

Embedded data processing using NI MyRIO and LabVIEW for magnetic field measurements

HANNA GAŁACH
FACULTY OF PHYSICS, WUT

SUPERVISOR: NIKITA DUNIN, JINR

Outline

- Introduction
- What has already been done?
- Tasks
 - LCD display
 - USB data log
 - calibration
- Summary and future plans



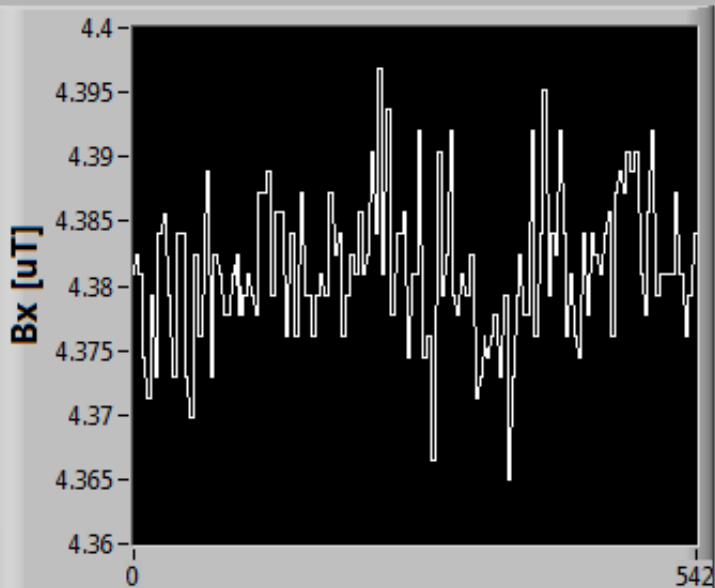
What has already been done?

Measurement system

Bx [uT]

4.3841

Bx [uT]

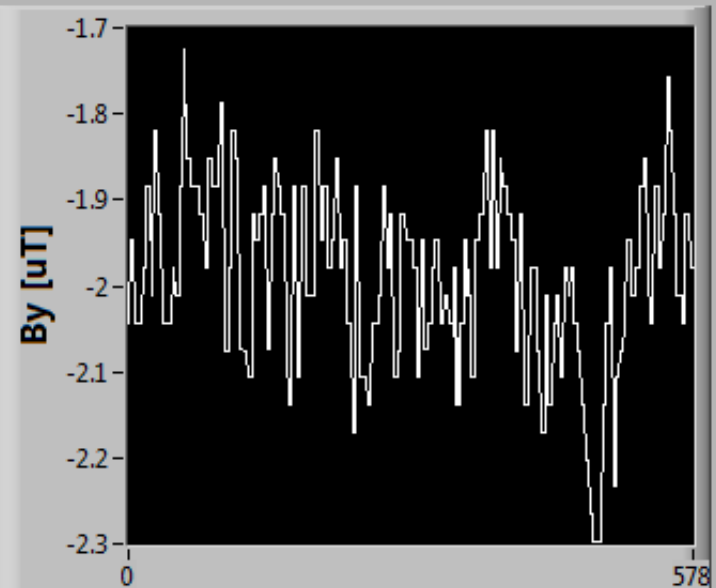


Seconds

By [uT]

-1.9791

By [uT]



Seconds

Measurement system

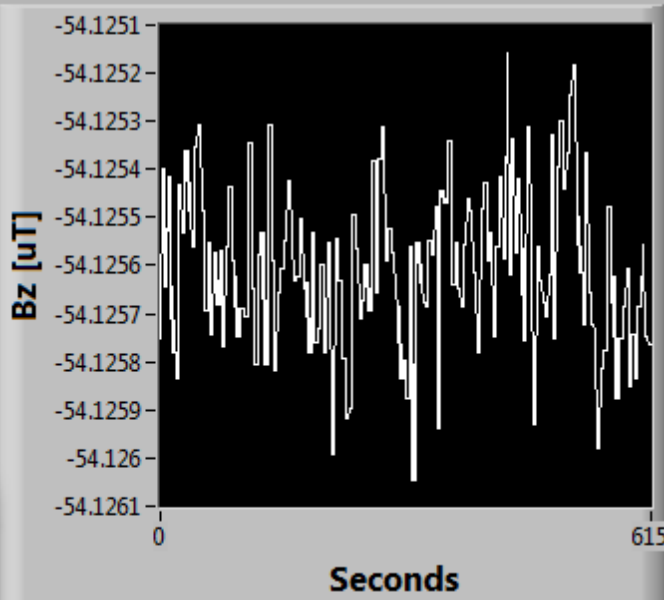
Bz [μT]

-54.126

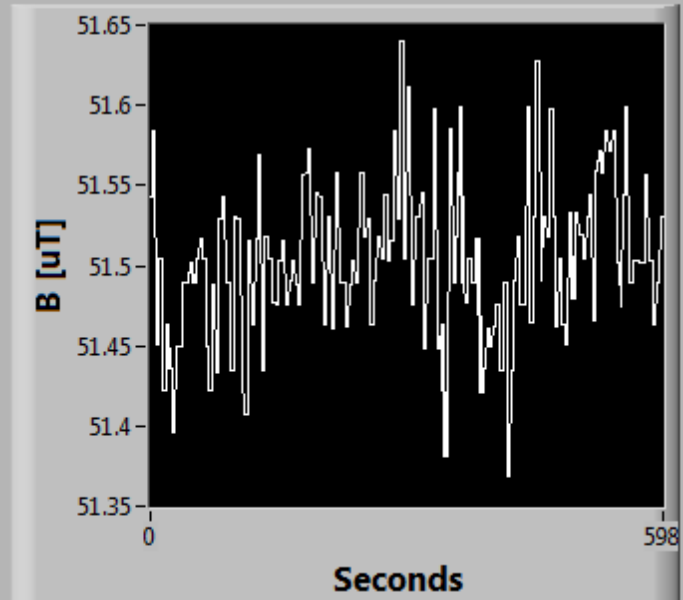
B [μT]

51.530

Bz [μT]

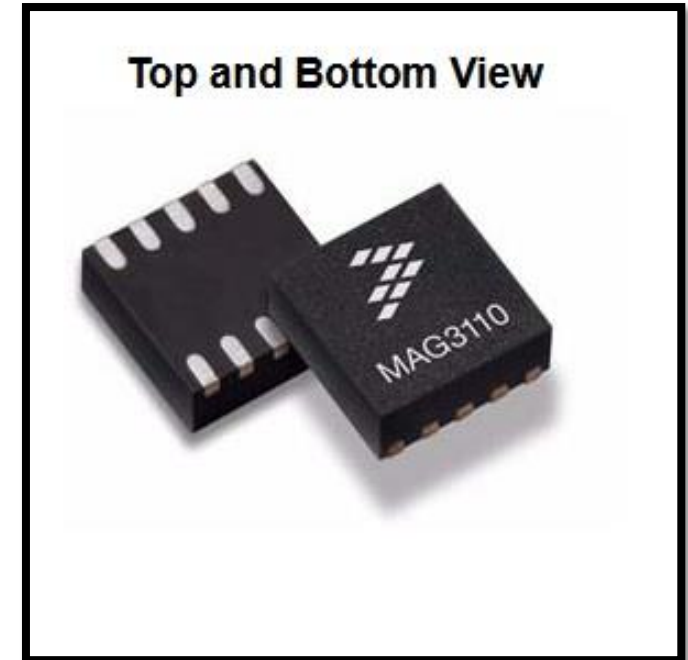


B [μT]

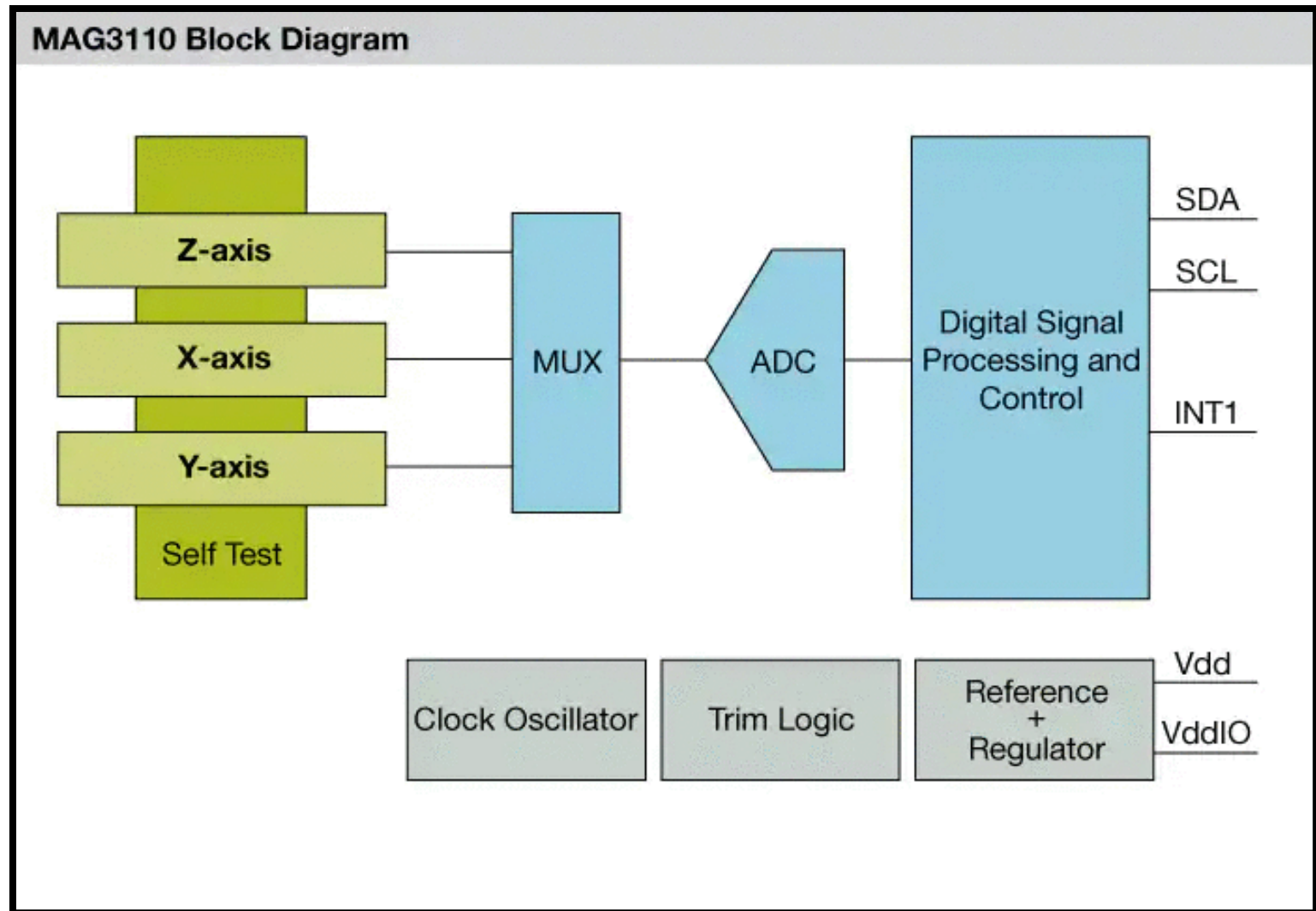


MAG 3110 magnetometer

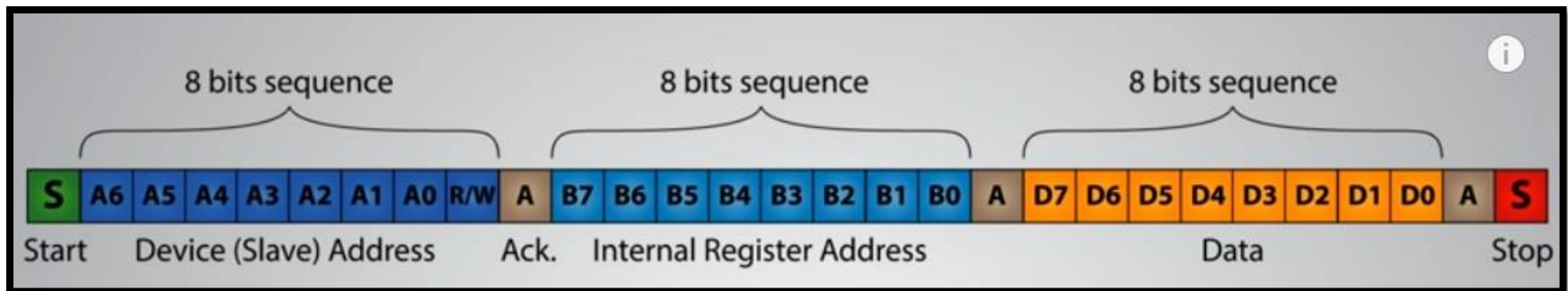
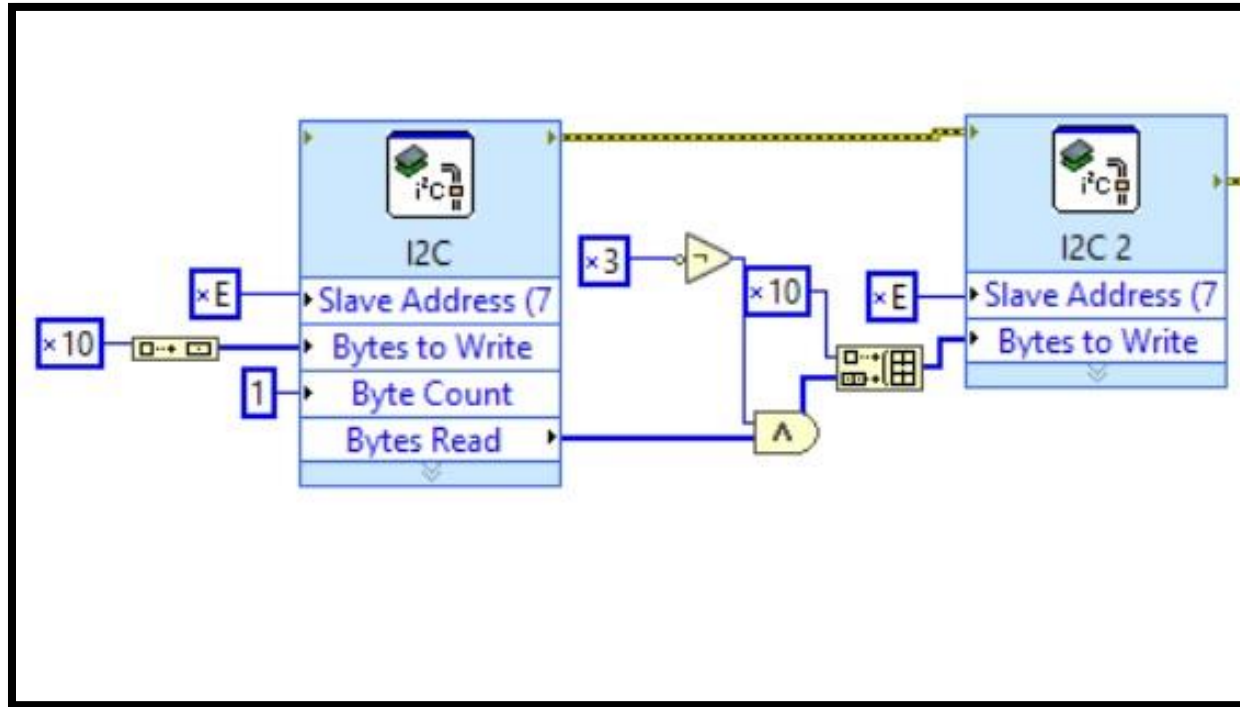
- standard I²C serial interface
- ODR (Output Data Rate) up to 80 Hz
- sensitivity of 0,10 μT
- 1,95 V to 3,6 V supply voltage (VDD)
- used in electronic compass
- low noise level (up to 0,14 μT)



MAG 3110 magnetometer



I²C (Inter-Integrated Circuit)

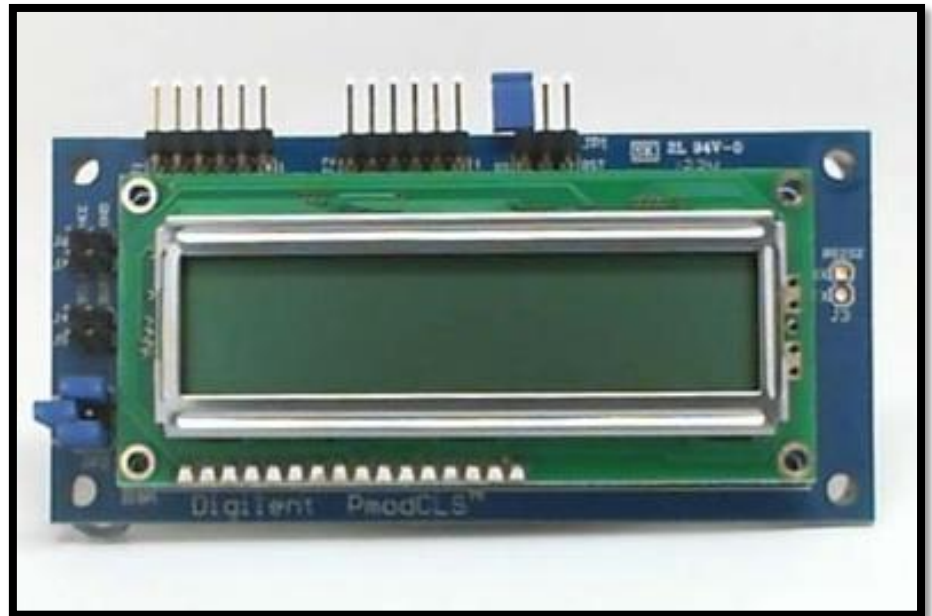




Tasks

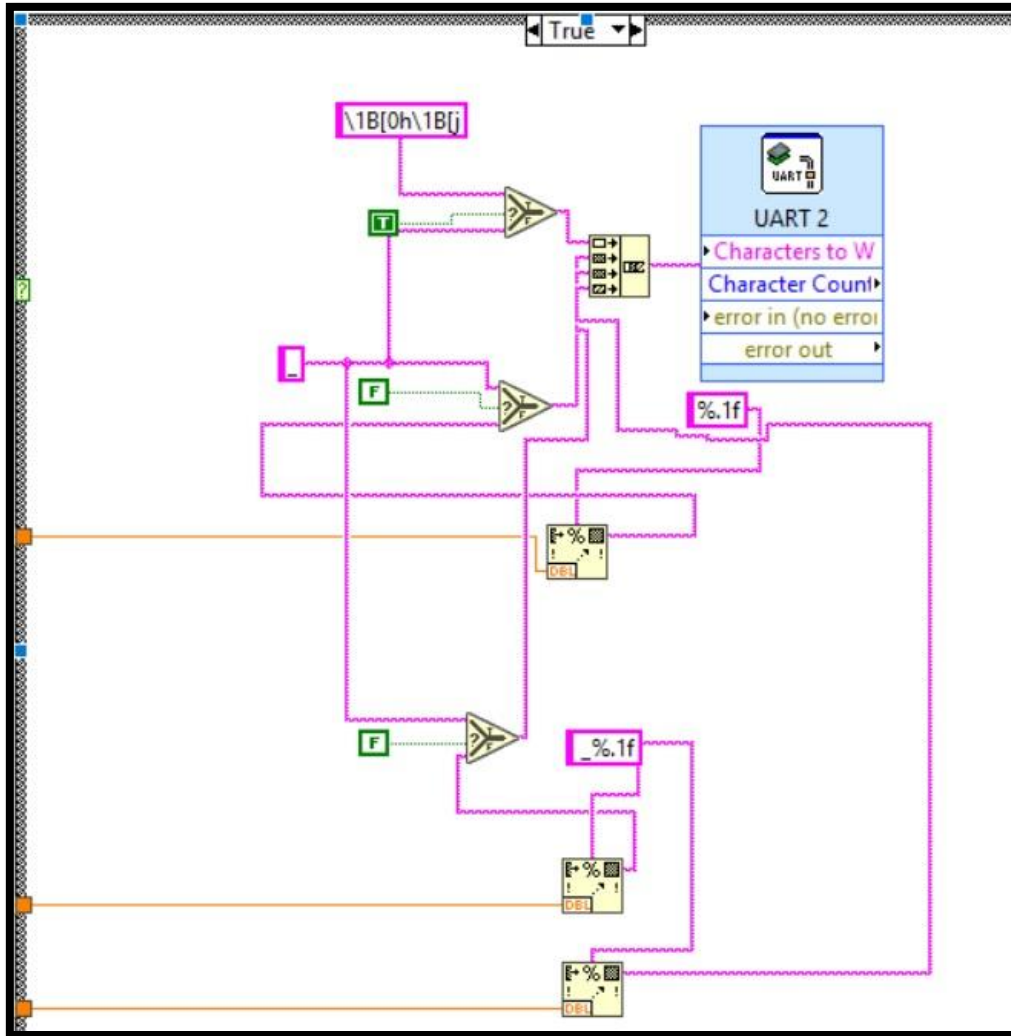
NI MyRIO LCD Display

- UART, SPI, I²C serial communications
- 2,7V to 5,5V voltage supply (VDC)
- 2×16 liquid crystal character display
- 2x40 character buffer



UART

(Universal Aynchronous Receiver-Transmitter)

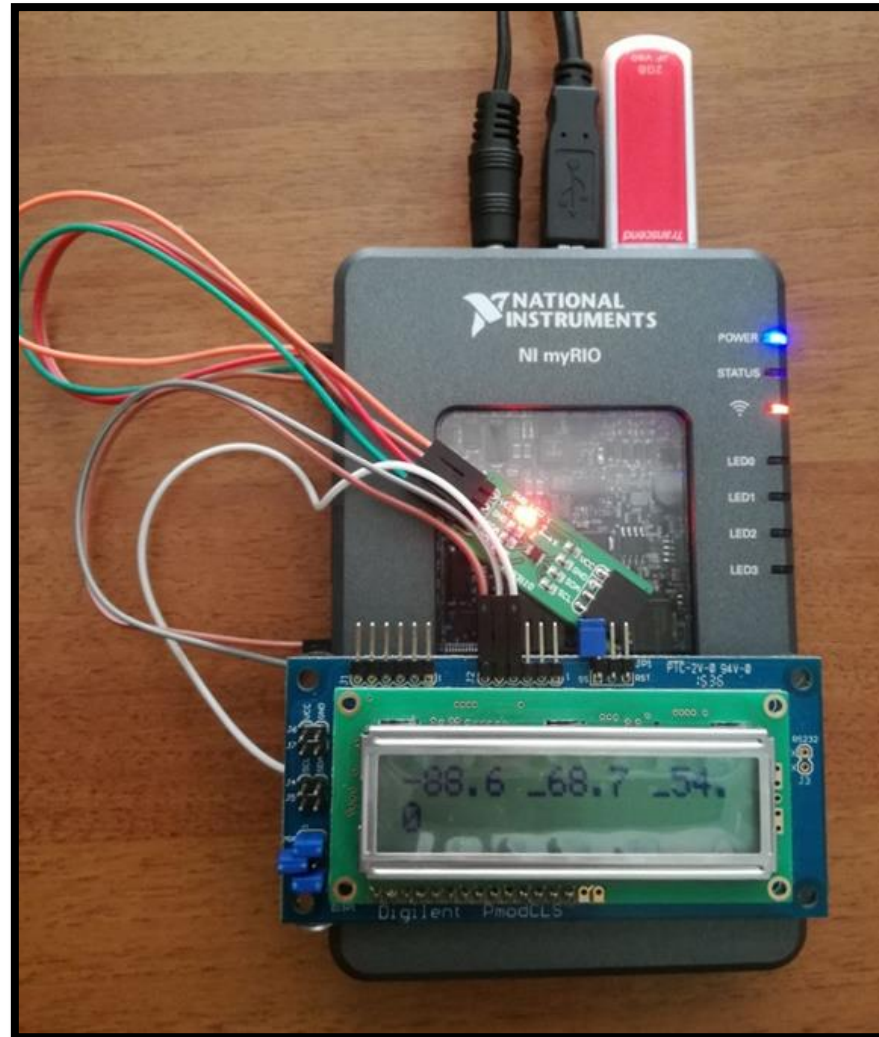


UART instructions

- \1B – ESC (0x1B hex)
- [0h – display mode (wrap at 16)
- [j – clear

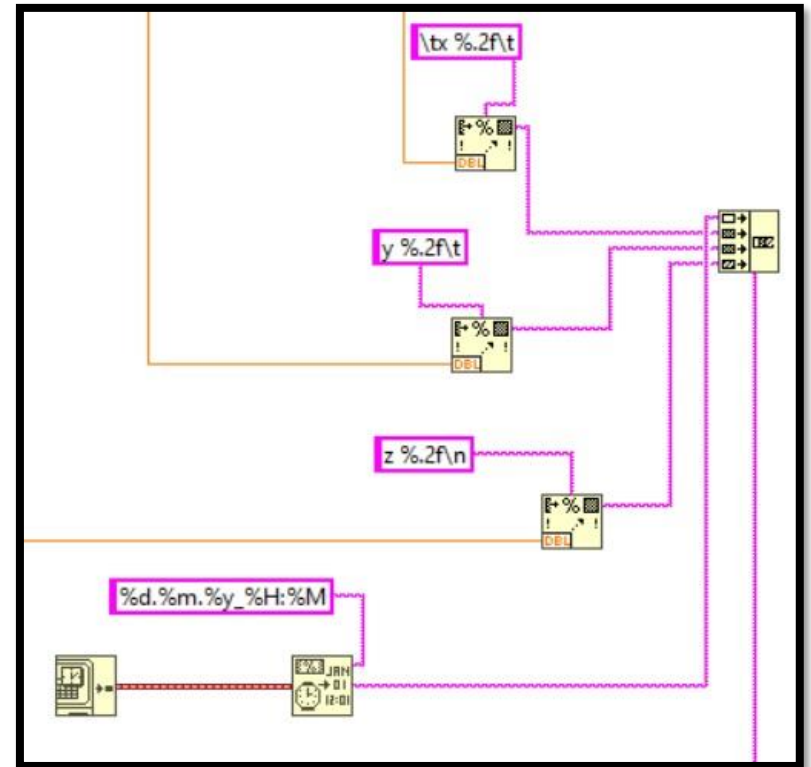
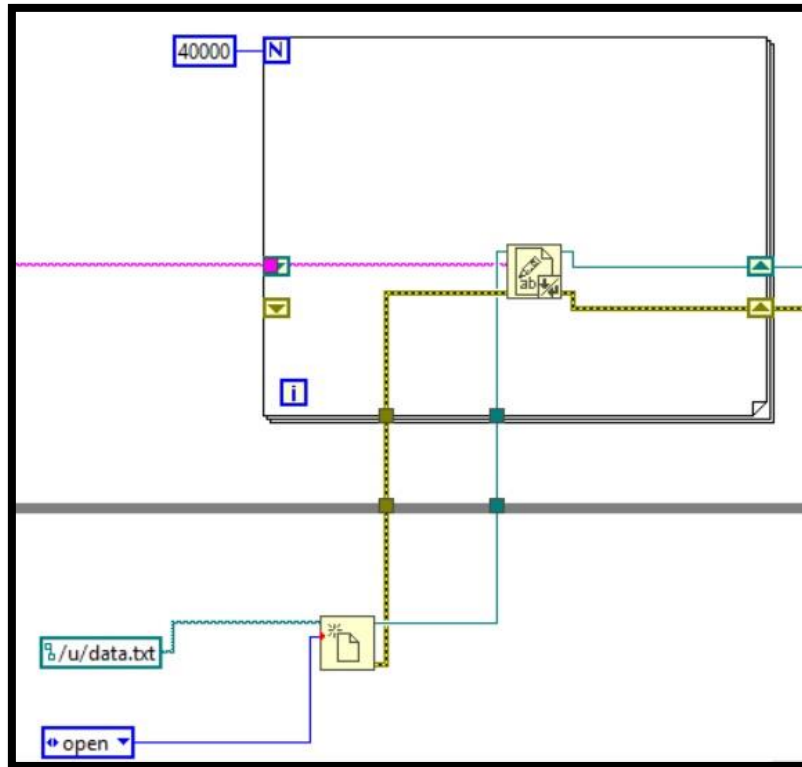
Each instruction shall be initialized with ESC (\1B)

Measurement system



Hanna Gałach Faculty of Physics WUT

USB log file



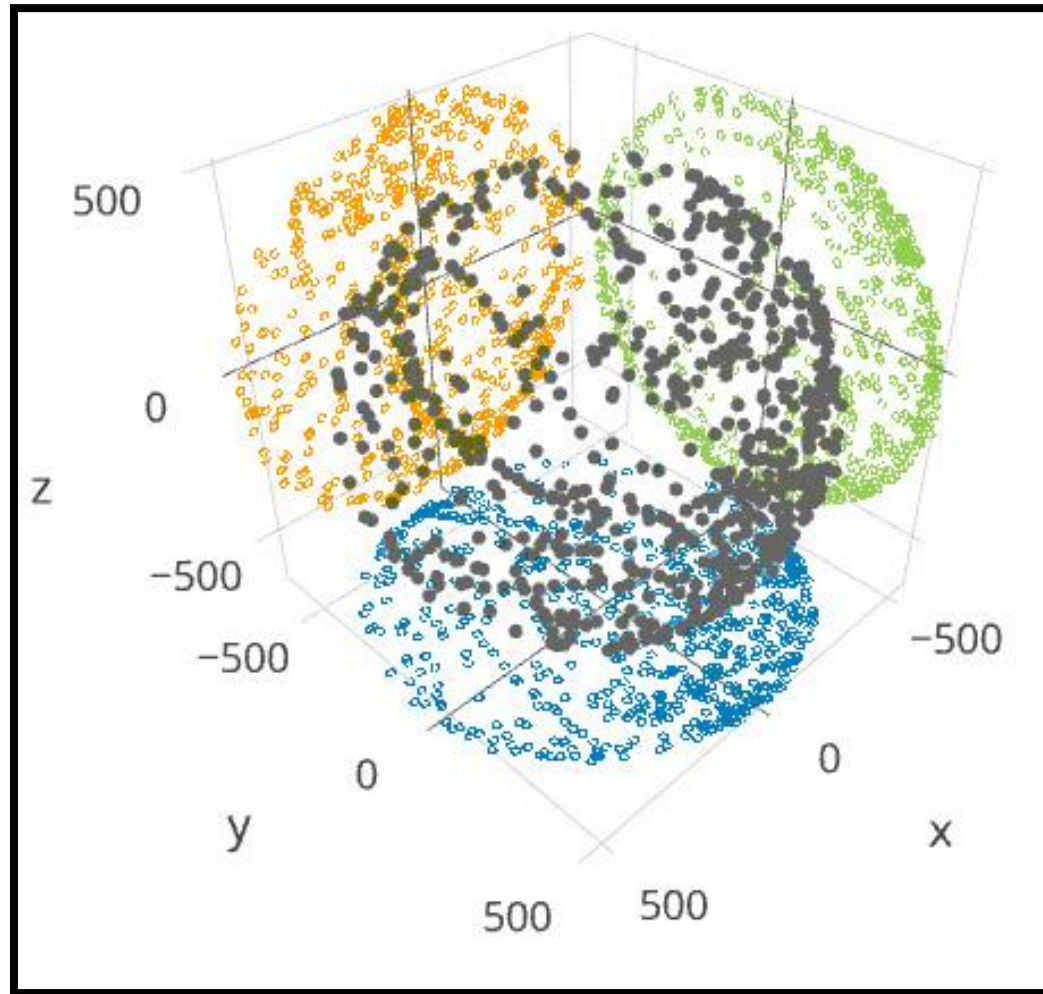
log file needs to be named data.txt

USB log file

Date and time	Bx [uT]	By[uT]	Bz[uT]	B[uT]
28.08.2019 10:28:14	0.0	78.6	53.97	134.358
28.08.2019 10:28:14	-94.9	78.7	53.97	134.552
28.08.2019 10:28:14	-94.9	78.9	53.97	134.682
28.08.2019 10:28:14	-94.9	78.9	53.97	134.727
28.08.2019 10:28:14	-94.8	78.7	53.97	134.548
28.08.2019 10:28:15	-94.6	78.8	53.97	134.406
28.08.2019 10:28:15	-94.8	78.7	53.97	134.488

Results in μT for x-axis, y-axis and z-axis

Calibration



[source](#)

Hanna Gałach Faculty of Physics WUT

Calibration

Magneto 1.2

Norm of Magnetic or Gravitational field:
(same units as the raw measurements)

Raw magnetic measurements (h) file:

Combined bias (b):

Correction for combined scale factors,
misalignments and soft iron (A^{-1}):

<input type="text" value="0.201606"/>	<input type="text" value="-0.000844"/>	<input type="text" value="-0.037686"/>
<input type="text" value="-0.000844"/>	<input type="text" value="3.005090"/>	<input type="text" value="-0.000169"/>
<input type="text" value="-0.037686"/>	<input type="text" value="-0.000169"/>	<input type="text" value="2.997852"/>

$$h_{cal} = A^{-1} \cdot (h - b)$$

Combined scale factors, misalignments
and soft iron (A):
(for comparison to MagCal)

<input type="text" value="4.971859"/>	<input type="text" value="0.001399"/>	<input type="text" value="0.062502"/>
<input type="text" value="0.001399"/>	<input type="text" value="0.332769"/>	<input type="text" value="0.000036"/>
<input type="text" value="0.062502"/>	<input type="text" value="0.000036"/>	<input type="text" value="0.334358"/>

From: www.sailboatinstruments.blogspot.com

Calibration

Copy and replace the combined bias values and combined scale factors in this sketchbook (check signs; by default, bias is subtracted from raw values):

Code: [Select]

```
Xm_off = compass.m.x*(100000.0/1100.0) - 8397.862881; //X-axis combined bias (Non calibrated data
Ym_off = compass.m.y*(100000.0/1100.0) - 3307.507492; //Y-axis combined bias (Default: subtractin
Zm_off = compass.m.z*(100000.0/980.0 ) + 2718.831179; //Z-axis combined bias

Xm_cal = 0.949393*Xm_off + 0.006185*Ym_off + 0.015063*Zm_off; //X-axis correction for combined sc
Ym_cal = 0.006185*Xm_off + 0.950124*Ym_off + 0.003084*Zm_off; //Y-axis correction for combined sc
Zm_cal = 0.015063*Xm_off + 0.003084*Ym_off + 0.880435*Zm_off; //Z-axis correction for combined sc
```

[source](#)

Summary and future plans

- Successful data logging and display
- Quicker solution
- Additional accelerometer in order to provide better accuracy
- A more accurate calibration should be performed
- Magnetometer for stronger fields
- Mounting the sensor to the X-scanner

Useful links

- <https://www.nxp.com/docs/en/data-sheet/MAG3110.pdf>
- <http://www.ni.com/pdf/manuals/376047c.pdf>
- https://thecavepearlproject.org/2015/05/22/calibrating-any-compass-or-accelerometer-for-arduino/?fbclid=IwAR0my3t_ICg1aFiwyQd4L46yb5Mb0Kj1z-UdrQ1_Xzd3Y05reKS6zpHu060



Thank you for your attention

e-mail: hpgal68@gmail.com