EE 117B/217B Microwave and Wireless Measurements

Lab 7 Questionnaire - Radar

Fall 2026

Group members: _____

Answer each question in the space provided. One combined report per lab group.

1. Generating an FMCW Chirp with the PLL

1.2 Programming the PLL and Verifying Lock

Q1.2.1: With the PLL locked at 12 GHz, record the carrier frequency and power P_c measured on the FieldFox. Is the line clean and stable?

Q1.2.2: Record the DC tuning voltage `VTUNE` at 12 GHz and compare it with your V_{tune} vs. frequency curve from Lab 4.

1.3 Configuring the Chirp

Q1.3.1: Report the product CLK1 $\times$ CLK2 required for $t_{\text{step}} = 1$ μs, and the value of `DEV` required for a per-step deviation of 200 kHz at the ADF4159 with `DEV offset` $= 2$. Because `DEV` is an integer, the deviation per step cannot be exactly 200 kHz: report the resulting actual bandwidth B and chirp slope β at `EXT_VCOOUT`.

Q1.3.2: Record and plot the `VTUNE` sawtooth waveform.

Q1.3.3: What is the ramp period? Does it agree with the programmed T_{ramp}?

Q1.3.4: Describe the transient at the falling edge (flyback) of the sawtooth and estimate how long it takes `VTUNE` to settle at the start frequency. Do you observe cycle slipping? Include a plot of the cycle slipping.

Q1.3.5: Why does the flyback interval have to be excluded from the useful part of an FMCW radar chirp?

1.4 Measuring the Chirp Spectrum on the FieldFox

Q1.4.1: With the trace in `Clear/Write`, describe the trace you see from one sweep to the next. Why does a single sweep not show a continuous band?

Q1.4.2: Plot the chirp spectrum measured with the `Positive Peak` detector and `Max Hold`.

Q1.4.3: There is a section of spectrum below 11.8 GHz that is not part of the chirp parameters and is lower in power than the flat top. Where does this part of the spectrum come from?

Q1.4.4: Compare the level of the flat top with the CW carrier power P_c from Q1.2.1. Is the chirp power the same as the CW power?

Q1.4.5: Plot the displayed level of the flat top versus RBW (3 MHz, 1 MHz, 500 kHz, 100 kHz, 50 kHz and 10 kHz). Explain why the power level drops when the RBW is lowered. Based on Appendix B, at what RBW do you expect the peak power level to start dropping for the current chirp slope? Does your measurement agree?

Q1.4.6: Plot the spectrum measured with a 20 kHz span and 100 Hz RBW, and report the measured line spacing. How does it compare with $1/T_{\text{ramp}}$?

2. Building an FMCW Radar System

2.1 Adding a Power Divider and an Amplifier

Q2.1.1: Report the CW power measured at one output port of the 4-way power divider. From the datasheet of the mixer (ZX05-24MH-S+), what LO power does it require? Is the divider output enough to drive the mixer?

Q2.1.2: Report the power measured on the SA, the cable loss (measured in VNA mode) and the attenuation. What is the RF power (in dBm) at the output of the amplifier? Is this within the driving range of the mixer?

2.2 Mixer, Delay Line and IF Filter

Q2.2.1: Why do we need the low-pass filter (SLP-1200+) at the IF port of the mixer?

Q2.2.2: Plot the measured response ($|S_{21}|$ in dB) of the LPF and report its rejection at 12 GHz.

Q2.2.3: Record and plot the IF beat signal (Channel 2) together with `VTUNE` (Channel 1).

2.3 Measuring the Beat Frequency

Q2.3.1: Based on the electrical length of the delay line (measured in Lab 2) and the chirp slope β, what do you expect the IF beat frequency to be? Show your calculation.

Q2.3.2: Plot the FFT of the IF signal and report the measured beat frequency. Does it agree with your calculation in Q2.3.1? If not, explain the difference.

Q2.3.3: There is a peak close to DC in the FFT. Where does this peak come from?

3. FMCW Radar Over the Air

Q3.1: With the delay line disconnected, does the peak close to DC still exist? What does this tell you about where it comes from?

Q3.2: With the antennas connected, a second peak appears close to DC. What happens to this peak when you place your hand in the gap between the two antennas? Where does this peak come from?

Q3.3: With the corner reflector at a distance of 5 ft, what is the expected beat frequency? Show your calculation. Does it match the peak observed on the oscilloscope?

Q3.4: Plot the FFT trace with the corner reflector in place and mark the peak corresponding to the corner reflector, as well as the peaks identified in Q3.1 and Q3.2.

Q3.5: Sitting about 1 ft in front of the radar and breathing deeply, do you see the time-domain trace changing with your breathing? Describe what you observe.

Q3.6: What is the range resolution of this radar?

Q3.7: The movement due to breathing is much smaller than the range resolution. How are you able to see the fluctuations on the screen?

Q3.8 (Optional): Include a screenshot of the range-Doppler map with a moving target. Based on the radar parameters, what is the maximum unambiguous velocity and the velocity resolution of this radar?