Setup of the heat transfer inside the TOF-MPD detector

Jakub Zdziebłowski, Krystian Idźkowski
Supervisor: MSc Krystian Rosłon

Faculty of Physics
Warsaw University of Technology

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Outline

1. Introduction
2. Hardware
3. Software
4. Problems
5. Results
MPD-TOF

Layout of front-end electronics

Preamplifier board
(ref. TOF MPD Collaboration JINR)

ref. nica.jinr.ru/projects/mpd.php
Sensors arrangement

A (1:4)

B (1:4)

C (1:4)

D (1:4)

ref. Engineering support group

Krystian Idźkowski, Jakub Zdziebłowski (zdzieblowski@opoczta.pl)
Setup of the heat transfer inside the TOF-MPD detector
Idea of multiplexing
Used equipment

- 2 LUMEL SM1 analog inputs modules,
- LUMEL PD10 RS485-USB converter,
- 4 8-channel relay modules,
- 32 Pt100 temperature sensors,
- NI myDAQ device;
LUMEL SM1

- Two multi-use channels (dedicated mode for Pt100),
- RS485 interface, MODBUS protocol in RTU or ASCII mode,
- Baud rate: 2400 - 115200 bit/s,
- Response time: 300ms (max),
- Temperature measuring range: $-200 \div +850^\circ C$,
- Measurement error: $\pm 0.2\%$ of range;

fot. www.lumel.com.pl
Relay modules

- 8 channels,
- Optocoupling,
- Relay model: JQC3F,
- Coil voltage: 5V (power requirement: 0.36W),
- Switch time: ≤ 10ms (according to datasheet),
- On-state resistance: 100mΩ;
Temperature sensors

Pt100 - RTD type platinum temperature sensor

- Class: B,
- Tolerance: \( \Delta t = 0.3 + 0.005t \),
- Measuring range: \(-50 \div +250^\circ C\),
- Nominal resistance: \(100\Omega\) at \(0^\circ C\);

Figure: Pt100
NI myDAQ

myDAQ Student Data Acquisition Device
(Used as 8 channel digital output)

Digital output parameters:

- 3.3V TTL logic,
- Total power: 500mW;

fot. National Instruments
Relay module schematic
Setup connections
RS485 connections
schematics and assembly
NI LabVIEW
Block diagram

START

switch on next relays → Delay → Measure (receive data from 4 Pt100’s) → Save to file (append new data to file)
Run panel

![Temperature (deg. C)](attachment:image)

<table>
<thead>
<tr>
<th>Temperature (deg. C)</th>
<th>24,43</th>
<th>23,94</th>
<th>22,54</th>
<th>23,73</th>
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Actual thermometers

Cycles passed: 42
Elapsed time (min.): 61,432
Service panel
Engineering panel

MULTIPLEXER:
- Sweep delay (ms)
  - 2000
- Number of samples written per channel
  - 1
- Lines
  - myDAQ1/port0/line0.7
- Line grouping
  - One channel for each line

MODBUS error out:
- Status
  - Code: 0
- Source

LUMEL:
- VISA Refnum in
  - COM3
- Serial type
  - RTU
- Parity
  - Odd
- Baud rate
  - 2400
- Unit_1 ID
  - 3
- Unit_1 starting address
  - 7503
- Unit_1 register values
  - 0
- Unit_2 ID
  - 5
- Unit_2 starting address
  - 7503
- Unit_2 register values

Calibration constant
- 0
Problems: 1. LUMEL transient state

Figure: measured temperature vs time
### Solution

applied actions:

- Adding delay after switching relays,
- Adding delay between single measurements;
Problems: 2. "frozen" temperature readings

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Solution

applied actions:

- Connecting cables’ shielding to ground,
- Rearranging wires in the installation,
- Slow down RS485 baud rate to 2400 bit/s;
Figure: example data
Results

Figure: three days measurement
Thanks for your attention
Pt100 tolerance

ref. www.lumel.com.pl
Type A evaluation of uncertainty

**arithmetic mean**

\[
\bar{x} = \frac{1}{n} \sum_{i=1}^{n} x_i
\]  
(1)

**standard deviation - \( u(\bar{x}) \)**

\[
u(x) = \sqrt{s_{\bar{x}}^2} = \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} (x_i - \bar{x})^2}
\]  
(2)
Type B evaluation of uncertainty

Type B standard uncertainty

\[ u(x) = \frac{\Delta x}{\sqrt{3}} = \sqrt{\frac{(\Delta x)^2}{3}} \quad (3) \]
Combined uncertainty

Combined (A+B) uncertainty

\[ u(x) = \sqrt{s_x^2 + \frac{\Delta x^2}{3}} \] (4)

ref: Joint Committee for Guides in Metrology Evaluation of measurement data — Guide to the expression of uncertainty in measurement. 2008.
"frozen" readings - continuation

![Graph showing standard deviation over time for Thermometer #11 and Thermometer #14.](image-url)