



## General Description

The EmStat4M LR and HR are OEM potentiostat modules designed for integration into products requiring electrochemical measurement functionality. Their footprints are small while maintaining standard 2.54 mm (100 mil) connections for ease of integration into (prototype) systems.

## Applications

- Gas detection
- Food quality
- Environmental sensing (air, water, soil)
- Blood glucose meters
- Life sciences and bio-sensing analysis
- Bio-impedance measurements
- General amperometry, voltammetry and impedance spectroscopy functions
- Test rigs

## Features

### Analog

- ±5 V (LR) or ±8 V (HR) compliance
- single current measurement channel with max. current of ±30 mA (LR) or ±200 mA (HR)
- impedance measurements between < 0.1 Ω up to 1 GΩ at frequencies from 10 μHz to 200 kHz
- resolution of 92 fA on lowest current range (LR)
- 16-bit analog-to-digital converter (ADC)
- 1 auxiliary analog input 0 – 3 V
- 1 auxiliary analog output 0 – 3 V (12-bit)

### Digital

- UART
- I<sup>2</sup>C
- 7 GPIO
- 500 MB memory for on-board data storage

See “[EmStat4M Brochure.pdf](#)” for functional and measurement specifications.

## Dimensions

62 mm X 40 mm X 7 mm  
(without connectors)

## ROHS statement

The EmStat4M module is RoHS compliant.

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## Terminology

CE: Counter Electrode  
RE: Reference Electrode  
WE: Working Electrode  
SE: (Working) Sense Electrode  
EIS: Electrochemical Impedance Spectroscopy

## Revision history

Rev.10-2021-001: First published.  
Rev.01-2022-002: Added footnote for *Operating temperature*.  
Rev.01-2022-003: Changed Table1: Con3\_12 from negative to positive rail.  
Rev.03-2022-004: Added section "Heat dissipation".  
Rev.08-2022-005: Updated "E\_Unipolar\_OUT" and "I\_BIPOLAR\_OUT" pins.  
Rev.11-2023-006: Updated E\_Monitor and VPST descriptions in Table 1  
Rev.12-2023-007: Added current range bandwidth information.  
Rev. 04-2025-008: Corrected current follower bandwidths

## Mechanical drawing

The LEMO cell connector is optional.

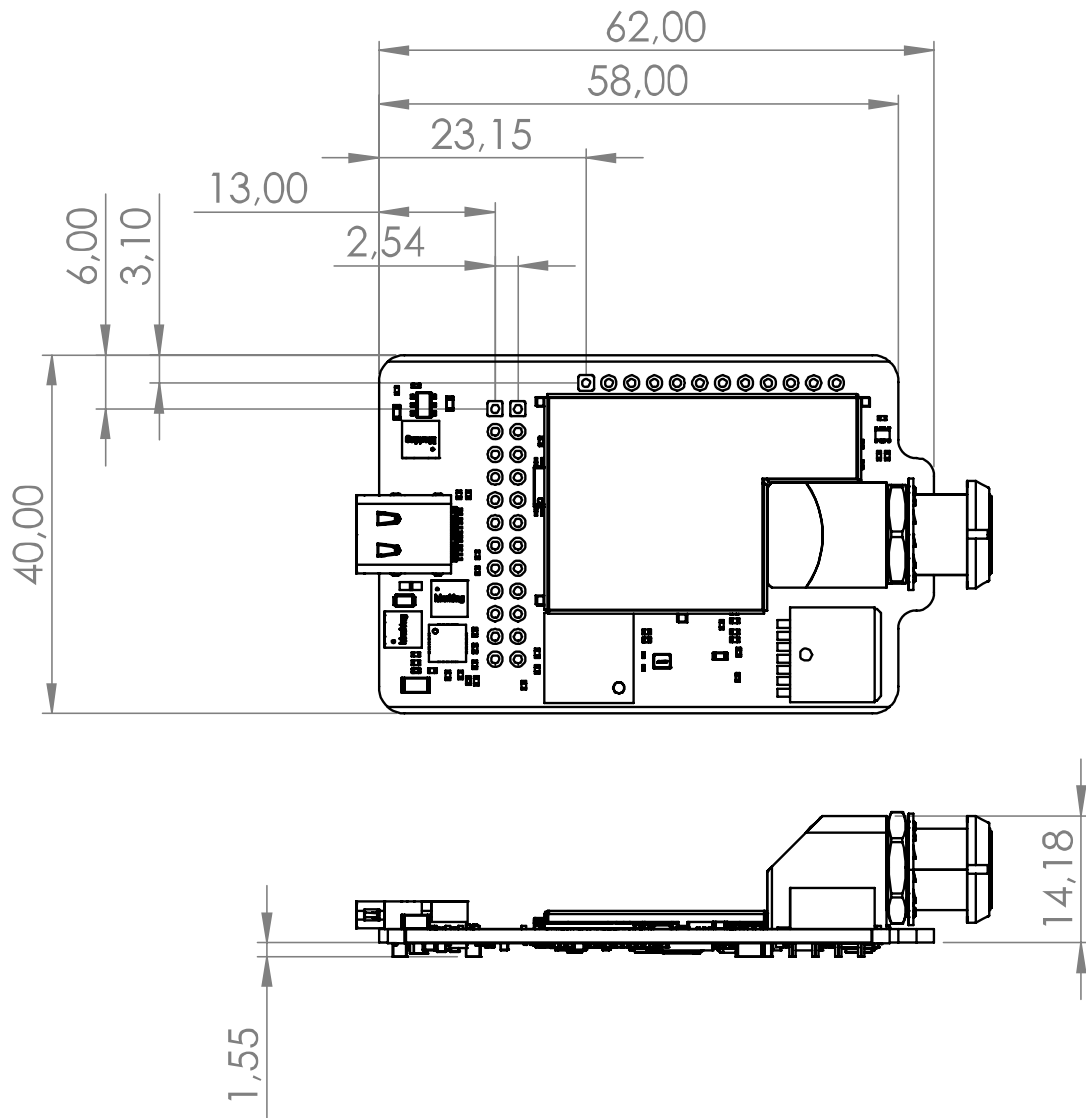


Figure 1: EmStat4M module dimensions in millimeters.

## Pin functions

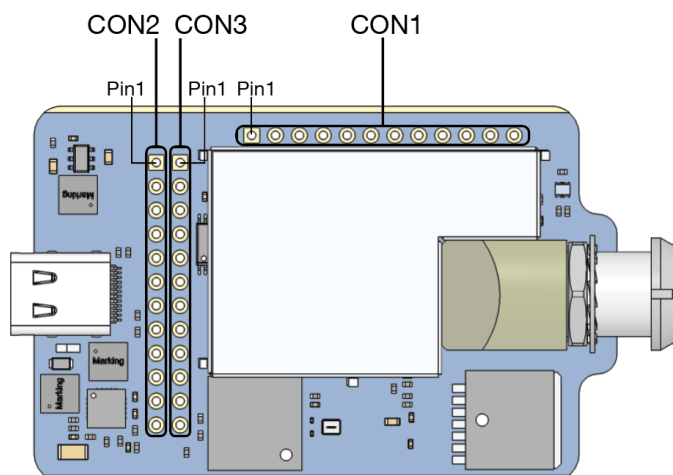


Figure 2: EmStat4M pinout (showing optional LEMO cell connector)

Table 1: Pin definitions

Pin	Name	Function
Con1_1	D3	Digital GPIO
Con1_2	D2	Digital GPIO
Con1_3	D1	Digital GPIO
Con1_4	D0	Digital GPIO
Con1_5	5V_In	5V power supply connected internally to USB Vbus
Con1_6	DGND	PCB common GND plane, digital zone
Con1_7	D4	Digital GPIO
Con1_8	SENSE	Potentiostat Sense Electrode
Con1_9	AGND	PCB common GND plane, Analog zone
Con1_10	WE	Potentiostat Working Electrode
Con1_11	RE	Potentiostat Reference Electrode
Con1_12	CE	Potentiostat Counter Electrode
Con2_1	TxD	UART Transmit
Con2_2	RxD	UART Receive
Con2_3	E_UNIPOLAR_OUT	E monitor, scaled to a voltage between 0 and 3, centered around 1.5 V where: LR: $V_{RE} = -2.1 * (V_{out} - 1.5)$ HR: $V_{RE} = -4.2 * (V_{out} - 1.5)$
Con2_4	I_BIPOLAR_OUT	Potentiostat measured current (scaled), this pin has a 1 kOhm output impedance $i = V_{out} * \text{current range}$
Con2_5	D5	Digital GPIO
Con2_6	DGND	PCB common GND plane, digital zone
Con2_7	nRESET	Active low reset
Con2_8	nDWNLD	Active low FW update
Con2_9	ADC_in	Auxiliary ADC input
Con2_10	DAC_out	Auxiliary DAC out

Con2_11	DGND	PCB common GND plane, digital zone
Con2_12	5V_In	5V power supply connected internally to USB Vbus
Con3_1	CTS	UART Clear To Send
Con3_2	RTS	UART Ready to Send
Con3_3	SDA_EXT	I2C SDA. Internally pulled up to 3.3V via a 10K resistor
Con3_4	SCL_EXT	I2C SCL. Internally pulled up to 3.3V via a 10K resistor
Con3_5	Reserved	Reserved
Con3_6	Reserved	Reserved
Con3_7	E_SET	External potentiostat voltage setpoint control
Con3_8	n3.3VD_SHDN	Active low Shutdown. Internally pulled up to 5V with 100K resistor. Pulling to GND disables all power on the ES4
Con3_9	D6	Digital GPIO
Con3_10	3.3V_OUT	3.3V digital supply. From a switching regulator on the ES4. Draw maximum 50 mA from this pin
Con3_11	VPST-	Potentiostat negative power rail. Draw maximum 20 mA from this pin. LR: -7V (typical) HR: -9.75V (typical)
Con3_12	VPST+	Potentiostat positive power rail. Draw maximum 20 mA from this pin. LR: 7V (typical) HR: 9.75V (typical)

## Absolute maximum ratings

Parameter	Rating
V_IN to GND	-0.3 V to +5.5 V
Analog Input Voltage to GND	-0.3 V to +3.6 V
Digital Input Voltage to GND	-0.3 V to +3.6 V
Total Positive GPIO Pins Current	50 mA
Total Negative GPIO Pins Current	-50 mA
Storage temperature	-65 °C to +100 °C
Operating temperature	-40 °C to +85 °C <sup>1</sup>
Hand soldering (single pin)	400 °C for 10 s
ESD Human Body Model (HBM)	4 kV
ESD Field-Induced Charged Device Model (FICDM)	1 kV

Stresses at or above those listed under Absolute Maximum Ratings may cause permanent damage to the product. This is a stress rating only; functional operation of the product at these or any other conditions above those indicated in the operational section of this specification is not implied. Operation beyond the maximum operating conditions for extended periods may affect product reliability.

## ESD caution



### **ESD (Electrostatic discharge) sensitive device.**

The EmStat4 module features protection circuitry on all Inputs and Outputs. However high energy ESD due to improper handling may cause damage or degradation of performance. Proper ESD precautions should be taken to prevent this.

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<sup>1</sup> All the components of the EmStat4M are rated to the industrial standard of -40 °C to +85 °C The EmStat4M is calibrated at 21 °C . The most sensitive components of the EmStat4M have a temperature drift of 50 ppm. At 1 °C or 41 °C, measurement drift of up to 0.1% may be experienced.

## Electrical specifications

Table 2: EmStat4M electrical characteristics. Determined at 25 °C.

Parameter	Min	Typical	Max	Unit	Details
<b>ADC</b>					
Data Rate			1M	SPS	
Resolution		16		Bits	
<b>Analog input (CON2-9)</b>					
Leakage Current	-1.5		1.5	uA	
Input Voltage Range	0.05		3	V	
<b>EIS measurement</b>					
Frequency range	10u		200k	Hz	
Applied AC voltage	1		900	mVrms	
Amplitude scaling resolution		14		Bits	
Sine DAC resolution		12		Bits	
<b>Potentiostat circuit</b>					
RE Input Bias Current		2	10	pA	RE input, 25 °C
SE Input Bias Current		2	10	pA	SE input, 25 °C
Offset voltage		0.1	1	mV	
Source/Sink current (LR)	-30		30	mA	
Source/Sink current (HR)	-200		200	mA	
Applied potential acc.		0.04	0.2	%	
Measured current acc.		≤ 0.2		%	Full Scale Range
Bandwidth settings		0.32, 3.2, 30 or 570		kHz	Selectable bandwidth
Electrometer Bandwidth		10		MHz	
<b>Current range bandwidth</b>					
1 nA, 10 nA (LR)		23		Hz	
100 nA, 1 μA		2.3		kHz	
10 μA, 100 μA, 1 mA		230		kHz	
10 mA		500		kHz	
100 mA (HR)		500		kHz	
<b>Main DAC</b>					
Resolution		16		Bits	
Voltage Range (LR)	-3		3	V	
Voltage Range (HR)	-6		6	V	
Bandwidth		10		kHz	

<b>DAC for Aux (CON2-10)</b>					
Resolution		12		Bits	
Voltage Range	0.05		3	V	
<b>GPIO</b>					
Input Voltage Low	-0.2		0.3	V	
Input Voltage High	0.7		3.5	V	
Output Voltage Low		0	0.4	V	
Output Voltage High	2.9	3.3		V	
Pin output source/sink current			±5	mA	
<b>Program memory</b>					
Endurance		10,000		Cycles	
Data Retention		30		Years	
<b>File storage memory</b>					
Storage size		500		MByte	
<b>Power requirements</b>					
V_IN voltage range	4.5	5	5.5	V	
EmStat4M HR		250		mA	@ 1 mA (WE)
		320		mA	@ 30 mA (WE)
		750		mA	@ 200 mA (WE)
EmStat4M LR		150		mA	@ 1 mA (WE)
		250		mA	@ 30 mA (WE)
<b>UART</b>					
Baudrate	9600	921600	921600	bit/s	Default: 230400 in v1.000
<b>I2C</b>					
Clock speed	100	400	400	kHz	
Internal pull-up		10		kOhm	Pull-up to 3.3V

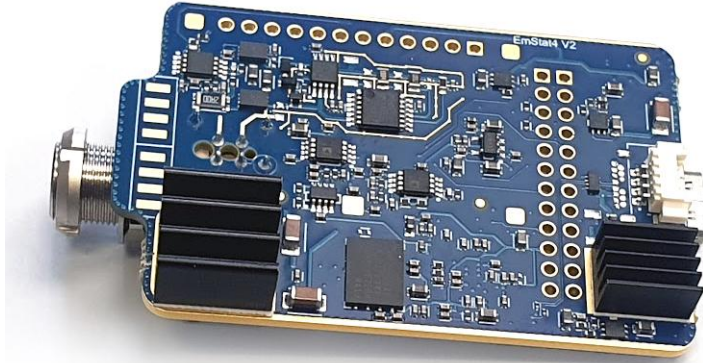
For functional and measurement specifications see [www.palmsens.com/emstat4m](http://www.palmsens.com/emstat4m)

## Power supply

Driving the EmStat4M V\_IN directly from a switching regulator may introduce measurement noise. Care should be taken to provide clean power to the V\_IN pin.

## Heat dissipation

The EmStat4 HR requires two heatsinks to be present on the golden pads at the bottom of the PCB. The board comes standard with the following two heatsinks from Fischer Elektronik: part numbers ICK PLCC 28 and ICK SMD F 10 SA.



It is recommended to ensure a steady airflow over the heatsinks when running measurements for a long duration (>10 minutes) with the 100 mA range enabled.

## Ordering information

When ordering high volumes, the EmStat4M module can be ordered with limited licenses to include only specific electrochemical techniques. Secondly the module can be populated with or without LEMO or USB connector. Contact PalmSens BV for more information: [info@palmsens.com](mailto:info@palmsens.com)

## Links

### Module components

N/A

### Design resources

3D model (see downloads):  
[www.palmsens.com/emstat4m](http://www.palmsens.com/emstat4m)

Symbol & PCB Footprint for Altium (see downloads):  
N/A

Development board:  
[www.palmsens.com/product/oem-emstat4m-development-kit](http://www.palmsens.com/product/oem-emstat4m-development-kit)

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

### Accessories

- SPE connector: [DS1020-03ST1D](http://www.palmsens.com/DS1020-03ST1D)

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

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