

# Multi EmStat4™

MULTI-CHANNEL POTENTIOSTAT / GALVANOSTAT /  
IMPEDANCE ANALYZER



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## 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; the **Low Range** version is great for applications that require a low current range down to 1 nA, whereas the **High Range** version is very suitable for applications that need a maximum current of 200 mA.

The following table shows the main differences:

	<i>MultiEmStat4 LR™</i>	<i>MultiEmStat4 HR™</i>
<b>Potential range</b>	±3 V	±6 V
<b>Max. compliance voltage</b>	±5 V	±8 V
<b>Current ranges</b>	1 nA to 10 mA (8 ranges)	100 nA to 100 mA (7 ranges)
<b>Max. current (per channel)</b>	±30 mA	±200 mA
<b>Electrode connections</b>	WE, RE, CE, and ground, 2 mm banana plugs	WE, RE, CE, S(ense), and ground, 2 mm banana plugs
<b>Hardware options</b>	<ul style="list-style-type: none"> <li>▪ EIS up to 200 kHz</li> <li>▪ Galvanic Isolation</li> </ul>	<ul style="list-style-type: none"> <li>▪ EIS up to 200 kHz</li> <li>▪ Galvanic Isolation</li> </ul>

software for Windows 

Configure your ideal MultiEmStat4 on:  
[www.palmsens.com/mes4](http://www.palmsens.com/mes4)

### Always a Backup



The MultiEmStat4 is equipped with 500 MB internal storage memory on each channel for storing your measurements as a backup. All internally stored measurements can be browsed and transferred back to the PC easily using the MultiTrace software.

Your data is always with your instrument wherever you take it.

## 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 Synched 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

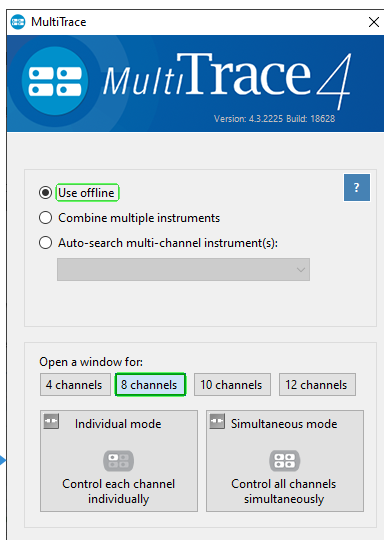
- Linear Sweep Potentiometry LSP 
- Chronopotentiometry CP 
- MultiStep Potentiometry MP 
- Open Circuit Potentiometry OCP 

#### Other

- Mixed Mode MM 
- Potentiostatic/Galvanostatic Impedance spectroscopy EIS/GEIS
  - Potential scan or current scan
  - Fixed potential or fixed current
  - Time scan

## 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.



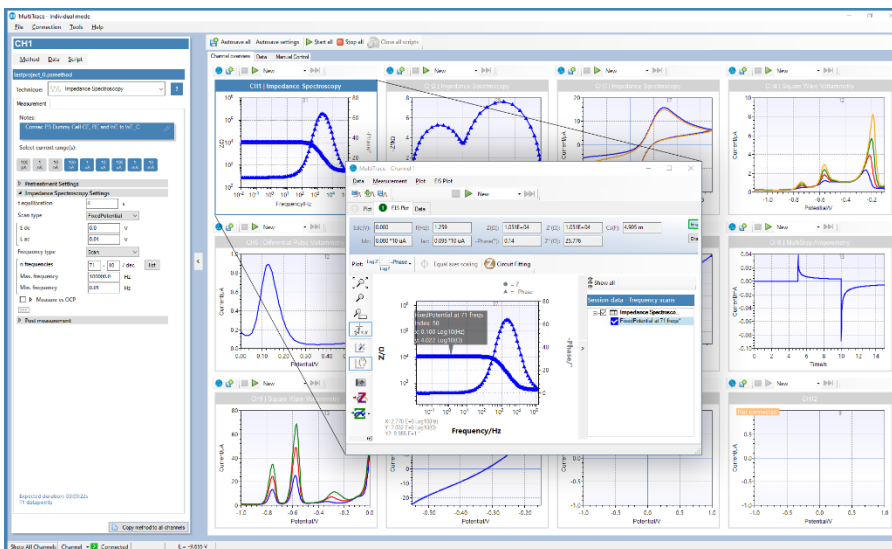
**Individual Mode:**  
where each channel can run a measurement or script independently from the other channels.

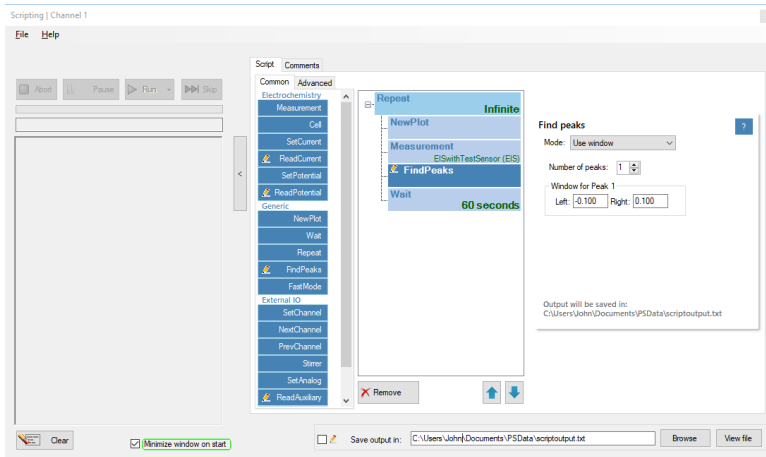
**Simultaneous Mode:**  
where all channels run the same measurement.

### 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.





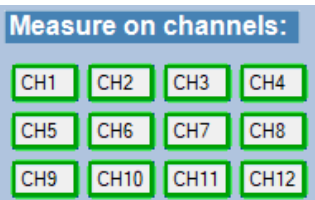
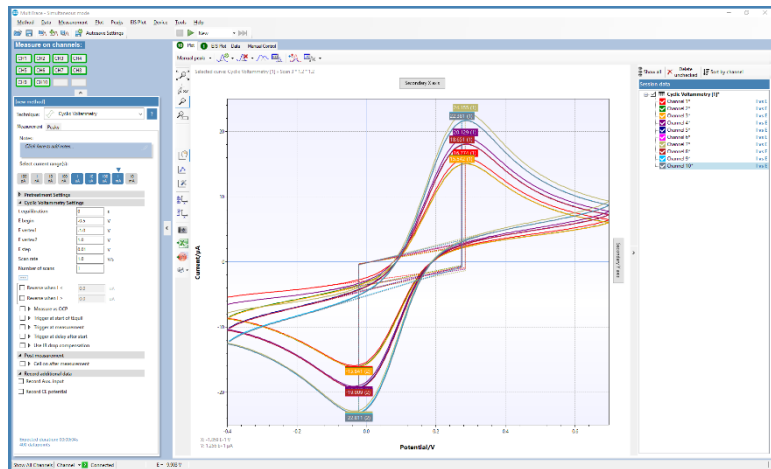
## Scripting

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

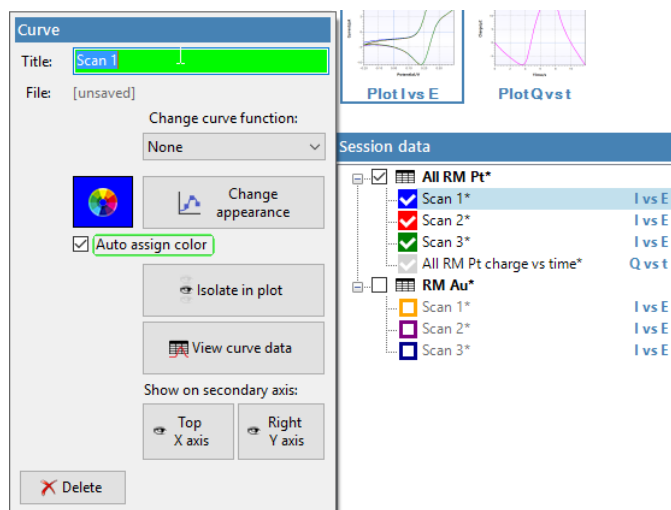
In the Simultaneous Mode the MultiEmStat4 works with all channels running the same measurement in parallel at the same time.

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.

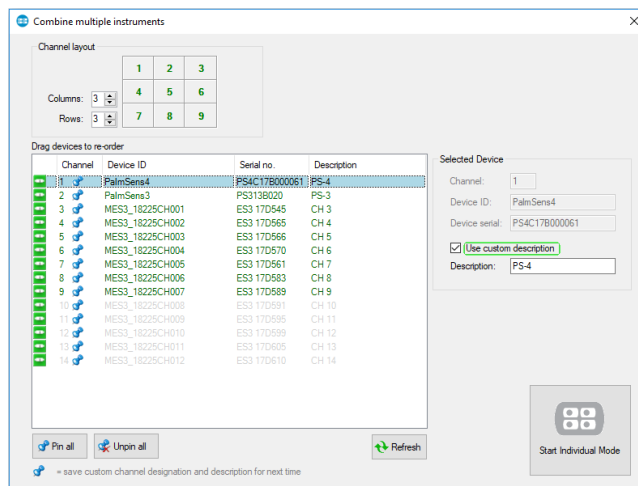


This panel in the main screen contains a toggle button for each channel determines which channels are participating in the measurement.

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



# MultiEmStat4 Measurement Specifications

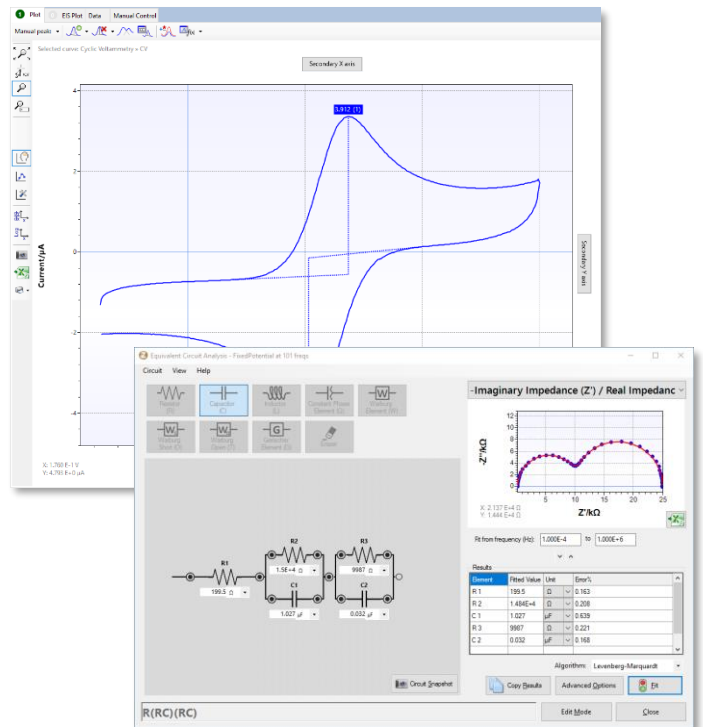


## Combining different instruments

MultiTrace supports all instruments 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.

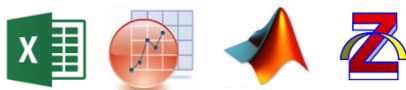
## Other functions in MultiTrace

- Equivalent Circuit Fitting
- Automatic peak search
- 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



## System requirements

Minimum PC requirements are:

- Windows 7, 8, 10 or 11
- 1 GHz or faster 32-bit (x86) or 64-bit (x64) processor with at least 2 processor cores (4 or more cores recommended)
- 2 GB RAM (32-bit) or 4 GB RAM (64-bit)
- Screen resolution of at least 1280 x 768 pixels (higher is recommended)

For more information about software visit

[www.palmsens.com/software](http://www.palmsens.com/software)

## MultiEmStat4 Measurement Specifications

Limits for technique-specific parameters.

	Parameter	Min	Max
<b>All techniques (unless otherwise specified)</b>	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
	Pulse potential	LR: 0.100 mV HR: 0.183 mV	250 mV
	N data points	3	1,000,000
<b>NPV DPV</b>	Scan rate	LR: 0.1 mV/s (100 $\mu$ V step) HR: 0.1 mV/s (183 $\mu$ V step)	1 V/s (5 mV step)
	Pulse time	0.4 ms	300 ms
<b>SWV</b>	Frequency	1 Hz	2500 Hz
<b>LSV CV</b>	Scan rate	LR: 0.01 mV/s (100 $\mu$ V step) HR: 0.01 mV/s (183 $\mu$ V step)	500 V/s (200 mV step)
	<b>PAD</b>	Interval time	50 ms
Pulse time		1 ms	1 s
N data points			1,000,000 (> 100 days at 10 s interval)
<b>CA CP OCP</b>	Interval time	0.4 ms	300 s
	Run time	1 ms	> year
When applying multiple potential or current levels:			
	N cycles	1	20,000
	N levels	1	255
	Level switching overhead time	+/-1 ms	





## System Channel Specifications

### General

	model	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	

### Potentiostat (controlled potential mode)

	model	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 CR (92 fA on 1 nA range)	
measured current accuracy		≤ 0.2% at Full Scale Range	

### Galvanostat (controlled current mode)

	model	LR	HR
current ranges		10 nA, 1 µA, 100 µA, 10 mA 4 ranges	1 µA, 100 µA, 10 mA, 100 mA 4 ranges
applied dc-current		±3 * CR (current range)	
applied dc-current resolution		0.01% of CR	0.0183% of CR
applied dc-current accuracy		<0.4% (gain) + 0.002 * CR (offset)	<0.4% (gain) + 0.002 * CR (offset)
measured dc-potential resolution		96 µV (gain 1) 48 µV (gain 2) 19.2 µV (gain 5) 9.6 µV (gain 10) 4.8 µV (gain 20)	193 µV (gain 1) 96.5 µV (gain 2) 38.5 µV (gain 5) 19.3 µV (gain 10) 9.65 µV (gain 20)
measured dc-potential accuracy		≤ 0.2% ±1 mV offset	

### FRA / EIS (impedance measurements, optional)

frequency range	10 µHz to 200 kHz
ac-amplitude range	1 mV to 900 mV rms, or 2.5 V p-p

### GEIS (galvanostatic impedance measurements, optional)

frequency range	10 µHz to 200 kHz
ac-amplitude range	0.9 * CR A rms

# System Channel Specifications

## Electrometer

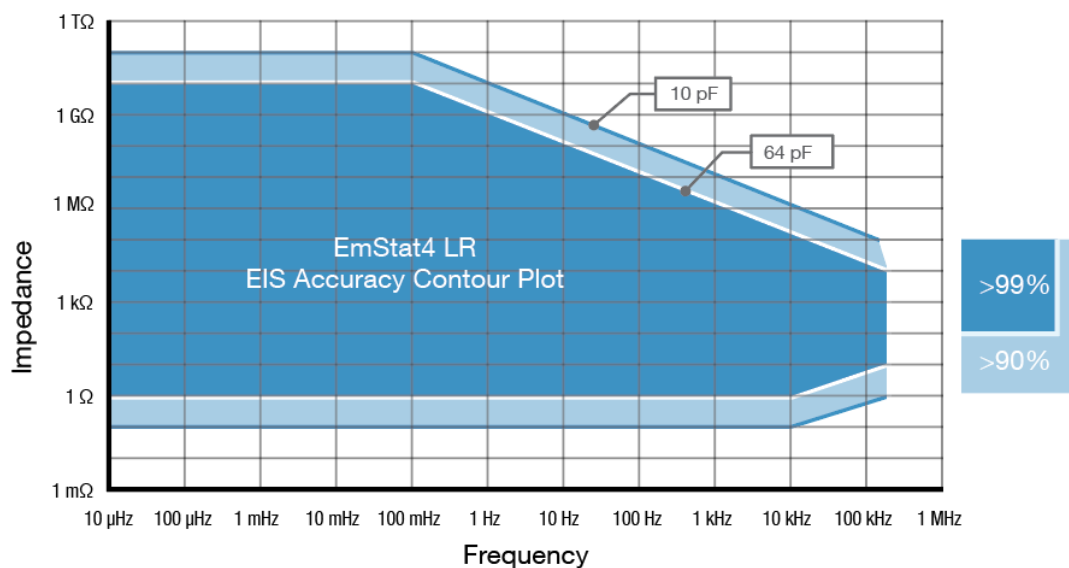
<b>electrometer amplifier input</b>	> 1 TΩ // 10 pF
<b>bandwidth</b>	10 kHz default or 500 kHz for EIS and fast CA/CP

## Other

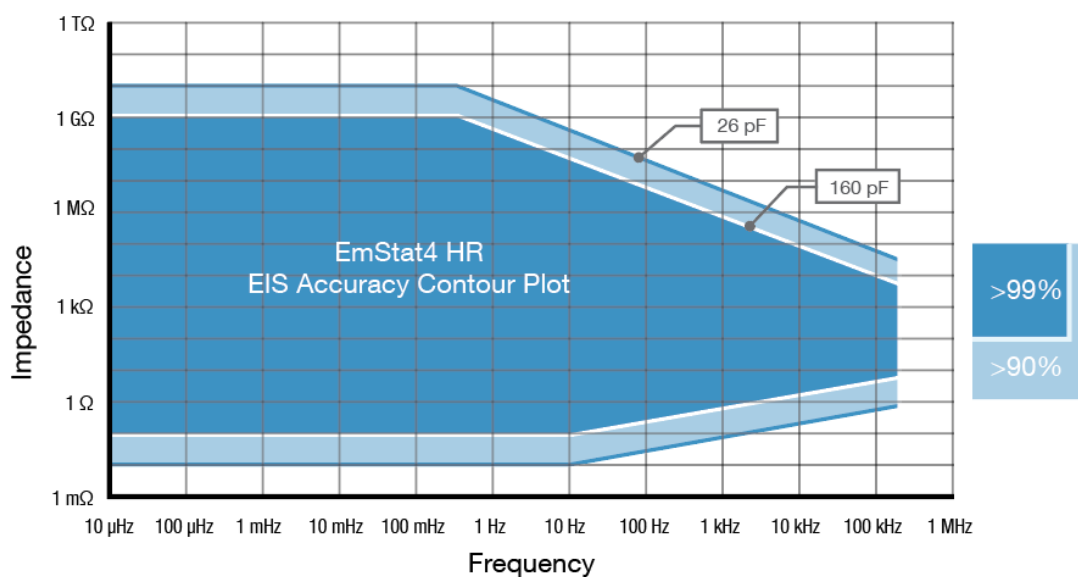
	model	LR	HR
<b>electrode connections</b>		WE, RE, CE, and ground, with 2 mm banana plugs	WE, RE, CE, S and ground, with 2 mm banana plugs
<b>housing</b>		aluminum body: 21.2 x 22.1 x 7.7 cm	
<b>weight</b>		+/- 3 kg	
<b>communication</b>		USB (type B)	
<b>power</b>		external 12 V AC/DC adapter	
<b>internal storage space on each channel</b>		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  $\leq 10$  mV rms for all limits, except for the high impedance limit, which was determined using an ac-amplitude of 250 mV.

The standard 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-A cable
- Sensor cables
- Croc clips
- 1x Dummy Cell

Also included:

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



MultiEmStat4 comes standard in a soft carrying case

## 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>
/// Initializes the EIS method.
/// </summary>
private void InitCVMethod()
{
    _methodEIS = new ImpedimetricMethod();
    _methodEIS.ScanType = ImpedimetricMethod.enumScanType.EIS;
    _methodEIS.Potential = 0.0f; //0.0V DC potential
    _methodEIS.Eac = 0.01f; //0.01V RMS AC potential amplitude
    _methodEIS.FreqType = ImpedimetricMethod.enumFrequencyType.FREQTYPE_LINEAR;
    _methodEIS.MaxFrequency = 1e5f; //Max frequency is 100kHz
    _methodEIS.MinFrequency = 10f; //Min frequency is 10Hz
    _methodEIS.nFrequencies = 11; //Sample at 11 different frequencies

    _methodEIS.EquilibrationTime = 1f; //Equilibrates the cell for 1 second
    _methodEIS.Ranging.StartCurrentRange = new CurrentRange(1e-10, 1e-08);
    _methodEIS.Ranging.MinimumCurrentRange = new CurrentRange(1e-10, 1e-08);
    _methodEIS.Ranging.MaximumCurrentRange = new CurrentRange(1e-10, 1e-08);
}
```

For downloads and details visit:

[www.palmsens.com/sdk](http://www.palmsens.com/sdk)

## (Multi)EmStat4 works with MethodSCRIPT™

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



### No libraries needed

No DLLs or other type of code libraries are required for using MethodSCRIPT™

MethodSCRIPT™ allows developers to program a human-readable script directly into the potentiostat module. The simple script language allows for running all supported electrochemical techniques and makes it easy to combine different measurements and other tasks.



**MethodSCRIPT™**

Code examples are available for:



C/C++



MethodSCRIPT features include:

- Use of variables
- (Nested) loops
- Logging results to internal storage or external SD card
- Digital I/O for example for waiting for an external trigger
- Reading auxiliary values like pH or temperature

For downloads and details visit:

[www.palmsens.com/methodscript](http://www.palmsens.com/methodscript)

Please do not hesitate to contact PalmSens for more details:  
[info@palmSens.com](mailto:info@palmSens.com)

**PalmSens BV**  
The Netherlands  
[www.palmSens.com](http://www.palmSens.com)

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