ACU2

Technical Reference Manual

ANSARI Controller Unit Type 2 technical reference manual

Document topics

Specifications
Interfacing
Dimensions

Document Version: 1.02
11. January 2013

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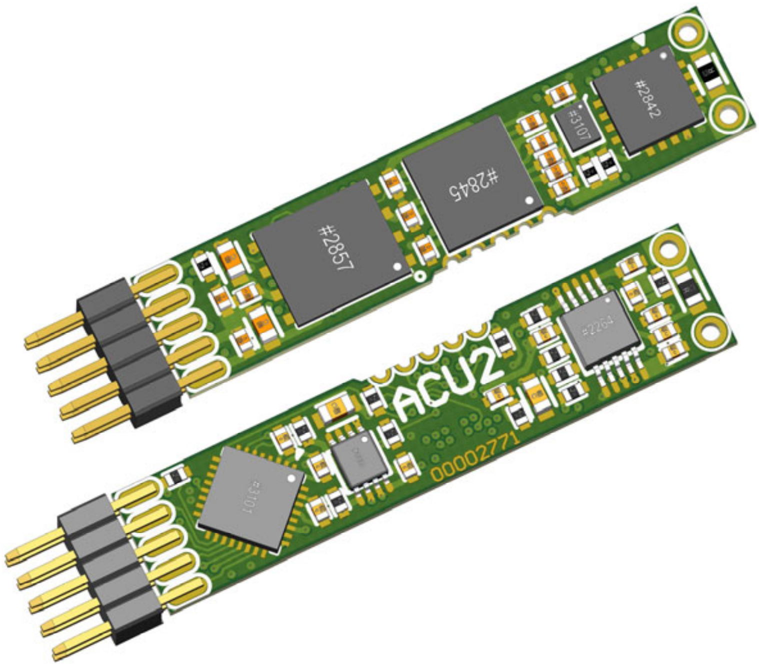
Table of Contents

1 Introduction of ACU2



Front and back side views of ACU2

1.1 Description

ANSARI controller Unit – Type 2 (**ACU2**) is designed to be an interface for various sensor types. It is capable of storing sensor data locally using an onboard serial Flash with 4MByte of capacity. Together with each record, the ACU2 can also store a time stamp and the temperature of the sensor at recording time.

The form factor of ACU2 is kept so small, that it can be integrated together with the sensor itself into a very small housing. The PCB is optimized to be fitted into M12 screw housing usual in the industry.

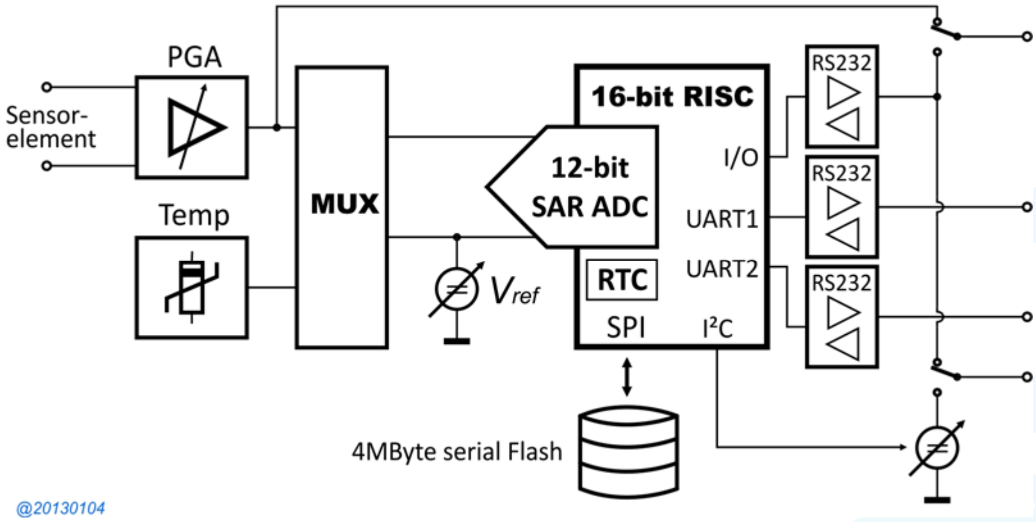
ACU2 can output sensor data and temperature data in analog and digital form on its interface. The digital interface of ACU2 is based on RS232 technology and can transmit the serial data about 15 meters on a cable. The baud rate is user selectable and up to 57600 baud.

A number of ACU2 modules can be networked together using one cable. It can be connected in parallel or cascade mode to build a chain. Each module in the chain becomes its own address (automatically or manually). Individual communication with each module is based on module address in the chain.

Digital processing and interfacing of the module is based on a 16-bit RISC processor with 16 MIPS, 128kByte Flash and 10kByte SRAM. The ADC module is a 200ksps fast 12-bit SAR analog-to-digital convertor with reference generator for sensor biasing if needed.

The chained system can also operate without a host or gateway. The modules are intelligent enough to be grouped and communicate with each other without the need of a master or host module. Configuration and data exchange with ACU2 can be done directly over a RS232 serial port on PC using a hyper terminal application.

1.2 Block diagram



1.3 Features

General

- 16-bit mixed signal RISC microcontroller with 16 MIPS
- 128kByte code Flash, 10Kbyte SRAM and additional 4MByte external serial Flash
- 12-bit 200ksps Analog-to-Digital converter with Reference voltage and auto scan
- Basic timers with real-time clock feature and time stamp for logging purposes
- SPI controlled programmable gain amplifier with input multiplexer
- Analog sensor and temperature voltage output with 200mA driving capability
- Local long term logging capability for 500.000 records with time & temperature stamps

Sensor Input Interface

- Low Noise: 12nV/√Hz
- Offset: 25µV, 100µV (max)
- Zerø Drift: 0.35µV/°C, 1.2µV/°C (max)
- Two Channel MUX
- Gain Error: 0.3% max
- Gain Switching Time: 200ns
- Input Offset Current: ±5nA max (+25°C)
- Binary Gains: 1, 2, 4, 8, 16, 32, 64, 128
- Gain Bandwidth: 350kHz @ G=128 to 10MHz @ G=1
- Calibration channels @ 10% and 90%
- Configurable signal reference voltage
- Operating temperature range -40°C to 125°C

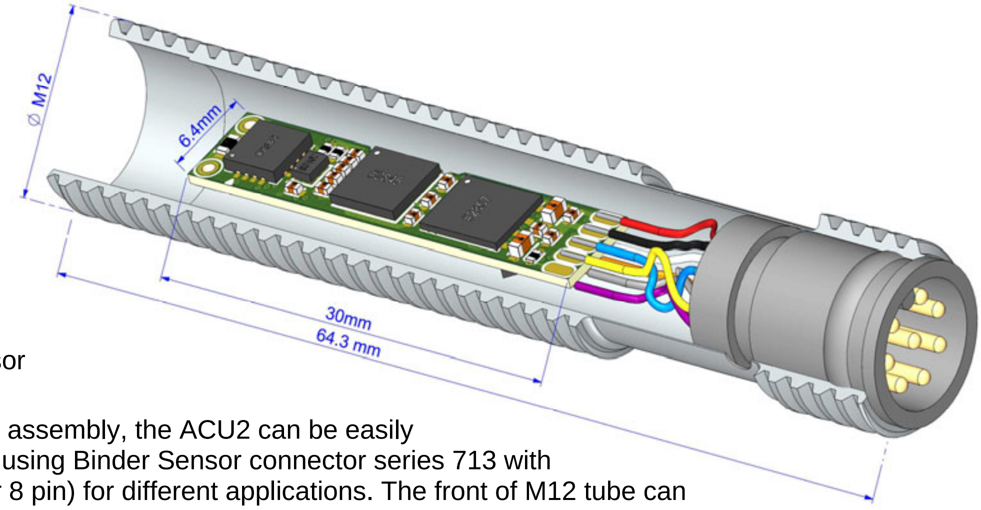
Digital Interface

- RS-232 transceiver with three-driver and five-receivers
- Specified for data rates up to 1000-kbps
- Enhanced ESD interface Protection:
  - ±8 kV IEC 61000-4-2 Air-Gap Discharge
  - ±8 kV IEC 61000-4-2 Contact Discharge
  - ±15 kV Human-Body Model

1.4 Applications

Industrial sensors in M12 housing like:

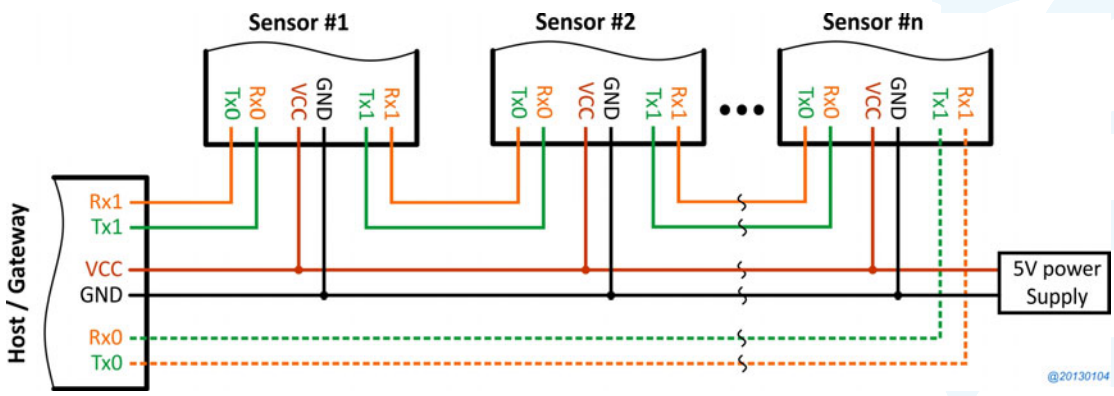
- Light sensor
- IR detectors
- CO_2 Sensors
- Motion detector
- Humidity Sensor
- Smoke detectors
- Temperature Sensor



As shown in the 3D-CAD assembly, the ACU2 can be easily placed into M12 housing using Binder Sensor connector series 713 with needed pin count (4, 5 or 8 pin) for different applications. The front of M12 tube can be assembled with a desired sensor.

ACU2 wiring example

An interesting aspect is how to wire the sensors to each other to create a networked system with same or different sensor types in the chain. Beside other alternative wiring shames, one possible shame is the cascaded wiring of the sensors shown in the figure below.



In this topology the modules are able to number themselves automatically. Each module has its own address to distinguish communication between the modules. If modules are added or removed, the chain is able to detect the change automatically and initiates a re-addressing of the modules in the chain.

This chain can operate without the need of a host system. Any module in the chain is able to communicate with another individual module if desired. The number of sensors in the chain is not limited, but it is recommended to not exceed 256 sensors in a chain.

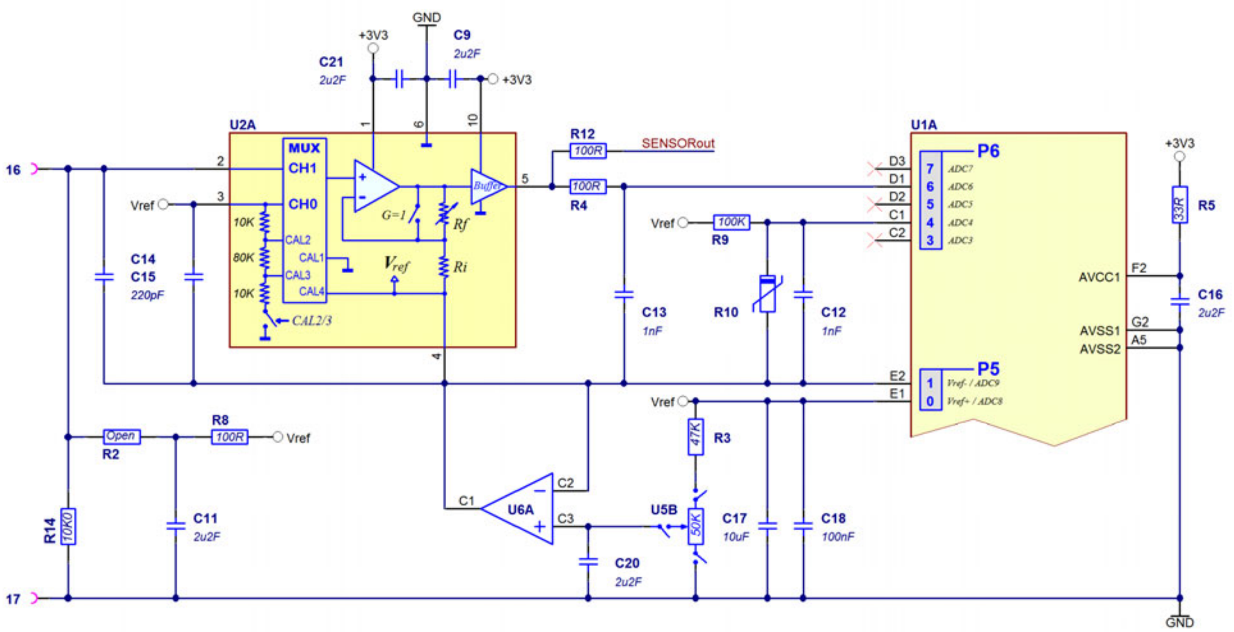
The both ends of the chain may be connected to each other as shown doted to realize a ring topology. Data shifted to the ring may be verified by sender if an application requires double checking of transferred data through the chain.

Local long term logging capability

The ACU2 is able to log sensor data together with a time and temperature stamp per record. More than 500.000 records can be stored in ACU2. If each minute one record is stored, the ACU2 can store more than one year of data locally!

2 Specifications

2.1 Sensor Interface Schematics



As shown in the schematic above a sensor should be connected to pin 16 (Sensor In+) and pin 17 (Sensor In-). If bias voltage is needed, then R2 needs to be populated with required value defined by sensor characteristics.

R10 is placed on the PCB near to sensor pins to observe the temperature as near as possible to the sensor. The ADC can sample with 200ksps in total. If sensor and temperature values both need to be sampled, then the sampling rate reduces to 100ksps for each in average if same time slot is taken.

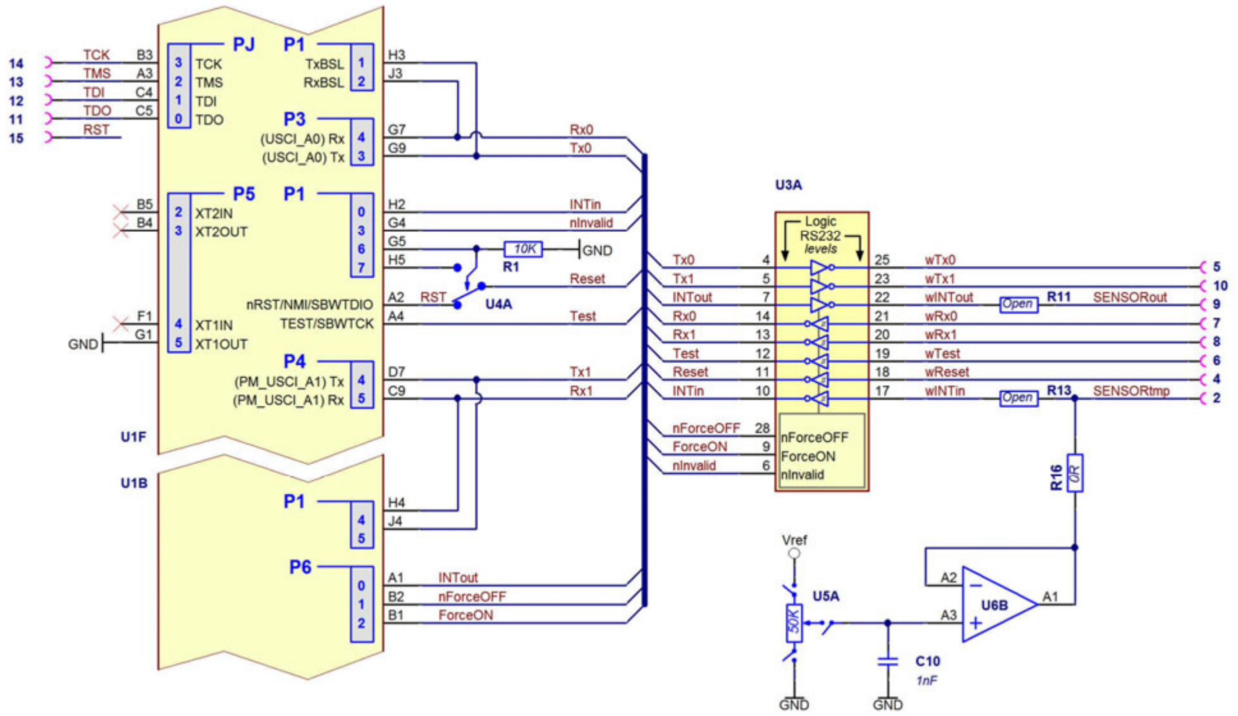
The whole dynamic range of the ADC is 4096 steps (due to 12 bit-ADC) between Vref+ and Vref-. The Vref+ is internally set to 1,5V or 2.0V or 2,5V. The Vref- can be set between GND and 1,3V in 8mV steps using the digital potentiometer U5B. This configuration allows the elimination of any DC offset values given by the sensor, when the offset is out of focus of the application.

The programmable gain amplifier (PGA) U2 can be set over the input multiplexer to 10% or 90% of the Reference voltage for offset and gain-linearity calibration purposes. Also temperature drifting can be eliminated at any time during normal operation. The PGA can be programmed to the binary gains of: 1, 2, 4, 8, 16, 32, 64 and 128.

Over R12 the conditioned sensor signal is also available as an analog output signal. Shorting current is limited to 30mA due to existence of R12. More current would be available by reducing the R12, but this would impact to much the ADC input stage and needs to be changed with care.

R14 builds a load for current driven sensors and might be needed to be matched to sensor signal characteristics. For voltage driven sensors with the need of biasing voltage, this resistor may have to be removed.

2.2 External Signal Interface Schematics



As shown in the figure above, two of the interfacing pins (pin #2 and #9) of the board can be configured alternatively during manufacturing time to be digital or analog signals, depending on R13, R16 and R11, R12 resistors.

When pin #2 is used as an analog pin, then an analog voltage in range of 0V to Vref, divided in 256 steps can signal to external interface any value wanted controlled by software. For example a temperature range can be mapped as an analog signal out. When configured as a digital signal, then this pin would be an input signal and can act as an external trigger input if needed by any application.

When pin #9 is used as an analog pin, then the conditioned sensor signal over R12, described earlier, will be available at the output interface. When used in digital configuration, this pin would be an output signal and may be used as a triggering signal for other modules in the system.

Two pins (#1 and #3) are used for 5V input power, which is not shown in above figure. The pins #11 to #15 are JTAG pins for programming the module, but they can also be used as simple µController GPIO pins, if an application requires this at run time.

The rest of the 6 pins to the board are RS232 transceiver signals. The pins #5 and #10 are output signals and the pins #4, #6, #7 and #8 are input signals of the RS232 transceiver.

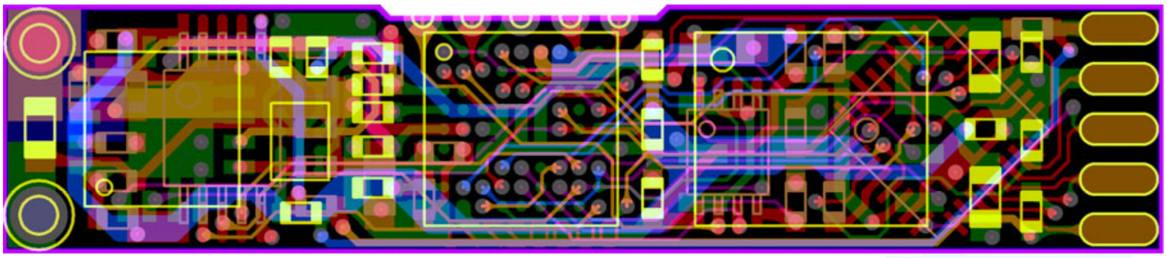
Pin #4 and #6 in combination with the pins #5 and #7 build the serial program loader signals for remote programming of one individual module in the chain. All other modules in the chain protect themselves of being also programmed by using the switch U4A controlled by firmware triggered by special commands from programmer unit.

Any UART signals to and from the module are connected with interrupt pins of the µController. Whenever any of the Rx or Tx signal lines start to toggle, the software is able to detect the activity. Together with the invalid signal form the RS232 transceiver, the firmware has the possibility to find out whenever a module is disconnected from chain. This helps to initiate automatic numbering of the modules in the chain.

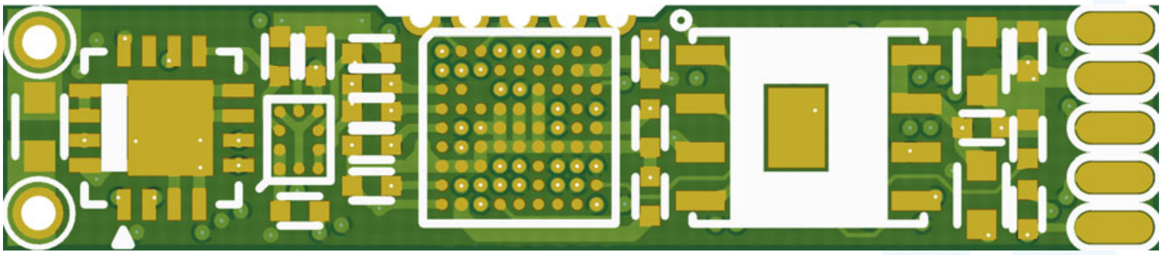
2.3 Printed Circuit board (PCB) design

The PCB design is done on 6 layers, in 100µm technology. The board has a total number of 121 plated drilling holes. The PCB has a thickness of approx. 1mm

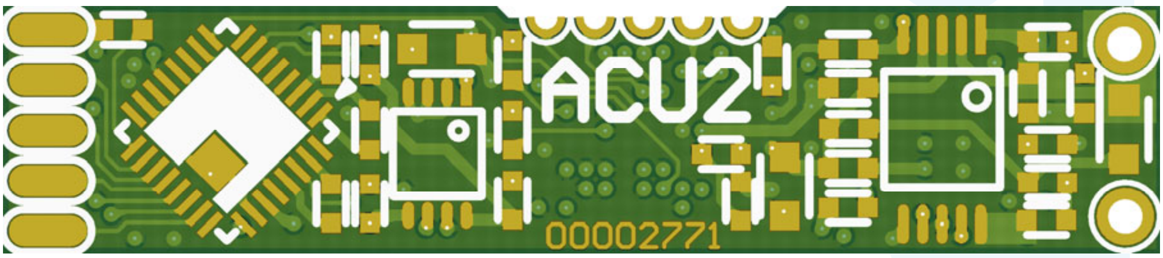
PCB CAD design view:



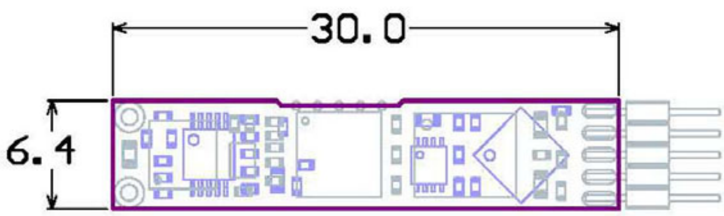
PCB CAD-photo (Top view):



PCB CAD-photo (Bottom view):

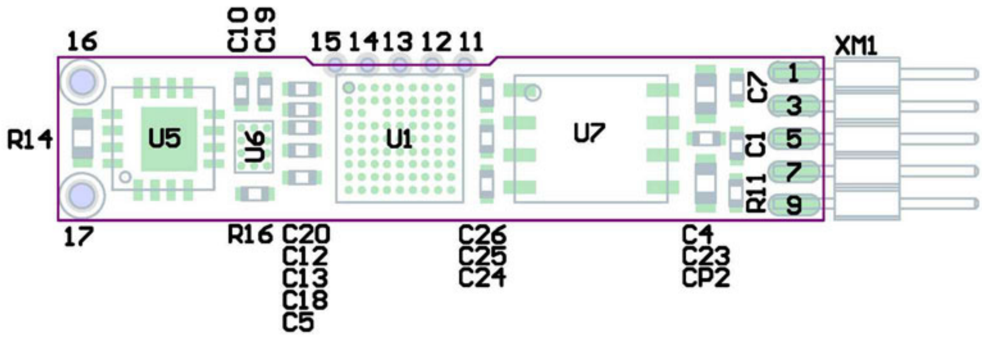


2.4 Dimensions

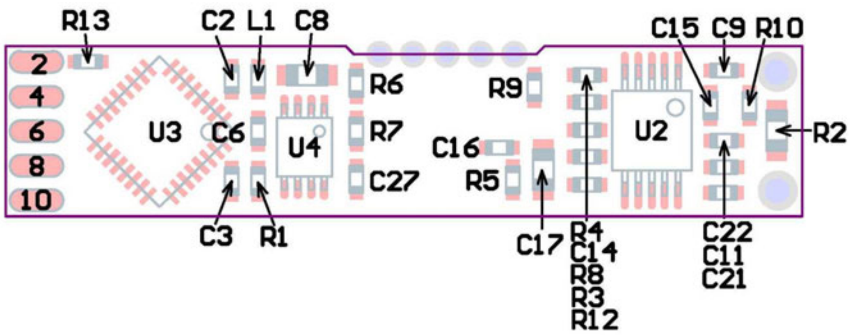


2.5 Assembly

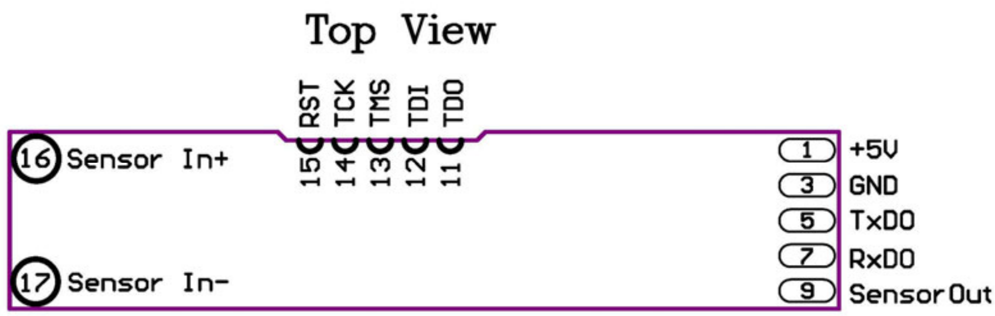
PCB CAD-assembly (Top view):

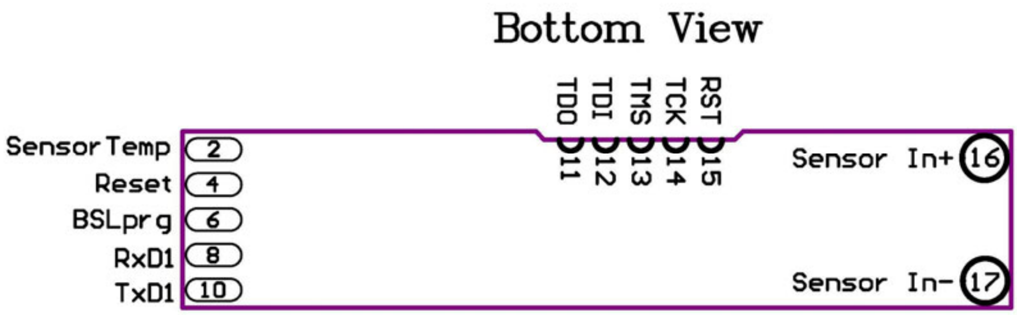


PCB CAD-assembly (Bottom view):



2.6 Interfacings





2.7 Electrical Pin Description

PIN #	Name	Type	Description	Note
1	+5V	Power	Main Supply voltage	5V ±10%
2	SensorTemp	Analog-Out	Firmware controlled output voltage Digital to Analog converter with 256 steps with Vref+ selectable by software (1.5V, 2.0V or 2.5V)	0 … V_{ref}+
3	GND	Power	Ground	
4	Reset	RS232-In	Software controlled (enable /disable) µController-Rest pin	Low active
5	TxD0	RS232-Out	UART0 serial data output	
6	BSLprg	RS232-In	Trigger signal for entering BSL mode programming of the µController in conjunction with Reset pin #4	
7	RxD0	RS232-In	UART0 serial data input	
8	RxD1	RS232-In	UART1 serial data input	
9	Sensor Out	Analog-Out	Analog Sensor Conditioned output voltage	0 … 2.5 V
10	TxD1	RS232-Out	UART1 serial data output	
11	TDO	GPIO	JTAG ping in programming and Debugging mode General purpose digital I/O pin as alternative function	
12	TDI	GPIO	JTAG ping in programming and Debugging mode General purpose digital I/O pin as alternative function	
13	TMS	GPIO	JTAG ping in programming and Debugging mode General purpose digital I/O pin as alternative function	
14	TCK	GPIO	JTAG ping in programming and Debugging mode General purpose digital I/O pin as alternative function	
15	RST	Input	µController Reset pin	
16	Sensor In+	Analog-In	Positive analog sensor input signal	0 … V_{ref}+
17	Sensor In-	Analog-In	Negative analog sensor input signal	0 … V_{ref}+