

# Getting started with the EmStat3+ module for OEM

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OEM Interface for electrochemical sensors



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## Contents

1	Introduction .....	3
1.1	EmStat communications .....	3
1.2	USB or serial / TTL .....	3
1.3	Baudrate settings .....	4
1.4	Connecting to PC via RS232 converter .....	4
2	Printed Circuit Board Layout .....	5
2.1	CON1 description .....	5
2.2	CON2 description .....	6
2.3	Heat transfer .....	6
2.4	Pinout of sensor plug .....	7
3	Firmware .....	8
4	Instrumental specifications .....	9
4.1	Power requirements .....	9
	Appendix A: Change EmStat USB connection to virtual COM port .....	10

## Important before you start unpacking

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Please read this quick start guide carefully before unpacking the boards from their antistatic bags or using the kit, as it contains important information on how to avoid damage to the PCB's.



The EmStat board can be damaged by static electricity (electrostatic discharge or ESD). Please take adequate precautions against static discharge during handling.

## 1 Introduction

The EmStat-series are potentiostats with an embedded microcontroller. They provide all the major potentiostatic techniques with automatic current ranging and peripheral control.

### 1.1 EmStat communications

The EmStat is interfaced to a PC or host controller by means of a powered USB bus or serial (TTL) port. The instrument can be used with the Windows program PSTrace. The Software Development Kit (SDK) of PalmSens is compatible with EmStat.

The instrument can also be controlled by using the commands as described in the 'Communications protocol'.

### 1.2 USB or serial / TTL

EmStat3+ is normally controlled and power via its mini USB port. This requires PalmSens drivers to be installed (automatically installed with PSTrace or the .NET SDK).

Optionally the USB port can be re-programmed to function as a virtual COM port, see appendix A.



Make sure the USB chip is not programmed as VCP (Virtual COM port) when using the Rx/Tx lines on CON2.

EmStat3+ can also be controlled from a host controller by means of Tx and Rx (5V TTL). Use the following pins for TTL communications (see next page for pin locations):

CON2 - pin 12: +5V power supply (500 mA min.)

CON2 - pin 11: GND (or CON2 – pin 6)

CON2 - pin 1: Tx

CON2 - pin 2: Rx



EmStat has a default baud rate of **230400 baud**.

This baudrate is generally not supported by the COM port on a regular desktop PC.

For communications using RS232 a baudrate of 57600 is advised.

See also section 1.3

When using RS232, it is advised to use short wires (max. 10 cm) to the controller in order to prevent 'reflections'. If serial communications is required in order to control the device directly from a PC without using the PalmSens drivers, it is advised to change the EmStat's USB port to function as Virtual COM port. See also appendix A.

## 1.3 Baudrate settings

The EmStat module has been set to a default baudrate of 230400 baud.

This baudrate is supported by PStTrace. PStTrace also supports 57600 baud.

The baudrate has the following influence on the maximum scanrate for measurements;

Baudrate	Max. number of data points / second	Min. interval time
230400	1000	1.00 ms
57600	197	5.07 ms

It is possible to change the baudrate setting of the EmStat module in the firmware (requires firmware v7.0 or higher).

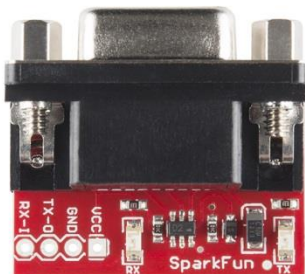
See the EmStat Communications Protocol section 4.6: *Changing the baudrate*.

The firmware update program will always be able to update the firmware regardless of the baudrate supported by the firmware.

See section *Firmware* in this document on how to update the firmware using a serial connection.

## 1.4 Connecting to PC via RS232 converter

Connect the SparkFun TTL-RS232 converter or any other similar converter as following:



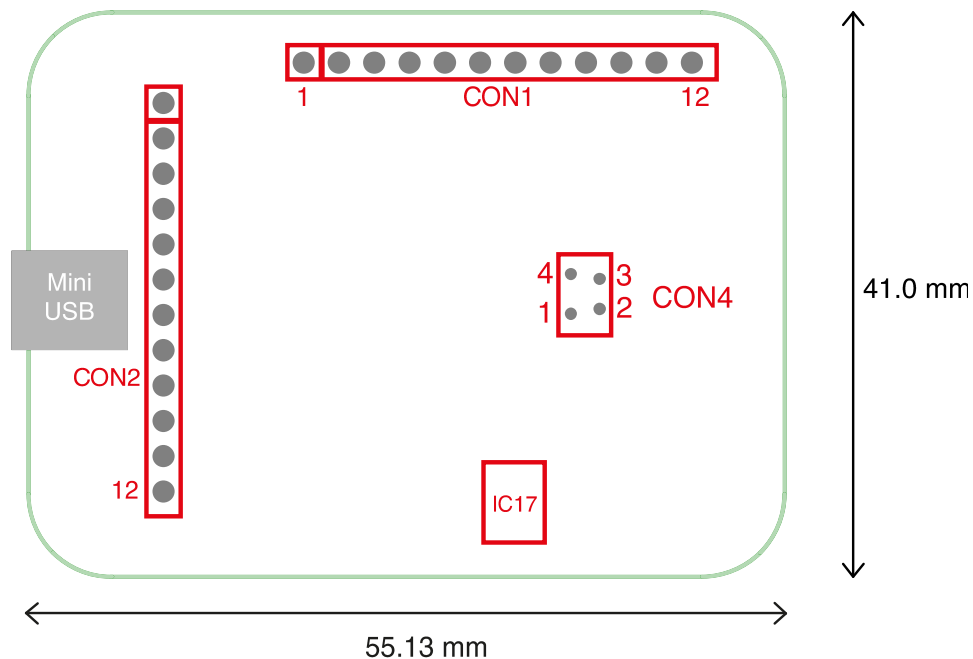
If using a null modem cable between EmStat and PC/controller:

EmStat:  
 RX: CON2 – PIN2  
 TX: CON2 – PIN1  
 VCC: CON1 – PIN5  
 GND: CON1 – PIN6

If connecting directly to PC/controller:

EmStat:  
 RX: CON2 – PIN1  
 TX: CON2 – PIN2  
 VCC: CON1 – PIN5  
 GND: CON1 – PIN6

## 2 Printed Circuit Board Layout



*EmSta3+ PCB layout*

The board has two pin headers: CON1 and CON2

**CON1** is used to connect for instance the MUX multiplexer or any other peripheral.

**CON2** is used when serial TTL communications is used and provides also an external analog input and analog output line, with a range of 0 - 4.095 V.

### 2.1 CON1 description

Pin	Function
1	Digital outputline d3 or can function as digital input line 0
2	Digital outputline d2
3	Digital outputline d1 reserved for switch box: 1 = off 0 = on
4	Digital outputline d0 reserved for switch box: 0 = off 1 = on
5	Output: 5 V digital (max. 30 mA when powered from USB), or input (if not powered from USB): 5 V power supply (100 mA min.),
6	DGND
7	10 V analog (advised max. 50 mA)
8	Sense
9	AGND (connect to metal housing / cable shielding)
10	WE
11	RE
12	CE

The digital I/O lines are at 5V.

## 2.2 CON2 description

Pin	Function
1	Tx (serial port)
2	Rx (serial port)
3	Reserved (DO NOT CONNECT THIS PIN)
4	Voltage reference (4.096 V)
5	Reserved for use with external interrupt signal
6	DGND
7	Reset (active high)
8	Download (active low)
9	ADC ch.2 (range 0 – 4.095 V)
10	DAC ch.1 (range 0 – 4.095 V) The load must have an impedance of at least 5 kohm.
11	DGND
12	5 V power supply (500 mA min.), if not powered from USB

## 2.3 Heat transfer

IC17 may dissipate about 1 Watt or even higher when the output current limit is set higher.

It is therefore advised to make a thermal connection from the bottom side of the PCB to something which can absorb heat, for instance using the thermal pad WX-3009-0227-6 from 3M, available from Farnell.

An adhesive heat sink like BGA-STD-015 is available from Farnell (2084425).



*Adhesive heat sink*



It is advised to make a thermal connection from the bottom side of the PCB to something which can absorb heat like a housing or heat sink.

## 2.4 Pinout of sensor plug

See CON4 on page 2.

Front view of socket

1 • • 4  
2 • • 3

Solder side of socket

4 • • 1  
3 • • 2

1. RE: blue connector or reference electrode
2. CE: black connector or counter electrode
3. S: red female/male connector or sense
4. WE: red connector is working electrode



The shield of the cable must make contact with the metal case of the sensor connector or AGND.

### 3 Firmware

The firmware of EmStat is downloaded by using the program 'Update firmware'. The EmStat with USB interface is updated automatically.

The serial version of EmStat requires the use of **CON2**.

Follow these steps:

- Remove the power supply from EmStat
- Connect pin 8 (download - active low) to pin 6 (GND).
- Connect the power supply
- Run program 'Update firmware'
- Press 'Connect'
- Load firmware file ESx##, where x is the EmStat type and ## the firmware version.
- Make sure the checkbox 'PalmSens or EmStat is on, but does not work properly' is checked
- Click button 'Update Firmware'.
- Remove the power supply briefly to force a reset
- Wait until updating has finished.
- Remove the connection between pin 8 and 6.
- Re-connect the power supply.



## 4 Instrumental specifications

Specifications of the EmStat3+ module:

- dc-potential range	$\pm 4.000 \text{ V}$
- compliance voltage	$\pm 8 \text{ V}$
- applied dc-potential resolution	$0.125 \text{ mV}$
- dc-offset error	$3 \text{ mV}$
- accuracy	$\leq 0.3 \%$
- current ranges	1 nA to 100 mA (9 ranges) using a ZRA (zero resistance ammeter)
- maximum measured current	$\pm 100 \text{ mA}$ typical
- current resolution	0.1 % of current range 1 pA on lowest current range
- accuracy	$\leq 0.5 \%$ of current range at 10 nA and $\leq 1 \%$ at 1 nA $\leq 0.2 \%$ at 100 nA to 100 $\mu\text{A}$ $\leq 0.5 \%$ at 1 mA, 10 mA and 100 mA all with additional 0.2 % offset error
- electrometer amplifier input	$> 100 \text{ Gohm} // 4 \text{ pF}$
- rise time	approx. 100 $\mu\text{s}$
- power	5 V, 130 mA (ES <sup>3</sup> ) or 500 mA (ES <sup>3+</sup> ) from USB connector
- interfacing	USB
- external I/O options	analog: 1 input and 1 output channel (both 0 V - 4.096 V) digital: 4 in/output lines (maximum rating: -0.3 V to 5.3 V)
- sensor connection	shielded cable with circular connector for WE, Sense (ES <sup>3+</sup> ), RE and CE.

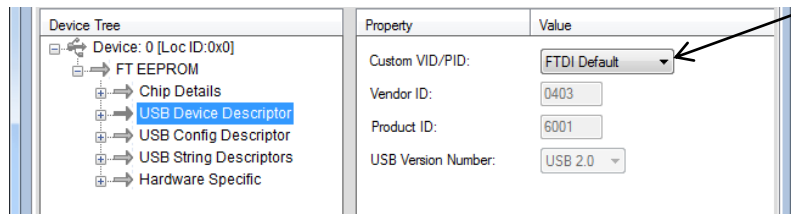
### 4.1 Power requirements

Power from USB port:

- Cell off 10 mA: 0.220 A
- Cell off 100 mA: 0.257 A
- Cell on 10 mA, with 10 mA output current: 0.277 A
- Cell on 100 mA, with 50 mA output current: 0.440 A

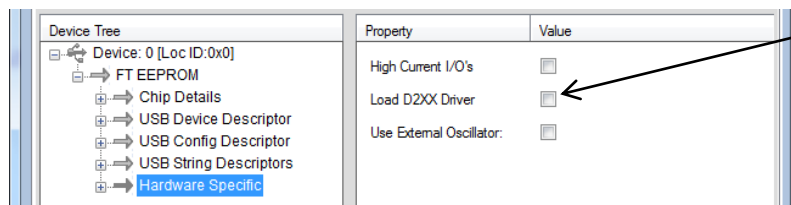
## Appendix A: Change EmStat USB connection to virtual COM port

1. Connect EmStat to the USB port.
2. Open FT\_PROG (see <http://www.ftdichip.com/Support/Utilities.htm>)
3. Click the “Scan and Parse” button 
4. Change the Custom VID/PID to FTDI Default:



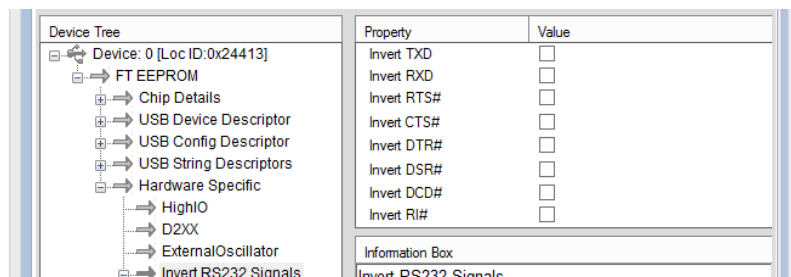
Select FTDI Default



5. Uncheck the checkbox “Load D2XX Driver”:



Uncheck “Load D2XX Driver”

6. Make sure all “Invert RS232 Signals” settings are unchecked:



7. Click the “Program Devices” button 
8. Click the “Scan and Parse” button  again to check if the settings are written correctly, especially the invert DTR# setting. If this setting cannot be changed, please contact us. Your FT\_PROG version might have a bug.
9. Remove the USB cable and insert again.
10. Your PC will now have found a virtual COM port which can be used to communicate with EmStat.
11. The com port number can be found in the Device Manager found in Windows Configuration. You can also press [windows key] + [pause] on your keyboard to find the Device Manager.



Make sure the USB chip is not programmed as VCP (Virtual COM port) when using the Rx/Tx lines on CON2.