PalmSens4™

POTENTIOSTAT / GALVANOSTAT / IMPEDANCE ANALYZER

PalmSens

Rev.9-2019-003

Contents

PalmSens4: Potentiostat / Galvanostat / Impedance Analyzer

The PalmSens4 is a battery-powered and USB-powered, handheld instrument which allows the application of the most relevant voltammetric, amperometric and potentiometric techniques as well as impedance spectroscopy (see below). Each PalmSens4 is shipped in a rugged carrying case (see page 8). The PalmSens4 together with a Windows or Android device forms a highly mobile electrochemical workstation.

Always a backup

The PalmSens4 is equipped with an internal storage of 8 GB.
This means all your measurements[1] can automatically be saved on-board as backup. All these measurements can be browsed and transferred back to the PC easily using PSTrace.
Your data is always with your instrument wherever you take it.

[1] *Not supported: EIS, MultiStep and MixedMode*

Available configurations

The PalmSens4 is available with ±5V or ±10V DC-potential ranges and with different maximum frequencies for FRA / EIS. The following table shows the applicable product codes:

	Potential range ±5V [05]	Potential range ±10V [10]
NO EIS [F0]	PS4.F0.05	PS4.F0.10
EIS up to 100 kHz [F1]	PS4.F1.05	PS4.F1.10
EIS up to 1 MHz [F2]	PS4.F2.05	PS4.F2.10

Supported Techniques

Voltammetric techniques

- Linear Sweep Voltammetry — LSV
- Differential Pulse Voltammetry — DPV
- Square Wave Voltammetry — SWV
- Normal Pulse Voltammetry — NPV
- AC Voltammetry — ACV
- (Fast) Cyclic Voltammetry — CV

Note: the above techniques can also be used for stripping voltammetry

Techniques as a function of time

- Chronoamperometry — CA
- Pulsed Amperometric Detection — PAD
- Multiple Pulse Amperometric Detection — MPAD
- Fast Amperometry — FAMP
- Chronopotentiometry — CP
- Open Circuit Potentiometry — OCP
- Multistep Amperometry — MA
- Multistep Potentiometry — MP
- Mixed Mode — MM

Electrochemical Impedance Spectroscopy (EIS)
Impedance spectroscopy / EIS

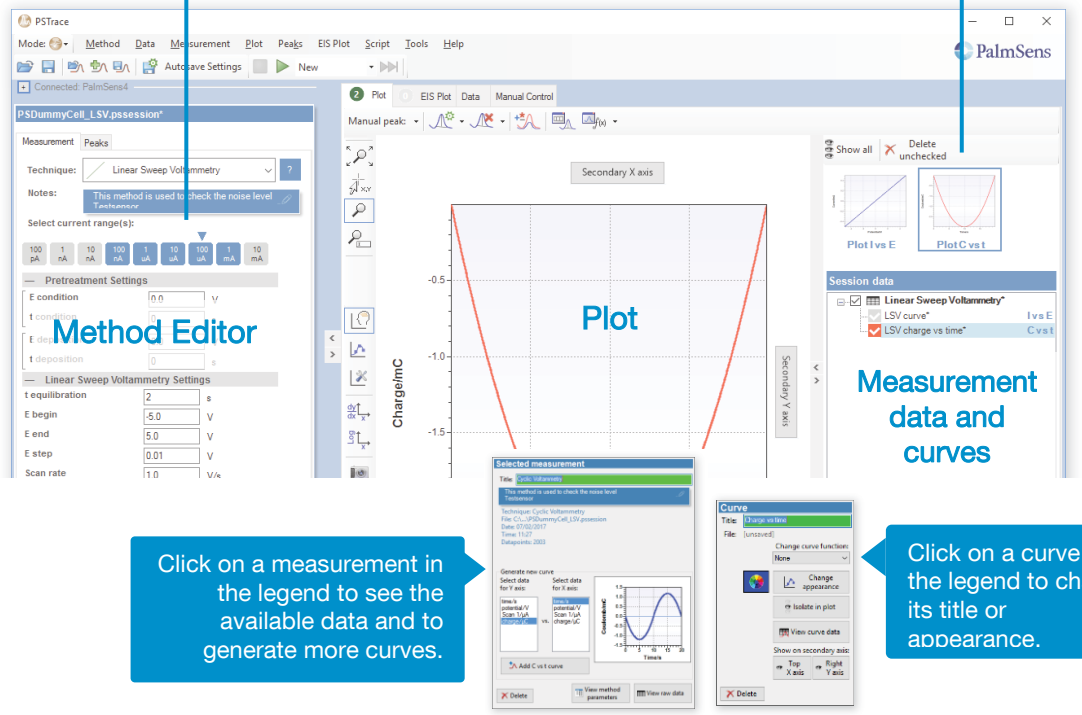
- Frequency scan
- Potential scan
- Fixed potential
- Time scan

Next to the classic spectrum (frequency scan with fixed DC potential) a DC potential scan can be done at fixed frequency or a frequency scan at each potential of the potential scan.

PSTrace: Software for PC

Select current ranges for auto ranging and the starting current range.

Switch between plots if curves with different units are available.

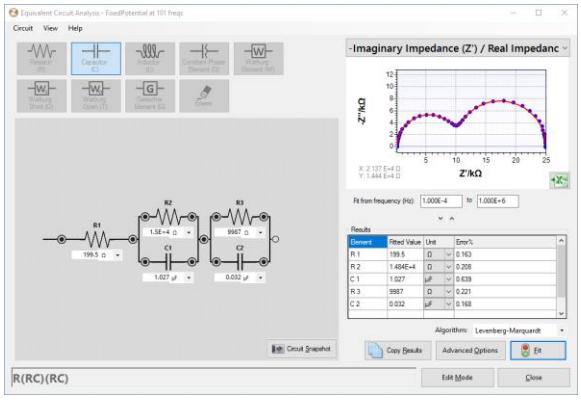


Click on a measurement in the legend to see the available data and to generate more curves.

Click on a curve in the legend to change its title or appearance.

Other functions in PSTrace 5

- Equivalent Circuit Fitting
- Scripting
- Open your data in Origin and Excel with one click of a button
- Save all available curves, measurement data and methods to a single file
- Browse measurements on PalmSens4's internal storage
- Direct feedback on method parameters



Integration with third party software:

- Excel
- Origin
- Matlab
- ZView

System requirements

Minimum PC requirements are:

- Windows Vista, 7, 8, or 10 (32-bit or 64-bit)
- 1 GHz or faster 32-bit (x86) or 64-bit (x64) processor
- 1 GB RAM (32-bit) or 2 GB RAM (64-bit)

For more information about software visit
www.palmsens.com/software

PStouch: App for Android

PStouch is an app for Android devices compatible with all PalmSens and EmStat potentiostats.
PStouch can communicate with PalmSens4 via USB (depending on the Android device) or wireless via Bluetooth.

PStouch features:

- Setting up and running measurements
- Loading and saving measured curves
- Analysing and manipulating peaks
- Sharing data directly via e-mail or Dropbox
- Concentration determination by means of Standard Addition or Calibration Curve
- Support for PalmSens accessories such as a Multiplexer or Stirrer

All method and curve files are fully compatible with PSTrace software for Windows.
PStouch is designed for use with tablets and smartphones.

Download PStouch for free in the Google Play Store

Google play

For more information about software visit www.palmsens.com/software

Measurement Specifications

General pretreatment

Apply conditioning, deposition or initial potential for: 0 – 1600 s

General voltammetric parameters

PS4 Model	PS4.F0.05 PS4.F1.05 PS4.F2.05	PS4.F0.10 PS4.F1.10 PS4.F2.10
Potential range	-5 V to +5 V	-10 V to +10 V
Step potential	0.075 mV to 250 mV	0.075 mV to 250 mV
Pulse potential	0.075 mV to 250 mV	0.075 mV to 250 mV

Limits of some technique specific parameters for PalmSens4

Normal Pulse and Differential Pulse Voltammetry	Scan rate: Pulse time:	0.1 mV/s (75 µV step) to 100 mV/s (5 mV step) 10 ms to 300 ms
Square Wave Voltammetry[1] **and AC Voltammetry**	Frequency:	1 Hz to 2000 Hz [1]
Linear Sweep and Cyclic Voltammetry	Scan rate:	0.01 mV/s (75 µV step) to 500 V/s (10 mV step)
Pulsed Amperometric Detection	Interval time: Pulse time: Maximum run time:	50 ms to 300 s 1 ms to 1 s 640000 s (> 7 days at 10 s interval)
Multiple Pulse Amperometric Detection	Pulse times: Run time: Number of potential levels:	100 ms to 2 s 10 s to 100000 s 3
ChronoAmperometry, ChronoPotentiometry and Open Circuit Potentiometry	Interval time: Maximum run time:	0.25 ms to 300 s 1000000 s (> 10 days at 300 s interval)
Multistep Amperometry, Multistep Potentiometry and Mixed Mode	Interval time: Level switching overhead time: Number of levels: Number of cycles: Maximum run time:	0.25 ms to 300 s ±80 ms 1 to 255 1 to 20000 > 1 year
Fast Amperometry	Interval time: Maximum run time: Maximum number of points:	0.02 ms to 1 s 30 s 65000 (4000 for interval time < 0.2 ms)

Note: some limits of parameters are set for practical reasons and can be modified on request.

[1] *PSTrace provides the option to measure forward and reverse currents separately.*

System Specifications

General			
▪ dc-potential range	model	PS4.F#.05 ±5 V	PS4.F#.10 ±10 V
▪ compliance voltage	±10 V		
▪ maximum current	±30 mA (typical)		
▪ max. acquisition rate	150000 points/s		

Potentiostat (controlled potential mode)	
▪ applied dc-potential resolution	75 µV
▪ applied potential accuracy	≤ 0.1% ±1 mV offset
▪ current ranges	100 pA to 10 mA (9 ranges)
▪ measured current accuracy	≤ 0.1% at Full Scale Range
▪ measured current resolution	0.006% of current range (5 fA on 100 pA range)

Galvanostat (controlled current mode)	
▪ current ranges	1 nA to 10 mA (8 ranges)
▪ applied dc-current range	± 6 times applied current range
▪ applied dc-current resolution	0.005% of applied current range
▪ measured dc-potential resolution	75 µV at ±10 V (no gain) 7.5 µV at ±1 V (gain 10) 0.75 µV at ±0.1 V (gain 100)
▪ measured dc-potential accuracy	≤ 0.05% or ±1 mV (for |E| < ±9 V) ≤ 0.2% (for |E| ≥ ±9 V)

FRA / EIS (impedance measurements)			
▪ frequency range	model	PS4.F1.## 10 µHz to 100 kHz	PS4.F2.## 10 µHz to 1 MHz
▪ ac-amplitude range	1 mV to 0.25 V rms, or 0.6 V p-p		

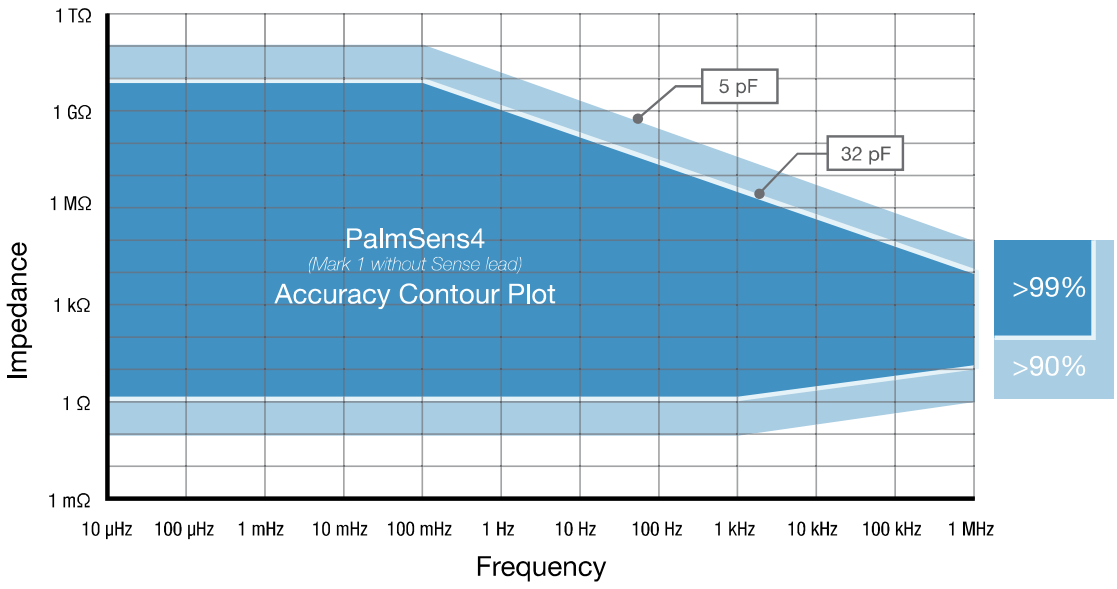
Electrometer	
▪ electrometer amplifier input	> 1 TΩ // 10 pF
▪ bandwidth	1 MHz

Other	
▪ housing	aluminium body with rubber sleeve: 15.7 x 9.7 x 3.5 cm^3
▪ weight	+/- 500 g
▪ temperature range	0 °C to +50 °C

▪ **power supply**	USB or internal LiPo battery
▪ **communication**	USB and Bluetooth
▪ **battery time**	> 16 hours idle time (> 5 hours with BiPot installed) > 4 hours with cell on at max. current Extendible by means of power bank
▪ **internal storage space**	8 GB or +/- 800000 measurements incl. method parameters (assuming 200 data points per measurement)

Auxiliary port (D-Sub 15)	
▪ **analog input**	±10 V, 18 bit
▪ **analog output**	0-10 V, 12 bit (1 kOhm output impedance)
▪ **4 digital outputs**	5 V
▪ **1 digital input**	5 V
▪ **i-out and E-out**	raw output of current and potential E-out ±10 V (1 kOhm output impedance) I-out ± 6 V (1 kOhm output impedance)
▪ **power**	5 V output (max. 150 mA)

EIS Contour Accuracy Plot



Note
The accuracy contour plot was determined under lab conditions and should be used for reference purposes. Please note that the true limits of an impedance measurement are influenced by all components in the system, e.g. cables, the environment, and the cell.

Optional BiPot specifications

The PalmSens4 can be expanded with a BiPot module for use with a second Working Electrode.

BiPot specifications	
▪ **dc-potential range**	± 5 V
▪ **dc-potential resolution**	75 µV
▪ **dc-offset error**	≤ 0.1% ±1 mV offset
▪ **accuracy**	≤ 0.1%
▪ **current ranges**	100 pA to 10 mA (9 ranges)
▪ **maximum measured current**	i(WE1) + i(WE2) < 30 mA
▪ **current resolution**	0.006% of current range (5 fA on 100 pA range)
▪ **current accuracy**	≤ 0.1% at Full Scale Range all with additional 0.2% offset error
▪ **connection**	Comes with a sensor cable with an additional (yellow) connector for WE2
▪ **power**	Comes with additional USB Y-cable for extra power

Note
The BiPot module decreases the battery life of the PalmSens4 in idle mode (cell off) down to > 5 hours.

Optional IR Compensation module specifications

IR Compensation for PalmSens4 is available as an in-factory add-on module.

IR Compensation module specifications	
▪ **Method used for IR-drop compensation**	Positive Feedback
▪ **Resolution of MDAC used for correcting potential**	16 bit
▪ **Max. compensated resistance**	1 MOhm
▪ **Max. bandwidth with IR-drop compensation enabled**	10 kHz

Standard PalmSens4 Configuration

A standard PalmSens4 case includes:

- PalmSens4
- USB cable
- Sensor cable
- 4 croc clips
- PS Dummy Cell

Also included:

- PSTrace software (on USB drive) + manual (hardcopy)
- Quick start document
- Calibration report

Optional

- *7" tablet*
- *Tablet charger*

PalmSens Dummy Cell

croc clips

PalmSens4 standard configuration in case with accessories.

PalmSens4 Accessories

In-factory add-on modules

BiPot module

The BiPot Module is an optional extension for the PalmSens4 and is for applications requiring control of two independent working electrodes. The module fits inside the PalmSens instrument. The PSTrace software supports this module for linear sweep, cyclic voltammetry and amperometric detection with two working electrodes.

See page 8 for BiPot specifications

IR Compensation module

The IR Compensation module is an optional extension for the PalmSens4. The resistance between the reference electrode and the double layer of the specimen can cause a significant potential drop, decreasing the applied potential where it is required. The module provides positive feedback to compensate for the IR drop between Reference electrode and the outside of the double layer of the electrochemical cell.

See page 9 for IR Compensation module specifications

Other accessories

MUX8-R2 or MUX16 multiplexer

The MUX8-R2 is an 8-channel multiplexer. It allows the PalmSens4 to measure up to 8 three-electrode cells or 8 sensors (2 or 3 electrode). In 8-WE mode it can measure up to eight working electrodes on sensor arrays with shared reference and counter electrodes. The MUX8-R2 is stackable.

The MUX16 is a 16-channel multiplexer. It allows the PalmSens4 to measure up to 16 working electrodes with shared counter and reference electrodes.

Magnetic stirrer with Switchbox

The magnetic stirrer controlled by PalmSens is ideal for stripping analysis applications. The stirrer is switched on during the conditioning and deposition stages by means of the Switchbox.

LM35/TMP36 temperature sensor

This temperature sensor allows for monitoring of temperature during an experiment.
Two point calibration allows the user to precisely calibrate the sensor for the required temperature range. The calibration curve shows a linear slope of +10 mV/°C with 0.5°C Ensured Accuracy (at 25°C). It is rated for full 2°C to 150°C range (LM35) or -40°C to 125°C range (TMP36). The sensor has low self-heating (0.08°C in still air).

Differential Electrometer Amplifier (DEA)

The PalmSens Differential Electrometer Amplifier (DEA) is a high impedance input amplifier. It can be used as a floating voltage amplifier with differential input and single output to the auxiliary port of PalmSens.

Default range is -10V to 10V (1x gain). Possible gains are: 2x, 5x, 10x, 20x, 50x and 100x.

Please don't hesitate to contact PalmSens for more details:
info@palmsens.com

PalmSens BV
The Netherlands
www.palmsens.com