Project Proposal: FPGA-Based Digital Oscilloscope

# Project Title: Design and Implementation of a Digital Oscilloscope Using FPGA

**Introduction**

Modern electronic systems require accurate signal monitoring tools. A digital oscilloscope is essential for visualizing and analyzing time-varying signals. Traditional oscilloscopes are costly, while software-based tools often lack real-time performance. This project proposes the design and implementation of a compact, cost-effective digital oscilloscope using an FPGA.

**Problem Statement**

There is a need for a low-cost, customizable digital oscilloscope that can:

* Accurately sample and display analog signals.
* Operate in real-time using digital logic.
* Be portable and easily modifiable for different educational and debugging applications.

**Objectives**

* Design core oscilloscope modules using Verilog on an FPGA platform.
* Interface the system with an external ADC to capture analog signals.
* Implement trigger logic and data buffering.
* Transmit the data to a PC using UART.
* Document the entire process and create a short demonstration video.

**Methodology**

1. Literature Review & Requirement Analysis
   * Study existing oscilloscope architectures.
   * Finalize performance parameters (e.g., sampling rate, resolution).
2. FPGA Design and Development
   * Create Verilog modules for:
     + ADC interface
     + Trigger logic
     + Data buffer
     + UART communication
   * Simulate each module individually using ModelSim or similar tools.
3. Hardware Implementation
   * Use an FPGA development board.
   * Connect with an external ADC module.
   * Program the FPGA and validate performance.
4. Testing and Validation
   * Connect known input waveforms.
   * Capture data via UART and verify correctness.
5. Documentation and Dissemination
   * Create detailed documentation with schematics, code, and test cases.
   * Record and edit a demonstration video.
   * Upload the complete project to GitHub.

**Expected Outcome**

* A working digital oscilloscope on FPGA.
* Real-time signal sampling and transmission over UART.
* Modular, reusable Verilog codebase.
* Professional documentation and video demo.

**Tools and Resources Required**

* FPGA Development Board (e.g., Xilinx Artix-7 or Intel Cyclone IV)
* External ADC module (e.g., MCP3008)
* Simulation tools: ModelSim / Vivado Simulator
* Serial terminal software (e.g., PuTTY, TeraTerm)
* Oscilloscope/function generator for signal testing

**Timeline**

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**Conclusion**

This project will provide hands-on experience with FPGA-based digital systems, while solving a practical need for signal analysis in embedded and electronics projects. With its modularity, this oscilloscope design can serve as a foundation for future enhancements like display outputs or multi-channel sampling.

**References**

* Xilinx and Intel FPGA documentation
* Verilog HDL guides
* Academic papers on digital signal processing on FPGA