USAF ACADEMY
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING
LESSON 14 LAB - HD RADIO
Lab Packet
Spring 2027

Name: _____ **Section:** _____ **Date:** _____

Learning Objective 6.3: I can describe how HD Radio works and demodulate an HD Radio signal.

This packet is the L14 Lab, in three parts, and you turn it in once, complete, before Lesson 15. Do **Part 1** on your own before the lab period: run the sideband finder, change one test-file setting, and slide Inner subcarrier to see what it does. **Part 2** is your own measurements, recorded in class on your own laptop with a PlutoSDR. Do **Part 3** on your own after the lab: explain what you measured and answer the analysis questions.

Grading. One submission, graded against Objective 6.3 on the course's 1 / 0 scale, with revision allowed under course policy. Paste screenshots where a question asks for one.

Transmitting. Nothing in this lab transmits. The PlutoSDR only receives, and both captures came from GNU Radio flowgraphs, not from an antenna.

The flowgraphs are on the L14 lesson page, `L14-hd-test-tx.grc` and `L14-hd-find.grc`, and the capture `L14-lab-capture.cu8`, which your instructor posts on the L14 Lab page before the lab. Both captures are simulated: unsigned 8-bit I and Q at 1,488,375 samples per second, the default format nrsc5 reads. Every number below uses the hybrid values from the lesson: subcarriers 363.4 Hz apart, one FFT bin at `fft_len` 4096, sidebands from subcarrier 356 to 546 on each side, partitions of 19 subcarriers, and an extended hybrid station adding one, two, or four partitions inside subcarrier 356 on each side.

Part 1: Pre-Lab (individual, before the lab period)

1. **Change a setting and read the finder.** Put both L14 flowgraphs in one folder. Open `L14-hd-test-tx.grc`, change the Variable `upper_dbc` from -23 to -18, and run it once to write `L14-hd-test.cu8`. Then open and run `L14-hd-find.grc`.

   (a) After about 5 s, record the three meter readings.

upper	
lower	
upper − lower	

   (b) Paste a screenshot of the running flowgraph's window. What changed on the frequency sink compared with the lesson's figure?

2. **The Inner subcarrier slider.** Keep the finder running on the same file. Slide **Inner subcarrier** from 356 down to 280, one step at a time, and record the upper sideband reading at each step.

Inner subcarrier	356	337	318	299	280
Upper (dBc)					

Part 2: Measurements (in class)

3. Build the sideband meter. Start GRC with an empty canvas. Do not open `L14-hd-find.grc`: build the meter yourself as the lab page lists.

(a) Paste a screenshot of your flowgraph on the GRC canvas. Every connection must be black, not red.

(b) Run it on the file you wrote in Question 1 and record the three readings. Paste a screenshot of the running window.

upper	
lower	
upper − lower	

4. Identify the lab capture. Run your meter on `L14-lab-capture.cu8`, as the lab page lists. Treat the center as 100.3 MHz.

(a) Zoom in on each sideband's edges with an FFT of 8192 points and read them. Are the inner edges at 129.4 kHz from the center, or closer to the host?

	Lower outer	Lower inner	Upper inner	Upper outer
Edge (MHz)				

(b) Record both meter readings with Inner subcarrier at 356. If the inner edge is not at 129.4 kHz, slide Inner subcarrier down until the readings stop rising, and record the setting and both readings there.

Inner subcarrier	Upper (dBc)	Lower (dBc)
356		

(c) Do the two sidebands read the same? If not, which is stronger, and by how many dB on the Upper minus lower meter?

difference

(d) Find the other station in the capture, give its offset from the center, and say whether it carries HD Radio. How can you tell?

5. A live station. Add the PlutoSDR Source to your meter and find a local station with HD Radio, as the lab page lists.

(a) Paste a screenshot with the shelves visible, and record the station, the Pluto RX gain, and the height of the shelves above the floor.

(b) Record the inner and outer edges in MHz, the Inner subcarrier setting where the readings stop rising, and the configuration.

(c) Record both meter readings. Then lower the gain in steps and record what happens to the shelves and the readings as the floor rises toward them.

upper

lower

6. **Decode it (optional).** This question is optional and does not count toward the grade. Record the same station with `L14-hd-find.grc` and decode the recording with nrsc5, as the lab page lists. These steps are documented usage from the nrsc5 README; we have not yet tested them in this course.

    (a) Record the station name, the title and artist of what is playing, and the programs the station carries.

    (b) Record and decode again at lower gains until the audio stops. What is the lowest gain at which nrsc5 still plays, and how high do the shelves stand above the floor in your meter at that gain?

Part 3: Writeup (individual, after the lab)

7. Analysis.

(a) Compare the live station with the lesson's test file: where its shelves sit, how high they stand, and whether the two sides match. What does each difference tell you about the station's HD Radio signal?

(b) Explain how the lab capture's waterfall, edges, and meter readings identified its configuration.

(c) nrsc5 cannot decode `L14-hd-test.cu8`, although its sidebands have the right subcarriers, spacing, and guard. Name two things nrsc5 needs from a signal that the test file does not provide.

Documentation: _____