# EmStat3
## Connecting to MUX8
Revision: July 2014

# Contents

# 1 EmStat$^3$ PCB

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'.

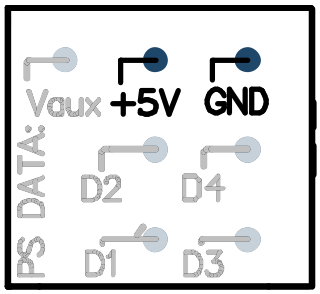
## 1.2 USB or serial / TTL

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.[1]

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):

CON1 - pin 5: +5V power supply (100 mA min.)
CON1 - pin 6: GND (or CON2 – pin 6 or pin 11)
CON2 - pin 1: Tx
CON2 - pin 2: Rx

If the EmStat3 PCB is placed on a MUX board, the +5V and GND pins on the MUX board can be used to power both the EmStat3 and MUX board:



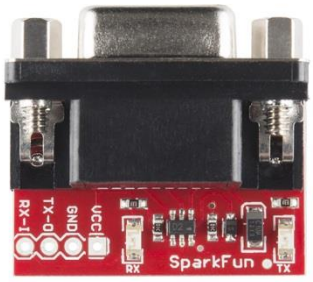

*Connection pins on MUX board*

[1] Contact PalmSens BV for more information

## 1.3 Connecting to PC via RS232 converter

The EmStat3 has a default baudrate of 230400 baud. Most normal serial ports on a regular PC or notebook do not support this. A new firmware file with a lower baudrate of 57600 is available on request. You can send us an e-mail: info@palmsens.com and ask for firmware for EmStat3 on the default lower baudrate of 57600 (also supported by PSTrace) or another baudrate.
The firmware update program will always be able to update the firmware regardless of the baudrate supported by the firmware.
See section *3 Firmware* on how to update the firmware using a serial connection.

Connect the SparkFun TTL-RS232 converter as following:



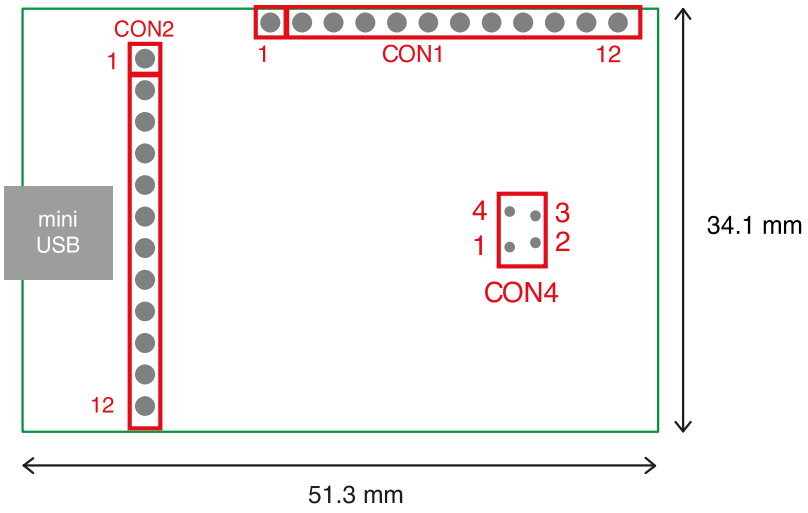

If using a null modem cable between EmStat and PC/controller:

| | EmStat: |
|---|---|
| RX: | CON2 – PIN2 |
| TX: | CON2 – PIN1 |
| VCC: | +5V on MUX board or EmStat CON1 – PIN5 |
| GND: | GND on MUX board or EmStat CON1 – PIN6 |

If connecting directly to PC/controller:

| | EmStat: |
|---|---|
| RX: | CON2 – PIN1 |
| TX: | CON2 – PIN2 |
| VCC: | +5V on MUX board or EmStat CON1 – PIN5 |
| GND: | GND on MUX board or EmStat CON1 – PIN6 |

# 2 Connection EmStat board to MUX8 multiplexer




*EmStat 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 an external analog input and analog output line, with a range of 0 - 4.095 V and a digital input line.

## 2.1 CON1 description

| Pin | Function |
|---|---|
| 1 | Output line 3 reserved for Mux16 or digital input line 0 |
| 2 | Output line 2 reserved for Mux16/8 |
| 3 | Output line 1 reserved for Mux16/8 and switch box |
| 4 | Output line 0 reserved for Mux16/8 and switch box and stirrer: 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 | GND |
| 7 | 5 V analog (max.20 mA when powered from USB) |
| 8 | –5 V analog (max. 10 mA) |
| 9 | AGND |
| 10 | WE |
| 11 | RE |
| 12 | CE |

## 2.2 CON2 description

| Pin | Function |
|---|---|
| 1 | Tx (serial port) |
| 2 | Rx (serial port) |
| 3 | Reserved (DO NOT CONNECT) |
| 4 | Voltage reference (4.096 V) |
| 5 | Reserved |
| 6 | GND |
| 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) |
| 11 | GND |
| 12 | 5 V output if powered via USB |

## 2.3 Pinout of sensor connector (CON4):

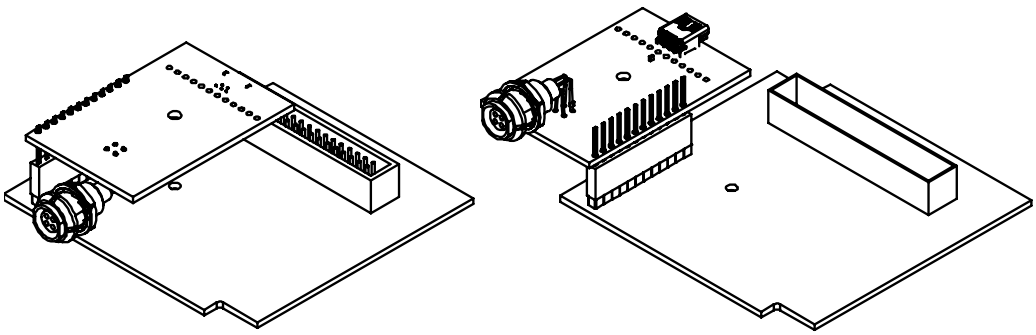
1 ● ● 4
2 ● ● 3

1. RE: blue connector or reference electrode
2. CE: black connector or counter electrode
3. Not connected
4. WE: red connector is working electrode

IMPORTANT:
**The shield of the cable must make contact with the metal case of the sensors connector.**

## 2.4 CON1 to MUX8

EmStat is to be connected to the MUX board using CON1. This can be done in two ways:



*Two ways of connecting the EmStat PCB to the MUX8 PCB*

# 3 Firmware

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

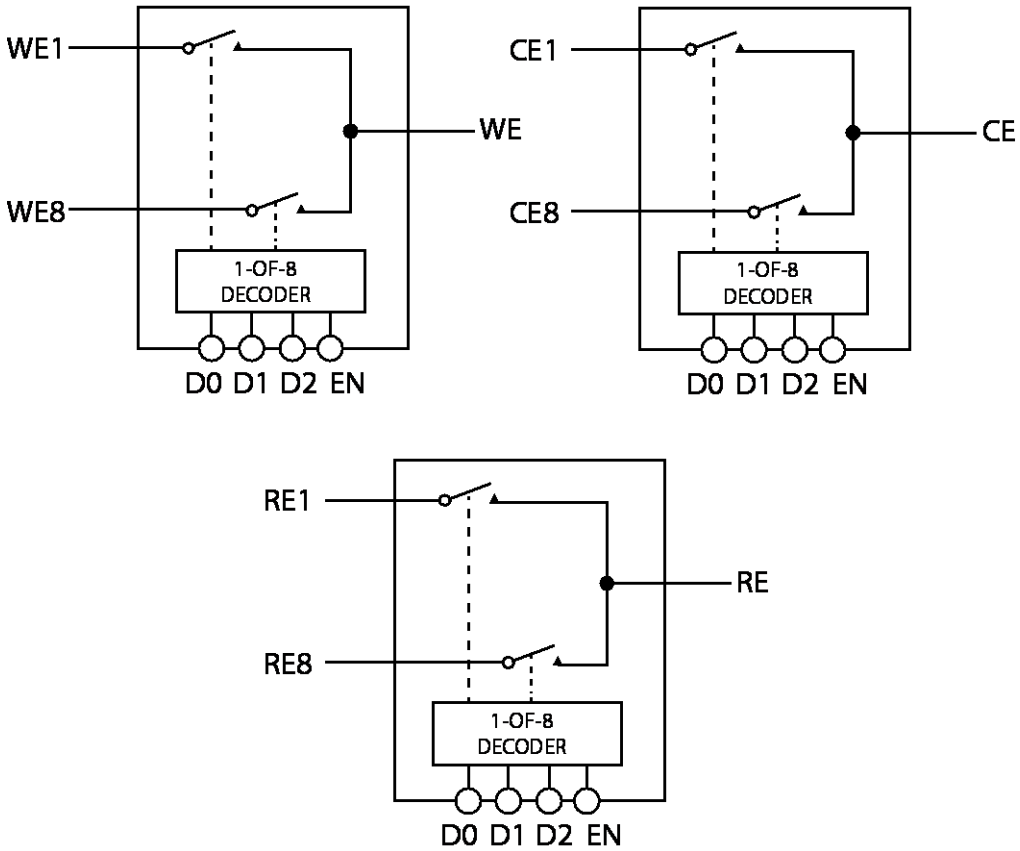
The serial version of EmStat requires the use of CON2.
Follow these steps:

- 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 EmStatnn, where nn is gives the version.
- Make sure the checkbox ‘PalmSens or EmStat is on, but does not work property' 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 MUX8 PCB

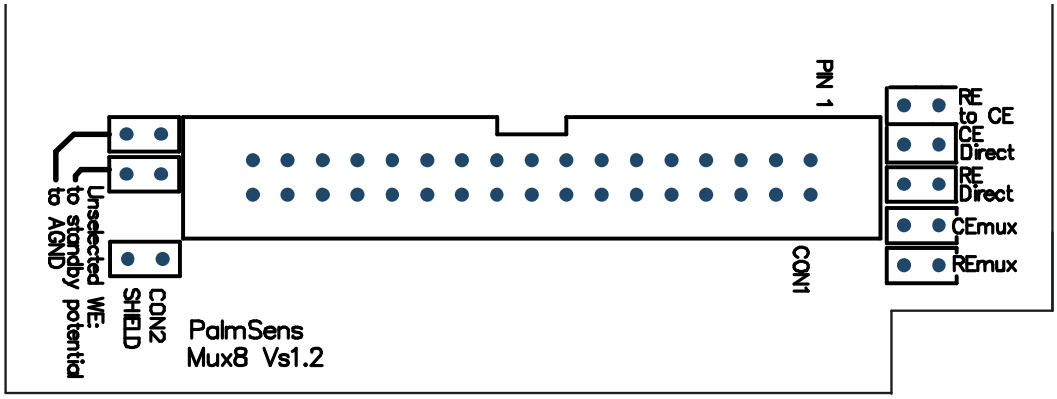
MUX8 multiplexer is meant for use with 2- or 3- electrode sensors or cells up to 8 channels.

## 4.1 Functional diagram



## 4.2 MUX8 configurations

The multiplexer can be used in different configurations or modes. Each configuration is set by a number of jumpers which are located on the board as shown in the illustration of the board layout below.




Possible sensor configurations are:

- Sensor arrays with (up to) eight working, reference and counter electrodes
- Sensor arrays with eight working and eight combined reference/counter electrodes
- Sensor arrays with eight working electrodes sharing a reference and a counter electrode
- Sensor arrays with eight working electrodes sharing a combined reference/counter electrode

In all configurations the sensors can be multiplexed, leaving the not-selected sensors or cells at open circuit.
Sensor configurations 2, 3 and 4 have the possibility to leave not-selected sensors or cells at open circuit or to apply the same potential to all sensors or cells.

**Jumpers:**

J1: RE to CE
Is placed when the sensor has a combined reference and counter electrode. This jumper therefore connects RE to CE.

J2: CE Direct
If the sensor array has more than one working electrode, but one counter and/or reference electrode, this jumper is placed. CE from PalmSens is connected directly to pin 1 and pin 2 of CON1

J3: RE Direct
If the sensor array has more than one working electrode, but one counter and/or reference, this jumper is placed. RE from PalmSens is connected directly to pin 13 and 14 of CON1

J4: CE MUX
This jumper is placed if CE has to be multiplexed. This is the case when each of the sensors has its own counter electrode using pin3 to 10.

J5: RE MUX
This jumper is placed if RE has to be multiplexed. This is the case when each of the sensors has its own reference electrode using pin 15 to 22

J6: Unselected WE to AGND:
If placed, all unselected working electrodes or sensors will remain polarized at the potential set by the PalmSens or EmStat. If this jumper is not placed only the selected channel is polarized leaving the not-selected WE's at open circuit.
When using Conf 1 and CE and RE are multiplexed (J4 and J5 are placed), this jumper is not relevant since only the selected channel's WE, CE and RE are polarized.

J7: Unselected WE to standby potential
Is always left open.

Jumper settings for the available configurations:

Conf. 1: Sensor array with up to eight working, eight reference and eight counter electrodes:

- Jumpers to be placed are: J4 and J5

  The potential is only applied to the selected channel. All channels NOT selected are at open circuit. (See remark below * )

Conf. 2a: Is suitable for working with a sensor array which has up to eight individual electrochemical cells consisting of up to eight working and eight combined reference/counter electrodes:

- Jumpers to be placed are: J1, J4 and J5

  Note: all leads CE1-8 and RE1-8 are connected together and this combined lead is connected to all eight combined reference/ counter electrodes.
  The potential is only applied to the selected channel. All channels NOT selected are at open circuit. (See remark below * ).

  When J6 is also placed, the potential is applied to all working electrodes continuously.

Conf. 2b: Sensor array with up to eight working and eight combined reference/counter electrodes:

- Jumpers placed are: J1, J2 and J3

  Note: the combined reference/counter electrodes are connected to the leads CE Direct and/or RE Direct

  When J6 is also placed, the potential is applied to all working electrodes continuously.

Conf. 3: Sensor array with up to eight working electrodes all sharing one reference and one counter electrode:

- Jumpers placed are: J2 and J3

  Note: the reference and counter electrodes are connected to RE Direct and CE Direct respectively.

  When J6 is also placed, the potential is applied to all working electrodes continuously.

Conf. 4: Sensor array with up to eight working electrodes all sharing one combined reference/counter electrode:

- Jumpers placed are: J1, J2 and J3

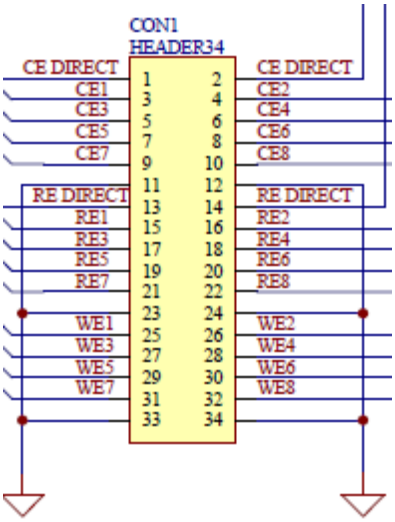
  Note: the reference/counter electrode is connected to RE Direct and/or CE Direct.

  When J6 is also placed, the potential is applied to all working electrodes continuously.

* IMPORTANT REMARK

It is not possible to apply a potential simultaneously to more than one sensor or cell each with three electrodes. This requires a multipotentiostat, one potentiostat for each channel. This is however possible with two electrode sensors or cells, so when combined counter and reference electrodes are applied.

## 4.3 Electrode connections

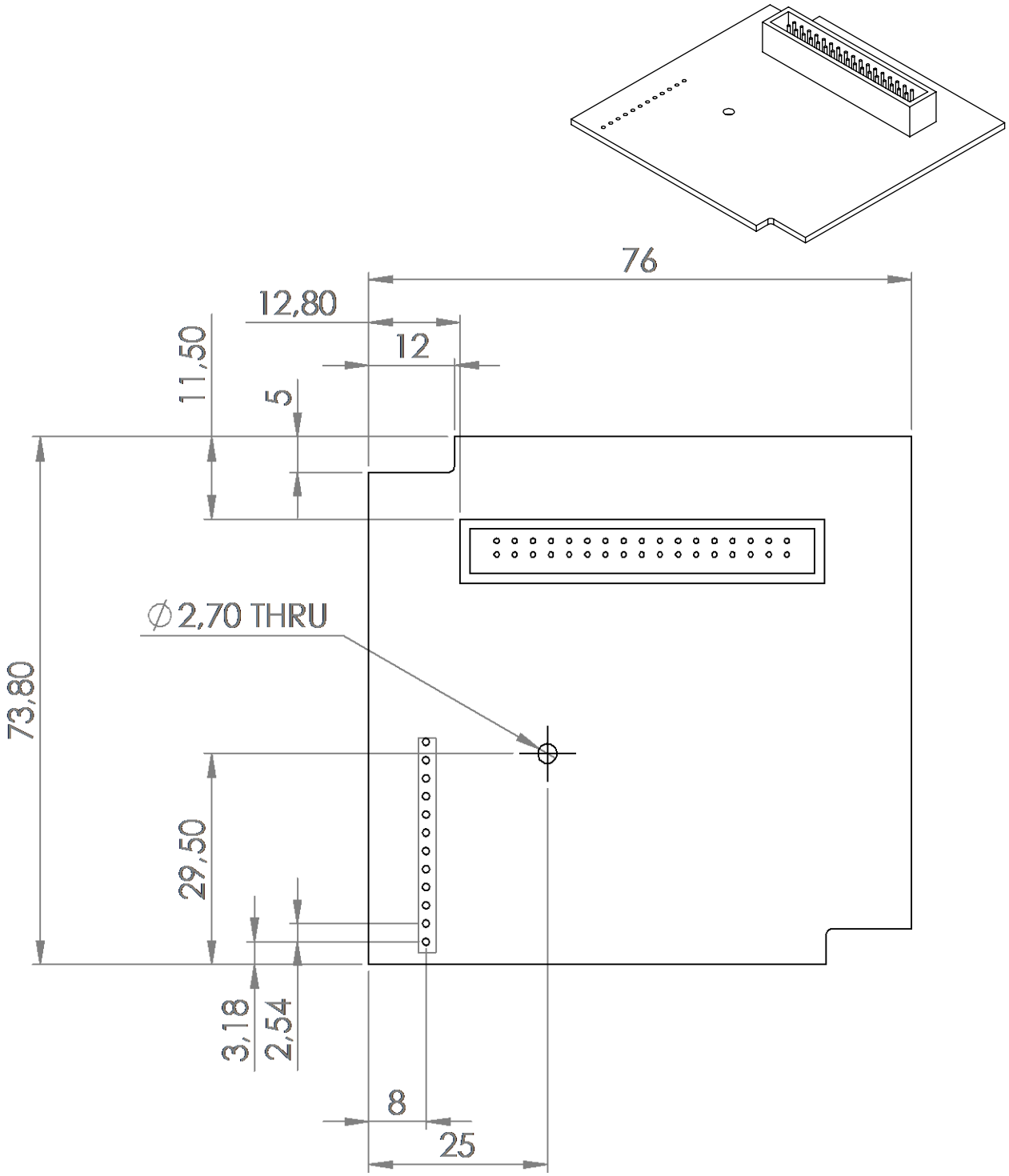



## 4.4 Specifications

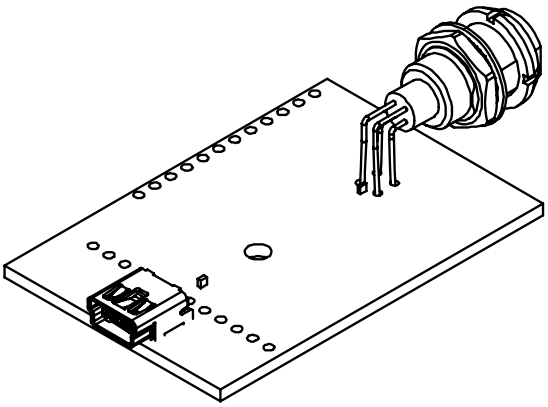
| | |
|---|---|
| Number of channels | 2-8 |
| Multiplexer use: | • Sensor arrays with up to eight working, reference and counter electrodes |
| | • Sensor arrays with up to eight working and eight combined reference/counter electrodes |
| | • Sensor arrays with up to eight working electrodes all sharing the same reference and the same counter electrode |
| | • Sensor arrays with eight working electrodes all sharing the same combined reference/counter electrode |
| On resistance | WE, CE and RE channels: 2 ohm typical (see note) |
| Leakage current | 10 pA typical at 25 °C (see note) |
| Charge injection | 20 pC typical (see note) |
| Connections: | Shielded flat cable, with stripped end leads or<br>by means of the MUX8 Terminal Block (in shielded housing) |
| | • eight WE's |
| | • eight CE's |
| | • eight RE's |
| | • one CE used when all WE's share one counter electrode |
| | • one RE used when all WE's share one reference electrode |
| | • analogue ground for shielding |
| Dimensions of PCB | 76 x 74 mm |

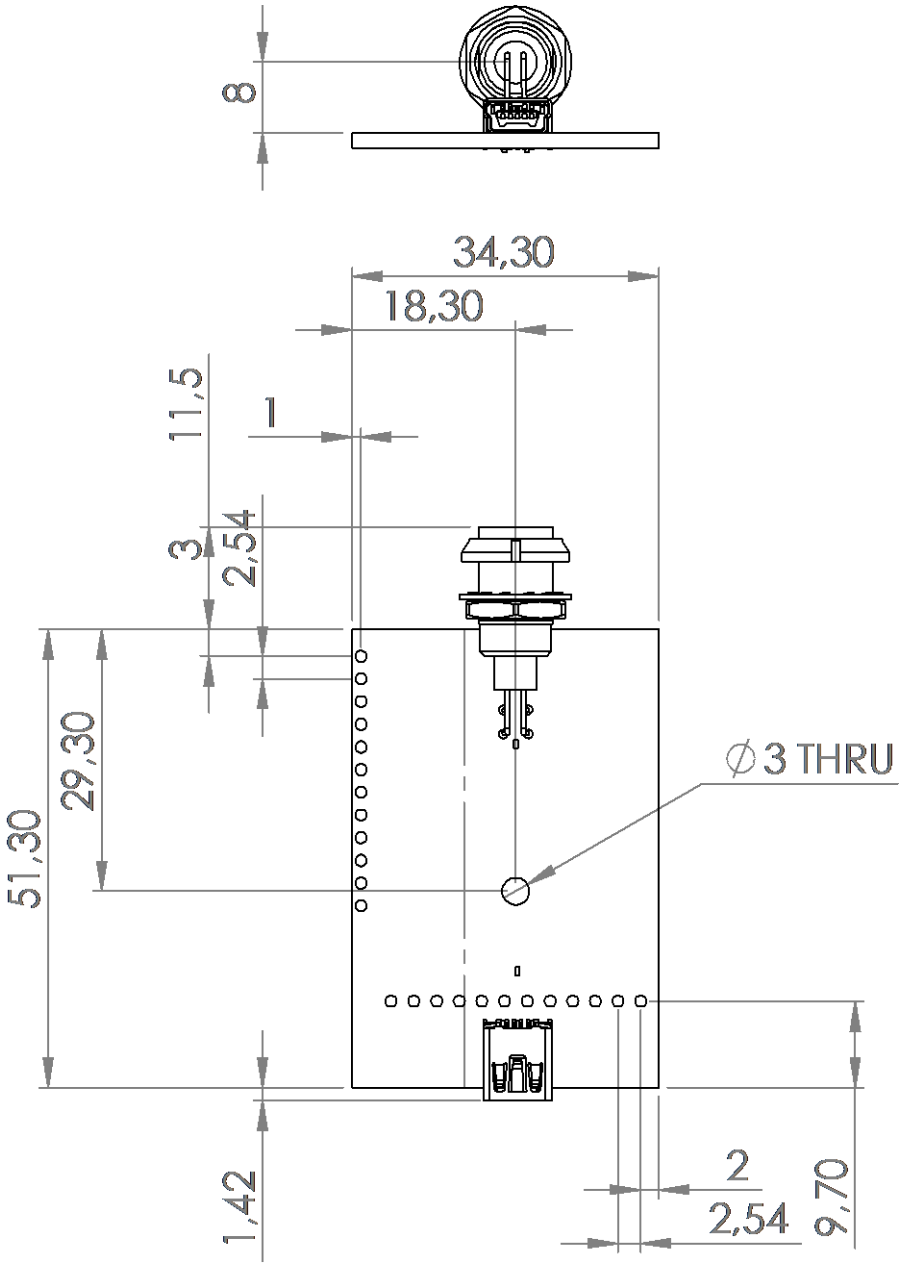
# 5 PCB dimensions

## 5.1 MUX8 PCB

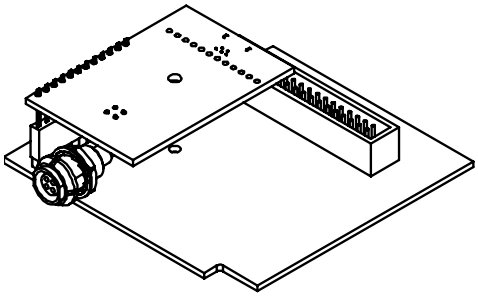


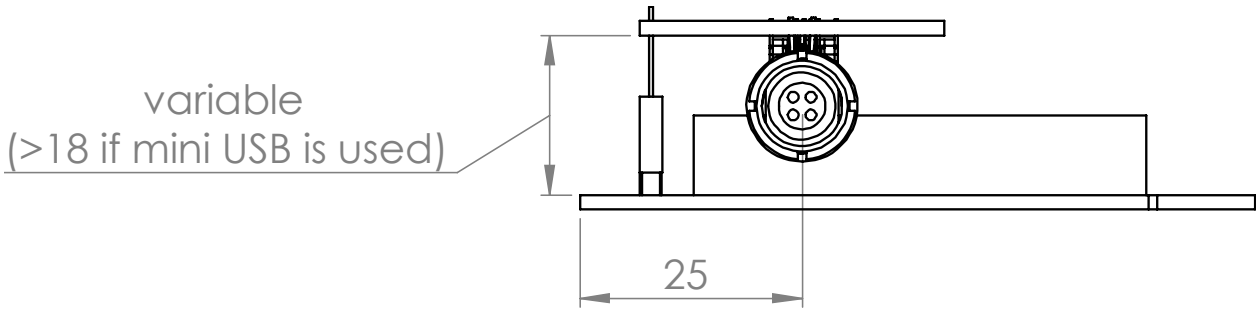
## 5.2 EmStat$^3$ PCB

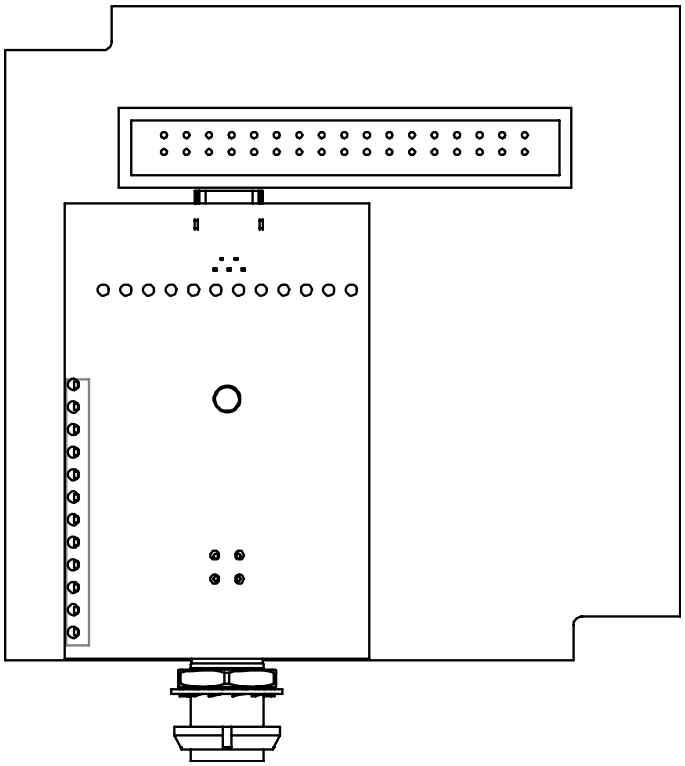




## 5.3 PCB's connected – option 1





## 5.4 PCB's connected – option 2