

EmStatTM*pico*
Built with  ANALOG
DEVICES

ELECTROCHEMICAL INTERFACE MODULE

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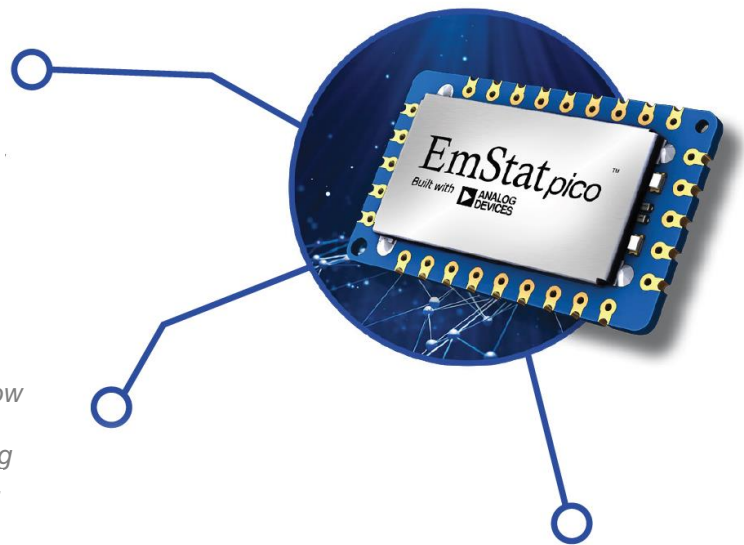
EmStat Pico: Electrochemical Interface Module

The EmStat Pico is a joint development by PalmSens BV and Analog Devices Inc. PalmSens is known for introducing the first commercially available handheld potentiostat. Over the last decade these have evolved to become smaller and more versatile. Together with Analog Devices, PalmSens now proudly presents the world smallest potentiostat module available on the market.



With a footprint of just 18x30 mm and a height of 3 mm the EmStat Pico can be embedded into virtually any design.

Different power modes and an ultra-low power sleep mode allow the EmStat Pico to be used in wearable applications or for long term monitoring at remote sites.



The EmStat Pico supports the new MethodSCRIPT™, a scripting language that allows you to let the EmStat Pico do what you want without the hassle of reading into spec sheets.

Supported Techniques

The following electrochemical techniques are supported by the EmStat Pico module.

Voltammetric techniques:

- | | |
|----------------------------------|-----|
| ▪ Linear Sweep Voltammetry | LSV |
| ▪ Cyclic Voltammetry | CV |
| ▪ Square Wave Voltammetry | SWV |
| ▪ Differential Pulse Voltammetry | DPV |
| ▪ Normal Pulse Voltammetry | NPV |

The above techniques can also be used for stripping voltammetry

Techniques as a function of time:

- | | |
|---------------------------------|-----|
| ▪ Chronoamperometry | CA |
| ▪ Pulsed Amperometric Detection | PAD |
| ▪ Open Circuit Potentiometry | OCP |
| ▪ MultiStep Amperometry | MA |

Electrochemical Impedance Spectroscopy

- | | |
|------------------------------------|-----|
| ▪ Scanning or fixed frequency mode | EIS |
|------------------------------------|-----|

Dual-channel and Bipotentiostat functionality

The second channel of the EmStat Pico can be used for running sequential measurements on two different cells each with their own Reference, Counter and Working electrodes. The second channel can also be used in Bipotentiostat mode, functioning as second Working Electrode versus the Reference and Counter electrode of channel 1. Both channels are recorded simultaneously in the Bipotentiostat mode.

The second Working Electrode (WE2) can either be set at a potential offset with respect to WE1 or at a fixed potential with respect to RE1.

The Bipotentiostat mode is supported in Low Speed mode (see table below) for all techniques, excluding EIS and OCP.

Main Specifications

The module works in three different modes;

Low Speed mode: for scan rates up to 1 V/s or a bandwidth of 100 Hz.

High Speed mode: for high scan rates and frequencies.

Max Range mode: a combination of the Low and High Speed modes for optimal dynamic dc-potential range

General	Low Speed mode	High Speed mode	Max Range mode
▪ Full dc-potential range	-1.2 to +2 V	-1.7 to +2 V	-1.7 to +2 V
▪ Dynamic dc-potential range ¹	2.2 V	1.2 V	2.6 V
▪ Compliance voltage	-2.0 to +2.3 V ²		
▪ Maximum current	±3 mA		
▪ Max. acquisition rate (datapoints/s)	100	1000	100
▪ Supports FRA/EIS	NO	YES	NO

Potentiostat (controlled potential mode)	Low Speed mode	High Speed mode	Max Range mode
▪ Channels	2 (2x WE, 2x RE and 2x CE)		
▪ Applied dc-potential resolution	537 µV	395 µV	932 µV
▪ Applied potential accuracy	< 0.2%	< 0.5%	< 0.5%
▪ Available current ranges	100 nA, 2 µA, 4 µA, 8 µA, 16 µA, 32 µA, 63 µA, 125 µA, 250 µA, 500 µA, 1 mA, 5 mA	100 nA, 1 µA, 6 µA, 13 µA, 25 µA, 50 µA, 100 µA, 200 µA, 1 mA, 5 mA	100 nA, 1 µA, 6 µA, 13 µA, 25 µA, 50 µA, 100 µA, 200 µA, 1 mA, 5 mA

¹ The dynamic range is the range that can be covered during a single scan within the full potential range. For example; a linear scan can start at -1.5 V and end at 1.1 V or vice versa, covering 2.6 V dynamic range.

² The compliance voltage is the maximum potential between Working and Counter electrode and depends on the selected mode.

▪ Current accuracy	< 0.5 % for current ranges > 100nA, < 1% for 100nA current range	< 1% of the selected current range	< 1% of the selected current range
▪ Measured current resolution	0.006% of selected current range (5.5 pA on 100 nA range)		
▪ Measured potential resolution (for OCP)	56 uV		

FRA / EIS (impedance measurements) in High Speed Mode only

▪ Frequency range	0.016 Hz to 200 kHz
▪ Ac-amplitude range	1 mV to 0.25 V rms, or 0.708 V peak-peak

Bipotentiostat

▪ Modes	1. WE2 at fixed potential (E offset vs RE1) 2. WE2 scanning (E offset vs WE1)
▪ Max. potential WE2	$E(WE1) + E(WE2) < 1.6 V^3$

Electrometer

▪ Electrometer amplifier input	> 1 TΩ // 10 pF
▪ Bandwidth	250 kHz

Communications and peripherals

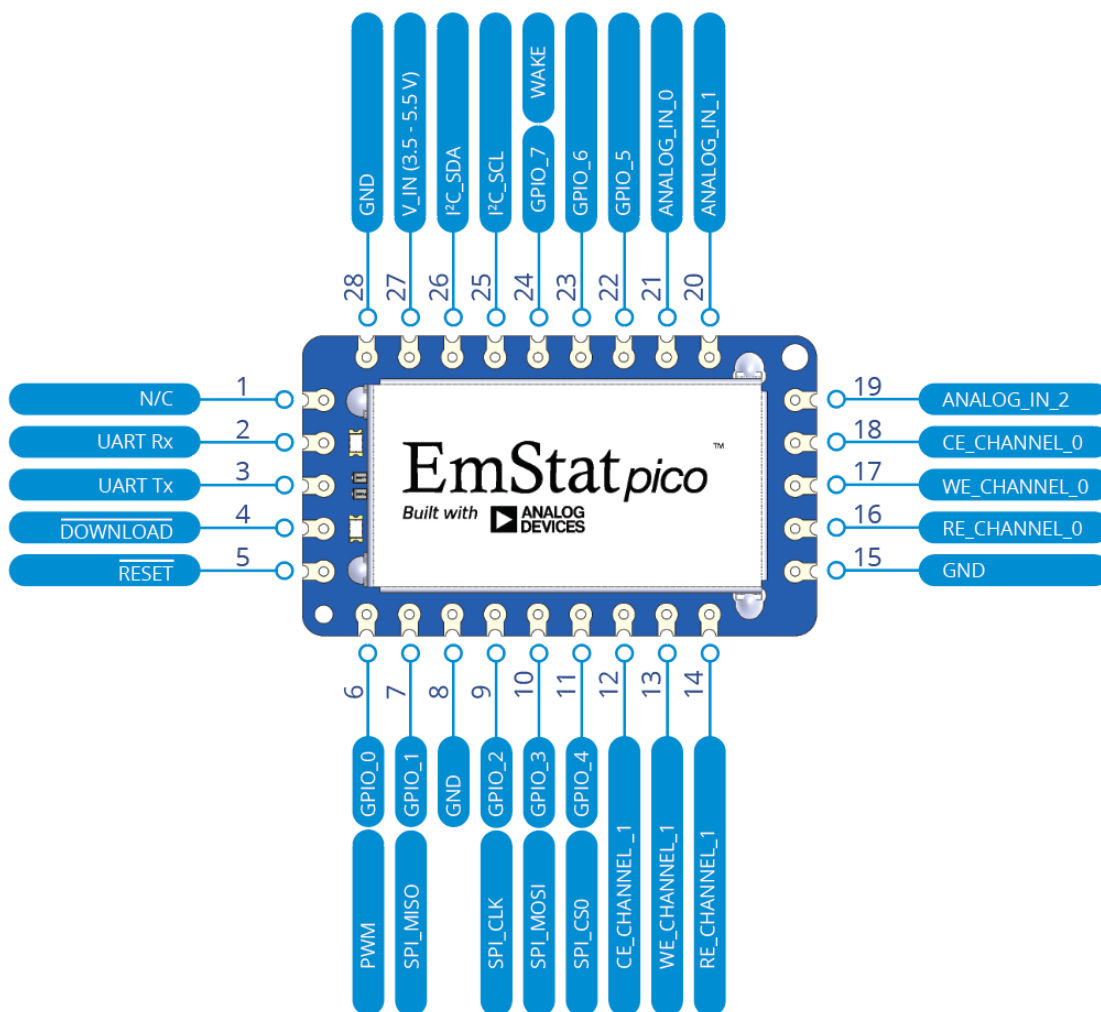
▪ Module communications	UART
▪ Communication with external peripherals	SPI and I ² C
▪ Analog I/O	3 analog input pins
▪ Digital I/O	7 general-purpose I/O pins 1 wake-up pin
▪ Optional on-board temperature sensor⁴	±0.25 °C

³ If your main WE1 is scanning from -0.5V to +0.5V, the WE2 can only have a maximum offset of 0.6V.

⁴ The high accurate on-board temperature sensor is standard available on modules that come with the EmStat Pico Development Kit. For separate EmStat Pico modules the temperature sensor is optional.

Other	
▪ Storage	4000 datapoints on-board (optional external SD card for mass storage)
▪ Mounting	Surface mounted with castellated pads Through hole pins (2.54 mm pitch)
▪ Dimensions	18 x 30 x 2.6 mm
▪ Operation temperature range	-40°C to +85°C

Module pin-out



All logic levels at 3.3V

MethodSCRIPT™: EmStat Pico Scripting Language

The EmStat Pico potentiostat module works with the new MethodSCRIPT™ scripting language. This language allows developers to program a human-readable script directly into the Pico module by means of a serial (TTL) connection. The simple script language allows for running electrochemical techniques supported by EmStat Pico and makes it easy to combine different measurements and other tasks.

More script features include:

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

Example MethodSCRIPT for EIS measurement on a test circuit

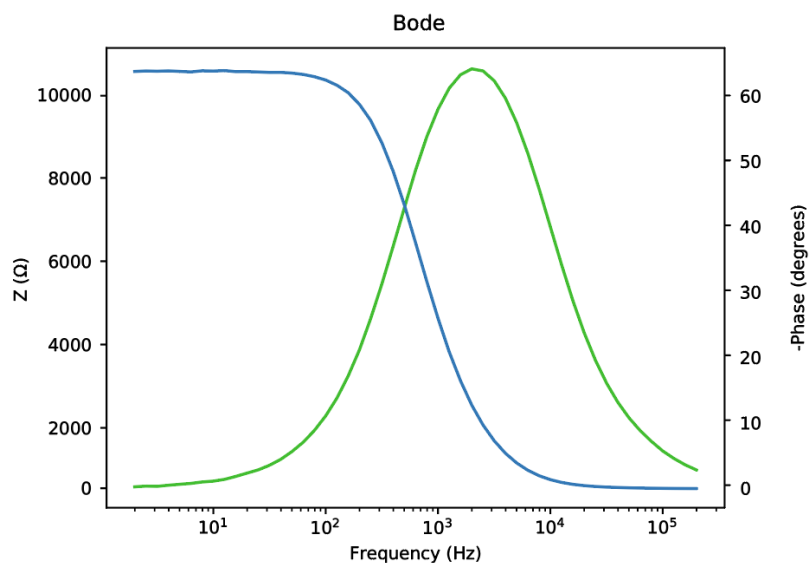
```
e
#Declare variables
var h
var r
var j
#Initialize device
set_pgstat_mode 3
#Set starting current range
set_cr 1m
#Turn cell on for measurement
cell_on
#Start EIS scan from 200kHz to 2 Hz in 41 steps
meas_loop_eis h r j 10m 200k 2 41 0
#Send results of measurement loop step
pck_start
#Send frequency
pck_add h
#Send Z real
pck_add r
#Send Z imaginary
pck_add j
pck_end
#Continue with next step of EIS scan
endloop
#Turn cell off after measurement
cell_off
```

Scripts can easily be generated in PStace for Windows. See page 8.

Run MethodSCRIPT on EmStat Pico

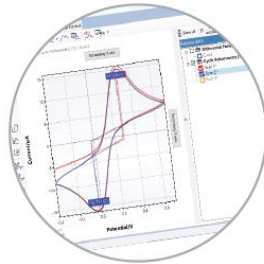


Actual measured result on dummy cell ran in Python



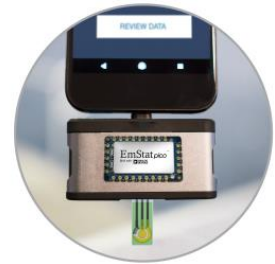
EmStat Pico Development Board

The EmStat Pico Development board allows to run your experiments conveniently in our PSTrace software for electrochemistry.



```

1 var j
2 var c
3 var p
4 var o
5 set_pgstat_chen 0
6 set_pgstat_mode 3
7 set_max_bandwidth 200
8 set_pos_range 0 0
9 set_cr 850n
10 set_autorangeing 850n 850n
11 call off
12 meses_loop_sep o 500m 3
13 pck_start
14 pck_add o
15 pck_end
16 endloop
17 call on
18 store_var b 0 ab
19 add_var b o
20 meses_loop_ca p c b 500m s
21 pck_start
22 pck_add p
23 pck_add c
    
```



STEP 1

Connect the EmStat Pico Development Board to a PC running PSTrace



STEP 2

Fine-tune your electrochemistry for optimal use of the EmStat Pico module



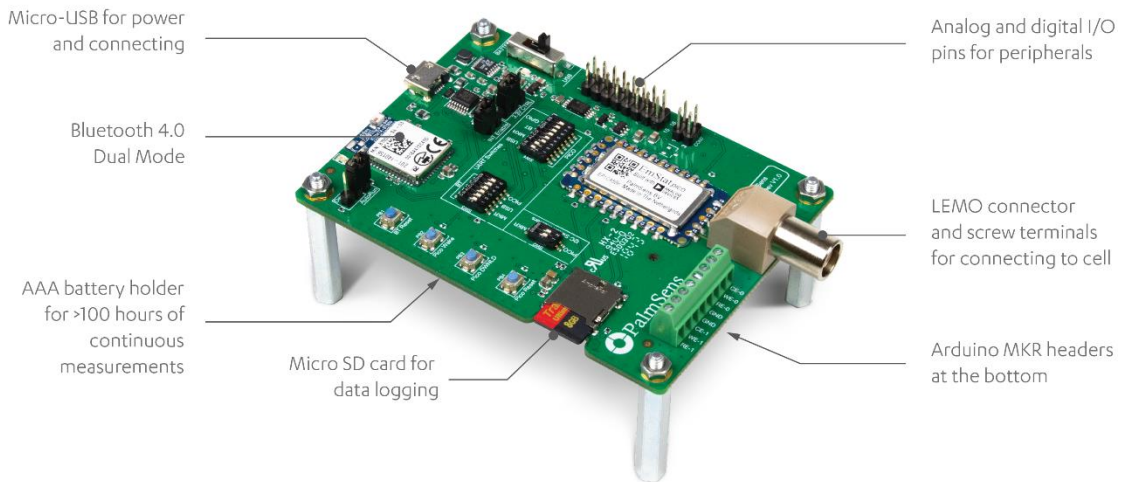
STEP 3

Generate the MethodSCRIPT™ snippet for running your measurement on the EmStat Pico

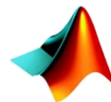


STEP 4

Use the MethodSCRIPT™ snippet to run the exact same measurement on the embedded EmStat Pico in your product

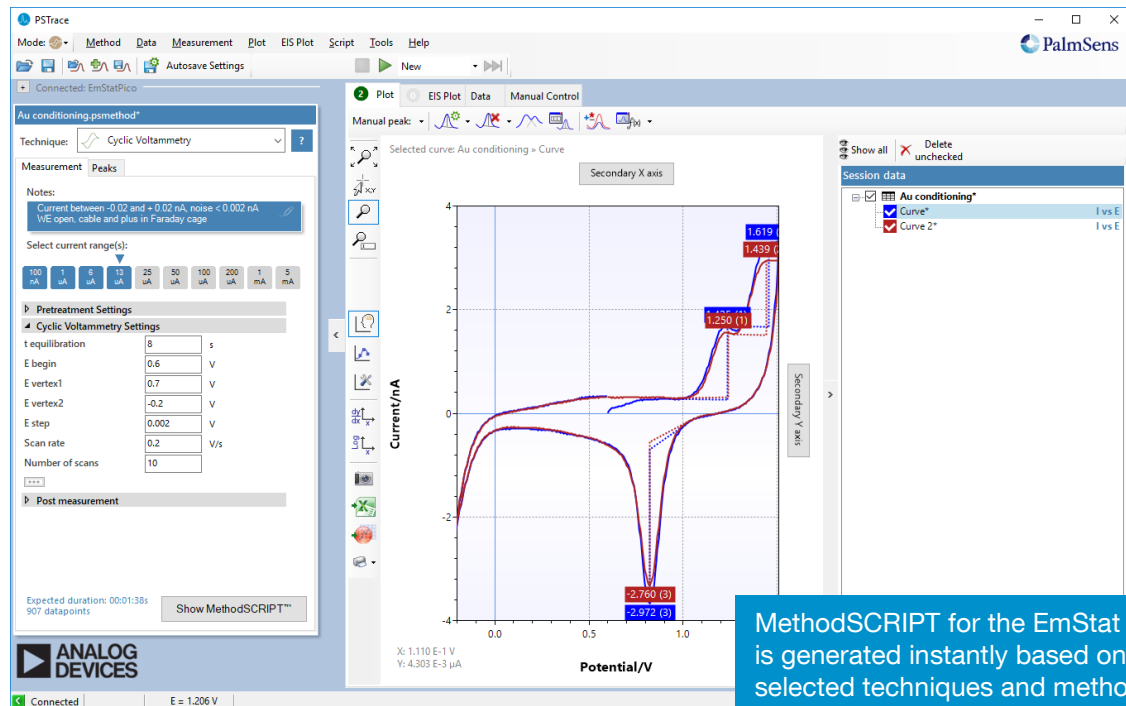


Comes with code examples for **Arduino** and:



PSTrace: research software for Windows

The EmStat Pico Development Board can be used directly with the PSTrace software for Windows. PSTrace automatically sets the EmStat Pico in the optimal mode based on the user specified method parameters.

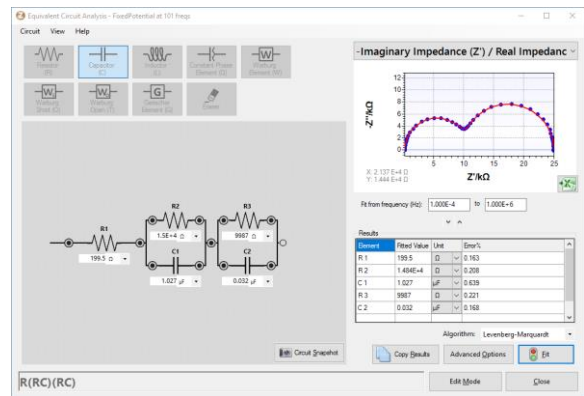


MethodSCRIPT for the EmStat Pico is generated instantly based on the selected techniques and method parameters used.

Show MethodSCRIPT™

Other functions in PSTrace 5

- Automatic peak search
- Equivalent Circuit Fitting
- Scripting
- 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
- Dynamic feedback on 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

Please don't hesitate to contact PalmSens BV for more details: info@palmsens.com

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www.palmsens.com

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