PalmSens

Compact Electrochemical Interfaces

PalmSens3

potentiostat/galvanostat/impedance analyser

Rev. 9-2014

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potentiostat/galvanostat/impedance

PalmSens3 is a battery-powered, handheld instrument which allows the application of most of the relevant voltammetric, amperometric and potentiometric techniques as well as impedance spectroscopy.

PSTrace for Windows provides all requirements for using PalmSens^3.
PStouch for Android is also available for use with PalmSens^3
See for more information: www.palmsens.com/software

The available methods are:

Voltammetric techniques

▪ Linear Sweep Voltammetry	LSV
▪ Differential Pulse Voltammetry	DPV
▪ Square Wave Voltammetry	SWV
▪ Normal Pulse Voltammetry	NPV
▪ ac Voltammetry	acV
▪ Cyclic Voltammetry	CV
▪ Stripping Chronopotentiometry (or PSA)	SCP

Note: these techniques can also be used for stripping voltammetry

Techniques as a function of time

▪ Amperometric Detection	AD
▪ Pulsed Amperometric Detection	PAD
▪ Multiple Pulse Amperometric Detection	MPAD
▪ Fast Amperometry	FAMP
▪ Potentiometry	POT
▪ Open Circuit Potentiometry	OCP
▪ Multistep Amperometry	MA
▪ Multistep Potentiometry	MP

Impedance spectroscopy / EIS

- Potential scan
- Fixed potential
- Time scan

A potential scan can be done at fixed frequency or making a frequency scan at each potential.

The current is measured using a **zero resistance ammeter** (ZRA).

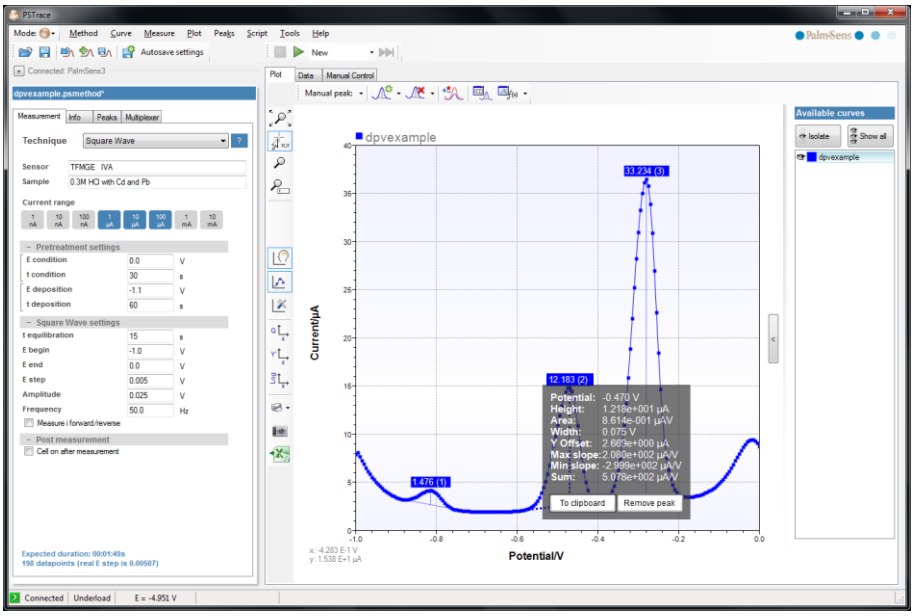
Where possible, the electrochemical techniques can be applied using **auto ranging** which means that the instrument automatically sets the optimal current range. The user can specify the highest as well as lowest current range which might be selected automatically.

See page 8 for instrumental specifications.

PSTrace main features

Data analysis

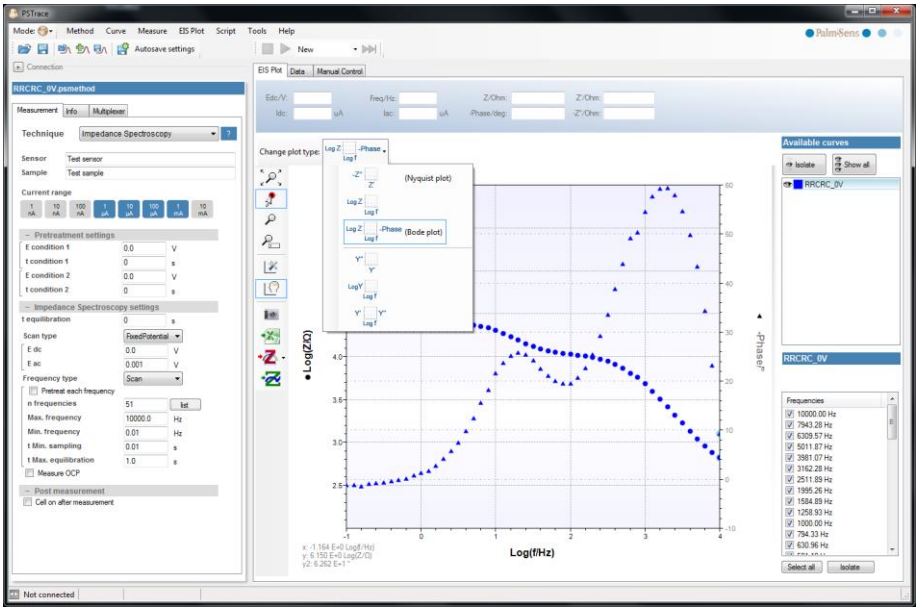
PSTrace performs automatic as well as interactive peak detection and shows the peak potential, height, area, and width. Linear regression or integration can be performed on a marked part of the obtained curve. Smoothing of the measured curve is possible with a number of different levels. Curves can be subtracted from each other or subtracted with a (non-)linear baseline.



PSTrace in Scientific mode (default)

Electrochemical Impedance Spectroscopy EIS (or FRA)

PSTrace switches it's layout automatically as soon as the impedance technique is selected or impedance data has been loaded.



PSTrace showing interface for impedance spectroscopy

Output
Data files can be stored (automatically) and loaded. These files are standard ASCII files and can easily be imported in other programs. With each data file a file with the method parameters is created and the user can create an additional text file (in Word format) with comments or information.

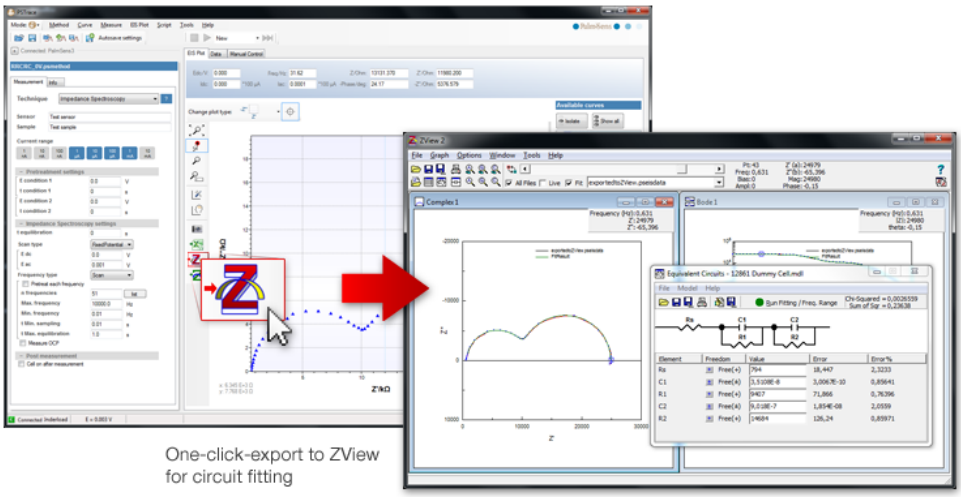
Excel
With one click of a button the measured curves are exported from PSTrace to Excel and converted to a (Excel native) graph object.

Multiplexer support
PSTrace supports the MUX8 or MUX16 multiplexer for PalmSens. Voltammetric scans can be measured on all 16 or 8 channels consecutively and stored in a single data file. Amperometric detection can be done simultaneously on all channels, with a minimum interval time of 0.25 s (MUX8).

Stirrer support
PalmSens is capable of controlling a stirrer. PalmSens has to be equipped with an optional module for this purpose. The stirrer is automatically switched on during the conditioning and deposition stages and switched off during the equilibration stage and measurement.

Bipotentiostat support
PalmSens can be extended with a bipotentiostat module. The techniques linear sweep and cyclic voltammetry as well as amperometric detection can be applied using two working electrodes.

Analysis of impedance spectra / circuit modeling
PSTrace has integrated export functions for **ZView™** from Scribner Associates. ZView is a popular program for equivalent circuit modeling and data analysis. This integration allows you to export measured data from PSTrace to ZView with one click of a button. The most recent circuit diagram used remains active for each new impedance curve exported to ZView.

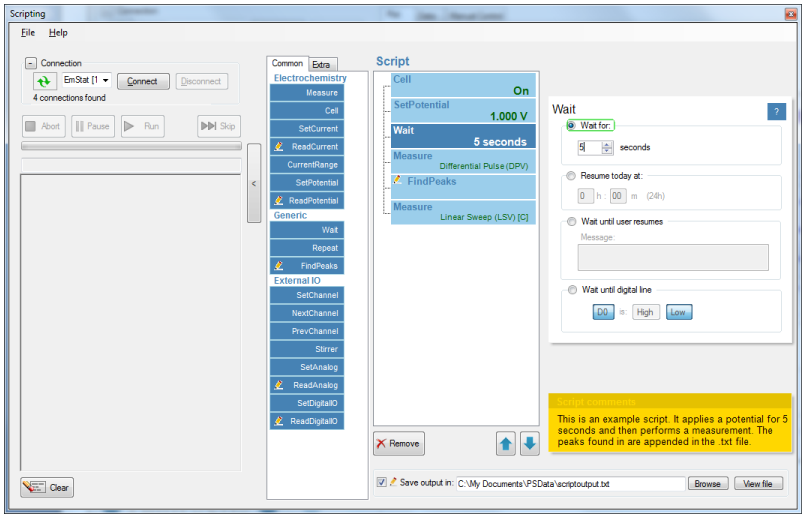


One-click-export to ZView for circuit fitting

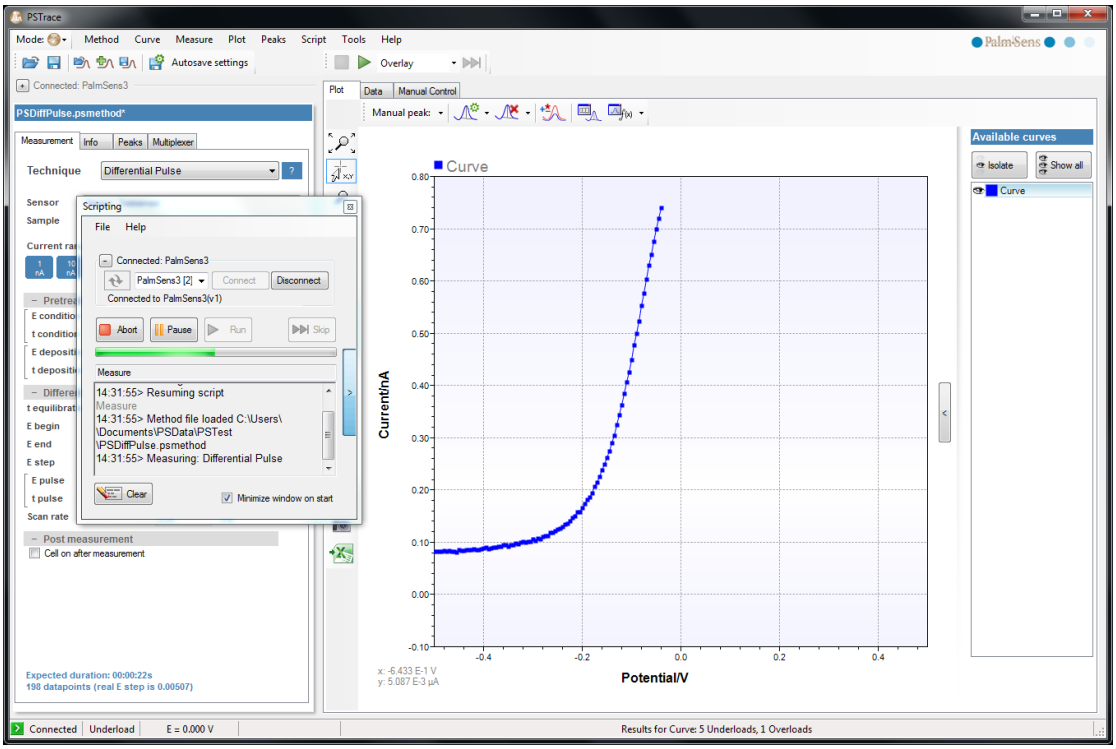
Measured impedance data can also be loaded into the **freeware program** [EIS Spectrum Analyser](#).

Scripting

PSTrace allows users to program a sequence of measurements by using Scripting. Such a sequence can include different techniques and provides control commands for the multiplexer as well as for the digital and analog input or output lines.



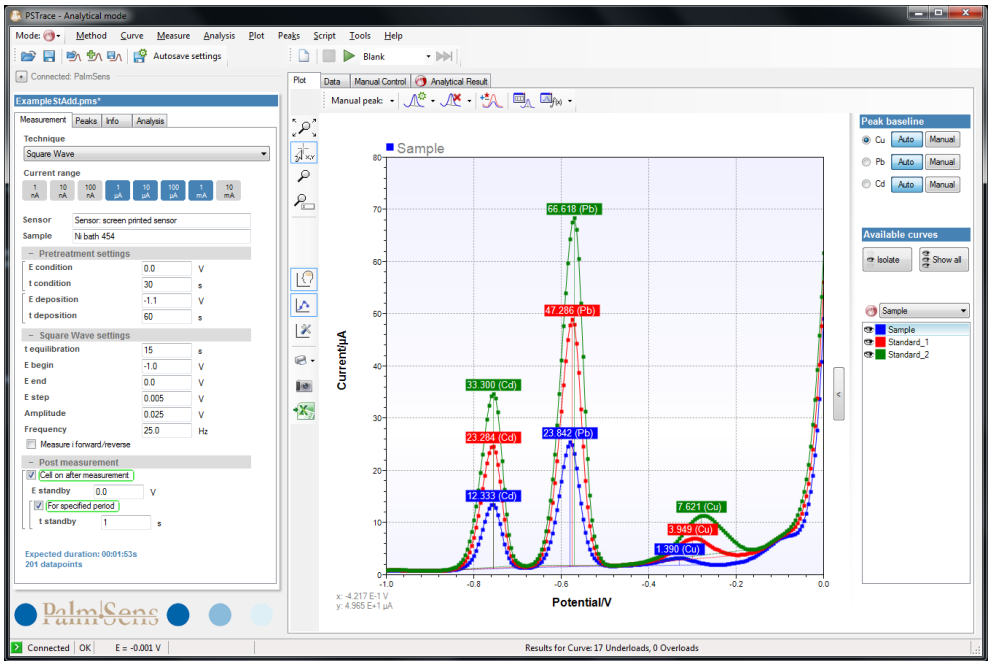
The script output and progress are shown during the run.



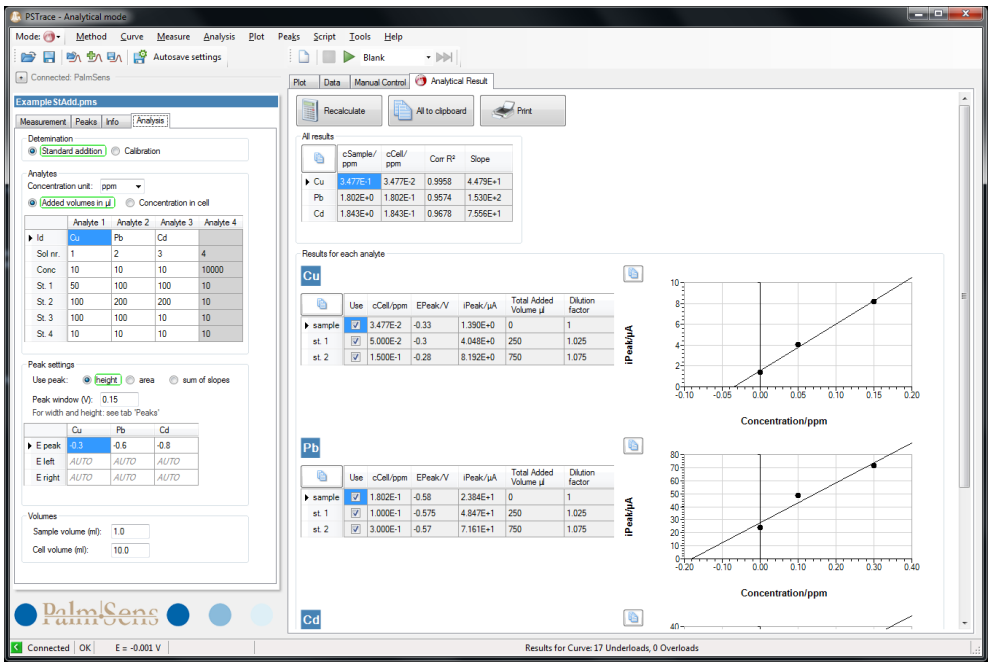
Output of the script is saved as curve files other readings or peak information is appended to a plain text file. A script can also be run directly from command prompt, making it easy to start a script from within a third party interface.

Analytical mode for quantitative analytical determinations

The Analytical mode provides the possibility to perform quantitative voltammetric analysis by means of standard addition or using a calibration curve by means of (stripping) voltammetry.



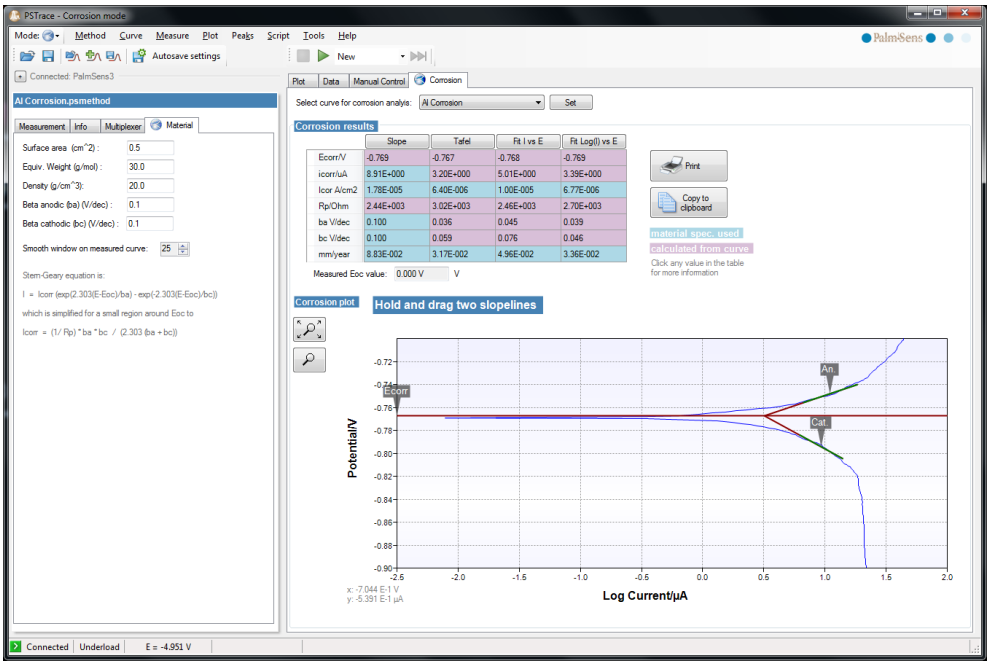
The program allows simultaneous determination of up to 4 components and with up to 4 standard additions or calibration curves. Background subtraction is also supported.



The plots and tables show the results of the voltammetric analysis.

Corrosion mode

The corrosion mode of PSTrace provides corrosion relevant data analysis:
- Linear polarization, from which the polarization resistance is obtained,
- Tafel plots, from which the corrosion rate is obtained.



The corrosion rate or polarization resistance can be obtained from the measured curve by means of drawing straight lines specified by the user or by means of a numerical fit method of the corrosion parameters using the theoretical Stern-Geary equation.

Specifications of general parameters

General pretreatment:
Apply conditioning, deposition or begin potential for: 0 – 1600 s

General voltammetric parameters:
Potential range: -5.000 V to + 5.000 V
Step potential: 0.1 mV to 250 mV
Pulse potential: 1 mV to 250 mV

Limits of some technique specific parameters for PalmSens[3]:

NPV and DPV:	Scan rate: Pulse time:	0.15 mV/s (0.15mV step) to 100 mV/s (5 mV step) 10 ms to 300 ms
SWV:	Frequency:	1 Hz to 2000 Hz [1]
SCP:	Sampling rate:	Approx. 100 kHz., max. 100 s
LSV and CV:	Scan rate:	0.01 mV/s (0.15 mV step) to 200 V/s (2 mV step)
AD and PAD:	Interval time: Pulse time: Run time: Maximum number of points:	1 ms (10 ms for PAD) to 300 s 1 ms to 1 s 10 s to 100000 s 65000
MPAD:	Pulse times: Run time: Number of potential levels: Maximum number of points:	100 ms to 2 s 10 s to 100000 s 3 65000
Fast amperometry:	Interval time: Maximum run time: Maximum number of points:	0.01 ms to 1 s 30 s 20000, but 4000 for interval time < 0.0002 s
Potentiometry at constant current or at open circuit:	Interval time: Maximum run time:	1 ms to 300 s 100000 s
Multistep amperometry and potentiometry	Interval time: Number of potential levels: Number of cycles: Maximum run time:	100 ms to 30 s 1 to 255 1 to 20000 100000 s

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.*

PalmSens3

Instrumental specifications

Controlled potential mode (potentiostat):

- dc-potential range	± 5.000 V
- compliance voltage	± 8.0 V
- dc-potential resolution	0.15 mV
- max. dc-offset error	2 mV
- accuracy	≤ 0.2 %
- current ranges	100 pA to 10 mA (9 ranges), using a ZRA (zero resistance ammeter)
- maximum current	± 30 mA (typical)
- current resolution	0.01 % of current range
- accuracy	≤ 1 % at 1 nA, 5% on 100 pA ≤ 0.5 % at 10 nA and 10 mA ≤ 0.2 % of current range at 100 nA to 1 mA all with additional 0.2 % offset error
- max. acquisition rate	200,000 pnts/s

Controlled current mode (galvanostat):

- current ranges	1 µA to 10 mA
- dc-current range	± 3.000 times selected current range
- dc-current resolution	0.01 % of selected current range
- max. dc-offset error	≤ 0.2 %
- current accuracy	≤ 0.4 %
- maximum output voltage	± 8 V

Impedance measurements:

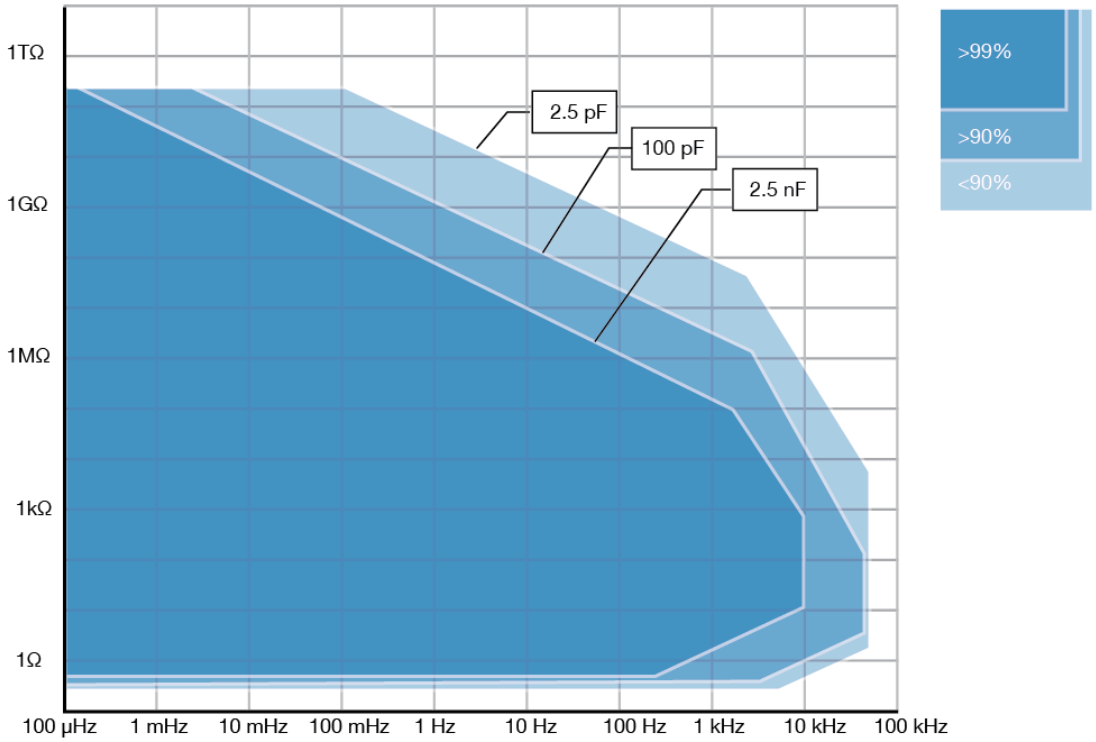
- Frequency range:	100 µHz to 50 kHz
- ac- amplitude range:	1 mV to 0.3 V (rms)

General:

- electrometer amplifier input	> 100 Gohm // 4 pF
- rise time	programmable from min. 0.5 µs
- external I/O	Analog: 1 input and 1 output channel (0 V - 3 V) Digital: 1 input and 4 output lines (3.3V)

Keypad	Run, Skip, Abort, Backlight and Power
Display	Blue, 4 lines of 16 characters with backlight
Dimensions	155 mm x 85 mm x 35 mm
Temperature range	0° C to + 40° C
Weight	0.43 kg
Power	USB and Li-ion battery
Interfacing	USB cable

Frequency Response Analyser for EIS accuracy contour 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, like cables, cell, and the instrument.

Extensions

Magnetic stirrer
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.

Optional extension MUX8 or MUX16 multiplexer
MUX8 is a multiplexer for use with 2 to 8 sensors or three-electrode cells. It is connected to the PalmSens instrument. This device allows application of sensor arrays with up to eight working electrodes sharing the reference and counter electrodes, but also with eight working, eight counter and eight reference electrodes. The device can also be used with two-electrode sensor arrays.

MUX16 is a multiplexer for use with 16 working electrodes all sharing the same counter and same reference electrode in a single solution or for 16 working electrodes each with a combined reference/counter electrode in separate solutions.

BiPot
A bipotentiostat module is available for use with two working electrodes.
This module is available in two different configurations (from factory).
Configuration 1: the second WE is kept at a constant potential
Configuration 2: the second WE scans at a fixed potential offset with respect to the first WE. In both modes the current for both WE's are simultaneously recorded in linear sweep and cyclic voltammetry as well as amperometric detection.

Other extensions
PalmSens is expandable. The external I/O possibilities provide possibilities to control external equipment as valves, stirrers, etc.
Additionally on the printed circuit board is space for an extra module. This provides the option to modify the instrument for specific sensors and applications.

Please do not hesitate to contact PalmSens for more details:
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