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PROJECT BACKGROUND

Outside factors like thermal, electrical, and mechanical noise disrupt the output wavelength of semiconductor lasers. This is normally corrected with dedicated hardware, but we are designing something cheaper and more modular.

Thorlabs
Infrared
Laser
Detector
Card
with
laser
active



OBJECTIVE

To explore the implementation of modular and extendable data acquisition and control for laser systems using low end, off the shelf FPGA boards.

WHAT IS AN FPGA?

A field-programmable gate array (FPGA) is a reconfigurable integrated circuit designed to be programmed to implement various logic and digital systems.

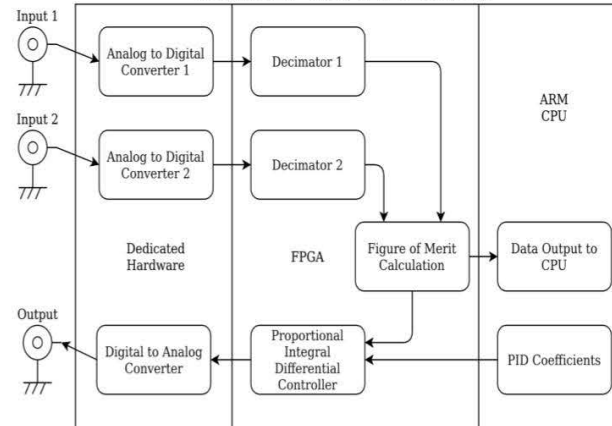
KEY REQUIREMENTS

- ❖ Be able to gather accurate data from the provided Pound-Drever-Hall laser instrument
- ❖ Be able to send acquired data from the FPGA to an external computer
- ❖ Be able to control the laser with a PID Control Loop
- ❖ Use low-cost boards
- ❖ Sampling speed of 5-10 MHz
- ❖ Solution must be modular and scalable

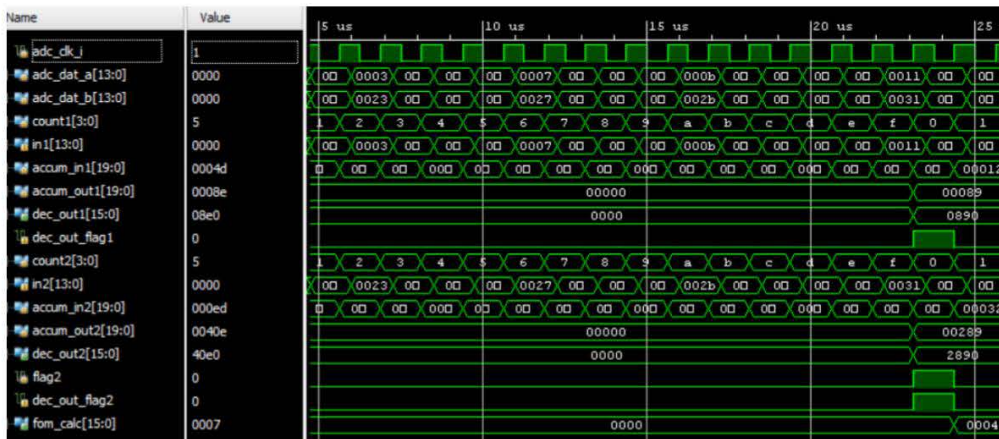
CONCEPTUAL DESIGN EXPLANATION

- ❖ Red Pitaya takes its input from the two Fast Analog Inputs
- ❖ Input values are accumulated and divided by 4 to decimate the values to receive 16 bits of resolution
- ❖ The two decimated inputs are divided by each other to calculate the Figure of Merit (FOM)
- ❖ FOM value goes into a PID Loop to calculate error of signal
- ❖ Sends output signal from PID to correct the laser.

CONCEPTUAL DESIGN

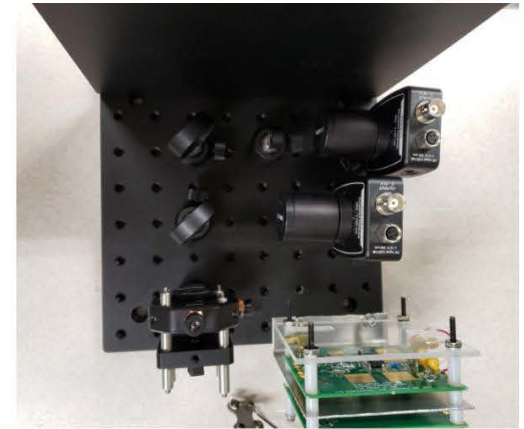


HARDWARE IMPLEMENTATION VALIDATION



EXPLANATION

- ❖ Demonstrates 2 values coming into Red Pitaya
- ❖ Demonstrates the accumulation of 16 samples
- ❖ Shows final decimated value for each
- ❖ When decimator out flag is set, calculates Figure of Merit
- ❖ Shows FOM calculation of decimated input 2 divided by decimated input 1



Pound-Drever-Hall Instrumentation Hardware (Courtesy of Thorlabs)

POUND-DREVER-HALL LOOP

Pound-Drever-Hall loops are a method of sampling a laser to determine how close the beam is to the desired wavelength. This signal is fed into a Proportional-Integral-Differential (PID) controller to drive a correction signal to the laser's power supply.

CONCLUSION

- ❖ Chosen board (Red Pitaya Stemlab 125-14) is less than \$300
- ❖ Final sampling speed is 7.8125 MHz
- ❖ Accurate data acquired and transmitted to an external computer
- ❖ Chosen solution scales with multiple boards because each board processes all of its own data

FUTURE WORK

- ❖ Implement Pound-Drever-Hall Control Loop
- ❖ Synchronize multiple Red Pitaya boards to a single clock source
- ❖ Implement a GPS time source