Digital Beamsteering Phased Array

Sponsor: L3Harris

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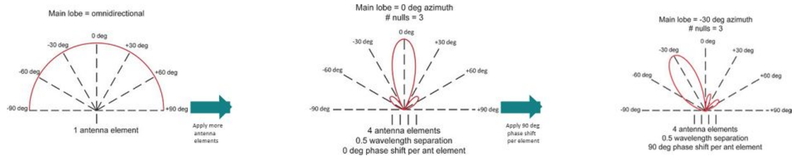
FAMU-FSU Engineering

L3HARRIS™

What is a Phased Array?



Why do we need Beamsteering?

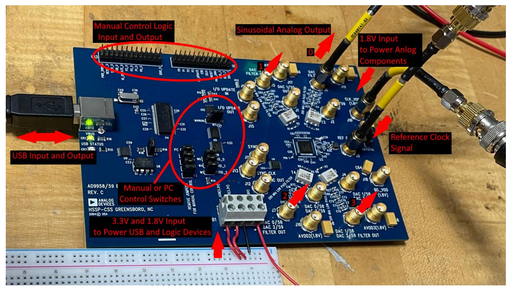
- Motivation for beamsteering is the need for higher data transmission rates.
- Beamsteering allows us to transmit a higher quality signal to receivers.
  - Leading to fewer errors in the transmission of data.
- We do not need to increase the transmitting power in order to achieve the higher quality signal.
  - Focusing the main lobe of the transmission radiation attenuates the side lobes of the radiation pattern.

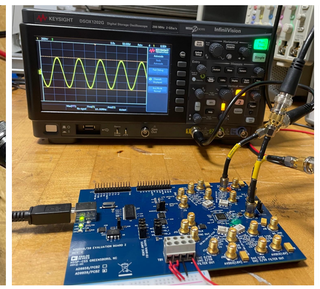
What is Beamsteering?

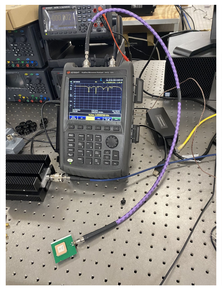
- Uses an array of antennas that differ by a phase to constructively and destructively interfere such that the majority of the constructive interference occurs in the direction that we want the main lobe to point.

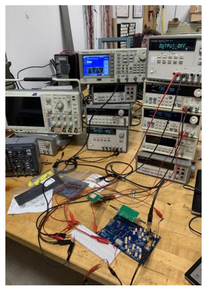
Market

- Used in civilian and military applications for 5G communications, satellite to ground communications, and improves the range of military communications.



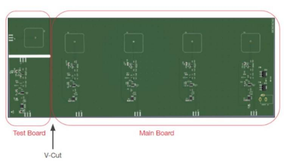




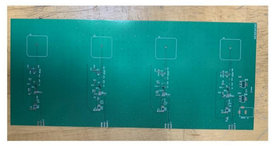


Stage 1 - PCB & Software Design

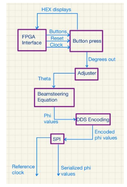
- Find components that will be used in the circuits required to raise the DDS output from 200 MHz to 2.4 GHz.
- Create a PCB for the circuit to operate by following the datasheets provided for the components.
- Code VHDL so that the user can change the beamsteering angle through the push buttons on the FPGA development board and output the required phase angles for the DDS in a format that the DDS can understand.



KiCad view of PCB

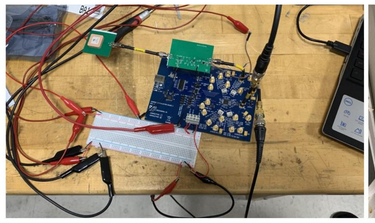


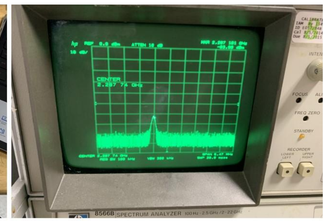
PCB after test boards have been cutoff

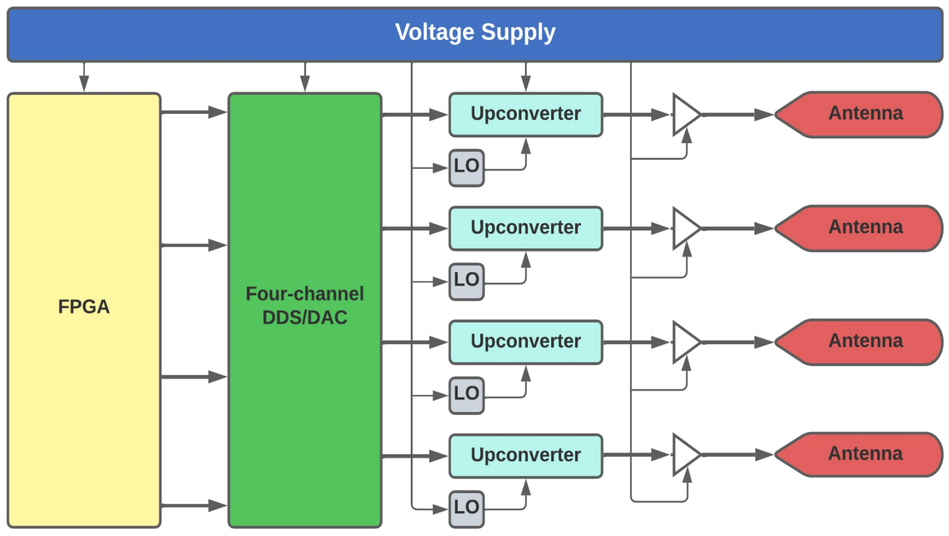


Stage 2 - Intermediate Testing

- Perform two stages of intermediate testing:
  - Antenna test cutout resulted in a return loss of -11.41 dB at 2.4 GHz.
  - Other components test cutout was connected to the DDS and a breadboard then powered and connected to the oscilloscope. An amplified signal of 2.287 GHz was measured.

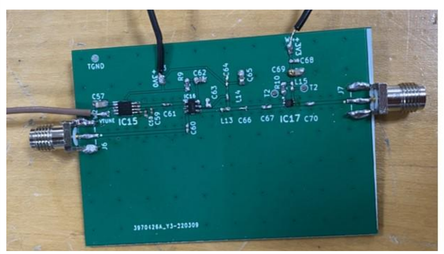


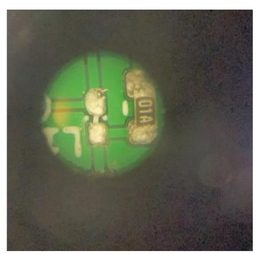




Stage 3 - Hardware Assembly

- Soldering components to the PCB while carefully upholding IEEE codes and standards.
  - Amplifiers, mixers, local oscillators, voltage regulators, and 50 Ω impedance matching networks.
- Assemble final designs with all subsystems.
  - Connect DDS, PCB, FPGA, and power supply.





Stage 4 - Final Testing

- Final testing will consist of using a receiver to estimate the angle of our transmitting beam relative to the antenna plane.
- Final design should be able to steer the beam based on the input of the FPGA.