MULTI EMSTAT 4™

multi-channel
potentiostat / galvanostat / impedance analyzer





PalmSens

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Contents

No Compromises on Productivity and Performance 3
Supported Techniques 4
Measurement Specifications 5
System Channel Specifications 6
MultiEmStat4 LR EIS Accuracy Contour Plot 8
MultiEmStat4 HR EIS Accuracy Contour Plot 8
Standard MultiEmStat4 Kit 9
MultiTrace: Software for Windows 10
Share the MultiEmStat4 in the Local Area Network 12
Integrate Electrochemistry into Your Own Applications 14
MultiEmStat4 works with MethodSCRIPT™ 15

› See for more information:
www.palmsens.com/mes4

No Compromises on Productivity and Performance

The MultiEmStat4 is a compact Potentiostat, Galvanostat, and optional Frequency Response Analyser (FRA) for Electrochemical Impedance Spectroscopy (EIS) with 4, 8 or 12 channels. The MultiEmStat4 comes in two versions:

1. the **Low Range** version which is great for applications that require measuring low currents down to picoamps,
2. the **High Range version**, which is very suitable for applications that need a maximum current of up to 200 mA.

The following table shows the main differences:





	MultiEmStat4 LR	MultiEmStat4 HR
▪ potential range	±3 V	±6 V
▪ max. compliance	±5 V	±8 V
▪ current ranges	1 nA to 10 mA (8 ranges)	100 nA to 100 mA (7 ranges)
▪ max. current (per channel)	±30 mA	±200 mA
▪ electrodes	WE, RE, CE, and ground, 2 mm banana plugs	WE, RE, CE, S(ense), and ground, 2 mm banana plugs
▪ hardware options	○ EIS up to 200 kHz ○ Galvanic Channel Isolation	○ EIS up to 200 kHz ○ Galvanic Channel Isolation

Your data always secured

The MultiEmStat4 is equipped with internal storage memory on each individual channel. This allows for storing your measurement data on board seamlessly while the measurement is running.
Your measurement even continues if the connection to the PC is lost.
All internally stored measurements can be browsed and transferred back to the PC easily using MultiTrace or PSTrace.

› Configure your ideal MultiEmStat:
www.palmsens.com/mes4

Supported Techniques

The MultiEmStat4 supports the following electrochemical techniques.

Synchronizing Channels

By enabling synchronization of channels and adjusting the setup of your cables, you can use the MultiEmStat4 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 exact same measurement.

Techniques marked with an ⏱ can be used in Alternate mode.

Voltammetric techniques

- Linear Sweep Voltammetry — LSV ⏱
- Cyclic Voltammetry — CV ⏱

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 ⏱
- Pulsed Amperometric Detection — PAD ⏱

Galvanostatic techniques

- Linear Sweep Potentiometry — LSP ⏱
- Chronopotentiometry — CP ⏱
- Multistep Potentiometry — MP ⏱
- Open Circuit Potentiometry — OCP ⏱

Other

- Mixed Mode — MM ⏱
- Potentiostatic/Galvanostatic Impedance spectroscopy at fixed frequency or frequency scan vs — EIS/GEIS
  - fixed potential or fixed current
  - scanning potential or scanning current
  - time

MethodSCRIPT™ allows for developing custom techniques. See page 15 for more information.

MethodSCRIPT™ by PalmSens

Measurement Specifications

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

	Parameter	Min	Max
All techniques (unless otherwise specified)	▪ Conditioning time	0	4000 s
	▪ Deposition time	0	4000 s
	▪ Equilibration time	0	4000 s
	▪ Step potential	LR: 0.100 mV HR: 0.183 mV	250 mV
	▪ N data points	3	1,000,000
▪ NPV ▪ DPV	▪ Scan rate	LR: 0.1 mV/s (100 µV step) HR: 0.1 mV/s (183 µV step)	1 V/s (5 mV step)
	▪ Pulse time	0.4 ms	300 ms
▪ SWV	▪ Frequency	1 Hz	1250 Hz
▪ LSV ▪ CV	▪ Scan rate	LR: 0.01 mV/s (100 µV step) HR: 0.01 mV/s (183 µV step)	500 V/s (200 mV step)
▪ PAD	▪ Interval time	50 ms	300 s
	▪ Pulse time	1 ms	1 s
	▪ N data points	3	1,000,000 (> 100 days at 10 s interval)
▪ 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	~1 ms (~100 ms with Hardware Sync.)	N/A
	▪ Interval time	0.4 ms	300 s



System Channel Specifications

General		
	LR	HR
▪ dc-potential range	±3 V	±6 V
▪ compliance voltage	±5 V	±8 V
▪ maximum current	±30 mA	±200 mA
▪ max. data acquisition rate	1M samples/s	
▪ control loop bandwidth (stability setting)	32 Hz, 320 Hz, 3.2 kHz, 30 kHz or 570 kHz	
▪ current follower bandwidth	23 Hz in 1 nA and 10 nA range 2.3 kHz in 100 nA and 1 uA range 230 kHz in 10 uA and 100 uA range > 500 kHz in ranges 1 mA and higher	
▪ channel to channel isolation (for G.I. option)	≥ 1 GΩ // ≤ 10 nF	

Potentiostat (controlled potential mode)		
	LR	HR
▪ applied potential resolution	100 µV	183 µV
▪ applied potential accuracy	≤ 0.2% ±1 mV offset	
▪ current ranges	1 nA to 10 mA 8 ranges	100 nA to 100 mA 7 ranges
▪ measured current resolution	0.009% of range (92 fA on 1 nA range)	
▪ measured current accuracy	< 0.2% of current ±20 pA ±0.2% of range	< 0.2% of current ±0.2% of range

Galvanostat (controlled current mode)		
	LR	HR
▪ current ranges	10 nA, 1 uA, 100 uA, 10 mA 4 ranges	1 uA, 100 uA, 10 mA, 100 mA 4 ranges
▪ applied dc-current	±3 * range	
▪ applied dc-current resolution	0.01% of range	0.0183% of range
▪ applied dc-current accuracy	< 0.4% of current ±20 pA ±0.2% of range	< 0.4% of current ±0.2% of range
▪ potential ranges	50 mV, 100 mV, 200 mV, 500 mv, 1 V	
▪ measured dc-potential resolution	96 µV (1 V) 48 µV (500 mV) 19.2 µV (200 mV) 9.6 µV (100 mV) 4.8 µV (50 mV)	193 µV (1 V) 96.5 µV (500 mV) 38.5 µV (200 mV) 19.3 µV (100 mV) 9.65 µV (50 mV)
▪ measured dc-potential accuracy	≤ 0.2% potential, ±1 mV offset	

Optional: FRA / EIS (impedance measurements)	
▪ frequency range	10 µHz to 200 kHz
▪ ac-amplitude range	1 mV to 900 mV rms, or 2.5 V p-p

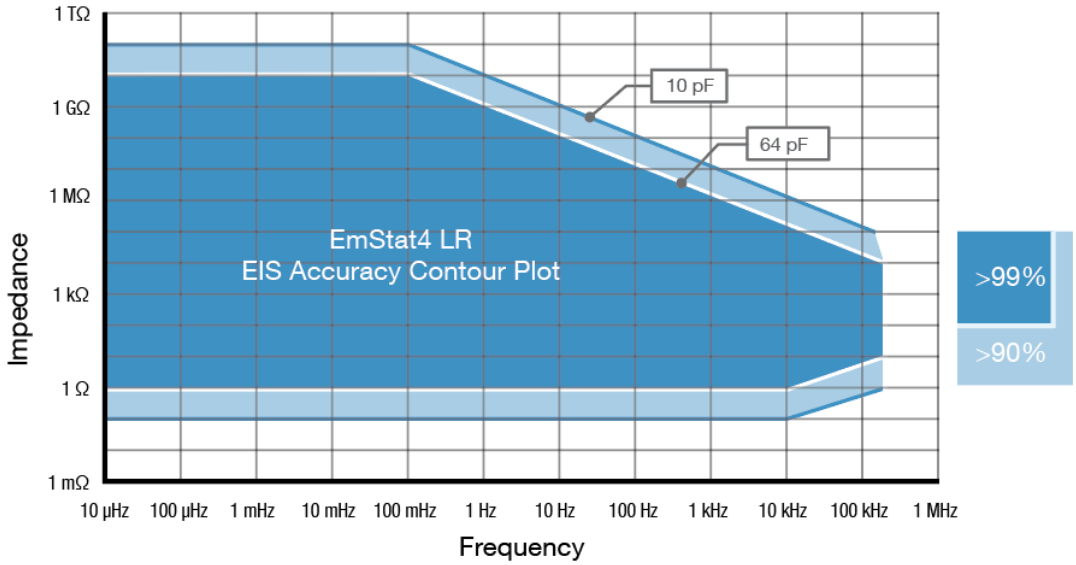
Optional: GEIS (galvanostatic impedance measurements)	
▪ frequency range	10 µHz to 100 kHz
▪ ac-amplitude range	0.9 * range A rms

Electrometer	
▪ electrometer amplifier input	> 1 TΩ // 10 pF
▪ bandwidth	10 kHz or 500 kHz

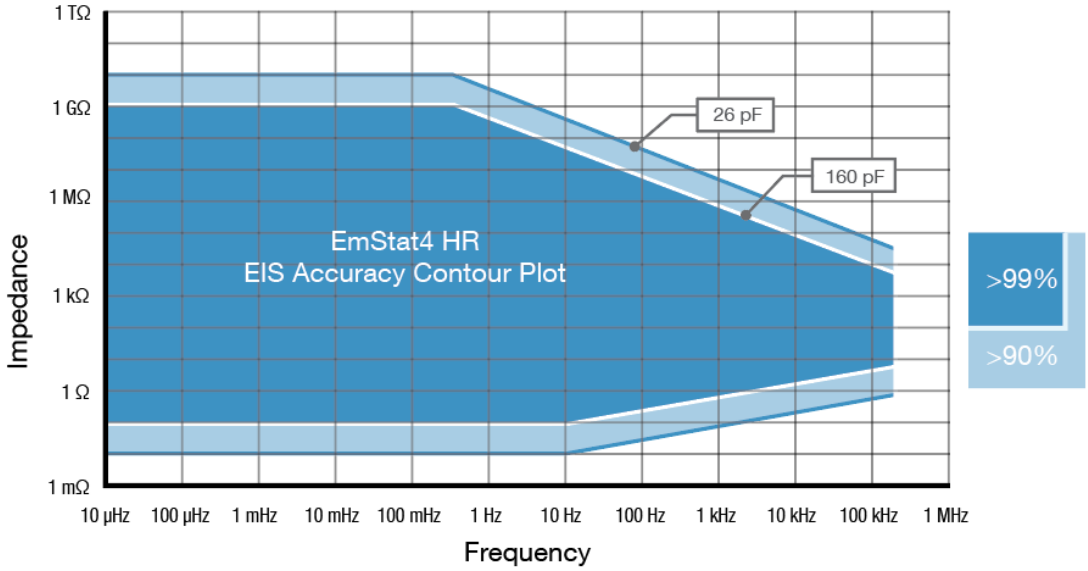
Other		
model	LR	HR
▪ electrode connections	WE, RE, CE, and ground, with 2 mm banana plugs	WE, RE, CE, S and ground, with 2 mm banana plugs
▪ housing	aluminium housing: 21.2 x 22.1 x 7.7 cm	
▪ weight	~3 kg	
▪ communication	USB (type B)	
▪ power	external 12 V AC/DC adapter	
▪ internal storage space on each channel	500 MB, equivalent to >15M datapoints	



MultiEmStat4 LR EIS Accuracy Contour Plot



MultiEmStat4 HR EIS Accuracy Contour Plot



Note
The accuracy contour plots were determined with an ac-amplitude of ≤10 mV rms for all limits, except for the high impedance limit, which was determined using an ac-amplitude of 250 mV. The standard 1-meter cell cables were used. Please note that the true limits of an impedance measurement are influenced by all components in the system, e.g. connections, the environment, and the cell.

Standard MultiEmStat4 Kit

A standard MultiEmStat4 comes in a soft case with:

- MultiEmStat4 LR or HR
- 12V external power supply
- USB cable
- 1 meter cell cable with 2 mm banana pins
- 4 or 5 croc clips per cable
- 1x Dummy Cell

Also included:

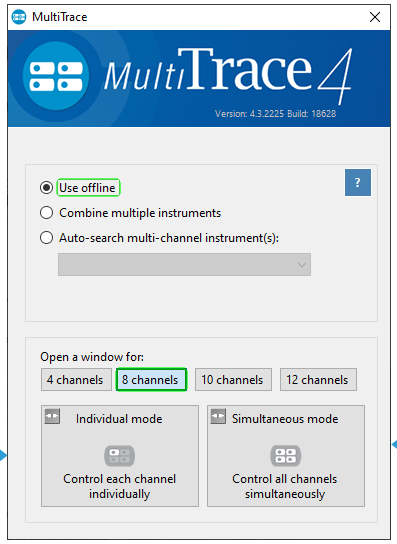
- MultiTrace software for Windows (on USB drive)
- Manual (hardcopy)
- Quick Start document
- Calibration report for each channel



MultiTrace: Software for Windows

The MultiEmStat4 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 in the start-up window of MultiTrace.

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

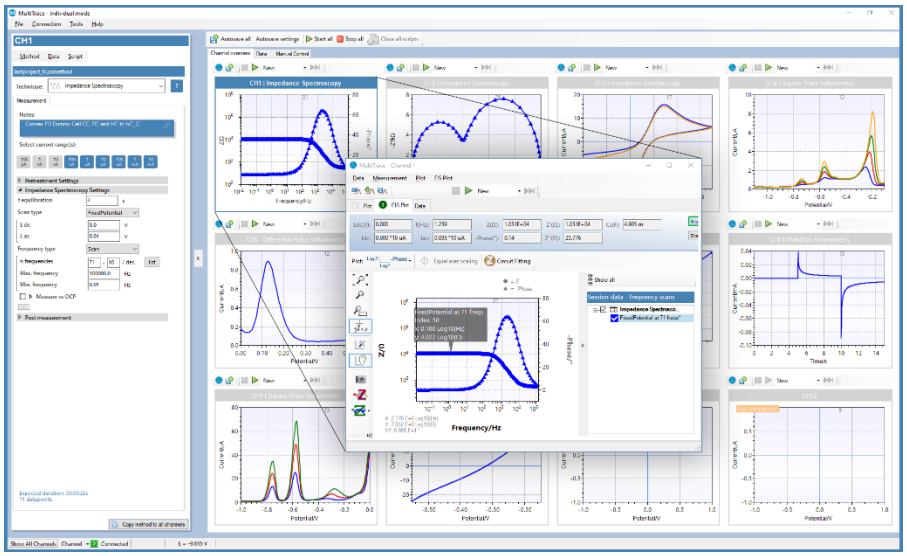


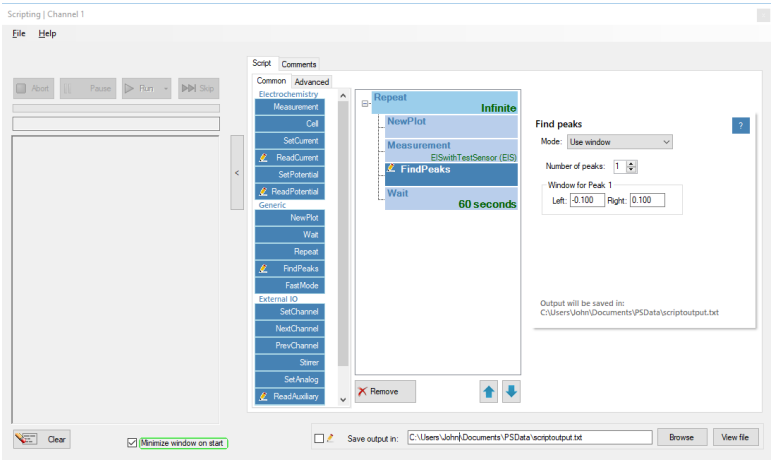
Simultaneous Mode: where all channels run the same measurement.

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.





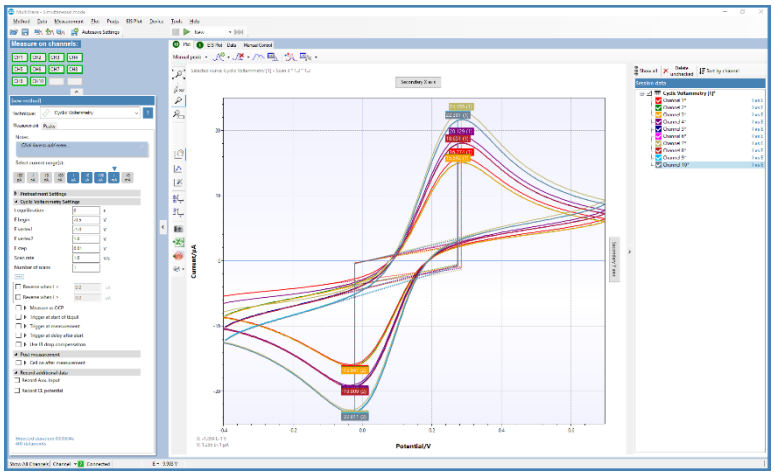
Scripting

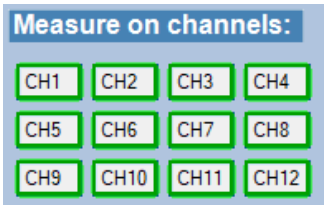
The Individual mode of MultiTrace also supports the option to run a sequence of measurements on a specific channel by using Scripting.
Such a sequence can include different techniques and provides control commands for manual cell control or digital input or output lines.

Simultaneous Mode

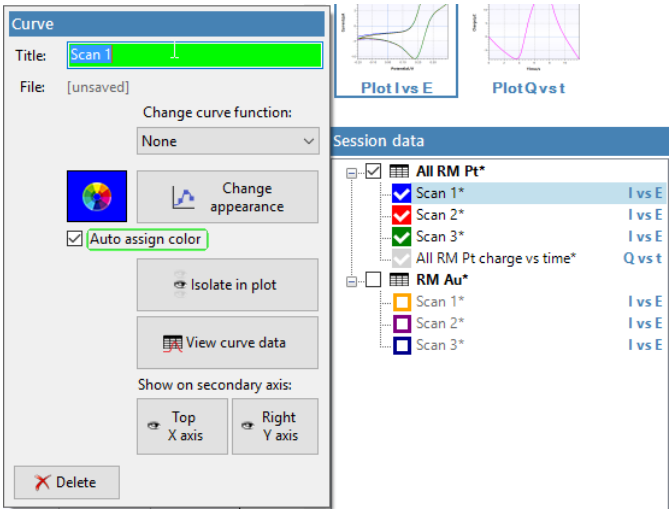
In the Simultaneous Mode the MultiEmStat4 works with all channels running the same measurement in parallel at the same time.

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

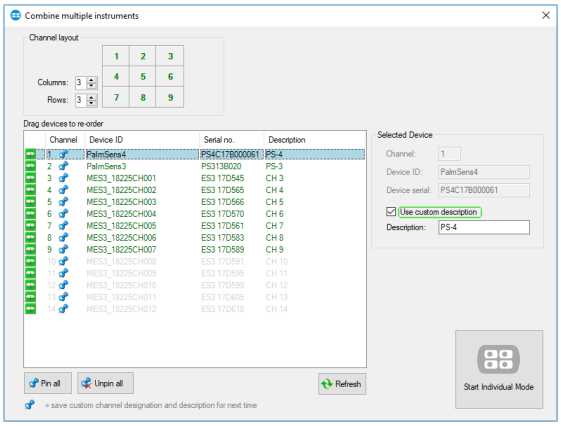




This panel in the main screen contains a toggle button for each channel determines which channels are participating in the measurement.



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

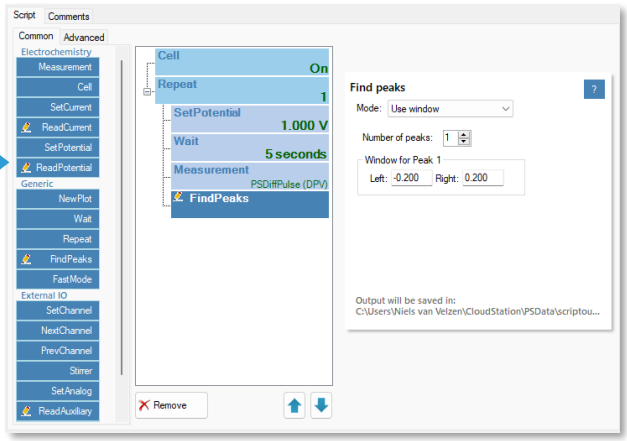


Combining different instruments

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.

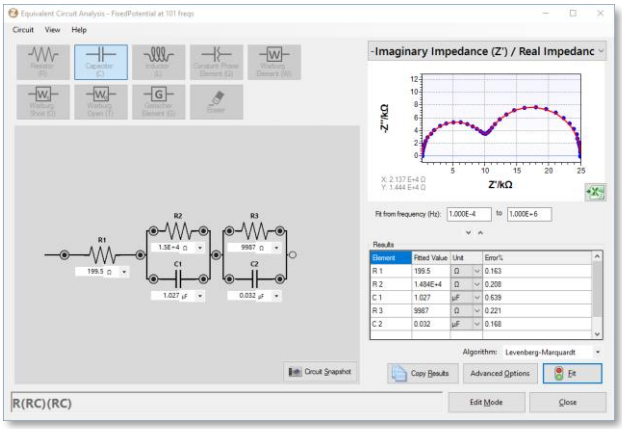
Scripting

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

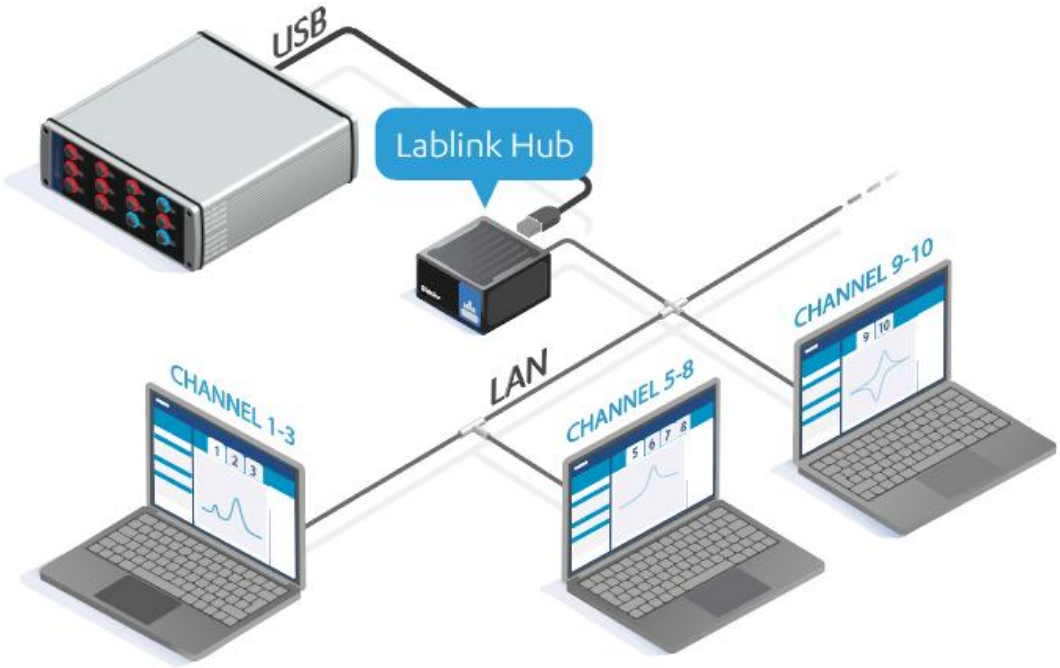
- Windows 7, 8, 10 or 11
- 1 GHz or faster 32-bit (x86) or 64-bit (x64) processor
- 2 GB RAM (32-bit) or 4 GB RAM (64-bit)
- Screen resolution of 1280 x 800 pixels

› See for more information:
www.palmsens.com/multitrace

Share the MultiEmStat4 in the Local Area Network

The Lablink Hub acts as the bridge between your MultiEmStat4 and the network, allowing multiple users to work with the multi-channel instrument simultaneously.





Lablink

› See for more information:
www.palmsens.com/lablink

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.

PalmSens
For Developers

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

python™

MATLAB

LabVIEW™

Microsoft® .NET

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

MultiEmStat4 works with MethodSCRIPT™

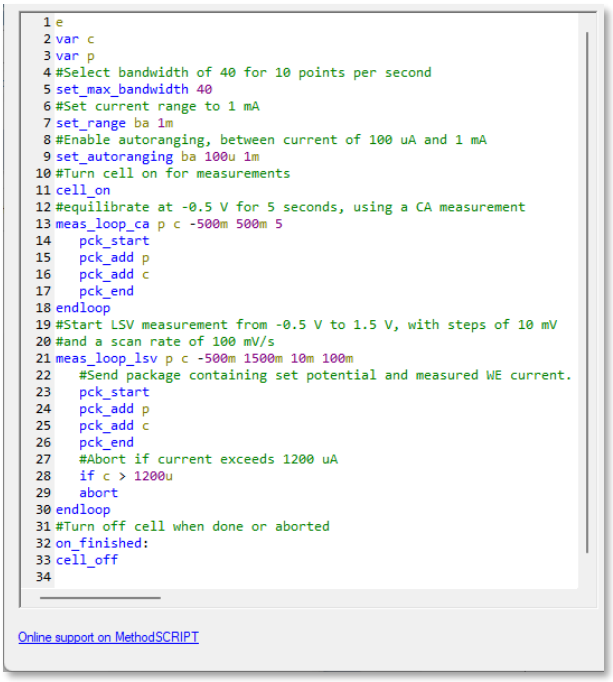
The MethodSCRIPT™ scripting language is designed to integrate our instruments and potentiostat (modules) effortlessly in your hardware setup, product, or experiment.

MethodSCRIPT™ gives you full control over your potentiostat. The simple script language is parsed on board the instrument and allows for running all supported electrochemical techniques, making it easy to combine different measurements and other tasks.

MethodSCRIPT can be generated, edited, and executed in PSTrace.

MethodSCRIPT features include:

- Use of variables
- (Nested) loops and conditional logic support
- User code during a measurement iteration
- Exact timing control
- Simple math operations on variables (add, sub, mul, div)
- Digital I/O, for example for waiting for an external trigger
- Logging results to internal storage or external SD card
- Reading auxiliary values like pH or temperature
- and many more..



Write your own software and integrate (generated) MethodSCRIPTs. No libraries needed.

MethodSCRIPT is parsed on board the instrument. No DLLs or other type of code libraries are required for using MethodSCRIPT™

MethodSCRIPT™

Code examples are available for:

C/C++ ARDUINO Swift Xamarin python Java

› See for more information:
www.palmsens.com/methodscript

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