# MULTI PALMSENS 4™

multi-channel
potentiostat / galvanostat / impedance analyzer

## Contents

❯ See for more information:
www.palmsens.com/mps4

## MultiPalmSens4: Highly Configurable

The MultiPalmSens4 is a flexible multi-channel potentiostat, galvanostat and impedance analyzer which you can tailor to your requirements and budget.

Each channel can be configured with:

- ±5 V or ±10 V maximum potential range
- EIS/FRA with maximum frequency of 100 kHz or 1 MHz
- BiPotentiostat for second WE
- iR-compensation
- Galvanic Channel Isolation

More information on page 10

The MultiTrace software allows for using each channel individually or simultaneously or running a sequence of automated tasks on each channel. Each channel provides an additional auxiliary port for controlling peripherals or monitoring temperature or other analog signals.

## Always a backup

Every channel of the MultiPalmSens4 is equipped with internal storage of 8 GB.
This means all your measurements[1] can automatically be saved on-board as backup. Measurements can be browsed and transferred to the PC easily using the MultiTrace software for Windows.

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



| | ALL | CH1 | CH2 | CH3 | CH4 | CH5 | CH |
|---|---|---|---|---|---|---|---|
| Potential Range | 10V ▾ | 10V ▾ | 10V ▾ | 10V ▾ | 5V ▾ | 5V ▾ | 5 |
| Max. freq. for EIS ℹ | NO EIS ▾ | 1MHz ▾ | 1MHz ▾ | 1MHz ▾ | 100kHz ▾ | 100kHz ▾ | 1 |
| BiPot ℹ | ☐ | ☑ | ☑ | ☑ | ☐ | ☐ | ☐ |
| IR-compensation ℹ | ☐ | ☑ | ☑ | ☑ | ☐ | ☐ | ☐ |
| Galvanically isolated | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

Channels: − 6 +

❯ Configure your ideal MultiPalmSens4:
www.palmsens.com/mps4

### PalmSens

## Supported Techniques

The MultiPalmSens4 supports the following techniques.

> ### Synchronising channels in Synched mode.
>
> By enabling synchronization of channels and adjusting the setup of your cables, you can use the MultiPalmSens4 as a polypotentiostat. This means you can use multiple working electrodes, one counter and one reference electrode in the same cell at the same time. Your working electrodes all perform the same measurement.
>
> Techniques marked with an ⏲ can be used in Synched mode.

### 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/PSA** | ⏲ |

### Other

| | |
|---|---|
| ▪ Mixed Mode | **MM** |
| ▪ Potentiostatic and Galvanostatic Impedance spectroscopy | **EIS/GEIS** |

at fixed frequency or frequency scan vs
- o fixed potential or fixed current
- o scanning potential or scanning current
- o time

## 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 (+ ~100 ms with HW sync) | |
| ▪ 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 |

## System Channel Specifications

| General | | | |
|---|---|---|---|
| | config | PS4.F#.05 | PS4.F#.10 |
| ▪ dc potential range | | ±5 V | ±10 V |
| ▪ compliance voltage | | ±10 V | |
| ▪ maximum current | | ±30 mA (typical) | |
| ▪ max. acquisition rate | | 150 000 points/s | |
| ▪ channel to channel isolation (for G.I. option) | | ≥ 1 GΩ // ≤ 10 nF | |

| 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<br>±10 pA ±0.1% of range |
| ▪ measured current resolution | 0.005% of current range<br>(18-bit, 5 fA on 100 pA range)<br>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)<br>0.0038% of 10 mA range |
| ▪ applied dc-current accuracy | < 0.2% of current<br>±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)<br>7.8 µV at ±1 V (100 mV range)<br>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<br>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 * range to 0.4 * range rms (<10 mA)<br>0.001 * range to 0.2 * range rms (10 mA) |

| 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 | 15 x 25 x 25 cm$^3$ |
| ▪ weight | ~4 kg |
| ▪ temperature range | 0 ºC to + 50 ºC |
| ▪ power supply | external 12 V AC/DC adapter |
| ▪ communication | USB-B |
| ▪ internal storage space | 8 GB<br>(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)<br>1x digital input (5 V) |
| ▪ i-out and E-out | raw output of current and potential<br>E-out ±10 V (1 kOhm output impedance)<br>i-out ±6 V (1 kOhm output impedance) |
| ▪ power | 5 V-output (max. 150 mA) |

## EIS Contour Accuracy Plot
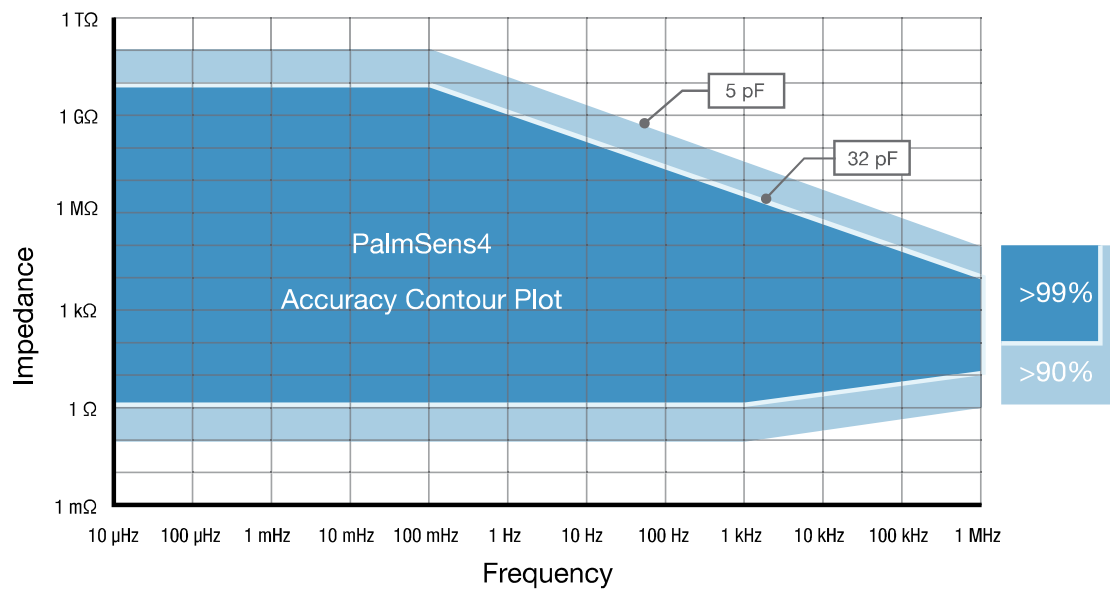


**Note**
The accuracy contour plot was determined under lab conditions using the standard 1 meter cell cable and should be used for reference purposes. Please note that the true limits of an impedance measurement are influenced by all components in the system, e.g. cables, the environment, and the cell.

## Optional BiPotentiostat Specifications



Each channel of the MultiPalmSens4 can be extended in-factory with a BiPotentiostat module for use with a second Working Electrode.

| BiPotentiostat 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 (yellow) connector for WE2 |
| ▪ supported techniques | ▪ Linear Sweep Voltammetry<br>▪ Cyclic Voltammetry<br>▪ Chronoamperometry<br>▪ Multistep Amperometry |

## Optional iR Compensation Module Specifications



Each channel of the MultiPalmSens4 can be extended in-factory with an iR Compensation 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 MultiPalmSens4 Kit

A standard MultiPalmSens4 comes in a soft carrying case with:
- MultiPalmSens4
- 12V external power supply
- USB cable
- 1 meter cell cables with 2 mm banana pins
- 4 croc clips per cable
- PalmSens Dummy Cell

Also included:
- MultiTrace software (on USB stick)
- Manual (hardcopy)
- Quick Start document
- Calibration reports

*PalmSens Dummy Cell*

**Each channel** can be configured with the following options and corresponding product codes:

| code: | MPS4.F#.05 | MPS4.F#.10 |
|---|---|---|
| Potential range | -5V to +5V | -10V to +10V |

| code: | MPS4.F0.## | MPS4.F1.## | MPS4.F2.## |
|---|---|---|---|
| EIS configuration | NO EIS | 100 kHz | 1 MHz |

Optional:
- BiPotentiostat module
- iR Compensation module
- Galvanic Channel Isolation

**Example:** channel configuration **MPS4.F1.05** corresponds to max. 100 kHZ for EIS with ±5V potential range.

**Example:** channel configuration **MPS4.F2.10+BiPot** corresponds to max. 1 MHz for EIS with ±10V potential range and a BiPotentiostat module.

*Soft carrying case*

**❯ Configure your ideal MultiPalmSens:**
www.palmsens.com/mps4

## MultiPalmSens4 Accessories

### In-factory add-on modules

#### BiPotentiostat add-on module

The BiPotentiostat 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 BiPotentiostat 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 or Sense.
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.

## Magnetic stirrer with switch dongle

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 switch dongle.

## 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.

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

## MultiTrace: Software for Windows

The MultiPalmSens4 comes with MultiTrace for Windows. MultiTrace allows the instrument to be controlled in two different modes: Individual and Simultaneous channel control mode. This mode can be selected when in the opening screen of MultiTrace.



**Individual Mode:** where each channel can run a measurement or script independently from the other channels.
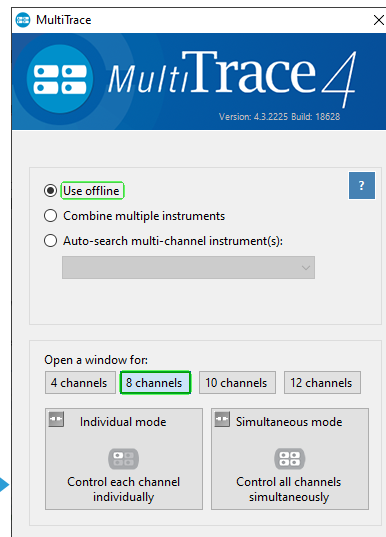
**Simultaneous Mode:** where all channels run the same measurement.

## Individual Mode

The individual mode gives an overview of all channels. Each channel can be selected separately and can run a measurement independently in parallel with other channels.

You can also run a script for a sequence of measurements and other actions on each channel.
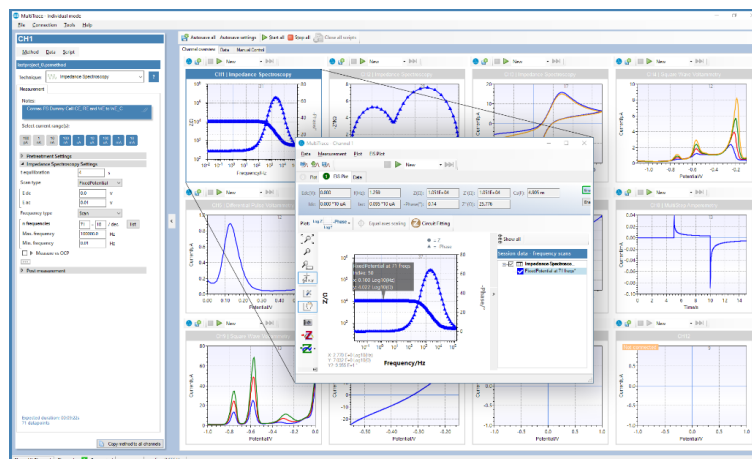


## Multiplexing each channel

Each MultiPalmSens4 channel can be extended with a MUX8-R2 multiplexer to connect eight individual cells (each with their own RE, CE and WE) to a single channel. This allows a fully equipped MultiPalmSens4 to work with 80 channels in total. You can stack multiple MUX8-R2 multiplexers for even more channels.

Each multiplexer connected to a channel of the MultiPalmSens4 is configurable in MultiTrace. See for more information:
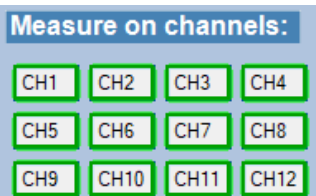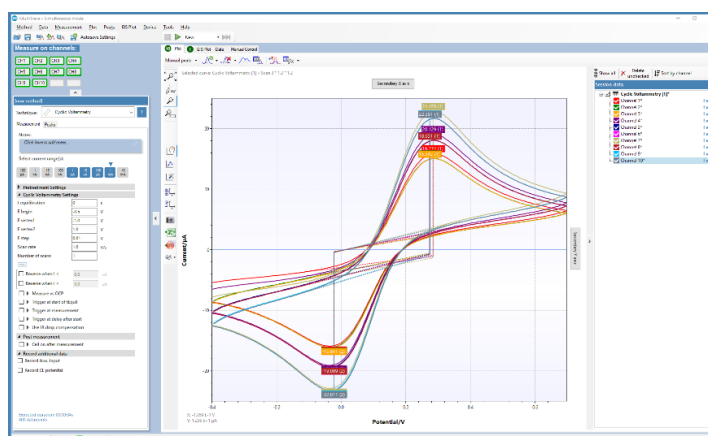www.palmsens.com/mux8-r2
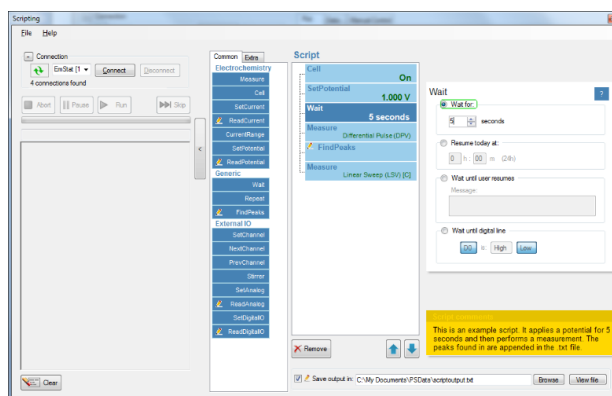
## Scripting

The individual mode also supports the option to run a sequence of measurements on a specific channel by using Scripting. Such a sequence can include different techniques and provides control commands for manual cell control or digital input or output lines.
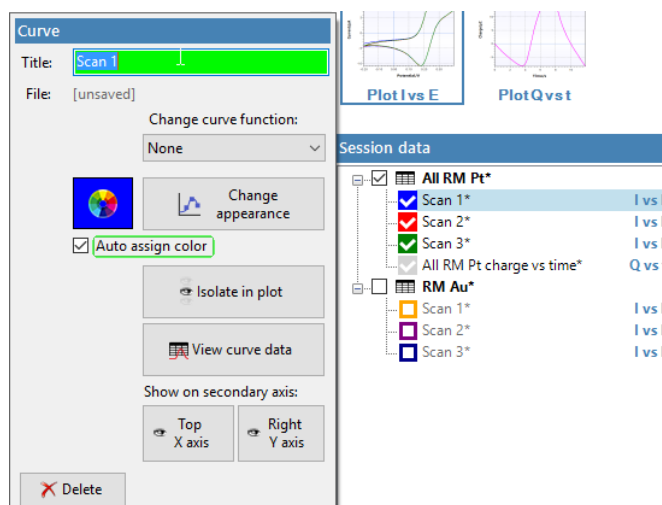
## Simultaneous Mode

In the Simultaneous Mode the MultiPalmSens4 works with all channels running the same measurement in parallel at the same time.

There is only one active method in the Method Editor which is started on all selected channels simultaneously upon start. All results are presented as overlays in the same plot.

**Measure on channels:**

| | | | |
|---|---|---|---|
| CH1 | CH2 | CH3 | CH4 |
| CH5 | CH6 | CH7 | CH8 |
| CH9 | CH10 | CH11 | CH12 |

This panel in the main screen contains a toggle button for each channel determines which channels are participating in the measurement.

Pop-up window shown when clicking a Curve in the legend.
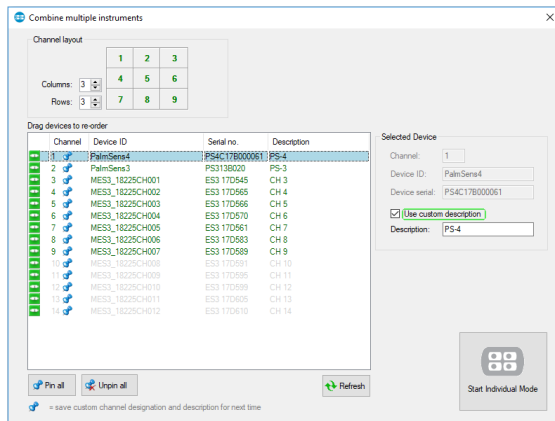
# MultiPalmSens4

## Combining different instruments

MultiTrace supports all instrument models provided by PalmSens BV. A collection of different instruments can be combined for control by MultiTrace in both Individual and Simultaneous mode. Either multiple multi-channel or single-channel instruments can be combined.

## 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.
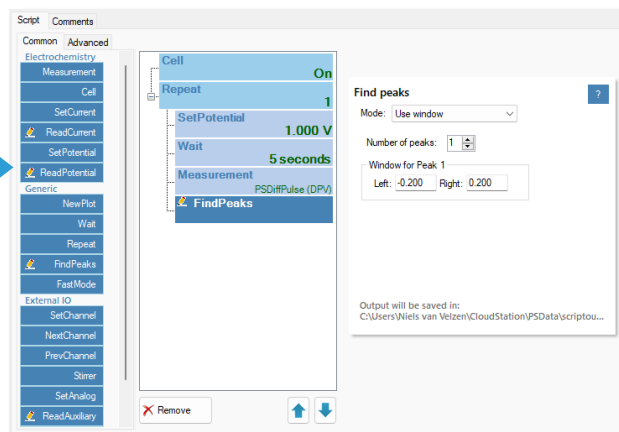
## Other functions in MultiTrace

- Equivalent Circuit Fitting
- Advanced peak search algorithms
- Scripting (on each channel)
- Automatic data saving
- 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
- Direct feedback on validity of method parameters
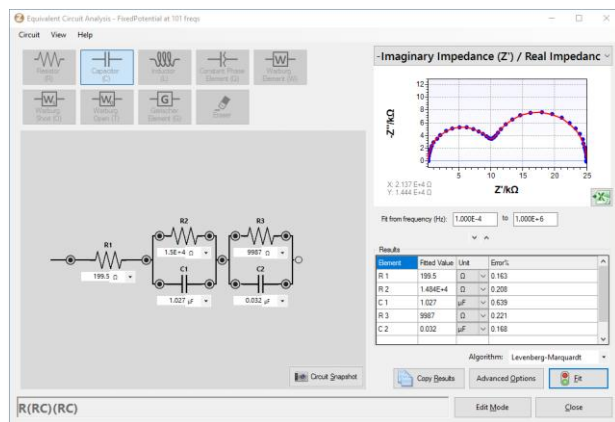
## Integration with third party software:
- Excel
- Origin
- Matlab
- ZView

## 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/multitrace

## Integrate Electrochemistry into Your Own Applications

### Seamless Instrument Control

- Access all PalmSens potentiostats (single- and multi-channel) through our SDKs.
- Full control of measurement techniques, data acquisition, and real-time analysis.

### Cross-Platform Support

- **Python SDK**
  Script and automate experiments across platforms.
- **Windows .NET SDK**
  Easily integrate in C#, VB.NET, or any .NET language.
- **Android & iOS SDKs**
  Build mobile apps to run PalmSens instruments in the field.
- **LabVIEW & MATLAB examples**
  Quick start for engineers and researchers.

### Accelerate Development

- Pre-built code sample
- Clear documentation & active support
- Sample apps to get started within minutes

## PalmSens SDKs
## put you in control
### from the lab to the field

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

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Please contact us at **info@palmsens.com** or go to our website to get
in touch with a distributor in your region.

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

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## PalmSens

ISO 9001:2015 certified