

# EMSTAT 4X™

potentiostat / galvanostat / impedance analyzer



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➤ See for more information:  
[palmSens.com/emstat4x](http://palmSens.com/emstat4x)

## High performance in a small footprint

The EmStat4X is a small battery-, and USB-powered Potentiostat, Galvanostat, and optional Frequency Response Analyser (FRA) for Electrochemical Impedance Spectroscopy (EIS).

The EmStat4X **Low Range (LR)** version is great for applications that require measuring low currents down to picoamps, like (bio)sensor research.

The **High Range (HR)** version is very suitable for applications that need a maximum current of up to 200 mA.



## EmStat4X LR and HR features

EmStat4X features:

- **Fast EIS support:** for running fixed-frequency EIS measurements at a very low interval of around 1 ms.
- **Auxiliary Port:** for connecting to a MUX8-R2 multiplexer, temperature sensor, pH sensor, stirrer control, triggering and more.
- **iR compensation:** to compensate for the iR drop between the Reference electrode and the outside of the double layer of the electrochemical cell.
- **Wireless connectivity:** for a wireless connection to a PC, smartphone or tablet.
- **11.1 Wh battery:** for more than 8 hours of measurements (with the LR).
- **Small borderless display:** showing the state of the battery and connectivity.

## Your data always secured



The EmStat4X is equipped with internal storage memory. 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 PStTrace.

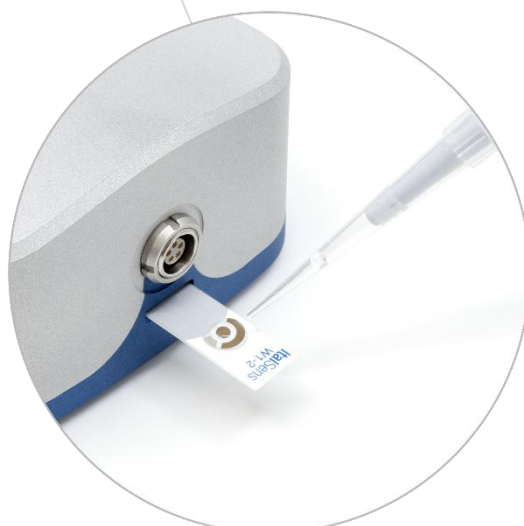
software for





Key specifications		
	Low Range (LR)	High Range (HR)
• potential range	±3 V	±6 V
• max. compliance voltage	±5 V	±8 V
• current ranges	1 nA to 10 mA (8 ranges)	100 nA to 100 mA (7 ranges)
• max. current	±30 mA	±200 mA
• FRA/EIS (optional)	10 μHz to 200 kHz	
• electrode connections	WE, RE, CE, and ground, with 2 mm banana plugs And SPE connector	WE, RE, CE, S, and ground, with 2 mm banana plugs

See page 7 for all specifications.



## Supported Techniques

The EmStat4X supports the following electrochemical techniques when used with PStTrace.

### 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 |

### Galvanostatic techniques

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

### Other

- |  |            |
|--|------------|
| ▪ Mixed Mode   | MM         |
| ▪ Potentiostatic and Galvanostatic Impedance spectroscopy at fixed frequency or frequency scan vs <ul style="list-style-type: none"> <li>○ fixed potential or fixed current</li> <li>○ scanning potential or scanning current</li> <li>○ time</li> </ul> | EIS/GEIS   |
| ▪ Fast EIS/GEIS<br>Very low interval fixed-frequency measurements  | FEIS/FGEIS |

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



## 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 $\mu$ V step) HR: 0.1 mV/s (183 $\mu$ V step)	1 V/s (5 mV step)
	▪ Pulse time	0.4 ms	300 ms
▪ SWV	▪ Frequency	1 Hz	1250 Hz
▪ LSV ▪ CV	▪ 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)
▪ FCV	▪ Scan rate	LR: 0.1 mV/s (100 $\mu$ V step) HR: 0.01 mV/s (183 $\mu$ V step)	500 V/s (50 mV step)
	▪ N averaged scans	1	65535
	▪ N equil. scans	0	65535
▪ PAD	▪ Interval time	50 ms	4294 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	4294 s
	▪ Run time	1 ms	> year
▪ MM ▪ MA ▪ MP	▪ N cycles	1	20000
	▪ N levels	1	255
	▪ Level switching overhead time	~1 ms (typical)	-
	▪ Interval time	0.4 ms	4294 s
▪ FAM	▪ Interval time	1 $\mu$ s	60 s
	▪ Run time	3 $\mu$ s	34 days (60 s interval) 50 ms (1 $\mu$ s interval)
	▪ N data points	3	50000
▪ Fast EIS	Interval time between points at fixed frequency	~1 ms (typical)	-

## System 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	

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 at ±3 V (1 V range) 48 µV at ±1.5 V (500 mV) 19.2 µV at ±0.6 V (200 mV) 9.6 µV at ±0.3 V (100 mV) 4.8 µV at ±0.15 V (50 mV)	193 µV at ±6 V (1 V range) 96.5 µV at ±3 V (500 mV) 38.5 µV at ±1.2 V (200 mV) 19.3 µV at ±0.6 V (100 mV) 9.65 µV at ±0.3 V (50 mV)
▪ measured dc-potential accuracy	≤ 0.2% potential, ±1 mV offset	

## FRA / EIS (impedance measurements)

▪ frequency range	10 $\mu$ Hz to 200 kHz
▪ ac-amplitude range	1 mV to 900 mV rms, or 2.5 V p-p

## GEIS (galvanostatic impedance measurements)

▪ frequency range	10 $\mu$ Hz to 100 kHz
▪ ac-amplitude range	0.9 * range A rms

## Electrometer

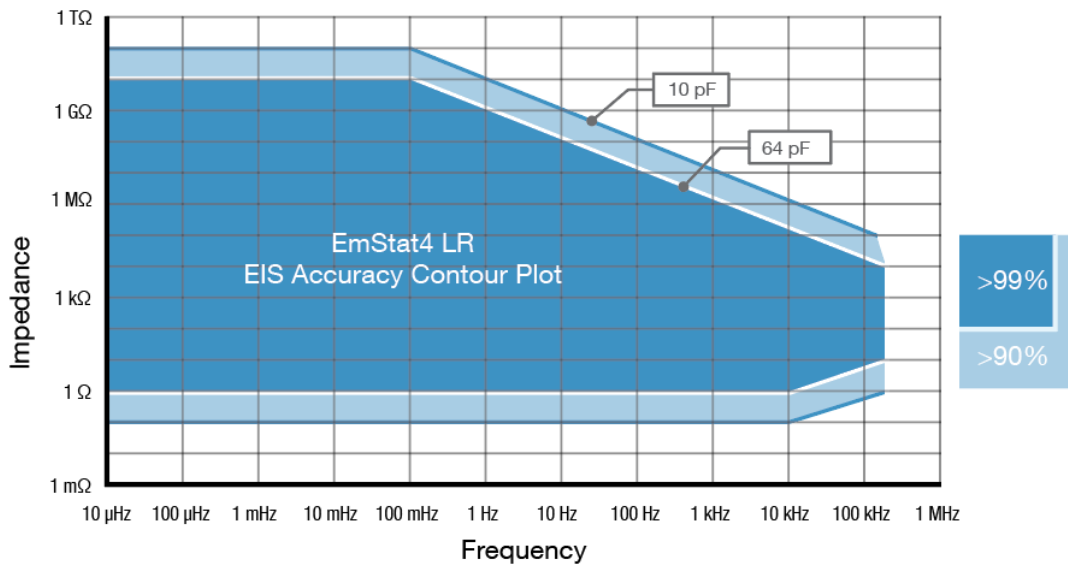
▪ electrometer amplifier input	> 1 T $\Omega$ // 10 pF
▪ bandwidth	500 kHz

## iR Compensation

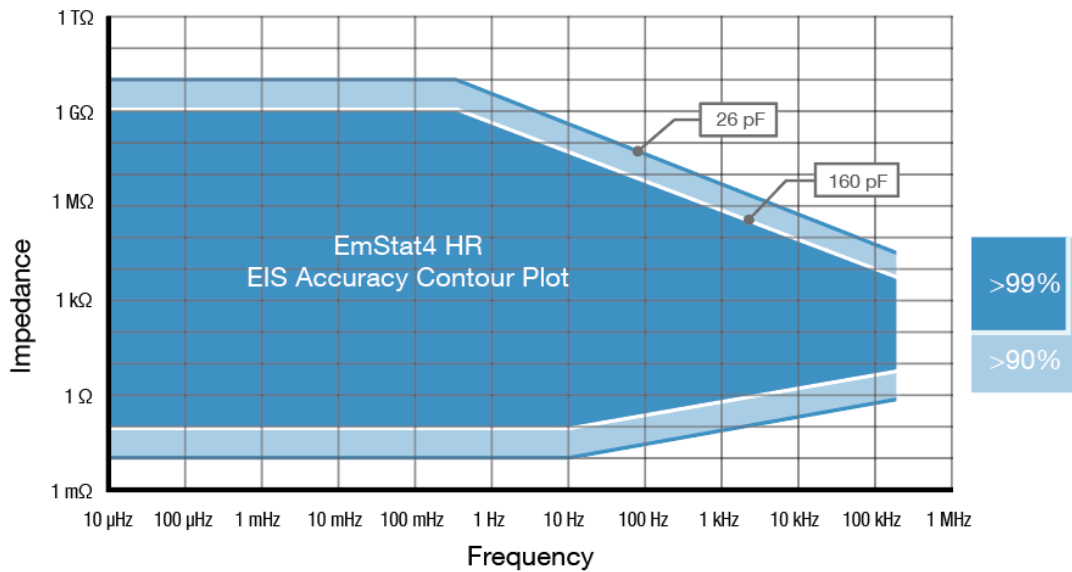
▪ method used for iR-drop compensation	Positive Feedback
▪ resolution of MDAC used for correcting potential	12-bit
▪ max. compensated resistance	1 MOhm

Other		
	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
▪ power consumption	Typical: 1W (idle) Max: 1.6W (cell @ 30 mA)	Typical: 1.5W (idle) 1.6W (cell @ 10 mA) Max: 4.6W (cell @ 200 mA)
▪ battery	11.1 Wh capacity 80% charge in 2.5 hours, full charge in 3 hours	
▪ power source	USB-C or internal LiPo battery	
▪ communications	USB-C or wireless	
▪ housing	aluminium body: 11.4 x 8.0 x 4.5 cm	
▪ weight	~500 g	
▪ internal storage space	500 MB, equivalent to >15M datapoints or ~1000 measurement files (whichever comes first)	
▪ auxiliary port	<ul style="list-style-type: none"> <li>▪ connector: D-subminiature 15</li> <li>▪ analog input <math>\pm 10</math> V, 16-bit</li> <li>▪ analog output 0-6 V, 12-bit</li> <li>▪ digital I/O:                             <ul style="list-style-type: none"> <li>- 4x digital output (0-3.3 V)</li> <li>- 1x digital input (0-3.3 V)</li> </ul> </li> <li>▪ power output (5 V, max. 300 mA)</li> </ul>	
	i monitor (raw output of cell current and potential)	
	<ul style="list-style-type: none"> <li>- 1 k<math>\Omega</math> output impedance</li> <li>- i-out in active current range (CR): <math>i = V_{out} \times CR</math></li> <li>- Max. output voltage <math>\pm 5</math>V</li> </ul>	<ul style="list-style-type: none"> <li>- 1 k<math>\Omega</math> output impedance</li> <li>- i-out in active current range (CR): <math>i = V_{out} \times CR</math></li> <li>- Max. output voltage <math>\pm 8</math>V</li> </ul>
	E monitor (raw output of cell current and potential)	
	<ul style="list-style-type: none"> <li>- 1 k<math>\Omega</math> output impedance</li> <li>- Output 0-3 V, centered around 1.5 V: <math>E = -2.1 \times (E-out - 1.5)</math></li> </ul>	<ul style="list-style-type: none"> <li>- 1 k<math>\Omega</math> output impedance</li> <li>- Output 0-3 V, centered around 1.5 V: <math>E = -4.2 \times (E-out - 1.5)</math></li> </ul>

## EmStat4X LR EIS Accuracy Contour Plot



## EmStat4X 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 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 EmStat4X Kit

A standard EmStat4X kit includes a rugged carrying case with:

- EmStat4X LR or HR
- USB-C - USB-C cable
- USB-C to USB-A adapter
- 1 meter cell cable with 2 mm banana pins
- 4 or 5 croc clips
- Dummy Cell

Also included:

- PStace software for Windows (on USB drive)
- Manual (hardcopy)
- Quick Start document
- Calibration Report



Dumm  
v Cell

## EmStat4X Accessories



## MUX8-R2 or MUX16 multiplexer

The MUX8-R2 is an 8-channel multiplexer. It allows the EmStat4X to measure up to 8 cells, switching RE, CE, WE and 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.

**Attention:** The MUX8-R2 max. current with the EmStat4X HR is 70 mA.



## 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.



## TMP36 temperature sensor

This temperature sensor allows for monitoring of temperature during an experiment.

The TMP36 provides accuracies of  $\pm 1^\circ\text{C}$  at  $+25^\circ\text{C}$  and  $\pm 2^\circ\text{C}$  over the  $-40^\circ\text{C}$  to  $+125^\circ\text{C}$  temperature range. The supply current runs well below  $50\ \mu\text{A}$ , providing very low self-heating, less than  $0.1^\circ\text{C}$  in still air.



## Differential Electrometer Amplifier (DEA)

The Differential Electrometer Amplifier (DEA) is a high impedance input amplifier. It can be used as a high-precision floating voltage amplifier with differential input and single output to the auxiliary port of an EmStat4X.

Default range is  $-10\text{V}$  to  $10\text{V}$  (1x gain). Possible gains are: 2x, 5x, 10x, 20x, 50x and 100x.

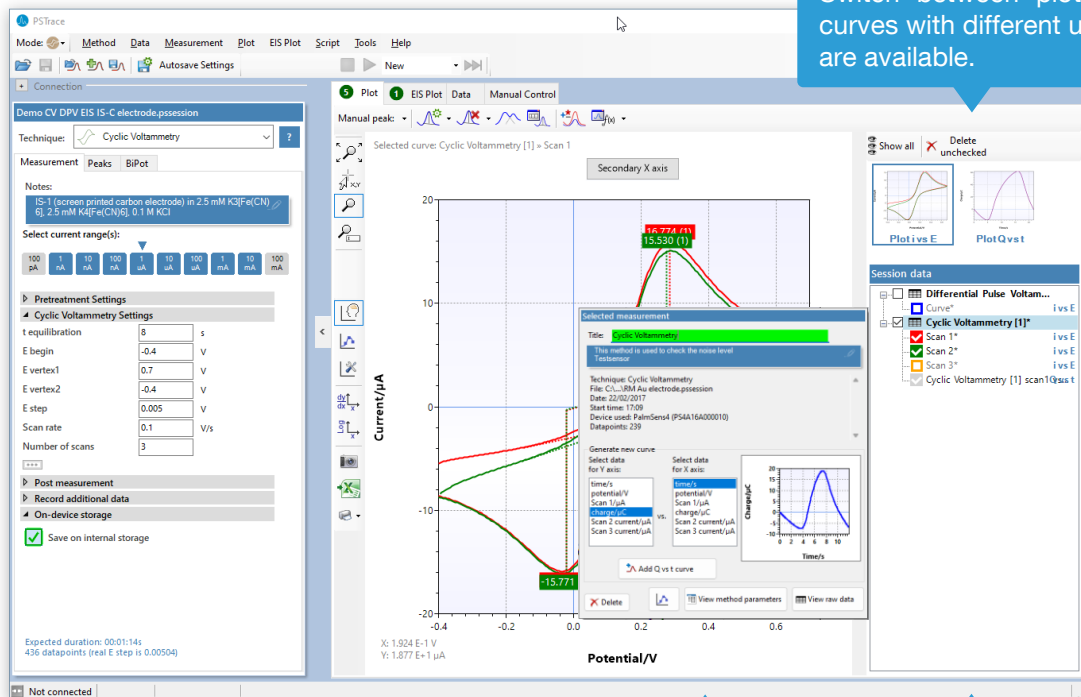
➤ See for more information:  
[palmSens.com/accessories](http://palmSens.com/accessories)

## PSTrace: Software for Windows

The EmStat4X operates seamlessly with PSTrace, a free software compatible with all our potentiostats. Additionally, all future updates are provided at no cost.

PSTrace is designed to get the most out of your instrument right after installation, without going through a long learning period. It has three modes:

1. **Scientific mode**, which allows you to run all the techniques our instruments have to offer;
2. **Corrosion mode**, suitable for corrosion analysis with corrosionists terminology and specific curve operations;
3. **Analytical mode**, designed for use with (bio)sensors and allows you to do concentration determinations.



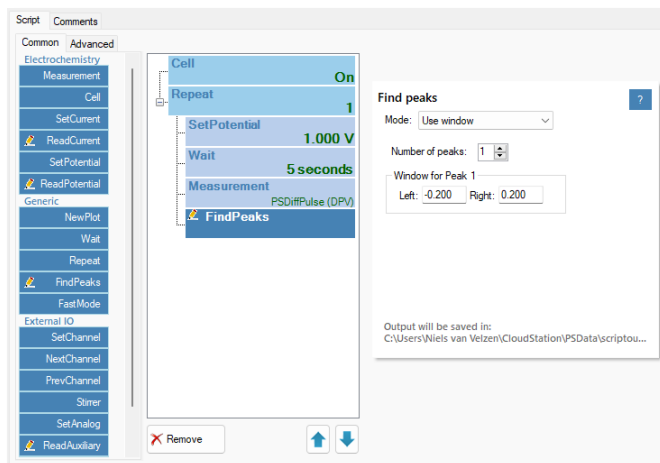
Setup your measurement easily and get immediate feedback on validity of parameters.

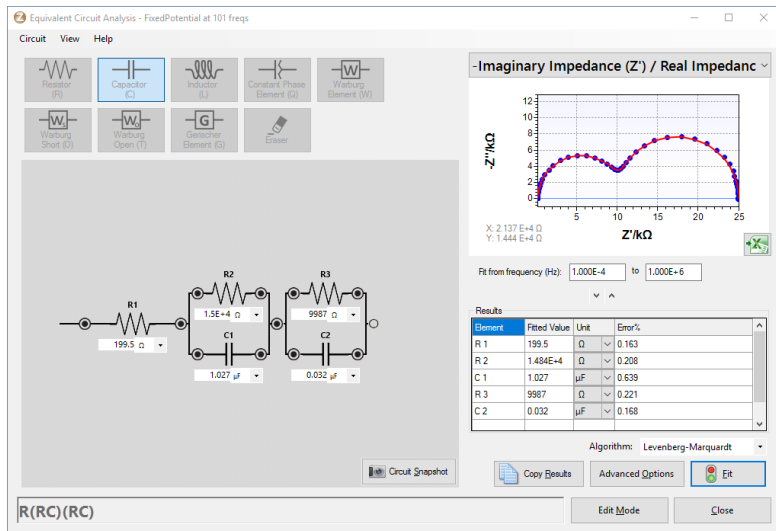
Click on a measurement for detailed information or generating new curves.

Quickly toggle the visibility of curves or groups of curves.

## 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.



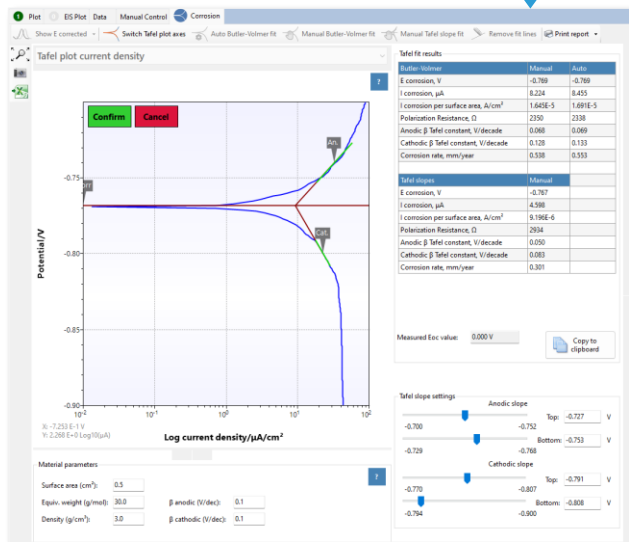


Use the graphical editor to draw the equivalent circuit or enter the CDC directly.

Corrosion mode for Tafel plot analysis and other corrosion data analysis.

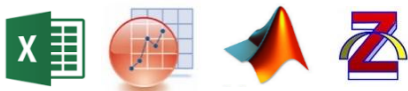
## Other functions in PSTrace

- Concentration determination
- Advanced peak search algorithms
- 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
- Load measurements from the internal storage
- Direct validation of method parameters
- Run custom MethodSCRIPT™



## 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 1366 × 768 pixels

➤ See for more information: [palsens.com/pstrace](http://palsens.com/pstrace)

## EmStat4X 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 PStace.

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...

```

1 e
2 var c
3 var p
4 #Select bandwidth of 40 for 10 points per second
5 set_max_bandwidth 40
6 #Set current range to 1 mA
7 set_range ba 1m
8 #Enable autoranging, between current of 100 uA and 1 mA
9 set_autoranging ba 100u 1m
10 #Turn cell on for measurements
11 cell_on
12 #Equilibrate at -0.5 V for 5 seconds, using a CA measurement
13 meas_loop_ca p c -500m 500m 5
14 pck_start
15 pck_add p
16 pck_add c
17 pck_end
18 endloop
19 #Start LSV measurement from -0.5 V to 1.5 V, with steps of 10 mV
20 #and a scan rate of 100 mV/s
21 meas_loop_lsv p c -500m 1500m 10m 100m
22 #Send package containing set potential and measured WE current.
23 pck_start
24 pck_add p
25 pck_add c
26 pck_end
27 #Abort if current exceeds 1200 uA
28 if c > 1200u
29 abort
30 endloop
31 #Turn off cell when done or aborted
32 on_finished:
33 cell_off
34

```

[Online support on MethodSCRIPT](#)



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++



Swift



python™

➤ See for more information:  
[palmens.com/methodscript](http://palmens.com/methodscript)

## 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](http://www.palmsens.com/dev)

## PStouch: App for Android



PStouch is an app for Android devices compatible with all PalmSens, EmStat and Sensit potentiostats.

## PStouch features:

- Setting up and running measurements
- Loading and saving measured curves
- Analyzing and manipulating peaks
- Sharing measurement data directly via any service like email or Dropbox
- Concentration determination by means of Standard Addition or Calibration Curve
- Support for PalmSens accessories such as a Multiplexer or Stirrer
- All method and curve files are fully compatible with PSTrace software for Windows.

➤ See for more information:  
[palsens.com/pstouch](http://palsens.com/pstouch)

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

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