

POTENTIOSTAT / GALVANOSTAT / IMPEDANCE ANALYZER





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



PalmSens4: Compact, Versatile and Powerful



Available configurations

The PalmSens4 is available with a $\pm 5V$ or $\pm 10V$ 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
-	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
 Potentiostatic and Galvanostatic Impedance spectroscopy at fixed frequency or frequency scan vs
 fixed potential or fixed current
 - fixed potential or fixed current
 - \circ scanning potential or scanning current
 - \circ 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 	\leq 0.1% or ±1 mV offset
current ranges	100 pA to 10 mA (9 ranges)
 measured current accuracy 	< 0.2% of current $\pm 10 \text{ pA} \pm 0.1\%$ 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 	$\leq 0.05\%$ for E <9 V, $\leq 0.2\%$ for E $\geq \! 9$ 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 р-р

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)



PalmSens4 Potentiostat / Galvanostat / Impedance Analyzer

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 °C to +50 °C1
 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

	Parameter	Min	Max
	Conditioning time	0	1600 s
	Deposition time	0	1600 s
All techniques (unless otherwise	Equilibration time	0	1600 s
	Step potential	0.076 mV	250 mV
opeomeay	Pulse potential	0.076 mV	250 mV
	N data points	3	1,000,000
• NPV	Scan rate	0.1 mV/s (76.3 µV step)	100 mV/s (5 mV step)
• DPV	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)
	Scan rate	400 mV/s (76.3 µV step)	500 V/s (10 mV step)
• FCV	N averaged scans	2	255
	N equilibration scans	1	255
	Interval time	50 ms	300 s
DAD	Pulse time	1 ms	1 s
PAD	N data points		1,000,000 (> 100 days at 10 s interval)
	Pulse time	100 ms	2 s
• MPAD	Run time	1.2 s	100,000 s
	N potential levels	3	3
• CA	Interval time	0.4 ms	300 s
• OCP	Run time	1 ms	> year
	N cycles	1	20,000
• MM • MA	N levels	1	255
• MP	Level switching overhead time	~80 ms	
	Interval time	0.02 ms	1 s
• FAM	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	

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



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 	\leq 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 	\leq 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





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 $\pm 1^{\circ}$ C at $\pm 2^{\circ}$ C and $\pm 2^{\circ}$ C over the -40° C to $\pm 125^{\circ}$ C temperature range. The supply current runs well below 50 μ A, 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



PalmSens



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.



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.

Common Advanced		
Electrochemistry	Cell	
Measurement	On	
Cell	Repeat	Find peaks ?
SetCurrent	C = (D = t = t)=1	Mode: Use window
A DeedCorrect		
	Wait	Number of peaks: 1 ≑
SetPotential	5 seconds	Window for Deals 1
🙋 ReadPotential	Measurement	Window for Peak 1
Generic	PSDiffPulse (DPV)	Left: -0.200 Right: 0.200
NewPlot	🙎 FindPeaks	
Wait		
Derect		
nepeat		
🖉 FindPeaks		
FastMode		
External IO		Output will be saved in:
SetChannel		C:\Users\Niels van Velzen\CloudStation\PSData\scriptou
NextChannel		
Description of the		
Prevenannel		
Stirrer		



PalmSens4 Potentiostat / Galvanostat / Impedance Analyzer



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 BAM (32-bit) or 4 GB BAM (64-bit)
- 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 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

/// </summary>
Ireference
private void InitMethod()
{
 _methodEIS = new ImpedimetricMethod();
 _methodEIS.ScanType = ImpedimetricMethod.enumScanT
 _methodEIS.Potential = 0.0f; //0.0V DC potential
 _methodEIS.FreqType = ImpedimetricMethod.enumFrequ
 _methodEIS.MinFrequency = 10f; //Max frequency is
 _methodEIS.nFrequencies = 11; //Sample at 11 diffe

_methodEIS.EquilibrationTime = 1f; //Equilabrates _methodEIS.Ranging.StartCurrentRange = new Current _methodEIS.Ranging.MinimumCurrentRange = new Curren _methodEIS.Ranging.MaximumCurrentRange = new Current _methodEIS.Ranging.MaximumCurrentRange = new CurrentRange = ne

> See for more information:

www.palmsens.com/sdk



Please do not hesitate to contact PalmSens for more details: info@palmsens.com

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