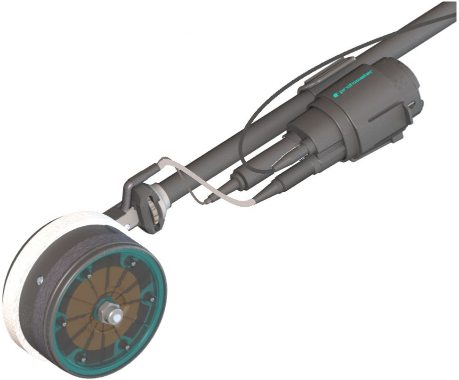
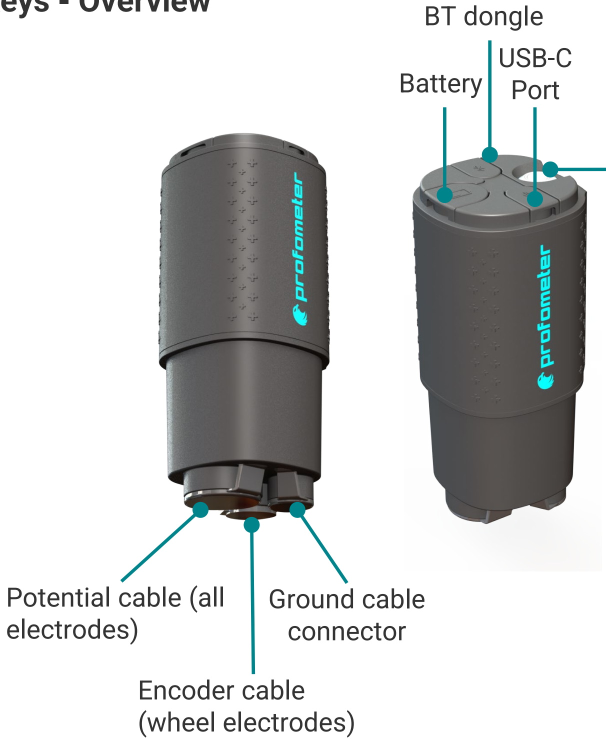
profometer

# PM8500



# Quick Reference

# Keys - Overview



BT dongle

Battery

USB-C Port

Potential cable (all electrodes)

Encoder cable (wheel electrodes)

Ground cable connector

Top Button ○

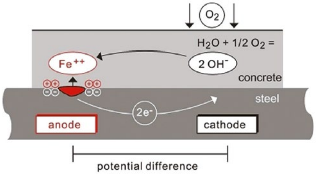
| Device ON/OFF | |
|---|---|
| **Medium** push (3s) | Power ON |
| **Medium** push (3s) | Power OFF |
| **Taking out the Battery** | Reboot device |

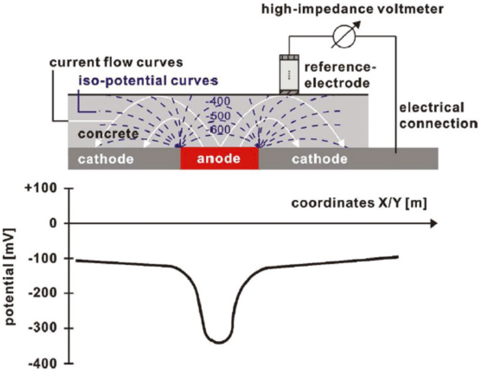
# LED - Behaviour

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

# Measurement Principle

## Half Cell Potential





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

# Typical Reference Values

## Half Cell Potential

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

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

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

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

# External Factors

## Half Cell Potential

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

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

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

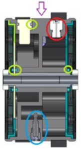
**Temperature**
High temperature will cause concrete resistivity to be lower and low temperature will cause concrete resistivity to be higher

$O_2$

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

# Preliminary operations

## Prepare the electrodes



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

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

The felt hoops and the felt hoop connector must be saturated before measuring. In normal use (with water and cupper solution), the thin felt is on the wooden spigot side.

The water should be dripping out slowly from the water tank throughout the 1mm nozzle (red mark). The bike valve should provide a high pressure; if water is dripping out from this valve, please apply some pressure blowing with your mouth.

## Copper Sulphate*

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

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

## Connect to rebar

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

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

# Preliminary operations

## Coated surfaces

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

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

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

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

## Pre-moistening

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

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

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

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

# Maintenance and Cleaning

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

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

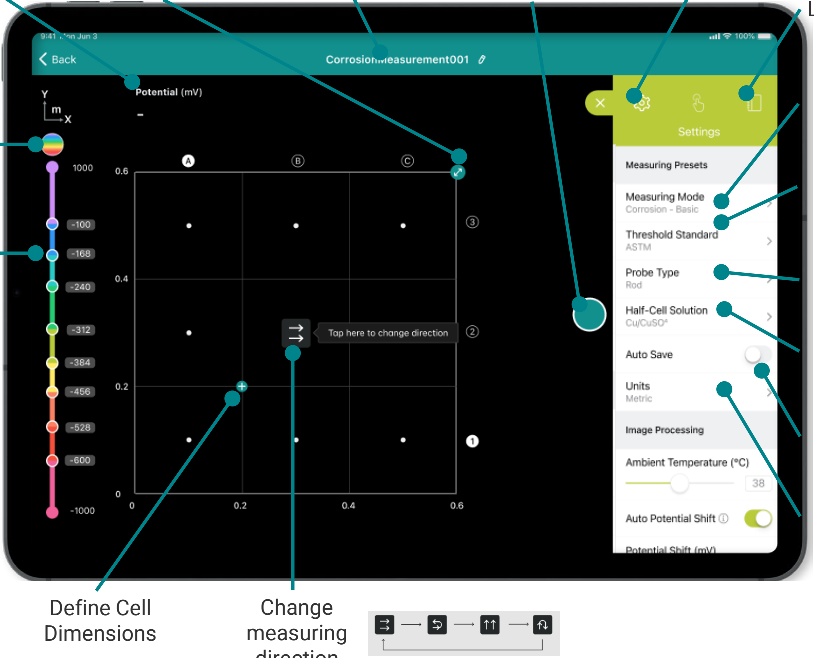
## Rod Electrode

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

## Wheel Electrode

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

# Settings



Measuring Presets

Measuring Mode
Corrosion - Basic

Threshold Standard
ASTM

Probe Type
Rod

Half-Cell Solution
Cu/CuSO⁴

Auto Save ○

Units
Metric

Image Processing

Ambient Temperature (°C)
38

Auto Potential Shift ●

Potential Shift (mV)

Live Potential

Expand Grid Limits

File Name

Start / Stop measurement

Settings Panel

Logbook

Change Color Palette

Potential View Color Range

**Measuring Mode:**
Basic / Advanced

**Threshold Standard:**
ASTM, Custom –
Only for Basic Mode

**Probe Type:**
Rod, one wheel,
four wheel

**Half Cell Solution:**
Cu/CuSO4, Ag/AgCl,
Hg/Hg2Cl2

**Auto Save Values**
Only for rod electrode

**Units:** Metric and
Imperial

Define Cell Dimensions

Change measuring direction

# Settings

Ambient Temperature (°C) 17

Auto Potential Shift

Potential Shift (mV) 1

Auto Save Delay (s) 1

Potential Values

Grid Lines

Aspect Ratio 1:1

Live Potential

Expand Grid Limits

File Name

Start / Stop measurement

Settings Panel

Logbook

Change Color Palette

Potential View Color Range

Concrete Temperature

Auto potential Shift: If yes, it assigns the drift associated to the temperature. If not, it assign the manual value

Auto Save Delay: Modify the waiting time between measurements

Potential Values: Show potential values on the grid (Yes/No)

Grid Lines: Show grid lines (Yes/No)

Aspect Ratio: Aspect ratio 1:1 of cells (Yes / No)

Define Cell Dimensions

Change measuring direction

# 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

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -340 | -315 | -310 | -310 | -321 | -366 | -431 | -374 | -333 | -356 | -341 | -323 | -319 | -310 | -304 | -298 | -274 | -306 | -312 | -322 | ⑮ |
| -313 | -287 | -275 | -288 | -312 | -354 | -385 | -386 | -365 | -353 | -332 | -340 | -310 | -302 | -298 | -276 | -312 | -323 | -321 | -318 | ⑭ |
| -288 | -277 | -260 | -252 | -279 | -314 | -324 | -336 | -354 | -389 | -331 | -323 | -305 | -287 | -294 | -301 | -334 | -345 | -364 | -354 | ⑬ |
| -281 | -270 | -262 | -247 | -289 | -284 | -324 | -336 | -354 | -347 | -376 | -323 | -305 | -287 | -294 | -301 | -307 | -345 | -364 | -354 | ⑫ |
| -292 | -283 | -278 | -300 | -300 | -271 | -324 | -336 | -354 | -399 | -356 | -323 | -305 | -287 | -294 | -301 | -307 | -345 | -364 | -354 | ⑪ |
| -281 | -266 | -249 | -298 | -302 | -294 | -324 | -336 | -354 | -354 | -356 | -323 | -305 | -287 | -294 | -301 | -307 | -345 | -364 | -354 | ⑩ |
| -295 | -317 | -311 | -365 | -390 | | | -336 | -334 | -334 | -376 | -323 | -305 | -287 | -294 | -340 | -334 | -345 | -364 | -354 | ⑨ |
| -295 | -342 | -343 | -431 | -452 | | | -399 | -382 | -381 | -356 | -323 | -305 | -287 | -294 | -340 | -307 | -345 | -364 | -354 | ⑧ |
| -290 | -320 | -317 | -305 | -357 | -383 | -324 | -345 | -412 | -383 | -356 | -323 | -305 | -287 | -294 | -301 | -307 | -345 | -364 | -354 | ⑦ |
| -298 | -296 | -288 | -285 | -305 | -283 | -356 | -363 | -354 | -334 | -356 | -323 | -305 | -287 | -294 | -301 | -307 | -345 | -364 | -354 | ⑥ |
| -292 | -283 | -278 | -300 | -300 | -271 | -337 | -336 | -354 | -334 | -356 | -323 | -305 | -287 | -294 | -301 | -307 | -345 | -364 | -354 | ⑤ |
| -281 | -270 | -262 | -247 | -289 | -284 | -324 | -336 | -354 | -334 | -356 | -323 | -305 | -287 | -294 | -301 | -307 | -345 | -364 | -354 | ④ |
| -288 | -277 | -260 | -252 | -279 | -314 | -324 | -336 | -354 | -334 | -356 | -323 | -305 | -287 | -294 | -301 | -334 | -345 | -364 | -354 | ③ |
| -313 | -287 | -275 | -288 | -312 | -354 | -385 | -386 | -365 | -353 | -332 | -340 | -310 | -302 | -298 | -276 | -312 | -323 | -321 | -318 | ② |
| -340 | -315 | -310 | -310 | -321 | -366 | -431 | -374 | -333 | -356 | -341 | -323 | -319 | -310 | -304 | -298 | -274 | -306 | -312 | -322 | ① |

# Statistic 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 rebars, then the two states exhibit two distinct partially overlapping distributions, with the corroding areas centered on a more negative potential.

Measurement statistics

| n | Min | Max | Corrosion | Passive |
|---|---|---|---|---|
| 50 | -459 | 109 | -270 | -20 |

# Statistic View

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 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.

Measurement statistics

| n | Min | Max | Corrosion | Passive |
|---|---|---|---|---|
| 50 | -459 | 109 | -270 | -20 |

# 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).

| | Ⓐ | Ⓑ | Ⓒ | Ⓓ | Ⓔ | Ⓕ | Ⓖ | Ⓗ | Ⓘ | Ⓙ | Ⓚ | Ⓛ | Ⓜ | Ⓝ | Ⓞ | Ⓟ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ⑪ | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -212 | -389 | -389 | -212 | -212 |
| ⑩ | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -212 | -212 | -212 | -389 | -212 |
| ⑨ | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 |
| ⑧ | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 |
| ⑦ | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 |
| ⑥ | -212 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 |
| ⑤ | -212 | -212 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 |
| ④ | -212 | -212 | -389 | -389 | -212 | -212 | -212 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 |
| ③ | -212 | -212 | -389 | -389 | -212 | -212 | -212 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 |
| ② | -212 | -212 | -389 | -389 | -212 | -212 | -212 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 |
| ① | -212 | -212 | -389 | -389 | -212 | -212 | -212 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 | -14 |

# Basic Mode

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

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

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

Threshold Standard

✓ ASTM
(Passive threshold >-200,
Corrosion threshold<=-350)

Manual

Passive threshold 0

Corrosion threshold 0

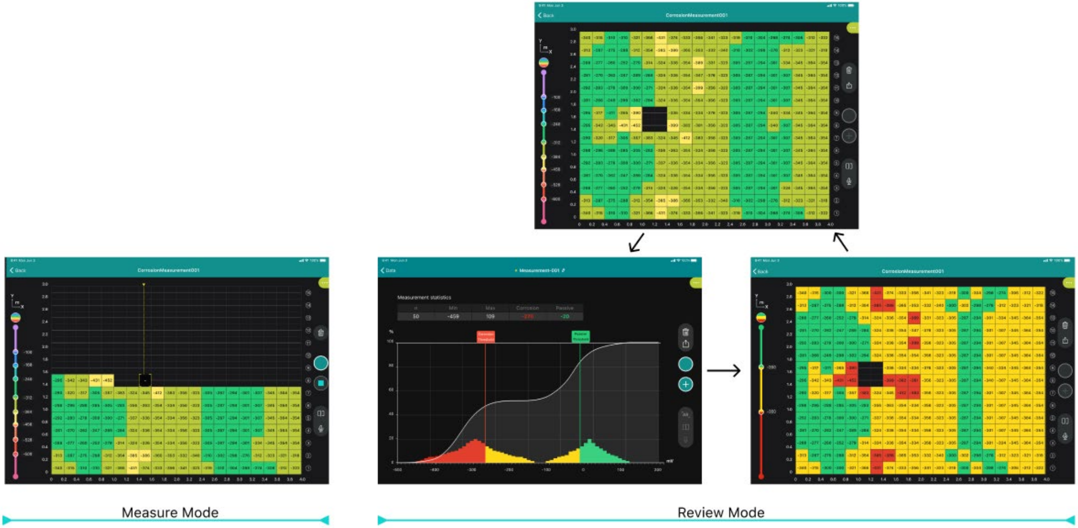
Measure Mode

Review Mode

# Advanced Mode

The Advanced Mode is recommended for expert users that want to create their own threshold limits based on the total measured values.

The process is the following: Potential map → Statistic View → Setting the threshold limits → Chipping Graph



SWISS MADE

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

It is available for download on

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

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