

Generating GPS-Timed Acoustic and RF Costas Array Sounding Signals

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Problem Statement

Ambiguity of in time of flight and Doppler shift estimation for ionospheric sounding measurements.

Context

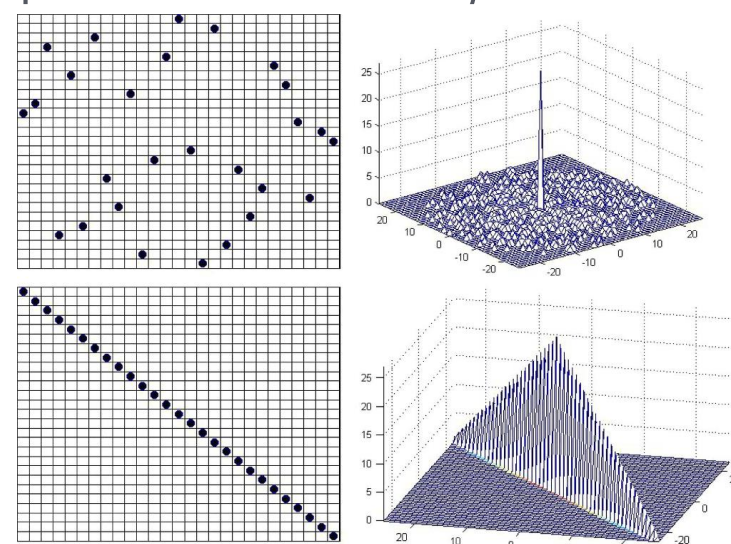
Demonstration of the use of Costas-encoded sounding waves for proposal to the National Institute of Science and Technology (NIST).

Background

•Motivation : Faithful estimation of time of flight and its derivative (doppler)

•Past approach : Barker Codes

New approach : Costas arrays



Autocorrelation of a Costas Array

Technical Constraints

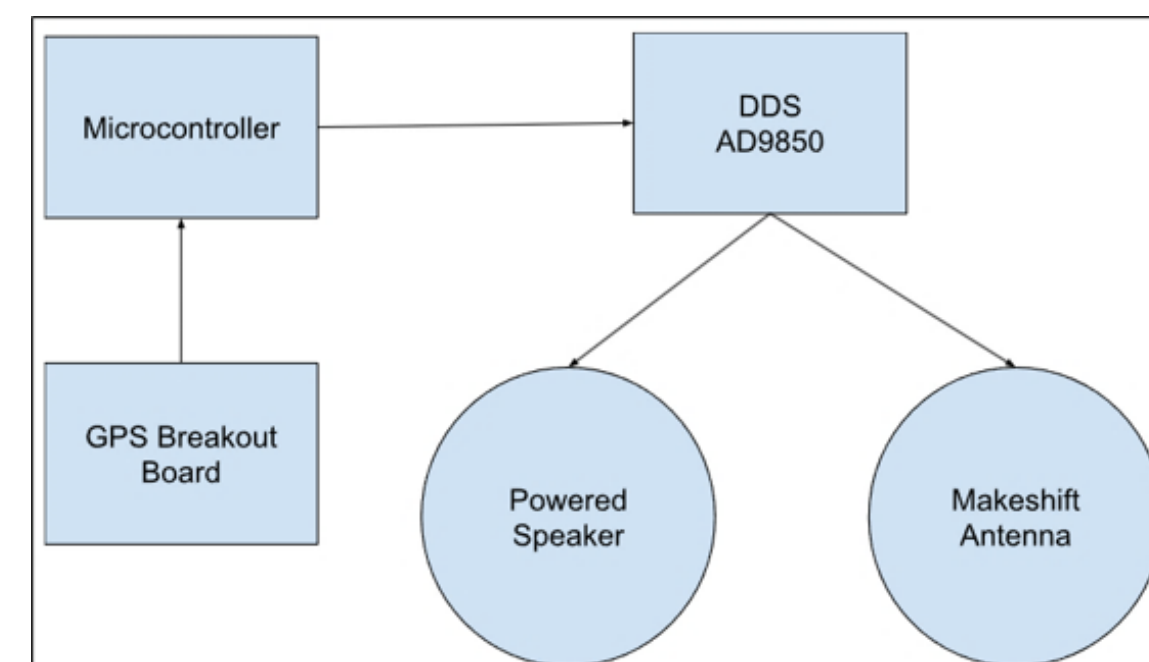
- **Sequence** : One second transmission, 100ms tones.
- **Frequency Range** : 300 Hz- 3000 Hz (Acoustic)
- **Synchronization** : GPS Antennas

Design Methodology

- Software Backend: nested interrupt service routine architecture for time-accurate wave synthesizing.
- GPS Module's pulse per second (PPS) signal that is the common view synchronization triggers hardware interrupt for transmission.

Approach

- Synchronized Costas array transmitter station
- Wave synthesizing : AD9850 Direct Digital Synthesis chip (DDS) programmed by a PJRC Teensy 4.0.
- Synchronization :GPS breakout board (Adafruit PA1616S)

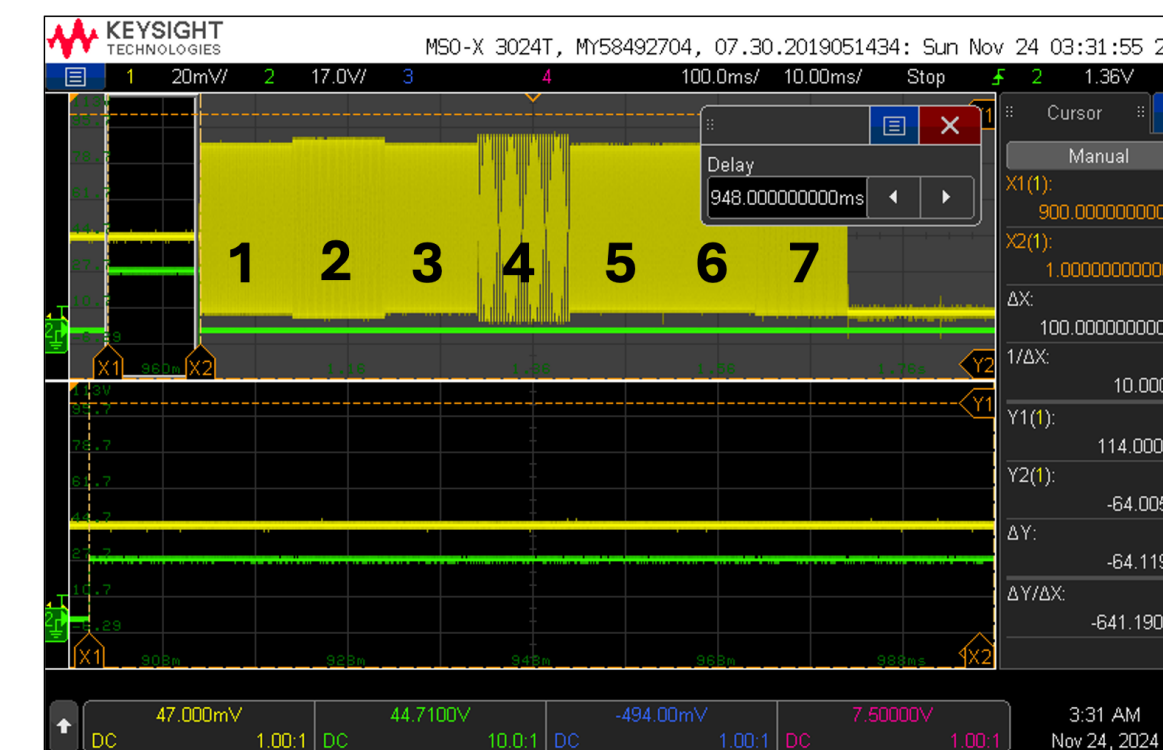


System Diagram

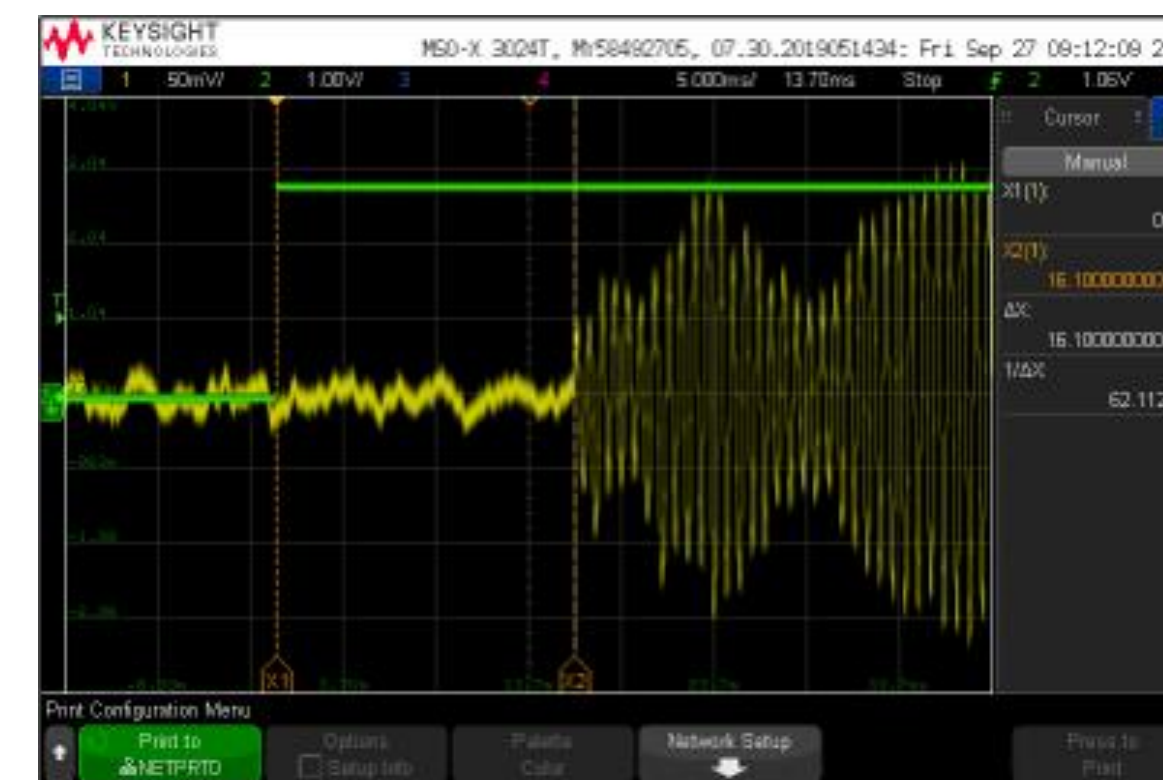


Transmission Station

Verification and Results:

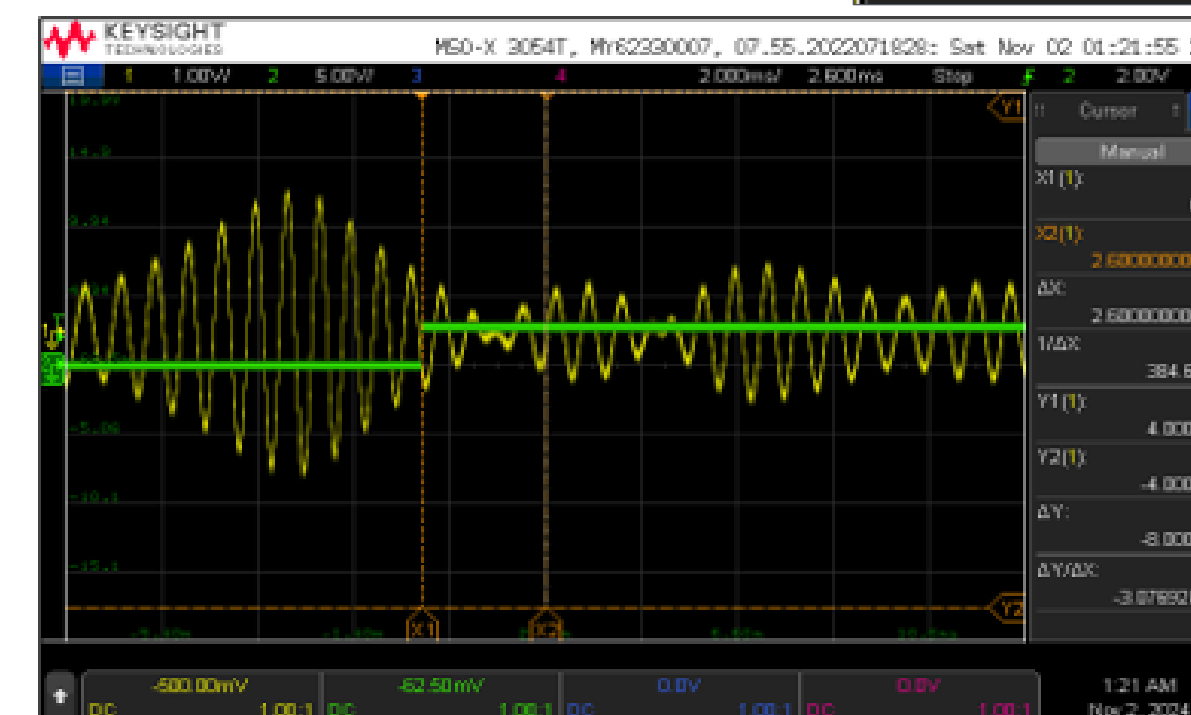


Costas array Transmission



Audio Frequency Range at ~5m of distance

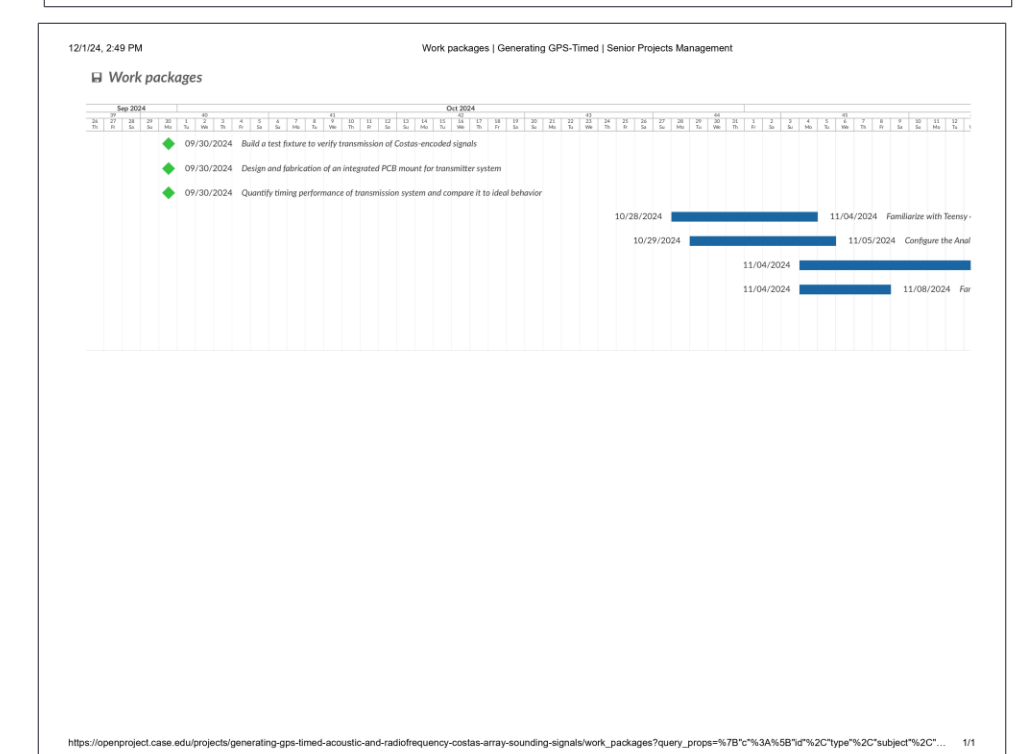
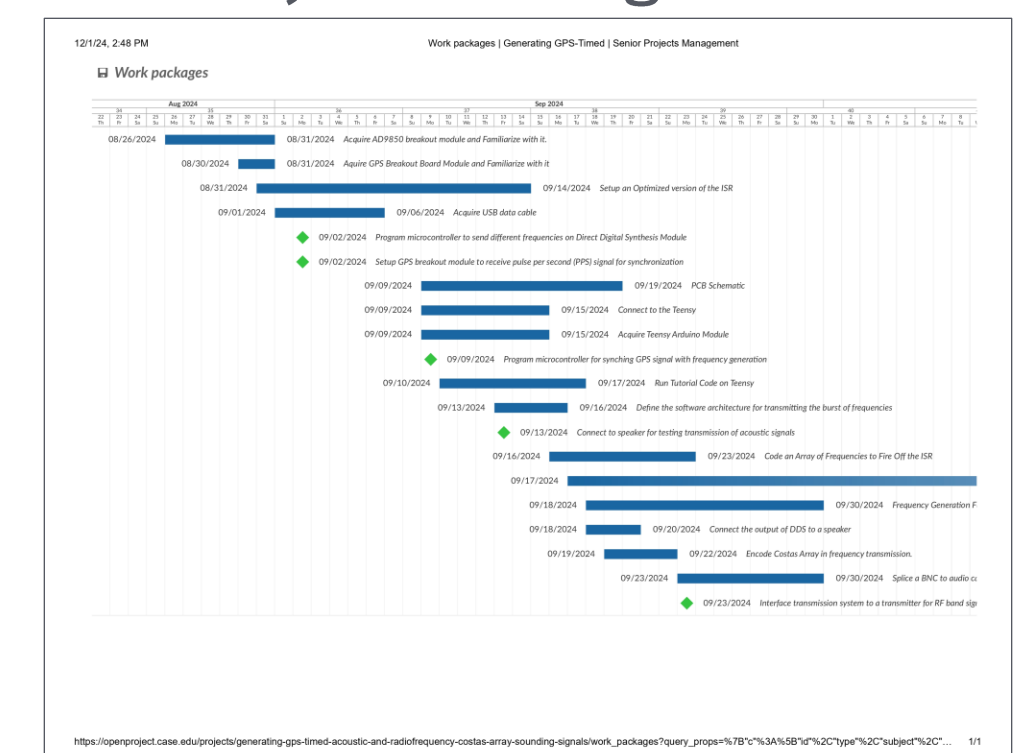
ΔX : 16.100000000ms



Radio Frequency Range at ~800km of distance

ΔX : 2.600000000ms

Project Management:



Project Gantt Chart

Standards and References:

- Title 47 CFR, Part 97 - Amateur Radio Service
- Title 47 CFT, Part 15 – Home Built Devices
- NIST, "Radio station WWV," NIST,

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