EENG490, Capstone:

Integrated Oscilloscope/Logic Analyzer/Signal Generator

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Student Report

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2.1 Introduction

In engineering laboratories and industrial settings, electrical engineers make use of a wide variety of test equipment. The large number of devices becomes difficult to manage on a desktop, especially in a University setting where twenty or more stations need to fit into a single room. We will construct a product that is able to cover all of the common test-equipment and lab needs for electrical engineering education with a single device that is still capable enough to fit into industrial use.

2.2 Motivation

Often, a proper electrical engineering workstation would need many devices: Bench power supplies, digital multimeters, signal generators, an LCR meter, logic analyzers, and oscilloscopes are the most common pieces of equipment...

2.3 Constraints

- Time
- Money
- Part Availability

2.4 Schedule

Oh Fuck. We've used half our time.

2.4.1 Gantt Chart

2.5 Costs

It will cost Jeremy way more than he wants to admit.

2.6 Deliverables

It'll make you breakfast and run your feet.

2.7 Conclusion

This thing will kick ass.

3 Team Organization

3.1 Background

3.1.1 Jeremy Munson

PCB Design Experience

3.1.2 Bryant

Programming Internship

3.1.3 Braeden

3.2 Responsibilities

3.2.1 Jeremy Munson

- PCB Design
- FPGA Programming
- Assembly
- Part Ordering

3.2.2 Braeden

- Power Supplies
- Breaboard pin function selection
- Embedded Programming

3.2.3 Bryant

- EZ USB
- User Space Software
- Embedded programming

4 Initial Research

4.1 Project Feasibility

Wanting a product to exist is all well and good, but if we don't consider the many moving parts needed to build a working product then we could be left with nothing but a dream, and no substance.

4.1.1 Oscilloscope

The oscilloscope really is the center-piece of the design. Preliminary research shows than often, oscilloscope manufacturers resort to ASIC[1] silicon for the Analog-to-digital conversion components. Since we don't have the millions of dollars and years of engineer time to design an ASIC, we will need to find a readily available chip that can perform the ADC conversions at an acceptable rate for an oscilloscope.

Jeremy spent many hours scouring over part catalogs, looking for a suitable chip that is cost-effective. Fortunately, a line of chips ... HMCAD

4.2 Similar Products

There are several products on the market that attempt to address the same goal, but they each fall short in one or more ways.

4.2.1 NI Instruments Elvis III

- Costs over $3000
- Oscilloscope updates at 0.5hz
- 50-ohm signal generator, but incapable of driving 50-ohm terminated load
- Slow Interface
- 20 second DMM settling time

5 Project Overview

5.1 Design Criteria

yep.

5.2 Overview

5.3 Architecture Block Diagram

Figure (1) is referenced here, as an example.

[1] Application Specific Integrated Circuit

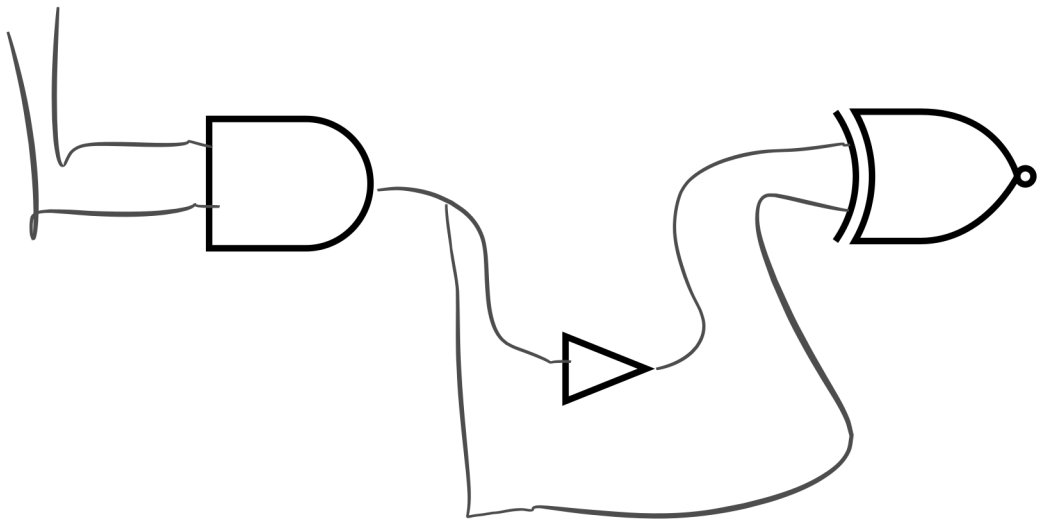

Figure 1: Block diagram showing high-level design

5.4 Interfaces

5.4.1 USB

5.4.2 Parallel

5.4.3 QSPI

6 Research of Proposed Solutions

6.1 Gsps ADC: HMCAD2011

The core of the oscilloscope design, the Analog To Digital converter takes the analog voltages that we want to measure.

6.2 Signal Generator

An unlikely source of capable signal generator chips: Display drivers! There are numberous triple-channel DAC chips that are intended to drive displays at a low(ish) cost. We can re-purpose one of these display driver chips as a three-channel signal generator, instead of a 3-color pixel control.

6.3 USB 3.2 Gen 1 Interface

The all-important interface than allows data to be delivered to a computer to be analyzed: the USB 3 interface. EZ USB...

6.4 Artix-7 FPGA

The glue that brings everything together. No other (feasible) device would be capable of aggregating the veritable firehose of data that we will be collecting. The FPGA forms the center of our design.

6.5 STM32, Providing ADC and DAC for logic analyzer

STM32G474RE Has n ADC and M DAC Capable of k Samples...

6.6 Power Supply

There are multiple aspects to the power supply: Power from the wall, then powr to the devices.

6.7 Bread Board Unit

While test equipment often has BNC connectors, or test leads, or banana plug jacks to connect wires to your project, we would like to take a different approach. We want to have a breadboard that can be switched onto all of the possible connections at each pin in software. This lets up place components down on a breadboard, use jumper wires to form the connections, then apply a stimulus with the signal generator or power rail functionality using software. This allows exploring a wide variety of stimuli quickly. Since every pin will also be an analog logic analyzer channel we will be able to visualize the operation of the entire circuit at once.