Optical Beam Position Monitor

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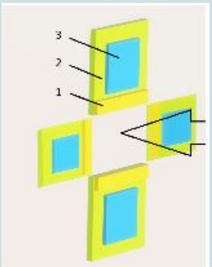
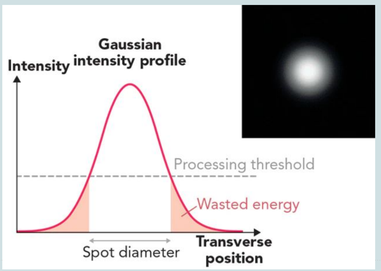
Abstract

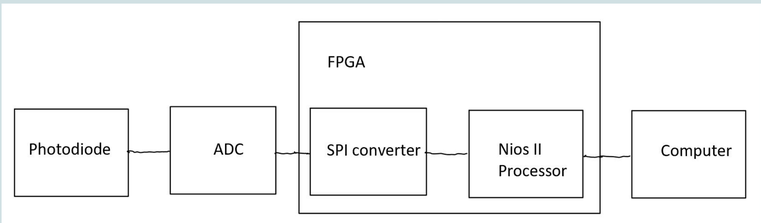
The objective is to design a system that will monitor the position of the beam by measuring the corners of the beam and using properties of a Gaussian beam. Lasers are used to measure with the highest spatial, temporal resolution. BPM uses photodiodes positioned to intercept the halo of the laser beam.





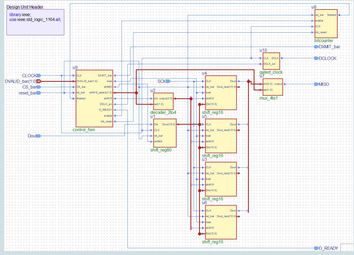
Introduction

Our goal is to design a system that make IC SPI to FPGA data acquisition with at least 1KHz sampling rate and 16-bit resolution. In order to probe high power closer to the beam center, the system should capable of operation with large input current, and small number of pixels. 4 photodiodes will be used, 1 for each corner.



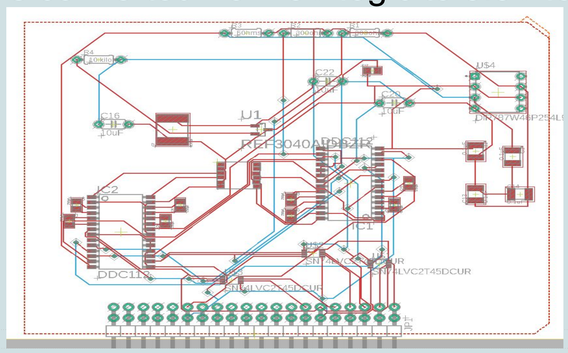
DDC112 to SPI Converter

The chosen ADC, the DDC112, does not have a standard serial protocol. A converter was designed to change the DDC112 output to SPI protocol output.



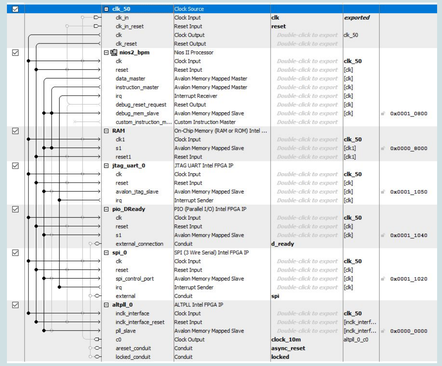
4 Layer PCB Design

A 4 layer PCB was designed to improve signal strength. The photodiode array sits in the middle of the PCB and outputs to the DDC112 chips. The output is converted from 5V logic to 3.3V logic.



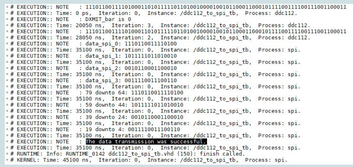
Nios II System and Data Processing

A Nios II processor is used for SPI. The program for the Nios II is written in C. The ADC values are then transferred to a PC in real time to be used by a Matlab program.

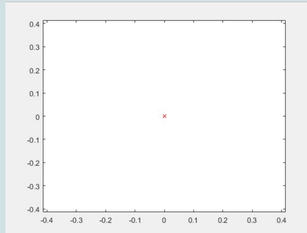


Testing Results

The converter was tested using processes to emulate the DDC112 and Nios II. The input is checked with the output in the testbench. The console confirms correct operation of the unit.



Due to COVID-19, testing of hardware was halted. The real time operation of the Matlab program is tested. An example of the output is shown below. The system only shows general direction of the beam drift. For exact position, more parameters are needed.



Glossary

ADC - Analog to Digital Converter
FPGA - Field Programmable Gate Array
Nios II - A “soft” processor that can be instantianted in a Altera FPGA

Acknowledgements

Dmitri Donetski for guiding us on this journey
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VZLF Technologies