

## ON-CHIP SYSTEM FOR ELECTROCHEMICAL (BIO)SENSORS

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## On-chip system for electrochemical (bio)sensors

The EmStat Pico Core is a joint development by PalmSens BV and Analog Devices Inc., based on the ADuCM355 and powered by the MethodSCRIPT™ protocol from PalmSens.



The ADuCM355 is an ultralow power, mixed-signal microcontroller based on the Arm® Cortex™-M3 processor. The device features current, voltage, and impedance measurement capability.

The on-board MethodSCRIPT parser on the EmStat Pico Core allows for using the AduCM355 as a generic potentiostat for use with any type of electrochemical sensor or biosensor. MethodSCRIPT allows you to use the full potential of the AduCM355 without reading its datasheets or touching a compiler. The human-readable MethodSCRIPT can be generated with PSTrace for Windows. You can also make use of the extensive MethodSCRIPT documentation with many code examples available.



More information:



- [EmStat Pico Core - PalmSens](#)
- [PSTrace - PalmSens](#)
- [ADuCM355 - Analog Devices Inc.](#)

### Advantages and Overview

The EmStat Pico Core is at the heart of the EmStat Pico module. There are two main advantages of the EmStat Pico Core, compared with the EmStat Pico module:

- Economical solution for high volumes
- Smaller footprint

The EmStat Pico Core is an attractive option if you need >10k units. Lower quantities are available for prototyping purposes only.

		
Pico vs Pico Core	EmStat Pico module	EmStat Pico Core
Based on ADuCM355	✓	✓
Works with MethodSCRIPT	✓	✓
Minimum Order Quantity	1	10k
Footprint	18 x 30 mm	6 x 5 mm
1TΩ Input impedance	✓	Optional
Extra 100 nA current range	✓	Optional
Calibration of external TIA resistor(s)	✓	Optional

The optional items depend on the implementation of the PalmSens reference design.

## Evaluation with the EmStat Pico module

For evaluating the EmStat Pico Core, it is recommended to use the EmStat Pico module or the EmStat Pico Development Kit, which implements the EmStat Pico Core. Measurement results obtained on the EmStat Pico module will be identical to measurements ran on a system implementing the EmStat Pico Core.

## Supported Electrochemical Techniques

The following electrochemical techniques are supported by the EmStat Pico Core:

### 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 Core can be used for running sequential measurements on two different cells each with their own Reference, Counter and Working electrodes. This second channel has a series resistor of typically 110  $\Omega$  in series with the WE2 signal in high-speed mode (see also EmStat Pico Main specifications).

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 found in the EmStat Pico module specifications) for all techniques, excluding EIS and OCP.

## Main specifications

When the EmStat Pico core is implemented according to our reference design, its specifications are identical to those of the [EmStat Pico module](#).

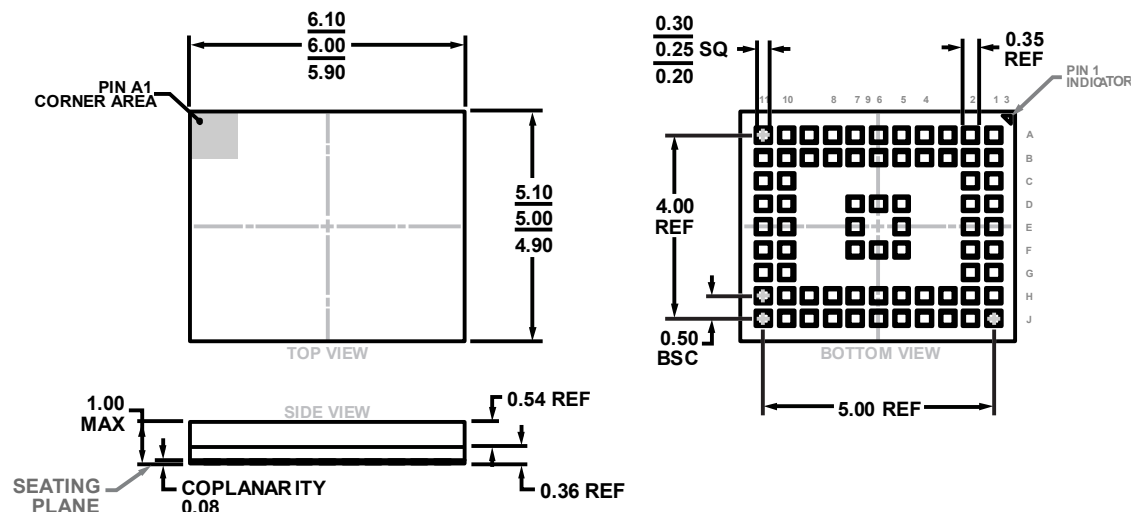
Other	
▪ On-chip storage	4000 datapoints
▪ Mass storage	supports optional external SD card or NAND chip for mass storage
▪ Package	6 mm × 5 mm, 72-lead LGA package
▪ Operation temperature range	-40 °C to +85 °C

For more technical aspects regarding thermal performance and other factors to take into account when implementing the ADuCM355, please refer to the [ADuCM355 Datasheet](#).

Limits of some technique-specific parameters for EmStat Pico		
<b>Normal Pulse and Differential Pulse Voltammetry</b>	Scan rate:	0.02 mV/s (0.280 mV step) to 5 V/s (10 mV step)
	Pulse time:	1ms to 300ms
<b>Square Wave Voltammetry</b>	Frequency:	1 Hz to 500 Hz
<b>Linear Sweep and Cyclic Voltammetry</b>	Scan rate:	0.02 mV/s (0.280 mV step) to 5 V/s (10 mV step)
<b>Pulsed Amperometric Detection</b>	Interval time:	1 ms to 10 s
	Pulse time:	1 ms to 1 s
	Maximum run time:	1000000 s
<b>ChronoAmperometry and Open Circuit Potentiometry</b>	Interval time:	1 ms to 300 s
	Maximum run time:	1000000 s (> 10 days at 300 s interval)
<b>Multistep Amperometry,</b>	Interval time:	1 ms to 300 s
	Level switching overhead time:	±10 ms
	Number of levels:	1 to 255
	Maximum run time:	1000000 s per level

## Dimensions

Dimensions shown in millimeters



## Reference design

A reference design and documentation for implementation of the EmStat Pico Core is available for customers. The reference design and the documentation explain how to place the EmStat Pico Core into your PCB design for achieving the same functionality and specifications of the EmStat Pico module. The documentation also contains PCB layout recommendations.

The reference design comes with

- 4 hours of technical support,
- and 10 EmStat Pico Core samples for prototyping purposes.

## Distribution

The EmStat Pico Core is delivered on reels, distributed via PalmSens BV and Arrow.



## MethodSCRIPT™ Scripting Language

The EmStat Pico Core works with the 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 Core and makes it easy to combine different measurements and other tasks.

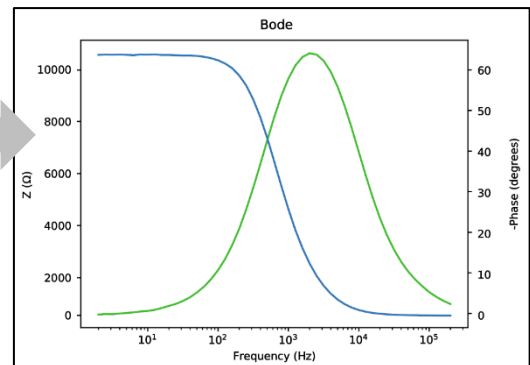
More script features include:

- 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 10.



Actual measured result on dummy cell ran in Python

More MethodSCRIPT 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, tutorials and documentation

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

**MethodSCRIPT™**





## Software Development Kits for .NET

Develop your own application in no time for use with any PalmSens instrument or potentiostat module or for the EmStat Pico Core.



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

See for more information:

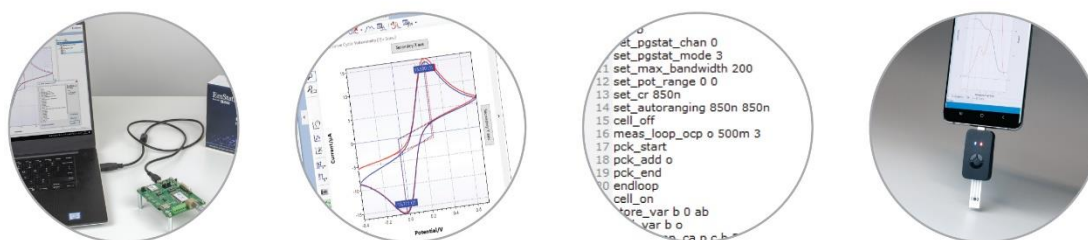
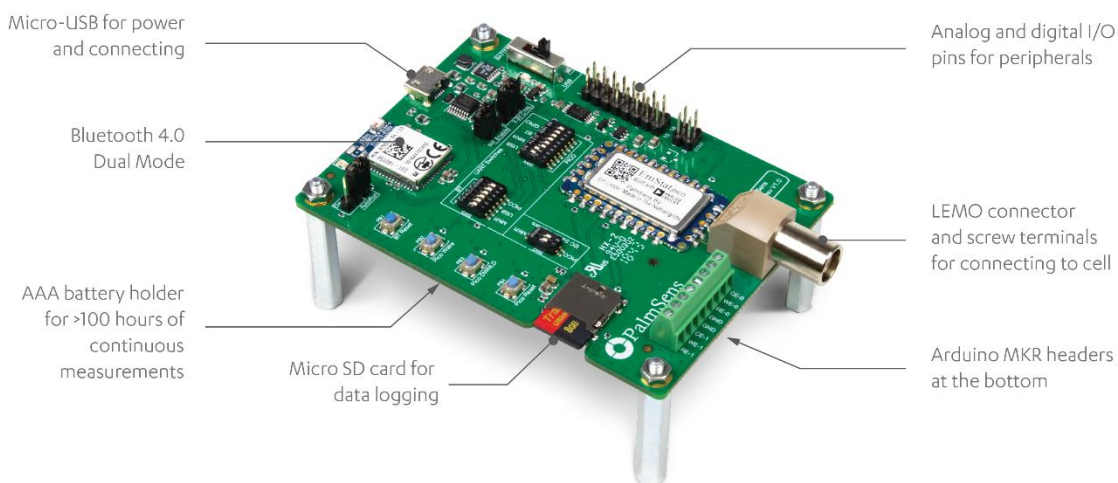
[www.palmsens.com/dev](http://www.palmsens.com/dev)

```
/// <summary>
/// Initializes the EIS method.
/// </summary>
1 reference
private void InitCVMethod()
{
    _methodEIS = new ImpedimetricMethod();
    _methodEIS.ScanType = ImpedimetricMethod.enumScanT
    _methodEIS.Potential = 0.0f; //0.0V DC potential
    _methodEIS.Eac = 0.01f; //0.01V RMS AC potential a
    _methodEIS.FreqType = ImpedimetricMethod.enumFreque
    _methodEIS.MaxFrequency = 1e5f; //Max frequency is
    _methodEIS.MinFrequency = 10f; //Min frequency is
    _methodEIS.nFrequencies = 11; //Sample at 11 diffe

    _methodEIS.EquilibrationTime = 1f; //Equilibrates
    _methodEIS.Ranging.StartCurrentRange = new Current
    _methodEIS.Ranging.MinimumCurrentRange = new Currel
    _methodEIS.Ranging.MaximumCurrentRange = new Curre
}
```

## EmStat Pico Development Board

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



### 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

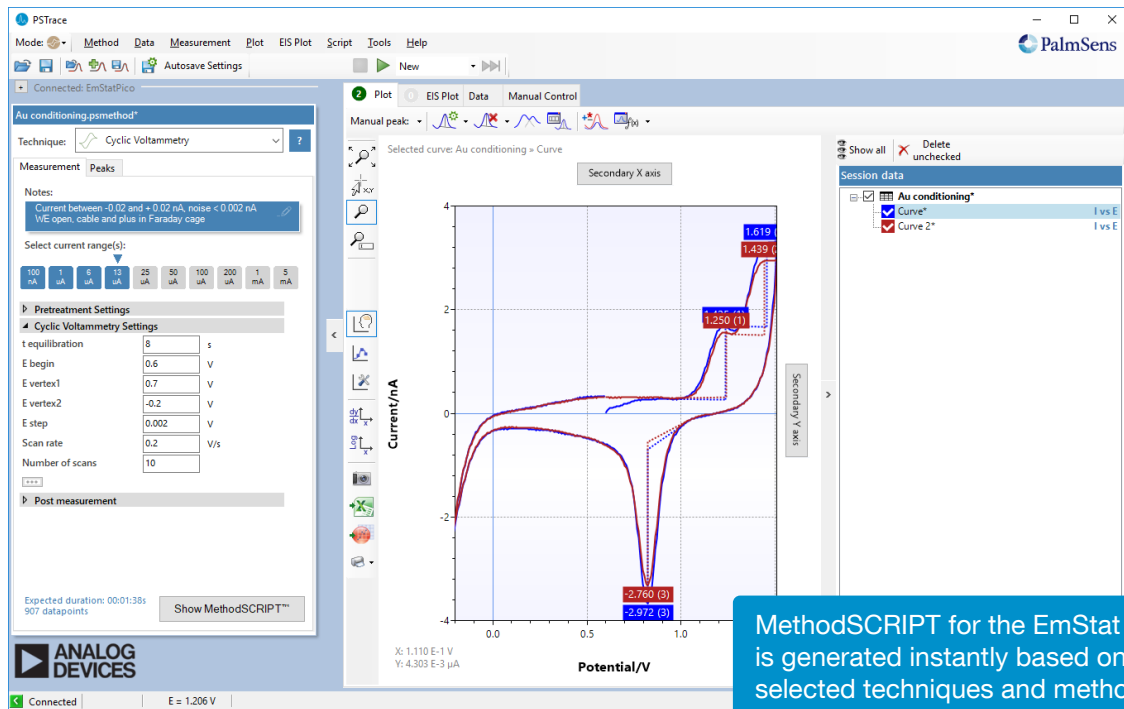
Use the MethodSCRIPT™ snippet to run the exact same measurement on the embedded EmStat Pico in your product

Comes with code examples for:



## PSTrace: research software for Windows

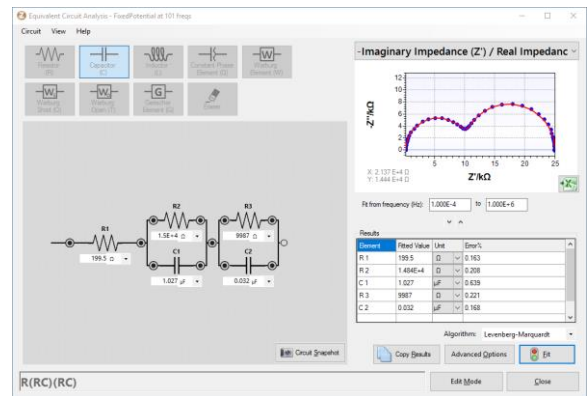
The EmStat Pico Development Board can be used directly with the PSTrace software for Windows. PSTrace automatically sets the EmStat Pico in the optimal mode based on the user specified method parameters.



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

**Show MethodSCRIPT™**

- ### Other functions in PSTrace 5
- Method validation
  - Automatic peak search
  - Equivalent Circuit Fitting
  - 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](http://www.palmsens.com/software)

Please don't hesitate to contact PalmSens BV for more details: [info@palmsens.com](mailto:info@palmsens.com)

**PalmSens BV**  
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[www.palmsens.com](http://www.palmsens.com)

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