

EmStat4s

POTENTIOSTAT / GALVANOSTAT /
IMPEDANCE ANALYZER (optional)



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➤ See for more information:
www.palmsens.com/emstat4s



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 measuring low currents down to picoamps, whereas the **High Range** version is very suitable for applications that need a maximum current of up to 200 mA.



Main differences between the Low Range (LR) and High Range (HR) versions:



EmStat4S LR EmStat4S 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 μ Hz to 200 kHz	
▪ electrode connections	WE, RE, CE, and ground, 2 mm banana plugs	WE, RE, CE, S, and ground, 2 mm banana plugs

Always a backup



The EmStat4S is equipped with 500 MB 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 PStTrace.

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 | 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 or PSA * |

Other

- | | |
|---|----------|
| ▪ Mixed Mode | MM |
| ▪ Potentiostatic and 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 11 for more information.



* This technique will be enabled with the release of PStace 5.10

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 μ V step) HR: 0.1 mV/s (183 μ V step)	1 V/s (5 mV step)
	▪ Pulse time	0.4 ms	300 ms
▪ SWV	▪ Frequency	1 Hz	2500 Hz
▪ LSV ▪ CV	▪ Scan rate	LR: 0.01 mV/s (100 μ V step) HR: 0.01 mV/s (183 μ V 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	
	▪ Interval time	50 ms	300 s

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 μ V	183 μ V
▪ applied potential accuracy		$\leq 0.2\% \pm 1$ 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% of current ± 20 pA $\pm 0.2\%$ of range	< 0.2% of current $\pm 0.2\%$ of range
▪ bandwidth settings		320 Hz, 3.2 kHz, 30 kHz or 570 kHz	

Galvanostat (controlled current mode)			
	model	LR	HR
▪ current ranges		10 nA, 1 μ A, 100 μ A, 10 mA 4 ranges	1 μ A, 100 μ A, 10 mA, 100 mA 4 ranges
▪ applied dc-current		$\pm 3 * CR$ (current range)	
▪ applied dc-current resolution		0.01% of CR	0.0183% of CR
▪ applied dc-current accuracy		< 0.4% of current ± 20 pA $\pm 0.2\%$ of range	< 0.4% of current $\pm 0.2\%$ of range
▪ potential ranges		50 mV, 100 mV, 200 mV, 500 mV, 1 V	
▪ measured dc-potential resolution		96 μ V (1 V) 48 μ V (500 mV) 19.2 μ V (200 mV) 9.6 μ V (100 mV) 4.8 μ V (50 mV)	193 μ V (1 V) 96.5 μ V (500 mV) 38.5 μ V (200 mV) 19.3 μ V (100 mV) 9.65 μ V (50 mV)
▪ measured dc-potential accuracy		$\leq 0.2\%$ potential, ± 1 mV offset	
▪ bandwidth settings		320 Hz, 3.2 kHz, 30 kHz or 570 kHz	

FRA / EIS (impedance measurements)

▪ frequency range	10 μ 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 μ Hz to 200 kHz
▪ ac-amplitude range	0.9 * CR A rms

Electrometer

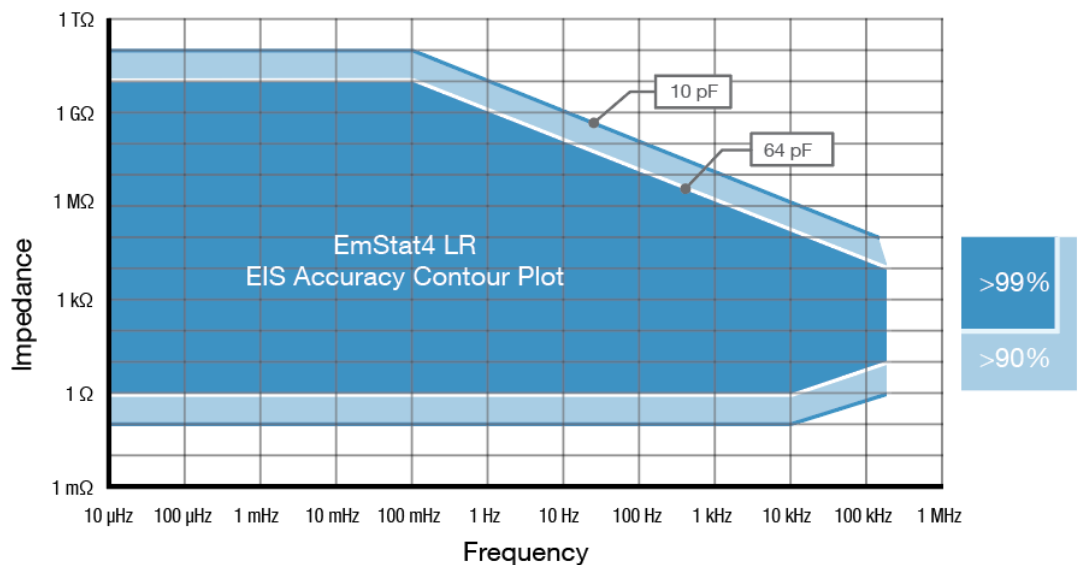
▪ electrometer amplifier input	> 1 T Ω // 10 pF
▪ bandwidth	10 kHz or 500 kHz

Other

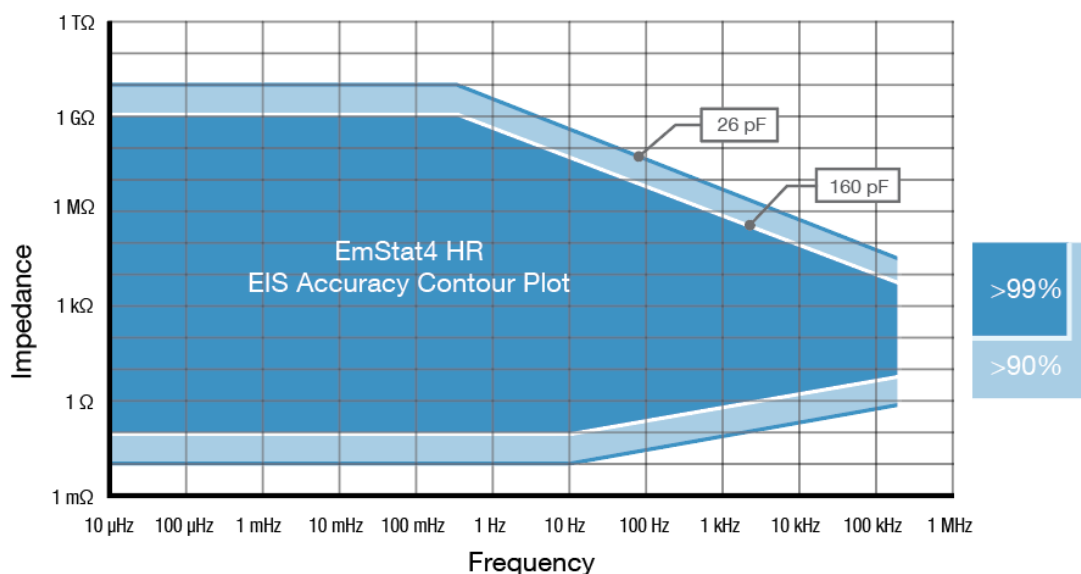
	model	LR	HR
▪ electrode connections		WE, RE, CE, and ground, with 2 mm banana plugs	WE, RE, CE, S and ground, with 2 mm banana plugs
▪ power consumption		0.75 W @ 1 mA (WE) 1.25 W @ 30 mA (WE)	1.25 W @ 1 mA (WE) 1.6 W @ 30 mA (WE) 3.75 W @ 200 mA (WE)
▪ power + communication		USB-C port	
▪ housing		aluminum body: 7.2 x 5.5 x 2.6 cm	
▪ weight		~130 g	
▪ 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 ≤ 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 EmStat4S Kit

A standard EmStat4S kit includes a rugged carrying case with:

- EmStat4S LR or HR
- USB-C cable
- USB-C splitter cable for extra power (EmStat4S HR only)
- 1 meter cell cable with 2 mm banana pins
- 4 or 5 croc clips
- Dummy Cell

Also included:

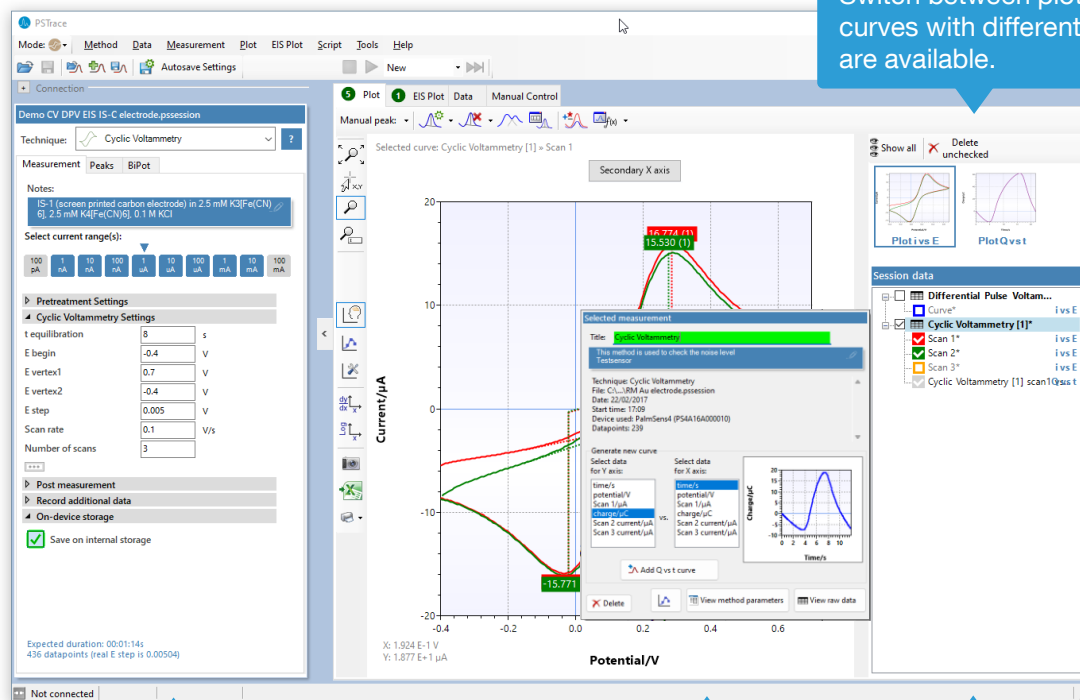
- PStTrace software for Windows (on USB drive)
- Manual (hardcopy)
- Quick Start document
- Calibration report



EmStat4S standard kit

PSTrace: Software for Windows

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; the Scientific mode which allows you to run all the techniques our instruments have to offer, and two dedicated modes for Corrosion analysis and the Analytical Mode. The Analytical Mode is designed for use with (bio)sensors and allows you to do concentration determinations. Extensive help files and prompts guide the user through a typical analysis.



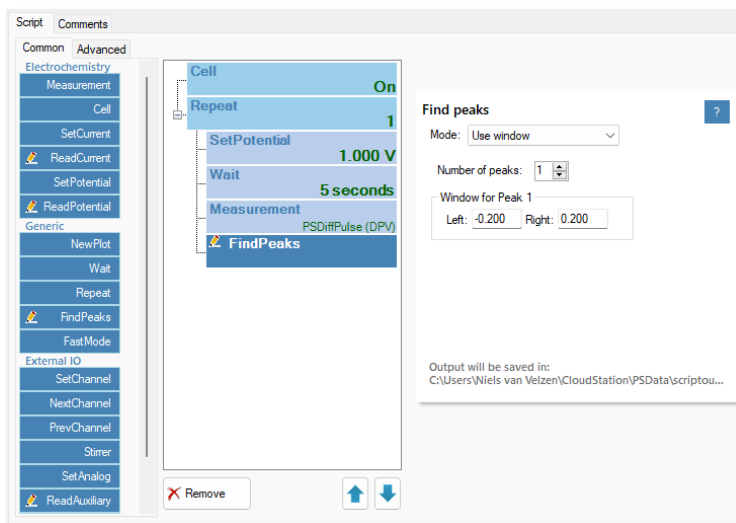
Setup your measurement easily and get immediate feedback on validity of parameters.

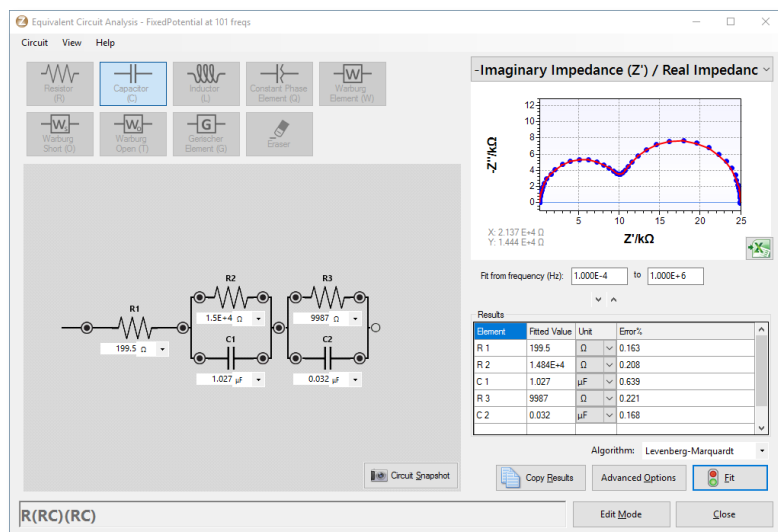
Click on a measurement for detailed information or generating new curves.

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.



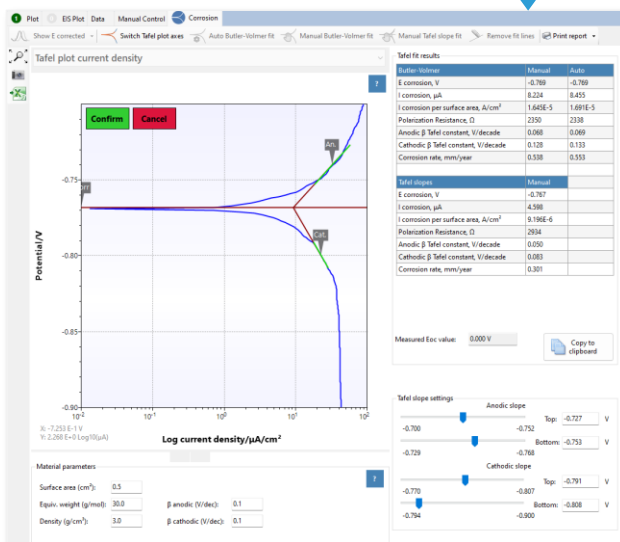


Use the graphical editor to draw the equivalent circuit or enter the CDC directly.

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

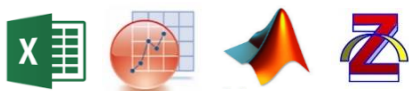
Other functions in PStTrace

- 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 MethodSCRIPTS™



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/pstrace

EmStat4S 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++



ARDUINO



Swift



Xamarin



python™



Java

> See for more information:

www.palmsens.com/methodscript

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>
/// </summary>
1reference
private void InitMethod()
{
    _methodEIS = new ImpedimetricMethod();
    _methodEIS.ScanType = ImpedimetricMethod.enumScanType;
    _methodEIS.Potential = 0.0f; //0.0V DC potential
    _methodEIS.Eac = 0.01f; //0.01V RMS AC potential at
    _methodEIS.FreqType = ImpedimetricMethod.enumFrequency;
    _methodEIS.MaxFrequency = 1e5f; //Max frequency is
    _methodEIS.MinFrequency = 10f; //Min frequency is
    _methodEIS.nFrequencies = 11; //Sample at 11 different
    _methodEIS.EquilibrationTime = 1f; //Equilibrates
    _methodEIS.Ranging.StartCurrentRange = new CurrentRange;
    _methodEIS.Ranging.MinimumCurrentRange = new CurrentRange;
    _methodEIS.Ranging.MaximumCurrentRange = new CurrentRange;
}
```

➤ See for more information:
www.palmsens.com/sdk

PStouch: App for Android



PStouch is an app for Android devices compatible with all PalmSens, EmStat and Sensit potentiostats. Your smartphone or tablet connects with the EmStat4S via USB. This requires your device to support USB OTG.

PStouch features:

- Setting up and running measurements
- Loading and saving measured curves
- Analysing 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 PStace software for Windows.

➤ See for more information:
www.palmsens.com/pstouch

Please do not hesitate to contact PalmSens for more details:
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