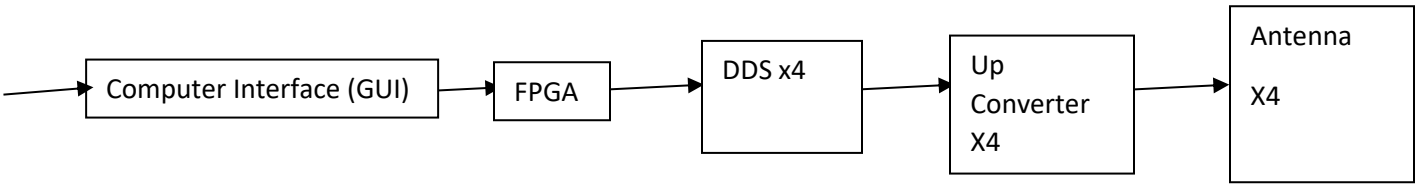
Team 311: FPGA Enhanced Digital Beam Steering Phased Array

Targets



Modules	Targets
Computer Interface (GUI)	A neat display of angle that the user is selecting. Should refresh at a reasonable rate (at least around 6 fps) when steering the angle of the beam. The end product would have the computer interface controlling the steering of the beam with the arrows on the mouse and the number pad for the order of magnitude that the user wants to change the angle of the beam.
FPGA	Successfully changes the direction of the beam that the user selects. The beam will be controlled with the push buttons and switches on the FPGA. The switches determine the magnitude that the angle is going to move and 2 push buttons will determine the direction that the beam should move. The outputs should be in the range of 1.8 and 3.3 volts to be compatible with the DDS.
Direct Digital Synthesizer (DDS)	Needs to be able to offset the phases of the signals depending on what the user chooses from the GUI and convert the digital signal into analog at a rate of about 200.3 MHz (highest the DDS can output).
Up-Converter	Takes the 200.3 MHz analog signal and upconverts it to a signal frequency of about 2.4 GHz (within the ISM band).
Antenna	Takes each resulting signal independently and outputs them as a radiation pattern. The main lobe should be pointed in the direction that the user chose using the interface. The signal propagating should be at 2.4 GHz.

Method of Validation & Discussion of Measurements

Graphical User Interface (GUI)

Make sure that there are no errors in the code and that the elements in the code align for example they are compatible in size, position, and width. The monitor should display a neat user interface that is refreshed at a reasonable rate when looked at.

Field-Programmable Gate Array (FPGA)

The FPGA code can be simulated in ModelSim. There the team can verify that the output is what we expected by using the pushbuttons and switches on the FPGA temporarily instead of the GUI in the end product.

Direct Digital Synthesizer (DDS)

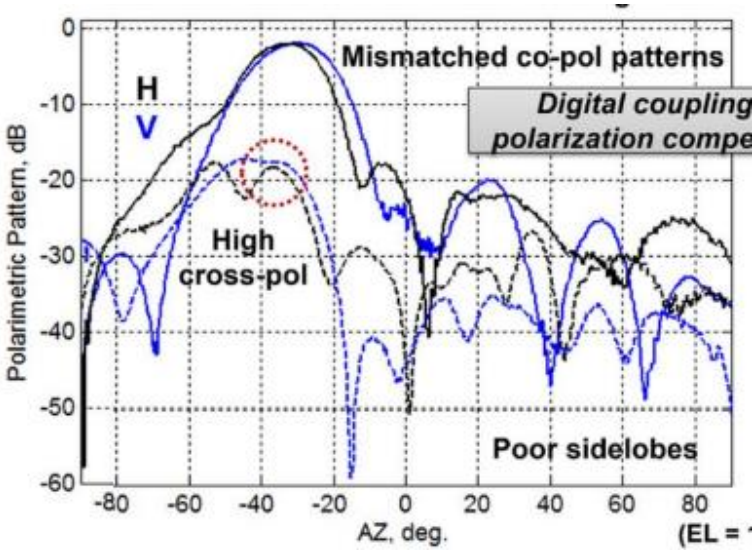
We can test the DDS by using an oscilloscope and test whether the sinusoidal waves that it is outputting is around 200 MHz which is the input that is required for the up converter to up convert to 2.4 GHz.

Up Converter

We can also test the Up Converter by using the oscilloscope, but instead of looking for 200 MHz we will test to make sure that the signal is at a frequency of 2.4 GHz.

Antenna

Dr. Arigong is going to have an RF lab available to students by next semester. We can test the transmitter through a receiver in the lab. To successfully have a beamsteered array of antennas, the gain needs to be controlled through the GUI. There were no specifications for gain or angle width of the beam. Those two variables depend on the quality of the antenna. The graph on the next page shows what the GUI should display when pointing the beam at around -35 degrees. The gain is significantly better at where the beam is steered.



Critical Target and Derivation of Targets and Metrics

We need to achieve a transmitting frequency within the ISM band. Dr. Arigong recommended 2.4 GHz. To do this that means we need an upconverter that can take our output from the DDS up to 2.4 GHz. An FPGA and DDS operates at around 200 MHz, which is why we need to upconvert to get the frequency within the ISM band.