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.

**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)
- Open Circuit Potentiometry (OCP)
- MultiStep Amperometry (MA)

**Electrochemical Impedance Spectroscopy**
- Scanning or fixed frequency mode (EIS)
EmStat Pico Main Specifications

The module works at 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.

**Combined Mode:** a combination of the Low and High Speed modes for optimal dynamic dc-potential range

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<table>
<thead>
<tr>
<th>General</th>
<th>Low Speed mode</th>
<th>High Speed mode</th>
<th>Combined mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Full dc-potential range</td>
<td>-1.2 to +2 V</td>
<td>-1.7 to +2 V</td>
<td>-1.7 to +2 V</td>
</tr>
<tr>
<td>▪ Dynamic dc-potential range</td>
<td>2.2 V</td>
<td>1.2 V</td>
<td>2.6 V</td>
</tr>
<tr>
<td>▪ Compliance voltage</td>
<td>-1.7 to +2 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>▪ Maximum current</td>
<td>±3 mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>▪ Max. acquisition rate (datapoints/s)</td>
<td>100</td>
<td>1000</td>
<td>100</td>
</tr>
<tr>
<td>▪ Supports FRA/EIS</td>
<td>NO</td>
<td>YES</td>
<td>NO</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Potentiostat (controlled potential mode)</th>
<th>Low Speed mode</th>
<th>High Speed mode</th>
<th>Combined mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Channels</td>
<td>2 (2x WE, 2x RE and 2x CE)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>▪ Applied dc-potential resolution</td>
<td>537 µV</td>
<td>395 µV</td>
<td>932 µV</td>
</tr>
<tr>
<td>▪ Applied potential accuracy</td>
<td>&lt; 0.2%</td>
<td>&lt; 0.5%</td>
<td>&lt; 0.5%</td>
</tr>
<tr>
<td>▪ Available current ranges</td>
<td>100 nA, 2 µA, 4 uA, 8 uA, 16 uA, 32 uA, 63 uA, 125 uA, 250 uA, 500 uA, 1 mA, 5 mA</td>
<td>100 nA, 1 uA, 6 uA, 13 uA, 25 uA, 50 uA, 100 uA, 200 uA, 1 mA, 5 mA</td>
<td>100 nA, 1 uA, 6 uA, 13 uA, 25 uA, 50 uA, 100 uA, 200 uA, 1 mA, 5 mA</td>
</tr>
<tr>
<td>▪ Current accuracy</td>
<td>&lt; 0.5% for current ranges &gt; 100 nA, &lt; 1% for 100 nA current range</td>
<td>&lt; 1% of the selected current range</td>
<td>&lt; 1% of the selected current range</td>
</tr>
<tr>
<td>▪ Measured current resolution</td>
<td>0.006% of selected current range (5.5 pA on 100 nA range)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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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.
## EmStat Pico Main Specifications

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

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td><strong>Frequency range</strong></td>
<td>0.016 Hz to 200 kHz</td>
</tr>
<tr>
<td><strong>Ac-amplitude range</strong></td>
<td>1 mV to 0.25 V rms, or 0.354 V peak</td>
</tr>
</tbody>
</table>

### Electrometer

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electrometer amplifier input</strong></td>
<td>&gt; 1 TΩ // 10 pF</td>
</tr>
<tr>
<td><strong>Bandwidth</strong></td>
<td>250 kHz</td>
</tr>
</tbody>
</table>

### Communications and peripherals

<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>Module communications</strong></td>
<td>UART</td>
</tr>
<tr>
<td><strong>Communication with external peripherals</strong></td>
<td>SPI and I²C</td>
</tr>
<tr>
<td><strong>Analog I/O</strong></td>
<td>3 analog input pins</td>
</tr>
</tbody>
</table>
| **Digital I/O**  | 7 general-purpose I/O pins  
|                  | 1 wake-up pin      |
| **Optional on-board temperature sensor** | ±0.25 °C |

### Other

<p>| | |</p>
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<tbody>
<tr>
<td><strong>storage</strong></td>
<td>4000 datapoints on-board (optional external SD card for mass storage)</td>
</tr>
<tr>
<td><strong>mounting</strong></td>
<td>Surface mounted with castellated pads Through hole pins (2.54mm pitch)</td>
</tr>
<tr>
<td><strong>dimensions</strong></td>
<td>18 x 30 x 2.6 mm</td>
</tr>
<tr>
<td><strong>operation temperature range</strong></td>
<td>-40°C to +85°C</td>
</tr>
</tbody>
</table>

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3 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.
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 script for EIS measurement on a test circuit

```plaintext
#Declare variables
define var h
define var r
define 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
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 PStrace for Windows. See page 8.

Run Script 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.

**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

Micro-USB for power and connecting
Bluetooth 4.0 Dual Mode
AAA battery holder for >100 hours of continuous measurements
Micro SD card for data logging
Analog and digital I/O pins for peripherals
LEMO connector and screw terminals for connecting to cell
Arduino MKR headers at the bottom

Comes with code examples for Arduino and:

- Visual Studio
- Xamarin
- Python
- C/C++
- MATLAB

PalmSens
Compact Electrochemical Interfaces
PSTrace: research software for Windows

The EmStat Pico Development Board can be used directly with the PSTrace software for Windows.

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 Vista, 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 for more details: info@palmsens.com

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