canin⁺

Operating Instructions
Corrosion Analyzing Instrument

proceq

Table of Contents

1 Safety and Liability

1.1 General Information

This manual contains important information on the safety, use and maintenance of the Canin⁺. Read through the manual carefully before the first use of the instrument. Keep the manual in a safe place for future reference.

1.2 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 this manual.
- Incorrect performance check for operation and maintenance of the instrument and its components.
- Failure to adhere to the sections of the manual 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 SA makes no warranties and excludes all liability as to the completeness and/or accuracy of the information.

1.3 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 this manual must be supervised when using the equipment.

- Carry out the stipulated maintenance properly and at the correct time.
- Following completion of the maintenance tasks, perform a functional check.
- Pay attention to the correct use and disposal of the copper sulphate solution and the cleaning material.

1.4 Symbols used in the operating instructions

> ⚠️ **Danger!:** This symbol indicates a risk of serious or fatal injury in the event that certain rules of behaviour are disregarded

> ⓘ **Note:** This symbol indicates important information

1.5 Correct Usage

- The instrument is only to be used to determine the corrosion potential of rebars in concrete or the electrical resistance of concrete.
- 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 forfeit.

2   Tutorial

2.1   The Half-Cell Potential Measurement Principle

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 (CO_2, carbonation), 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.
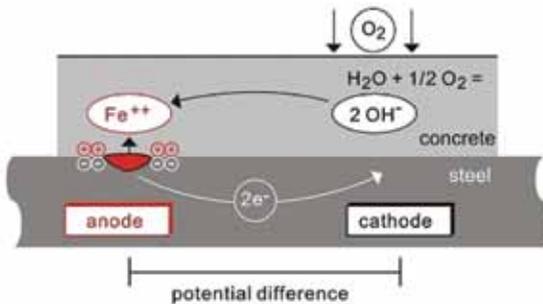
Principle of steel corrosion in concrete with oxygen availability

The basic idea of the potential field measurement is to measure the potentials at the concrete surface, in order 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 (in the case of the system Canin⁺ R = 10 MΩ) to the steel reinforcement and is moved in a grid over the concrete surface.

The reference electrode of the Canin⁺ system is a $Cu/CuSO_4$ half-cell. It consists of a copper rod immersed in a saturated copper sulphate solution, which maintains a constant, known potential.
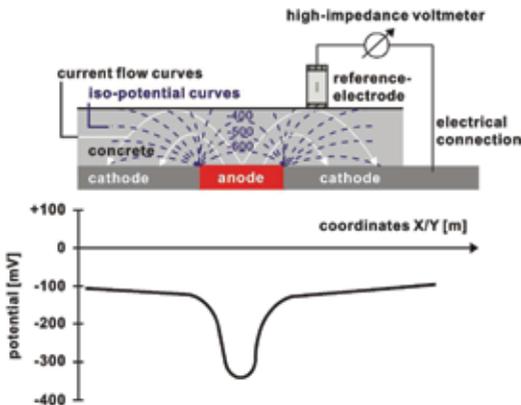
Typical orders of magnitude (for information only) for the half-cell potential of steel in concrete measured against a Cu/CuSO4- reference electrode are in the following range (RILEM TC 154-EMC):

- 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
- dry, carbonated concrete: 0 to +200 mV
- dry, non-carbonated concrete: 0 to +200 mV

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

Temperature

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.

Concrete cover thickness (Measure with Profometer / Profoscope)

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 cover (Measure with the Wenner Probe)

This topic is dealt with in detail in section 2.4

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 very 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.

2.3   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. This strongly affects the diameter of the reinforcement and thereby greatly affects the load bearing capacity. 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 resisitivity. 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.

2.4 The Electrical Resistivity Measurement Principle

As we have seen above, corrosion is an electro-chemical process. The flow of the ions between the anodic and cathodic areas and therefore the rate at which corrosion can occur is affected by the resistivity of the concrete.

The Wenner Probe is used to measure the electrical resistivity of the concrete. A current is applied to the two outer probes and the potential difference is measured between the two inner probes.
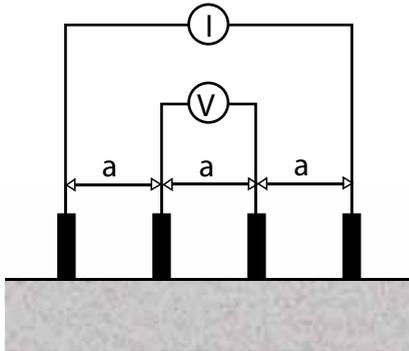
Resistivity $\rho = 2\pi a V/I$ [kΩcm]

Empirical tests have arrived at the following threshold values which can be used to determine the likelihood of corrosion.

When $\rho \geq 12$ kΩcm   corrosion is unlikely
When $\rho = 8$ to 12 kΩcm   corrosion is possible
When $\rho \leq 8$ kΩcm   corrosion is fairly certain

The electrical resistivity of the concrete cover layer decreases due to:

• increasing concrete water content
• increasing concrete porosity
• increasing temperature
• increasing chloride content
• decreasing carbonation depth

When the electrical resistivity of the concrete is low, the rate of corrosion increases.

When the electrical resisitivity is high, e.g. in case of dry and carbonated concrete, the rate of corrosion decreases.

2.5 Influence of Rebars on Electrical Resisitivity Measurements

The presence of rebars disturbs electrical resisitivity measurements as they conduct current much better than the surrounding concrete. This is particularly the case when the cover depth is less than 30mm. In order to minimize the effect, none of the electrodes should be placed above a rebar when measuring, or if this is unavoidable, then perpendicular to the rebar.

2.6 Effect of Electrical Resistivity on Half-cell Potential Measurements

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 resisitivity 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, in order to be able to locate an anode with a very steep gradient. However, the more potentials may be misinterpreted as passive areas when only considering the absolute value of the potential.

3　Getting Started

> ℹ️ **Note:** First time user: Complete the tutorial OR see a demo by a qualified Proceq representative.

3.1　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.

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. In order 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.

> ⚠️ **Caution!** When handling copper sulphate be careful to take note of the safety instructions on the packaging.

3.2　Connect the electrode / probe to the indicating device

Connect the half-cell electrode or Wenner Probe to the device as shown below:

Rod electrode connects to INPUT A and also requires GND connection.

Wheel electrode connects to INPUT A, path measurement connects to INPUT B.

GND connection is also required. (See 4.4)

Wenner probe connects to INTERFACE RS232C only.

3.3   Power ON and select the correct operating mode

Press the ON/OFF button to power on.

The indicating device has two distinct modes of operation:-

• Corrosion analysing
• Electrical resistivity meter

```
wenner

Resistivity Meter
www.proceq.com
SN 19.1234
Vers. 6.0w2
Test o.k.
▭▭
```

```
canin

Corrosion Analysing
www.proceq.com
SN 19.1234
Vers. 6.0
Test o.k.
▭▭
```

It will start up in whichever mode was used last. For potential measurements the instrument must be in "Corrosion analysing" mode.

Switch between modes by pressing MENU, place the cursor at "Wenner Probe", press START, select "OFF" for Corrosion Analysing" mode or "ON" for Resistivity Meter. (See 5.3) Press MENU or END.

3.4   Functional check of the equipment

Perform a functional check of the equipment as described in sections 4.5 and 11.

Congratulations! Your Canin+ is fully operational and you can now start your measurements.

4   Real Tests – Potential Measurements

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┌──────────────┐   Understand the principle and application limits of the
│      2       │   half cell potential measurement method.
│   Read the   │
│   Tutorial   │
└──────────────┘
        │
┌──────────────┐
│      3       │
│   Complete   │
│Getting Started│
└──────────────┘
        │
┌──────────────┐
│     4.1      │
│ Planning and │
│ preparation  │
└──────────────┘
```

4.4	4.5	5.4	4.6
Connect to the reinforcement	Functional check of the instrument	Check instrument configuration	Prepare the test surface

Measurement

4.7 Is a direct measurement on the concrete surface possible?

Yes	No

Can the influence from surface coatings be estimated and compensated?

Yes	No

Remove the surface coating

4.8, 4.9 Pre-moisten the surface if required and carry out the measurement

4.10 Evaluate the data

4.11 Confirm and refine corrosion hotspot positions at openings in the concrete

4.1   Planning and preparation

In Canin+, the measurement data is stored in files called "Objects". In order to make the evaluation simpler it is recommended before beginning work to map out the site and assign various sections to particular "Objects". This will facilitate the evaluation in ProVista at a later stage.

In order to minimize the effort needed for the investigation, the site can be divided into sections that are subjected to similar amounts of wear, by means of a visual inspection. (e.g. Multi-story car park: Entrance area, traffic lane, parking areas, areas with and without cracks or obvious areas where puddles form.) Following this inspection, representative sub-sections should be chosen, in which the potential field measurements are carried out with the Canin+ system.

4.2   Selecting the correct grid

One method is to use a relatively large grid for a first estimate, e.g. 0.50 x 0.50 m^2 up to a max of 1.0 x 1.0 m^2 using the coarse grid. (See 5.4).

Suspect areas can be further investigated using a finer grid (e.g. 0.15 x 0.15 m^2), to identify as closely as possible 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^2). 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^2 to 0.5 x 0.5m^2 is typically sufficient.

4.3   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.

4.4   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 with (e.g using an angle grinder) and to connect the 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. 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.

4.5   Functional check of the instrument

Before real tests begin, a functional check is recommended (see section 11).

Additionally the probes should provide a stable value close to zero (typically E = ± 20 mV) when they are held in the air and the Canin+ instrument is connected to earth.

It is also a good idea to make comparison measurements on areas that are clearly damaged against areas that are clearly intact. (e.g. at the base of a column with obvious corrosion compared with columns at a height of approximately 1.50 m without any visual damage.) Here also stable values should be obtained, whereby the measured values in the damaged area should be significantly more negative than the values from the undamaged area.

If the results obtained are doubtful, then it is often the case that there is a contact problem, e.g. connection to the reinforcement or the connection between the probe and the Canin⁺-instrument, respectively inadequate preparation of the probe (copper sulphate solution). Furthermore it is possible that a film of water on the probe or telescopic extension can create an electrical connection to the person carrying out the measurement. This can also affect the results. These error sources are easily corrected and the check should be repeated.

Check the instrument configuration (See 5.4).

4.6   Preparation of the test surface

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.

4.7   Check to see if coatings need to be removed

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 or not 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. $\Delta E = \pm 50$ mV), then a measurement can be made directly on the coating. If not, then the coating must be removed before making the measurement.

4.8   Pre-moistening the concrete surface

The contact between the pore solution of the concrete and the probe can be impaired by a dried out concrete skin. This can greatly increases the electrical resisitivity 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 has to 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.

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 section wise and to measure in intervals of a few minutes.

4.9 Carrying out the measurement

Configure your instrument as described in section 5. Pressing the END button saves the settings and takes the user to the measuring screen.

4.9.1 Reading the display screen

From here press the START button to begin. This brings up the empty page.
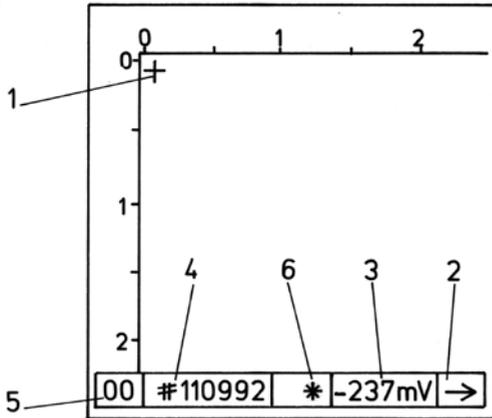
Fig 4.1 Page with a grid of 150/150 mm.

The XY- coordinates are displayed in meters. The display has 16 points x 15 points (240 points) for displaying the measured values as a grey scale. This constitutes a "page". With the XY-grid set to 150/150mm, as in the example here, this represents a total area of (2250mm x 2100mm).

A total of 980 pages can be stored in the memory. The number of pages that are still available for use is shown in the top right hand corner of the measuring screen (Fig 5.1). (e.g. 491 P indicates 491 pages are still available.)

The number of pages contained in an object is not limited except by this.

1 – The cursor shows the next measurement location

2 – The arrow shows in which direction the cursor will move. This can be altered to match the measurement direction by pressing the arrow keys.

3 – The measured value.

4 – The Object number.

5 – The meter value. E.g. a 10 will be shown here if we have travelled 10m in the X-direction.

6 – Indications (Switch between the two by pressing MENU whilst in the measuring screen):

Indicator	Probe type	Indication
r	Rod Electrode	XY-grid
R	Rod Electrode	coarse grid
*	Wheel Electrode	Measurements will be automatically overwritten
-	Wheel Electrode	Measurements will not be overwritten

4.9.2   Measuring with the Rod Electrode

The cursor begins in the top left hand corner of the XY-Grid (Fig 4.1). This indicates where the first measurement will be stored, so it is important to take the first measurement in the corresponding point marked on the concrete.

> **i**   **Note:** The first measurement must not necessarily be made in the top left hand corner. Before making any measurement, you may move the cursor around on the screen using the ↑↓← → buttons to the desired location. This is particularly useful if there is some kind of obstruction on the test object which means that a measurement cannot be made in that position. By moving the cursor as described you can move on the grid to clear the obstruction and continue measuring. The important thing is that your position on the screen should match the actual position on the concrete.

- Moisten the foam rubber plug of the electrode with water and press it lightly onto the first measuring point. The measured value will be shown in mV in the centre of the display. Once it stabilizes, a beep will indicate when the measurement has been acquired automatically. (See 5.4). At this point the mV value is blended out and a grey scale indication will be placed on the grid. The cursor will move to the next point to be measured.
- Following the measurement it should be possible to see a wet patch when applied on dry concrete. If this is not the case then the foam rubber plug should be moistened with water again.
- The simplest way to proceed is to make the measurements as proposed by the instrument. i.e. begin in the top left hand corner and move along the row in the X-direction according to the column width, e.g. 150mm between measuring points.
- When you come to the end of a row, you must press the ↓ button to indicate this and the cursor will jump down to the next row. The direction arrow (Field 2 in fig 4.1) will automatically change direction to ←.
- Now you can proceed to measure in the opposite direction along this row. When the end is reached, i.e. you are back at the Y-axis, the cursor will automatically jump down to the next row and the direction arrow will change back to →.
- When you come to the end of a page the cursor automatically jumps to the next page.

> **i**   **Note:** The instrument can also be used to measure along the Y-axis, i.e. up and down the columns. This is done by altering the direction arrow to ↓ before starting. In this case you must indicate to the instrument that you have reached the end of a column by pressing the → button.

> **i**   **Note:** The PRINT button can be used to mark an "X" on the display in the place of a measurement value. This is useful for marking the position of cracks etc.

When you have finished making all of the measurements you require on the concrete press the END button. The measured values are stored automatically.

4.9.3   Measuring with the Wheel Electrode

As described in 4.9.2, begin at the location corresponding to the top left hand corner of the screen and move in the direction indicated or alter this accordingly.

• Press the START button to acquire the first reading.
• Now proceed to move the wheel electrode in the Y-direction (down) as indicated by the direction arrow (Field 2 in fig 4.1). The measurement readings will be acquired automatically in the pre-selected row spacing.
• When you come to the end of a column, press the → button to indicate this and the cursor will jump right to the next column. The direction arrow will automatically change direction to ↑.
• Now place the wheel physically one column spacing to the right and acquire the first measurement by pressing the START button. Proceed to measure back along the Y-axis (up) as indicated by the direction arrow.
• When you come to the end of the measurement surface, (the X-axis) the cursor will automatically jump to the next column and the direction arrow will change back to ↓.
• Following each manual or automatic change in the direction arrow, the path measurement and the automatic acquisition of the potential reading is halted.
• These breaks in the measurement process can be used for example to refill the water compartment. Automatic measurement begins again when the START button is pressed.
• During such breaks, the measured value is shown in the status row. (Field 3 in Fig 4.1)
• The maximum speed of travel should not exceed a maximum of 1m/sec.
• Measurements along the X-axis cannot be acquired. (Objects may be rotated later in ProVista)

i	**Note:** The nozzle (Ø 1 mm) is fit as standard. On dry surfaces, the felt hoop should leave a clearly visible trace as you measure. Depending on the character of the concrete it may be necessary to increase to one of the larger nozzle diameters (Ø 2 or 3 mm).

i	**Note:** On dry, vertical surfaces, measurements should be made downwards as this ensures an even moistening of the surface.

4.9.4   Re-opening an object

An object can be re-opened and missing measurements can be entered or suspect measurements can be overwritten. However the following points should be observed.

Once an object has been closed and a new object has been opened, it is no longer possible to add pages to a previously opened object.

If you have worked out the size of the area assigned to an object (see 4.1), it is possible to reserve the number of pages you will require in the case that you are not able to complete the measurement in one go.

A page is reserved once it has appeared on the screen. In order to reserve the necessary pages, simply move the cursor to each page you will require. For a better orientation it may help to place an "X" (see Note in 4.9.2) somewhere on the page (but not in the top left hand corner).

The last object that was opened can be re-opened and extended at any time.

4.9.5   Overwriting or deleting readings

Existing readings can be overwritten by moving the cursor to the appropriate point and making a new reading with the electrode. Once the reading has registered, the cursor will move to the next measuring point along the axis indicated by the direction arrow.

To delete an existing reading, move the cursor to the point you wish to delete and press PRINT for two seconds. Once the reading has been deleted, the cursor will move to the next measuring point along the axis indicated by the direction arrow.

4.10   Evaluation

Typically, two criteria must be considered for the evaluation. (This is merely a guideline. The actual evaluation should be carried out by a corrosion engineer.)

1.   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 with delta of around +100mV within a 1m measurement area, together with negative potentials are a clear indication of active corrosion.

2.   In order to plan corrective maintenance it is necessary to draw a border between areas of active corrosion (anodes) and passive areas (cathodes) within the surfaces showing potential gradients. In order to do this it is necessary to set a threshold potential that defines the intersection between the two states. ProVista has functionality which aids in this. (Read section 6 for details).

4.10.1 Example of a typical distribution

If the surface under test has both actively corroding as well as passive rebars, then the two states exhibit differing statistical distributions of the potential. In the graphical representations provided by ProVista there are typically three characteristic sections (Fig. 4.2). A flattening out of the section shows that in these value ranges, there is less data available, i.e. the boundaries of the distribution are here.
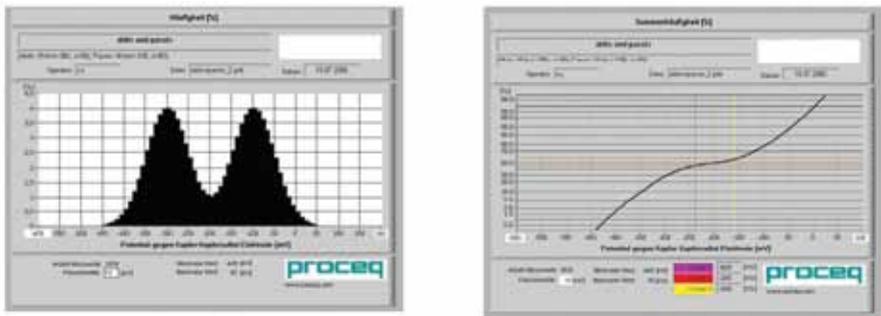
Fig. 4.2 Example of a relative frequency chart and cumulative frequency chart.

The potential ranges of active corrosion and passivity overlap.

The red cursor (leftmost) = minimum of the passive distribution.

The yellow cursor (rightmost) = maximum of the active distribution.

Active corrosion is practically certain in the region of the left hand (more negative) straight section. Once these cursor lines have been set, the surfaces in this potential range will be automatically displayed in the corresponding colour in the CANIN ProVista "Chipping Plot".

In the example the red cursor line marks this threshold. A typical "Chipping Plot" taken from a practical example is shown below.
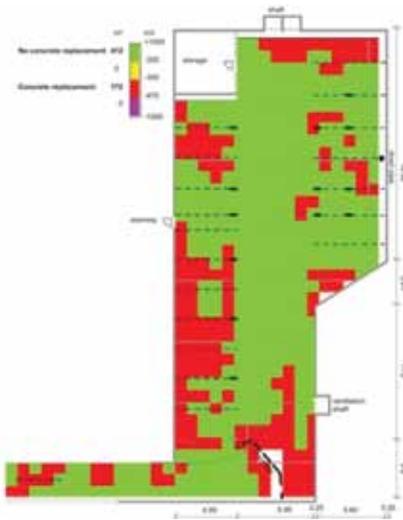
The right hand side straight section almost certainly corresponds to passive reinforcement. This is displayed automatically in the "Chipping Plot" in green.

In the overlapping range active corrosion and areas of passivity can be present with the same potential values. Areas with potential values in this area are displayed automatically in yellow in the "Chipping Plot". In this overlapping range it is assumed that a definite statement on the corrosion state is not possible and such sub-sections may only be evaluated by more extensive investigations.

4.11 Confirmation and refining of hotspot positions

Once the potentials have been evaluated, it is recommended to make openings in the concrete to verify the threshold potential. Prior to making the opening it is recommended to locate the exact position of the reinforcement bars by means of a rebar locator (e.g. Proceq's Profometer, Profoscope). Moreover a fine measurement with the Rod Electrode using a small grid is recommended to determine the actual "Hotspot" (local potential minimum).

5   General Settings

5.1   Backlight

The display has a back light which can be switched on or off by pressing the END button for more than 2 seconds when the measurement screen is displayed. When the backlight is on, an asterisk is shown in the top right hand corner.

5.2   Navigating around the menus

The diagrams in Fig 5.1 and Fig 5.2 show the menu structure for configuring the equipment for potential measurement and electrical resisitivity measurement respectively. On start up, the measuring screen is shown. Press MENU to access the main menu for the mode selected.

For all the selected menus: Use the ↑↓ and ← → buttons to select menu items and adjust settings.

- If the option START is indicated at the bottom of the screen, pressing this will take you to the selected menu item.
- Pressing MENU saves the settings and takes you back to the main menu.
- Pressing END saves the settings and takes you to the measurement screen.

5.3   Selecting the operating mode

Wenner Probe – This menu item switches between operating modes.

For potential measurement it is OFF.

For resistivity measurement it is ON.

Fig 5.1 Menu Overview for Potential Measuring
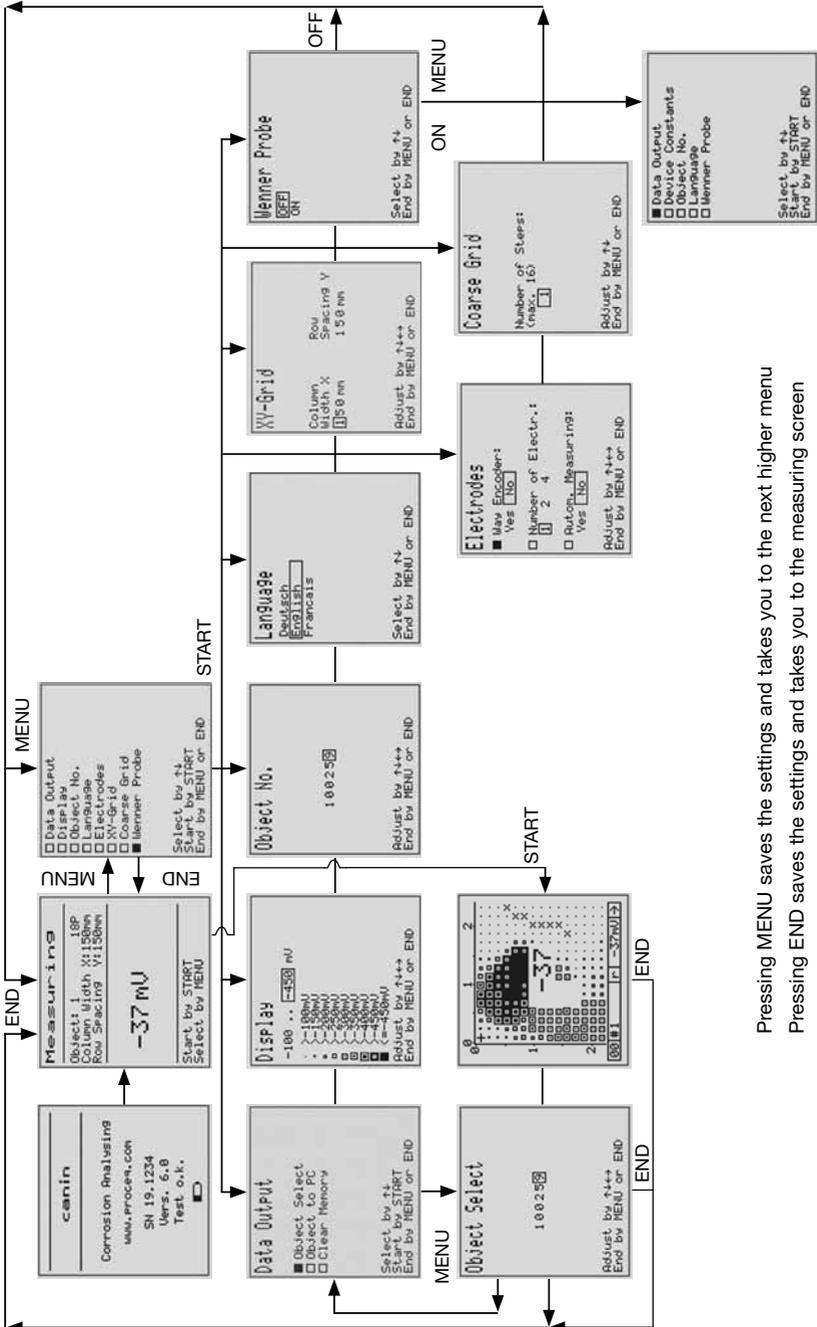
Main menu for resistivity measuring

Pressing MENU saves the settings and takes you to the next higher menu
Pressing END saves the settings and takes you to the measuring screen
Use the ↑↓ and →←→ to select, navigate and adjust settings

MENU

END

wenner

Resistivity Meter

www.proceq.com

SN 19.1234
Vers. 6.0w2
Test o.k.

#100020 *
σ̄ = 9.0 kΩcm / n = 7
Min/Max = 8.7/9.2 kΩcm

Position: G7

Actual 8.7 kΩcm

Memory 9.2

Current 100 %

Position with ↑↓ ←→
Store with STORE
Menu by MENU

MENU

END

Data Output
■ Data Output
□ Device Constants
□ Object No.
□ Language
□ Wenner Probe

Select by ↑↓
Start by START
End by MENU or END

START

Wenner Probe
OFF
ON

Select by ↑↓
End by MENU or END

ON

MENU

OFF

Language
Deutsch
English
Francais

Select by ↑↓
End by MENU or END

Object No.

1 0 0 0 2 **0**

Adjust by ↑↓ ←→
End by MENU or END

Device Constants

Wenner Code= 622

Adjust by ↑↓ ←→
End by MENU or END

Main menu for potential measurement
□ Data Output
□ Display
□ Object No.
□ Language
□ Electrodes
□ XY-Grid
□ Coarse Grid
■ Wenner Probe

Select by ↑↓
Start by START
End by MENU or END

Data Output
■ Object Select
□ Object Display
□ Object to PC
□ Clear Memory

Select by ↑↓
Start by START
End by MENU or END

START

MENU

Object Select
1
100259

Select by ↑↓ ←→
End by MENU or END

END

Object Display
#100020

σ̄ = 23 kΩcm
n = 7
Min = 14 kΩcm
Max = 38 kΩcm

End by END

END

Pressing MENU saves the settings and takes
you to the next higher menu

Pressing END saves the settings and takes you
to the measuring screen

Use the ↑↓ and →←to select, navigate and
adjust settings

Fig. 5.2 Menu Overview for Resistivity Measuring

5.4 Configuring the instrument for potential measurement (See Fig 5.1)

Display – The values determine the grey scale values that will be used on the screen. The total range possible is between +200 and -950 mV. An optimal base setting is between -0 and -350 mV.

This range can be adjusted at any time later to make the display easier to read. It does not affect any measurements made, only how they are displayed.

Object No. – Set the name for the "file" where the current measurement data will be stored.

> [i] **Note:** Object No. 1 is a Demo-Object consisting of 6 pages of data, which can be edited. However, when the instrument is switched off and on, the original values will be restored.

Language – The language is valid for both potential and resistivity modes.

Electrodes – Set Way Encoder to "Yes" for the wheel electrode and "No" for the Rod Electrode. Select the number of electrodes, typically 1 for the Rod Electrode and 1 or 4 for the wheel electrode.

The option Automatic Measuring is for the Rod Electrode only. The wheel electrode always measures automatically.

> [i] **Note:** If automatic measuring is selected, then measured values of < -50mV will be acquired automatically once the value has stabilized. If automatic measuring is not selected then values have to be acquired by pressing the START button. In both cases, values between +200 and -50mV have to be acquired by pressing the START button.

XY-Grid – Define the scale of the measurement grid.

> [i] **Note:** The XY-Grid values can only be altered if a new "Object" has been defined. If an Object already contains measurements, then it is no longer possible to change the grid.

> [i] **Note:** X and Y must be equal if you wish to export the data to ProVista

Coarse Grid – Define how many times the coarse grid is larger than the XY-Grid already defined.

Example: when distance between measurement points in the XY-Grid is set to 150 mm and the number of steps in the coarse grid is set to 5, the distance between measurement points in the coarse grid is 5x 150 = 750mm. This is useful for carrying out an initial sweep and switching to a fine grid for detailed investigations. (See 4.2)

> [i] **Note:** When the equipment is switched off, the coarse grid number of steps is reset to "1".

Data Output – Used to clear the memory and re-open objects for display. Data transfer to a PC is handled by CANIN ProVista (See 6.3).

Clear Memory erases all of the stored measurements for the active mode. It is not possible to delete single objects. Once this has been confirmed, it is not possible to undo the action. The objects for the other mode are unaffected.

5.5 Configuring the instrument for electrical resisitivity measurement (See Fig 5.2)

Most of the screens are identical to the potential mode and have been explained there.

Device Constants – Enter the 3-digit code engraved on the resistivity probe. (See 11.4)

Data Output – Used to clear the memory and re-open objects for display as in 5.4. In this mode also used to export data to a PC. Select the Object you wish to export. Press the END button to open the measuring screen where the main information of this object will be displayed. Transfer the data to the PC using Hyperterminal as described in section 8.

6 CANIN ProVista Software

The CANIN ProVista software enables the data transfer, the graphical presentation of the potential fields and a statistical analysis of the measurement data collected and stored on the Canin+. In addition, CANIN ProVista allows the automatic derivation of a chipping plot for concrete replacement.

These graphs can be inserted in an assessment report and serve the corrosion engineer together with results of non-destructive and destructive tests like concrete cover depth, carbonation depth, chloride profile etc. as basis for interpretation of his results.

The programme does not state the condition of the concrete structure, e.g. severity of corrosion of the rebars and it cannot propose the remedial actions. The engineer must be able to interpret all measured values in order to propose the necessary actions.

Additionally all graphics can be exported for editing in drawing programs and thereby inserted into plans for the execution of repair measures.

6.1 Installing CANIN ProVista

Locate the file "CaninInstallerx.xx.zip" file provided on the data carrier. Unzip the file and open the folder called "Volume".

Locate the file "setup.exe" and click on it.
Follow the instructions you see on the screen. This will install CANIN ProVista on your PC. It will also create a desktop icon for launching the program.

6.2 Starting CANIN ProVista

Either click on the desktop icon or click on the CaninProVista entry in the "Start" menu. "Start – Programs – CaninProVista".

The user can insert his own company logo by placing a bit-map file with the name Logo. bmp in the Configuration folder in the CaninProVista installation directory.

The size of the bitmap has to be 210 x 50 pixels. From there it will automatically be copied into the graphs.

The Proceq logo is unchange-able.
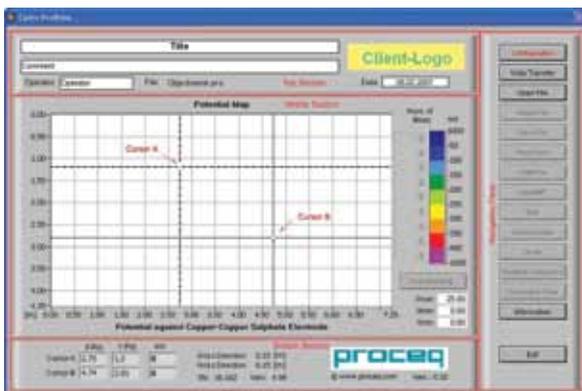
Fig. 6.1: Canin ProVista Main Window

There are four sections. The top contains labelling information including a user logo, the middle is the graphical representation of the measurement, the bottom contains additional numerical information regarding the measurement and the graph, and the right hand side contains the navigation pane.

6.3   Downloading and Saving Data

Connect the indicating device to your PC using the transfer cable (330 00 456) and the RS-232 – USB adaptor (390 00 542). In order to download data, the Data Output submenu must be visible on the indicating device. Select Menu "Data Output" (Fig 5.2) in the Canin+ display device and press START. Click on VistaTransfer button to start the download programme. A dialog box appears (see Fig. 6.2).

Select the respective COM port.

All the objects stored in the dis-play unit are listed in the field on the left. By default, all objects are selected for downloading, i.e. all the check boxes contain a cross.

Especially If you are using a USB to Serial converter make sure that a COM port from COM1 to COM4 is assigned. All higher COM ports are not supported.
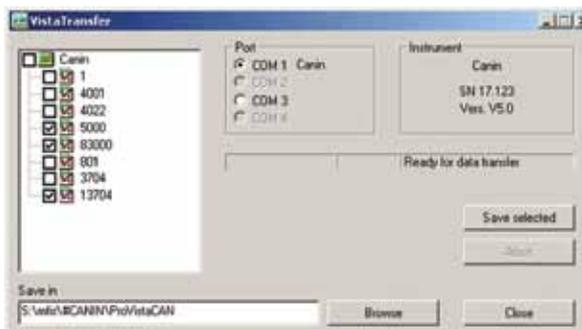
Fig. 6.2: VistaTransfer Window

If the object list is empty, please check the following:

• Whether the correct COM port is selected.
• Whether the cable is properly connected.
• Whether the Data Output submenu is visible on the indicating device.

Click the check boxes to select and de-select the individual list entries.

Use "Browse" to select the location you wish to store the data. Click the "Save selected" button to start the downloading procedure. The PC downloads all the selected objects and stores them as files in the selected folder. The file names are identical to the object numbers and the file type is PVO.

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6.4   Renaming Files

You can use Windows Explorer to rename stored files. Any file names can be used. The file type must always be PVO.

6.5   Opening and Editing Files

Click on the button Open File in the navigation pane and select the desired file in the Window that appears.

Files of type pvo or bin are the only files that Canin ProVista recognizes.

If the file is valid, the window in Fig. 6.3 appears asking you for the desired rotation/mirroring.
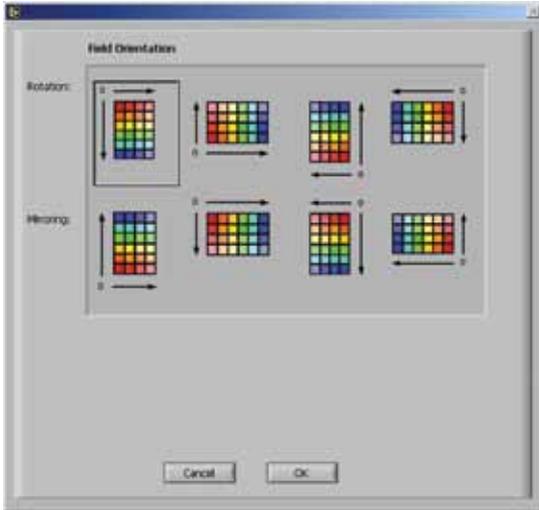
It may be that the objects from a complete site were not all measured in the same direction. (See 4.9.3). ProVista allows this to be corrected. Select the correct orientation and press "OK" again to display the measurement file as a potential map in the main window (see Fig. 6.4). If the selected file is invalid for any reason a warning dialog box will pop up.

To be valid, the grid that is set in the Canin+ display device must be equal in x-and y-direction, e.g. 150x150mm or 305x305mm (1x1ft).

The Canin+ display device accepts the unit length [mm] only. CANIN ProVista can convert and display the scale of length in ft.

Fig. 6.3: Orientation selection window

Fig. 6.4: Potential Map

A title, short comment, the name of the operator and the date can be entered at the top of the screen.

The scale represents the dimensions in either meters or feet. (See 6.6) The legend to the right shows the colour coding of the measurement values (in millivolts) and the number of measurement points in each range. The three fields Xmax, Xmin, Ymin allow the user to zoom in on a particular area in the graph.

The bottom section of the window shows the positions for cursors A and B and the mV value of their current position. The grid direction values indicate the resolution of the measurement.

6.6   Configuration

Click on "Configuration" to alter the appearance and the language of the potential map.
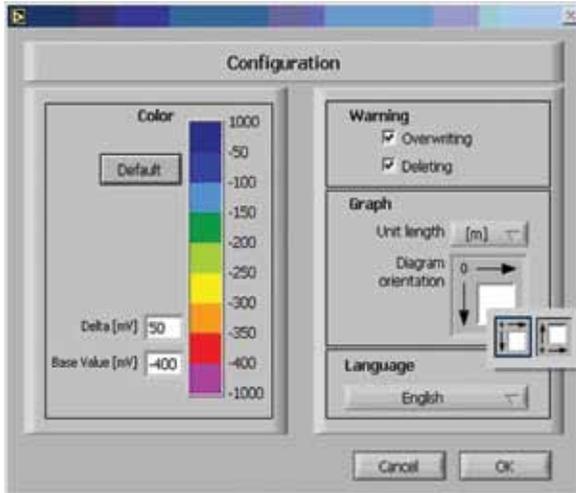
Fig. 6.5: Configuration Window

The number range to which the colours are assigned can be changed through varying the base value and delta. The base value may not be any smaller than -999 and the combination of the base value delta may not lead to any colour representing anything above 1000 mV. By pressing "Default", the base value and delta are changed to -400mV and 50mV respectively.

- Left clicking on a colour allows the colour for that particular range to be selected.
- Warnings for overwriting and deleting values in a graph can be set.
- Set imperial or metric units for the display with the drop down menu "Unit length".
- "Diagram Orientation" allows the origin of the graph to be changed.
- Set the language of the program with the drop down menu.

6.7   Insert file

Separately measured objects with the same grid resolution can be merged to form a complete potential map. Place one of the two cursors at the position in which the new file is to be added. Press the "Insert File" button and select the file you wish to add. If the file is valid, the next screen (Fig. 6.6) will allow the file to be correctly positioned.
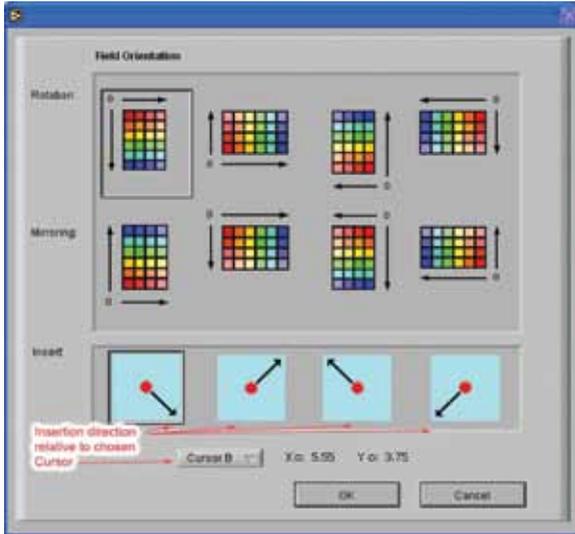
The new file may be rotated or mirrored to match its orientation to the current file. The insertion point is defined as either cursor A or B and finally the insertion direction is selected.

Press "OK" to return to the updated potential map.

Fig. 6.6: Insert Window
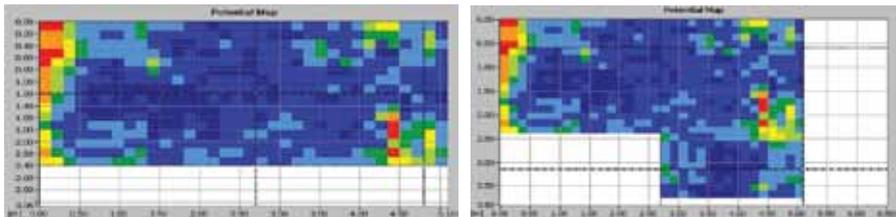
Fig. 6.7: Potential Map before and after Insertion

6.8   Edit

Individual values and sections of the potential graph may be edited.
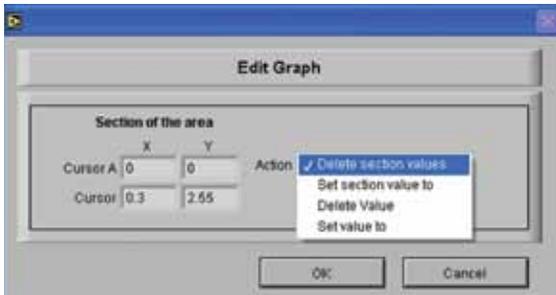
Fig. 6.7: Edit graph screen

Use the A and B cursors to select the values to be edited. Press "Edit". Four actions are available.

- Delete the values lying in the area between cursors A and B.
- Set the values lying in the area between A and B to a specific value.
- Delete the value to the bottom right of cursor A.
- Set the value to the bottom right of cursor A to a specific value.

6.9   Additional Functions

- "Save File" to save your changes.
- "Print View" prints the currently visible section of the potential map respectively chipping graph.
- "Print File" prints the entire measurement file, even areas that are not visible in the current view of the potential map/chipping graph, using as many pages as necessary.
- "Get BMP" creates a BMP image file of the current view of the potential map or chipping graph which can be exported to third party software for reporting.
- "General View" resets the range of the potential map and chipping graph so that the entire graph is visible again.
- "Undo" allows the last 10 edits and insertions to be undone.

6.10 Relative frequency

With the relative frequency function, a bar graph (as show in Fig. 6.8) of the measurement data is created. The width of the bars represents the measurement range while the height of the bar represents the relative frequency of measurements points within that range. The range of the graph can be changed by entering the desired minimum and maximum values in the respective fields on the x-axis. The limits are -1000 to +1000 mV. The class width can also be changed.

Fig. 6.8: Relative frequency diagram

6.11 Cumulative frequency
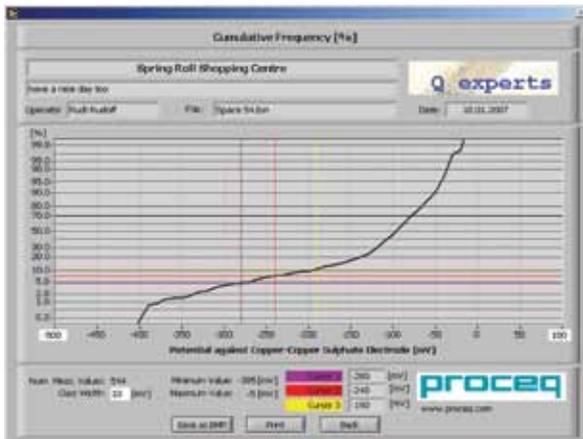
Fig. 6.9: Cumulative frequency diagram

Following an evaluation (See 4.10), the corrosion engineer can place the 3 cursors in such a way that they represent areas of different corrosion degrees.

They determine the colour distribution in the chipping graph.

It is possible to overlay two or even all three cursors and thereby decrease the number of divisions.

The cumulative frequency needs to be activated at least once for a newly opened file in order to be able to view the chipping graph.

The range of the cumulative frequency graph can be changed by entering the desired minimum and maximum values in the respective fields on the x-axis. The limits are -1000 to +1000 mV. The class width can also be changed.

6.12   Chipping graph

After having accessed the cumulative frequency graph, the "Potential Map" button becomes active. By clicking on it, the visualization switches to the chipping graph (see Fig. 6.10).

The four colour regions of the chipping graph are based upon the three cursor positions in the cumulative frequency graph.

These positions represent potential limits identified by the engineer as areas of equal condition where the concrete has to be chipped to a certain depth for repair purposes.
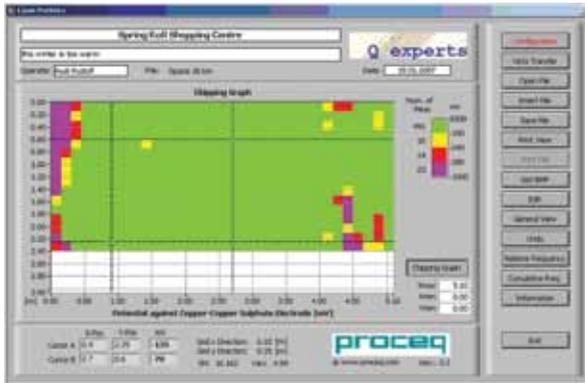
Fig. 6.10: Chipping graph

6.13   Annotations

Information about the concrete structure like measured chloride content, cracks or other defects can be placed directly in the potential map or the chipping graph. The information will be printed and shown in bitmaps.

By default they are created with an arrow that can be moved to point at a specific spot in the graph. Annotations can be added by right clicking on the potential map or chipping graph and selecting "Create Annotation".

Fig. 6.11: Annotation window

Fig. 6.12: Annotation Attributes

Right click on an annotation to select its attributes. If the Lock Name attribute is not selected, the entire annotation (point, label and arrow) can be moved by left clicking on the annotation and dragging it around. If the Lock Name attribute is selected, the name will stay fixed and only the annotation point with the arrow can be moved.

Once you have added annotations, it is recommended that the file is saved. The dimensions of the graph or the colour scale can then be changed. When changes to the dimensions of the graph are relatively large, it can occur that label location of the annotation will move. To restore the annotations correctly, the file can be re-opened.

It is also not recommended that annotations within one file be added at different dimension levels, i.e. zoom levels.

7   Measuring the electrical resistivity

Fig 7.1 Wenner four-point probe with cable and control plate

The four foam pads of the probe should be moistened with water. Connect the resistivity probe to the INTERFACE RS 232 C of the indicating device and assure that the device is in resistivity mode. (See 5.3)

Check the configuration of the instrument. (See 5.5)

> **Note:** The Wenner Probe constantly draws current. Therefore it should only be connected to the Indicating Device when measurements are being carried out.

7.1   Preparing the concrete surface for measurement

The concrete surface must not be coated with any electrically insulating coating and it should be clean. The rebar grid beneath the surface should be marked out with the help of a rebar locator (e.g. Profometer, Profoscope). The desired measurement grid should be suitably marked out on the surface and mapped to objects.

7.2   Reading the display screen

Object number

Mean value / measured values.

Minimum value / maximum value.

Table position: Value stored at that position.

Actual resistivity measurement: Proportion of current flow through the concrete relative to the nominal current.

The position in which a measured value can be stored in the table can be selected with the cursor keys.

Fig 7.2 Resistivity measurement screen

7.3   Measuring with the Wenner Probe

In order to obtain a reliable reading, it is necessary to have a good electrical contact between the foam pads of the resistivity probe and the concrete surface.

As far as possible, reinforcement bars should not be directly beneath the probe and should not run parallel to the probe. The recommended procedure is to measure diagonally to the rebars. (e.g RILEM TC154-EMC: ELECTROCHEMICAL TECHNIQUES FOR MEASURING METALLIC CORROSION recommends making 5 readings from the same location moving the probe a few mm between each measurement and taking a median from the 5 values.).

The well-moistened probe should be pressed lightly against the surface of the concrete until the reading is stable.

The "Current" field (See Fig 7.2) monitors the current flow through the concrete. If there is a bad contact between the electrodes and the concrete or if the conductivity of the concrete is small, the flow of the current will be reduced. This gives an indication as to the reliability of the reading obtained.

50% to 100%   The reading is reliable.

20% to 50%   "Value not exact" will be displayed on the screen.

0% to 20%   The resistance is >99kΩcm or the contact is very poor.

Once the reading is stable it can be saved by pressing the STORE button. It will be saved in a table in the position indicated on the display (e.g "G7" in Fig 7.2). The table has a maximum size of 16x16 cells. The position in the table where the measurement is stored must be selected manually on the screen (Fig 7.2).

Use the ←—→ buttons to select a letter from A to P.

Use the ↑↓ buttons to select a number from 1 to 16.

	A	B	C	D	E	F	G	H	I	J	..
1	38	30	27	20	17	14	14	15	25	27	
2	34	29	24	18	12	12	9	6	13	25	
3	32	26	23	15	13			5	11	24	
4	32	28	23	16	13			4			
5	32	28	23	17	13			6			
6	34	29	24	16	14	11	9	7			
7	29	26	25	17	14	13	10	8			
8	28	28	26	20	18	16	14	11			
..											

Fig 7.3 Table for resistivity measurements.

Each time a new reading is stored, the statistical values (mean value, max and min values) are re-calculated and displayed.

An existing reading can be deleted by pressing the STORE button for two seconds.

An existing reading can be overwritten by selecting the corresponding position in the table and performing a new measurement.

The table structure is maintained when the data is transferred to the PC so that the user can generate a graphical representation in EXCEL.

<table>
<tr><td>⚫ i</td><td>Note: As a general rule of thumb from literature on this topic:</td><td></td></tr>
<tr><td></td><td>When ρ ≥ 12 kΩcm</td><td>Corrosion is unlikely</td></tr>
<tr><td></td><td>When ρ = 8 to 12 kΩcm</td><td>Corrosion is possible</td></tr>
<tr><td></td><td>When ρ ≤ 8 kΩcm</td><td>Corrosion is fairly certain</td></tr>
</table>

8. Transfer of Electrical Resisitivity Data to a PC (Windows 2000 / XP / Vista)

Windows HyperTerminal is used to transfer the resistivity data to a PC via the INTERFACE RS232C port.

Preparing the Hardware

• Connect the serial port of the PC with the transfer cable (part no. 330 00 456) to the RS232 port of the indicating device. In case your PC hardware doesn't support serial ports you can use the USB converter (part no. 390 00 542).

Preparing the PC for the Data Transfer

• Create directory "C:\PROCEQ"
• **Windows 2000 / XP**   Start HyperTerminal via Menu:
  Start/Programs/Accessories/Communications/HyperTerminal
  If two items "HyperTerminal" are installed, start PC/phone Icon and choose "Hypertrm".
  Go to "Settings"
• **Windows Vista**   Install HyperTerminal from Internet:
  In case your operating system doesn't include a HyperTerminal application, you can download it from www.hilgraeve.com and install it.
  Go to "Settings"
• **Settings**
    – Do not install a Modem   Cancel with «No»
    – Enter "PROCEQ" and choose an Icon   Confirm with «OK»
    – Select line "Connect using e.g. Com1"   Confirm with «OK»
    – Change the default data to:
        Baud rate :   9600
        Data Bits :   8
        Parity :   none
        Stop Bits :   1
        Flow control :   Xon/Xoff   Confirm with «OK»
    – Check if you can not get line feeds:
      Open "file/properties/settings/ASCII-setup" und activate the checkbox
      "Append line feeds to incoming line ends".   Confirm twice with «OK»
    - Choose "transfer/capture text" in the menu and enter the complete path of the new file
      e.g. C:\PROCEQ\Data.txt in the dialog box.   Confirm with «Start»

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Start of Transfer
- Switch on the Indicating Device.
- Press "MENU" and select "Data Output"
- Select "Data to PC" as described in the operation instructions of the instrument.
- Start by pressing the button "START".

Data Storage in the PC
- Choose in the menu "Transfer/capture text/stop".

The data are stored in the file Data.txt and are ready for further processing.

Saving the HyperTerminal Settings
- Choose "File/Exit" in the menu.
- Answer the question "You are currently connected, you want to disconnect now?" with "Yes".
- Answer the question "Do you want to save the connection named PROCEQ ?" with "Yes".

Display and Processing the Data

The text file "Data.txt" in the folder "C:\PROCEQ" can be displayed with any text editor or word processing program. For editing and further processing of the data we recommend MS Excel.

9   Technical Specifications

General	
Temperature range:	0° to 60°C
Display:	128 x 128 pixel graphic LCD with backlight
Impedance:	10 MΩ
Memory:	Non-volatile memory for simultaneous storage of up to 235'000 potential measurements (980 pages @ 240 measurements each organised in up to 71 objects) and 5'800 resistivity measurements (24 object files / tables @ 256 measurements each)
Data Output:	RS 232 interface, with USB adapter
Battery Operation:	Six LR 6 batteries, 1.5V for up to:
	- 60 hours (or 30 hours with activated backlight) during potential measurement
	- 40 hours (or 20 hours with activated backlight) during resistivity measurement
Case Dimensions:	580x480x210 mm (22.8"x18.9"x8.3")
Weight:	Net. 10.6 kg (23.5 lbs); Shipping 14kg (31.1 lbs) (with rod and 1-Wheel Electrodes as well as Wenner Probe)
Potential Measurement	
Measurement range:	-999 mV to +340 mV
Resolution:	1mV
Electrodes:	Rod Electrode (copper/copper sulphate)
	1- and 4-Wheel electrode systems (copper/copper sulphate) with telescopic handle, integrated path measurement and water reservoir
Data Transfer:	CANIN ProVista software for downloading data and evaluation on PC
Resistivity Measurement	
Measurement range:	0 to 99 kΩcm
Resolution:	1 kΩcm
Resistivity probe:	Resistivity probe with integrated electronics for measuring the specific resistivity using the four-point method.
Nominal current:	180µA
Frequency:	72 Hz
Data Transfer:	by Windows Hyperterminal for analysis with third party software (e.g. EXCEL)

9.1 Technical Information CANIN ProVista software

System requirements: Windows 2000, Windows XP, Windows Vista

9.2 Standards and Regulations Applied

- BS 1881, Part 201   UK
- UNI 10174   Italy
- DGZfP B3   Germany
- SIA 2006   Switzerland
- RILEM TC 154-EMC   International
- ASTM C876-91   USA

$C\epsilon$

10 Part Numbers and Accessories

10.1 Complete Units

Part No.	Description
330 00 201	**Canin+ Configuration with Rod Electrode** **Basic equipment** Indicating device Canin+, carrying strap, protection sleeve for indicating device, transfer cable, USB-serial adapter, operating instructions, carrying case Canin+ **Rod Electrode accessories** Rod Electrode with spare parts, electrode cable 1.5m (4.9 ft.), cable coil 25m (82 ft.), CANIN ProVista PC software on memory stick, bottle with copper sulphate 250g,
330 00 205	**Canin+ Configuration with Rod and Wheel Electrodes** **Basic equipment (see item 330 00 201)** **Rod Electrode accessories (see item 330 00 201)** **Wheel Electrode accessories** 1-Wheel Electrode system, tool kit to wheel electrode system, bottle with citric acid 250g
330 00 203	**Canin+ with Wenner Probe** **Basic equipment (see item 330 00 201)** **Wenner Probe accessories** Wenner resistance probe with spare rubber foam pads, cable to Wenner Probe, control plate to Wenner Probe
330 00 206	**Canin+ Combined Configuration with Rod and Wheel Electrodes and Wenner Probe** **Basic equipment** (see item 330 00 201) **Rod Electrode accessories** (see item 330 00 201) **Wheel Electrode accessories** (see item 330 00 205) **Wenner Probe accessories** (see item 330 00 203)

10.2   Accessories

330 00 259	Canin+ Rod Electrode copper/copper sulphate
330 00 322	Telescopic extension for Rod Electrode, with 3 m cable
330 01 001	Canin+ 1-Wheel Electrode
330 01 004	Canin+ 4-Wheel Electrode
330 00 286	Cable coil, l=25 m (82 ft), with clamp (Required for potential measurements)
330 00 320	Felt hoop for Wheel Electrode Canin+
380 02 520	Canin+ Wenner Probe with cable
380 04 250	Test block for resistance-probe
330 01 224	O-Ring 120 X 5 mm
330 00 285	Copper sulphate 250g
330 00 290	Citric acid 250g
330 00 470	Protective sleeve for display instrument
330 01 225	Cable clip for telescopic extension
380 02 508 S	Foam pad to resistance probe, set of 4 pcs.

11   Maintenance and Support

11.1   Functional check of the electrodes

Correct function can be checked by use of a reference electrode.
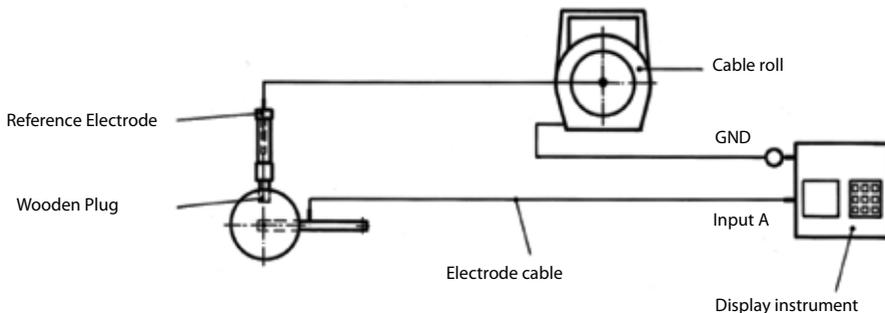
Fig 11.1 Functional control set-up

Fig 11.1 shows a wheel electrode under control. The Rod Electrode is used as reference electrode and the potential of the two electrodes cancel each other out. For correct operation, the tolerance values indicated below should be observed.

Tolerance values:

Reference electrode with Rod Electrode   0 ± 5 mV

Reference electrode with wheel electrode   0 + 20 mV

If the electrode is out of tolerance, clean it as described below and redo the functional test.

11.2   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 (See section 3.1)

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

11.3   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. (See 3.1)
- 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.

11.4   Functional check of the resistivity probe

See section 5.5. Assure that the Device Constant shown on the Indicating Device corresponds to the code engraved on the probe.

- Moisten the 4 foam rubber pads with water.
- Connect the probe with the RS232 interface of the indicating device.
- Power on. If necessary switch to "Wenner" mode. (See 5.3).
- Place the 4 foam pads on the 4 spots of the test plate.
- In the „actual" window the reading (e.g. $\rho = 12 \pm 1$ kΩcm.) appears. The value should be according to the one mentioned on the test plate.

If the value is outside of the tolerance, the instrument should be returned to Proceq for re-calibration.

11.5   Support Concept

Proceq is committed to providing a complete support service for this instrument by means of our global service and support facilities. It is recommended that the user register the product on www. proceq.com to obtain the latest on available updates and other valuable information.

11.6   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.

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