

# PalmSens4™

POTENTIOSTAT / GALVANOSTAT / IMPEDANCE ANALYZER



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## PalmSens4: Compact, Versatile and Powerful



software for Windows  and Android 

### Always a backup



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

*Not compatible with techniques: EIS, MultiStep and MixedMode*

### Available configurations

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

	Potential range $\pm 5V$ [05]	Potential range $\pm 10V$ [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

The PalmSens4 supports the following electrochemical techniques:

### Voltammetric techniques

- |                            |     |
|----------------------------|-----|
| ▪ Linear Sweep Voltammetry | LSV |
| ▪ Cyclic Voltammetry       | CV  |
| ▪ Fast Cyclic Voltammetry  | FCV |
| ▪ AC Voltammetry           | ACV |

### Pulsed techniques

- |                                  |     |
|----------------------------------|-----|
| ▪ Differential Pulse Voltammetry | DPV |
| ▪ Square Wave Voltammetry        | SWV |
| ▪ Normal Pulse Voltammetry       | NPV |

These methods can all be used in their stripping modes which are applied for (ultra-) trace analysis.

### Amperometric techniques

- |   |      |
|---|------|
| ▪ Chronoamperometry                     | CA   |
| ▪ Zero Resistance Amperometry           | ZRA  |
| ▪ Chronocoulometry                      | CC   |
| ▪ MultiStep Amperometry                 | MA   |
| ▪ Fast Amperometry                      | FAM  |
| ▪ Pulsed Amperometric Detection         | PAD  |
| ▪ Multiple-Pulse Amperometric Detection | MPAD |

### Galvanostatic techniques

- |                                 |            |
|---------------------------------|------------|
| ▪ Linear Sweep Potentiometry    | LSP        |
| ▪ Chronopotentiometry           | CP         |
| ▪ MultiStep Potentiometry       | MP         |
| ▪ Open Circuit Potentiometry    | OCP        |
| ▪ Stripping Chronopotentiometry | SCP or PSA |

### Other

- |   |          |
|---|----------|
| ▪ Mixed Mode  | MM       |
| ▪ Potentiostatic/Galvanostatic Impedance spectroscopy | EIS/GEIS |
| ○ Potential scan or current scan                      |          |
| ○ Fixed potential or fixed current                    |          |
| ○ Time scan   |          |

# PSTrace: Software for Windows

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



Switch between plots if curves with different units are available.

**Method Editor**

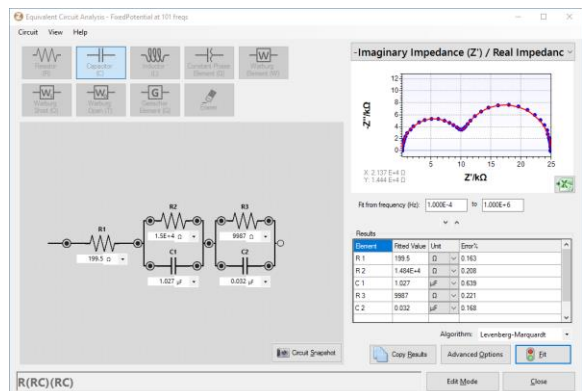
**Measurement data and curves**

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 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](http://www.palmsens.com/software)



## PStouch: App for Android



PStouch is an app for Android devices compatible with all PalmSens, EmStat and Sensit potentiostats. Works 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 measurement data directly via any service like email 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 PStouch software for Windows.

For more information about our software visit:

[www.palmsens.com/software](http://www.palmsens.com/software)



Download PStouch for free in the Google Play Store

## PalmSens4 Measurement Specifications

The following table shows limits for technique-specific parameters.

	Parameter	Min	Max
<b>All techniques (unless otherwise specified)</b>	Conditioning time	0	1600 s
	Deposition time	0	1600 s
	Equilibration time	0	1600 s
	Step potential	0.076 mV	250 mV
	Pulse potential	0.076 mV	250 mV
	N data points	3	1,000,000
<ul style="list-style-type: none"> <li>▪ Normal Pulse Voltammetry (NPV)</li> <li>▪ Differential Pulse Voltammetry (DPV)</li> </ul>	Scan rate	0.1 mV/s (76.3 $\mu$ V step)	100 mV/s (5 mV step)
	Pulse time	10 ms	100 mV/s (5 mV step)
<ul style="list-style-type: none"> <li>▪ Square Wave Voltammetry (SWV)</li> </ul>	Frequency	1 Hz	1250 Hz <sup>1</sup>
<ul style="list-style-type: none"> <li>▪ AC Voltammetry (ACV)</li> </ul>	Frequency	1 Hz	2000 Hz
<ul style="list-style-type: none"> <li>▪ Linear Sweep Voltammetry (LSV)</li> </ul>	Scan rate	0.01 mV/s (76.3 $\mu$ V step)	500 V/s (10 mV step)
<ul style="list-style-type: none"> <li>▪ Cyclic Voltammetry (CV)</li> </ul>	Scan rate	0.01 mV/s (76.3 $\mu$ V step)	500 V/s (200 mV step)
<ul style="list-style-type: none"> <li>▪ Fast Cyclic Voltammetry (CV)</li> </ul>	Scan rate	0.4 V/s (76.3 $\mu$ V step)	500 V/s (10 mV step)
	N averaged scans	2	255
	N equilibration scans	1	255
<ul style="list-style-type: none"> <li>▪ Pulsed Amperometric Detection (PAD)</li> </ul>	Interval time	50 ms	300 s
	Pulse time	1 ms	1 s
	N data points		1,000,000 (> 100 days at 10 s interval)
<ul style="list-style-type: none"> <li>▪ Multiple-Pulse Amperometric Detection (MPAD)</li> </ul>	Pulse time	100 ms	2 s
	Run time	1.2 s	100,000 s
	N potential levels	3	3
<ul style="list-style-type: none"> <li>▪ Chronoamperometry (CA)</li> <li>▪ Chronopotentiometry (CP)</li> <li>▪ Open Circuit Potentiometry (OCP)</li> </ul>	Interval time	0.4 ms	300 s
	Run time	1 ms	> year
	When applying multiple potential or current levels:		
	N cycles	1	20,000
	N levels	1	255
	Level switching overhead time	+/-80 ms	
<ul style="list-style-type: none"> <li>▪ Fast Amperometry (FAM)</li> </ul>	Interval time	0.02 ms	1 s
	Run time	1 ms	30 s
	N data points	3	4000 for interval time < 0.2 ms

<sup>1</sup> PSTrace provides the option to measure forward and reverse currents separately.

## PalmSens4 System Specifications

General			
▪ <b>dc-potential range</b>	model	PS4.F#.05	PS4.F#.10
		±5 V	±10 V
▪ <b>compliance voltage</b>	±10 V		
▪ <b>maximum current</b>	±30 mA (typical)		
▪ <b>max. acquisition rate</b>	150,000 points/s		

Potentiostat (controlled potential mode)	
▪ <b>applied dc-potential resolution</b>	76.3 $\mu$ V
▪ <b>applied potential accuracy</b>	$\leq 0.1\%$ ±1 mV offset
▪ <b>current ranges</b>	100 pA to 10 mA (9 ranges)
▪ <b>measured current accuracy</b>	$\leq 0.1\%$ at Full Scale Range
▪ <b>measured current resolution</b>	0.005% of current range (5 fA on 100 pA range) 0.0025% of 10 mA range

Galvanostat (controlled current mode)	
▪ <b>current ranges</b>	1 nA to 10 mA (8 ranges)
▪ <b>applied dc-current range</b>	$\pm 6 \times$ applied current range
▪ <b>applied dc-current resolution</b>	0.0076% of applied current range (<10 mA) 0.0038% of 10 mA range
▪ <b>measured dc-potential resolution</b>	78 $\mu$ V at $\pm 10$ V (gain 1) 7.8 $\mu$ V at $\pm 1$ V (gain 10) 0.78 $\mu$ V at $\pm 0.1$ V (gain 100)
▪ <b>measured dc-potential accuracy</b>	$\leq 0.05\%$ or $\pm 1$ mV (for $ E  < \pm 9$ V) $\leq 0.2\%$ (for $ E  \geq \pm 9$ V)

FRA / EIS (impedance measurements)			
▪ <b>frequency range</b>	model	PS4.F1.##	PS4.F2.##
		10 $\mu$ Hz to 100 kHz	10 $\mu$ Hz to 1 MHz
▪ <b>ac-amplitude range</b>	1 mV to 0.25 V rms, or 0.7 V p-p		

GEIS (galvanostatic impedance measurements)			
▪ <b>frequency range</b>	model	PS4.F1.##	PS4.F2.##
		10 $\mu$ Hz to 100 kHz	10 $\mu$ Hz to 100 kHz
▪ <b>ac-amplitude range</b>	0.001 x CR to 0.4 x CR (<10 mA) 0.001 x CR to 0.2 x CR (10 mA) (CR=current range)		

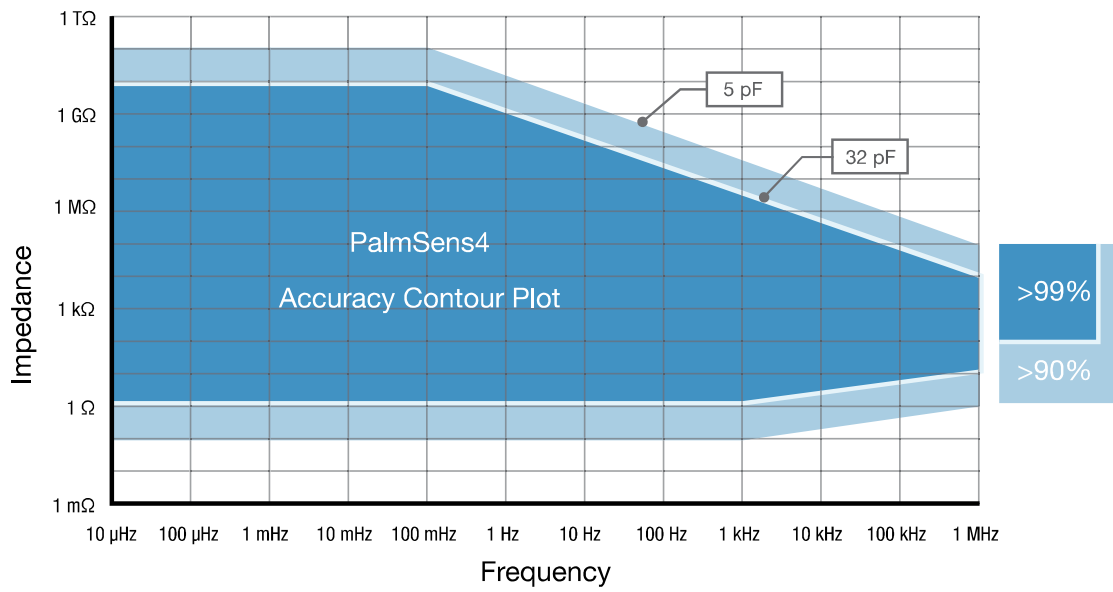
Electrometer	
▪ <b>electrometer amplifier input</b>	$> 1$ T $\Omega$ // 10 pF
▪ <b>bandwidth</b>	1 MHz



Other	
▪ <b>electrode connections</b>	2 mm banana pins for RE, WE, CE and GND
▪ <b>housing</b>	aluminium body with rubber sleeve: 15.7 x 9.7 x 3.5 cm <sup>3</sup>
▪ <b>weight</b>	+/- 500 g
▪ <b>temperature range</b>	0 °C to +50 °C
▪ <b>power supply</b>	USB or internal LiPo battery
▪ <b>communication</b>	USB and Bluetooth
▪ <b>battery time</b>	> 16 hours idle time > 5 hours idle time with BiPot module installed > 4 hours with cell on at max. current Extendible by means of power bank
▪ <b>internal storage space</b>	8 GB or +/- 800000 measurements incl. method parameters (assuming 200 data points per measurement)

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

## PalmSens4 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	
▪ <b>dc-potential range</b>	±5 V
▪ <b>dc-potential resolution</b>	153 $\mu$ V
▪ <b>dc-offset error</b>	≤ 0.1% ±1 mV offset
▪ <b>accuracy</b>	≤ 0.1%
▪ <b>current ranges</b>	100 pA to 10 mA (9 ranges)
▪ <b>maximum measured current</b>	$i(\text{WE1}) + i(\text{WE2}) < 30 \text{ mA}$
▪ <b>current resolution</b>	0.005% of current range (5 fA on 100 pA range) 0.0025% of 10mA range
▪ <b>current accuracy</b>	≤ 0.1% at Full Scale Range all with additional 0.2% offset error
▪ <b>connection</b>	Comes with a sensor cable with an additional (yellow) connector for WE2
▪ <b>power</b>	Comes with additional USB Y-cable for extra power

Supported techniques for use with BiPot:

- Linear Sweep Voltammetry
- Cyclic Voltammetry
- Chronoamperometry
- Multistep Amperometry

### 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	
▪ <b>Method used for iR-drop compensation</b>	Positive Feedback
▪ <b>Resolution of MDAC used for correcting potential</b>	16-bit
▪ <b>Max. compensated resistance</b>	1 MOhm
▪ <b>Max. bandwidth with iR-drop compensation enabled</b>	10 kHz

## Standard PalmSens4 Configuration

A standard PalmSens4 includes a rugged carrying case with:

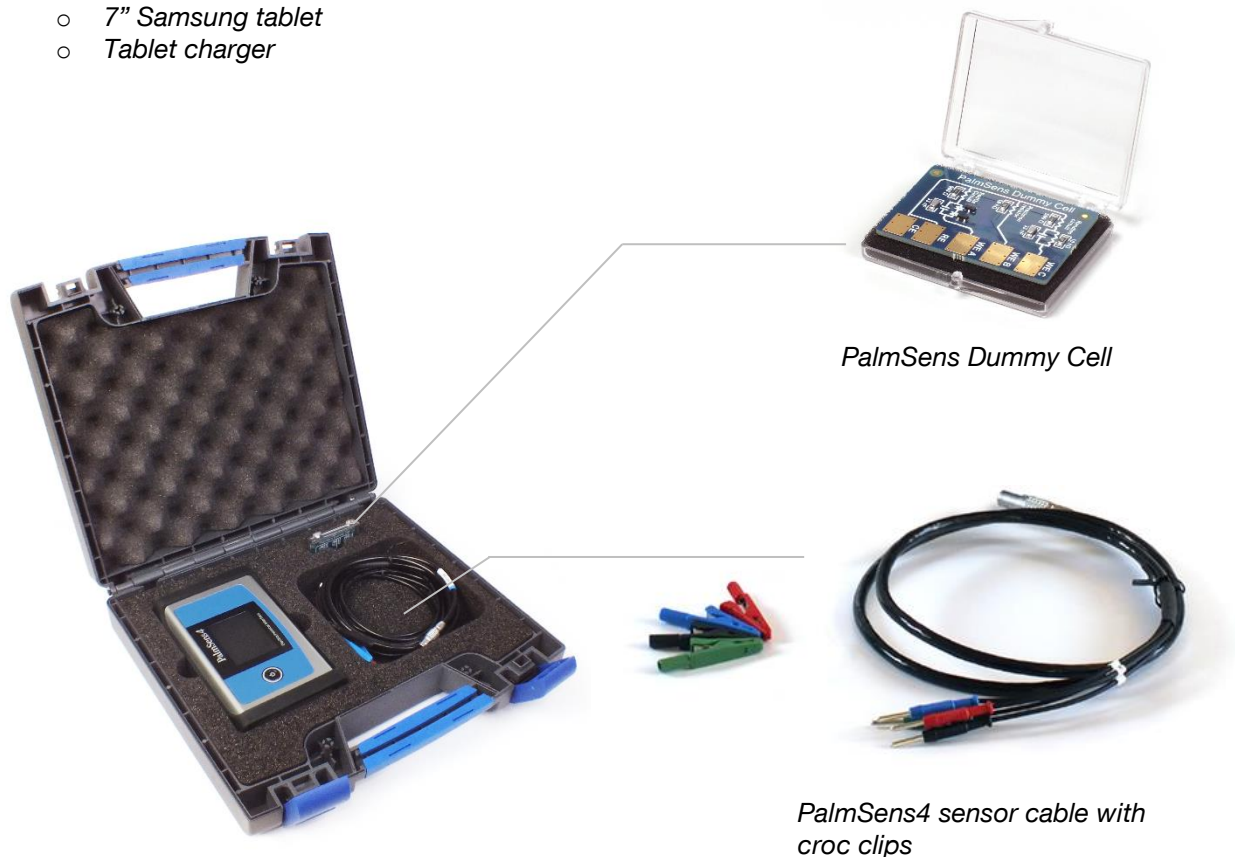
- PalmSens4
- USB cable
- Sensor cable
- 4 croc clips
- PalmSens Dummy Cell

Also included:

- PSTrace software (on USB drive)
- Manual (hardcopy)
- Quick Start document
- Calibration report

Optional

- 7" Samsung tablet
- Tablet charger



*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 PStTrace software supports this module for linear sweep, cyclic voltammetry and amperometric detection with two working electrodes.

*See page 10 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 10 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 devices.

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](mailto:info@palmSens.com)

**PalmSens BV**  
**The Netherlands**  
[www.palmSens.com](http://www.palmSens.com)

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