Oscilloscope
Project Proposal

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CSEE E4840 Embedded System Design
Columbia university

Feature Wish List

Feature	Description
Input	The oscilloscope will take in voltage input from a signal generator or a circuit
Output	The oscilloscope will display the signal on a screen. The display will have grids
Scale	Adjust time division and voltage division to obtain a visible signal
Cursor	Move cursors horizontally and vertically to take data at any given point
Measurements	Measure values such as peak-to-peak voltage, amplitude, frequency, period
MIMO	The oscilloscope will display multiple signals with multiple inputs
GUI	A GUI will be used to take user inputs to adjust screen settings, time and voltage divisions, and trace colors

Description: What and Why

What

- Our objective is to implement a digital oscilloscope using our Intel Cyclone V SoC FPGA. This FPGA has two analog-to-digital converters and a 10-pin analog input. The two A/D converters are ADI AD9254 devices which are made for high speed and high-performance applications. The device can provide 14-bit accuracy at 150 MSPS data rate. This powerful analog-to-digital converter thus provides us with a strong hardware platform to implement the digital oscilloscope. We plan to operate on the data using FPGA logic and draw waveforms on a monitor through the VGA port.

Why

- Oscilloscopes are invaluable for planning or repairing electronic equipment.
- Oscilloscopes are very valuable and widely used by people globally--from TV repair professionals to physics researchers.

Description

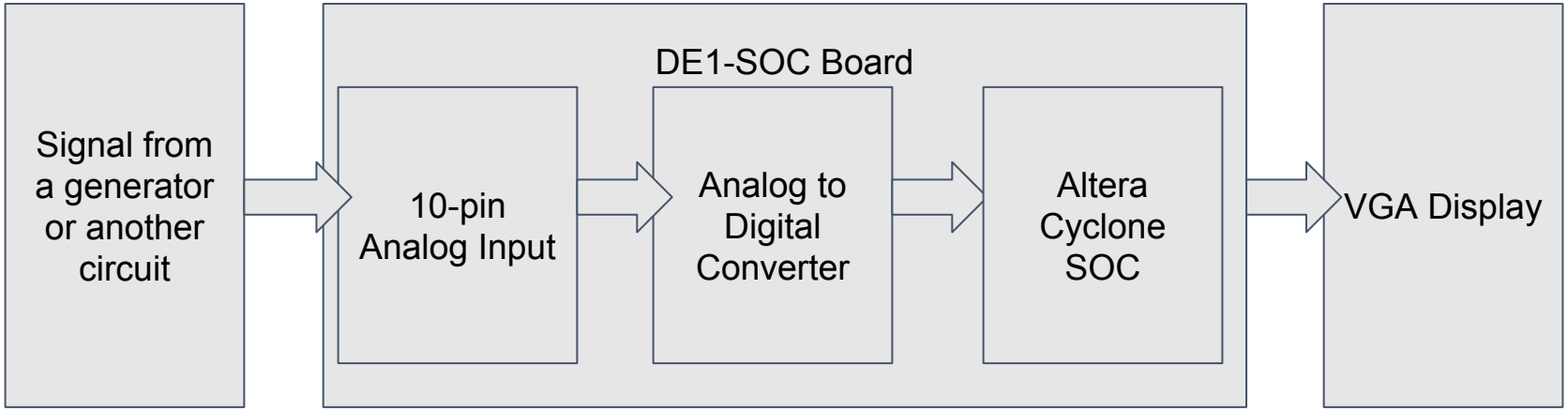
How

We are going to build an oscilloscope by hooking up an ADC and an FPGA together. We will be using the FPGA to model various mathematical functions and display them using various waveforms. Our goal is to hopefully be able to navigate between two to three different functions and their corresponding waveforms.

- FPGA
- ADC
- Signal Generator

We will be creating a GUI to display these waveforms. Ideally, the GUI will also contain some buttons that symbolize some basic functions of the oscilloscope.

Block Diagram



Feasibility Study (Risks)

- **The project can be divided into two parts:**
  1. HDL design (create the oscilloscope logic inside the FPGA): FIFO-based design, RAM-based design, Trigger mechanism, more functionality can be added. and,
  2. Oscilloscope hardware device.

- **These two parts should be carried out simultaneously.**

- **The Challenging part and Problems to be solved:**
- **The software part:** will it run successfully?
- **Visualization of oscilloscope**
- **The hardware part:** Which kind of chips to purchase? (Pluto I or II, and other materials.) Will Prof. Edwards provide us the materials or money(around 100$)?

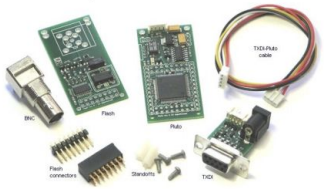
Components/Resources and Budget

Bill of materials
2019/2/22

A simple digital oscilloscope recipe
Using parts from KNJN.com, here are the basic items of our recipe.

- 1 x Pluto FPGA board, with TXDI and cable (item#6120 and #6130 = $36.90)
- 1 x Flash 100MHz acquisition board (item#1206 = $39.95)
- BNC connector + nylon standoffs + connectors 2x8 (item#1250 + #1270 + #1275 = $10.85)

Here's how they look.



We also need the following (these are common items, hopefully available in many people's lab).

- A small DC adapter 5V to 9V, 100mA or more.
- An RS-232 extension cable.
- A little screwdriver.
- And of course, an oscilloscope probe.

(Shopping website: KNJN.com)

1. Flashy acquisition board

1.1 flash/flashy?

Flash analog acquisition board

- One channel

Item#1205 (Flash/ADC08060 @60MHz)	+1 -1	($34.95)
Item#1206 (Flash/ADC08100 @100MHz)	Out of stock	($44.95)
Item#1207 (Flash/ADC08200 @125-133MHz)	+1 -1	($59.95)

Flashy analog acquisition board

- One channel
- V-pos, V-range and period output

Item#1225 (Flashy/ADC08060 @60MHz)	Out of stock	($54.95)
Item#1226 (Flashy/ADC08100 @100MHz)	+1 -1	($64.95)
Item#1227 (Flashy/ADC08200 @125-133MHz)	+1 -1	($89.95)

1.2 Pluto II

Pluto FPGA boards

Item#6120 (Pluto EP1K10)	+1 -1	($29.95)
Item#6122 (Pluto-II EP1C3)	+1 -1	($49.95)
Item#6110 (Pluto-IIx XC3S50)	+1 -1	($49.95)
Item#6111 (Pluto-IIx XC3S200)	+1 -1	($59.95)
Item#6112 (Pluto-IIx XC3S200 HDMI)	+1 -1	($59.95)
Item#6117 (Pluto-IIx XC3S200 HDMI) (pre-programmed with GCVideo 2.4b for Gamecube)	+1 -1	($59.95)
Item#6118 (Pluto-IIx XC3S200 HDMI) (pre-programmed with GCVideo 2.4b for Wii)	+1 -1	($59.95)
Item#6119 (100Ω resistor)	+1 -1	($0.01)
Item#6124 (Pluto-3 EP2C5)	+1 -1	($79.95)
Item#6128 (Pluto-3 EP2C8)	+1 -1	($129.95)

Possible improvements

1. Use a Pluto-II instead of a Pluto (Pluto-II has a boot-PROM so can be active at power-up, and the bigger FPGA allows more features in the oscilloscope).
2. a Pluto-3 and a FlashyD can get a two channels oscilloscope.
3. A different Flashy revision - for example rev. K allows precise frequency measurements and equivalent-time sampling.
4. Make the oscilloscope USB-based (see here) or use a Saxo or Xylo board instead of a Pluto (which are natively USB controlled/USB-powered, and support FlashyD = two channels).
5. Another possibility is to add an LCD (like KNJN item#5300) but don't use a Pluto FPGA board in this case (it wouldn't work because its FPGA is too small to drive the LCD while the oscilloscope is running).

Link to Doc

Milestones and Timeline

Milestone	Description
0	**HDL design (create the oscilloscope logic inside the FPGA):** FIFO-based design, RAM-based design, Trigger mechanism, more functionality can be added.
1	**Making an oscilloscope hardware device.** • This design was created using the Flashy boards. • See also the "hands-on" page on how to build a simple oscilloscope.
2	**Test oscilloscope for proper functionality**

References

1. https://www.fpga4fun.com/digitalscope.html
2. http://yyao.ca/projects/oscilloscope/
3. http://www.signalintegrity.com/Pubs/straight/probes.htm
   https://people.ece.cornell.edu/land/courses/eceprojectsland/STUDENTPROJ/2015to2016/hj424/hj424_report_201605191237.pdf
4. https://www.fpga4fun.com/Hands-on_Flashy.html
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6. http://www.academia.edu/32402650/An_FPGA_Implementation_of_a_Digital_Storage_Oscilloscope
7. https://download.atlantis-press.com/article/25865730.pdf