PalmSens4 ™

POTENTIOSTAT / GALVANOSTAT / IMPEDANCE ANALYZER

Contents

❯ See for more information:
www.palmsens.com/palmsens4

PalmSens

PalmSens4: Compact, Versatile and Powerful

BiPot and iR Compensation (optional)

Wireless Bluetooth or USB connection

Shipped in rugged carrying case (see page 10)

Battery and USB powered

EIS up to 1 MHz

Aluminium body in a rugged rubber sleeve

18-bit resolution

8 GB internal storage

software for Windows and Android

Always a backup

The PalmSens4 is equipped with internal storage memory of 8 GB. This means all your measurements[1] 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.

[1] Not supported for internal storage: EIS, MultiStep and MixedMode

Available configurations

The PalmSens4 is available with a ±5V or ±10V dc-potential range and with different maximum frequencies for FRA / EIS. The following table shows the available configurations with corresponding 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

❯ Configure your ideal PalmSens4:
www.palmsens.com/palmsens4

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 and Galvanostatic Impedance spectroscopy   **EIS/GEIS**
  at fixed frequency or frequency scan vs
  - fixed potential or fixed current
  - scanning potential or scanning current
  - time

System Specifications

General		
	PS4.F#.05	PS4.F#.10
▪ dc potential range	±5 V	±10 V
▪ compliance voltage	±10 V	
▪ maximum current	±30 mA (typical)	

Potentiostat (controlled potential mode)	
▪ applied dc-potential resolution	76.3 µV (18-bit)
▪ applied potential accuracy	≤ 0.1% or ±1 mV offset
▪ current ranges	100 pA to 10 mA (9 ranges)
▪ measured current accuracy	< 0.2% of current ±10 pA ±0.1% of range
▪ measured current resolution	0.005% of current range (18-bit, 5 fA on 100 pA range) 0.0025% of 10 mA range

Galvanostat (controlled current mode)	
▪ current ranges	1 nA to 10 mA (8 ranges)
▪ applied dc-current	±6 x applied current range
▪ applied dc-current resolution	0.0076% of applied range (<10 mA) 0.0038% of 10 mA range
▪ applied dc-current accuracy	< 0.2% of current ±10 pA ±0.1% of range
▪ potential ranges	10 mV, 100 mV, 1 V
▪ measured dc-potential resolution	78 µV at ±10 V (1 V range, 18-bit) 7.8 µV at ±1 V (100 mV range) 0.78 µV at ±0.1 V (10 mV range)
▪ measured dc-potential accuracy	≤ 0.05% for |E| <9 V, ≤ 0.2% for |E| ≥9 V or ±1 mV offset

FRA / EIS (impedance measurements)		
config	PS4.F1.##	PS4.F2.##
▪ frequency range	10 µHz to 100 kHz	10 µHz to 1 MHz
▪ ac-amplitude range	1 mV to 0.25 V rms, or 0.7 V p-p	

| GEIS (galvanostatic impedance measurements)	
▪ frequency range	10 µHz to 100 kHz (all configurations)
▪ ac-amplitude range	0.001 * CR to 0.4 * CR rms (<10 mA) 0.001 * CR to 0.2 * CR rms (10 mA) (CR=current range)

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

Other	
▪ electrode connections	2 mm banana pins for RE, WE, CE and GND
▪ housing	aluminium body with rubber sleeve: 15.7 x 9.7 x 3.5 cm
▪ weight	~ 500 g
▪ temperature range	0 ºC to +50 ºC[1]
▪ power supply	USB or internal LiPo battery
▪ communication	USB and Bluetooth
▪ battery time	> 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
▪ internal storage space	8 GB (or >100 million datapoints)

Auxiliary port (D-Sub 15)	
▪ analog input	±10 V, 18-bit
▪ analog output	0-10 V, 12-bit (1 kOhm output impedance)
▪ digital I/O	4x digital output (5 V) 1x 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)

[1] All the components of the PalmSens4 are rated to the industrial standard of -40 °C to +85 °C The battery of the PalmSens4 is rated -20 °C to +60 °C when discharging and rated 0 °C to +45 °C when charging. The PalmSens4 is calibrated at 21 °C . The most sensitive components of the PalmSens4 have a temperature drift of 50 ppm. At 1°C or 41 °C, measurement drift of up to 0.1% may be experienced.

EIS Contour Accuracy Plot
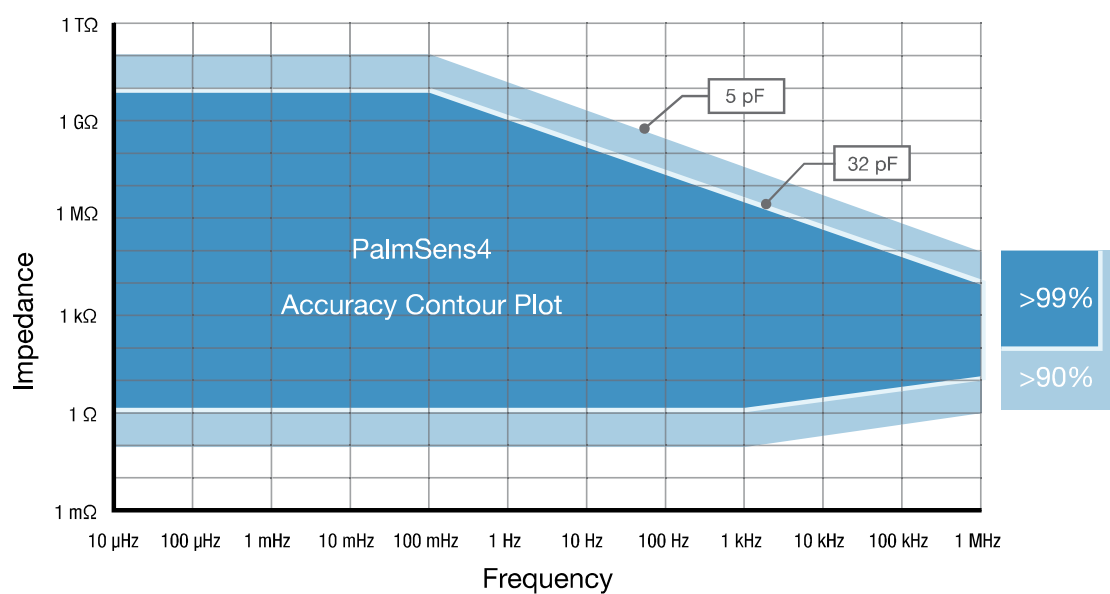
Note

The accuracy contour plot was determined under lab conditions using the standard 1 meter cell cable 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.

Measurement Specifications

The following table shows limits for some technique-specific parameters.

	Parameter	Min	Max
All techniques (unless otherwise specified)	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
▪ NPV ▪ DPV	Scan rate	0.1 mV/s (76.3 µV step)	100 mV/s (5 mV step)
	Pulse time	10 ms	300 ms
▪ SWV	Frequency	1 Hz	1250 Hz
▪ ACV	Frequency	1 Hz	2000 Hz
▪ LSV	Scan rate	0.01 mV/s (76.3 µV step)	500 V/s (10 mV step)
▪ CV	Scan rate	0.01 mV/s (76.3 µV step)	500 V/s (200 mV step)
▪ FCV	Scan rate	400 mV/s (76.3 µV step)	500 V/s (10 mV step)
	N averaged scans	2	255
	N equilibration scans	1	255
▪ PAD	Interval time	50 ms	300 s
	Pulse time	1 ms	1 s
	N data points		1,000,000 (> 100 days at 10 s interval)
▪ MPAD	Pulse time	100 ms	2 s
	Run time	1.2 s	100,000 s
	N potential levels	3	3
▪ CA ▪ CP ▪ OCP	Interval time	0.4 ms	300 s
	Run time	1 ms	> year
▪ MM ▪ MA ▪ MP	N cycles	1	20,000
	N levels	1	255
	Level switching overhead time	~80 ms	
▪ FAM	Interval time	0.02 ms	1 s
	Run time	1 ms	30 s
	N data points	3	4000 for interval time < 0.2 ms
▪ EIS	Interval time between measuring frequencies	~900 ms	

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	153 μV (16-bit)
▪ 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	0.005% of current range (5 fA on 100 pA range) 0.0025% of 10mA range
▪ current accuracy	≤ 0.1% current, ±0.2% range
▪ connection	comes with a cell cable with an additional connector for WE2
▪ supported techniques	▪ Linear Sweep Voltammetry ▪ Cyclic Voltammetry ▪ Chronoamperometry ▪ Multistep Amperometry

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 Kit

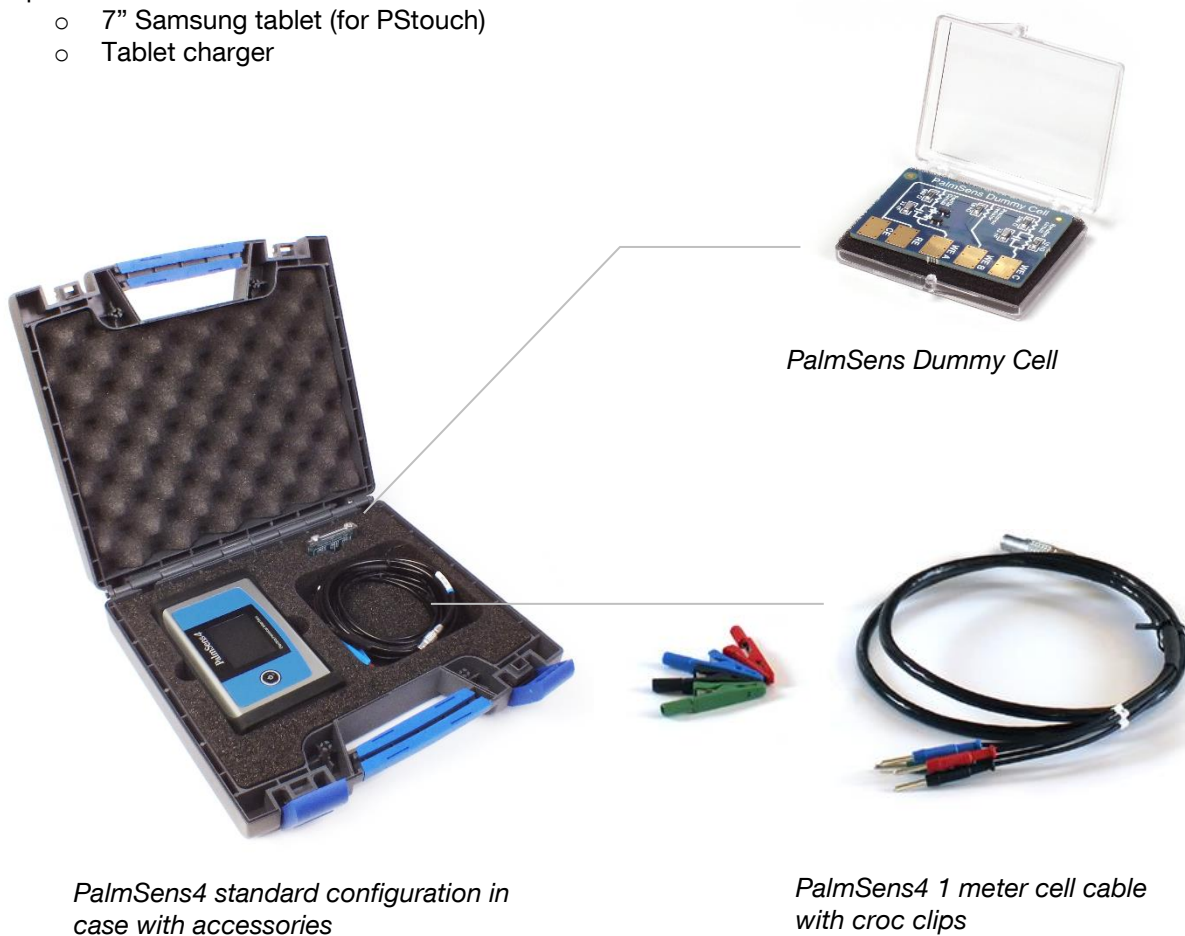A standard PalmSens4 kit includes a rugged carrying case with:
- PalmSens4
- USB cable
- 1 meter cell cable with 2 mm banana pins
- 4 croc clips
- PalmSens Dummy Cell

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

Optional:
o 7" Samsung tablet (for PStouch)
o Tablet charger

PalmSens Dummy Cell

PalmSens4 standard configuration in case with accessories

PalmSens4 1 meter cell cable with croc clips

PalmSens4 Accessories

In-factory add-on modules

BiPot add-on 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 9 for BiPot specifications

iR Compensation add-on 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 cells, switching RE, CE, WE1 and WE2.
In 8-WE mode it can measure up to eight working electrodes on sensor arrays with shared reference and counter electrodes as well. The MUX8-R2 is stackable up to 128 channels.

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

TMP36 temperature sensor

This temperature sensor allows for monitoring of temperature during an experiment.
The TMP36 provides accuracies of ±1°C at +25°C and ±2°C over the −40°C to +125°C temperature range.The supply current runs well below 50 µA, providing very low self-heating, less than 0.1°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 high-precision voltage amplifier with differential input and single output to the auxiliary port of a PalmSens4.

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

❯ See for more information:
www.palmsens.com/accessories

PSTrace: Software for Windows

PSTrace is designed to get the most out of your instrument right after installation, without going through a long learning period. It has three modes; the Scientific mode which allows you to run all the techniques our instruments have to offer, and two dedicated modes for Corrosion analysis and the Analytical Mode. The Analytical Mode is designed for use with (bio)sensors and allows you to do concentration determinations. Extensive help files and prompts guide the user through a typical analysis.

Switch between plots if curves with different units are available.
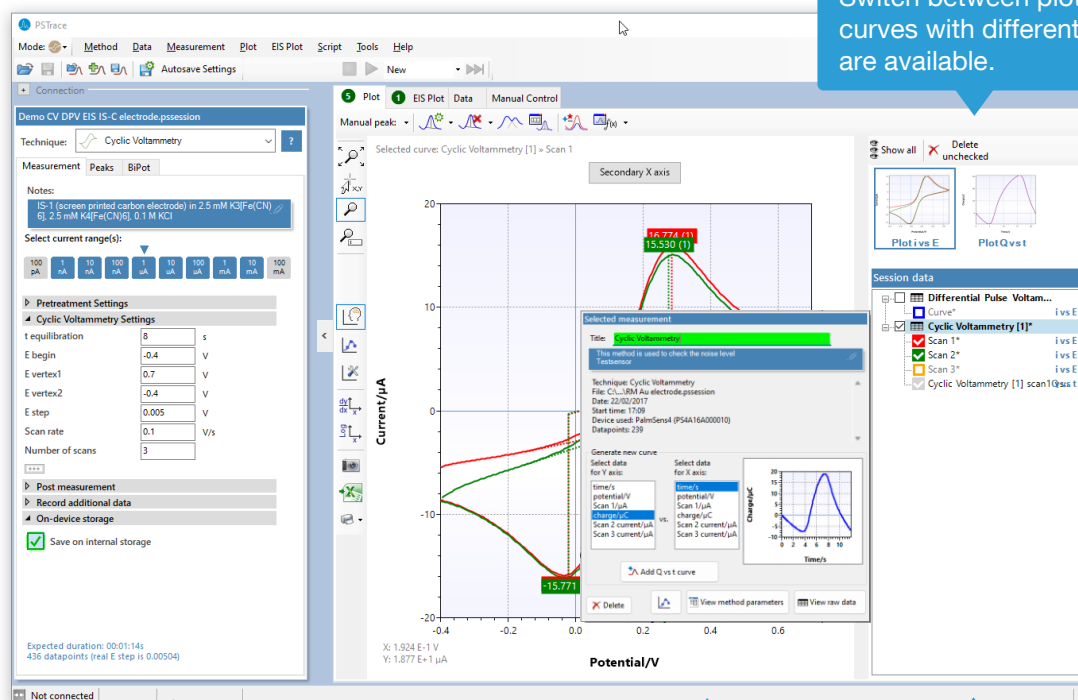
Setup your measurement easily and get immediate feedback on validity of parameters.

Click on a measurement for detailed information or generating new curves.

Quickly toggle the visibility of curves or groups of curves.

Scripting

The intuitive script editor allows for easily creating a sequence of measurements or other tasks, by means of dragging and dropping actions in a list.
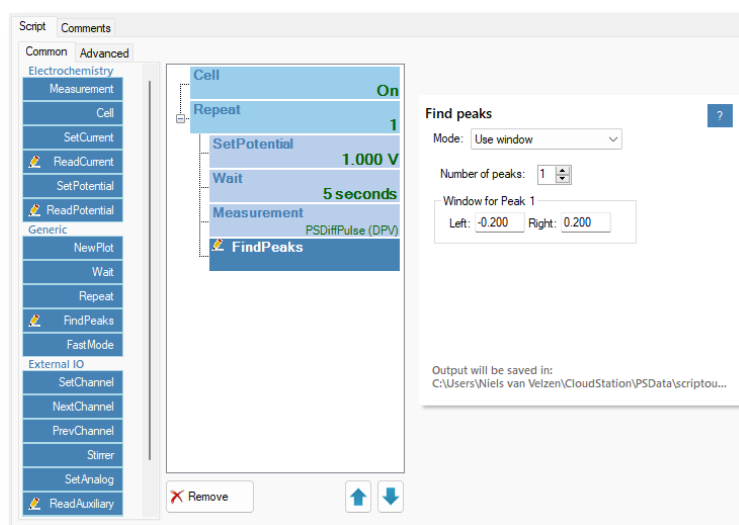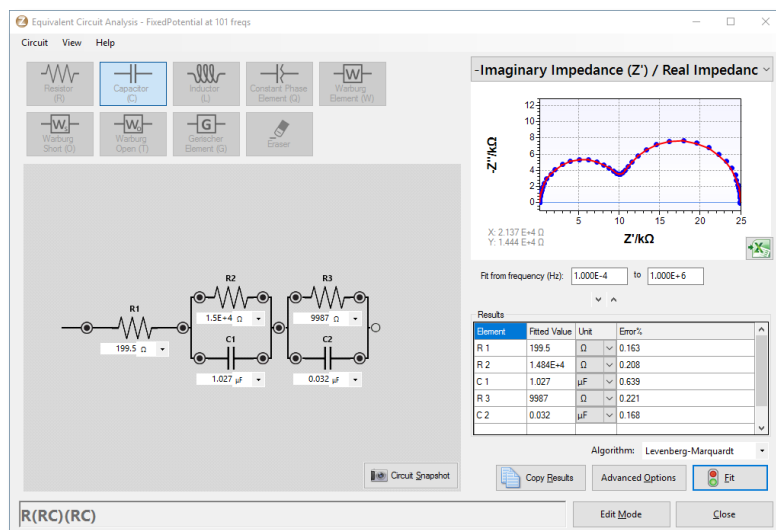
Use the graphical editor to draw the equivalent circuit or enter the CDC directly.

Corrosion mode for Tafel plot analysis and other corrosion data analysis.

Other functions in PSTrace

- Concentration determination
- Advanced peak search algorithms
- 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
- Load measurements from the internal storage
- Direct validation of method parameters
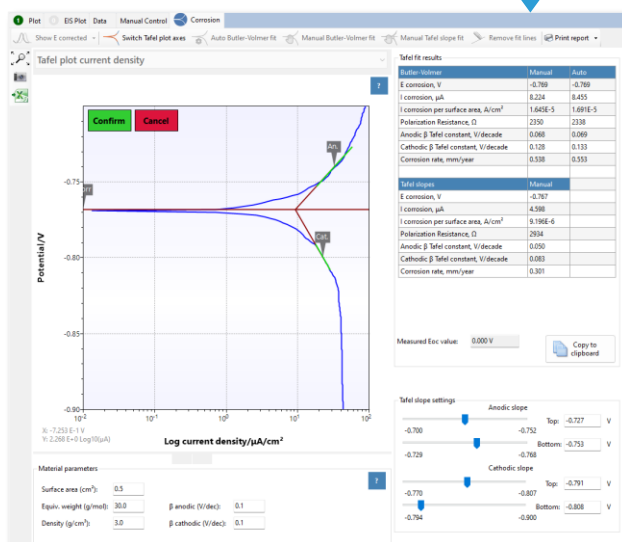
Integration with third party software

- Excel
- Origin
- Matlab
- ZView

Minimum System Requirements

- Windows 7, 8, 10 or 11
- 1 GHz or faster 32-bit (x86) or 64-bit (x64) processor
- 2 GB RAM (32-bit) or 4 GB RAM (64-bit)
- Screen resolution of 1280 x 800 pixels

❯ See for more information:
www.palmsens.com/pstrace

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 PSTrace software for Windows.

> See for more information:
www.palmsens.com/pstouch

Software Development Kits for .NET

Develop your own application in no time for use with any PalmSens instrument or potentiostat (module). Our SDKs are free of charge.

There are three PalmSens Software Development Kits (SDKs) for .NET. Each SDK can be used with any of our instruments or OEM potentiostat modules to develop your own software. The SDK's come with a set of examples that shows how to use the libraries. PalmSens SDKs with examples are available for the following .NET Frameworks:

- WinForms
- Xamarin (Android)
- WPF

Each SDK comes with code examples for:
- Connecting
- Running measurements and plotting data
- Manual control of the cell
- Accessing and processing measured data
- Analyzing and manipulating data
- Peak detection
- Equivalent Circuit Fitting on impedance data
- Saving and loading files

❯ See for more information:
www.palmsens.com/sdk

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

PalmSens BV
The Netherlands
www.palmsens.com

DISCLAIMER
Changes in specifications and typing errors reserved. Every effort has been made to ensure the accuracy of this document. However, no rights can be claimed by the contents of this document.

PalmSens