

EmStat4R™

Operator's Manual

Version 02-2024



If you have problems

First make sure to check the “Troubleshooting” section in this document and the Knowledge Base on our website: www.palmsens.com/knowledgebase/

This page contains support information on installation, software updates, and training.

Please make sure your software and firmware are up-to-date.



In case of persistent problems:

Use the contact form: www.palmsens.com/contact/

Give us a call: +31 30 2459211

Or send an email: info@palmsens.com

Try to describe the problem as detailed as possible. Sending us the relevant method files, data files and screenshots can be helpful.

Please include your instrument model and serial numbers, as well as any applicable software and firmware version you are using.

Limited Warranty

Except as otherwise provided herein, PalmSens BV warrants to buyer three years from the date title to the product passes (transfer date of goods from seller to buyer), each product sold hereunder will be free of defects in materials or workmanship and will conform to specifications set forth in PalmSens BV’ published data sheets or, where applicable, user manuals for PalmSens BV’ system products in effect at the time title passes.

PalmSens BV’s sole liability and responsibility for products under this warranty is for PalmSens BV to repair or replace any product that is returned to it by buyer or credit buyer’s account for such returned product, provided that PalmSens BV shall have the right to reject any such remedy where PalmSens BV determines that the warranty does not apply product returned to PalmSens BV for warranty service will be shipped to PalmSens BV at buyer’s expense and will be returned to buyer at PalmSens BV’ expense. PalmSens BV’ obligation to honor its warranty for a product is contingent upon receipt of payment in full for such product.

See our website for more detailed information:

www.palmsens.com/terms-and-conditions/

Disclaimers

PalmSens BV cannot guarantee that its instruments will work with all computer systems, operating systems, and third-party software applications hardware/software. The information in this manual has been carefully checked and is believed to be accurate as of the time of compiling. However, PalmSens BV assumes no responsibility for errors that might appear.

See Appendix A for CE declaration of conformity.

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1 Introduction

1.1 The scope of this manual

This manual covers the handling, characteristics, troubleshooting, and other practical information regarding the hardware specifics of the EmStat4R, as well as maintenance and compliance.

Please refer to the “Quick Installation Guide” that was supplied with the instrument for instructions on installing the instrument and the software. Additionally, the section “Getting Started” in the digital “PSTrace Manual”, that is installed with the software, provides detailed instructions for conducting first measurements with your instrument.



Initial setup and basic operational instructions for conducting initial measurements are detailed in the “Quick Installation Guide” supplied with the instrument.

The “PSTrace Manual” is an in-depth document covering not only the PSTrace software but also the hardware limitations for each technique supported by the instrument. It is written to give you a full understanding of both the software and hardware aspects, making sure you're well-equipped to use all the functionalities of the EmStat4R.

1.2 About the EmStat4R

The EmStat4R is a portable Battery or USB-powered Potentiostat, Galvanostat, and optional a Frequency Response Analyzer (FRA) for Electrochemical Impedance Spectroscopy (EIS).

The EmStat4R instrument incorporates the EmStat4 LR potentiostat module, extending its functionality with Bluetooth connectivity, a Li-Po battery and a Connection Module in a rugged enclosure.

The EmStat4R is great for applications that require low currents, from 30 mA down to picoamps, such as sensor applications. The cell or sensor interface of the instrument (the Connection Module) can easily be exchanged to accommodate for specific form factors of Screen-Printed Electrodes (SPEs).



Figure 1 The Connection Module of the EmStat4R can easily be exchanged.

The EmStat4R is on the market since 2022 and is also available as tailored instrument for OEM purposes. See for more information the OEM section on our website.

2 Operating the EmStat4R

The EmStat4R can be used either on battery using a wireless Bluetooth connection or by connecting it via its USB-C port to a PC or Android device. A single button on the top side of the instrument is used to switch the instrument on and off again. Push the button briefly to turn in the instrument on. Do the same for turning the instrument off again.

2.1 USB and charging

The EmStat4R has a USB Type-C (USB-C) port and uses the High-Speed USB 2.0 specification. The instrument comes standard with a shielded USB-C to USB-A (standard rectangular plug) cable and can be used with any standard USB port.

When the EmStat4R is connected to a USB port which is either a USB power source or host it will charge the battery. Charging the battery from depleted to full takes about 5 hours. Charging up to 80% takes about 3.5 hours.

The white ring around the power button will show a spinning light pattern while the instrument is charging.

2.2 Bluetooth

Every EmStat4R has a unique Bluetooth identifier. The Bluetooth identifier always starts with the letters PS, followed by a dash and the last four characters of its MAC address. For example: PS-F93A. The Bluetooth MAC address of the EmStat4R instrument can be found on the bottom of the instrument, see Figure 2.

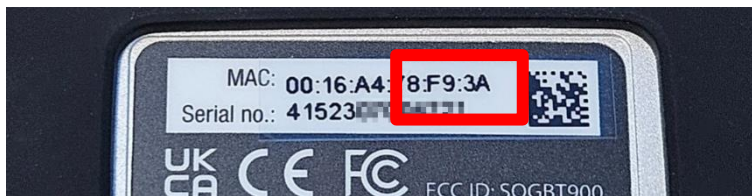


Figure 2 The last four characters of the MAC address.

When connecting to the USB port of a PC, Bluetooth will switch off automatically unless there is a Bluetooth connection active. This allows the instrument to be charged via the PC while a Bluetooth connection is present.

See also section: "Connecting using Bluetooth" in the PSTrace Manual.

2.3 Cell connections

The EmStat4R comes in two versions: the SNS and SPE version. The difference between the two versions is in which Connection Module is installed, which is the interface to the sensor or cell. The table below describes the different versions of the EmStat4R.

Table 1 The differences between the SNS and SPE version.

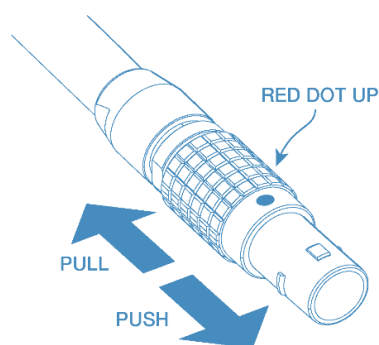
	SNS version	SPE version
Connection module	Cell cable compatible	Screen-Printed Electrode compatible
Cell cable included	Yes	No
Electrode connections	WE, RE, CE and ground	WE, RE, CE
Connectors	2 mm banana	Max 11 mm wide SPE with 2.54 mm pitch

Please note that Screen-Printed Electrodes with a ceramic substrate can have very sharp edges that might damage the SPE connector when used frequently.



Ceramic substrates can have very sharp edges that might damage the SPE connector.

The cell cable is connected to the EmStat4R by means of a LEMO push-pull connector. Make sure the red dot on the connector is facing upwards when plugging the connector into the EmStat4R.



The EmStat4R cell connector is a push-pull connector. Do not try to twist it!

For more information about making a connection to the cell, see also section: "Connecting a cell to the potentiostat" in the PSTrace Manual.

2.4 Replacing the Connection Module

Required tool:

- Small Pozidriv or Philips screwdriver



The Connection Module can be damaged by static electricity (electrostatic discharge or ESD). Please take adequate precautions against static discharge during handling.

Step 1: Remove the rubber sleeve

Push the rubber sleeve down at the USB-port (back) side of the instrument. Then pull the aluminium housing out the front side.



Figure 3 Removing the rubber sleeve.

Step 2: Remove the Connection Module screw at the bottom

The screw near the edge of the instrument keeps the Connection Module in place. Remove the screw.



Figure 4 The Connection Module screw location.

Step 3: Pull out the module

There are two indentations at the side of the instrument providing a grip for two fingers to pull out the Connection Module.



Figure 5 Pulling out the Connection Module.

Step 4: Replace the module

Place the new module carefully in while making sure the module is aligned with the slide connector inside the instrument. Make sure that the gold-plated connection pads at the edge of the new module are facing upwards. Push the module all the way in and put the screw back in place to fixate it. Do not use excessive force while screwing.



Figure 6 Replacing the Connection Module

Step 5: Put the sleeve back in place

Push the front side of the aluminium housing back in the front (deep pocket) of the sleeve. Then pull the back side (USB-port side) over the back of the aluminium housing using your thumb. The rubber sleeve can handle enough stress to firmly pull it over.



Figure 7 Pulling the rubber sleeve over the back of the housing.

2.5 Display and status LED indicator

The EmStat4R has three indicators in the black area on the top of the instrument.



The Bluetooth indicator (A) is solid blue when a Bluetooth connection is established. The indicator will turn off again when the Bluetooth connection is severed.

The Power ring indicator (B) can be in one of the following states:

Table 2 *EmStat4R power ring states*

State	Meaning
Steady white	Not connected to USB: powered with sufficient battery charge Connected to USB power source: fully charged
Spinning	Charging
Blinking fast	Low battery

The cell indicator (C) turns red whenever the cell is on, which means the Counter Electrode is connected internally and current can flow. If the cell indicator is off, the cell is at open circuit (OCP) and only potentials can be measured.

2.6 Cell connector pin-out

The following schematics show the EmStat4R SNS cell connector pin-out and pin functions.

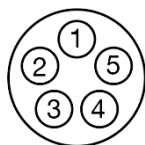


Figure 8 Front view of the female cell connector on the EmStat4R.

Table 3 Cell connector pin functions of the EmStat4R.

Pin	Function	Connector color
1	Reference Electrode (RE)	Blue
2	Reference Electrode Shield	N/A
3	Counter / Auxiliary Electrode (CE)	Black
4	NC	N/A
5	Working Electrode (WE)	Red
Connector housing	Analog Ground (AGND)	Green

The following table shows the EmStat4R SPE connector specifications.

Table 4 SPE connector specifications of the EmStat4R.

Connection pads	
Connection pads pitch	2.54 mm (0.1")
Allowed sensor thickness	between 0.1 mm and 0.8 mm
Maximum sensor width	11 mm

3 Battery replacement

Required tool:

- Small Pozidriv or Philips screwdriver

Step 1: Remove the rubber sleeve

Push the rubber sleeve down at the USB-port (back) side of the instrument. Then pull the aluminium housing out the front side.



Figure 9 Removing the rubber sleeve.

Step 2: Remove the screws of the battery lid

The battery lid is held in place by two screws



Figure 10 The two screws of the battery lid.

Step 3: Remove the battery lid

The battery lid has a tight fit in the enclosure and it can require some mild shaking of the instrument to get the lid out. If this is not enough, a pointy tool can be used to pull mildly at the screw holes of the battery lid. Be careful not to scratch the aluminium enclosure.



Figure 11 The battery lid removed.

Step 4: Replacing the battery

Pull gently on the three wires close to the battery connector and wiggle it a little while pulling to unplug. Put the new battery in place that was acquired from PalmSens BV.



Figure 12 Unplugging the Li-Po battery

Step 5: Closing the battery compartment

Put the rubber gasket back in place, making sure the holes in the gasket are aligned with the screw holes in the aluminium housing. Then put the battery lid back in place and put the screws back in without using excessive force.

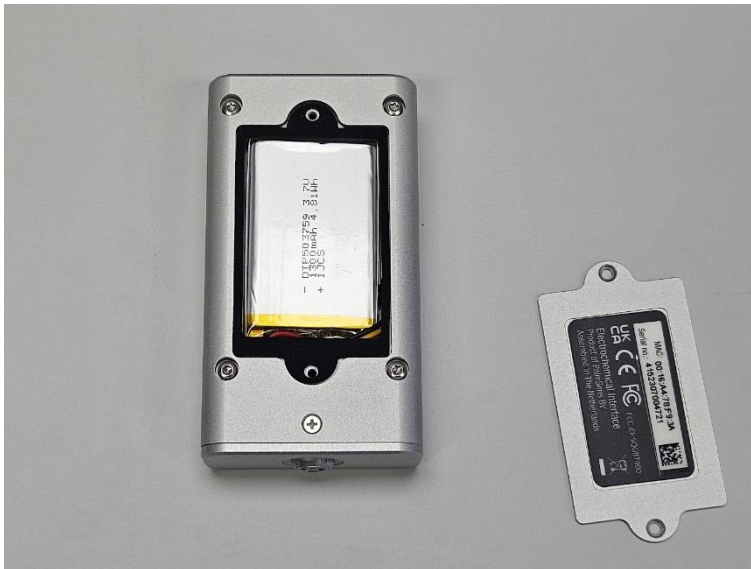


Figure 13 Putting the rubber gasket in place.

Step 6: Put the sleeve back in place

Push the front side of the aluminium housing back in the front (deep pocket) of the sleeve. Then pull the back side (USB-port side) over the back of the aluminium housing using your thumb. The rubber sleeve can handle enough stress to firmly pull it over.



Figure 14 Pulling the rubber sleeve over the back of the housing.

4 Specifications

The EmStat4R has the exact same specifications as the regular EmStat4S LR, but the instrument is extended with, Bluetooth connectivity, a battery and connection module. Specifications are subject to change, due to regular firmware updates. See the EmStat4R product page on our website for accurate and detailed specifications.

The table below shows the EmStat4R key specifications.

Table 5 *EmStat4R specifications*

EmStat4R key specifications	
housing	<ul style="list-style-type: none">▪ aluminum body only: 11.1 x 6.0 x 2.7 cm▪ with rubber sleeve: 11.8 x 6.8 x 3.3 cm
weight	+/- 310 g
power source	USB-C or internal Li-Po battery
battery	Connected via Bluetooth: ~3 hours with cell on at 10 mA current ~5 hours with cell off
communications	USB Type-C port or Bluetooth (4.0 - Dual-Mode)
internal storage space	500 MB, equivalent to >15M datapoints

5 Troubleshooting

5.1 Verifying your potentiostat

Your instrument can be tested by using the test sensor or dummy cell supplied with the instrument.

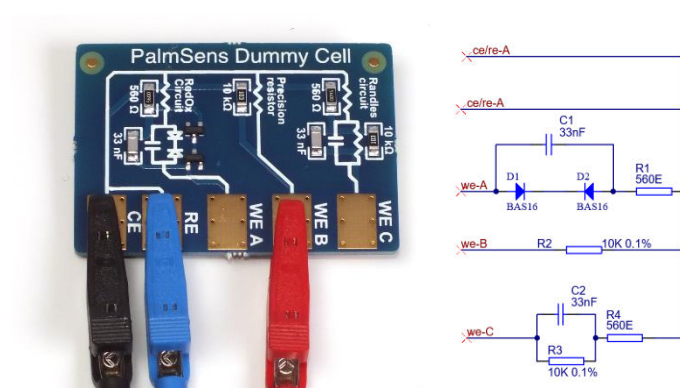


Figure 15 PalmSens Dummy Cell supplied with the EmStat4R SNS version.

The easiest way to verify the functioning of your instrument is to use the “WE B” circuit, which consists of a resistor with a value of 10 kΩ with a max deviation of 0.1%.

In case you are using the EmStat4R SPE version, connect the SPE dummy cell. Keep in mind that this SPE has a simplified Randles Circuit with an extra 560 Ω resistor in series with the 10 kΩ resistor.



Figure 16 The SPE dummy cell supplied with the EmStat4R SPE version.

The WE lead is connected to one side and both RE and CE to the other side of the resistor. If your instrument has a Sense lead, make sure to connect the Sense lead to the WE lead as well.



If your instrument has a Sense lead, make sure to connect the Sense lead to the WE lead as well.

Any of the electrochemical techniques can be applied. The current response obtained with a resistor with value R is equal to the applied potential or potential pulse divided by the value of R . So, if a potential of 0.5 V is applied on a resistor of 10 k Ω , the obtained current should be $0.5 \text{ V} / 10 \text{ k}\Omega = 50 \text{ }\mu\text{A}$.

Contact PalmSens BV if the problems are found: info@palmsens.com and report the problems as detailed as possible.

5.2 Noise

Our instruments are designed with hardware noise suppression filters to reject noise from internal and external sources. If a higher level of noise is your issue, the solving strategies are rather numerous, but the sources for noise are also numerous. Here we describe the most successful and common methods for noise reduction.

To determine the noise levels for your instrument, please refer to section “Measuring the noise level of the instrument” of the PSTrace Manual.

5.2.1 Power grid

Your power grid is usually using an alternating current. This undulating current influences the measured currents. PSTrace and PStouch have a filter for this mains frequency. In PSTrace, check in the ‘Tools’ menu under ‘General Settings’ if the mains frequency is set correctly.

5.2.2 Electrical fields

Our environment is filled with electrical fields. Some of them are created by devices around us as side effects or in case of wireless communication on purpose. Although it is a bad idea to measure directly next to an electric arc furnace, it is usually not possible to have a workspace free of electrical fields, especially not during point-of-care measurements. A Faraday cage is usually sufficient to create a field-free environment. A metal box or cage out of metal mesh is a good Faraday cage. Even a shield out of aluminum foil can help. Place your electrochemical cell inside the Faraday cage and connect the cage to the ground lead (green) of the potentiostat. The cable delivered with your EmStat or PalmSens has an inbuilt shield and should protect your signal outside the Faraday cage. This is one of the most effective methods to reduce noise.

5.2.3 Cables

Cables should not be unnecessarily long, since they act as antennas for noise, but the cable delivered with your EmStat or PalmSens has an inbuilt shield and as long as you use the original cable, there is little reason to worry about cable induced noise.

5.2.4 Grounding

Ground your measurement equipment. The best way to connect your equipment is star-shaped, that is all parts are connected with the ground at the same point. In an

electrochemical lab that point is usually one small space of the faraday cage. This way earth loops that induce noise are avoided.

5.2.5 Contacts

Check if the contacts are corroded. If so, remove the stains, for example with sandpaper.

6 Maintenance and compliance

6.1 Lithium-Polymer batteries

The typical estimated life of a Lithium-Polymer battery is about two to three years or 300 to 500 charge cycles, whichever occurs first. One charge cycle is a period of use from fully charged, to fully discharged, and fully recharged again. Consider a two-to-three-year life expectancy for batteries that do not run through complete charge cycles.

Rechargeable Lithium-Polymer batteries have a limited life and will gradually lose their capacity to hold a charge. This loss of capacity (aging) is irreversible. As the battery loses capacity, the length of time it will power the product (run time) decreases. Lithium-Ion batteries continue to slowly discharge (self-discharge) when not in use or while in storage.

Detailed instructions for battery replacement can be found in this document.

The new battery or battery pack must be obtained from PalmSens BV. Lithium-ion batteries have specific voltage operation and temperature control requirements, so using the wrong model may lead to overheating and fire.



The use of an unauthorized battery may compromise safety, pose a risk of fire, and result in irreversible damage to the device.

6.2 Temperature compliance

Our instruments are designed for indoor use at ambient temperatures between 0 °C and 45 °C. All the components of PalmSens products (except their batteries) are rated to the industrial temperature standard of -40 °C to +85 °C.

The battery of the EmStat4R is rated -20 °C to +60 °C when discharging 0 °C to +45 °C when charging.

6.3 Humidity compliance

PalmSens instruments have not been tested in high humidity environments.

Elevated humidity however may cause measurement errors if condensation forms on the electronics. This affects measurements in the nA ranges or lower. Prolonged exposure to a condensing environment may severely decrease the life expectancy of the instrument and void its warranty.

6.4 Temperature drift

PalmSens instruments are calibrated at 21 °C. The most sensitive components of the instrument have temperature drift of 50 ppm. For instance at 1 °C or 41 °C, measurement drift of up to 0.1% may be experienced.

6.5 Atmospheric pressure

PalmSens instruments are not intended for use in safety-critical applications. Consequently, the power supplies utilized are not selected based on a specific pressure rating.

6.6 Cleaning

Make sure to disconnect your instrument from any cell or power source, if applicable, prior to cleaning. Use a cloth lightly dampened with either clean water or water containing a mild detergent to clean the outside of the instrument. Alternatively, you can use isopropyl alcohol. Avoid using a wet rag and prevent any fluids from entering the instrument. It is crucial not to immerse the instrument in any cleaning solution.

6.7 Periodic calibration and preventive maintenance

PalmSens instruments are designed in a way that eliminates the need for periodic calibration. While not mandatory, PalmSens does provide a calibration service for users with specific demands such as QC/ISO purposes. This service includes a new calibration certificate.

It's important to note that PalmSens instruments do not require preventive maintenance, further simplifying their use and reducing the overall maintenance demands on users.

6.8 Service and repair

Except for the battery in some models, your PalmSens instrument contains no user-serviceable parts internally. Any service or maintenance needs should be directed to a qualified service technician employed by PalmSens BV. Attempting to access or modify internal components without proper expertise may result in additional damage to the instrument and void warranties. It is recommended to rely on authorized service personnel for any required maintenance or repairs.

6.9 RoHS Compliance

All instruments from PalmSens have been built using lead free components and lead-free solder. They are in compliance with the European RoHS initiative.

A. EU Declaration of conformity



EU DECLARATION OF CONFORMITY

Certificate number: PSDOC-ES4R-B



Manufacturer: PalmSens BV
Address: Vleugelboot 22,
3991 CL Houten,
The Netherlands

This declaration is valid for the following product:

EmStat4R: (V1.0 and higher) Portable electrochemical analyser.

- USB power and communications
- Battery power
- Bluetooth communication

The object of the declaration described above is in conformity with the Radio Emissions Directive 2014/53/EU (RED) and applicable standards listed below:

- Health & Safety
- EN 62479
 - EN 61010-1

- EMC
- EN 61326-1
 - EN 301 489 parts 1 & 17

- Efficient Usage of Radio Spectrum
- EN 300 328

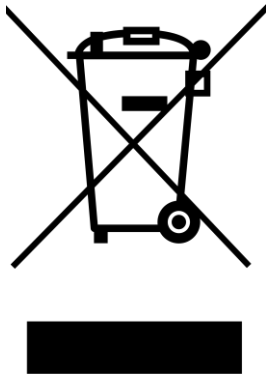
This declaration is issued under the sole responsibility of PalmSens BV.

Date: 29th of November 2023

A handwritten signature in black ink, appearing to read "C.J. van Velzen", with a long horizontal stroke extending to the right.

C.J. van Velzen, CTO

B. EU Waste Electrical and Electronic Equipment (WEEE) Directive



The pictogram shown above, located on the product(s) and / or accompanying documents means that used electrical and electronic equipment (WEEE) should not be mixed with general household waste. For proper treatment, recovery and recycling, please take this product(s) to designated collection points where it will be accepted free of charge.

Alternatively, in some countries, you may be able to return your products to your local retailer upon purchase of an equivalent new product. Disposing of this product correctly will help save valuable resources and prevent any potential negative effects on human health and the environment, which could otherwise arise from inappropriate waste handling. Please contact your local authority for further details of your nearest designated collection point. Penalties may be applicable for incorrect disposal of this waste, in accordance with your national legislation.

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