

Waveform modulation on locked PIC lasers for Microwave Photonic Radars

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Motivation / Problem

Statement:

- Although RF signal generation using beat frequencies of two phase-locked lasers has been studied, the results have been focused on frequency-modulated RF chirp generation by tuning the operation mode on one of the phase-locked lasers. This approach makes it difficult to achieve versatile waveform and amplitude modulation.

Project Summary:

- To address the challenges of phase and amplitude modulation on the laser signal while rejecting unwanted harmonics, we will leverage RF-photonic technologies developed and delivered by STTR and ACT projects.
- Radar waveform modulation will be achieved via phase and amplitude modulation of one of the two mixed laser signals.

Project Objectives:

- Evaluate the photonic system for radar waveform modulation to determine possible areas of improvement. This will include the characterization of photodetectors and phase modulators, and the evaluation of optical filtering of microwave signals.

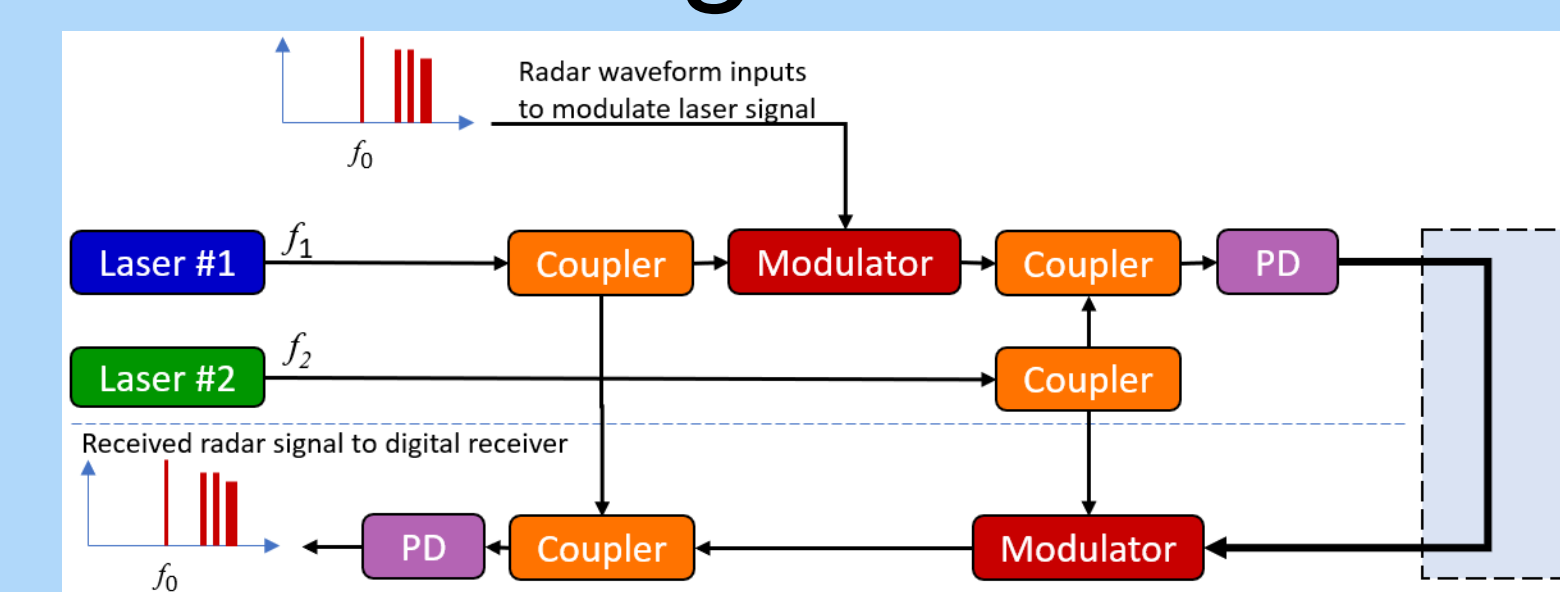


Fig. 1. Simultaneous RF amplitude and phase modulation using photonics

Process / Materials /

Methodology:

- Characterize the balanced photodetectors through measurements
- Characterize the phase modulators through measurements and analysis
- Evaluate the optical filtering and amplification through measurements and analysis
- Characterize system performance through measurements and analysis.

Results:

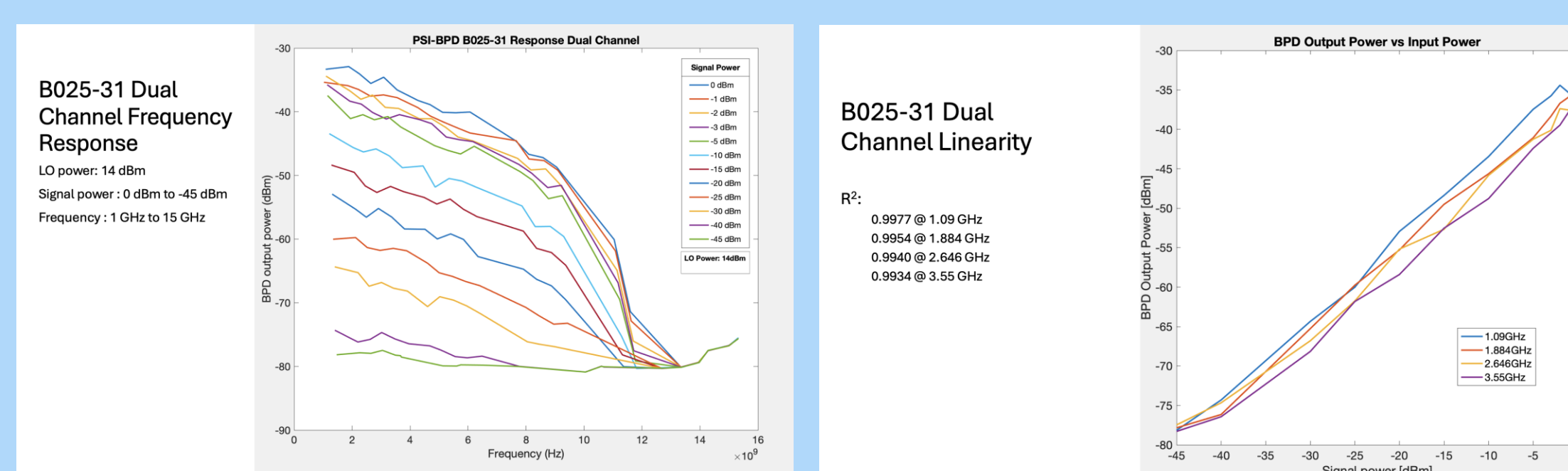


Fig. 2. Evaluation of the balanced photodetectors (BPD) for responsivity as a function of frequency and signal power (left) and linearity as a function of input power (right).

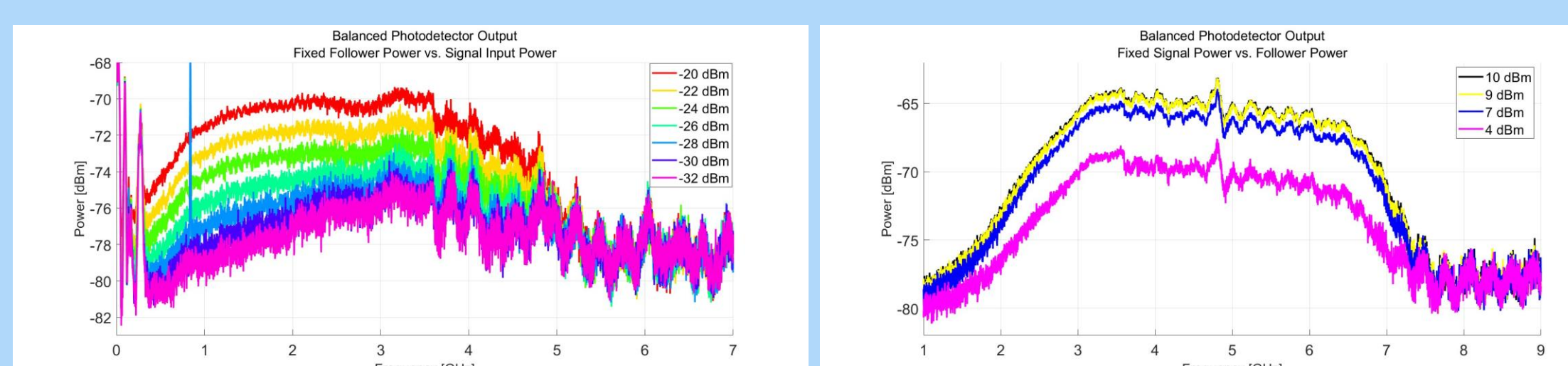


Fig. 3. Evaluation of the balanced photodetectors (BPD) for responsivity as a function of signal power (left) and follower laser power (right).

Conclusions:

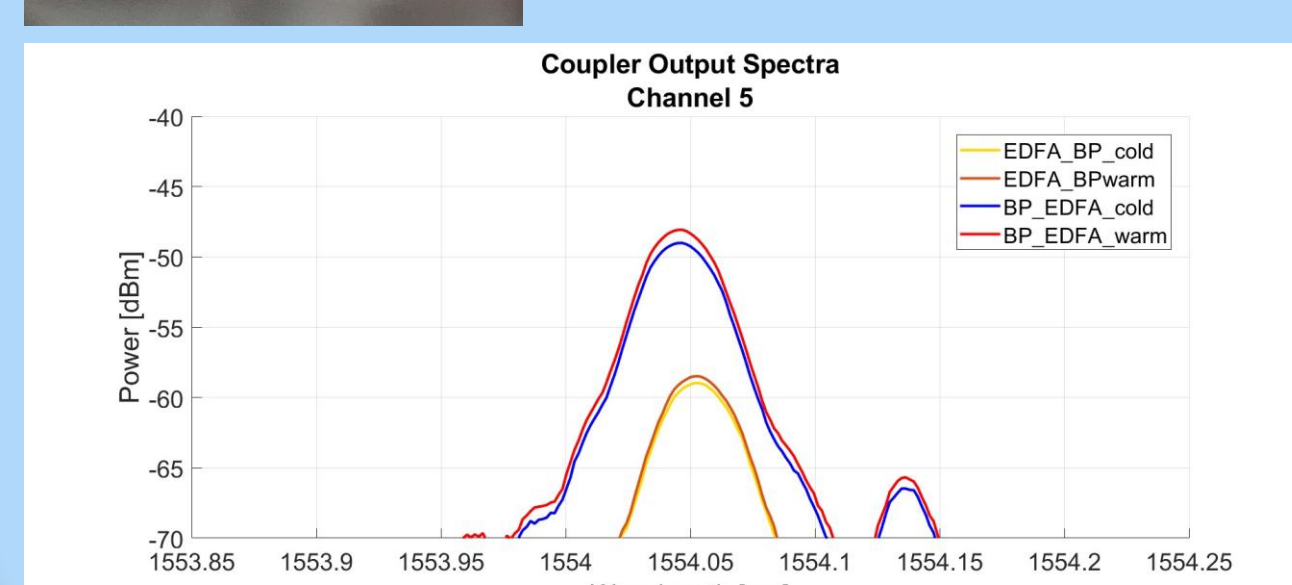
- These detectors require an input signal of at least -30 dBm for it to be detectable
- The power of the local oscillator can be used to boost the input signal strength
- Future work will include investigating more stable laser locking mechanisms, simultaneous amplitude and frequency modulation and utilize a PIC device to generate the RF beat.

Challenges Encountered / Lessons

Learned:



- Phase modulator arrived with a damaged RF input connector.



- Defining the optical amplification architecture to maximize output power without compression

Future Plans / Next Steps:

- Demonstrate a preliminary prototype of an array of optical phase-locked loop (OPLL) lasers at fixed frequencies.
- Apply to ESTO Advanced Component Technologies
- Following proof of concept, apply to the ESTO IIP to develop a breadboard, test it in a laboratory environment (TRL 4), and potentially validate it in an environment relevant to target missions, bringing the TRL up to 5

