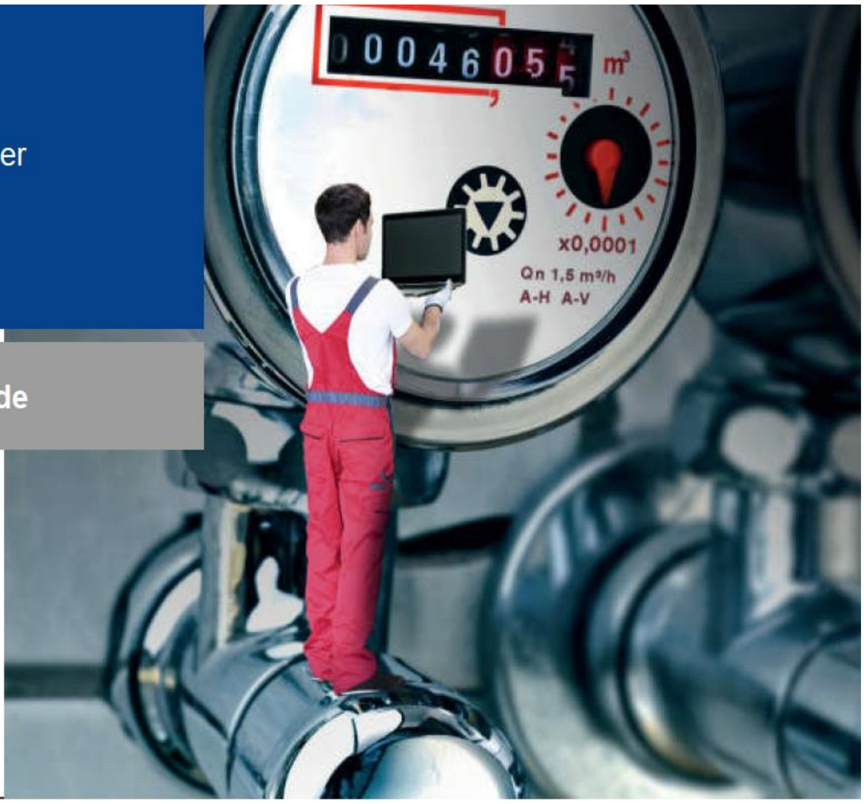
Flow-It-EvoAir
Rotational Flow Meter

Quick Startup Guide



Revision History

Revision	Date	Description
1.0	02.11.2020	Initial draft
1.1	06.10.2021	Add ‘Service configuration’, chapter 2.1 Add ‘Read parameters’, chapter 2.5 Update ‘Hardware description’
1.2	27.10.2021	Add specific note for read commands
1.3	29.10.2021	Add ‘Point Measurement’ command Add ‘Upload the new firmware’ chapter

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1. Start Flow Meter Kit

1.1. Unpacking

The Flow-it Kit is shipped with the following items:

- Development board with printed coils

1.2. Hardware description

The Flow-It Kit contain the following element

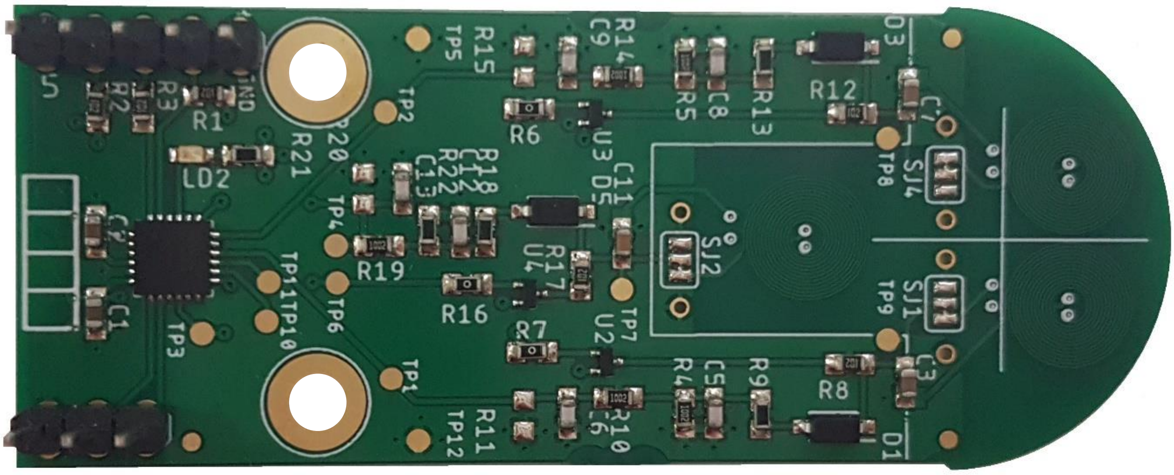


Figure 1 Flow-It board top

Figure 2 Flow-It board bottom

1.3. Installation

The document describes the functional principles of the Flow-It EvoAir board which is configurate to capture and count the rotation of a disk sensor using onboard printed coil or external coil sensors.
For each complete rotation of the disk sensor the LED will be activated (200 ms green light pulse is visible on every rotation).

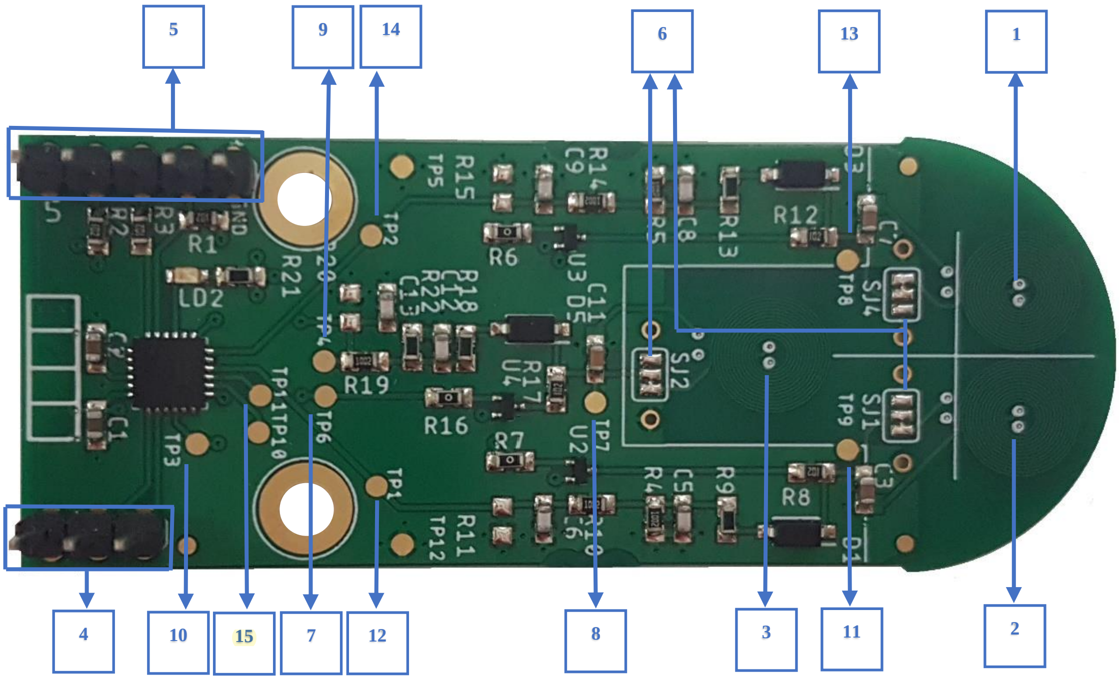


Figure 3 Flow-It EvoAir Hardware description

1 – Coil sensor 1

2 – Coil sensor 2

3 – Reference coil

4 – UART connector

5 – Debugger connector

6 – Jumpers for external coil

7 – Test pad 6: Reference excitation pulse

8 – Test pad 7: Reference LC oscillation

9 – Test pad 4: Reference filter output

10 – Test pad 3: Sensor1 + Sensor2 excitation pulse

11 – Test pad 9: Sensor1 LC oscillation

12 – Test pad 1: Sensor1 filter output

13 – Test pad 8: Sensor2 LC oscillation

14 – Test pad 2: Sensor2 filter output

15 – Test pad 11: Sampling point

1.4.Debugger connector

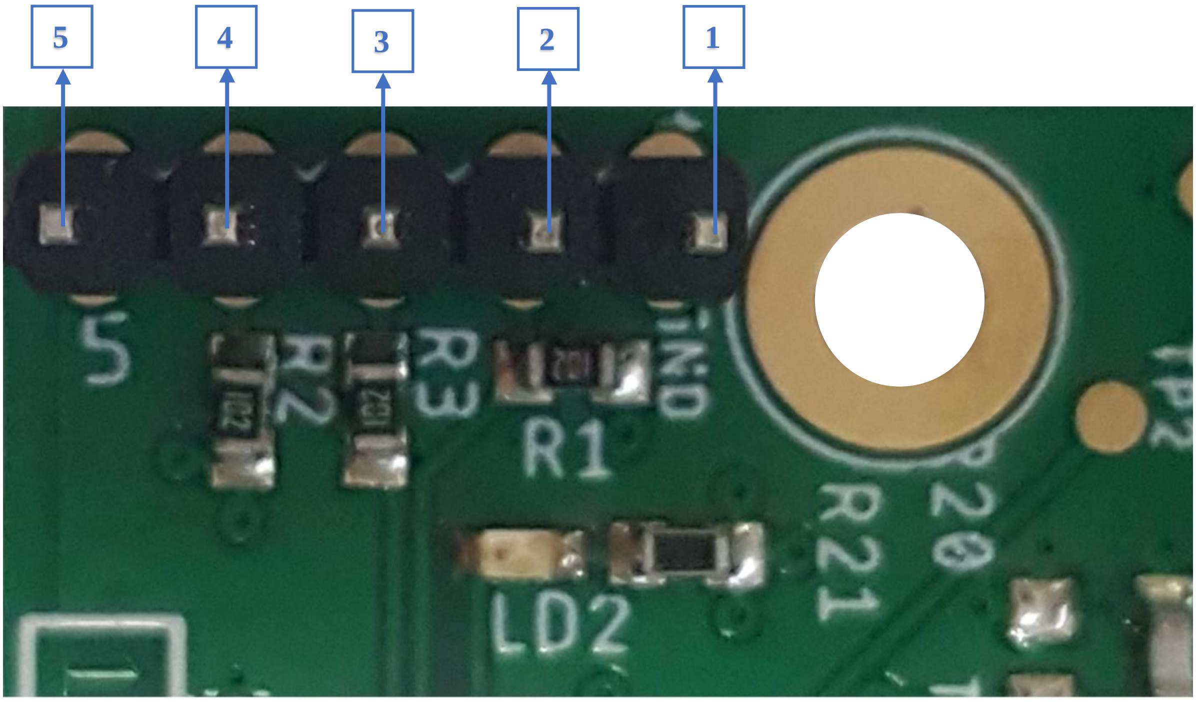


Figure 4 Debugger connector

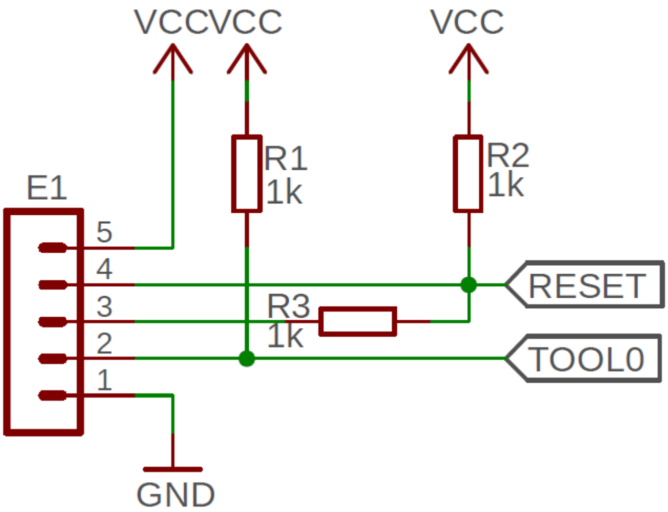


Figure 5 Debugger connector schematic

1.5. UART connector

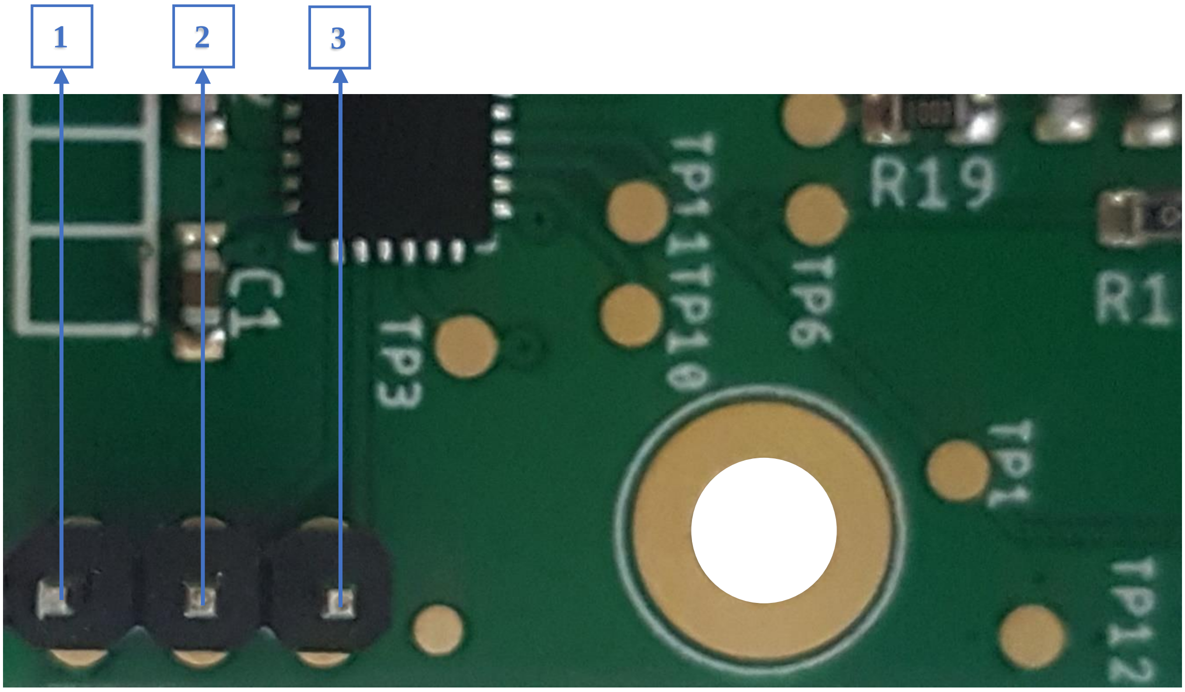


Figure 6 UART connector

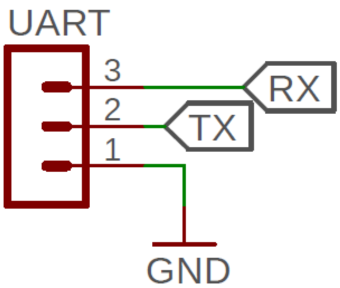


Figure 7 UART connector schematic

1.6. Coil sensor

1.6.1. Printed coil sensor

The coil sensor circuit is composed by an RCL circuit excited by a pulse and create a damped oscillator signal which is filtered by an envelope detector and a lowpass filter.

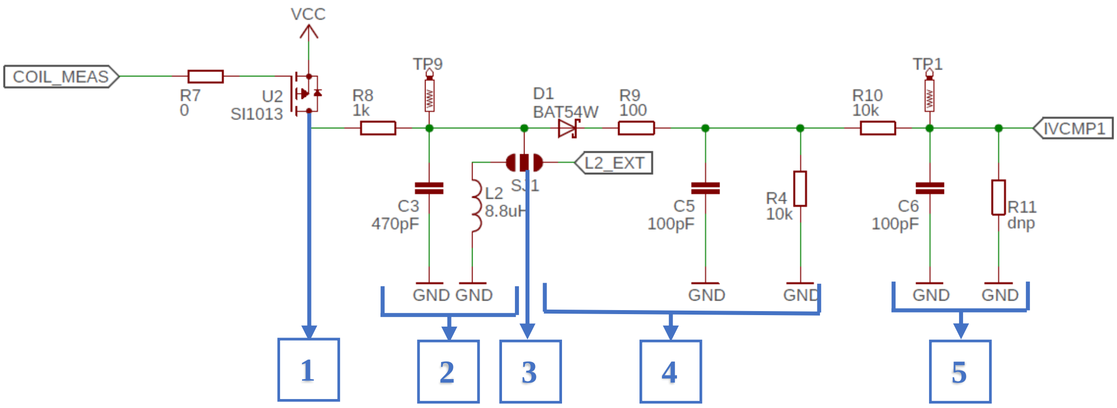


Figure 8 Coil sensor schematic

1 – Transistor for excitation pulse
2 – Oscillator circuit
3 – Solder jumper for external coil
4 – Envelope detector circuit
5 – Low pass filter circuit

The current value of R8 was chosen to minimize the power consumption, in order to change the detection distance of the metal disc that value can be changed.

1.6.2. External coil sensor

For external coils usage the solder jumper configuration is presented in the table below:

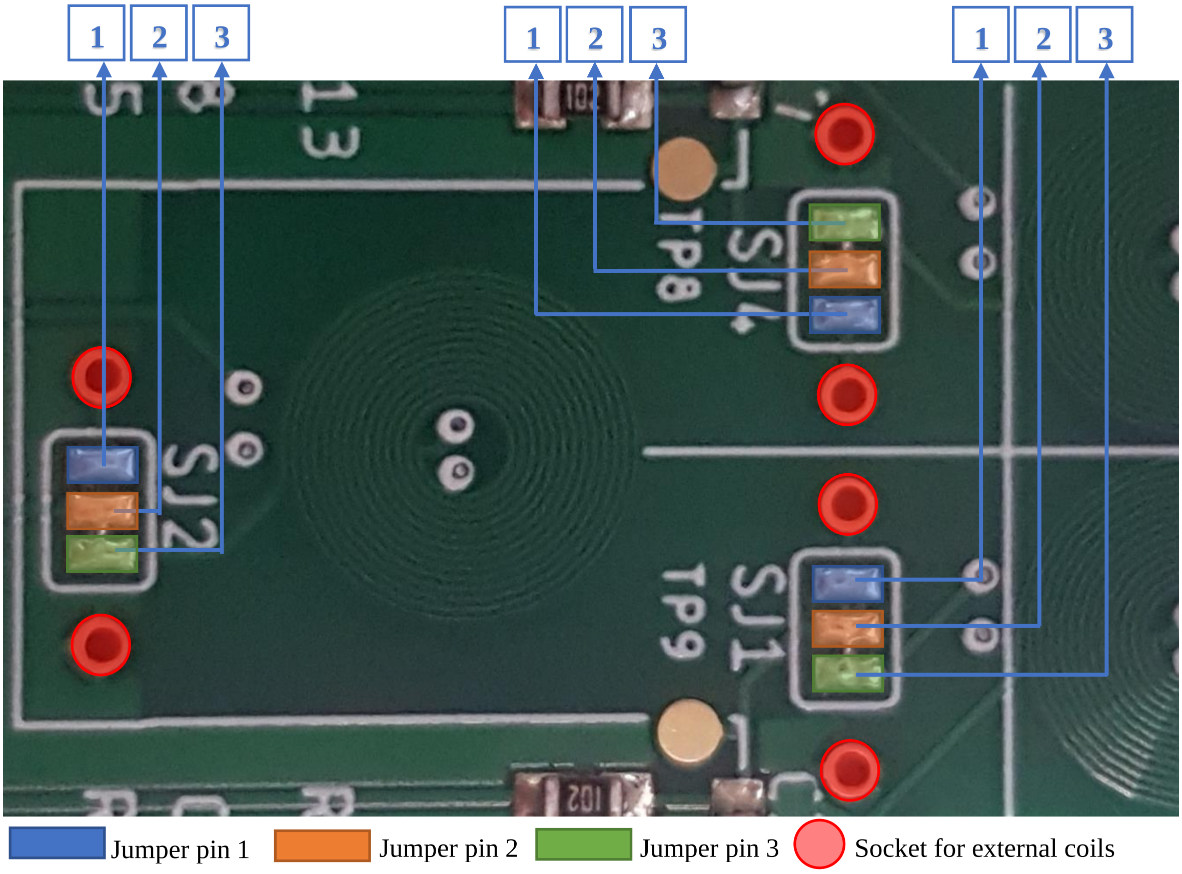


Figure 9 Solder jumper pin number

The external coils need to be placed on the socket highlighted with red in the picture.

1-2 open 2-3 short for using printed coils on the board

1-2 short and 2-3 open for using the external coils.

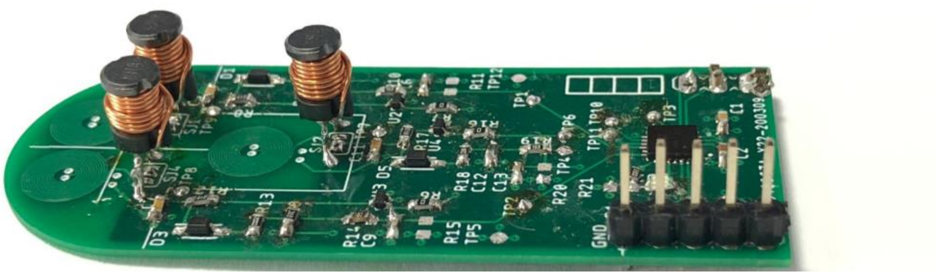


Figure 10 External coils configuration

1.7. Power consumption

The power consumption is dependent of sample rate and the coil type.

The minimum power consumption measured with printed and external coils can be found below.

1.7.1. Printed coil power consumption

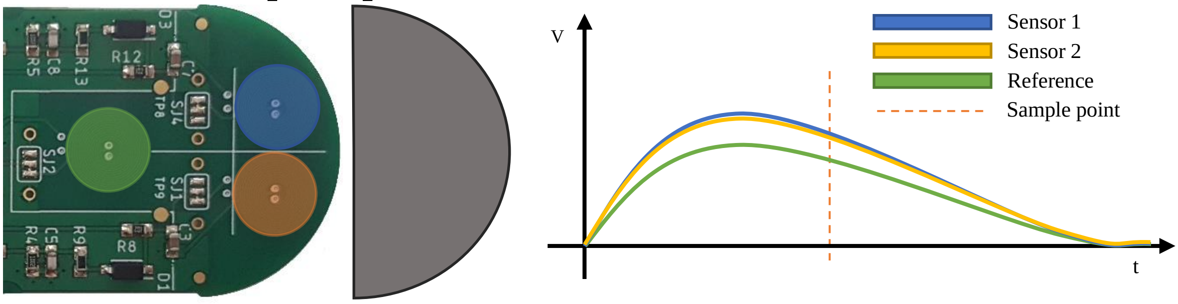
For onboard coils type 8.8 [**µH**] the minimum power consumption is presented in the table below.

Sample rate [**Hz**]	Power consumption [**µA**] standby	Power consumption [**µA**] Rotation detection
58.82	2.07	2.21
100	3.07	3.21
150	4.33	4.46
200	5.5	5.65
250	6.72	6.87
300	7.95	8.08

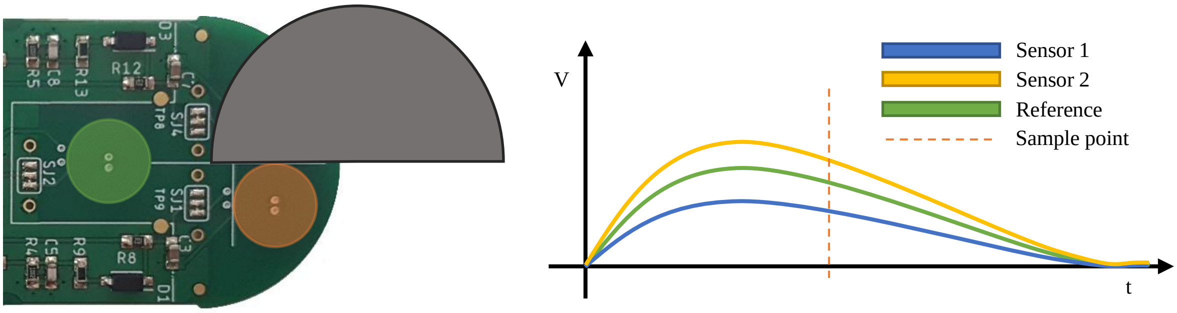
1.7.2. External coil power consumption

For an external coil with 6.8 [**µH**] and the sample rate at 250 [**Hz**] the power consumption is 6.42 [µA] in standby and 6.9 [**µA**] in rotation detection.

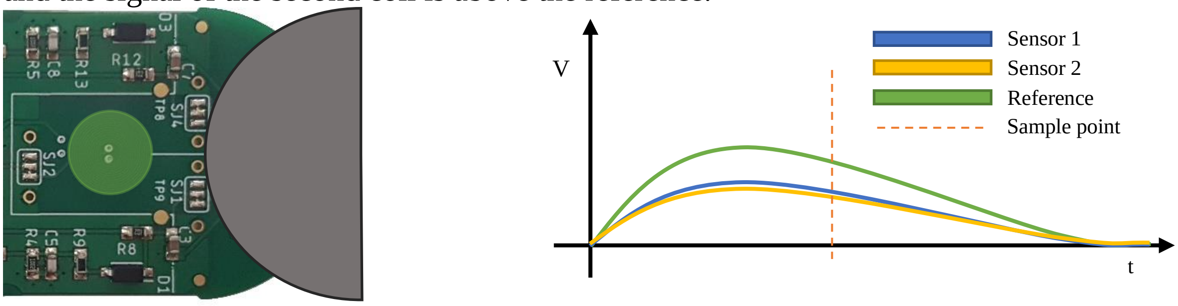
1.8. Functional principle



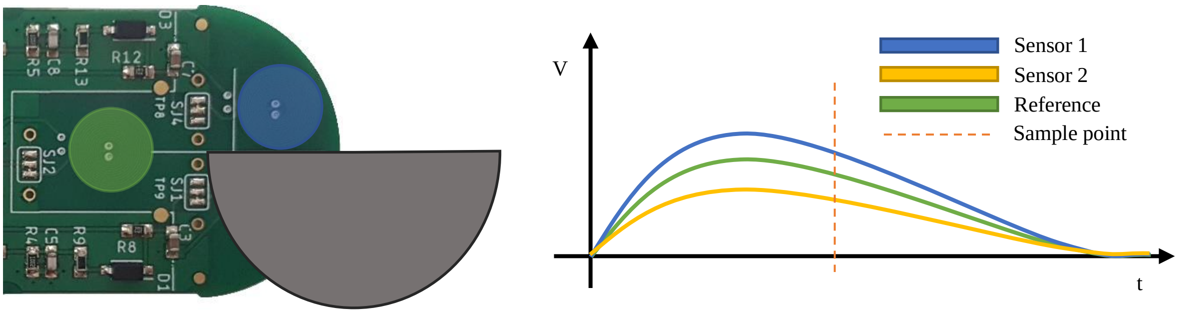
The metal disc dose not cover the coils. Their signals are above the reference level



After a rotation of 90 degree the disk covers only coil 1, its signal level is below the reference and the signal of the second coil is above the reference.



After a rotaion of 90 degree the disk covers both coils, the signals level are below the reference



After a rotation of 90 degree the disk covers only coil 2, its signal level is below the reference and the signal of the first coil is above the reference.

Figure 11 Functional principle

1.9. Schematic

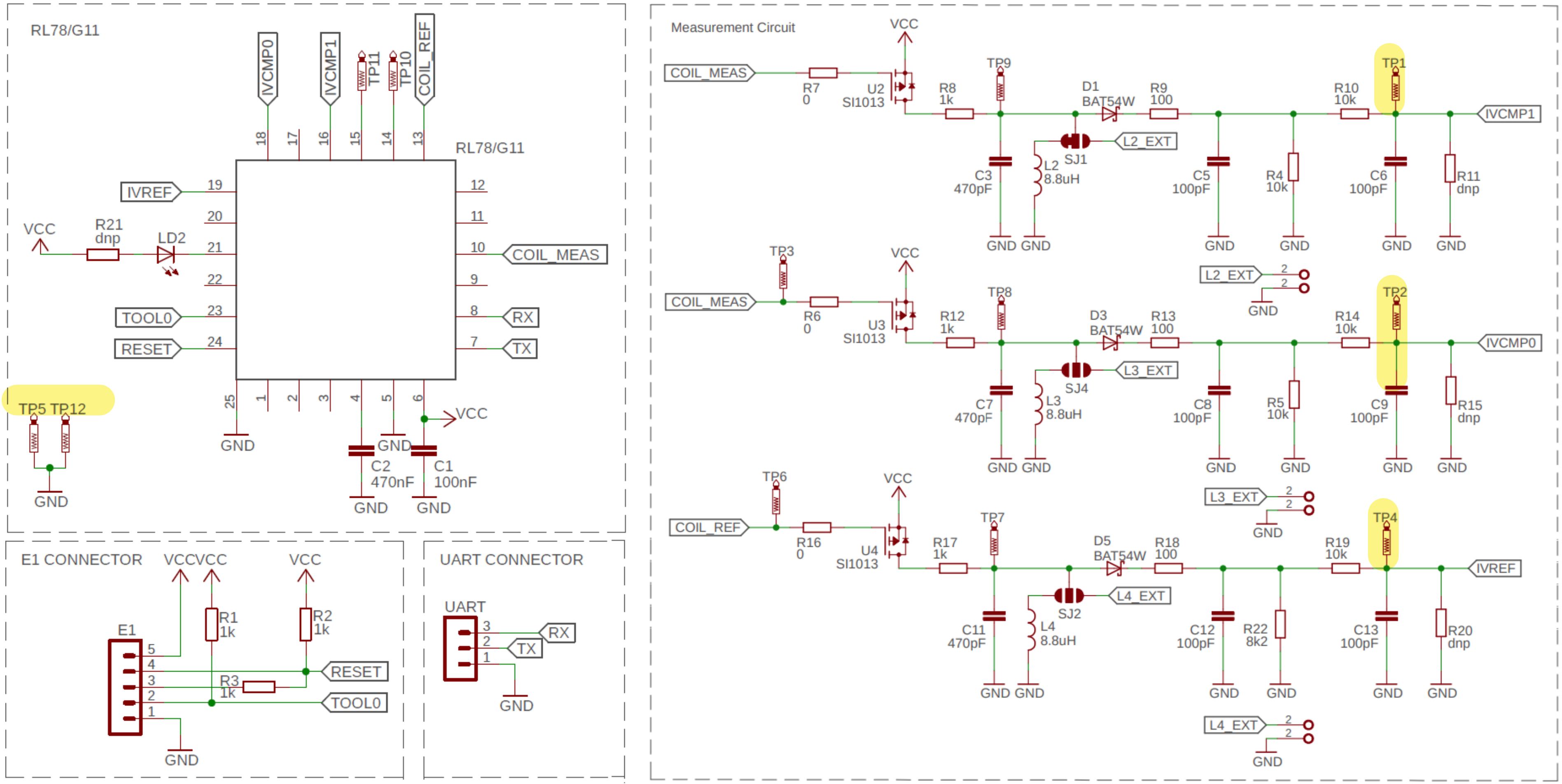


Figure 12 Hardware Schematic

Pin	Label
1	P137/INTP0/SSIO/(TI03)
2	P122/X2/EXCLK/(SI10/RXD1)/(TI02)/INTP1
3	P121/X1/(TI01)/INTP2/(SI01)
4	REGC
5	VSS
6	VDD
7	P51/KR7/INTP8/(TI02)/(TO02)/SCK01/SCL01/(TXD0)
8	P52/KR6/INTP7/SI01/SDA01/(RXD0)/(SDAA0)
9	P53/KR5/INTP6/SO01/SDAA0
10	P54/KR4/SO00/TXD0/TOOLTXD/(TI03)/(TO03)/SCLA0
11	P55/KR3/SI00/RXD0/SDA00/TOOLRXD/TI02/TO02/INTP11/(VCOUT0)/SDAA1
12	P56/ANI22/KR2/SCK00/SCL00/(SO11)/INTP10/(TO03)/(INTFO)/SCLA1
13	P30/ANI21/KR1/TI00/TO01/INTP3/SCK11/SCL11/(TXD0)/PCLBUZ0/TKBO1/(SDAA0)
14	P31/ANI20/KR0/TI01/TO00/INTP4/TKBO0/(RXD0)/SI11/SDA11/(SCLA0)
15	P32/ANI19/SO11/(INTP10)/(VCOUT1)/(SDAA1)
16	P33/ANI18/IVCMP1/(INTP11)/(SCLA1)
17	P23/ANI3/ANO1/PGAGND
18	P22/ANI2/PGAI/IVCMP0
19	P21/ANI1/AVREFM/IVREF0
20	P20/ANI0/AVREFP/IVREF1/(SO10/TXD1
21	P01/ANI16/INTP5/SO10/TXD1
22	P00/ANI17/PCLBUZ1/TI03/(VCOUT1)/SI10/RXD1/SDA10/(SDAA1)
23	P40/TOOL0/TO03/(PCLBUZ0)/SCK10/SCL10/VCOUT0/VCOUT1/INTFO/(SCLA1
24	P125/RESET/INTP9
25	DIEPAD-GND

RL78/G11 pins labels

2. Calibration services

The sensibility of rotational metal detection can be configured using a set of diagnostic services, based on an UART communication. The following items and services are possible:

- Phase between excitation signals (sensors and reference)
- Sensors excitation pulse width
- Reference excitation pulse width
- Sampling rate
- Save calibration values to Data Flash
- Send information regarding number of rotations
- Continuous transmission of the number of rotations
- Stop UART communication

2.1. System configuration

To establish a communication between the evaluation board and the user device is required to follow the next steps:

1. Install a serial terminal tool (e.g. Real Term).

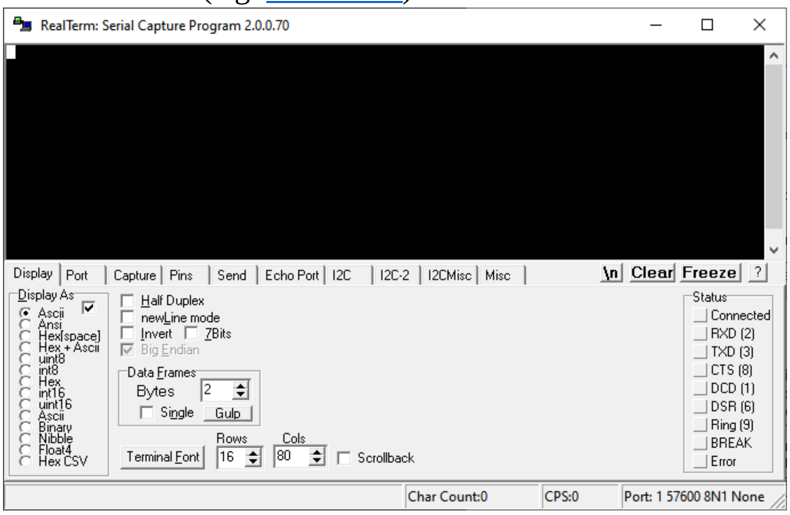


Figure 13 Real Term – Display Settings

2. Use a USB to UART adapter and connect it to the UART connector (see Chapter 1.5).
3. Connect the evaluation board to a 3V3 power supply using debugger/ power supply connector (see Chapter 1.4).

4. In terminal tool select the port terminal and set the baud rate at 9600.

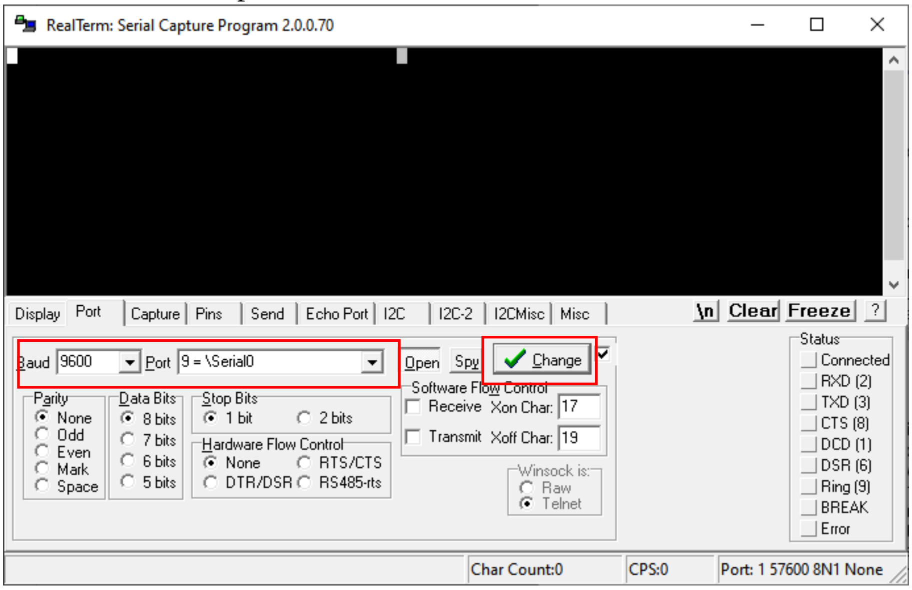


Figure 14 Ream Term – set the baud rate and port terminal

(Is required to press the ‘Change’ button to save the changes)

5. After the previews setting steps, the user can send the command messages.

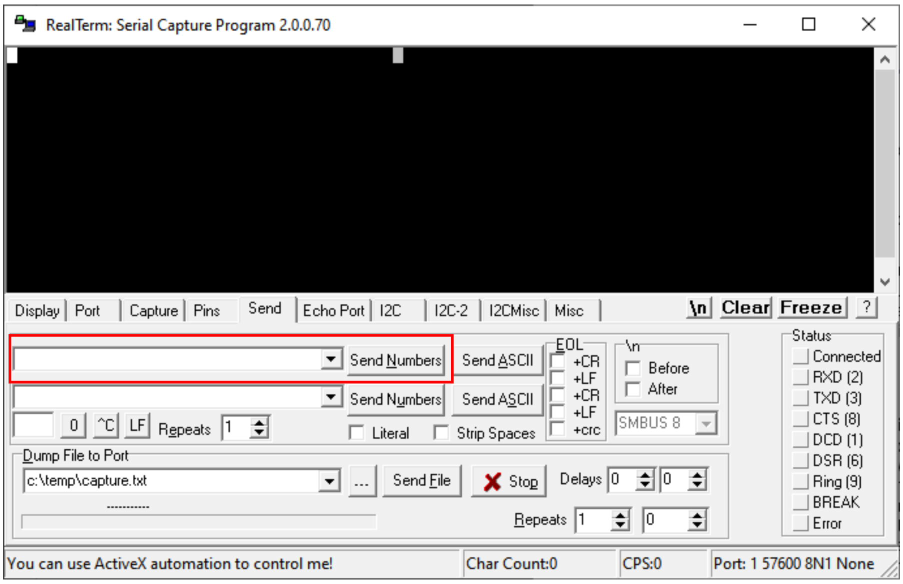


Figure 15 Real Term – Send interface

NOTE: The first message is a dummy one, and is used to wake up the MCU from the low power mode. After the configuration was done, is recommanded to send the ‘Close communication command’ to resume the low power consumption. (see Chapter 2.6).

Phase between excitation signals

UART command: **0x2E 0x01 [Data0] [Data1]**

- **Data0** and **Data1** form an *int16* value representing the phase difference between sensors pulse and reference pulse (**Data0** is less significant byte, **Data1** is the most significant byte)
- Phase shall be calculated considering a clock frequency of 8MHz for TAU

The following formula shall be used for calculation of the delay time and pulse width:

$$Phase\_difference = TDR_{mn\_master\_difference} * Count\_Clock\_period$$

Example:

1.

200 ns phase delay needed

$$200 * 10^{-9} = TDR_{mn\_difference} * \frac{10^{-6}}{8} \Rightarrow TDR_{mn\_difference} = 4{,}8 \Rightarrow TDR_{mn\_difference} = 5;$$

UART command: **0x2E 0x01 0x05 0x00**

2.

-160 ns phase delay needed

$$-160 * 10^{-9} = TDR_{mn\_difference} * \frac{10^{-6}}{8} \Rightarrow TDR_{mn\_difference} = -3.84 \Rightarrow TDR_{mn\_difference} = -4$$

UART command: **0x2E 0x01 0xFC 0xFF**

2.2. Sensor Signal Pulse Width Calibration

UART command: **0x2E 0x02 [Data0] [Data1]**

- **Data0** and **Data1** form an uint16 value representing the pulse width of sensors excitation signal (**Data0** is less significant byte, **Data1** is the most significant byte)
- Phase shall be calculated considering a clock frequency of 8MHz for TAU

The following formula shall be used for calculation of the delay time and pulse width:

$$Pulse\_width = TDR_{mn\_slave} * Count\_Clock\_period$$

Example:

1.

200ns phase delay needed

$$200 * 10^{-9} = TDR_{mn\_slave} * \frac{10^{-6}}{8} => TDR_{mn\_slave} = 4{,}8 => TDR_{mn\_slave} = 5;$$

UART command: **0x2E 0x02 0x05 0x00**

2.3. Reference signal Pulse Width Calibration

UART command: **0x2E 0x03 [Data0] [Data1]**

- **Data0** and **Data1** form an uint16 value representing the pulse width of sensors excitation signal (**Data0** is less significant byte, **Data1** is the most significant byte)

- Phase shall be calculated considering a clock frequency of 8MHz for TAU

The following formula shall be used for calculation of the delay time and pulse width:

$$Pulse\_width = TDR_{mn\_slave} * Count\_Clock\_period$$

Example:
1.

200ns phase delay needed

$$200 * 10^{-9} = TDR_{mn\_slave} * \frac{10^{-6}}{8} \Rightarrow TDR_{mn\_slave} = 4{,}8 \Rightarrow TDR_{mn\_slave} = 5;$$

UART command: **0x2E 0x03 0x05 0x00**

2.4. Sample Rate Calibration

UART command: **0x2E 0x04 [Data0] [Data1]**

- **Data0** and **Data1** form an uint16 value representing the pulse width of sensors excitation signal (**Data0** is less significant byte, **Data1** is the most significant byte)
- Phase calculation shall be calculated considering a clock frequency of 32.768 kHz for IT8

The following formula shall be used for calculation of the delay time and pulse width:

$$Sample\_rate = (TRTCMP0 + 1) * Count\_Clock\_period$$

Example:
1.

8 ms sample rate (8 Hz) needed

$$125 * 10^{-3} = (TRTCMP0 + 1) * \frac{10^{-3} * 16}{32.768} \Rightarrow TRTCMP0 = 255;$$

UART command: **0x2E 0x04 0xFF 0x00**

2.5. Point measurement

UART command: **0x2E 0x05 [Data0] [Data1]**

- **Data0** and **Data1** form an uint16 value representing the point measurement delay (**Data0** is less significant byte, **Data1** is the most significant byte)
-

The following formula shall be used for calculation the sample point timing:

Sample_point = (Sample point * 1.1) [us] + 1 [us] offset

Example:

~4 us sample point

(3*1.1) + 1 (offset) = 4.3[us]

UART command: **0x2E 0x05 0x03 0x00**

- **Note: the recommended value for point measurement is in interval [1 – 9].**

2.6. Read parameters

UART command: **0x22**

This command is used to read the parameters stored in the data flash and used to set the sensors calibration. The command response represents 6 parameters, each of them is divided in 2 x 8 bytes block, as follow:

1		2		3		4		5		6	
LSB	MSB	LSB	MSB	LSB	MSB	LSB	MSB	LSB	MSB	LSB	MSB

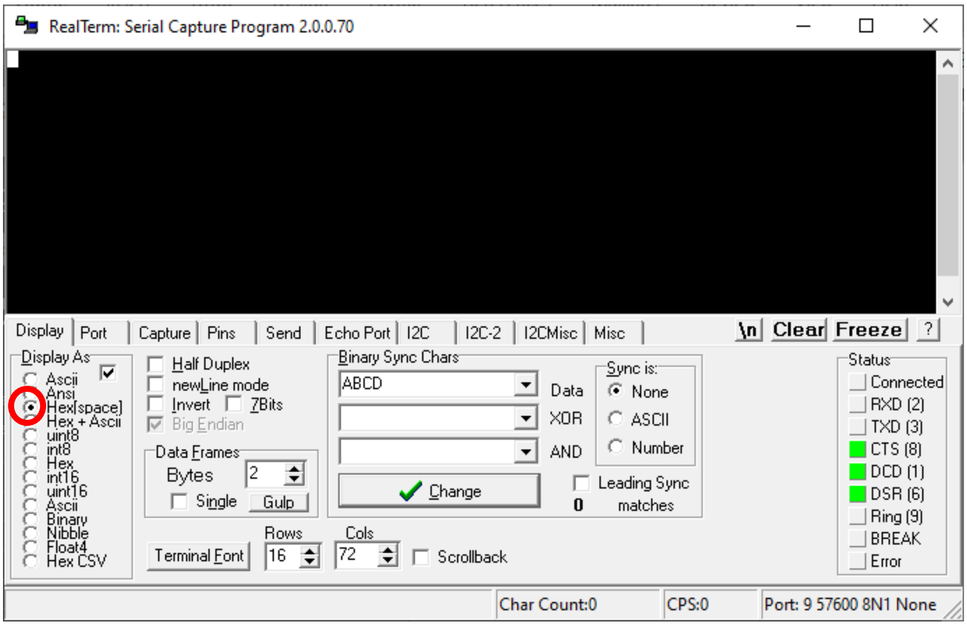
1. Phase shift between reference and sensors.
2. Sensor pulse width.
3. Reference pulse width.
4. Sampling point.
5. Sampling rate.
6. *Reserved.*

2.7. UART commands

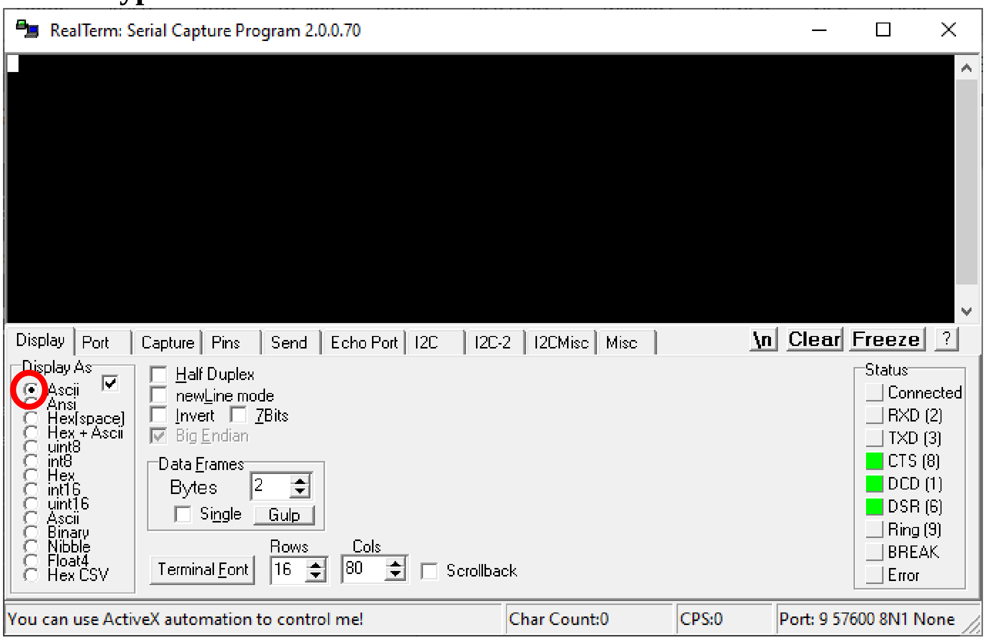
Save Calibration Values to Data Flash	**0x10**
Read information regarding number of rotations	**0x20**
Stop UART communication	**0x09**

Note: Reading commands require the correct data type to be set as follows:

- **0x22: the response is in hexadecimal format. In Real Term, the user should select the correct type of data before to send the command.**



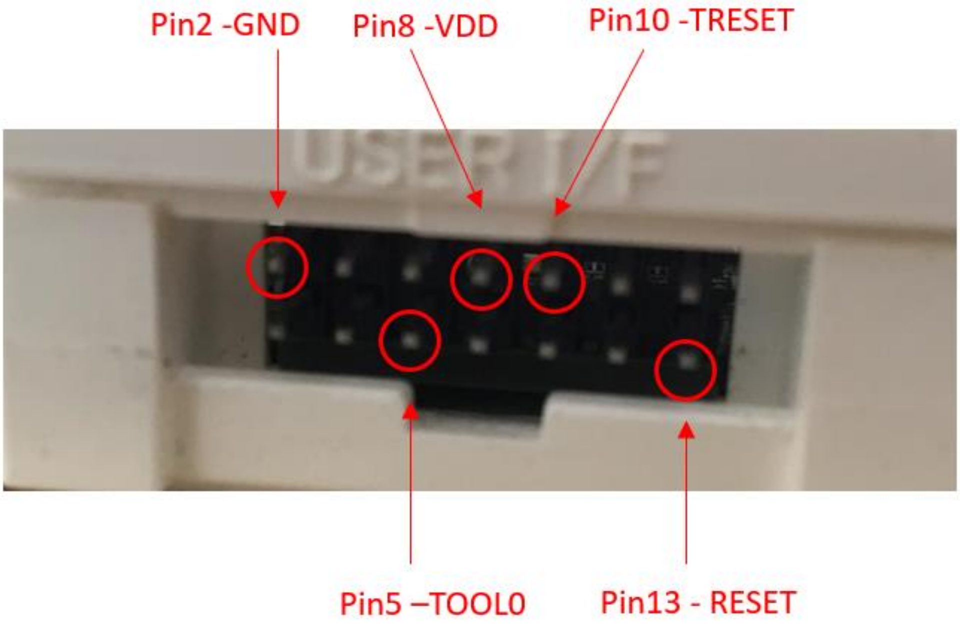
- **0x20: the response is in ASCII format. In Real Term, the user should select the correct type of data before to send the command.**



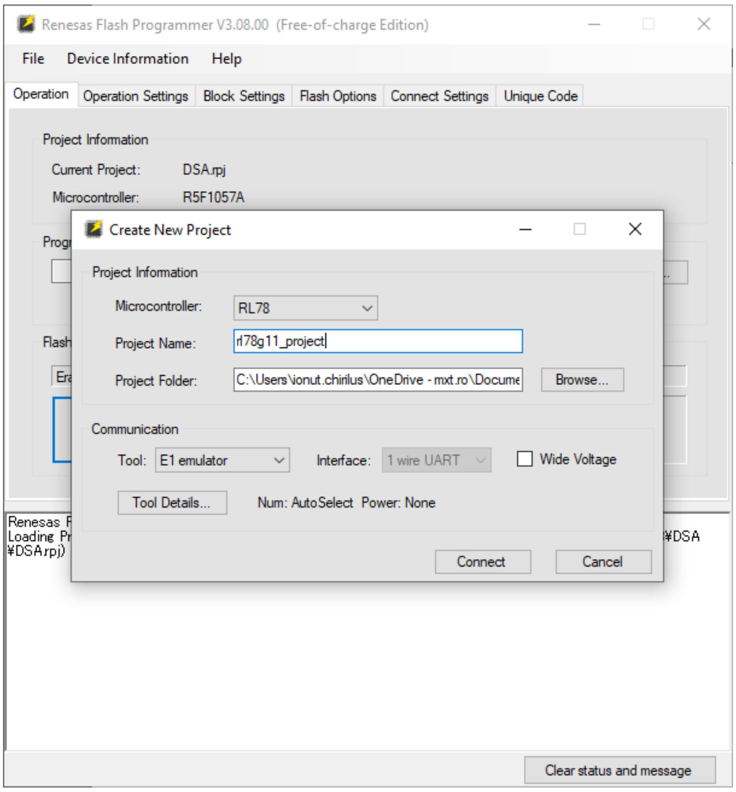
3. Upload the new firmware

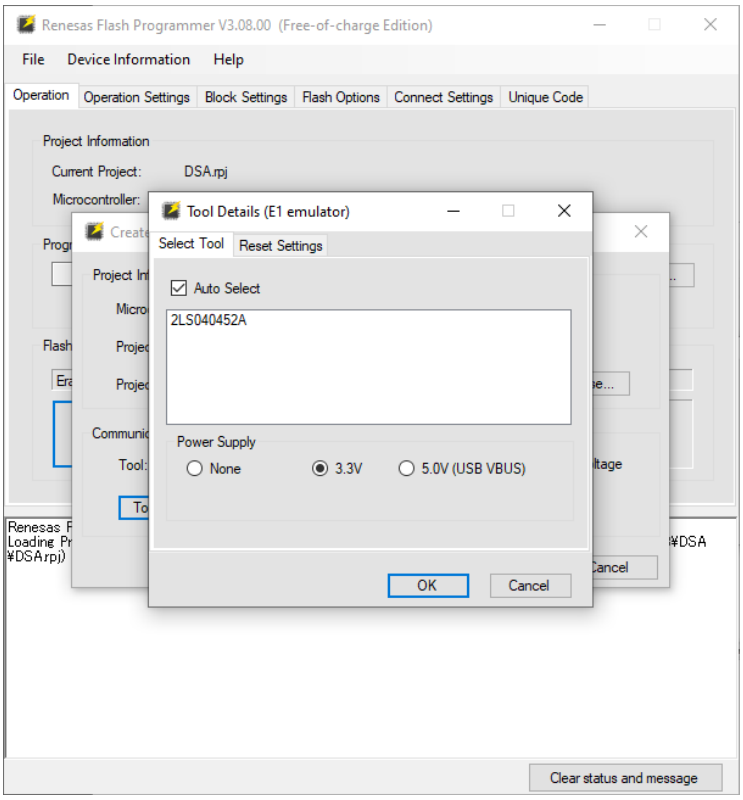
For programming is required a set of steps as follow:

- Install Renesas Flash Programmer tool.
- Connect the debugger with RFM boards. E1 debugger pinout example in correlation with board debugger pinout (see Chapter 1.4):

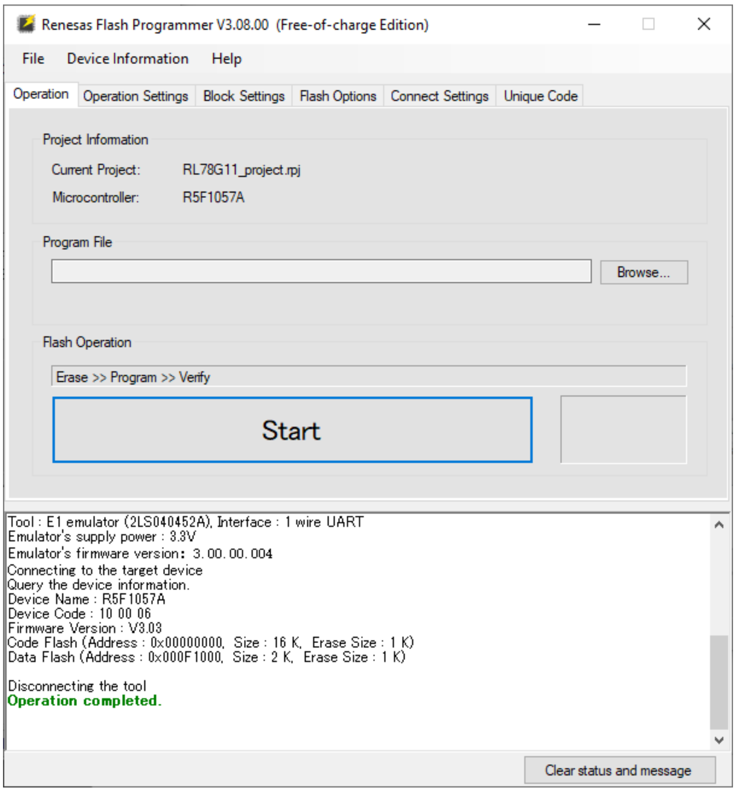


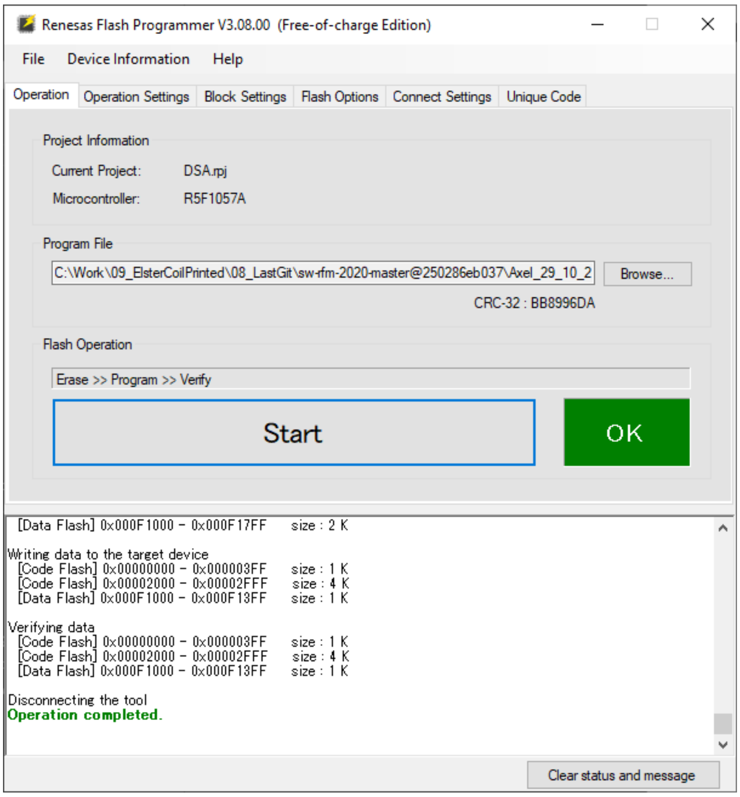
- Open the program and create a new project from ‘File’ tab.
- Select the microcontroller to RL78.
- Give the project a name.
- Select the debugger type.
- Select 3V3 Power Supply from ‘Tool Details…’ list.
- Press connect button.





- Select the programming file using ‘Browse’ button.
- Press ‘Start’ and wait the uploading process.
- The process status will be displayed on the right side and console log.





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