THE SINGLE CHANNEL DAQ MODULE DEVELOPED FOR DARK MATTER SEARCH EXPERIMENT USING SUPERHEATED LIQUID

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Overview

- Detection
- DAQ System
- Hardware
- Firmware
- Experiment & Results
- Future Plans
Detection of particle

Detector
SED (Superheated Emulsion Detector)
R-134a \( \text{C}_2\text{H}_2\text{F}_4 \) (tetrafluoroethane) \( \text{b. p.} \ - 26.3^0\text{C} \)
suspended in inactive polymerized gel

Sensor
Piezo-electric Transducer

Technique
Production of acoustic emission by SED due to the bubble nucleation

Detector response
Depends on the type and energy of particle
**DAQ System requirement**

**Gain**
Largely dependent on the sensor and its physical contact with detector (4K/3K/2K)

**Bandwidth**
Lower cut-off : 150 Hz
(Pow supp. ripples, Material handling vibration)
Higher cut-off : 100 kHz

**Sampling rate**
400 kSPS

**Data length**
25 ms (10,000 samples @ 400kSPS)

**No of channels**
One
DAQ System

- Sensor (Piezo)
- 2-stage Amplifier (A = 3000) + 2-stage bandpass filter
- ADC (12 bit) unipolar
- Line Driver
- DAC
- PSOC-5
Hardware

Op-Amp (*First Stage*)

**Device specs**

- **Bias Current**: 3 fA (FET based input)
- **Noise**: 6.5 nV/√Hz
- **Offset**: ±26 µV
- **GBW**: 17 MHz

- **Voltage Gain**: 54 (34.6dB)
- **Corr. BW**: 400kHz
Hardware

Op-Amp (Second Stage)

Device specs

Offset : ±150 µV (ADC LSB = 500 µV)

GBW : 20 MHz

Noise : 7 nV/√Hz

Voltage Gain : 54 (34.6dB)

Corr. BW : 350kHz

DC shift : +1V
(for using unipolar ADC as bipolar)
Hardware

Embedded System

- PSOC-5 (Programmable System-on-Chip)
- ARM based 32 bit system @ 90MHz
- 2 x 12 bit built-in ADC (1 MSPS)
- ADC with internal reference (100 ppm stability)
- Unipolar analog input (2V ≡ ± 1V)
Firmware

Acquisition in a circular queue

Buffer size : 10000
Trigger type : Level (20% above mid-level)
Pre-triggered data : 1200 (3 ms)
Post triggered data : 8800 (22 ms)
Final assembly
Detector and sensor
DAQ Setup
Noise
Signal
Signal

Amplitude (mV)

Frequency (Hz)

FFT
Conclusion

- The single channel DAQ system is performing well with Piezo sensor
- Different gains were tried to avoid amplifier saturation at different temperature
- Basic methodology of the main experiment, having higher number of sensors, was verified
- Dead time between events could not be minimised due to RAM size
Future plans

• A module is being developed with 10 analog channels
• Acquisition will be done using FPGA with time stamping to correlate the data from all channels for a particular event
• Dead time will be equal to the sampling interval (2µs @ 500kSPS)
• This instrument will be used at Jaduguda (JUSL) for the main experiment
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