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

Show your work. Write a **Documentation** line at the end (**None** if you did not collaborate). From the lesson: a hybrid station's sidebands run from 129.4 to 198.4 kHz on each side of its center, subcarriers 356 to 546, spaced 363.4 Hz apart.

1. **Reading the display.** You tune `L14-hd-find.grc` to a station at 98.5 MHz.

   (a) Type 98.5 into the finder's Center, zoom in on the frequency sink, and read where each shelf starts and ends, in MHz.

   upper

   lower

   (b) On the waterfall, the station at 98.5 MHz shows a rounded band whose width changes from moment to moment, and two straight bands of constant width on either side. Which is the analog host, and which are the HD Radio sidebands? What makes each look the way it does?

   (c) A second station shows shelves that start much closer to its host than 129.4 kHz and end at 198.4 kHz. A third shows a rounded host and nothing beside it. Name the mode of each.

2. **Reading the OFDM blocks.** Open `L14-hd-test-tx.grc`.

   (a) The OFDM Carrier Allocator's occupied carriers for the upper sideband are `list(range(356, 547))`. Which subcarrier numbers does that list hold, and where does each end of the list appear on the frequency sink?

   (b) A Multiply Const after each OFDM Cyclic Prefixer sets that sideband's level. Halve the lower sideband's constant, rerun both flowgraphs, and record how far the lower shelf and the lower meter drop. What happens to the upper side?

   (c) You set the OFDM Cyclic Prefixer's rolloff from 112 to 0. What do you expect to see at the edges of the shelves, and why does it matter to a neighboring station?

3. **Setting the meter.** The sideband meter in `L14-hd-find.grc` uses a Frequency Xlating FFT Filter, Complex to Mag^2, a Moving Average of `avg_len` samples (0.2 s), Keep 1 in N, and Log10 for each band.

   (a) You shorten the Moving Average to 0.02 s. What changes in the readings, and what stays the same?

   (b) You type `sb_center` into the lower sideband's filter instead of `-sb_center`. What do the two readings show?

   (c) On an extended hybrid station, you leave Inner subcarrier at 356. Does the meter read high or low, and what do you do with the slider?

4. **What noise does.** In `L14-hd-test-tx.grc` you raise the Variable `noise_amp`, run it again, and play the new file in the sideband finder.

   (a) Describe what happens to the floor, the shelves, and the host on the frequency sink as `noise_amp` goes up.

   (b) What happens to the two meter readings, and why?

   (c) On a real station, what would you expect to hear from nrsc5, and from the analog station on Lesson 7's FM receiver, as the shelves sink into the floor?