DIGITAL OSCILLOSCOPE

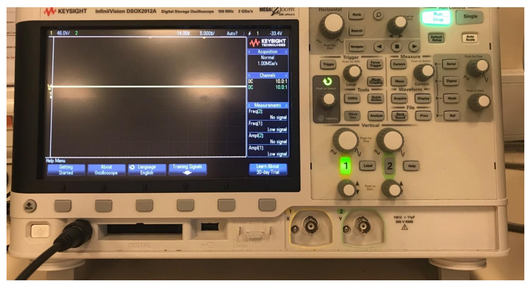
▶ STUDENTS / UNIVERSITIES

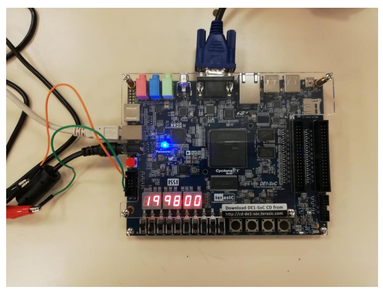
Cemal Baran Erdoğan/Sabancı Üniversitesi
Hamza Murat Yılmaz/Sabancı Üniversitesi

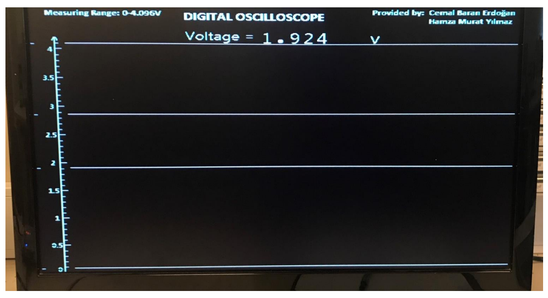
▶ SUPERVISOR(S)

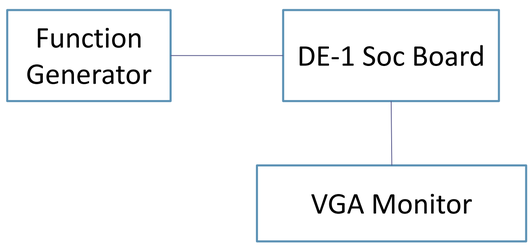
Yaşar Gürbüz
Melik Yazıcı
Ömer Ceylan

ABSTRACT









- Building a digital oscilloscope using Alter DE1-SoC board is the motivation of our project.
- The difference from any oscilloscope used in labs:
  - ✓ Cheaper
  - ✓ Easier to use
- Disadvantage: Less functionality
- **Main concepts to manage this aims:**

➢ FPGA Technology(Field Programmable Gate Array): Kind of devices that have programmable logic blocks and interconnection circuits. It is programmed using Verilog language during our project.

➢ DE1-SOC board: This board was chosen because it includes all hardware modules required for this project.

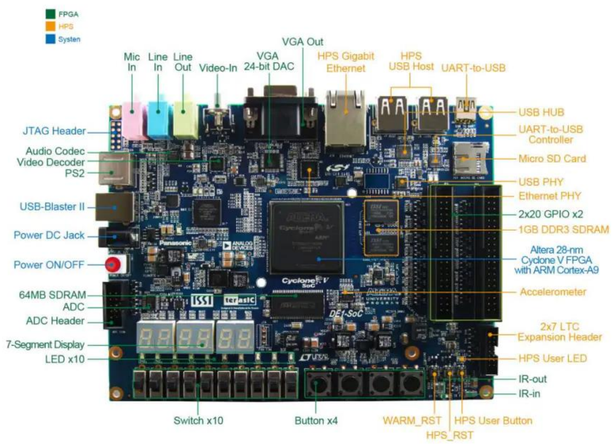
- ✓ 12-bit 500Ksps ADC converter LTC2308: To sample analog signal (our input)
- ✓ 85K programmable logic elements: Very helpful to store and process informations coming from ADC converter

➢ VGA DAC (8-bit high-speed triple DACs) with VGA-out connector

➢ 10 slide switches: To make some adjustments and control digital oscilloscope

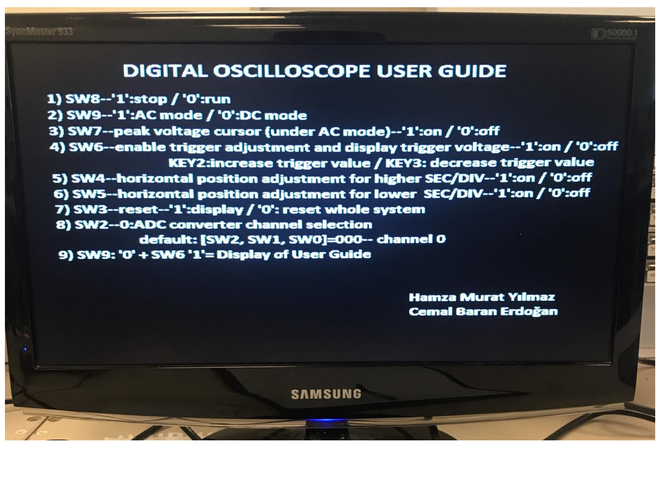
➢ 4 push buttons: To make some adjustments and control digital oscilloscope

HARDWARE PART OF THE PROJECT(DE1-SOC BOARD)



- ✓ Cyclone V FPGA [3]
- ✓ ADC header
- ✓ ADC
- ✓ 64MB SDRAM
- ✓ 7-segment display
- ✓ VGA 24-bit DAC
- ✓ VGA out
- ✓ LED x 10
- ✓ Switch x 10
- ✓ Button x 4

THE GUIDE FOR USERS



It is the guide that we prepared to allow users to use digital oscilloscope easily.

OUR METHOD

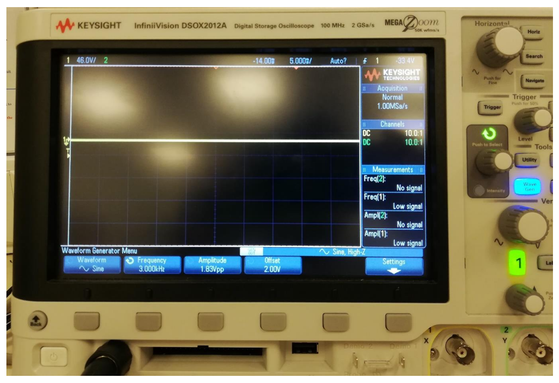
1) **Signal Generator**: An analog signal was taken by 2*5 pin header of our board.

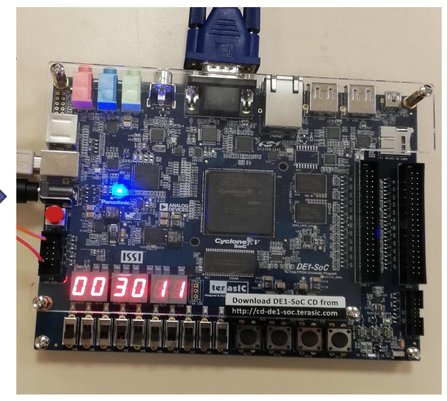
2) **Sampling of the Signal**: 500Ksps, 8-channel, 12-bit ADC module of the board was used to convert analog input to a digital signal[3] . Its internal conversion clock allowed us to operate at the frequency up to 40MHz. Additionally. Some adjustments were made on QSYS module to allow this part to work properly [1]. In order to test ADC value seven segment LEDs were applied by creating a module to transfers binary value to decimal value.

3) **.Data Storage and Processing**: After true DC value could be observed at seven segment LEDs, ADC values were stored into FPGA register arrays.

4) **VGA signal generation**: This is the part that we draw the waveform on the monitor. Timing specifications were provided through 25MHz Pixel clock. Then, some static notes were wrote using «Paint» and bmp files were converted to mif files which can be directly used in the project through Matlab. Furthermore, functions like trigger and horizontal position adjustment which relate to basic display strategies were prepared on this part[1] .

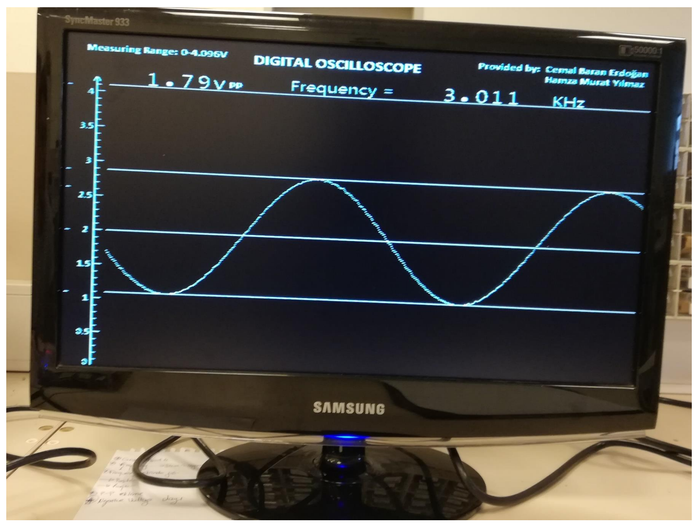
5) **Video DAC**: After all this process was completed succesefully, DAC port on DE1-Soc board was used and so that waveforms of signals, parameters and some notes were displayed on monitor.





The signal that we gave our design as an input.

Frequency value of the signal is displayed on seven-segment LEDs also.



Shape of the waveform, frequency and peak to peak values of the AC signal are available on the screen.

CONCLUSION

- We could implement a digital oscilloscope which has:

➢ ability to display voltage between 0-4.096V (ADC converter has 12-bit values).

➢ quite low errors (under %1) at DC mode.

➢ quite low errors(under %1) for low frequencies (under 10kHz) on AC mode.

➢ errors around %2-3 for high frequencies, which cannot be ignored.

bec: sample rate of ADC converter is limited.

- As a result; the project was successful in achieving the desired functionality but it has some limitations about performance.

OUR GAINS

Technical

- Ability to control DE1-SOC board
- Understanding the logic of FPGA
- Hardware designing via Verilog

Other

- Research techniques
- Time management
- Problem solution
- Team-work ability

REFERENCES

1)Jin, H. (n.d.). Digital Scope Implemented on Altera DE1-SoC. Retrieved from https://people.ece.cornell.edu/land/courses/eceprojectsland/STUDENTPROJ/2015to2016

2)Adam Walter, Hart. (n.d.). Digital Oscilloscope and High Speed Analog Conversion Card For The
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3)DE1-SoC_v.5.1.3_HWrevF.revG_SystemCD.zip (n.d.). Retrieved from http://download.terasic.com/downloads/cd-rom/de1-soc/