

# EmStat4s

POTENTIOSTAT / GALVANOSTAT / IMPEDANCE ANALYZER



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## Desktop performance in the palm of your hand

The EmStat4S is a portable USB-powered Potentiostat, Galvanostat, and optional Frequency Response Analyser (FRA) for Electrochemical Impedance Spectroscopy (EIS). The EmStat4S 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 up to 200 mA.

### Two versions for different applications

The EmStat4S is available in two versions: the LR (Low Range) and HR (High Range) versions. The following table shows the main differences:

	<i>EmStat4S LR</i>	<i>EmStat4S HR</i>
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
Electrode connections	WE, RE, CE, and ground, 2 mm banana plugs	WE, RE, CE, S, and ground, 2 mm banana plugs

software for Windows 

## Always a backup



The EmStat4S is equipped with internal storage memory. This means all your measurements can be saved on-board as a backup. All internally stored measurements can be browsed and transferred back to the PC easily using PSTrace.

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

## Supported Techniques

The EmStat4S supports the following electrochemical techniques:

### Voltammetric techniques

- |                            |              |
|----------------------------|--------------|
| ▪ Linear Sweep Voltammetry | <b>LSV</b>   |
| ▪ Cyclic Voltammetry       | <b>CV</b>    |
| ▪ Fast Cyclic Voltammetry  | <b>FCV *</b> |
| ▪ AC Voltammetry           | <b>ACV</b>   |

### Pulsed techniques

- |                                  |            |
|----------------------------------|------------|
| ▪ Differential Pulse Voltammetry | <b>DPV</b> |
| ▪ Square Wave Voltammetry        | <b>SWV</b> |
| ▪ Normal Pulse Voltammetry       | <b>NPV</b> |

These methods can all be used in their stripping modes which are applied for (ultra-) trace analysis.

### Amperometric techniques

- |   |               |
|---|---------------|
| ▪ Chronoamperometry                     | <b>CA</b>     |
| ▪ Zero Resistance Amperometry           | <b>ZRA</b>    |
| ▪ Chronocoulometry                      | <b>CC</b>     |
| ▪ MultiStep Amperometry                 | <b>MA</b>     |
| ▪ Fast Amperometry                      | <b>FAM *</b>  |
| ▪ Pulsed Amperometric Detection         | <b>PAD</b>    |
| ▪ Multiple-Pulse Amperometric Detection | <b>MPAD *</b> |

### Galvanostatic techniques

- |                                 |                     |
|---------------------------------|---------------------|
| ▪ Linear Sweep Potentiometry    | <b>LSP</b>          |
| ▪ Chronopotentiometry           | <b>CP</b>           |
| ▪ MultiStep Potentiometry       | <b>MP</b>           |
| ▪ Open Circuit Potentiometry    | <b>OCP</b>          |
| ▪ Stripping Chronopotentiometry | <b>SCP or PSA *</b> |

### Other

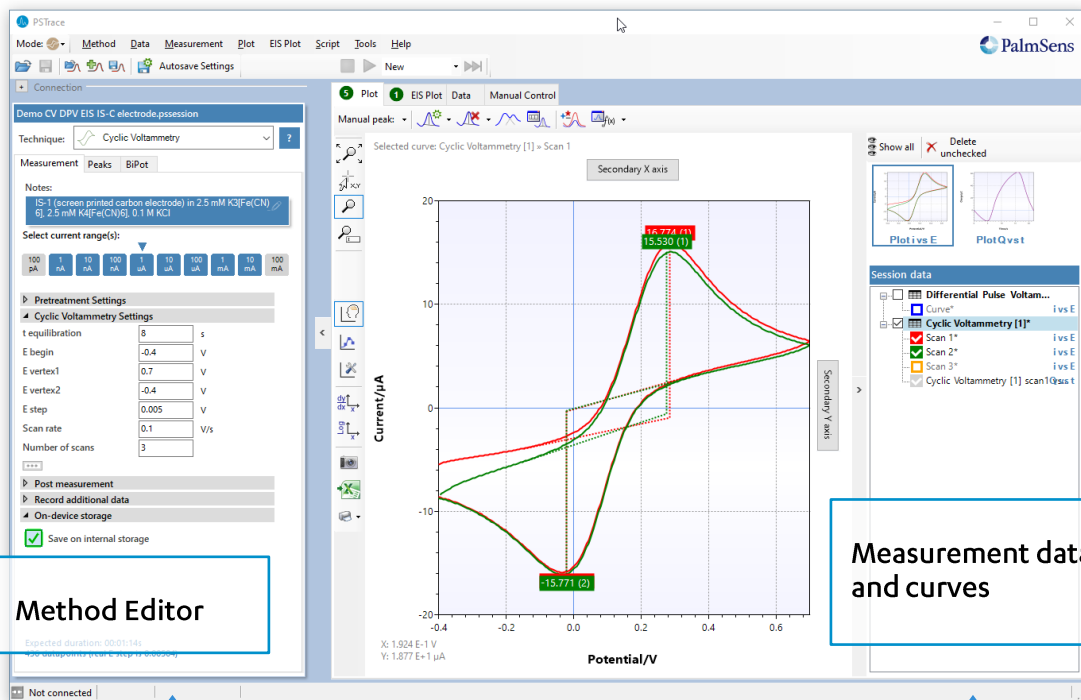
- |   |                   |
|---|-------------------|
| ▪ Mixed Mode  | <b>MM</b>         |
| ▪ Potentiostatic/Galvanostatic Impedance spectroscopy | <b>EIS/GEIS *</b> |
| ○ Potential scan or current scan                      |                   |
| ○ Fixed potential or fixed current                    |                   |
| ○ Time scan   |                   |

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\* This technique will be enabled with the next software update due in October 2021.



## PSTrace: Software for Windows

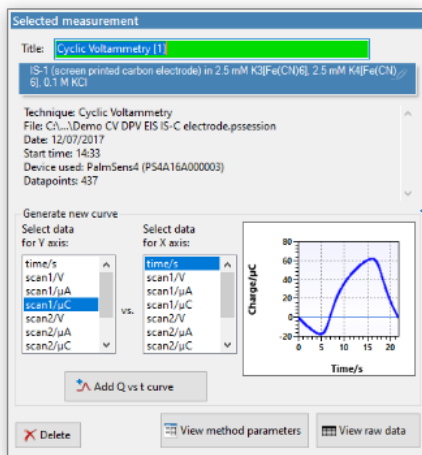


**Method Editor**

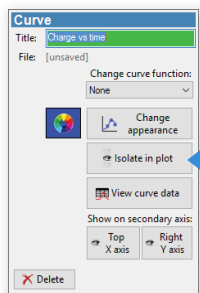
**Measurement data and curves**

Select current ranges for auto ranging and the starting current range.

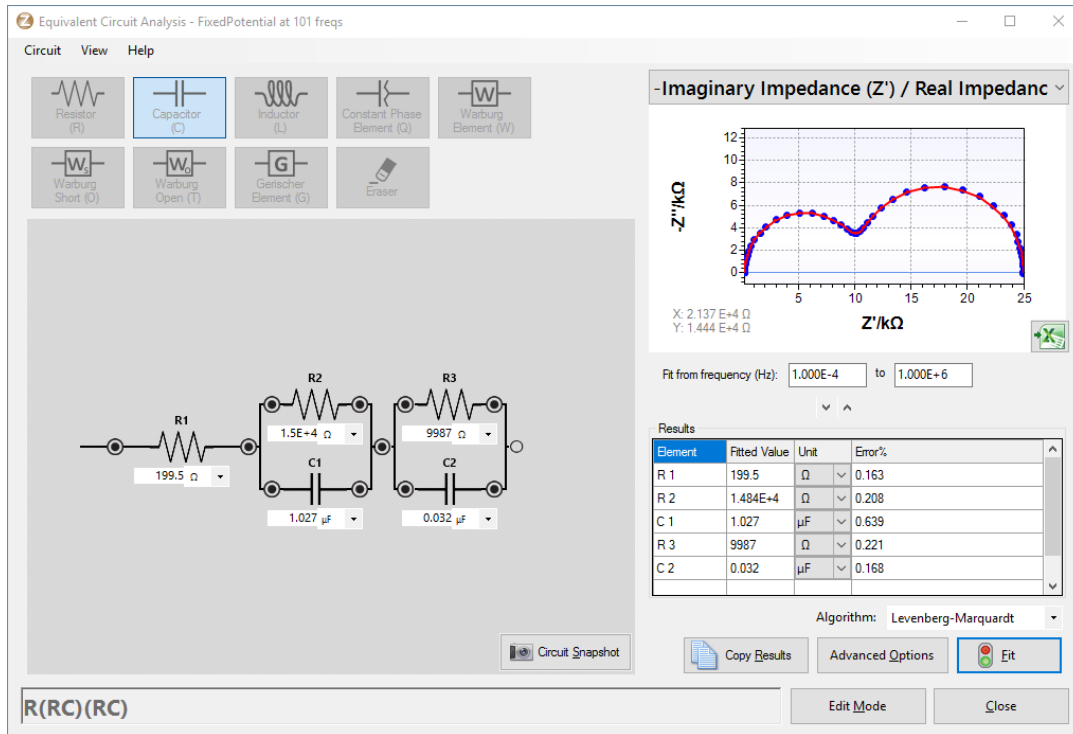
Switch between plots if curves with different units are available.



Click on a measurement in the legend to see the available data and to generate more curves.



Click on a curve in the legend to change its title or appearance.



### Other functions in PSTrace 5

- Equivalent Circuit Fitting for EIS
- Automating tasks and measurements
- Open your data in Origin and Excel with one click
- Save all available curves, measurement data, and methods to a single file
- Browse measurements on EmStat4's internal storage
- Direct validation of method parameters

### Integration with third-party software:

- Excel
- Origin
- Matlab
- ZView



### System requirements

Minimum PC requirements are:

- Windows 7, 8, or 10 (32-bit or 64-bit)
- 1 GHz or faster 32-bit (x86) or 64-bit (x64) processor
- 1 GB RAM (32-bit) or 2 GB RAM (64-bit)

For more information about software visit

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

## EmStat4S 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	300 s
	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	

## EmStat4S System 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)

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)

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



# EmStat4S System Specifications

## Electrometer

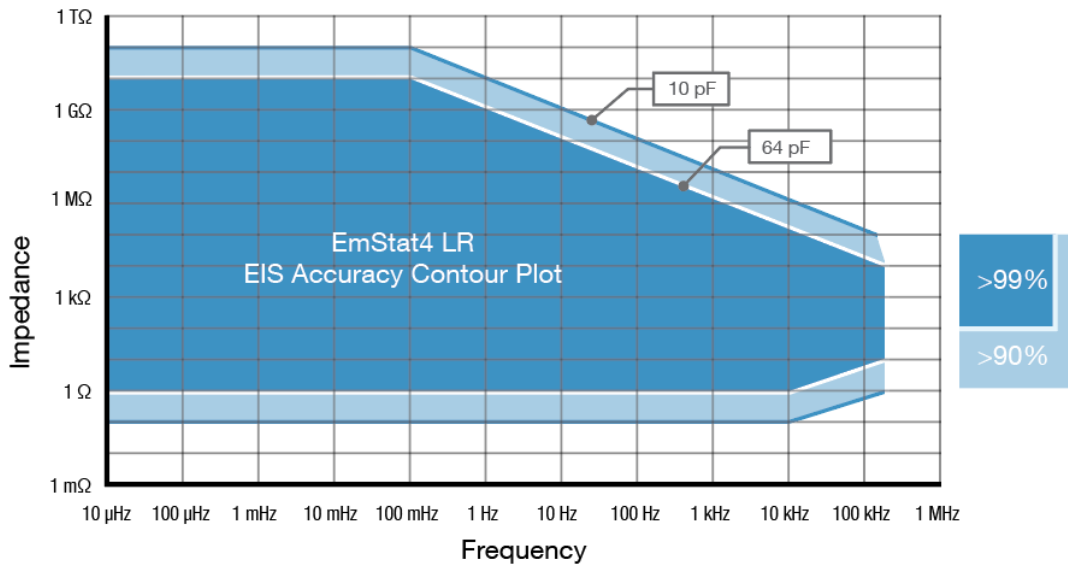
electrometer amplifier input	> 1 TΩ // 10 pF
bandwidth	10 kHz default or 500 kHz for EIS and fast CA/CP

## Other

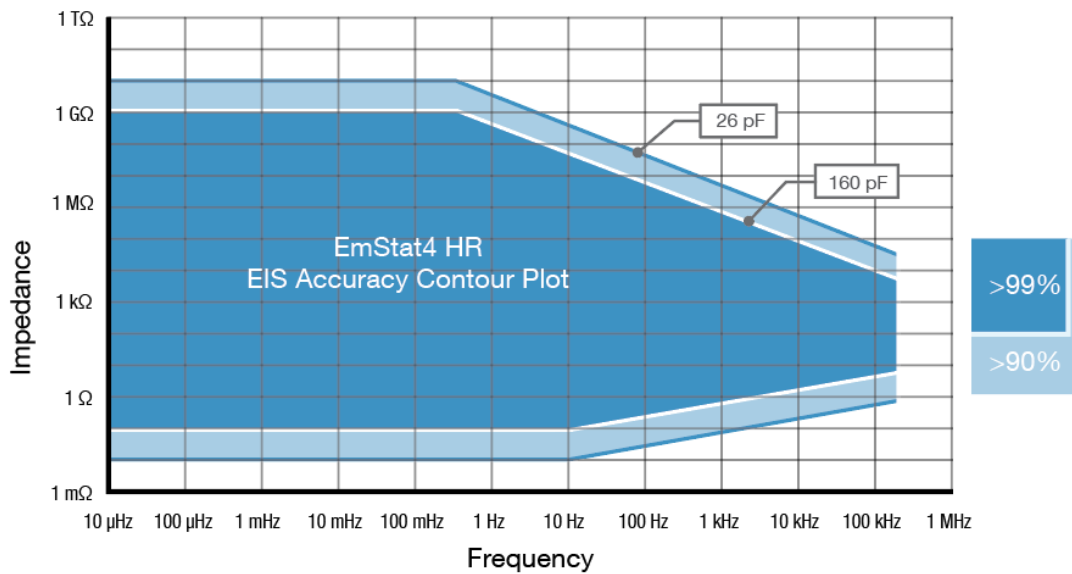
	model	LR	HR
electrode connections		WE, RE, CE, and ground, with 2 mm banana plugs	WE, RE, CE, S and ground, with 2 mm banana plugs
housing		aluminum body: 7.2 x 5.5 x 2.6 cm <sup>3</sup>	
weight		+/- 130 g	
power + communication		USB-C port	
internal storage space		500 MB, equivalent to >15M datapoints	



## EmStat4S LR EIS Accuracy Contour Plot



## EmStat4S 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 EmStat4S Kit

A standard EmStat4S includes a rugged carrying case with:

- EmStat4S LR or HR
- USB-C cable
- USB-C splitter cable for extra power (EmStat4S HR only)
- Sensor cable
- 4 or 5 croc clips
- Dummy Cell

Also included:

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



EmStat4S standard kit

## EmStat4S works with MethodSCRIPT

The MethodSCRIPT™ scripting language is designed to integrate our OEM 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.

Code examples are available for:

- Android
- Arduino
- C/C++
- Python
- iOS
- and C#

More script 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



### More information

For more information about MethodSCRIPT visit [www.palmsens.com/methodscript](http://www.palmsens.com/methodscript)

## MethodSCRIPT™

Please do not hesitate to contact PalmSens for more details:  
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