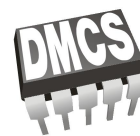




Politechnika Łódzka



Politechnika Łódzka

Wydział Elektrotechniki, Elektroniki, Informatyki i Automatyki Politechniki Łódzkiej

Praca Dyplomowa Magisterska Real Time Digital Pulse Processing from Radiation
Detectors Using Field Programmable Gate Arrays inż. Wojciech Mateusz Walewski Nr
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18 lipca 2022

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Abstract

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1 Introduction

1.1 Motivation

Concerns regarding the sustainability of using fossil fuels for energy generation have been raised as early as the 1970s [2]. One of the most well-known examples from that time was the 1972 report titled "Limits to Growth" by Meadows et. al. [3]. In it a group of MIT scientists attempted to answer the question of how long will the Earth's natural resources last for considering the seemingly neverending growth of human civilisation. As a result of a conducted computer simulation, a rough estimate of around 100 years was given as a timeframe, after which the population would start to collapse due to a lack of resources.

This estimate did not go without controversies back when it was first published. The methodology was thoroughly picked apart leading many to dismiss the study findings [2]. Naturally, nowadays, we are much better poised to verify the claims made by the now 50 year old book. The impending resource depletion has certainly been made a less valid claim as technological progress made it possible to locate and tap into previously inaccessible fossil fuel fields [5]. Taking into account other issues, however, the original timeline of 100 years might have actually shifted closer.

When it comes to fossil fuel usage, in the last twenty years, the primary concerns have changed from resource depletion to global warming and irreversible environmental damage [2]. In 2018 the Intergovernmental Panel on Climate Change (IPCC) published a report indicating the need to stop the global temperature increase at 1.5°C above the levels measurable in the pre-industrial era. Failure to do so is projected to lead to irreversible climate changes and in turn serious damage to human settlements around the world [1].

Fossil fuels account for as much as 70% of greenhouse gas emissions. Electricity generation alone causes 25-35% [4] of the total amount. Such a high share means that reducing this output is going to be crucial in meeting the goals outlined by the IPCC.

1.2 Fusion energy

1.3 Fission energy

1.4 ITER tokamak

1.5 Field Programmable Gate Arrays

1.6 Problem statement

2 Hard X-Ray spectroscopy

2.1 Runaway electrons

2.2 PhotoMultiplier Tubes

2.3 Preamplifiers

2.4 Analogue processing chains

2.5 Digital processing chains

3 System requirements

3.1 General requirements

3.2 ITER HXRM specification

4 Research setup

4.1 System overview

4.2 PMT

4.3 Preamplifier

4.4 Digitizer board

4.5 Host computer

4.6 Software package

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5.1 Level trigger

5.2 Boxcar filter

5.3 Trapezoidal filter

5.4 Triangular filter

5.5 Other solutions

5.6 Simulation performance

5.7 Hardware implementation

6 Pulse Height Analysis

6.1 Pulse shaping algorithms

6.2 Integration

6.3 Hardware implementation

7 Data transfer

7.1 PCIe interface

7.2 Direct memory access

7.3 Data pathways in the system

7.4 Multi-threaded data transfer

7.5 Software optimization

8 Conclusions

8.1 Further problems

8.2 Future research

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