Transfer-to-Excellence (TTE) Program

FPGA-Based Multiplexer in Quantum Computing

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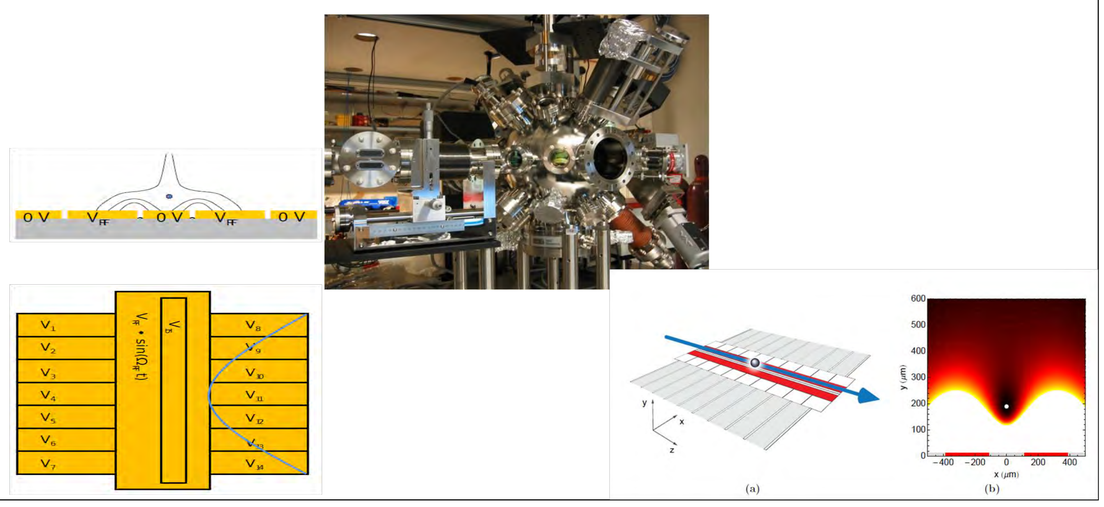
Abstract

Quantum computers offer greater processing capabilities than conventional computers by using the laws of quantum mechanics. One of the methods used to develop Quantum computers is through the use of RF Ion traps. In an Ion trap, ions are confined by manipulating electrostatic potential by applying varying voltages to the DC electrodes. The voltages required to trap the ions will be produced by a DAC and an Amplifier, and will be measured using an FPGA-based multiplexer.

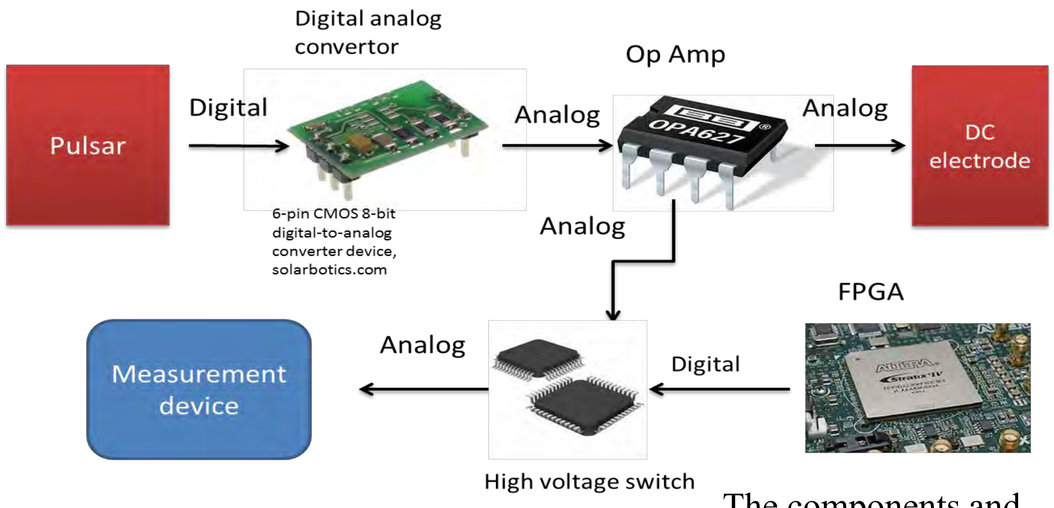
Introduction/Background

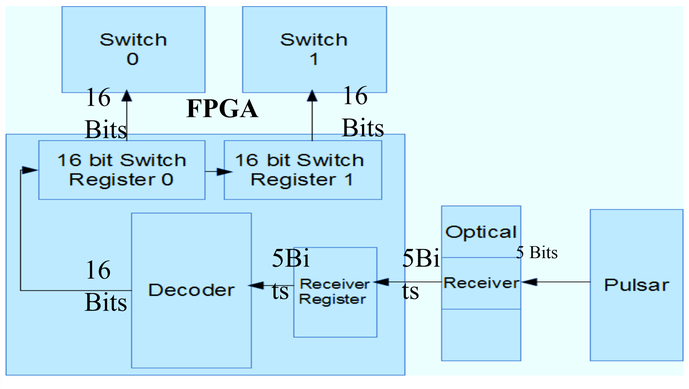
It is expected that by the year 2020 the basic components of digital computers will reach the size of an atom. At that point the physical rules that govern computers will no longer be valid due to quantum effects. One way we can deal with this is to embrace the quantum effects and utilize them in computing, by developing quantum computers. Which we can develop by using Ion traps to manipulate quantum systems.

Ion traps confine ions by utilizing four electrodes, two DC electrodes and two RF electrodes. The RF electrodes confine the ions radially, and the DC electrodes confine the Ions in the axial direction by making use of electrostatic potentials as a results of applying varying voltages. A DAC board and an amplifier generate the voltages and an FPGA multiplexer selects the voltages to measure.



Methods



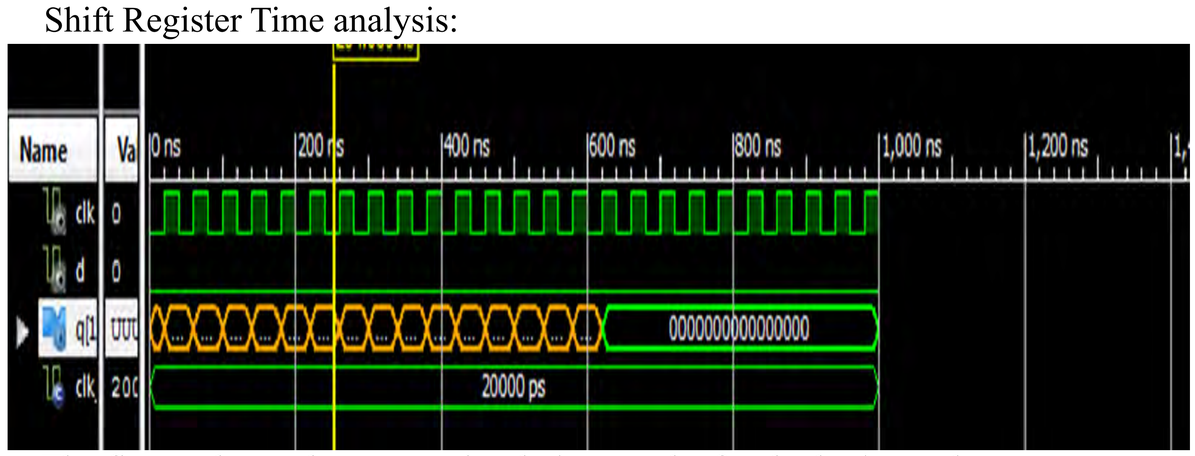


. The components and how they are connected with each other

FPGA based multiplexer setup

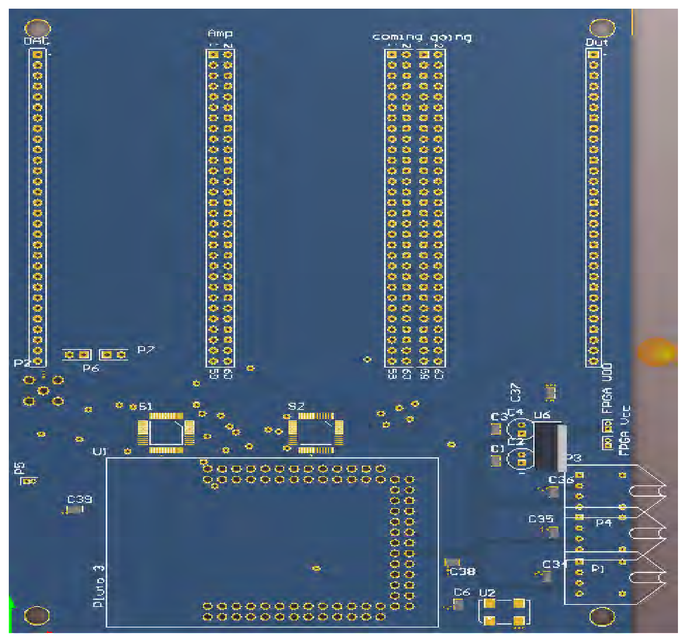
Results/Data Analysis

Shift Register Time analysis:



The figure above shows our simulation results for the logic used to code the shift register used to communicate with the switches

A 3D image of the PCB board Design, displaying how it would look like once Fabricated.



Discussion/Conclusion

Our digital logic for interfacing between the FPGA and the two switches has been successful. we can see from the time analysis of our shift register that we were able to shift one bit at each clock event and were able to output a 16 bit word after 16 clock events. This will be used to select the channels to measure from the amplifier using the switches.

The PCB board has yet to be fabricated.

It is expected that it will insulate noise, output amplified analog signals to the electrode, and incorporate the FPGA-based multiplexer.

References

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