EMSTAT4 MUX™

2-in-1 multiplexed
potentiostat / galvanostat / impedance analyzer

PalmSens

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› See for more information:
www.palmsens.com/emstat4mux

2-in-1: Potentiostat with Integrated Multiplexer

Gone are the days with too many cables. With the EmStat4 MUX you have a potentiostat and a multiplexer in one. The EmStat4 MUX is a powerful potentiostat, galvanostat and impedance analyzer and supports all popular electrochemical techniques. Its eight channels allow for sequential measurements, for example eight screen-printed electrodes, or eight working electrodes in eight different cells.

Main Specifications

channels	8 x [Working (WE), Sense (S), Counter (CE) and Reference electrode (RE) and Ground]
potential range	±3 V
max. compliance	±5 V
current ranges	1 nA to 10 mA (8 ranges)
max. current	±30 mA
FRA / EIS	10 µHz to 100 kHz when switching WE, RE and CE 10 µHz to 200 kHz when switching WE and RE+CE combined (2-electrode configuration)
electrodes	WE, S, RE, CE, and Ground, 2 mm banana plugs

See page 9 for more detailed system specifications.

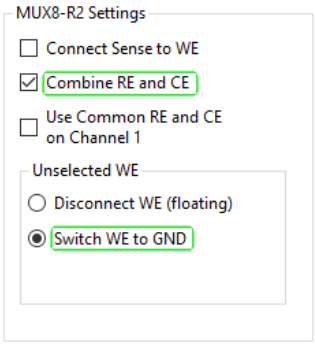
Cell Configurations

The internal multiplexer is designed for use up to 128 channels with 2-, 3- or 4- electrode sensors or cells.
The multiplexer can be used with different electrode or sensor configurations:

1. Eight separate cells or sensors each with a working/sense, reference and counter electrode.
2. Eight separate cells or sensors each with a working/sense and combined reference and counter electrode.
3. Cell or sensor array with eight working/sense electrodes sharing one reference and one counter electrode.
4. Cell or sensor array with eight working/sense electrodes sharing one combined reference/counter electrode.

In all configurations the cells can be multiplexed, leaving the non-selected working electrodes either at open circuit (individually floating) or at Ground potential.
When in configurations 3 and 4, the unselected channels are switched to Ground, they will have the working electrode's potential. This is since the active WE is always at Ground potential.

You can easily change the hardware configuration of the multiplexer as part of the measurement settings in our PSTrace software or the PStouch app for Android.



The hardware configuration can be set in PSTrace.

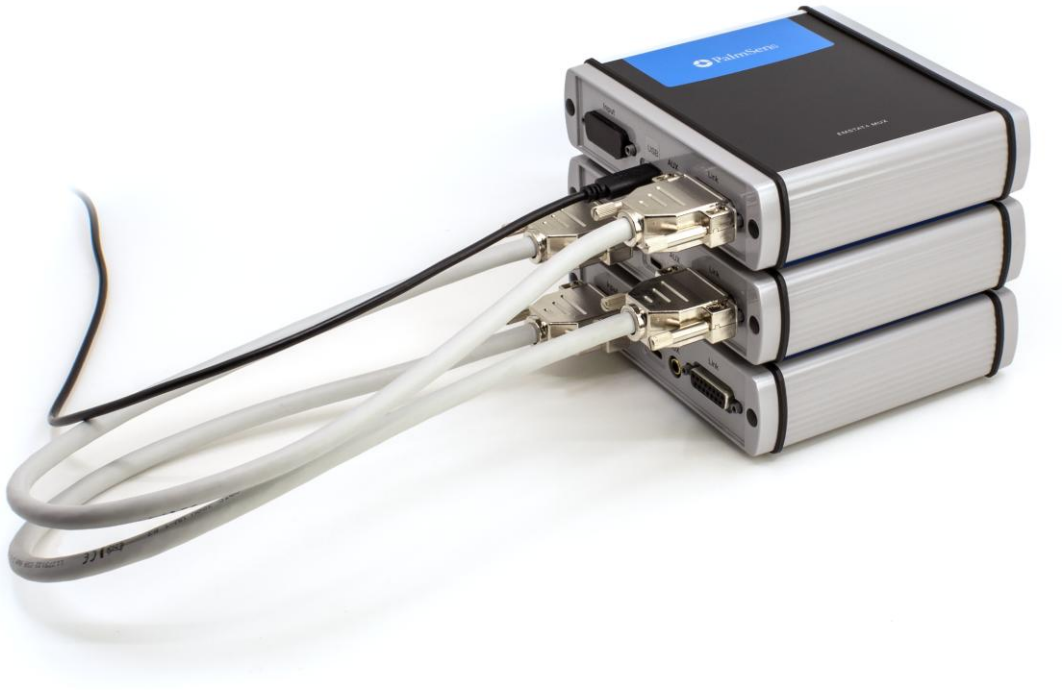
Connectors

The EmStat4 MUX has the following connectors:

Connector	Function
AUX	Can be used to control an external switch or stirrer or to measure an auxiliary input like temperature.
Link	Connects to Input of next multiplexer, for daisy-chaining multiple multiplexers.
USB-C	For providing extra power in case more than two multiplexers are connected to a single instrument.
Channel 1-4	Connects to WE, RE and CE of channels 1-4.
Channel 5-8	Connects to WE, RE and CE of channels 5-8.

Adding More Channels

The number of available channels can be increased by connecting one or more MUX8-R2 multiplexers to the EmStat4 MUX. The additional multiplexers are daisy chained through the Link to Input of each successive multiplexer. The software automatically detects the total number of channels available.



Magnetic feet

The magnetic feet on the EmStat4 MUX and magnets embedded in the op side of the MUX8-R2 multiplexers ensure a solid and stable stack of instruments.

Cell Connection Options

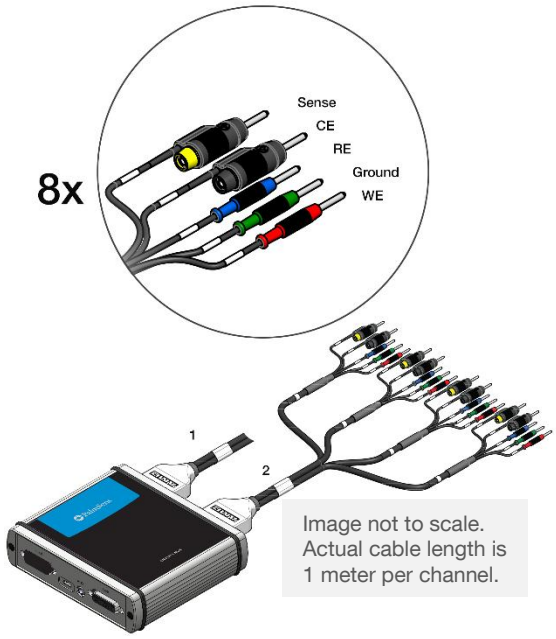


Image not to scale. Actual cable length is 1 meter per channel.

Option A (default):

The channels are divided in two sets of four sensor cables joined with a D-SUB connector.

Order code: [CBL-MUX08R2-SNS-5S]

Option B:

The cable here shown at the right can be used in case the multiplexer needs to be connected to a fixed setup by means of soldering or screw-terminals.

Order code: [CBL-MUX08R2-HD]

Option C:
You can also connect one or two screw-terminals directly in the multiplexer.

Order code: [MUX08R2-ST]

Option D:
The SPE adapter for our multiplexer allows you to connect 8x Screen Printed Electrodes (SPE's). The pitch of the SPE connector is 2.54 mm and compatible with the most popular brands of SPE's.

Order code: [MUX08R2-SPE]

Supported Techniques

The EmStat4 MUX supports the following electrochemical techniques.

Alternating Mode

In **sequential** mode each channel is set before the next measurement starts. In **alternating** mode, the channels are quickly scanned during each interval time giving a virtual-simultaneous measurement across the selected channels.

Techniques marked with an ⟳ can be used in Alternating mode.

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/Galvanostatic Impedance spectroscopy at fixed frequency or frequency scan vs — EIS/GEIS
  - fixed potential or fixed current
  - scanning potential or scanning current
  - time
- Fast EIS/GEIS — FEIS/FGEIS
  Very low interval fixed-frequency measurements

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	0.100 mV	250 mV
	▪ N data points	3	1 000 000
▪ NPV ▪ DPV	▪ Scan rate	0.1 mV/s (100 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	0.01 mV/s (100 µV step)	500 V/s (200 mV step)
▪ FCV	▪ Scan rate	0.1 mV/s (100 µV 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 µs	60 s
	▪ Run time	3 µs	34 days (60 s interval) 50 ms (1 µs interval)
	▪ N data points	3	50000
▪ Fast EIS	Interval time between points at fixed frequency	~1 ms (typical)	-

System Specifications

General	
▪ dc-potential range	±3 V
▪ compliance voltage	±5 V
▪ maximum current	±30 mA
▪ max. data acquisition rate	1M points/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)	
▪ applied potential resolution	100 µV
▪ applied potential accuracy	≤ 0.2% ±1 mV offset
▪ current ranges	1 nA to 10 mA (8 ranges)
▪ measured current resolution	0.009% of range (92 fA on 1 nA range)
▪ measured current accuracy	< 0.2% of current ±55 pA (25 pA typical) ±0.2% of range

Galvanostat (controlled current mode)	
▪ current ranges	10 nA, 1 uA, 100 uA, 10 mA (4 ranges)
▪ applied dc-current	±3 * range
▪ applied dc-current resolution	0.01% of range
▪ applied dc-current accuracy	< 0.4% of current ±20 pA ±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 ±0.150 V (50 mV)
▪ measured dc-potential accuracy	≤ 0.2% potential, ±1 mV offset

Optional: FRA / EIS (impedance measurements)	
▪ frequency range	10 µHz to 100 kHz when switching WE/S, RE and CE 10 µHz to 200 kHz when switching WE/S and RE+CE combined (2 electrodes configuration)
▪ 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	500 kHz

Other	
▪ electrode connections	8x [WE, S, RE, CE, and ground] default with 2 mm banana pins and croc clips
▪ power + communication	USB-C
▪ housing	aluminium body: 13.8 x 12.1 x 3.7 cm^3
▪ weight	500 g
▪ internal storage space	500 MB, equivalent to >15M datapoints or ~1000 measurement files (whichever comes first)

Multiplexer	
▪ number of channels	8 (up to 128 channels when adding more MUX8-R2 multiplexers)
▪ on resistance for WE	1.5 Ω typical
▪ charge injection for WE	20 pC typical
▪ switching time	2 ms
▪ switching time when alternating	25 ms (min. 0.5 s interval time when alternating over 8 channels)

Standard EmStat4 MUX Kit

A standard EmStat4 MUX kit includes a rugged carrying case with:

- EmStat4 MUX
- USB-C cable
- 2x 1 meter cell cable assembly (default option, quoted separately)
- Dummy Cell

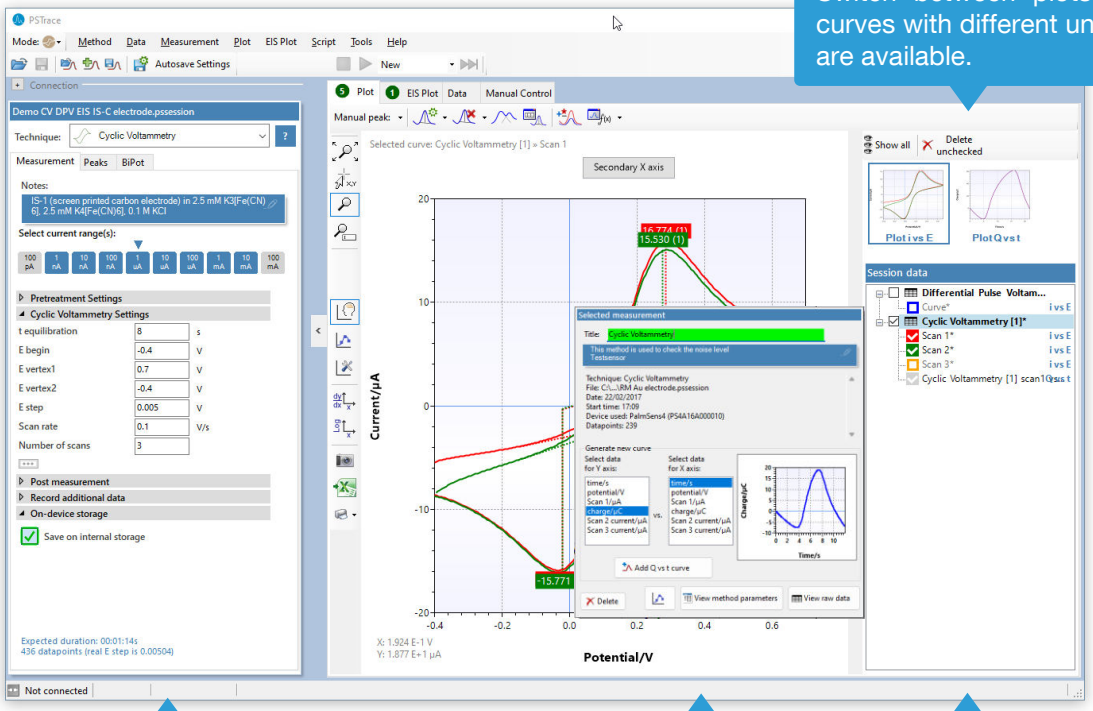
Also included:

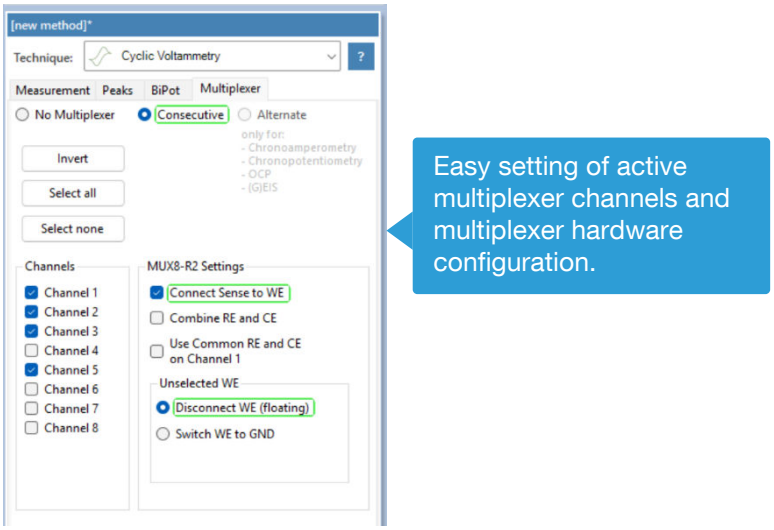
- PSTrace software for Windows (on USB drive)
- Manual (hardcopy)
- Quick Start document
- Calibration report

PSTrace: Software for Windows

The EmStat4 MUX 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:

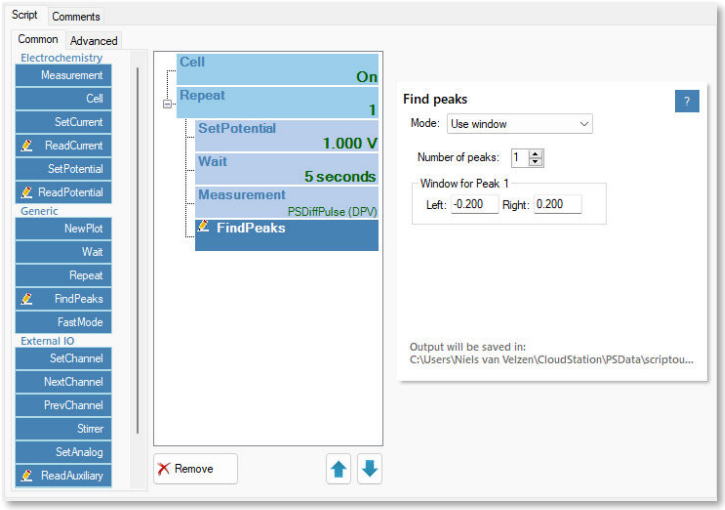
1. **Scientific mode**, which allows you to run all the techniques our instruments have to offer;
2. **Corrosion mode**, suitable for corrosion analysis with corrosionists terminology and specific curve operations;
3. **Analytical mode**, designed for use with (bio)sensors and allows you to do concentration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





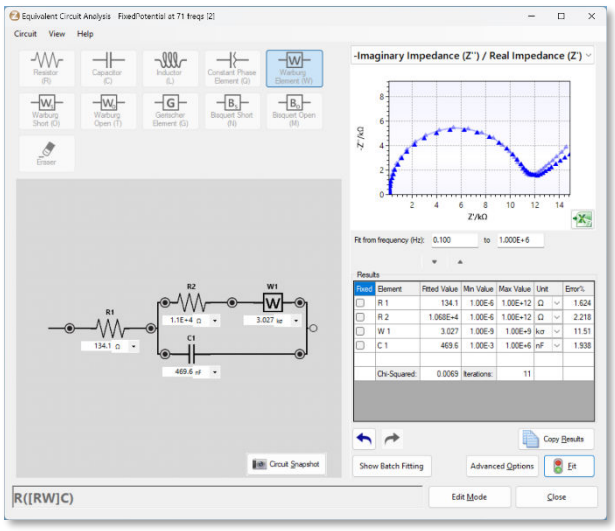
Scripting

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.



Equivalent Circuit Fitting on EIS data

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



Other functions in PSTrace

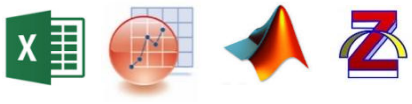
- Concentration determination
- Advanced peak search algorithms
- Open your data in Origin and Excel with one click of a button
- Save all available curves, measurement data and methods to a single file
- Load measurements from the internal storage
- Direct validation of method parameters
- Run custom MethodSCRIPT™ scripts

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

Integration with third-party software

- Excel
- Origin
- Matlab
- ZView



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

EmStat4 MUX works with MethodSCRIPT™

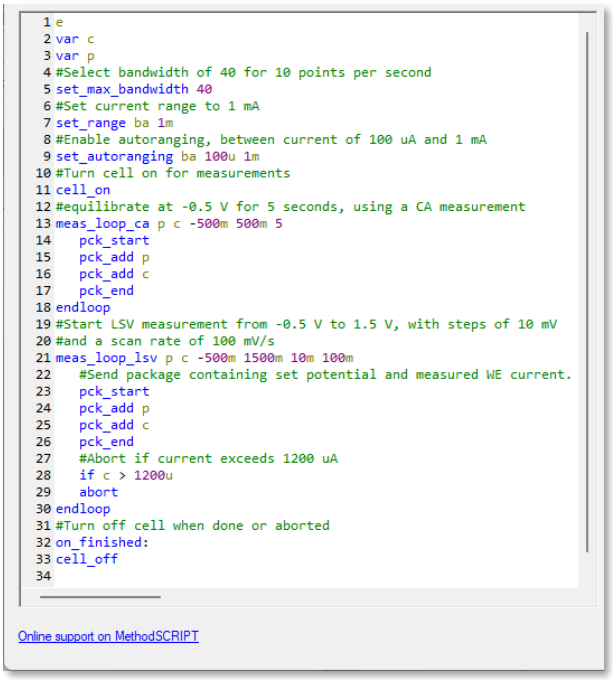
The MethodSCRIPT™ scripting language is designed to integrate our instruments and potentiostat (modules) effortlessly in your hardware setup, product, or experiment.

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:

- Multiplexer control
- (Nested) loops and conditional logic support
- User code during a measurement iteration
- Exact timing control
- Simple math operations on variables (add, sub, mul, div)
- Logging results to internal storage or external SD card
- and many more…



Write your own software and integrate (generated) MethodSCRIPT scripts. 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

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**
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  Build mobile apps to run PalmSens instruments in the field.
- **LabVIEW & MATLAB examples**
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For Developers

Accelerate Development

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PalmSens SDKs
put you in control
from the lab to the field

python™

MATLAB

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