

GalvaPulseTM

Instruction and Maintenance Manual

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FORCE Technology
Park Allé 345
DK-2605 Brøndby

Phone: +45-43267000 Fax: +45-43267011

E-mail: concrete@force.dk

Internet: www.force.dk

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1. The GalvaPulse Kit

The kit is supplied in one suitcase containing, see photo 1.:

- 1.1. AT-Link Cable for data transfer to PC.
- 1.2. Measuring cable, banana-banana.
- 1.3. One calibration box including 9V battery.
- 1.4. PSION computer with installed FORCE software and attached electronic box containing the pulse generator (Calibrated and ready for testing).
- 1.5. Two sponges for electrode.
- 1.6. Handheld electrode with 3 meter of cable.
- 1.7. Two adjustable clamping pliers.
- 1.8. Reinforcement conductivity meter
- 1.9. Four spare AA batteries for PSION computer.
- 1.10. Operation Manual for the GalvaPulse™ equipment.
- 1.11. Chalk.
- 1.12. User manual for the PSION is supplied as a separate manual.
- 1.13. Cable drum with extension cable for reinforcement connection.

Extra needed on-site:

- 1.14. Electricity and an extension cable.
- 1.15. Drill hammer.
- 1.16. An accurate cover meter for locating the reinforcement.
- 1.17. A garden spray pump with sufficient amount of tap water.



Photo 1. The GalvaPulse kit

2. Introduction

The galvanostatic pulse measurement technique is a fast polarization technique for determination of the actual corrosion rate at the time of testing – the instantaneous corrosion rate. The technique was originally developed as Half-Cell Potential (HCP) measurements on wet and semi-wet constructions may be difficult to evaluate due to lack of oxygen. When Galvanostatic pulse measurements are performed the HCP, the Corrosion Rate and the ohmic Resistance are determined, all in one operation.

As default the equipment apply a current of 25 μA for 5 seconds. These values will in passive areas most often give a reasonable polarization of the reinforcement evaluated by the regularity of the polarization graph. Otherwise, the current has to be increased.

In active areas a current of 80-100 μA is recommended, again for 5-10 seconds. In very active areas currents up to 400 μA can be necessary to obtain a reasonable polarization. However, always try to use as low a current and time as possible to minimize the polarization of the reinforcement.

The recorded polarization curve has to exhibit a general shape as shown in Fig. 1; in principle, less steep at the beginning in passive corroding areas and steeper in active corroding areas.

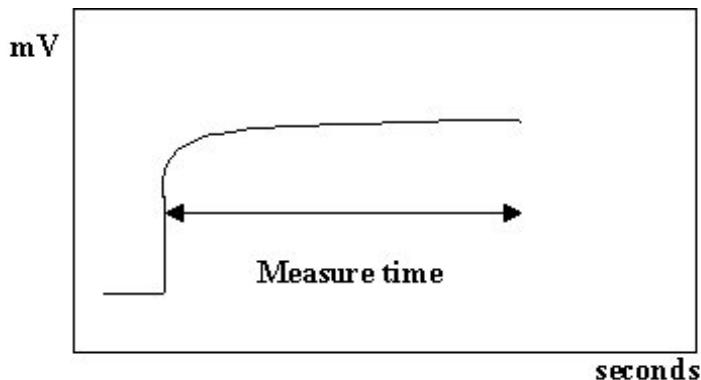


Fig. 1. Galvanostatic pulse response

The essential issue is that the graph, consisting of points, is increasing over time without a large scatter. A decreasing graph indicates a false reading, e.g. caused by a lack of electrical contact and will not be accepted by the equipment.

A large scatter may indicate bad connections and/or an insufficient current pulse.

At passive areas the polarization will change the original half-cell potential in the positive direction for some time. The half-cell potential recorded by the GalvaPulse will be prior to applying the pulse.

At active areas the original half-cell potential will maintain the same value, even after several galvanostatic pulses.

3. Operation instruction of the PSION computer

3.1. Detailed operation of the FORCE program

- a. Turn the PSION on by pressing the *On/Esc* key. Fig. 2.

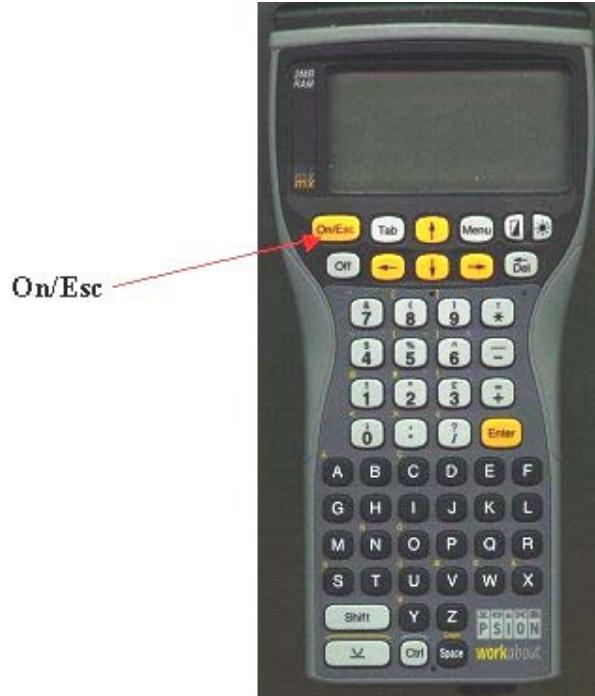


Fig. 2. The PSION computer

- b. Select the icon named FORCE using the yellow arrow keys and press *Enter*. Fig 3-4.

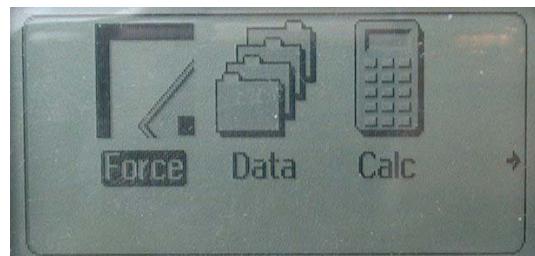


Fig. 3. Display while loading



Fig. 4. Display when ready

- c. Press the *Menu* key.
- d. To set the parameters of the instrument prior to a new set of readings select the *Settings* menu.

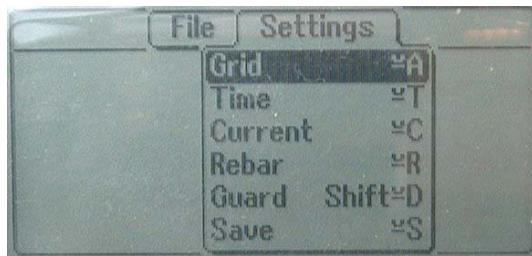


Fig. 5. Settings display, Grid

3.2. Selection of number and spacing of measurement points

- a. In the *Settings* menu the general settings for the measuring area can be changed. Fig. 6 shows the orientation of the X and Y parameters.

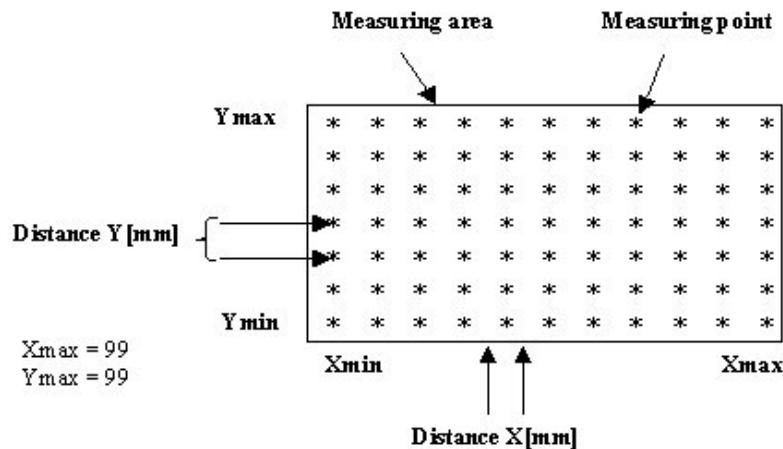


Fig. 6. Sketch of X and Y parameters.

- b. Select Grid and press Enter. Fig. 7.

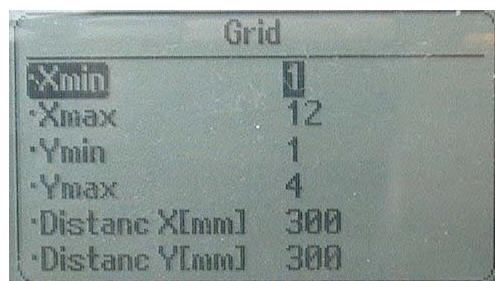


Fig. 7. Grid display

- c. Use the arrow keys to select the starting point in the X-direction, X_{min} and the last point in the X-direction, X_{max} (50 is default). Similarly set Y_{min} and Y_{max} (50 is default).
- d. If the total number of test points is not known use the default parameters. Only the grid points with data will be used later in the software.

- e. Set the distance between the measuring points in the X-direction, **Distance X [mm]** and in the Y-direction, **Distance Y [mm]** (300 mm is default for both directions)
- f. Press **Enter** when the parameters are set.

3.3. Setting pulse duration time.

- a. Press the *Menu* key. Fig. 8.

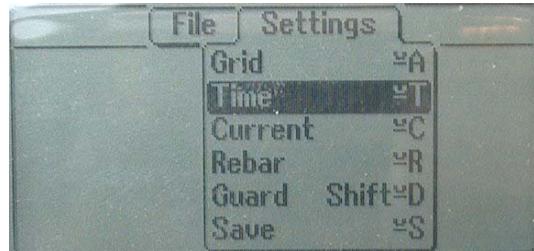


Fig 8. Settings display, Time

- b. Select *Time* and press the *Enter* key. Fig. 9.



Fig .9 Time display

- c. Enter the galvanostatic pulse time in seconds “Measure time[s]” and press *Enter*. 5 seconds is default. Maximum is 20 seconds.

3.4. Setting galvanostatic pulse current

- a. Press the *Menu* key to enter the settings menu. Fig. 10.

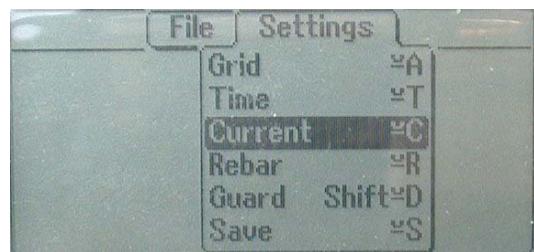


Fig .10. Settings display, current

- b. Select *Current* and press *Enter*. Fig. 11.



Fig .11. Current display

- c. Enter the galvanostatic pulse current “I measure [μA]” and press *Enter*. The range is from 5-450 μA . Default is 25 μA .

3.5. Setting the reinforcement parameters.

- a. Press the *Menu* key to enter the settings menu. Fig. 12.

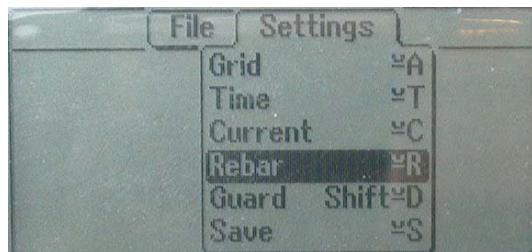


Fig .12. Settings display, rebar

- b. Select *Rebar* and press *Enter*. Fig. 13.



Fig .13. Rebar display

- c. Use the arrow keys to select “Diameter [mm]” and enter the reinforcement diameter. The range is from 2-100 mm diameter. Default is 16 mm diameter. Using the standard electrode system and the guard ring, the **Length** is default set to 70 mm, equal to the diameter of the electrode.
- d. If the Guard Ring is **not** used e.g. if the reinforcement is cut off at both ends, select **Length [mm]** and enter the actual length of the exposed reinforcement.
- e. Moving the cursor down to **Calc.area [mm²]** with the arrow keys the correct area will be calculated. Alternatively it is possible to enter the **Calc.area [mm²]** directly.
- f. Press *Enter* when the parameters are set.

3.6. Turning On/Off the guard ring system

- Press the *Menu* key. Fig. 14.

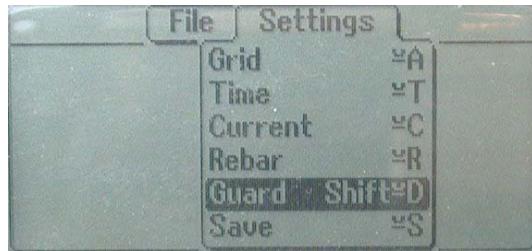


Fig .14. Settings display, guard

- Select *Guard* and press *Enter*. Fig. 15.

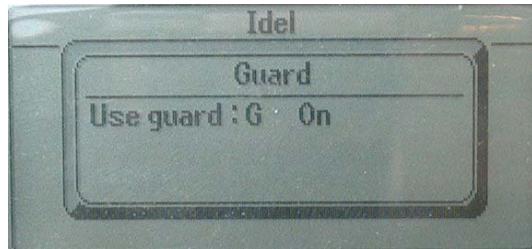


Fig .15. Guard display

- Turn the Guard Ring on/off by pressing the *G* key on the keyboard.

- Press *Enter*.

3.7. Save the settings

- Press the *Menu* key Fig. 16.

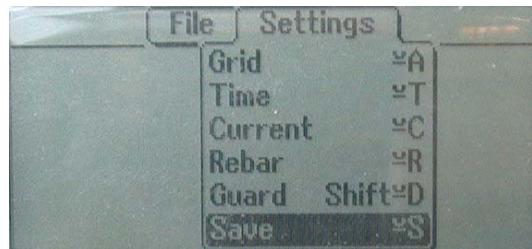


Fig .16. Settings display, save

- Select *Save* and press *Enter*.

All information is now saved in the memory and will be the default parameters for all future measurements until the settings are changed again.

It is possible to change the parameters for an individual measuring position during testing as described in section 3.12.

3.8. Calibrating the instrument

The instrument is calibrated at delivery, ready to be used, and should NOT be re-calibrated, unless:

- The FORCE program has to be re-installed and the software gives the message: “General settings not saved” or “No calibration file exist, please do calibrate”
- The ambient temperature has been very extreme, affecting the stability of the electronics. Extreme temperatures are less than -10°C or more than $+60^{\circ}\text{C}$

NOTE: Should the calibration not be performed correctly the measured values will be out of range.

If calibration is required the following setup of the equipment and procedure has to be applied to:



Fig 17. PSION and calibration box connected ready for calibration

The calibration procedure is as follows.

- a. Connect the calibration box to the PSION. Fig. 17.
- b. Check that the battery inside the calibration box is fully charged, 9V.
- c. Turn on the PSION. Select the FORCE program and press *Enter*
- d. Press the *Menu* key and select *Settings*.
- e. Use the down  key to select the *Calibrate* option. Fig. 18. (The *Calibrate* option is located below the *Save* option and will be visible when moving the cursor down through the menu).

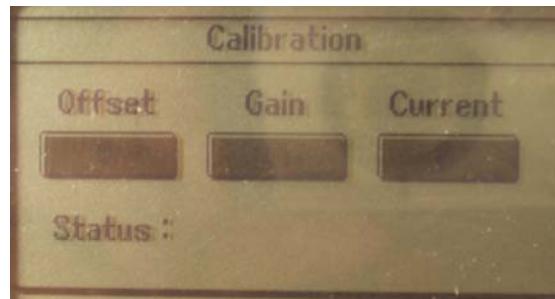


Fig. 18. Calibration display

- f. Make sure the on/off switch on the calibration box is in the OFF position and the Gain/Curr. switch is in the Gain position. See Fig. 19.



Fig. 19. Calibration box

- g. Press the letter *O* on the PSION keyboard. The Offset is calibrated and the calibration is confirmed with the message “Offset calibrated” in the display.
- h. Set the on/off switch in the ON position.
- i. Press the letter *G* on the PSION keyboard. The Gain is calibrated and the calibration is confirmed with the message “Gain calibrated” in the display.
- j. Leave the on/off switch in the ON position and set the Gain/Current switch in the Current position.
- k. Press the letter *C* on the PSION keyboard. The Current is calibrated and the calibration is confirmed with the message “Current calibrated” in the display.
- l. Reset the on/off switch to the OFF position.
- m. Press *Enter* and the PSION-computer have been calibrated.

3.9. Create a new file for storage of the readings

Since Pulse software version 3.1, April 2001, it has been made possible to make Galvanostatic Pulse measurements as well as Half-Cell Potential measurements separately. Therefore there are two options when making a new file depending on what type of measurement is required, GalvaPulse or HCP. Both options are described below.

- a. Open the FORCE program and press the *Menu* key.
- b. Select the *File* menu. Fig. 20.

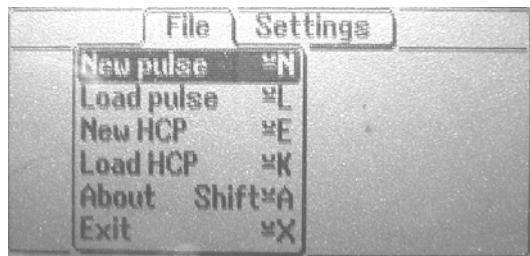


Fig. 20. File menu display

- c. Select "New pulse" or "New HCP" and press *Enter*. Fig. 21.

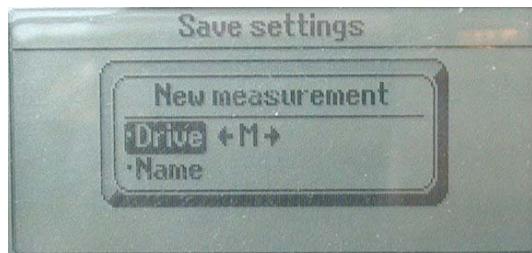


Fig. 21. File menu display, Drive

- d. Select Drive $\leftarrow M \rightarrow$ by using the left arrow or the right arrow. The M-drive is equal to the hard disk of the PSION. Approximately 15.000 readings can be stored on the M-drive. Alternatively data can be stored on a FLASH-card. The PSION contains two slots, A and B. The A-drive is used for a 128 KB FLASH-card where a backup of the FORCE program is installed.
- e. Enter a Name by using the **▼** key and write the file name (max. 8 letters or numbers can be entered. **NO** symbols or space can be used). Fig. 22.



Fig. 22. File menu display, Name

- f. Press *Enter* when ready for measuring. Go to measuring procedure, section 3.11.

3.10. Load an old file

To load an existing file (Pulse or HCP) for taking up measuring again or to look at data the following procedure is used:

- a. Press the *Menu* key. Fig. 23.

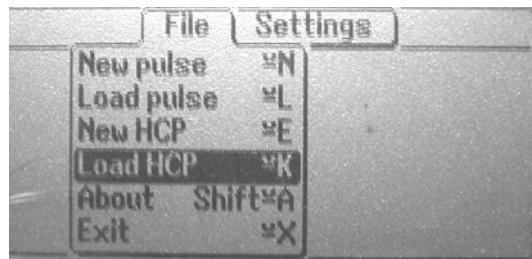


Fig. 23. File menu display

- b. Select the *File* menu. Fig. 24.

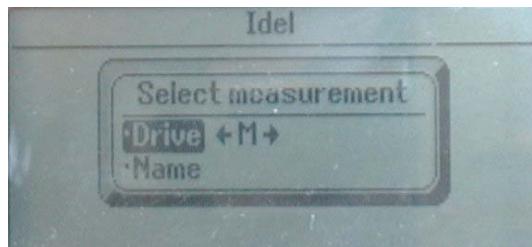


Fig. 24. File menu display

- c. Select *Load pulse* or *Load HCP* and press *Enter*.
- d. Select Drive $\leftarrow M \rightarrow$ by using the \leftarrow or \rightarrow keys.
- e. Use the \downarrow key and select Name. Select the file in question using the \leftarrow or \rightarrow keys. Fig. 25.



Fig. 25. File menu display, Name

- f. Press *Enter* to open the existing file to view the data and/or to continue measuring.

3.11. Measuring with the Galvanostatic Pulse technique.

General description of “readings display”. Fig. 26.

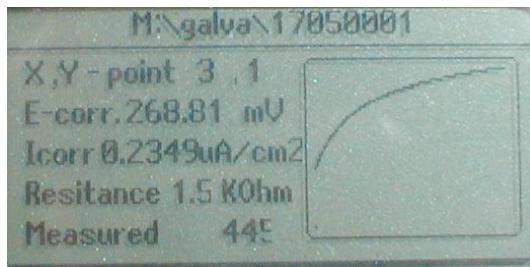


Fig. 26. Reading's display

The bottom status line shows the status of the current action of the equipment whether a reading is “Not measured”, the equipment is “Measuring” or a reading has been “Measured”.

While measuring the readings will be counted and displayed at the bottom of the display. The results of the HCP-value (E-corr.), the Corrosion Rate (Icorr) and the Resistance are displayed in mV vs. Ag/Agcl, μ A/cm² and kOhm.

The actual reinforcement potential response to the galvanostatic pulse is plotted in the plotting area. The parameters of the plot can be changed as follows:

- Press the *Menu* key.
- Select the *Action* menu Fig. 27.

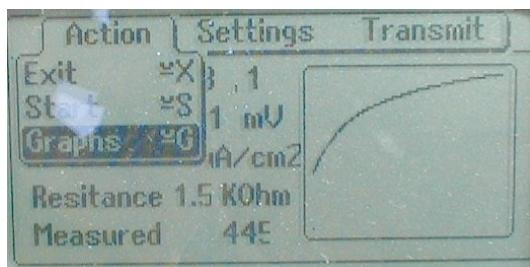


Fig. 27, Selecting the graph option

- Select *Graphs* and press *Enter*. The Setup graphs display will appear. Fig. 28.

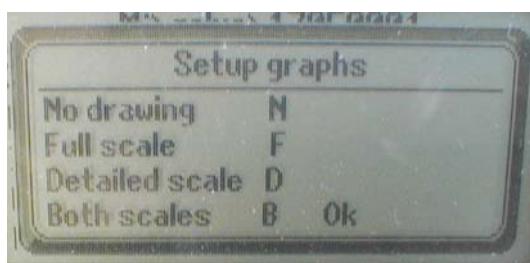


Fig. 28, Graph options

- By pressing the *N* key no graph will be plotted. This option is chosen to cut down time between the measurements. By pressing the *F* key the complete pulse including E-corr, IR-drop and polarization is plotted.
- By pressing the *D* key only the polarized part of the pulse is plotted.

- f. By pressing the *B* key both the detailed and the complete plot are shown in the same window. This is the default setup.
- g. The **←**, **→**, **↑** and **↓** keys change the coordinates of the measuring points in the X and Y directions from start point to end point (X-point, Y-point)
- h. The *M* key starts the measurement.
- i. The *N* key clears the plot area
- j. The *R* key redraws the data plot

NOTE: If a new measurement is made at the same X, Y point as a previous measurement, the data from the previous measurement will be replaced and is lost.

Should the quality of a measurement not be accepted a pop-up menu is displayed as shown below saying: "Please make a new measurement". To redo the measurement, press *Enter* and repeat the measurement by pressing the *M* key. Fig. 29.

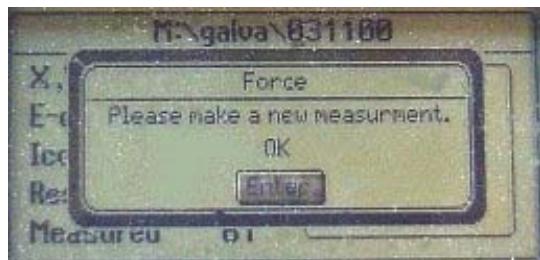


Fig. 29. Error message due to poor quality of data

If the message appears again, move the electrode to a new spot, a few centimetres from the first reading and try again. If the message appears once more wet the surface again and wait some time before a new measurement is made. Alternatively the current could be increased by e.g. a factor 2, see section 3.12.

3.12. Changing settings at a single measuring point

If the performed measurement is not satisfactory it is possible to change the setting at the particular measuring point.

- a. Press *Menu*, select *Settings* and press *Enter*.
- b. Proceed from section 3.3, page 6.
- c. The new settings are automatically saved for this X, Y measuring point, only.
- d. When all measurements are performed press *Menu*, select *Exit* and press *Enter*.

It is advised always to leave the PSION in this state when shut off while it not is Possible to lock the keyboard and it is therefore possible to perform measurements accidentally.

3.13. Exit

- a. Press *Menu* and select *Action*.
- b. Select *Exit* and press *Enter*. It is safe to leave the PSION in this state.
- c. Press *Menu* and select *File*.
- d. Select *Exit* and press *Enter*.
- e. If the PSION is turned OFF, it will start with the same display next time it is turned ON.

3.14. Measuring with the HCP technique.

General description of “readings display”. Fig. 30.

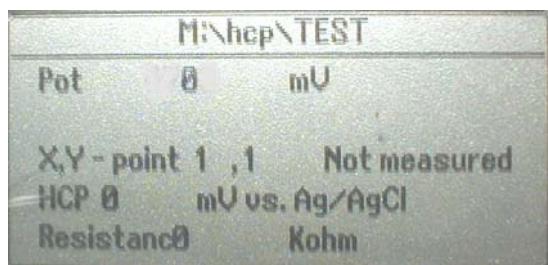


Fig. 30. Reading's display.

- a. At the top line the actual potential is displayed in mV vs. the Ag/AgCl reference electrode. The equipment is measuring continuously until a reading is taken.
- b. At the next line the X, Y position is displayed as well as the status of the measurement.
- c. At line 3 the HCP measurement is displayed after a reading is taken.
- d. At the bottom line the resistance between the electrode system and the reinforcement in KOhm is shown after a reading is taken.
- e. When the potential is steady press the letter *M* on the PSION keyboard and the potential and the resistance will be displayed. The status will change from "Not measured" to "Measured".
- f. It is now possible to perform a new measurement at the same point or to use the Arrow keys to move to the next position in the grid.
- g. When all measurements are performed press the *Menu* key, select *Exit* and press *Enter*.

4. Preparation before testing on-site

4.1. Connection to reinforcement and reinforcement continuity

The reinforcement has to be electrically connected in the area to be tested and the electrical connection from the equipment to the reinforcement has to be made properly.

Should the reinforcement be exposed, the adjustable clamping pliers are most easily used for connection at two locations, e.g. opposite corners of the testing area. Make sure there are metallic connections between the reinforcement and the clamping pliers.

The procedure for testing the electrical continuity of the reinforcement is as follows:

- a. Two connections have to be made at the periphery of the area to be tested.
- b. Locate the reinforcement by means of a CoverMeter/reinforcement locator.
- c. Expose the reinforcement e.g. by means of a drill hammer or a hammer and chisel in two positions most far apart across the measuring area.
- d. Attached the adjustable clamping pliers to the reinforcement. Make the connections very tight.
- e. Connect the conductivity meter to the two pliers with the cable of the cable drum in between (max. 15 meter, length of cable in cable drum).
- f. Turn the meter on by switching it to the "Diode" function,  , adjacent to the 200 ohm position. The reading has to be zero or close to zero. Alternatively, the 200 ohm position may be attempted. For a good electrical connection, the reading has to be close to zero. Higher values indicate a bad electrical connection; either caused by a lack of reinforcement connection, or by the adapter bolts connections. A lack of reinforcement connection can only be detected by repeated drilling at various distances from the first drilled two holes.

4.2. The reinforcement area below the counter electrode

The diameter of the reinforcement below the counter electrode needs to be measured or estimated. For such estimation an accurate CoverMeter, which is able to measure the diameter of the reinforcement, ca be used. Alternatively the diameter of the reinforcement is measured in one of the locations where the clamping pliers are attached.

For active corroding reinforcement caused by chlorides the area of corrosion may be (much) smaller than the area of the reinforcement. To estimate such pitting areas, the concrete cover should be removed at a couple of locations, e.g. by coring.

4.3. Wetting the surface

To reduce the electrical resistance between the electrode placed on the surface and the reinforcement, wetting can be done according to ASTM C876-91. Such wetting should be done uniformly at every testing point in the grid. In general, it is recommended to wet three times every 15 minutes before measurements starts out, otherwise diffusion potentials and change in resistivity may disturb the measurements.

The polarization curve will show different behaviour when wetting is not sufficient/resistance in the concrete is too high. Two typical examples are given below showing a potential drop due to too high concrete resistance. Fig. 31-32.

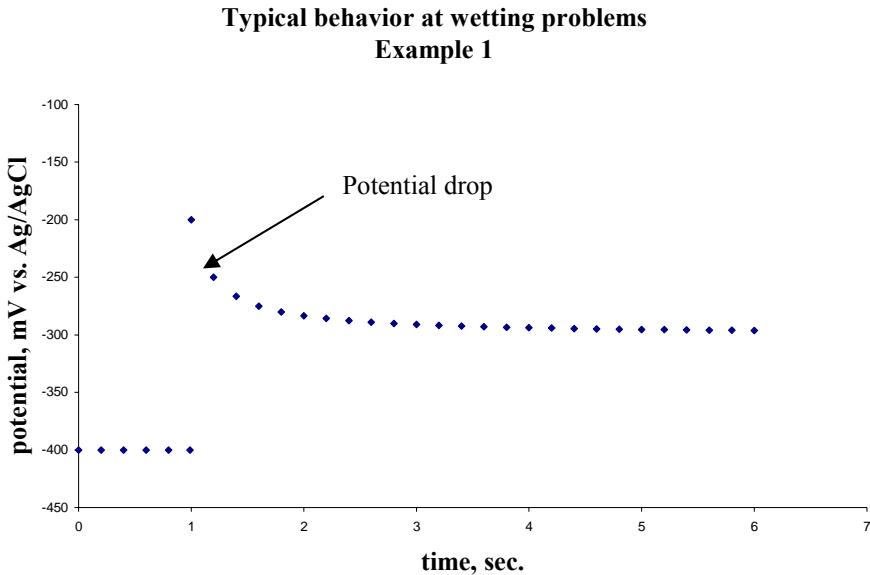


Fig. 31. Wetting problems

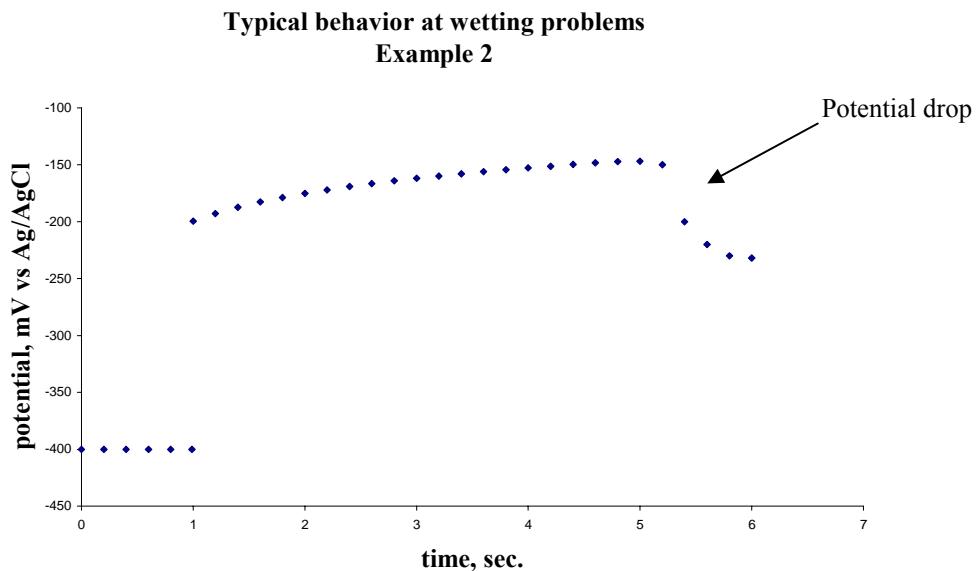


Fig. 32. Wetting problems

To check the effect of the wetting, the electrical resistance may be used. To obtain corrosion rate measurements the electrical resistance has to be lower than about 50 kOhm.

An example: If the resistance is changed 1 kOhm while the reinforcement is polarised an applied current of $25\mu\text{A}$ will result in a potential drop of 25 mV. At the same time the equipment is trying to increase the potential of the reinforcement.

NOTE: In case of presence of delaminations, membranes or a very dry or dense cover the resistance will be so high that the corrosion rate estimate is wrong since the pulse generator cannot apply the pulse current. Performing GalvaPulse measurements under such conditions makes no sense. Such conditions are most efficiently evaluated by means of the electrical resistance only.

The output voltage of the GalvaPulse electrode system is approximately 6.5 Volt. Using Ohms law $U=R*I$ where U = voltage, I = current and R = resistance makes it possible to calculate the maximum possible applied current at different resistances. Fig. 32.

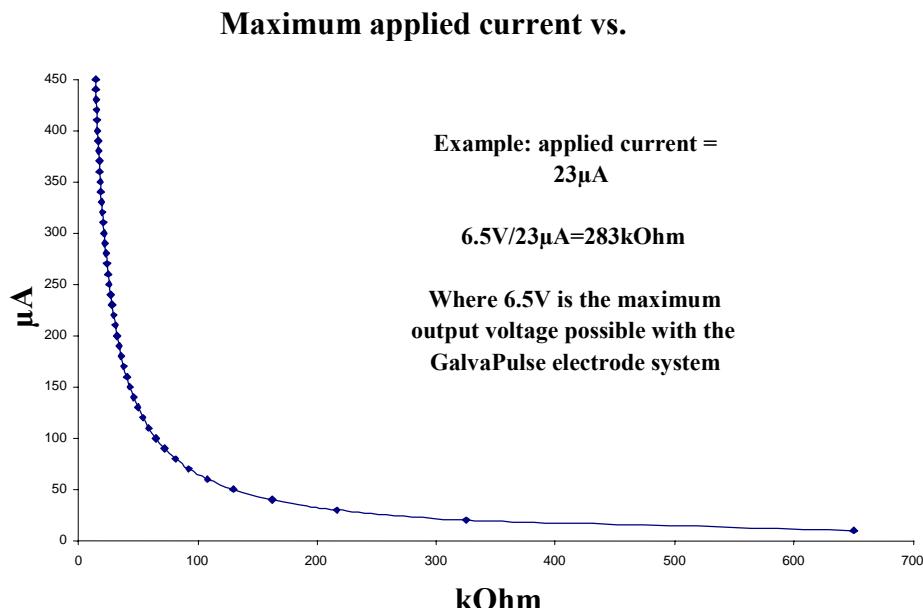


Fig. 32. Relation between voltage and applied current

4.4. The reference electrode

The reference electrode used is an Ag/AgCl electrode. The Ag/AgCl electrode measures 110 mV higher at 20°C than a Cu/CuSO₄ cell as mentioned by ASTM C 876-91. If e.g. a reading with the Ag/AgCl shows -250 mV, the corresponding Cu/CuSO₄ measurement would be -360 mV.

4.5. Selecting the proper measuring method

GalvaPulse (GPM) measurements are valuable inputs for service life estimations and contribute to optimise the planning of the maintenance thus saving money on repair.

Half-Cell Potential (HCP) measurements are approximately 5 times faster to perform than the GalvaPulse measurements. Therefore on dry and semi-dry structures it is an advantage to use the HCP to locate the corroding areas. After the areas with corrosion has been detected use the GalvaPulse for further evaluation of the corrosion activity.

On wet chloride induced structures the GPM is the only method, which can be used to locate corroding reinforcement, as the corrosion products will not cause cracking of the cover layer. In such cases the corrosion can proceed without being noticed for years.

Both methods (HCP and GPM) must be verified with chemical analysis (e.g. chloride content) and excavations to the reinforcement in some locations.

On the next page recommendations on where the methods can be used with advantage is shown. See Table 1.

Concrete condition		HCP	GalvaPulse	Remarks
Un-treated Dry, semi-wet	Carbonated	?	Yes	Due to low pH corrosion is possible at higher potentials
	Chlorides	Yes	Yes	
Un-treated Wet	Carbonated	?	Yes	Exceptional combination
	Chlorides	?	Yes	Corrosion or lack of oxygen?
	Washed Out	?	Yes	Due to low pH corrosion is possible at higher potentials
Surface treated Dry, semi-wet and wet	Bitumen	No	No	Electrically insulating
	Epoxy	No	No	Electrically insulating
	Miscellaneous	?	?	Depending of resistance
Inhibitor treated	Mixed in	No	Yes	Inhibitors can change the potential
	Surface	No	Yes	Inhibitors can change the potential
Delaminated/cracked	Treated	No	No	
Miscellaneous				
Coated Rebars	Epoxy	No	No	Electrically insulating

Table 1. Overview of where the HCP and GalvaPulse method can be used.

5. Testing

When the electrical connection to the reinforcement is established, the PSION computer is connected to one clamping plier by means of the banana - banana cable and the cable drum. The electrode is also connected to the PSION.

Turn on the computer and follow the instructions from section 3 on how to set up the computer.



Fig. 33. Bottom of electrode with red plug attached

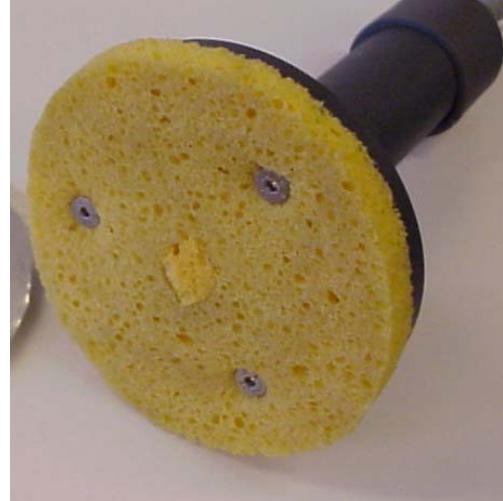


Fig. 34. Sponge and centre sponge attached to the electrode



Fig. 35. Connection cable, electrode and GalvaPulse computer

The red plug at the bottom of the electrode is removed and the centre sponge is wetted with tap water. The sponge should rest in its natural position – sticking approx. 10 mm out of the electrode head. Fig. 33.

The large sponge, with the three holes, is also wetted and attached to the electrode using the three holes matching the screws of the electrode. The sponges need to be wetted regularly during testing. Fig. 34.

Attach the cable to the electrode and the GalvaPulse computer. Fig. 35.

Lay out the grid on the testing surface. **For accurate measurements the grid points have to be positioned above the reinforcement. Should measurement be needed where bars are crossing, the additional reinforcement area has to be taken into account (GPM).**

If needed spray water on the testing point as outlined in section 4.3.

Press the electrode firmly against the surface on the first testing point. The three attached screws in the electrode plastic disk have to rest against the surface and the electrode kept completely steady as long as the “counter” on the display of the PSION is running. Fig. 36.

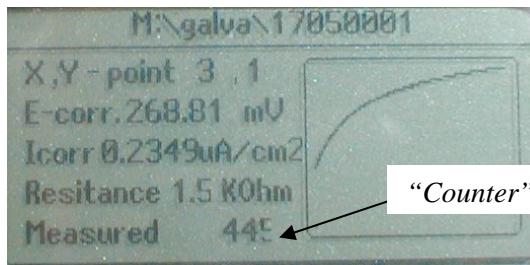


Fig. 36. If the “Measure time” display

The potential is measured 10 times every second. When the “counter” stops the measurement has been taken and it is safe to remove the electrode to a new position.

The record is stored in the file created when an arrow key is activated to move to a new testing point on the PSION keyboard.

6. Practical steps on-site after testing

From the examination of the data additional testing may be decided upon, e.g. for making repeated measurements in a smaller grid, chloride analysis, carbonation, impact-echo, strength testing and coring.

Where high apparent corrosion rates are found the reinforcement has to be visual inspected at a couple of locations to measure the actual reduction of the cross-section.

7. Transfer of data to a PC for examination or for reporting

The data collected in a file is most easily exported to a spreadsheet using the supplied “GalvaPulse” PC program found on the enclosed CD ROM. The instruction for this program is described in section 8.

It is recommended to make backup and delete old data in the PSION computer regularly to avoid loss of data in case of data-overflow. See **Appendix B** for detailed instructions.

The raw data from the PSION can be transferred to a PC using the Hyper Terminal in Windows, as described below.

7.1. Transferring data by using the Hyper Terminal

- a. To transfer data from the PSION to a standard PC use the supplied cable and connect it to the RS 232 terminal of the PSION and a com-port on the computer.
- b. If the program Psiwin2.1 is installed to your PC make sure to deactivate it. It will block the com-port.
- c. Prepare the PC for receiving data (WIN 95/98 and WIN 2000)
- d. Select at the PC start/programs/Accessories/Communications/Hyper Terminal and press enter.
- e. Double click the Hyper Terminal Icon.
- f. Make a new connection and call it PSION.
- g. Select Direct to COM 1 - if the cable is connected to COM 1on the PC.
- h. Press OK. At port setting select 9600 Bits per second, 8 Data bits, No parity, 1 stop bit and Hardware flow control.
- i. Press OK.
- j. Select Transfer menu and select Receive File.
- k. The PC is now ready to receive data from the PSION. (If there is no HyperTerminal program installed in the PC it can be installed from the Windows installation CD-ROM).
- l. Load the data set to be transferred at the PSION (section 3.10, page 11) and press *Menu*.
- m. Select the *Transmit* Menu at the pulse data set.
- n. Select *Measure data* and press *Enter*. The raw data from the measurement at point X, Y will now be transmitted to the PC. These data has to be converted to Volts by this conversion formula: $V=-(-15,5 \cdot X / 65535 + 1,085)$ where the X is the raw data. There is always 100 msec between two readings.
- o. Select *Data set* and press *Enter* and all E-corr, I-corr and resistance data from the file will be transmitted.
- p. **NOTE: The units for the corrosion rate data will be $\mu\text{A}/\text{cm}^2$.**

7.2. For transmitting data from HCP measurements

- q. Load the data set to be transferred at the PSION (section 3.10, page 11) and press *Menu*.
- r. Select the *Transmit data set* at the HCP data set and press *Enter* and all the HCP and resistance data will be transmitted to the connected PC.

8. GalvaPulse PC program

The GalvaPulse PC program is a small program used for exporting the recorded measurements from your GalvaPulse instrument and in to an Excel spreadsheet, allowing further analysis and presentation of data. The use of the program is described in the following.

8.1. Installation on PC

To install and start the GalvaPulse PC program follow the steps below:

- a. Insert the enclosed CD ROM in the CD drive of your PC.
- b. Using the “Windows Explorer” go to the folder “GalvaPulse PC” on the CD ROM.
- c. Double click on the file “setup.exe” and follow the instructions on the screen. The message “GalvaPulse setup was completed successfully” will appear on the screen when installation is complete. Click “OK” to close the installation session. The GalvaPulse PC program is now ready for use.
- d. To start the GalvaPulse PC program use the “Windows Explorer” and locate the file “GalvaPulse.exe” (Typically found in C:\Program Files\GalvaPulse). Double click on the “GalvaPulse.exe” file. The program window shown in Fig. 37 should now appear

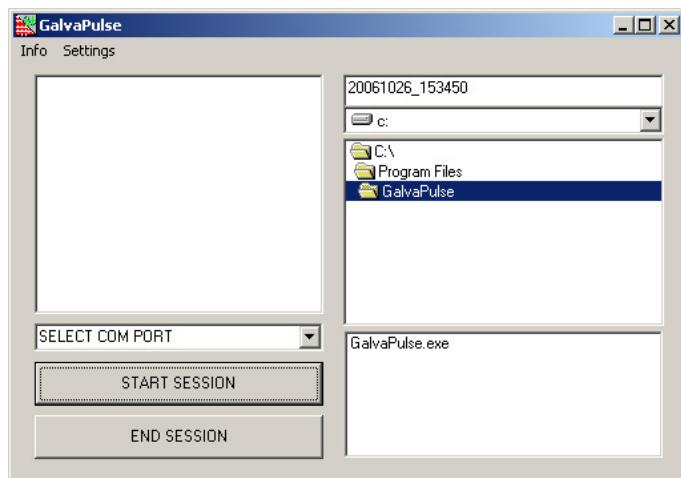


Fig. 37. The GalvaPulse PC program window.

8.2. Exporting data from the GalvaPulse instrument

The following section describes how to export data from the GalvaPulse instrument into an Excel spreadsheet where data can be further analysed and e.g. presented in iso-potential plots. The procedure is as follows:

- a. Start the GalvaPulse PC program as described in section 8.1
- b. Connect the PSION to the PC as described in section 7.1 a. In the GalvaPulse PC program window select the used COM port from the “SELECT COM PORT” list.

- c. When the GalvaPulse PC program is opened a default file name based on date and time is created (yyyymmdd_hhmmss) and inserted in the uppermost text field on the right side of the program window. The file name may be changed by the user if e.g. a more describing file name is desired.
- d. The location to where the data should be stored is selected from the drop-down menu (selection of drive) and the list below the menu (path to folder). See Fig. 37.
- e. Press the *Settings* menu. A pop-up box for grid settings will appear. Enter the horizontal and vertical distance between the measurements in centimetres and select the preferred orientation of the coordinate system. To use the entered values tick the box “Use Absolute Grid” and click *OK*. See Fig. 38.
- f. Press the *Start session* button in the GalvaPulse PC program window. The program is now ready for receiving data from the GalvaPulse instrument.

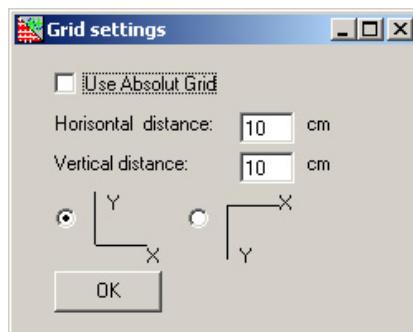


Fig. 38. The GalvaPulse PC program window.

- g. Export the data from the PSION as described in section 7.1, l – r. The transfer status of the GalvaPulse PC program is shown in the text box on the left side in the program window. After exporting the data press the *End session* button in the program window.
- h. An Excel file with the default or the user specified file name containing the transferred data should now appear on the selected location. The GalvaPulse PC program can now be closed.
- i. The data in the Excel spreadsheet can now be analysed and plotted as desired by the user. The values in the Excel spreadsheet is given in the following units:
 - Half-Cell Potential: mV vs. Ag/AgCl.
 - Corrosion rate: $\mu\text{A}/\text{cm}^2$.
 - Resistance: kOhm.

9. Maintenance

9.1. The PSION computer

The only maintenance of the PSION is to renew the two main batteries before a full day of testing is commenced. The Lithium back-up battery needs to be renewed approximately every 2-3 years.

The PSION should be cleaned after every use with a damp cloth only using mild soap and water. Make sure that the PSION is dried with a soft dry cloth after cleaning.

Make sure either of the batteries (the set of two main batteries or the back-up battery) are functioning and in-place when the other is replaced, otherwise the FORCE program will be lost and has to be reinstalled, see **Appendix A**.

9.2. The electrode unit

Remove the sponges from the electrode unit after the investigation is finished. Clean both with tap water and squeeze them, gently. Place them in the suitcase adjacent to the electrode unit. Do not place them in a sealed plastic bag; this will only cause that they over time might rotten. Do also not leave them on the electrode. This will cause the electrode rings to corrode and the lifetime of the electrode will be shortened.

The reference electrode positioned inside the electrode unit is long lasting and needs no special maintenance. Nevertheless the electrode is protected from dust and drying out by installing the red plug with a moist sponge.

The rings positioned in the circular plastic part of the electrode unit needs to be inspected before storage. If they are corroded they need to be grinded to a smooth finish using emery clothe. Flush afterwards with tap water and dry with a soft cloth. Do not use any other material.

9.3. Battery Replacement

The PSION computer contains two main batteries (1.5 Volt, size AA Alkaline) and a back-up battery (3 Volt, Lithium R 16 battery CR 1620).

To replace the batteries remove the D-connector with the cable from the pulse generator and press the black knob on the backside of the PSION. The released tray containing the batteries will emerge. Pull it gently out, fully.

NOTE: Do not remove the two main batteries and the back-up battery at the same time. If this is done, the FORCE program and the data on drive "M" may be lost.

It is recommended to replaces the two main AA batteries in the PSION computer before one full day of measuring. This is to make sure no malfunctioning of the computer occur. The low battery warning is displayed to late on the PSION display since the PSION terminal is not as sensitive to "low" batteries as the pulse generator. Low batteries will generate results out of range. A large scatter of the points in the polarization graph(s) detects such results, which normally are regular curves.

Replacing batteries:

Main batteries: To avoid loss of data or applications, leave the backup battery in when changing the main batteries.

Backup battery: To avoid loss of data or applications, leave the main batteries in when the backup battery is changed.

The location of the batteries is shown in the Fig. 39.

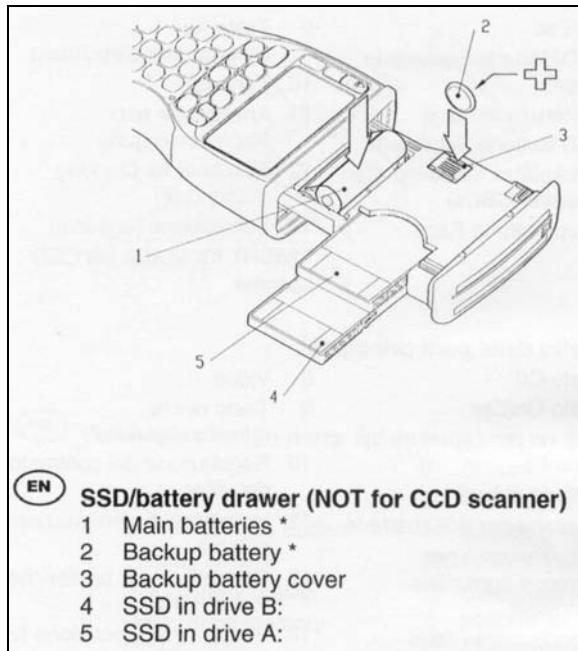


Fig. 39. Location of batteries in PSION

Note: When replacing the backup battery make sure that the positive terminal of the backup battery (the flatter of the two sides and marked with a “+” symbol) faces towards the outer edge of the PSION as it is inserted. There is a risk of explosion if Lithium batteries are inserted.

10. Emergency recovery of PSION

If the PSION blocks or the FORCE icon has disappeared from the main screen the recovery procedure is as follows:

- a. Press at the same time the following keys: Ctrl, \cup and Del and the PSION will restart. Wait for the computer to restart and for the following screen to appear. Fig. 40.



Fig. 40. Startup screen on PSION

- b. Press *Menu* and select System screen.
- c. Press *Enter*.
- d. Press *Menu* and select *Apps*
- e. Select *Install* and press *Enter*.
- f. Select the “Disk Internal” (default) or alternatively **Disk \leftarrow A \rightarrow** , which contains a backup of the FORCE program should it be lost from the M-drive.
- g. Select File: Name \blacktriangleleft BRUGER.app \triangleright and press *Enter*.

The FORCE program will now be installed and the FORCE icon will appear on the display.

NOTE: Should the calibration be lost a message will appear on the display the first time the program is started. The calibration procedure is described in section 3.8.

Appendix A

Updating or reinstalling the software in the PSION computer

If the FORCE-program has to be updated the following procedure is used. To update the software in the PSION a computer with a CD-drive is needed as well as the RS232 cable with female plugs in both ends.

1. A program (Psiwin2.1) used to communicate with the PSION has to be installed on your PC before the software on the PSION can be updated.
2. Insert the supplied CD-ROM in the CD-drive of your computer
3. Double click on the icon “my Computer” on your desktop
4. Double click on the CD-drive.
5. On the CD-ROM supplied you will find a folder with the name psiwin21english.
6. Double click on the icon with the name psiwin21english.
7. Double click on the icon with the name disk1
8. Double click on the icon with the name Setup (the icon with the blue screen) to start the installation
9. Follow the instructions on the screen to complete the installation.
10. After the installation don't remove the CD as it contains the software, which have to be transferred to the PSION computer

When you turn on the PSION the screen is showing icons with the name DATA, Calc, etc. First you have to check if the PSION is set up correct for transfer of data.

11. Press MENU
12. Chose the Spec-menu with the arrow keys (all the way to the right)
13. Chose Remote link with arrow-down keys and press Enter
14. The Remote Link has to be set to ON, Use the arrow left/right key to set the on/off
15. With arrow down you can chose the baud rate. Set the baud rate to 115200 by using the arrow left/right keys
16. With arrow down you can chose the Port. Set the port to ← A →
17. Press Enter

Now the PSION has to be connected to a PC with the serial cable. The cable is connected to the PSION in the RS232 plug and to the PC in a com-port.

When the PsiWin software has been installed an icon with the name "My PSION" is shown on the desktop. Double click this icon now.

1. To set up the proper connection chose File and Properties and the following window is shown. Fig. A1.

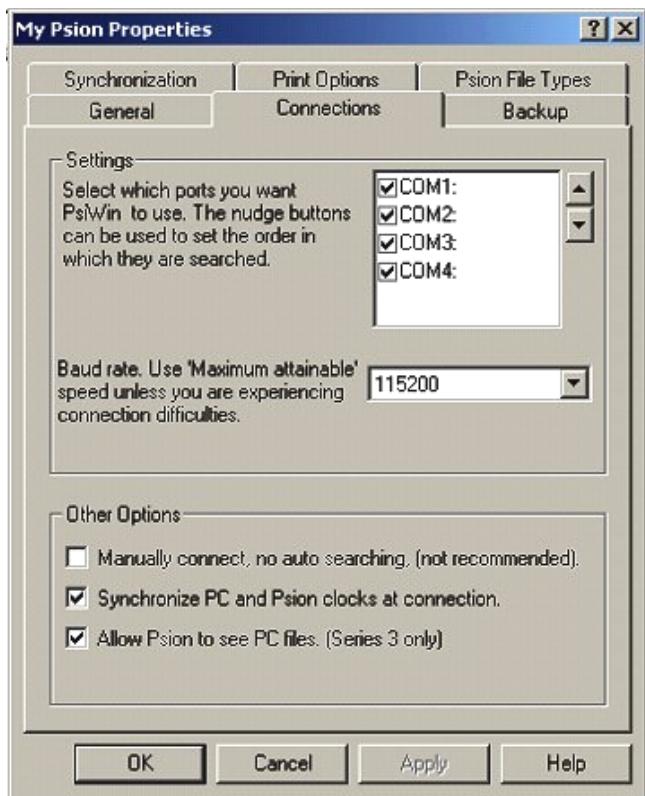


Fig. A1, PSION setup

2. Make sure the Baud rate is set to 115200 and all the COM-ports is market as shown in the figure above. Press OK.
3. The icon "Not connected" is shown on the screen, double click this icon.
4. After 5-10 seconds the connection should be established and you can see the M-drive of the PSION. You can also see if the connection is established, which is indicated by a small icon in the lower right corner of your screen. When the "My Psion" icon is double clicked an ↔ icon is shown. Once the connection is established it will change into a waveform.
5. Now double click on the M-drive-icon to see the content of the M-drive on the PSION.
6. To update the FORCE-program the folder APP has to be updated.
7. Make sure the CD-ROM is in the CD-drive
8. Double click on the icon “my Computer” on your desktop
9. Double click on the CD-drive.
10. Point at the APP folder with the mouse, click with the left button and hold the button down
11. Now drag the file down to the bottom of your screen where you have the minimized “beam” showing the M-drive of the PSION
12. The window of the M-drive will be maximized after 1 second
13. Release the button and the program will be copied to the PSION computer. Accept to overwrite the existing files if asked.
14. Turn off the computer and disconnect the PSION.

15. Follow the procedure in the manual for Emergency recovery of PSION, page 19 to install the FORCE-program again.

Appendix B

Backup and delete data in the PSION computer:

It is recommended to make backup and delete old data in the PSION computer regularly to avoid loss of data in case of data-overflow.

1. The program PsiWin supplied on the CD with the equipment has to be installed on the computer being used for backup or deleting data.
2. Connect the PSION computer to com1-port on the PC with the RS-232 cable.
3. Turn on the PSION computer and press the MENU-button.
4. Choose SPEC in the menu and select the REMOTE LINK and press Enter.
5. The Remote Link shall have the following setup:
 - i. Remote Link: ON (Press the → to change between on/off)
 - ii. Baud rate: ← 115200 →
 - iii. Port: A
6. Pressing ENTER saves the settings.
7. The PSION is now ready to communicate with the computer.
8. Once the PsiWin software is installed an icon will be shown on the desktop with the name “My Psion” (see icon to the right). Double click the icon and the window shown below will appear. Fig. B1

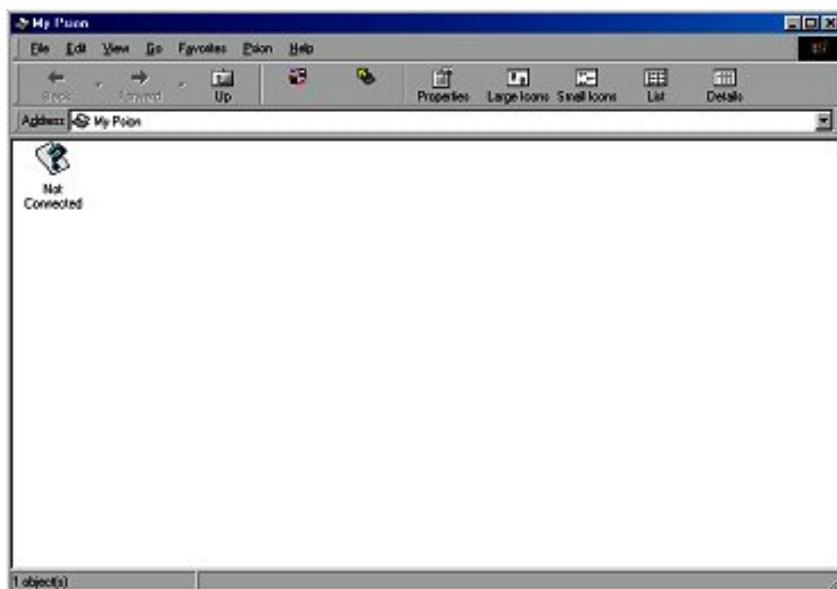


Fig. B1. Startup screen for My Psion

9. Double click the icon "Not Connected" to connect the PSION to the computer and the following window will appear. Fig. B2.

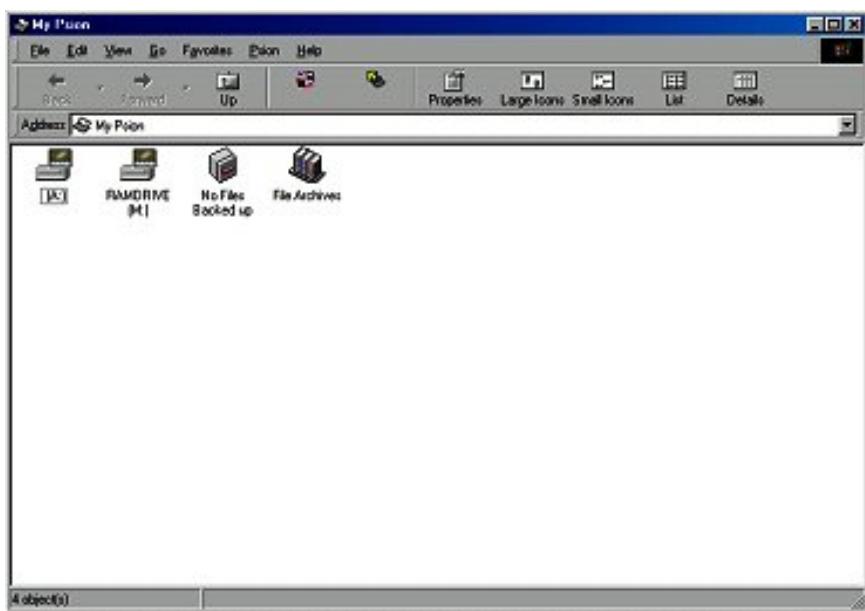


Fig. B2. Explorer screen for My Psion

10. The A-drive is the Flash-memory card. On the A-drive the FORCE software is installed as backup. Fig. B3.

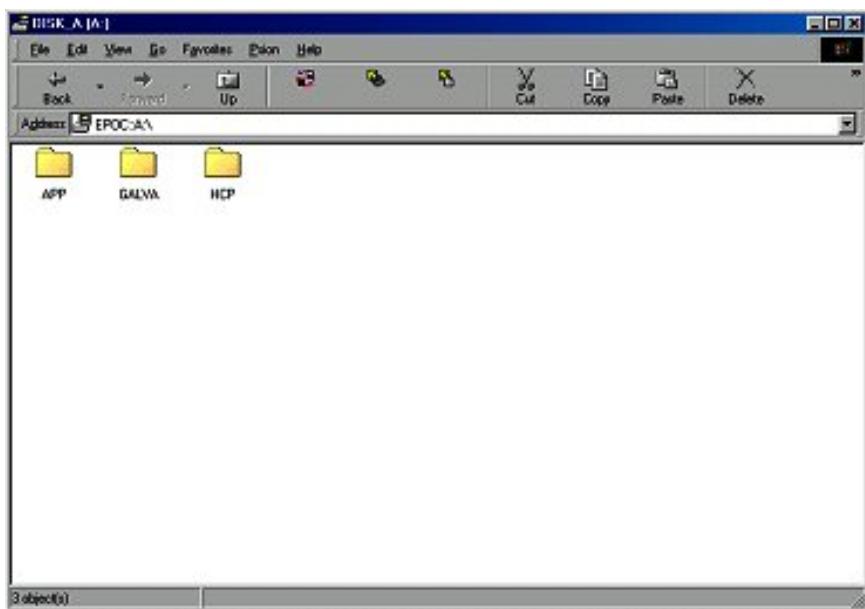


Fig. B3. Explorer screen for My Psion (A-drive)

11. On the M-drive (RAM DRIVE) all data is stored. Double click on the icon RAM DRIVE (M:) and the content on the M-drive will be shown. Fig. B4.

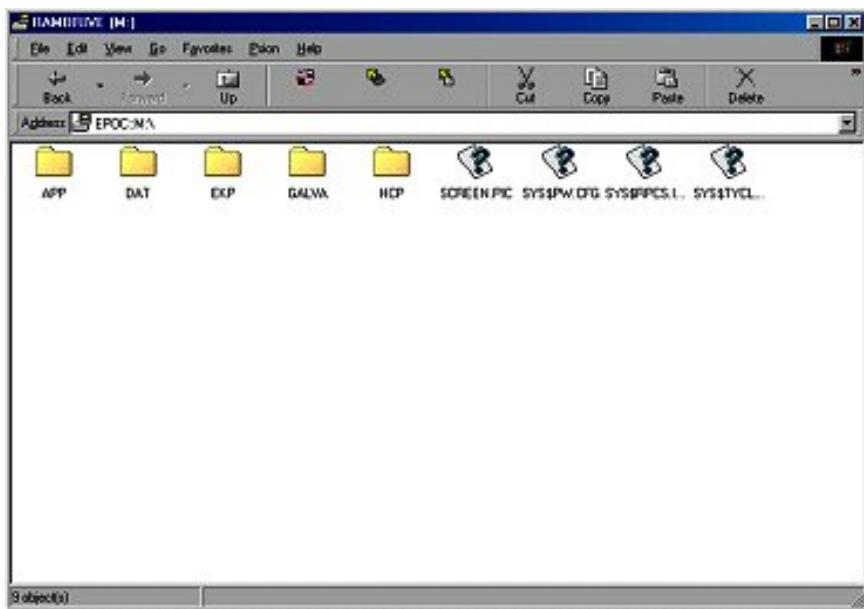


Fig. B4. Explorer screen for My Psion (M-drive)

12. The data with the GPM reading (corrosion rate, potentials and resistance) are located in the GALVA-folder. Double click this folder to see the content of the folder. Fig. B5.

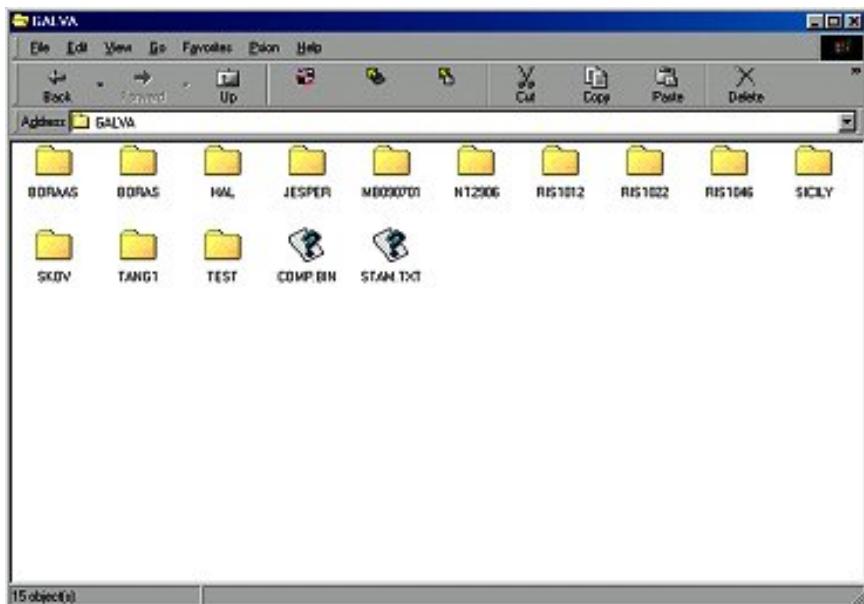


Fig. B5. Explorer screen for My Psion (sub folder)

13. **It is recommended first to make a backup of the data that has to be deleted.** Select the data/folder that has to be copied to the PC with the mouse and move it to the desktop on the computer and the folder will be copied.
14. Click with the mouse on the folder that has to be deleted and press DELETE. The program will ask for a confirmation to delete the selected folder. Click YES to confirm and NO to cancel.

15. If only a few data has to be deleted open the folder, select the data and press DELETE.
16. Once the data has been deleted choose FILE and CLOSE
17. The connection indicated on the lower right corner on the screen will automatically disconnect after some time.
18. The REMOTE LINK now has to be changed again to the original settings.
19. Choose SPEC in the menu and select REMOTE LINK and press Enter
20. The Remote Link has as default the following settings.
 - i. Remote Link: OFF (Press the → to change between on/off)
 - ii. Baud rate:
 - iii. Port:
21. Pressing ENTER saves the settings.
22. The PSION is now ready for further testing.