PalmSens Compact Electrochemical Interfaces

PalmSens3™
potentiostat / galvanostat / impedance analyser

Rev. 6-2016
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PalmSens3: potentiostat / galvanostat / impedance analyser

PalmSens3 is a battery-powered, handheld instrument which allows the application of the most relevant voltammetric, amperometric and potentiometric techniques as well as impedance spectroscopy. Each PalmSens3 is shipped in a rugged carrying case (see page 7).

PalmSens3 can be controlled by PC and tablets as well as phones using Android.

PSTrace for Windows provides support for all techniques and device functionalities.
Minimum PC requirements are:
- Windows XP, Vista, 7, 8, or 10 (32-bit or 64-bit)
- 1 gigahertz (GHz) or faster 32-bit (x86) or 64-bit (x64) processor
- 1 gigabyte (GB) RAM (32-bit) or 2 GB RAM (64-bit)

PSTouch for Android supports all techniques supported by PalmSens3.
See also the Mobile Expansion Pack on page 8.

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

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 / Chronoamperometry (AD / CA)
- 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
- Frequency scan
- 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 a highest and lowest current range in which the most appropriate range is selected automatically.

See page 5 for system specifications.
Measurement specifications

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

**General voltammetric parameters:**
<table>
<thead>
<tr>
<th></th>
<th>Potential range:</th>
<th>Step potential:</th>
<th>Pulse potential:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-5.000 V to + 5.000 V</td>
<td>0.1 mV to 250 mV</td>
<td>1 mV to 250 mV</td>
</tr>
</tbody>
</table>

**Limits of some technique specific parameters for PalmSens3:**

<table>
<thead>
<tr>
<th>Technique</th>
<th>Parameter</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPV and DPV</td>
<td>Scan rate:</td>
<td>0.15 mV/s (0.15 mV step) to 100 mV/s (5 mV step)</td>
</tr>
<tr>
<td></td>
<td>Pulse time:</td>
<td>10 ms to 300 ms</td>
</tr>
<tr>
<td>SWV</td>
<td>Frequency:</td>
<td>1 Hz to 2000 Hz</td>
</tr>
<tr>
<td>acV</td>
<td>Frequency:</td>
<td>1 Hz to 2000 Hz</td>
</tr>
<tr>
<td>SCP</td>
<td>Sampling rate:</td>
<td>Approx. 100 kHz, max. 100 s</td>
</tr>
<tr>
<td>LSV and CV</td>
<td>Scan rate:</td>
<td>0.01 mV/s (0.15 mV step) to 500 V/s (5 mV step)</td>
</tr>
<tr>
<td>AD and PAD</td>
<td>Interval time:</td>
<td>1 ms (10 ms for PAD) to 300 s</td>
</tr>
<tr>
<td></td>
<td>Pulse time:</td>
<td>1 ms to 1 s</td>
</tr>
<tr>
<td></td>
<td>Run time:</td>
<td>10 s to 100000 s</td>
</tr>
<tr>
<td></td>
<td>Maximum number of points:</td>
<td>65000</td>
</tr>
<tr>
<td>MPAD</td>
<td>Pulse times:</td>
<td>100 ms to 2 s</td>
</tr>
<tr>
<td></td>
<td>Run time:</td>
<td>10 s to 100000 s</td>
</tr>
<tr>
<td></td>
<td>Number of potential levels:</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Maximum number of points:</td>
<td>65000</td>
</tr>
<tr>
<td>Fast amperometry</td>
<td>Interval time:</td>
<td>0.01 ms to 1 s</td>
</tr>
<tr>
<td></td>
<td>Maximum run time:</td>
<td>30 s</td>
</tr>
<tr>
<td></td>
<td>Maximum number of points:</td>
<td>200000, but 4000 for interval time &lt; 0.2 ms</td>
</tr>
<tr>
<td>Potentiometry at</td>
<td>Interval time:</td>
<td>1 ms to 300 s</td>
</tr>
<tr>
<td>constant current or</td>
<td>Maximum run time:</td>
<td>100000 s</td>
</tr>
<tr>
<td>at open circuit:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multistep</td>
<td>Interval time:</td>
<td>100 ms to 30 s</td>
</tr>
<tr>
<td>amperometry and</td>
<td>Number of potential levels:</td>
<td>1 to 255</td>
</tr>
<tr>
<td>potentiometry</td>
<td>Number of cycles:</td>
<td>1 to 200000</td>
</tr>
<tr>
<td></td>
<td>Maximum run time:</td>
<td>100000 s</td>
</tr>
</tbody>
</table>

*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

### Controlled potential mode (potentiostat)
- **dc-potential range**: ± 5.000 V
- **compliance voltage**: ± 8.0 V
- **dc-potential resolution**: 0.15 mV
- **applied potential accuracy**: ≤ 0.2 % with max. 2 mV offset error
- **current ranges**: 100 pA to 10 mA (9 ranges)
- **maximum measured current**: ± 30 mA (typical)
- **current resolution**: 0.01 % of current range
- **accuracy**: ≤ 5 % at 100 pA
- **all with max. 0.2 % offset error**:
  - ≤ 1 % of current range at 1 nA
  - ≤ 0.5 % at 10 nA
  - ≤ 0.2 % at 100 nA to 1 mA
  - ≤ 0.5 % at 10 mA
- **max. acquisition rate**: 200 000 data points/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 (deviation)**: ≤ 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

### Other
- **keypad**: run, skip, abort, backlight and power
- **housing**: aluminium: 155 mm x 85 mm x 35 mm
- **weight**: 430 g
- **temperature range**: 0°C to + 40°C
- **power supply**: USB or internal Li-ion battery
- **battery time**: >10 hours idle time
- **>9 hours idle time with Bluetooth extension**:
- **communication**: USB, RS232 or TTL (via auxiliary port)

### Auxiliary port (D-Sub 15)
- **analog input**: 0-3 V, 12 bit
- **analog output**: 0-3 V, 16 bit
- **4 digital outputs and 1 digital input**: 0-3.3 V
- **l-out and E-out**: raw output of current and potential
- **serial comms**: Rx / Tx (RS232 or TTL)
- **power**: 5 V output (max. 50 mA)
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, the environment, and the cell.
Standard PalmSens3 configuration

A standard PalmSens3 case includes:

- PalmSens3
- Mini-USB cable
- Sensor cable
- 4 croc clips
- Test sensor

Also included:

- PTrace software + manual
- Quick start document

Optional

- 7" tablet
- Bluetooth extension
- Tablet charger

(see Mobile expansion pack on next page)
PalmSens3 accessories

Mobile expansion pack
Upgrade to enable wireless control of PalmSens for PC and (mini-) laptop for optimal mobility.

A tablet with PStouch and Bluetooth extension for PalmSens3 allows you to run your experiments anywhere.

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.

Pt1000
This temperature sensor allows the user to monitor the temperature during an experiment and record it via PSTrace. The convenient two point calibration allows you to precisely calibrate the sensor for the needed temperature range. The Pt1000 temperature sensor for PalmSens3 comes with dongle for connection to PalmSens I/O port.

MUX8 or MUX16 multiplexer
The 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.

The 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 extension

A bipotentiostat module is available for use with two working electrodes. This module can be set in two different configurations. 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 WEs are simultaneously recorded in linear sweep and cyclic voltammetry as well as amperometric detection.

Building in the module needs to be done at PalmSens’ workshop.

Differential Electrometer Amplifier (DEA)

The PalmSens Differential Electrometer Amplifier (DEA) is a general purpose 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 -5V to 5V (1x gain). Possible gains are: 2x, 5x, 10x, 20x, 50x, 100x, etc.

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

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