

FPGA Spectrometer



AI Overview

FPGA spectrometers leverage field-programmable gate arrays to perform high-speed digital signal processing, enabling flexible, high-resolution, and broadband spectroscopic measurements.

Overview An FPGA spectrometer uses a field-programmable gate array (FPGA) as the core processing unit to handle tasks traditionally performed by analog or dedicated digital hardware. The FPGA manages pulse sequence control, digital signal acquisition, quadrature demodulation, filtering, and communication with a PC, allowing for highly customizable and precise spectroscopic measurements. These systems are often paired with peripheral boards for direct-digital synthesis (DDS), RF transmission, and USB communication.

Key Advantages

- High Bandwidth and Resolution:** Modern FPGA spectrometers, especially those using RFSoc chips, can achieve instantaneous bandwidths of several GHz with frequency resolutions in the kHz range.
- Time Efficiency:** FPGA-based designs can implement pipelined FFT algorithms that minimize memory usage and maximize real-time processing, achieving over 99% time efficiency.
- Flexibility:** Users can program the FPGA using hardware description languages like VHDL to create custom digital modules, making it suitable for experimental setups and rapid prototyping.
- Portability and Cost-Effectiveness:** Open-source FPGA spectrometers, such as OpenCore NMR, provide compact, laptop-sized systems at a fraction of the cost of commercial spectrometers.

Applications

- Nuclear Magnetic Resonance (NMR):** FPGA spectrometers control RF pulse sequences and perform digital demodulation for portable or laboratory NMR systems.
- Impedance Spectroscopy:** FPGAs process complex impedance signals in real-time, enabling fast, low-power, and portable measurements for biomedical and food quality applications.
- Remote Sensing and Space Instruments:** Broadband digital spectrometers using FPGA architectures are applied in planetary missions, hyperspectral sensing, and cryogenic detectors, offering reduced size, ma...

Article Content

Opencore NMR

Its key feature is that a single Field-Programmable Gate-Array (FPGA) chip does most digital jobs of the spectrometer. It allows building digital hardware modules,

Real-time signal processing in field programmable gate array based ...

Field programmable gate arrays (FPGAs) are attractive for a digital spectrometer due to its advantages of digital signal processing. However, how to improve the versatility of the

FPGA implementation of a real-time digital pulse processing analysis ...

A new universal, flexible firmware has been implemented on field-programmable gate array (FPGA) for gamma-ray spectroscopy. The firmware of the FPGA

An autonomous, highly portable NMR spectrometer based on a low

We have described an autonomous, highly-portable NMR spectrometer based on a low-cost SoC that integrates an FPGA fabric with an embedded ARM processor. The ability of the ARM

Design and experimental validation of a SoC-FPGA based

Download Citation | Design and experimental validation of a SoC-FPGA based compact NQR Spectrometer | Nuclear Quadrupolar Resonance (NQR) is a radio frequency spectroscopy

SoC-FPGA based compact NQR Spectrometer

The proposed spectrometer was successfully tested over the NQR frequency ranges by detecting the expected frequencies of several samples. Enhancement in sensitivity and new features were also

SpectraFlux: Harnessing the Flow of Multi-FPGA in Mass Spectrometry ...

The identification and quantification of proteins through mass spectrometry (MS) are foundational to proteomics, offering insights into biological systems and disease states. However,

Improving FPGA Based Impedance Spectroscopy

The typical FPGA-based impedance spectroscopy is composed of an FPGA, one Data Acquisition Converter (DAC), an analog front-end, sensor

Digital Spectrometer on an FPGA

This methodical approach provides a low-barrier entry into FPGA-based signal processing, helping users bridge the gap between algorithm design and hardware deployment with little need for direct...

OPENCORE NMR

Here, a kit for implementing the spectrometer inside FPGA is open to public. This kit, referred to as OPENCORE NMR, is composed of core modules such as pulse programmers, direct-digital

An FPGA-Based Spectroscopic Gas Sensing System Enhanced by

To address this issue, we develop a general detection framework for spectral signal analysis by implementing neural networks. The proposed architecture is extremely lightweight and suitable for

Linear CCD-Based Spectrometry Using Either an ASIC or FPGA

We report on the implementation of a FPGA-based ultra-violet (UV), infra-red (IR) visible (Vis) CCD spectrometer using a linear CCD detector operating at room temperature. The host

<PDF/22/aa2227-04.pdf.url>

We describe the technological concept and the first-light results of a 1024-channel spectrometer based on field programmable gate array (FPGA) hardware. This spectrometer is the prototype for the seven

Linear CCD-Based Spectrometry Using Either an ASIC or FPGA

We begin by discussing the design methodologies that might be considered when designing a spectrometer for scientific applications, such as wavelength resolvable imaging using a linear CCD.

basedNQRCompactSpectrometer HW/SWCo-DesignandtestofaSoC-FPGA

Fig. 4 Reference samples: lowest and highest frequencies of NaNO_2 (a and c respectively), HMT frequency (b), 1,3,5-TCB sensitivity comparison between a Bruker commercial spectrometer and the

In-house development of an FPGA-based MCA8K for gamma-ray spectrometer

The aim of this work is to study and develop a novel MCA8k for Gamma-ray spectrometer concerning experimental nuclear physics. An approach for design and construction of

Digital gamma-ray spectroscopy based on FPGA technology

In this paper, FPGA technology is applied in realization of a pulse processor for high counting rate gamma-ray spectroscopy with NaI (TI) detector. The pulse processor is linked to a

A fully digital coincidence Doppler broadening spectrometer based on

In this article, we implemented a fully digital Coincidence Doppler Broadening (CDB) spectrometer consisting of two HPGe detectors, a fully digital processing and acquisition board, and

OCTAD-S: Digital Fast Fourier Transform Spectrometers by FPGA

We have developed a digital fast Fourier transform (FFT) spectrometer made of an analog-to-digital converter (ADC) and a field-programmable gate array (FPGA). The base instrument

A 3Gigahertz Bandwidth FPGA Spectrometer

The spectrometer digitizer will be implemented using a pair of ADC083000 chips from National Semiconductor . Due to the inability of the logic within the Xilinx Virtex-5 (XC5VSX95T) FPGA to

<PDF/22/aa2227-04.pdf.url>

FPGA-spectrometers consume only a few W, so heat transfer via coolers is unnecessary. The low power consumption and compact size of FPGA-spectrometers are attributes that recommends this

On Design and Testing of a Spectrometer Based on An FPGA

The spectrometer is then used in two X-band electron spin resonance experiments, showing how the advantages of the system allow for superior results to that possible with the previous equipment. In

FPGA Based RF Pulse Generator for NQR/NMR Spectrometer

NQR/NMR spectrometer An NQR spectrometer for detection of nuclei ^{14}N has been designed constructed and tested using an FPGA module. It consists of four modules viz, Transmitter,

Design of high speed miniature spectrometer based on FPGA

In order to meet the demand for portable use of the spectrometer and improve the spectral acquisition rate, the driving circuit of the miniature fiber optic spectrometer was designed.

Contact Us

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