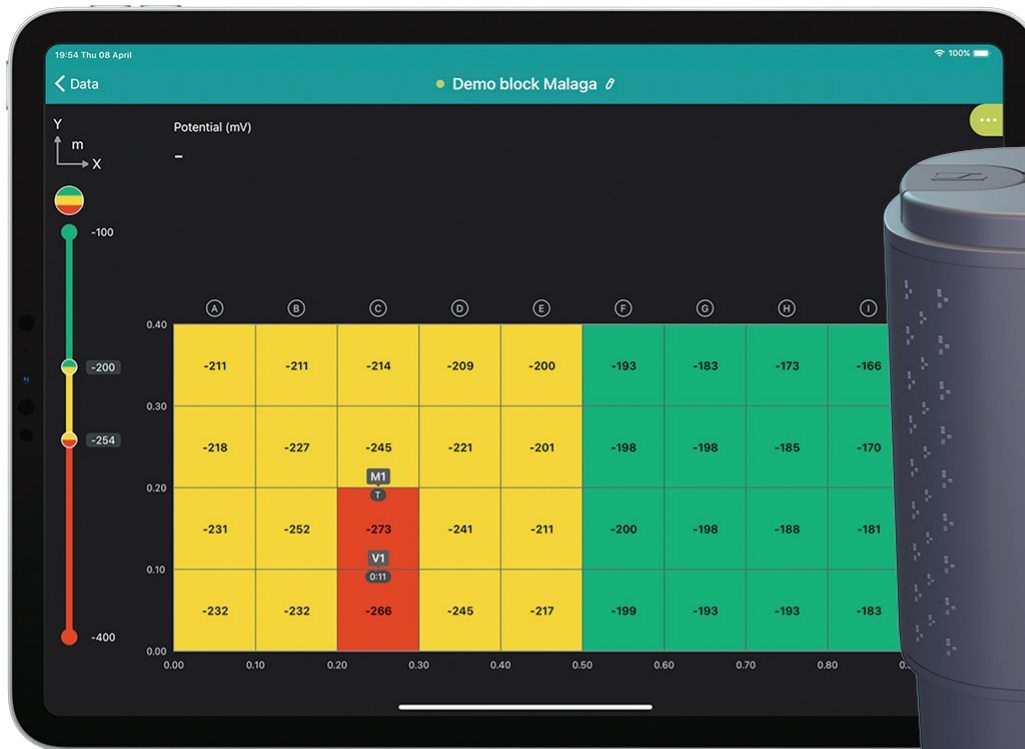
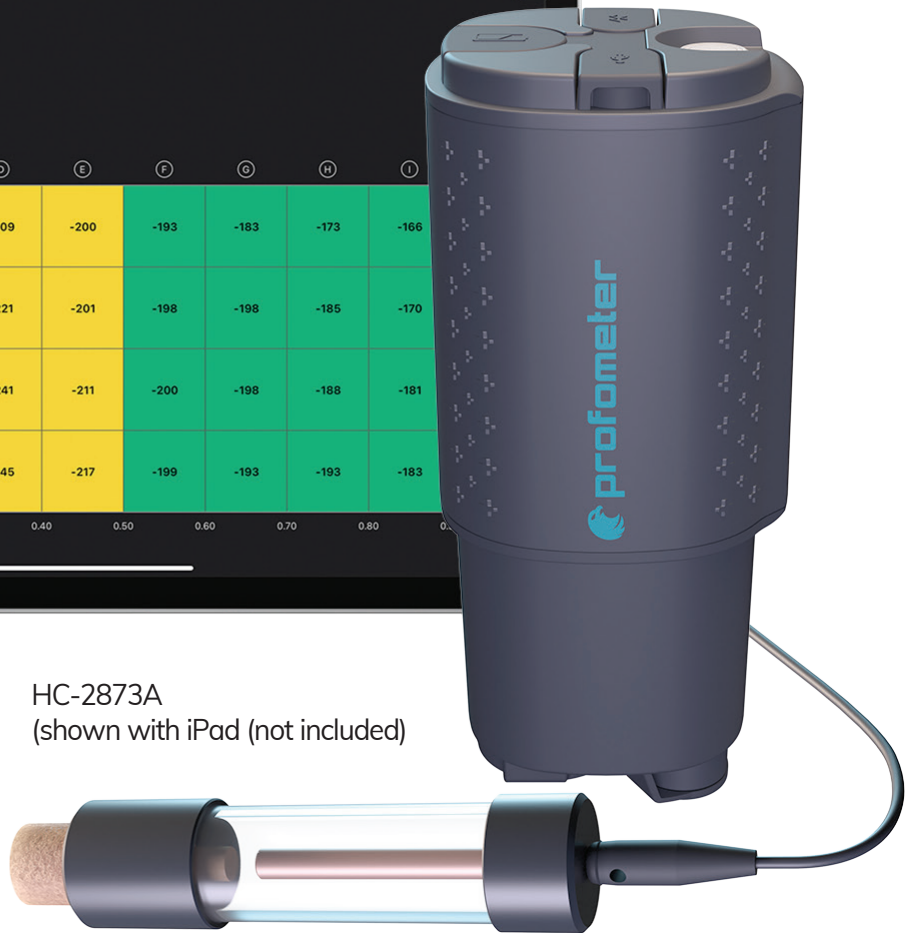




HC-2873A— Profometer PM8500 Corrosion



HC-2873A
(shown with iPad (not included))



Building upon the versatility, reliability and accuracy of the original Profometer Corrosion, the newly, redesigned PM8500 Profometer Corrosion has made a significant leap in providing major gains in ease-of-use, productivity, ergonomics and enhanced on-site data. The new HC-2873A Profometer Corrosion's new design now utilizes an iOS app, which is used with an Apple iPad, supplied by the user, for all control functions.

The PM8500 sensor is wirelessly connected to an iPad via low-power Bluetooth, which runs the downloadable Profometer app. Given mobile data connectivity (Wi-Fi or mobile network), the Profometer (pm) app automatically and safely stores all measurements on the Screening Eagle Workspace, where you can log in to see the data from any internet-connected device.

The universal, ergonomic iPad harness and sensor holder make it extremely easy and comfortable to perform scanning tasks. The iPad mounts to the harness, and is positioned at the operator's stomach area, making it easy to view and operate while not interfering with any operations.

The Profometer comes with a Rod electrode for spot scans, which allows you to scan small areas, such as columns, beams and footings. The Profometer can also be fitted with optional Wheel Electrodes. These come in single- and four-wheel models:

Single-wheel Electrode—

This electrode provides flexible and fast line and area scans. It's designed for use on medium-sized horizontal, vertical and overhead areas, such as walls and ceilings or difficult to access spots.

The Single-wheel Electrode features:

- Uses Copper (Cu/CuSO₄) solution.
- Stable wheel, which provides smooth operation during a scan.
- Sensor holder, which provides an alternative mounting location to the belt/harness mounting.
- Minimal cabling, which reduces errors due to lose or damaged cables.
- High-precision encoder minimizes errors providing more accurate and consistent results.
- Robust telescopic rod, which provides rigid and steady operation, ensuring constant, even pressure of the wheel against the surface, ensuring fast and reliable measurements.
- Capable of scanning areas at a rate of 450m² per hour.

Four-wheel Electrode—

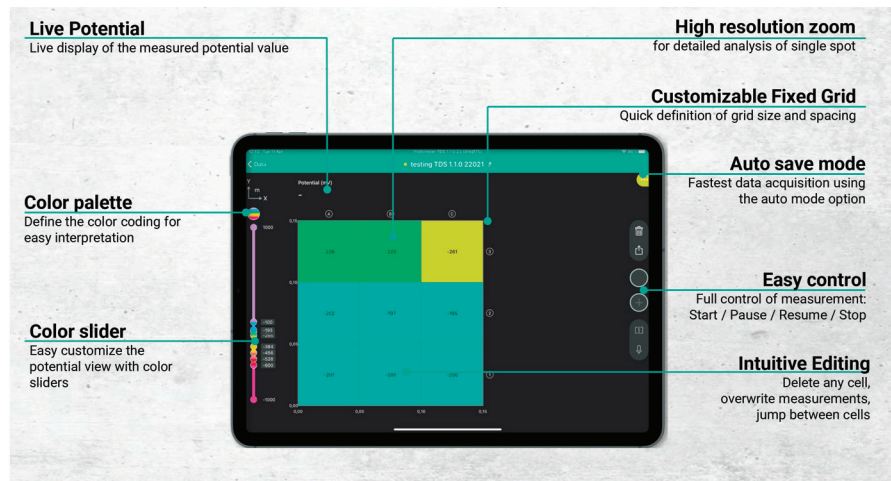
This electrode provides flexible and fast line and area scans. It's designed for use on large-sized horizontal, areas, such as bridge decks and similar areas.

The Four-wheel Electrode features:

- Uses Copper (Cu/CuSO₄) solution.
- Adjustable wheel spacing (from 150 to 250mm), which allows wheel placement optimization for scanning speed or resolution.
- Sensor holder, which provides an alternative mounting location to the belt/harness mounting.
- Minimal cabling, which reduces errors due to lose or damaged cables.
- High-precision encoder minimizes errors providing more accurate and consistent results.
- Robust telescopic rod, which provides rigid and steady operation, ensuring constant, even pressure of the wheel against the surface, ensuring fast and reliable measurements.
- Capable of scanning areas at a rate of 1800m² per hour.

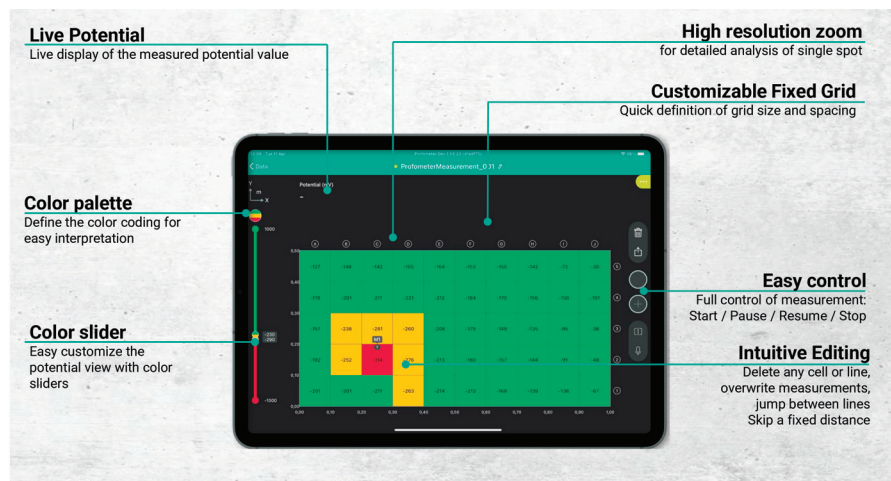
Spot Scan with Rod Electrode

- Spot scan using the Rod Electrode
- Scanning small concrete elements: columns, walls, beams, etc
- Highly customizable grid definition
- Huge versatility during measurement using the controls and edit buttons
- Quicker data acquisition using the auto save mode



Area Scan with Fixed Grid Wheel Electrode

- Area scan using the Wheel Electrode
- Fastest scanning of big concrete elements: slabs, walls, roofs, decks...
- Fixed customizable grid for when the surface dimension is known
- Huge versatility during measurement using the controls and edit buttons
- Measure areas with obstacles using the Skip distance feature



Area Scan with Flexible Grid Wheel Electrode

- Area scan using the Wheel Electrode
- Fastest scanning of big concrete elements: slabs, walls, roofs, decks...
- Flexible measurement on the go for when the surface dimension is irregular or unknown
- Huge versatility during measurement using the controls and edit buttons
- Measure areas with obstacles using the Skip distance feature



Potential Map



Statistical View



Chipping Graph

Potential Map

The potential map provides an area mapping of the measured 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.

Statistical View

Distribution and cumulative distribution 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.

In the upper part, the median, standard deviation, minimum and maximum values are shown, together with the number of measurements. If the surface under test has both actively corroding as well as passive rebar, 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 the passive potential thresholds that will affect the Chipping Graph, discriminating actively corroding areas from passive areas where no corrosion is to be expected.

If the surface under test has both actively corroding, as well as passive rebar, then the curve will typically exhibit a central region with a lower gradient (flatter). The two points where the gradient changes can be marked on the screen by dragging the two vertical cursors.

The red cursor will define the maximum (most positive) potential value expected of the active distribution. Active corrosion is to be expected in the region of the left hand (more negative) straight section.

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

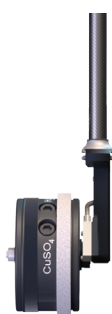
Chipping Graph

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 Distribution View.

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

HC-2873A— Profometer PM8500 Corrosion

Instrument Tech Specs	
Technology	Half-cell Potential
Measured Quantity	Corrosion potential in millivolts [mV]
Connection	Wireless - Bluetooth
Depth	First rebar layer
Voltage Meas. Range	-3000mV to +3000mV
Resolution	1.0mV
Input Impedance	100M Ohm
Sampling Rate	900Hz
Encoder Accuracy	+/- 0.5 mm / 0.02" + 0.78% of measured length Resolution: 3.3 mm / 0.13" (128 steps / rotation)
Max Scanning Speed	Normal conditions: 0.5 m/s - 1.7 ft ² Max recommended: 2m/s - 6.6 ft ²
Max Area Scan	100m x 100m - 328' x 328'
Dimensions (in / mm)	
Sensor Unit	5 x 2.3 x 2.2" (127 x 59 x 56mm) w/o holder 5 x 3.9 x 2.8" (127 x 98 x 72mm) w/ holder
Rod Electrode	D=1.4" (36mm) x 6.1" (155mm) with protection-cap
One wheel electrode:	7.6 x 5.4 x 5" (194 x 138 x 127mm) w/o telescopic rod 78.7 x 5.4 x 5" (2000 x 138 x 127mm) w/ extended telescopic rod 27.6 x 5.4 x 5" (700 x 138 x 127mm) w/ pulled-in telescopic rod
Four wheel electrode:	32.6 x 13.8 x 5.5" / (830 x 350 x 140mm) without telescopic rod // 84.6 x 32.6 x 5.5" / (2150 x 830 x 140mm) with extended telescopic rod // 32.8 x 32.6 x 5.5" / (840 x 830 x 140mm) / with pulled in telescopic rod
Weight (lb. / g)	
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



HC-2873A.3—
Single-Wheel Electrode



HC-2873A.4—
Four-Wheel Electrode

Profometer Corrosion App	
Display Unit	Compatible Apple iPad (iOS 11.0 and higher) Measurement Modes: <ul style="list-style-type: none"> • Basic Mode • Expert Mode • Spot Scan (rod electrode) • Line Scan (wheel electrode) • Area Scan (wheel electrode) • Fixed Grid (rod electrode) • Flexible and Variable Grid (Wheel electrodes) • Auto save mode (rod electrode) • Grid set up (Origin of coordinates; Grid size; Cell size; Direction of measurement; Pattern of measurement) • Delete and overwriting information (Cells; Lines; Whole scan) • Skipping data (Cells; Lines; Fixed distance) • Pause and resume • Stop and start
	<ul style="list-style-type: none"> • Potential View for displaying a heat map with the potential values • Statistic View - distribution and cumulative graph • Chipping graph view for displaying the corroded areas based on the analysis
Advanced Features	<ul style="list-style-type: none"> • Support for copper, silver, mercury and SCE calomel electrodes • Temperature correction • Zoom in and out
Calibration Features	<ul style="list-style-type: none"> • Calibration of length
On-site annotations	<ul style="list-style-type: none"> • Markers - comments and voice notes • Photos • Geolocation
Reporting	<ul style="list-style-type: none"> • Cloud connectivity • Workspace integration • Share via URL • Automatic Logbook • Raw data export • Instant report generation
Export formats	<ul style="list-style-type: none"> • JPG (Screenshot) • PNG • CSV • HTML
Display Unit Specs*:	<ul style="list-style-type: none"> • Latest Apple® iPad recommended (iPad with iOS 11.0 and higher) • Screen size: From 7.9" to 12.9" • Resolution: Up to 2732-by-2048 • Memory: Up to 2TB • Weight: Down to 301 g / 10.6 oz • Camera: Up to 12MP Wide and 10MP UltraWide • Optional: USB-C, 5G, Face ID
Display Unit Sensors*:	<ul style="list-style-type: none"> • LiDAR Scanner (optional) • Three-axis gyro • Accelerometer • Ambient light sensor • Barometer • Built-in GPS/GNSS

* Depending on iPad— iPad is a trademark of Apple Inc; iOS is a registered trademark of Cisco in the US and is used by Apple under license

PM8500

Profometer Corrosion

User Manual



purchase from Humboldt Mfg. Co.
www.humboldtmfg.com
1,800.544.7220



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Legal Notice

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 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.

Liability

Our “General Terms and Conditions of Sales and Delivery” apply in all cases. Warranty and liability claims arising from personal injury and damage to property cannot be upheld if they are due to one or more of the following causes:

- 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.
- Serious damage resulting from the effects of foreign bodies, accidents, vandalism, and force majeure. All information contained in this documentation is presented in good faith and believed to be correct. Proceq AG makes no warranties and excludes all liability as to the completeness and/or accuracy of the information.

Safety Instructions

The equipment is not allowed to be operated by children or anyone under the influence of alcohol, drugs, or pharmaceutical preparations. Anyone who is not familiar with the instrument must be supervised when using the equipment.

Reserved Rights

The content of this document is intellectual property of Proceq SA and prohibited to be copied neither in a photomechanical or electronic way, nor in excerpts, saved and/or be passed on to other persons and institutions. This document can be changed at any time and without any prenotification or announcement.

- ! Unauthorized modifications and changes of the product are not permitted.

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.

If there are any damages also inform your authorized Proceq agent or **Proceq SA** immediately.

Shipment

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

The product consists of:

- the PM8500 high-performance sensor unit,
- the electrodes (rod, one wheel and 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.

Therefore, some pictures or functional descriptions may differ from your model.

1.2 Product versions

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









The following licenses are available and offer different functionality:

- Profometer PM8500 License

1.3 Product applications

In general, two measurement types can be differentiated:

- Spot measurement using the rod electrode,
- Area measurement using the one wheel or the four-wheel electrode.

 PM8500				Spot Scan	Line Scan	Area Scan
	Rod Electrode	Scan small areas: columns, beams, footings...				
	One Wheel Electrode	Scan bigger vertical and overhead areas: walls, roofs...			100m 	100x100m2 
	Four Wheel Electrode	Scan big horizontal areas: slabs, parking garages, bridge decks...				100x100m2 

2 Scope of Delivery

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

3 Measurement Principle

3.1 Measuring Principle

3.1.1 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.

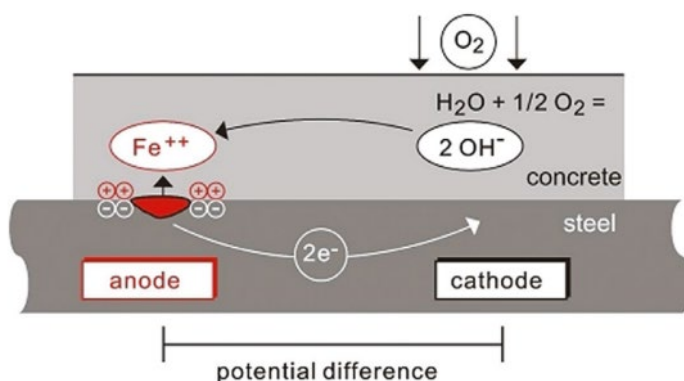


Figure 2: Principle of steel corrosion in concrete with oxygen availability.

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.

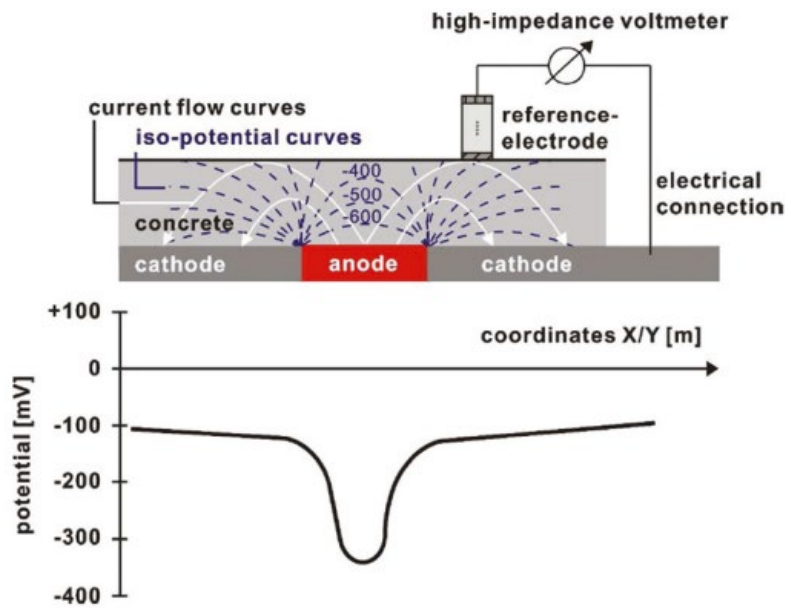


Figure 3: Measuring principle.

3.1.2 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

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.

3.1.3 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.

The air permeability of the concrete may be tested with Proceq's Torrent instrument.

3.1.4 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.

4 PM8500 Operation

4.1 Preliminary Operations

4.1.1 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 for water, that will slowly leak out to wet the felt during the measurement. The other one should be filled in with the copper 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.

4.1.2 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.

4.1.3 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.

4.1.4 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 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.

4.1.5 Sensor Unit overview

Keys - Overview

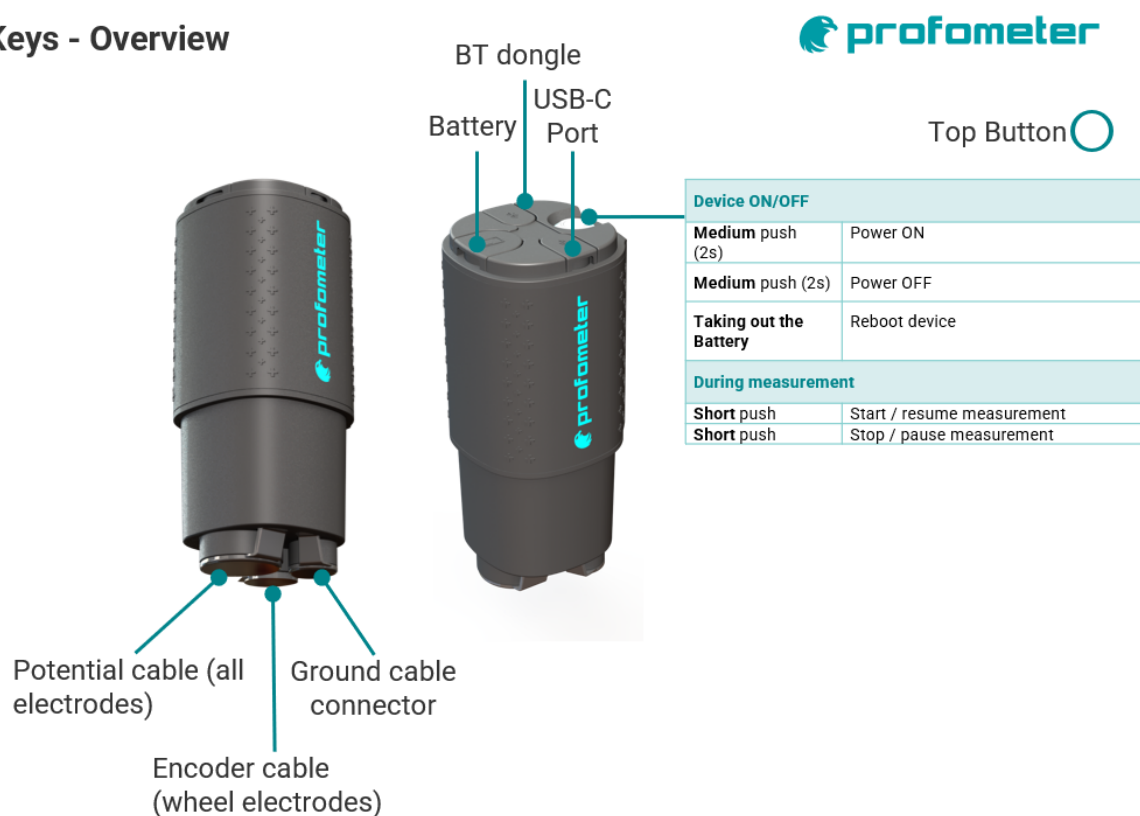


Figure 4 : PM8500 Sensor Unit: Keys Overview

LED - Behaviour

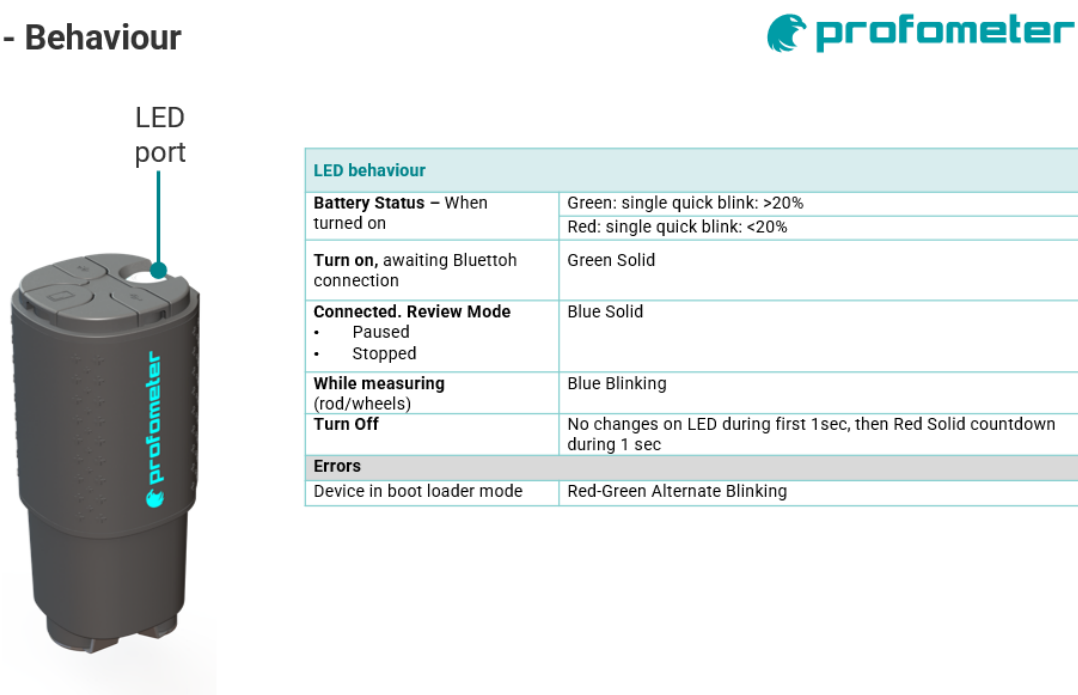


Figure 5 : PM8500 Sensor Unit: LED behavior

4.1.6 Connecting the electrode cables with the sensor unit

Rod Electrode:

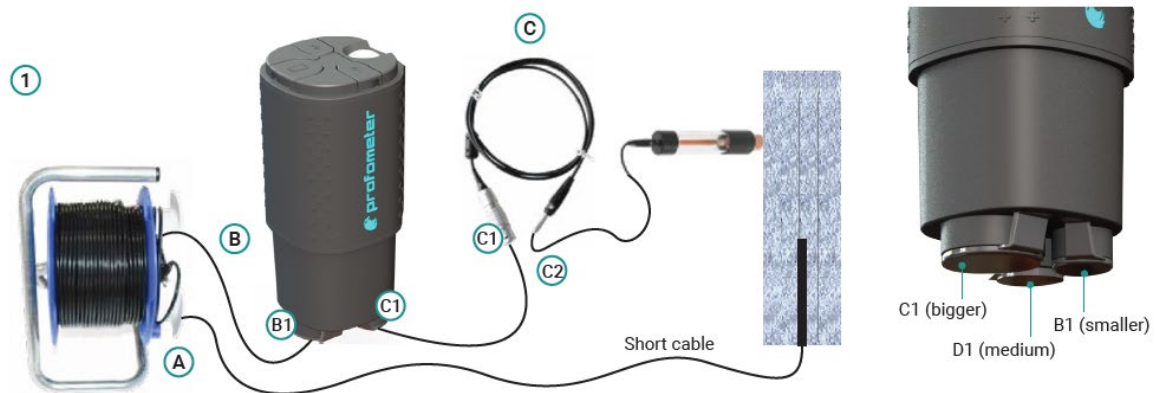


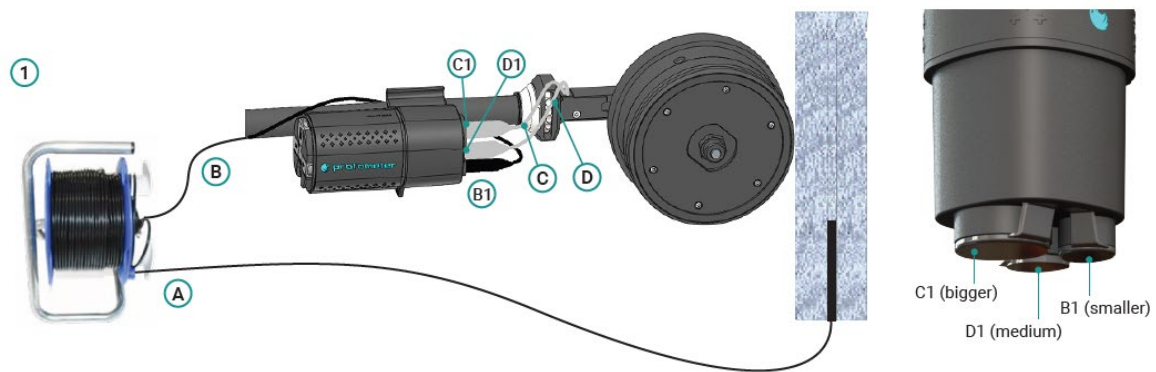
Figure 6 : PM8500 Rod electrode cabling set up

- 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

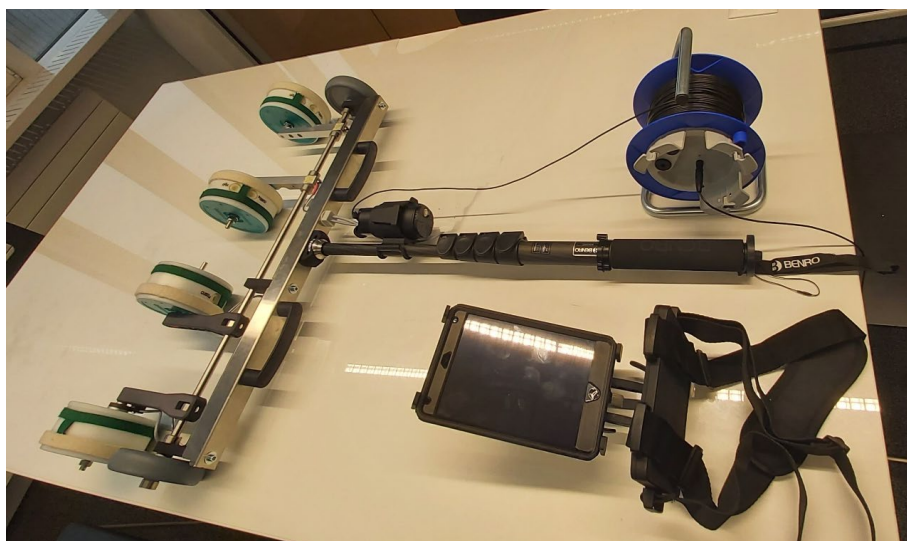


Figure 9 : PM8500 Four-wheel electrode cabling set up

4.1.7 How to mount the sensor on the harness

PM8500 includes a chest harness to carry the iPad, helping the user for free hands operation.

This harness is also very useful to carry the sensor unit when using the rod electrode. To do so, you can use 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.

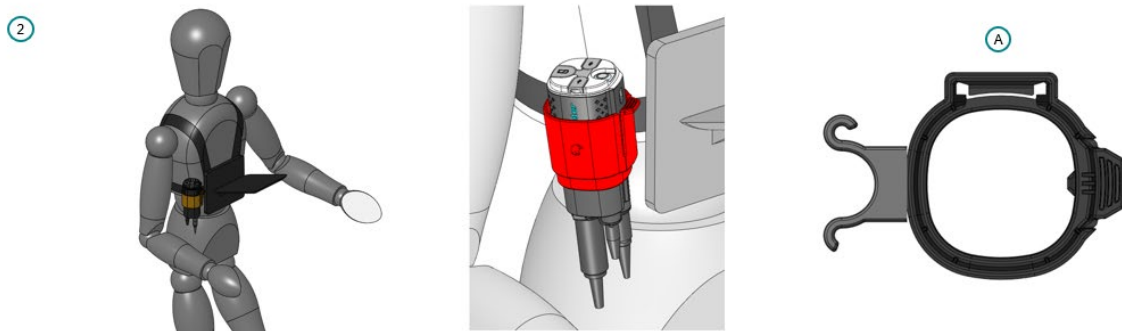


Figure 10 : PM8500 Universal Holder for Rod Electrode

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

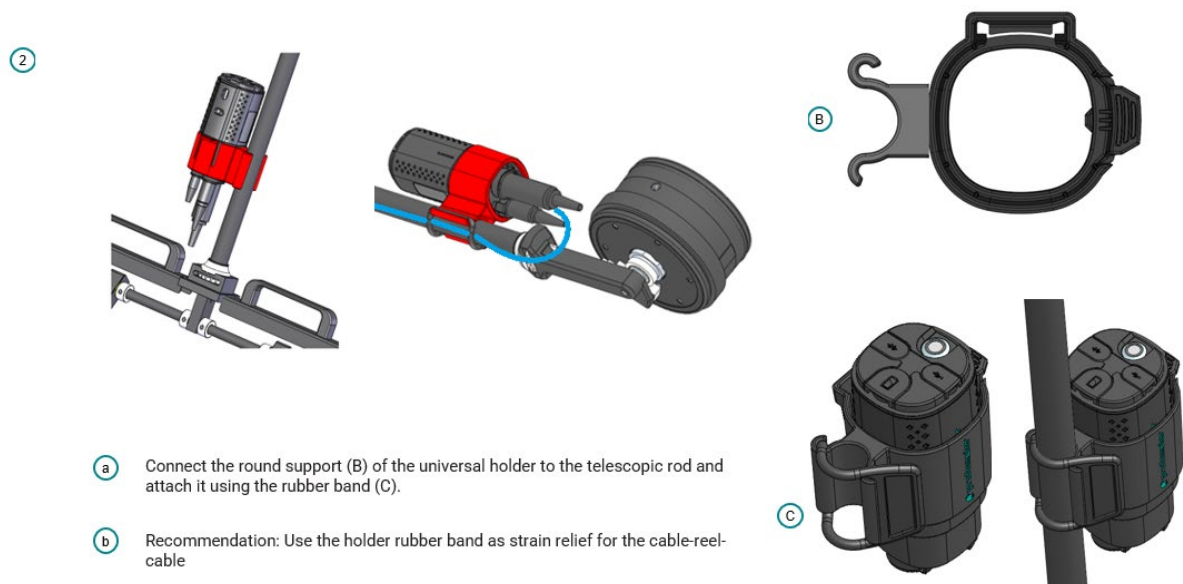


Figure 11 : PM8500 Universal Holder for Wheel Electrodes

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

One telescopic rod is provided in the one wheel and the four-wheel kit. This extensible system is very useful to comfortably do measurements while using the wheel electrodes.

It also allows you to reach high elements, such as big walls, or roofs.

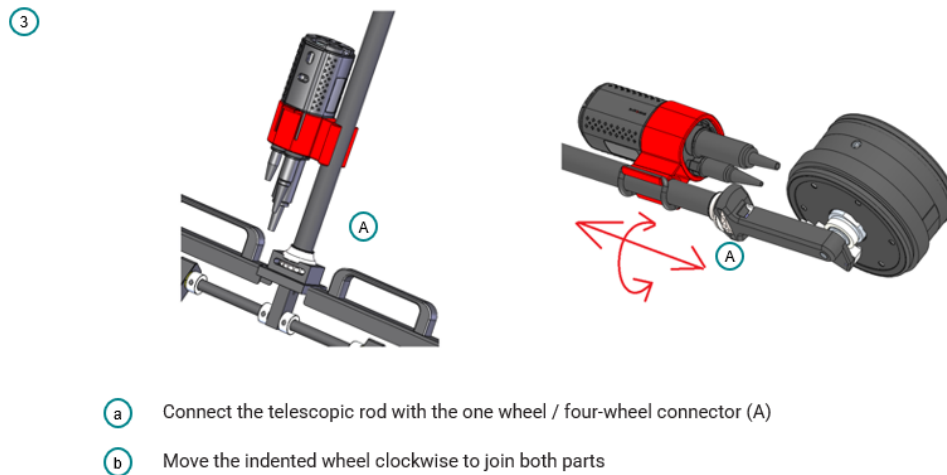


Figure 12 : PM8500 Telescopic Rod

4.1.9 How to replace the foam of the rod electrode

The rod electrode brings a foam that allows the copper solution to enter the concrete surface. This foam might be deteriorated within the time, and that is why some replacements are provided in the standard kit.

Replacing a deteriorated foam is very easy following the next steps:

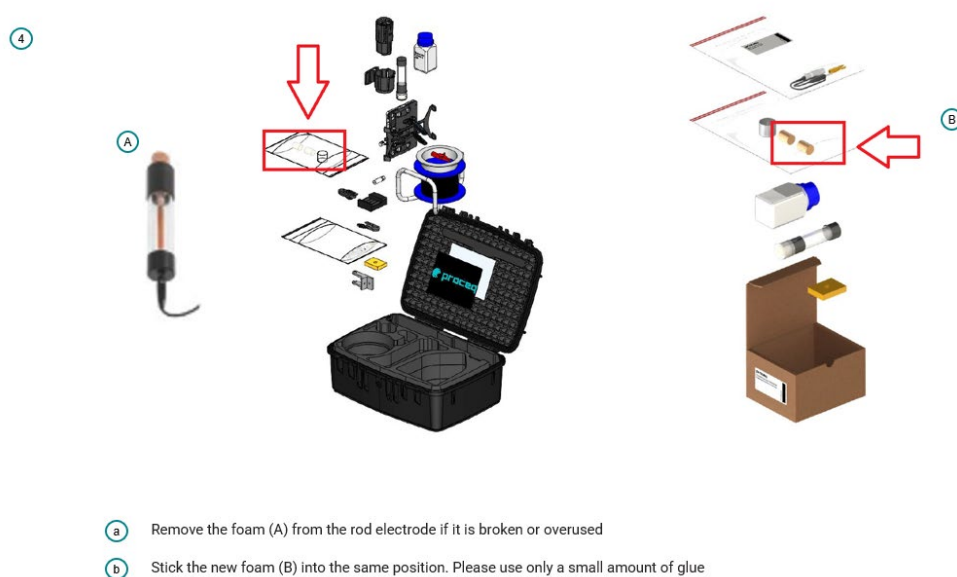


Figure 13 : PM8500 Rod Electrode: Foam replacement

4.1.10 How to change the distance between the wheels

The four-wheel electrode allows the user to define 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 when a big surface must be tested.

This task is very easy to do, and all the tools are included in the four-wheel kit.

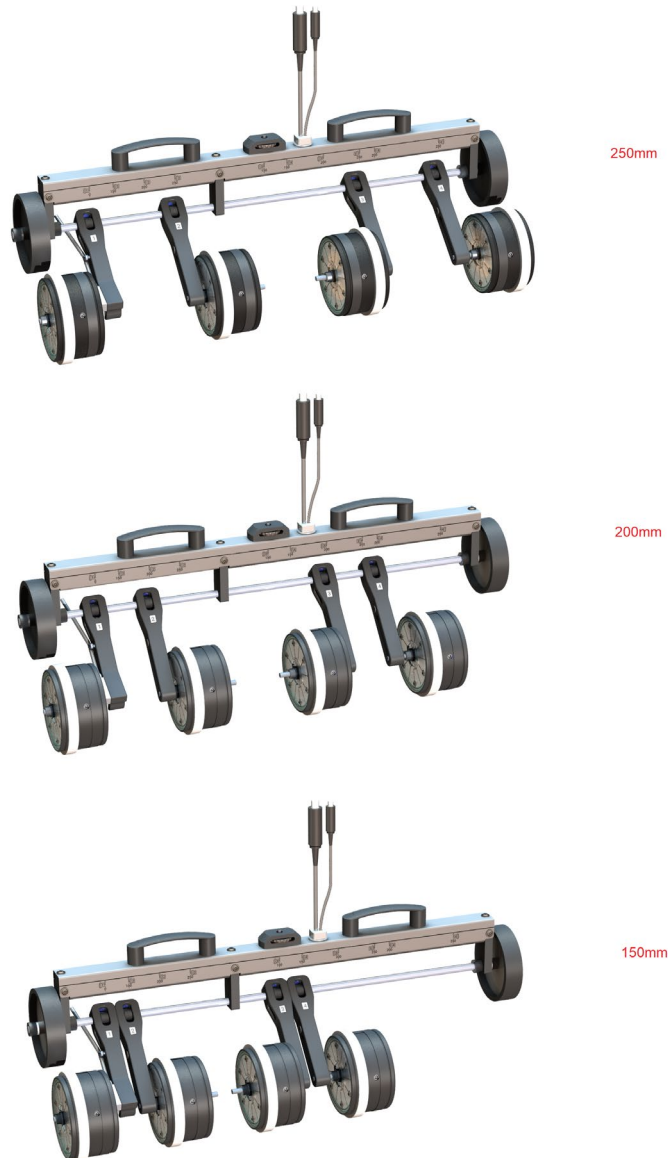


Figure 14 : PM8500 Four Wheel Electrode: 150, 200 and 250mm spacing options

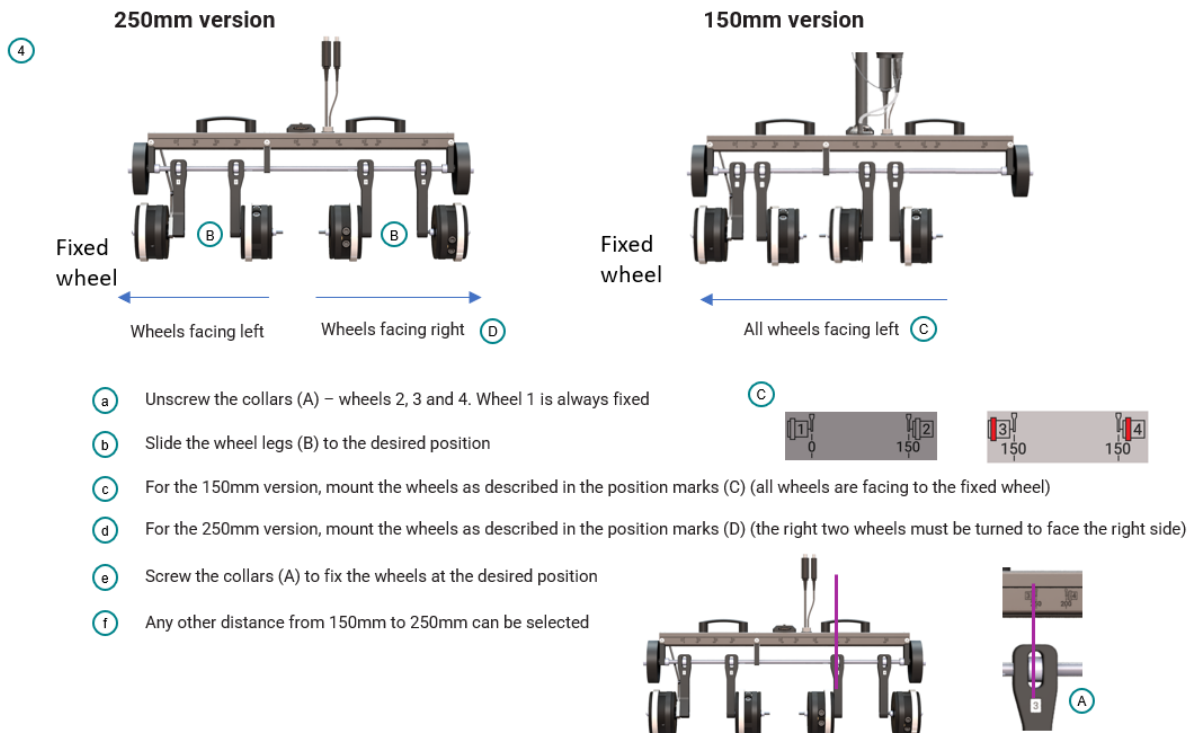


Figure 15 : PM8500 Four Wheel Electrode. Wheel spacing set up

4.1.11 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.

4.1.12 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.

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.

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.

4.2 Starting a measurement

4.2.1 Download the Profometer App and Create Eagle Account

This app downloadable for free in the Apple Store. To do so, you need to have one compatible iPad (see the most recent information for compatible iPads at Screening Eagle website).

Download the app "Profometer"
on the Apple® App Store



**For product usage information, please refer
to the Profometer PM8500 documentation.**

It is available for download on:
www.screeningeagle.com/en/products/profometer-pm8500

Figure 16 : PM8500 Profometer App: Download Link

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

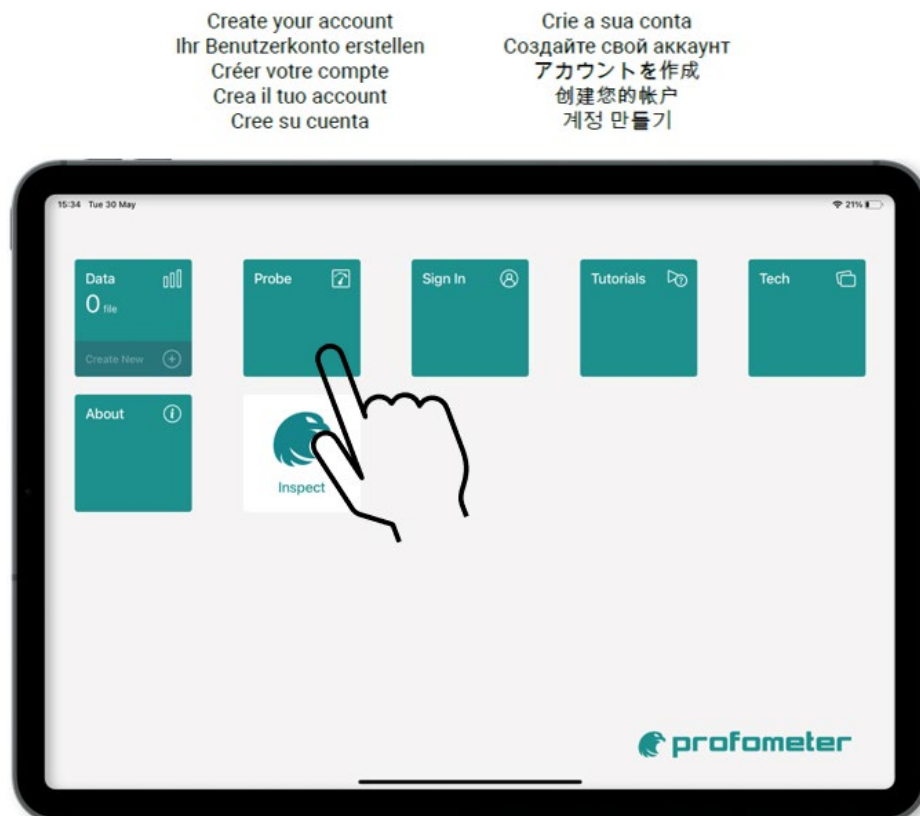


Figure 17 : PM8500 Profometer App: Signing and logging in

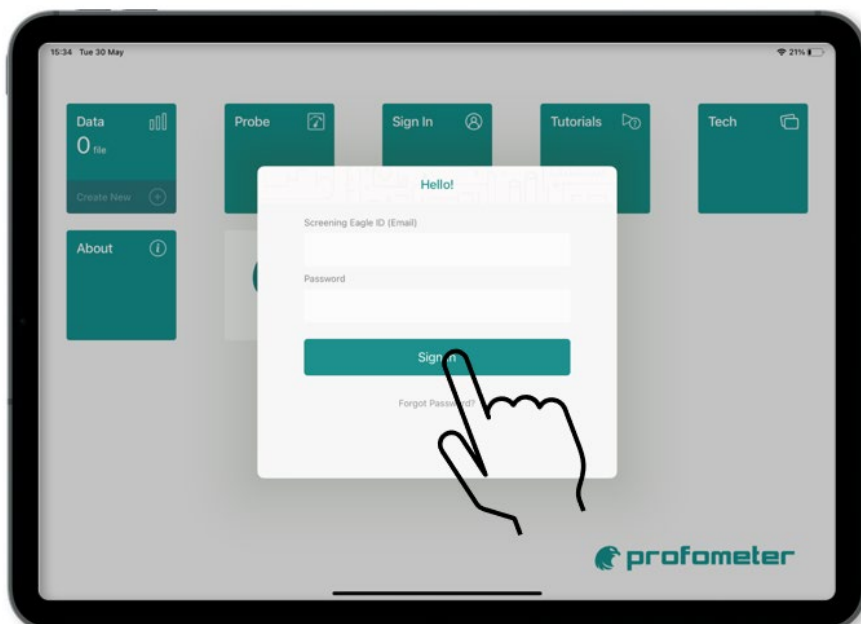


Figure 18 : PM8500 Profometer App: Signing and logging in

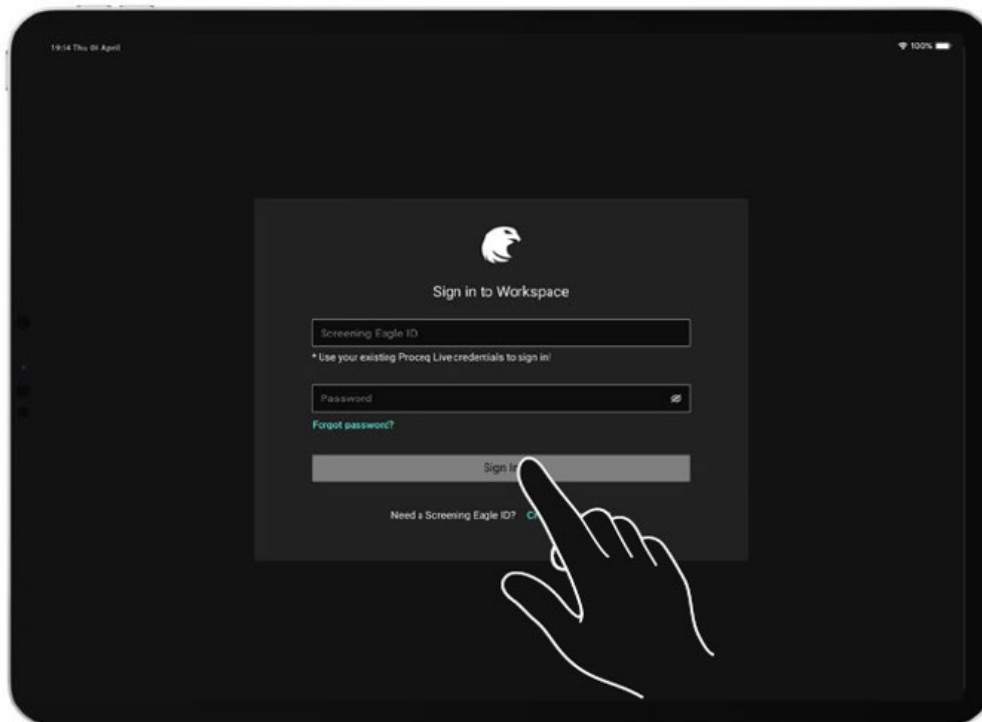


Figure 19 : PM8500 Profometer App: Singing and logging in

4.2.2 Turning on and off the device

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



Figure 20 : PM8500 Sensor Unit: Turn on and off

4.2.3 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” whenever you find your sensor unit.



Figure 21 : PM8500 Profometer App: connecting the probe

4.2.4 Create a new file and start your first measurement

Click “Create New” to start a new measurement:

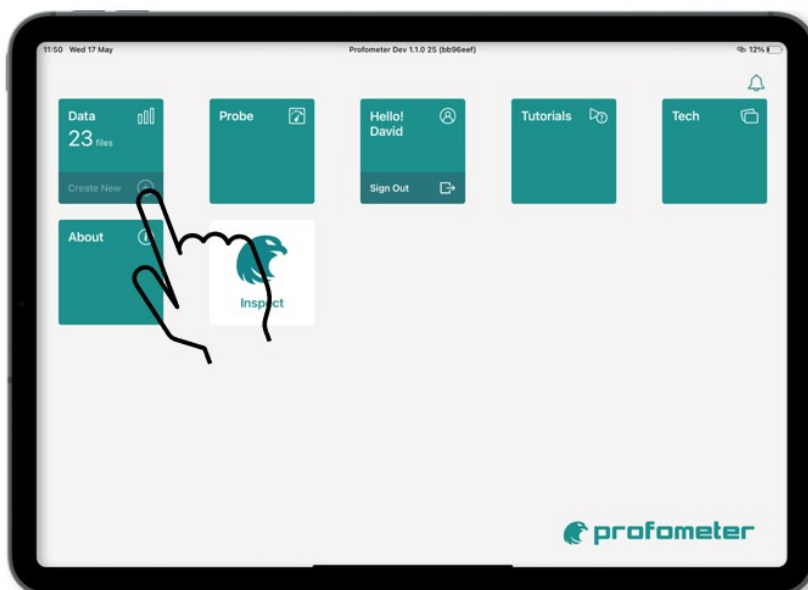


Figure 22 : PM8500 Profometer App: creating new measurement

4.3.1 Quick overview



Measuring Mode

Select between Basic and Advanced.

- Basic Mode: Directly shows the chipping graphic during the measurement process. The threshold limits can either be selected manually or using the ASTM standard.
- Advanced Mode: recommended for expert users. It will display the potential map, and then will present a statistical analysis of all the potential values measured. Taking these values into account, the threshold limits can be selected, and therefore, the chipping graph created.

Threshold standard

If basic mode is selected, this additional feature will appear. Threshold limits can be selected either manually or 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/Hg₂Cl₂ (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.

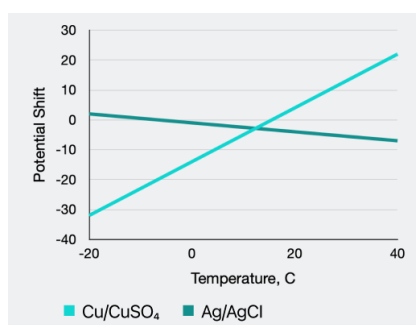


Figure 25 : PM8500 Profometer App: potential shift according to temperature

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 by manually.

Auto Save Delay

If Auto Save is selected, this feature allows the user to manually adjust the time of stabilization between two consecutive measurements that are automatically acquired with the auto save mode.

Potential Values

It shows and hides the potential values of each cell.

Grid Lines

It shows and hides the grid lines.

Aspect Ratio 1:1

It applies an aspect ratio 1:1 for zooming and un-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 (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 prefixed but can be 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 at the needed level.



Pan

The image from left to right by dragging.

4.3.2 Tutorial videos

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

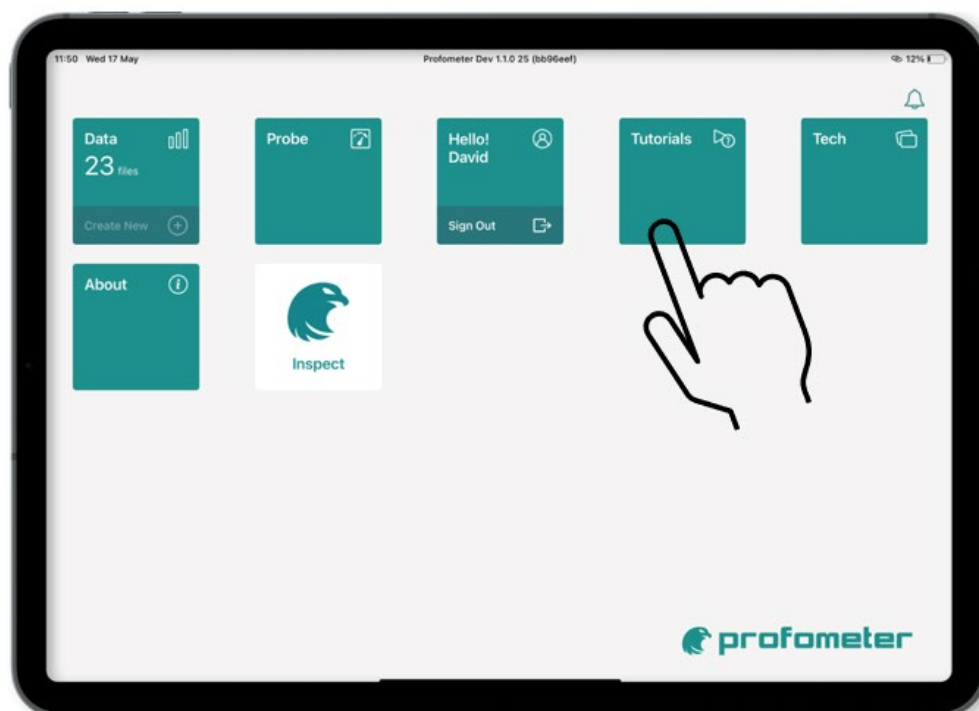


Figure 26 : PM8500 Profometer App: tutorial videos

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

4.3.3 Corrosion Display Views

Measured data can be displayed in one or 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.

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 27 : PM8500 Profometer App: Potential View

Statistic View

Distribution and cumulative distribution 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 cursor bar can be moved to any potential value.

In the upper left corner the median, minimum and maximum values are displayed, together other statistic data, such as the number of measurements, the standard deviation, the lowest and bigger values, and the current interval set with the vertical cursor.



Figure 28 : PM8500 Profometer App: Statistic View

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 the surface under test has both actively corroding as well as passive rebars, then the curve will typically exhibit a central region with a lower gradient (flatter). The two points where the gradient changes can be marked on the screen by dragging the two vertical cursors.

The red cursor will define the maximum (most positive) potential value expected of the active distribution. Active corrosion is to be expected in the region of the left hand (more negative) straight section.

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.

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.

NOTE! It is always advisable to perform direct visual check on open locations to confirm/refine the expected corrosion potential thresholds.



Figure 29 : 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).

5 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.

5.1 Performing a Calibration

A calibration check of the potential values can be done using a Calomel (HgCl) reference electrode.

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 30 : 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 (orange cable) of the PM8500 Sensor Unit.
3. Connect either the rod or the wheel electrode to the Electrode - Input (blue cable).
4. Put both probes together to close the electrical circuit. Recommendation for wheel electrodes: measure direct on the wooden spigot (copper sulphate side).

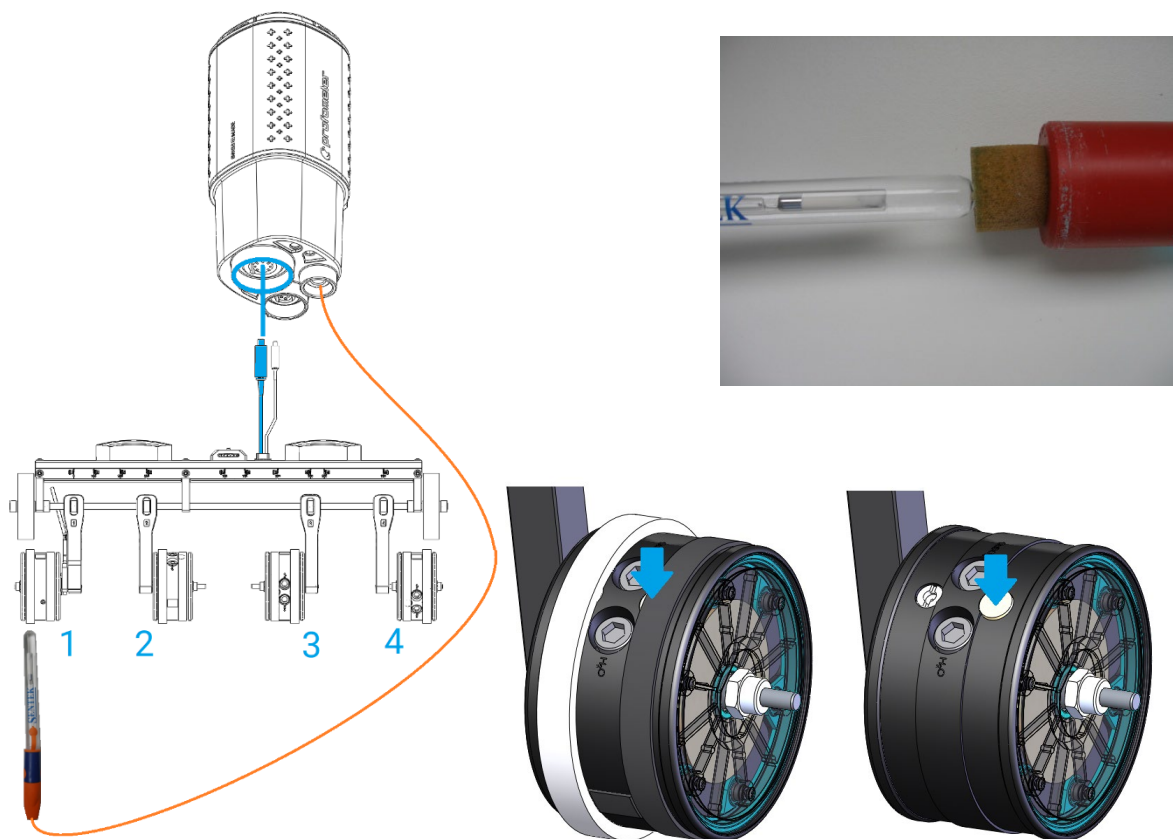


Figure 31 : Calibration Check. Rod and Wheel Electrodes

The theoretical potentials of the Cu/CuSO_4 and Calomel electrodes are the following:

- $\text{Cu}/\text{Saturated CuSO}_4 \rightarrow +316 \text{ mV}^*$
- Saturated Calomel $\rightarrow +242 \text{ mV}^*$

**(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 measuring value depends also on the temperature. Temperature drift is calculated:

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

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

$$\underline{\underline{1.66\text{mV}/^\circ\text{C}}}$$

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.

5.2 Measurement files visualization & storage

The Profometer app enables the visualization of measurements such as potential views, statistics view, and chipping graph. In addition, there is a logbook providing traceability of each measurement: time, operator, position and instrument information, pictures (with iPad camera) and written or oral notes.

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. Reporting is done from the Screening Eagle Workspace.

5.2.1 Data storage, reading, sharing & reporting

Screening Eagle Workspace is the 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 printing of tab) is possible. The tabs provide all the statistical values, screenshot views & logbook information.

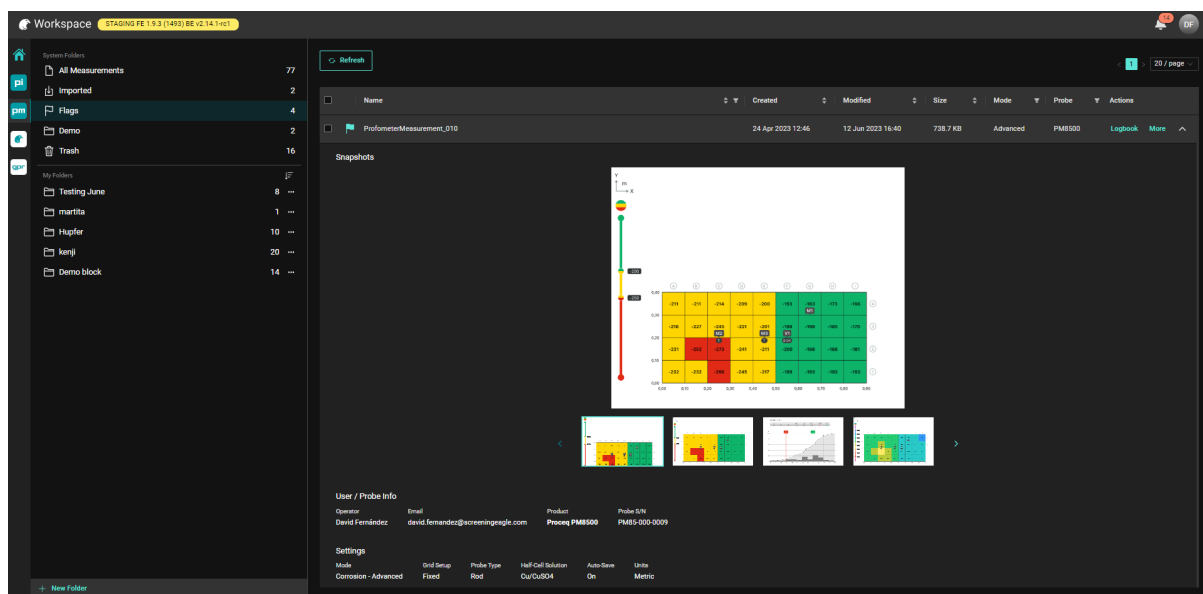


Figure 32: Screening Eagle Workspace

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. An extended warranty for one, two or three years for the electronic portion of the instrument may be purchased up to 90 days of date of purchase.

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 milivolts [mV]
Connection	Wireless - Bluetooth
Depth	First rebar layer
Voltage Measurement Range	-3000mV to +3000mV
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: 2m/s - 6.6 ft/s
Max Area Scan	100m x 100m - 328ft x 328ft
Dimensions --> mm / in	<p>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</p> <p>Rod electrode: D= 36mm x 155mm / D=1.4 in x 6.1in with protection-cap</p> <p>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 pulled in telescopic rod</p> <p>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</p>
Weight --> g / lb.	<p>Sensor Unit: 150g / 0.33 lbs. without holder; 220g / 0.49 lbs.</p> <p>Rod electrode: 120g / 0.26 lbs. without cable / without copper sulfate, without Sensor Unit</p>

	<p>One wheel electrode: 2000g / 4.41 lbs. without fluid, with sensor unit a telescopic rod // (fluid 435g / 0.96 lbs.)</p> <p>Four-wheel electrode: 6900g / 15.2 lbs. without fluid; (fluid 435g / 0.96 lbs. per wheel).</p> <p>Standard kit (all items including carrying case): 7400g / 16.3 lbs.</p> <p>One wheel kit (all items including cartoon box): 2900g / 6.39 lbs.</p> <p>Four-wheel kit (all items including carrying case): 15200g / 33.51 lbs.</p>
Battery	<ul style="list-style-type: none"> • 1xAA (NiMH) rechargeable or non-rechargeable • Removable • Flight-safe • 8 hours autonomy • USB-C charger
Environmental Conditions	<ul style="list-style-type: none"> ▪ Humidity <95% RH, non-condensing ▪ Operating temperature: -10°C to +50°C <p>PCB should work with wider range, limited by battery and BLE dongle</p>
IP Classification	<p>IP67 with closing caps inserted.</p> <p>IP64 when cables are connected.</p>
Standards and Guidelines	<p>ASTM C876, RILEM TC 154-EMC, DGZfP B3, SIA 2006, UNI 10174, JGJ/T 152, JSCE E 601, CE certification</p>

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

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