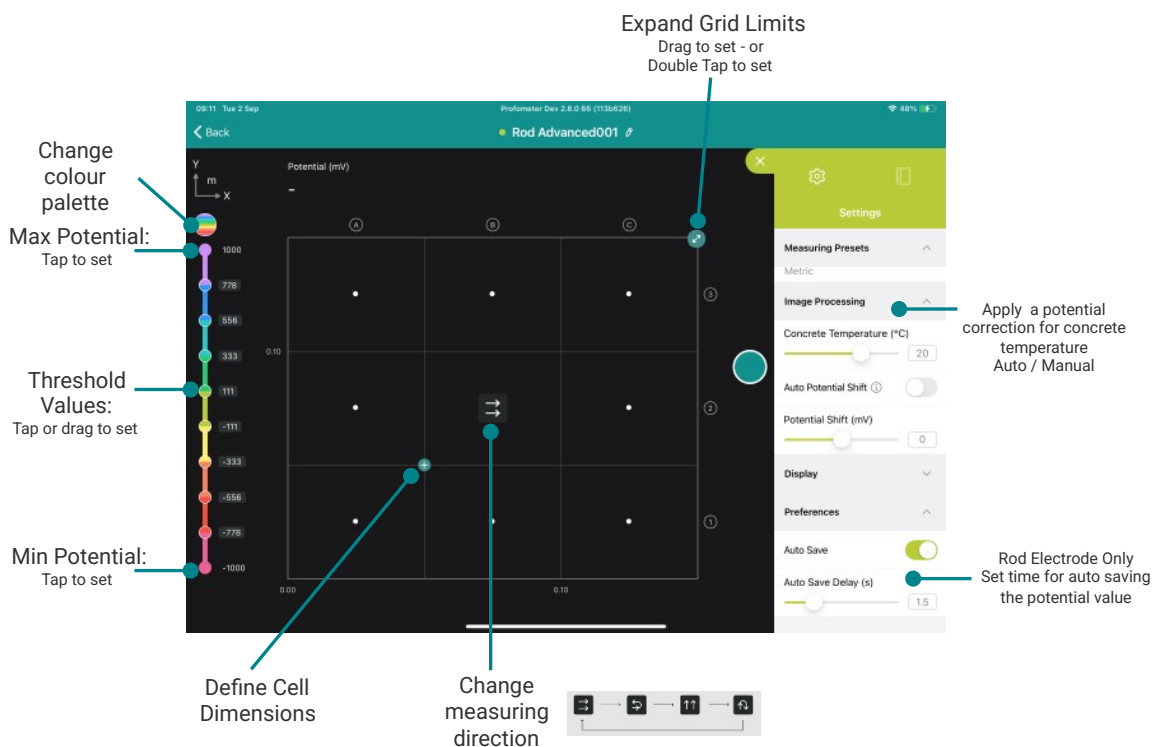


Figure 25 : Settings Rod Electrode Advanced

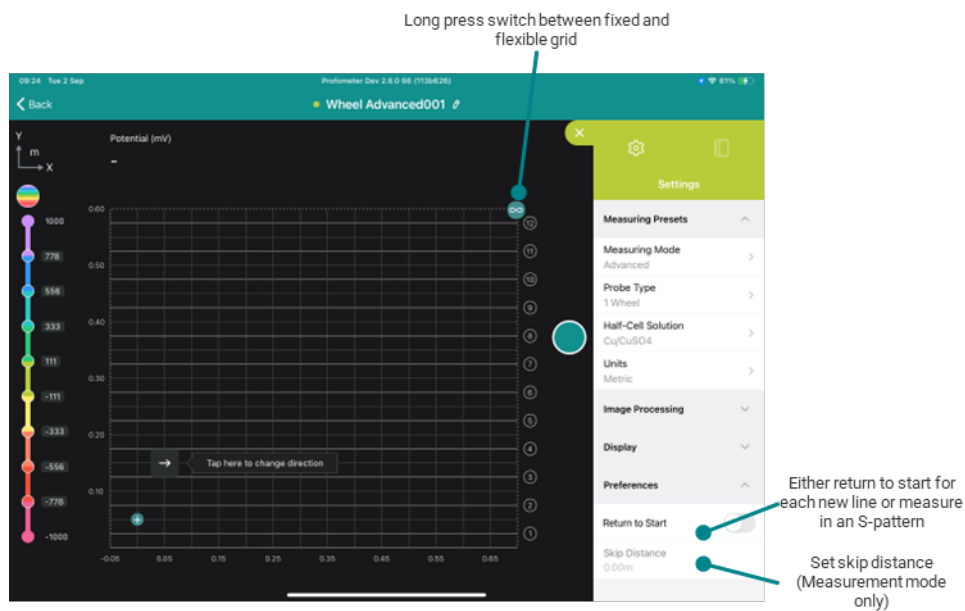


Figure 26 : Settings Wheel Electrode Advanced

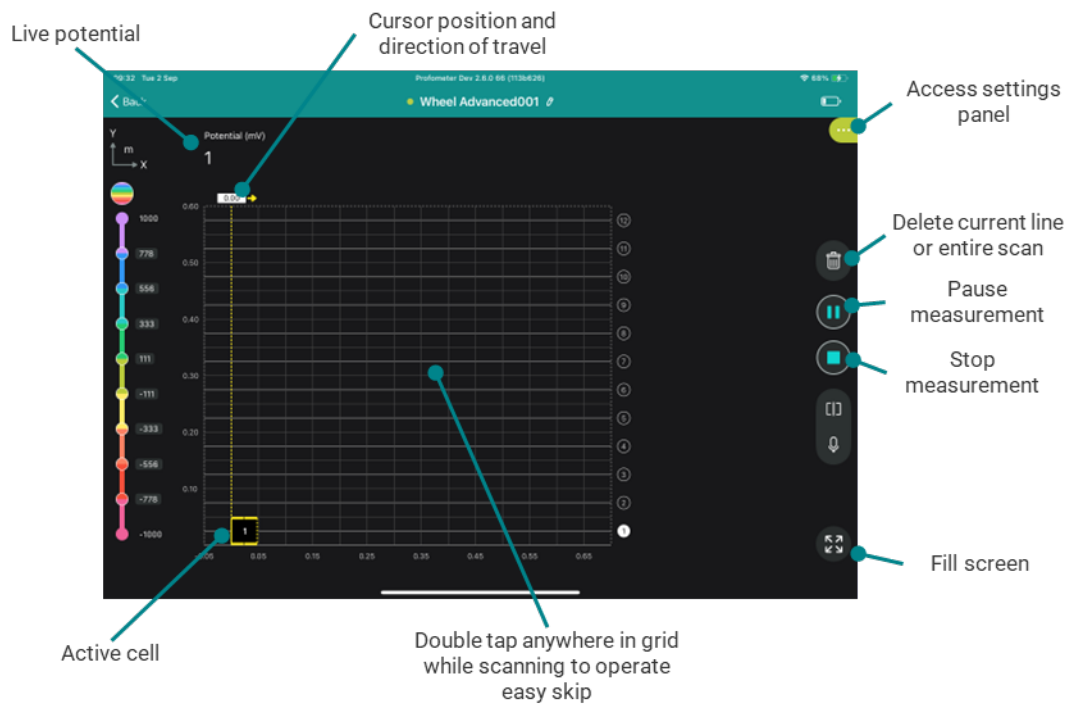


Figure 27 : Settings Wheel Electrode Advanced

Measuring Mode

Select between Basic and Advanced.

- Basic Mode: Directly shows the chipping graphic during the measurement process. By default the threshold are those defined in the ASTM standard, but they can also be selected manually.

- Advanced Mode: recommended for expert users. It will display the potential map in 9 colour bands and then will present a statistical analysis of all the potential values measured. Taking these values into account, the corrosion and passive threshold limits can be selected, and from this the chipping graph is created.

Threshold standard

If basic mode is selected, this additional feature will appear. Threshold limits can be selected either manually or by using the ASTM standard (passive threshold = -200mV, corrosion threshold = -350mV).

Probe Type

Select between Rod, One Wheel and Four wheel depending on the electrode connected.

Half-Cell Solution

Select between Cu/CuSO₄ (Copper / Copper sulphate), Ag/AgCl (Silver / Silver chloride) or Hg/Hg₂ Cl₂ (SCE Calomel).

Unit

Select Metric or Imperial.

Concrete Temperature

Input the temperature of the concrete surface that is being tested.

Auto potential shift

Enabling this feature will correct the potential readings automatically based on the concrete temperature and the selected electrode.

Disabling this feature will correct the potential readings manually taking into consideration the potential value included under the “Potential Shift” setting.

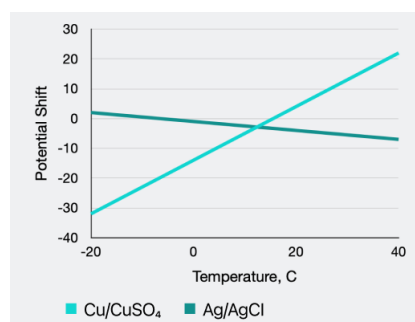


Figure 28 : PM8500 Profometer App: potential shift according to temperature

Potential Shift

If Auto Potential Shift is not enabled, the potential readings will be corrected considering this value.

Auto Save

This feature only applies to the Rod Electrode.

If selected, then measured values of $< -50\text{mV}$ will be acquired automatically once the value has stabilized. If automatic measuring is not selected, then values must be acquired manually. In both cases, values $> -50\text{mV}$ must be acquired manually.

Auto Save Delay

If Auto Save is selected, this feature allows the user to manually adjust the time allowed for the measurement to stabilize between two consecutive measurements when using the auto save mode.

Potential Values

Show or hide the potential values of each cell.

Grid Lines

Show or hide the grid lines.

Aspect Ratio 1:1

It applies an aspect ratio 1:1 which can be affected while zooming.



Cell Spacing:

Grid X Spacing It determines the horizontal width of the measured cell (wheel electrode) or the horizontal distance between measured points (rod electrode).

Grid Y Spacing It determines the vertical distance between two adjacent measuring lines (wheel electrode) or the vertical distance between measured points (rod electrode). In case of four-wheel electrode, it should be set equal to the distance between the wheels (from 150 mm to 250 mm or custom).



Measurement Path

It determines the direction of the measuring sequence when using the rod or the wheel electrode with the fixed grid (Left to right, bottom to top, horizontal zig zag, vertical zig zag).



Fixed Grid

This applies both to the rod electrode and the wheel electrode.

The grid dimension is fixed for the current measurement once it has been defined by the user.



Flexible Grid

This option applies only to wheel electrodes. The grid is not fixed, and its dimension is defined by the distance travelled by the wheel electrodes. Once the edge is reached, the grid will expand if the user keeps moving the wheel electrode.



Change color palette

Three color palettes can be selected: rainbow, red to grey, and green to white.



Start / Stop button

Click this button to start or stop collecting data.



Zoom in

By placing thumb and index finger together on the screen and spreading them apart.



Zoom out

By placing thumb and index finger apart on the screen and pinching them together.

The potential values associated to each cell can be visualized by zooming in to a sufficient level.

The zoom level can be adjusted while scanning and will be maintained as set by the user until further adjustment.



Pan

Pan the image from left to right by dragging.

3.3.2 Scanning Flexibility

Scanning Limits Fixed Grid

The maximum grid size is 100 m x 100m.

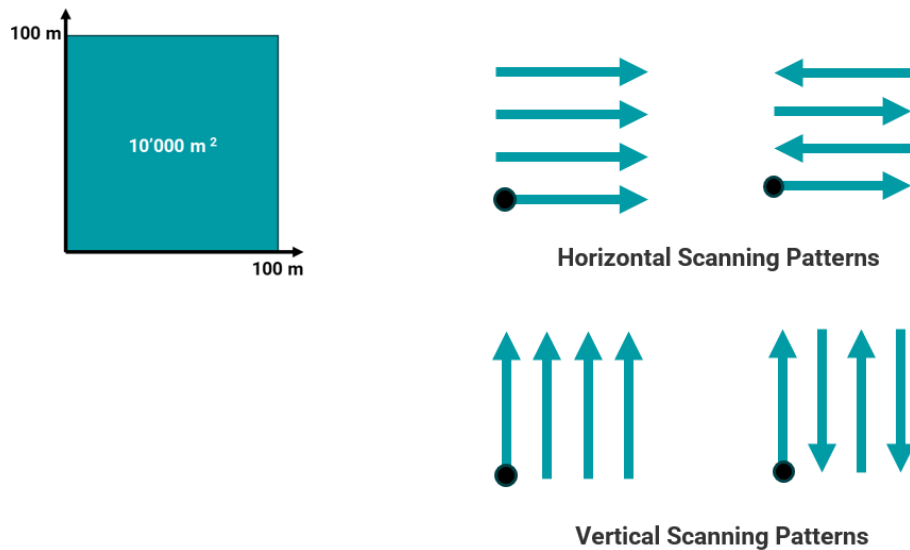


Figure 29 : Fixed grid, scanning limits and scanning patterns

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.

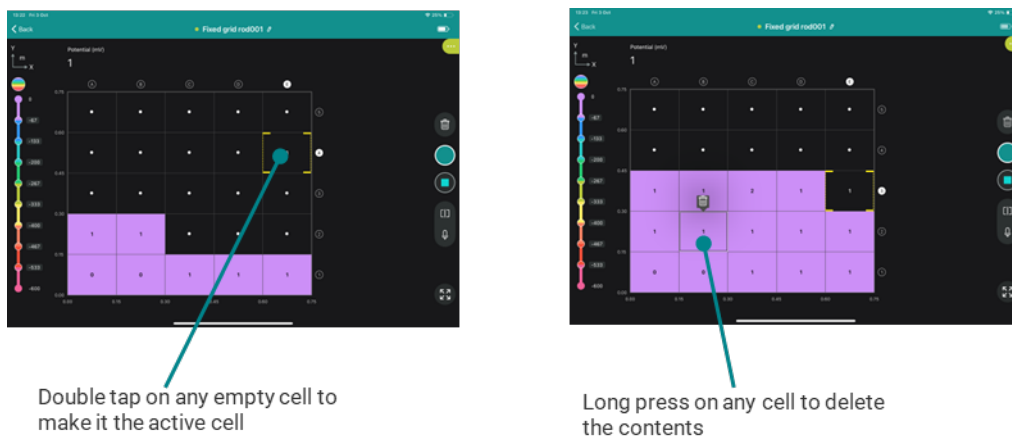


Figure 30 : Fixed grid, selecting and deleting a cell

Scanning Limits Flexible Grid

When using the flexible grid, it is possible to scan in both the positive and negative direction. The maximum grid size is +/-100 m x 100m.

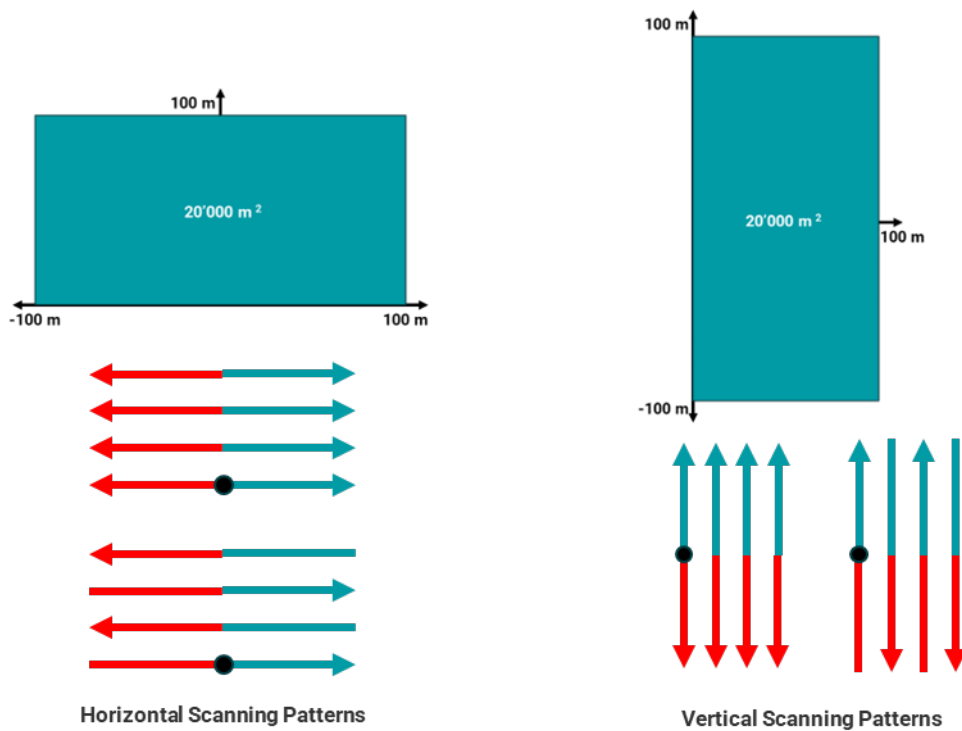


Figure 31 : Flexible grid, scanning limits and scanning patterns

Setting the Scanning Pattern in the Flexible Grid

The scanning pattern is set by using a combination of the button for horizontal / vertical scanning in the measurement screen and the use of the “Return to Start” setting.

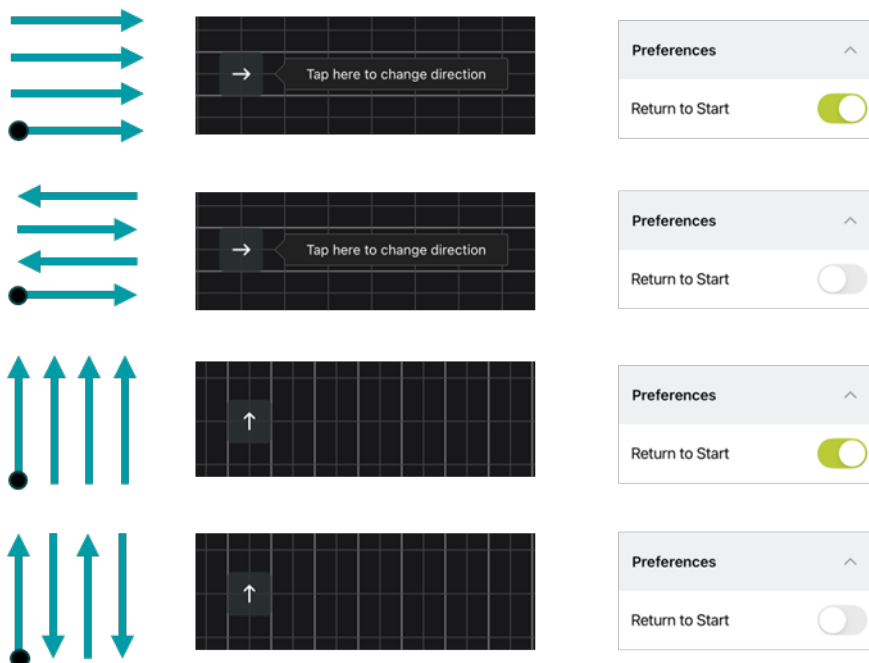


Figure 32 : Flexible grid selecting the scanning pattern

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.

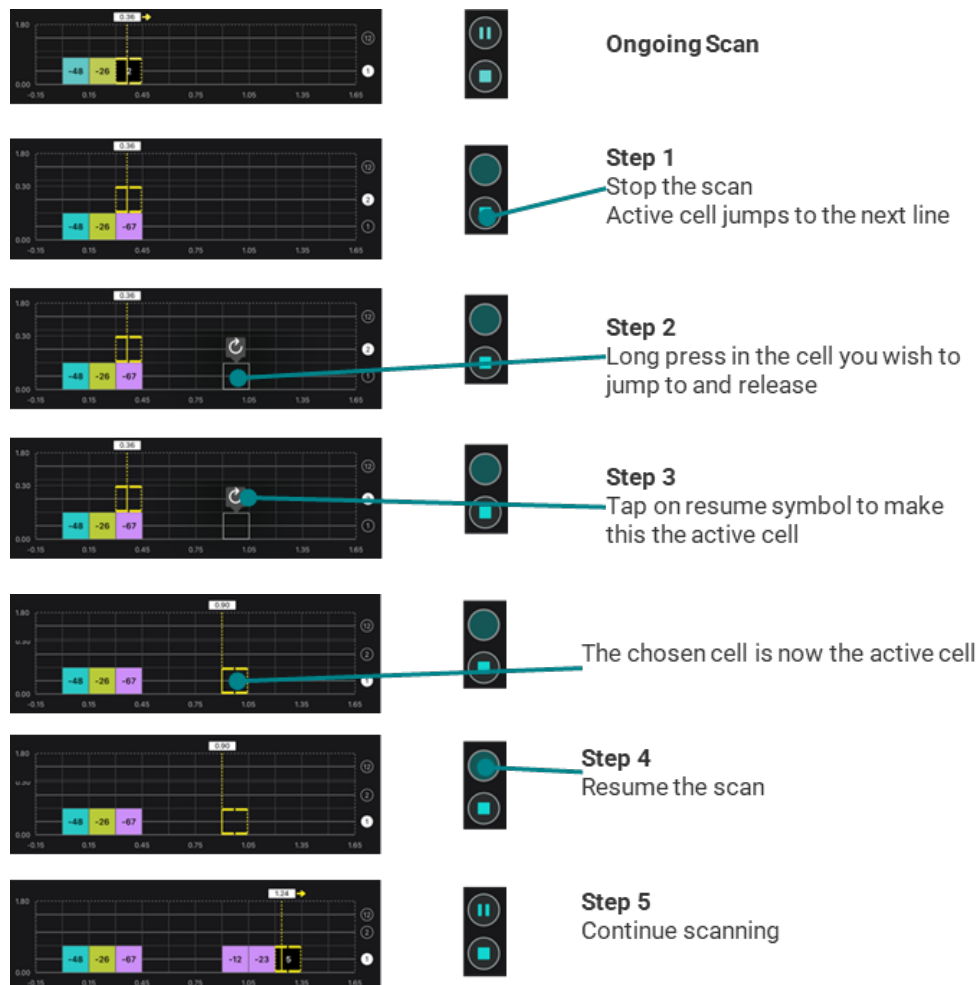


Figure 33 : Flexible grid, resuming from any cell

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.

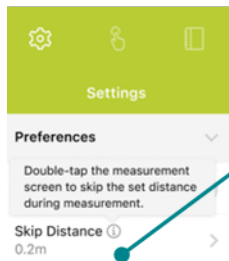
Set the easy skip distance in “preferences”. Note this can only be set while scanning.

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.



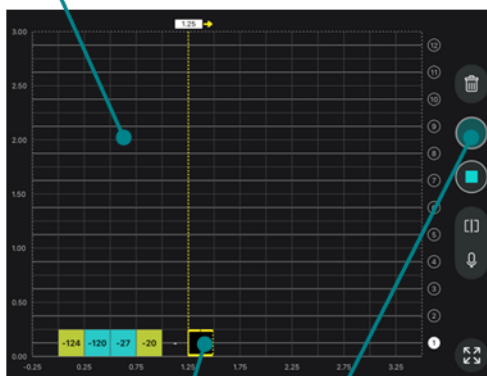
Ongoing Scan



Step 1
Set the Skip Distance

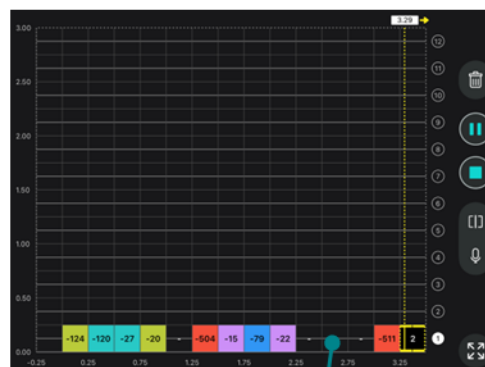


Step 2
Double tap anywhere in the measurement grid to activate easy skip



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

Step 3
Continue scanning



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

Figure 34 : Easy skip

3.3.3 Tutorial videos

For more information to understand how to use the app, please download the tutorial videos in the app:

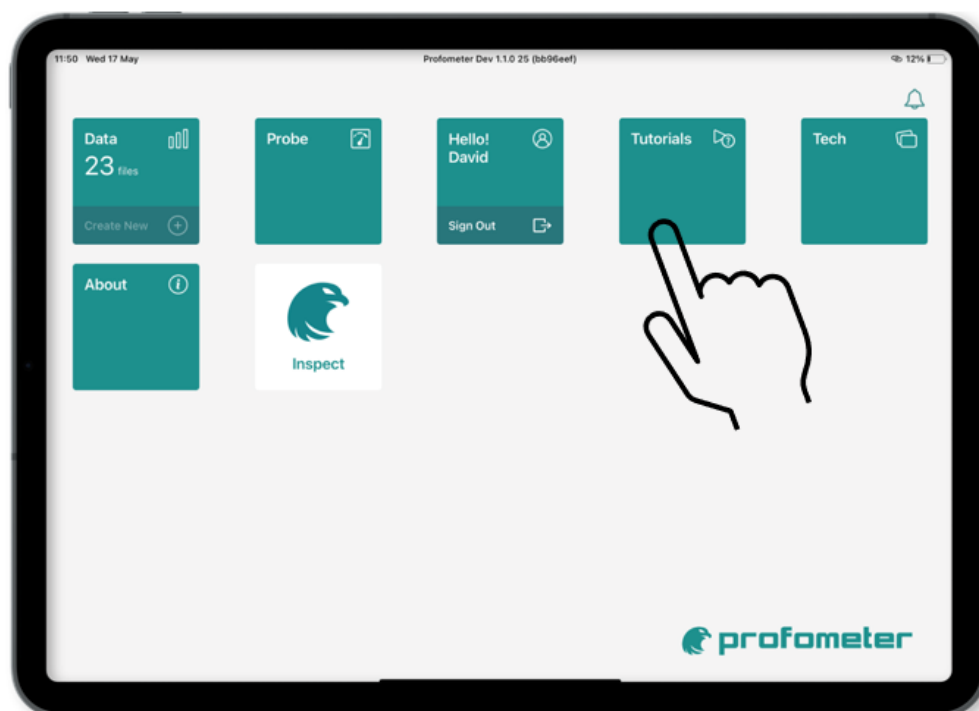


Figure 28 : PM8500 Profometer App: tutorial videos

The following videos are available:

- Firmware updates
- Getting started
- Odometer calibration
- Settings
- Grid definition
- Measuring with rod electrode
- Measuring with one wheel electrode
- Measuring with four-wheel electrode
- Review mode

3.3.4 Corrosion Display Views

Measured data can be displayed in one of three different views:

- **Basic Mode:** Chipping Graph.
- **Advanced Mode:** Potential View, Statistic View, and Chipping Graph View.



To change from one view to the next one, please swipe up using two fingers at the bottom of the screen.



Figure 29 : Advanced mode views

ADVANCED MODE:

Potential View

The potential map provides an area mapping of the measured raw potential values. The cells where no potential value was measured are displayed in black.

Zoom and scroll to any desired location, change the color palette and the potential thresholds to enhance the readability and highlight the desired details.

Text notes can be added to any cells.



Figure 30 : PM8500 Profometer App: Potential View

Statistics View

Frequency and cumulative frequency graphs are shown in the same view.

On the horizontal axis, the potential values are displayed; the vertical bars show the percentage of the respective potential values measured and stored; you can adjust the horizontal scale with the Zoom button.

The vertical cursors can be moved to any potential value.

In the upper left corner the median, minimum and maximum values are displayed, together other statistical data, such as the number of measurements, the standard deviation, the lowest and highest values, and the current thresholds set with the vertical cursors.



Figure 31 : PM8500 Profometer App: Statistic View

Corrosion Analysis Basic Theory

If the surface under test has both actively corroding as well as passive rebars, then the two states exhibit two distinct partially overlapping distributions, with the corroding areas centered on a more negative potential.

The cumulative distribution graph is used to determine the active and passive potential thresholds that will affect the Chipping Graph, discriminating actively corroding areas from passive areas where no corrosion is to be expected.

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.

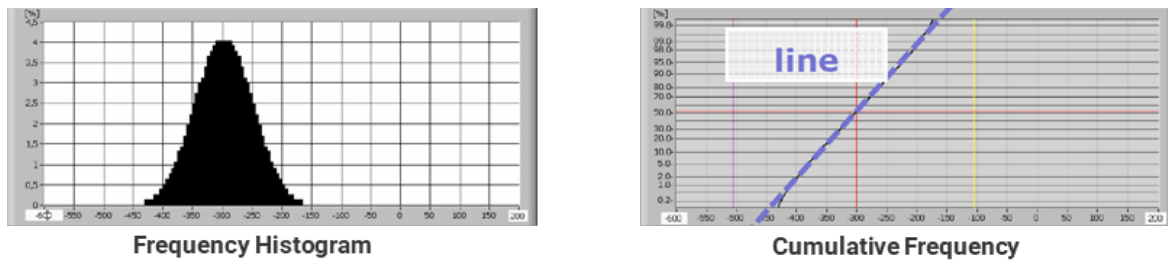


Figure 39 : Measurement on corroding steel

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.

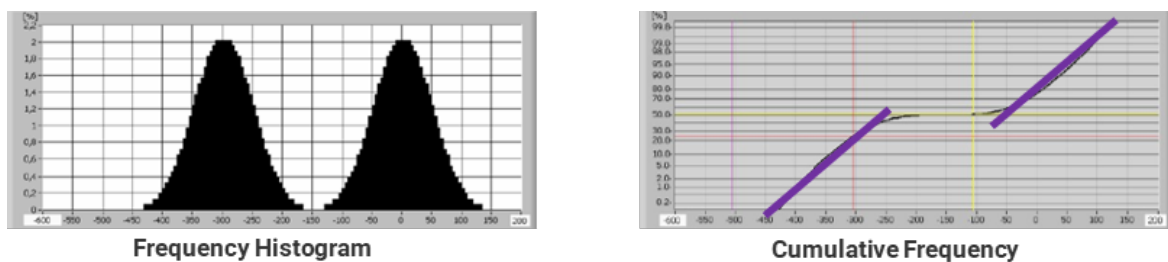


Figure 40 : Measurement on separated corroding and passive steel

On real structures the populations will overlap, then the curve will typically exhibit a central region with a lower gradient (flatter). The cumulative frequency graph is used to identify the straight-line sections which indicate the passive and corrosive thresholds.

The red cursor will define the maximum (most positive) potential value expected of the active distribution. Active corrosion is to be expected in cells with a more negative potential than the cursor value.

The green cursor will define the minimum (most negative) potential of the passive distribution.

Once these cursor lines have been set, the surfaces in this potential range will be automatically displayed in the corresponding color in the Chipping Graph View.

NOTE! It is always advised to make an opening in the concrete at locations with these threshold potentials to verify the analysis.

Chipping Graph View

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 Statistic View.

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

You can zoom and scroll to any desired location and add text notes to any cell or group of cells.

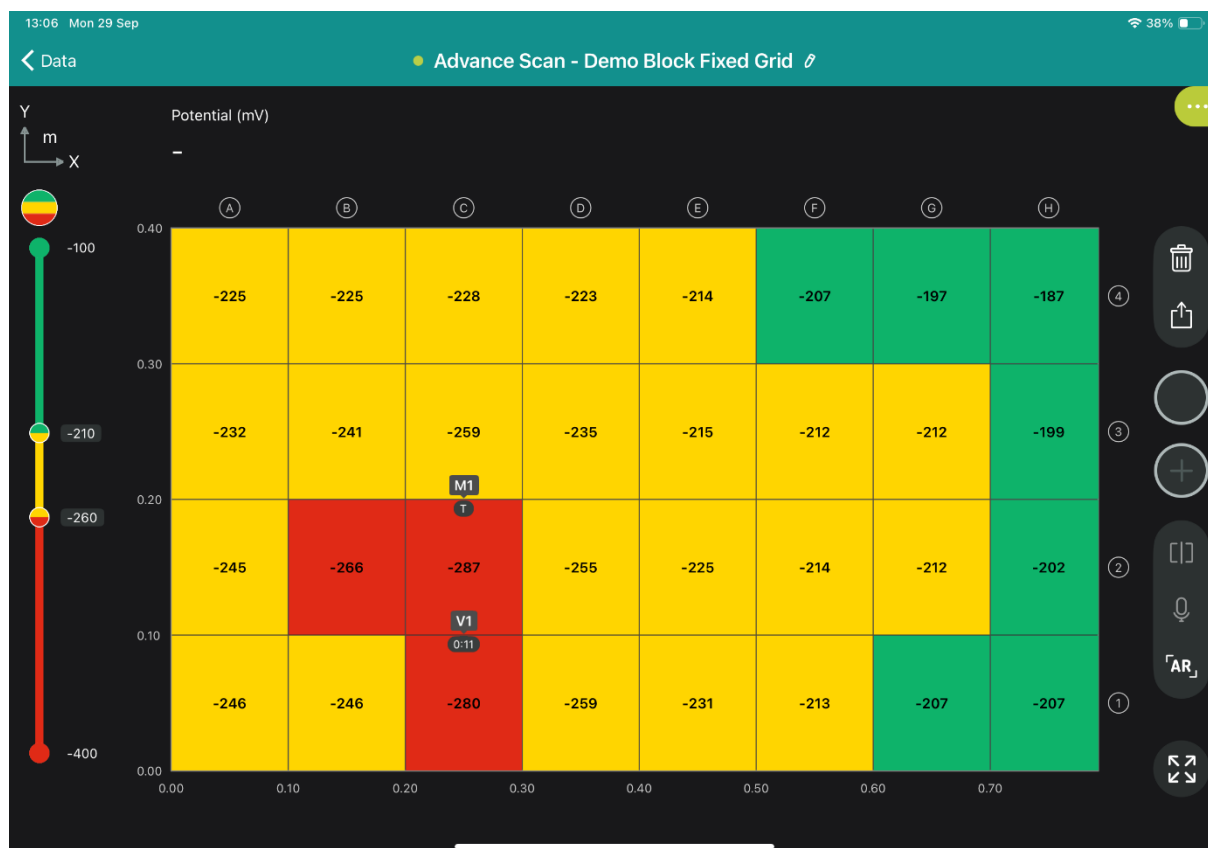


Figure 32 : PM8500 Profometer App: Chipping Graph View

BASIC MODE:

Chipping Graph

The threshold limits can be selected manually or using the limits suggested by ASTM C 876-09, 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, judging uncertain the behavior in the regions in between the two thresholds.

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

4 Operation and handling

A Quick Start Guide is provided in the packaging (case) to help you to start the device and to set your Eagle ID which is necessary for using the pm app software.

- Carefully read the Quick Start Guide and the Quick Reference Guide.
- Be careful when you assemble the one wheel and the four-wheel electrode to the telescopic rod.
- Be careful when you modify the spacing of the four-wheel electrode.
- Be careful when you prepare the Cu/CuSO₄ solution.

4.1 Performing a Calibration

A calibration check of the potential values can be done using a Calomel (HgCl) reference electrode. (Part No. 33000701)

The principle consists in measuring the potential difference between the electrode to be checked (the rod or the wheel electrode) and an electrode taken as a reference. The reference electrode used is a saturated calomel electrode for laboratory purposes.



Figure 33 : Calomel (HgCl) Reference Electrode

1. Fill the electrode to be tested with copper sulfate as described in this manual.
2. Connect the reference electrode to the Ground cable - Input of the PM8500 Sensor Unit.
3. Connect either the rod or the wheel electrode to the Electrode - Input.
4. Put both probes together to close the electrical circuit. Recommendation for wheel electrodes: measure direct on the wooden spigot (copper sulphate side).

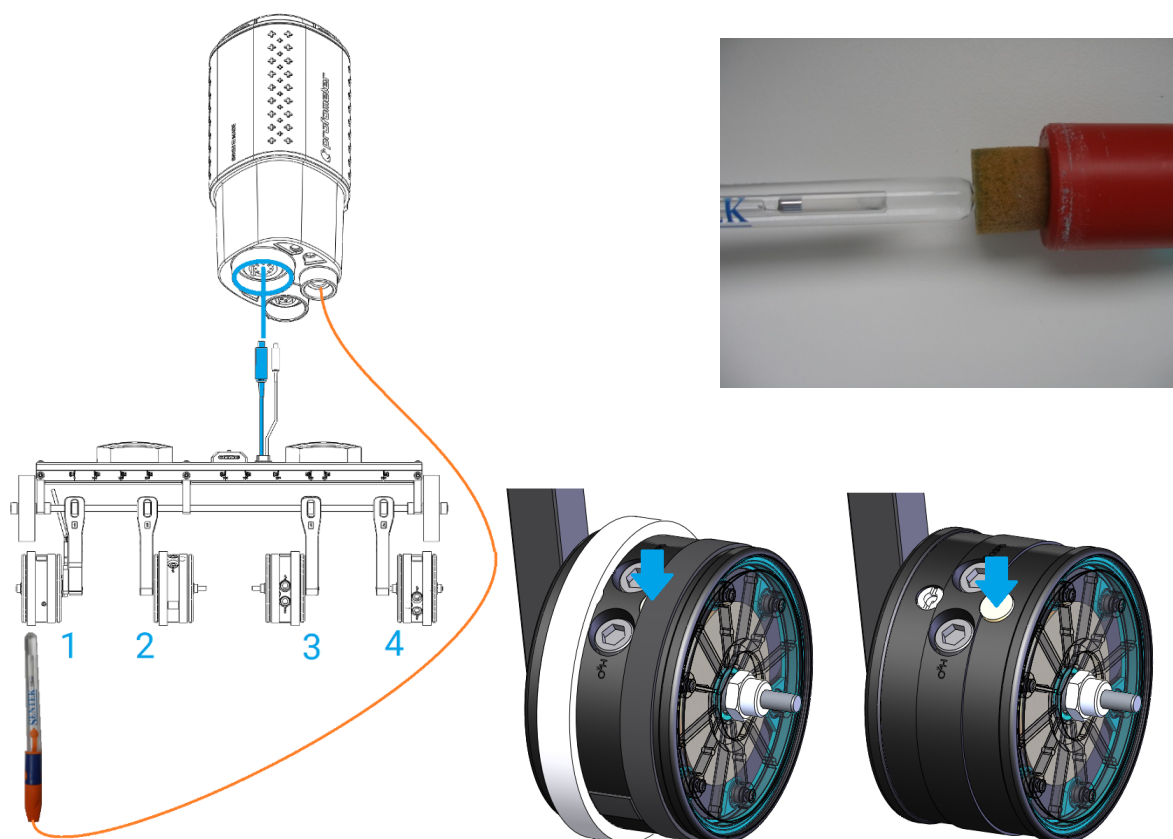


Figure 34 : Calibration Check. Rod and Wheel Electrodes

The theoretical potentials of the Cu/CuSO₄, Ag/AgCl, and Calomel electrodes are the following:

- Cu/Saturated CuSO₄ → + 316 mV*
- Ag/Saturated AgCl → + 197 mV*
- Saturated Calomel → + 242 mV*

*(at 25°C, regard to the standard hydrogen reference electrode)

The potential difference that theoretically should be read on the PM8500 is given by:

$$\Delta E = E_1 - E_2,$$

E_1 : potential of the reference electrode

E_2 : the theoretical potential of the electrode to be checked.

$$242\text{mV} - 316\text{mV} = \mathbf{-74\text{mV}}$$

The measured value depends also on the temperature. Temperature drift is calculated:

$$\text{Cu/Saturated CuSO}_4 \rightarrow +0.90\text{mV}/^\circ\text{C}$$

$$\text{Ag/Saturated AgCl} \rightarrow -0.13\text{mV}/^\circ\text{C}$$

$$\text{Saturated Calomel} \rightarrow -0.76\text{mV}/^\circ\text{C}$$

For the copper electrode:

$$+0,9\text{mV}/^{\circ}\text{C} - -0,76\text{mV}/^{\circ}\text{C} = \underline{\underline{1.66\text{mV}/^{\circ}\text{C}}}$$

20°C	68°F	-82mV
25°C	77°F	-74mV
30°C	86°F	-66mV
35°C	95°F	-57mV

We recommend a maximum error of +/-10mV at the specific temperature.

In the event of major deviations, contact the technical support.

5 Export Formats

A number of data export formats are available. .

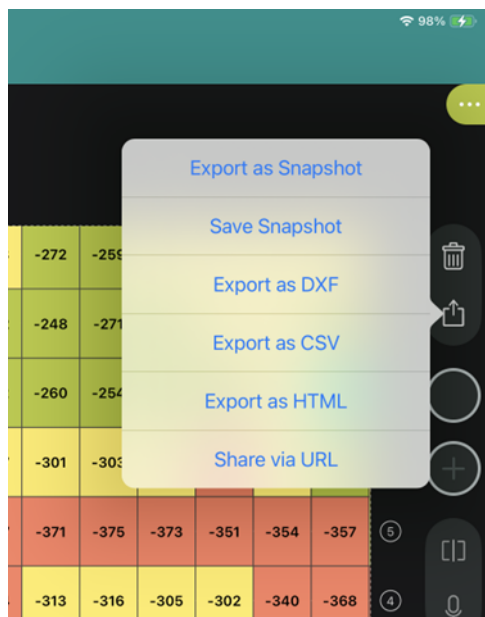


Figure 35: Export formats

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

5.1 Workspace - Data storage, reading, sharing & reporting

Given mobile data connectivity (Wifi or mobile network), the Profometer app automatically and safely stores all measurements on the Screening Eagle Workspace by synchronizing with the iPad.

Screening Eagle Workspace is a web-based online platform where all measurements are stored automatically as soon as there is data connectivity (Wifi or mobile network) allowing synchronization of the iPad.

Reading, sharing & reporting (pdf or docX printing of tab) is possible. Export in dxf format for alignment with construction drawings is also available. The tabs provide all the statistical values, screenshot views & logbook information. A user guide for Workspace can be downloaded from the website.

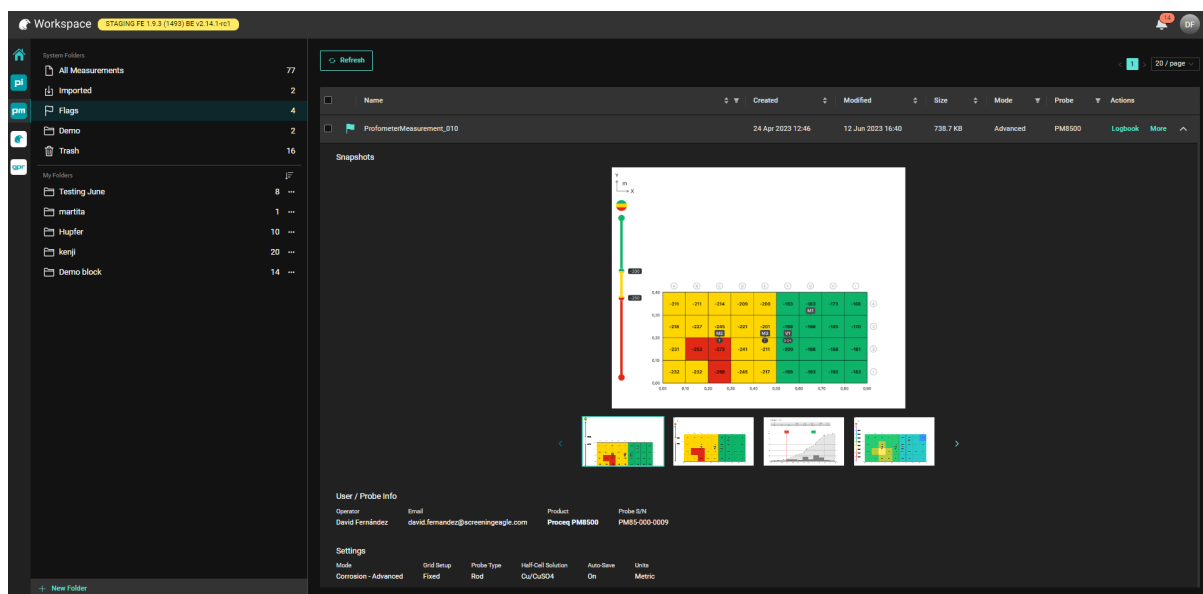


Figure 36: Screening Eagle Workspace

6 Maintenance and Support

6.1 Maintenance

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.
- Always keep the housing clean.
- 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.

Maintenance of the 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.

Maintenance of the 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.

6.2 Support Concept

Screening Eagle Technologies is committed to providing a complete support service for this instrument by means of our global service and support facilities. As soon as you download the app on the Apple Store, you will obtain the latest available updates both for the Firmware and the Software, as well as other valuable information.

6.3 Standard Warranty and Extended Warranty

The standard warranty covers the electronic portion of the instrument for 24 months and the mechanical portion of the instrument for 6 months.

6.4 Disposal



Disposal of electric appliances together with household waste is not permissible. In observance of European Directives 2002/96/EC, 2006/66/EC and 2012/19/EC on waste, electrical and electronic equipment, and its implementation, in accordance with national law, electric tools and batteries that have reached the end of their life must be collected separately and returned to an environmentally compatible recycling facility.

7 Technical Specifications

Technology	Half-cell Potential
Measured Quantity	Corrosion potential in millivolts [mV]
Connection	Wireless - Bluetooth
Depth	First rebar layer
Voltage Measurement Range	-1000mV to +1000mV
Resolution	1.0mV
Input Impedance	100MOhm
Sampling Rate	900Hz
Encoder Accuracy	+/- 0.5 mm / 0.02 in + 0.78% of measured length Resolution: 3.3 mm / 0.13 in (128 steps / rotation)
Max Scanning Speed	Normal conditions: 0.5 m/s - 1.7 ft/s Max recommended: 1m/s – 3.3 ft/s
Max Area Scan	Fixed grid 100m x 100m – 328ft x 328ft Flexible grid 200m x 100m – 656ft x 656 ft
Dimensions --> mm / in	Sensor Unit: (127 x 59 x 56) mm / (5 x 2.3 x 2.2) in without holder // (127 x 98 x 72) mm / (5 x 3.9 x 2.8) in with holder Rod electrode: D= 36mm x 155mm / D=1.4 in x 6.1in with protection-cap One wheel electrode: (194 x 138 x 127) mm / (7.6 x 5.4 x 5) in without telescopic rod // (2000 x 138 x 127) mm / (78.7 x 5.4 x 5) in with extended telescopic rod // (700 x 138 x 127) mm / (27.6 x 5.4 x 5) in with retracted telescopic rod Four wheel electrode: (830 x 350 x 140) mm / (32.6 x 13.8 x 5.5) in without telescopic rod // (2150 x 830 x 140) mm / (84.6 x 32.6 x 5.5) in with extended telescopic rod // (840 x 830 x 140) mm / (32.8 x 32.6 x 5.5) in with pulled in telescopic rod
Weight --> g / lb.	Sensor Unit: 150g / 0.33 lbs. without holder; 220g / 0.49 lbs.

	Rod electrode: 120g / 0.26 lbs. without cable / without copper sulfate, without Sensor Unit One wheel electrode: 2000g / 4.41 lbs. without fluid, with sensor unit and telescopic rod // (fluid 435g / 0.96 lbs.) Four-wheel electrode: 6900g / 15.2 lbs. without fluid; (fluid 435g / 0.96 lbs. per wheel). Standard kit (all items including carrying case): 7400g / 16.3 lbs. One wheel kit (all items including cardboard box): 2900g / 6.39 lbs. Four-wheel kit (all items including carrying case): 15200g / 33.51 lbs.
Battery	• 1xAA (NiMH) rechargeable or non-rechargeable • Removable • Flight-safe • 8 hours autonomy • USB-C charger
Environmental Conditions	▪ Humidity <95% RH, non-condensing ▪ Operating temperature: -10°C to +50°C
IP Classification	IP67 with closing caps inserted. IP64 when cables are connected.
Standards and Guidelines	ASTM C876, RILEM TC 154-EMC, DGZfP B3, SIA 2006, UNI 10174, JGJ/T 152, JSCE E 601, CE certification

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For safety and liability information, please check www.screeningeagle.com/en/legal

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