Laboratory 6: Applications of a Digital Spectrum Analyzer to signal characterization

Part 1.- Analysis of the terrestrial broadcasting TV signal distributed by cable (CATV)

The purpose of this part of the experiment is use the spectrum analyzer to characterize one of the signals most frequently used: The terrestrial television signal distributed by cable.

With the full range of frequency in the spectrum analyzer (up to 1.5 GHz) connect the output from the cable connector to the input of the spectrum analyzer. The information shown on the screen shows the frequencies and region of the spectrum where there are signals distributed by cable.

To help discern the relationship between audio and video frequencies with the channel number, please consult the following table.

### BROADCAST AND CABLE TELEVISION FREQUENCIES

**Question 1.** The previous table shows that for example, CATV (Cable TC) channel 14 has assigned a video carrier frequency of 121.25 MHz and an audio carrier frequency of 125.75 MHz. However, in Practicum 1 we learned that according to the NTIA US Frequency allocation chart, these frequencies are reserved for exclusive use for Aeronautical Navigation (Air traffic control and similar). How do you explain this discrepancy? Can CATV operators interfere and jeopardize the safety of civil air traffic?
**Question 2.** Roughly estimate the range of frequencies used by this cable TV operator. Note that different operators will use different frequencies depending on the number of channels that they carry and how they are numbered.

Change the frequency set up to the most adequate to visualize the full spectrum of signals carried by the CATV operator.

**Question 3.** Explain, describe and sketch the pattern of signals that show on the Analyzer's screen.

**Question 4.** Is the energy spectrum continuous? Explain possible gaps
Question 5. Are there any distinctly different signals that appear on the spectrum? If so, describe them and give possible reasons for their origin.

Once again, configure the analyzer to visualize the lowest complete channel on the screen. Change the resolution bandwidth, video bandwidth and sweep time as necessary to display an adequate signal on the screen.

Question 6. Sketch the signal shown on the screen. Give details on frequencies and amplitudes as necessary.

Change the analyzer configuration to display in detail the video portion of the CATV signal. Pay special attention to the signal changes because of resolution and sweep time changes. Choose the most adequate configuration.
Question 7. Sketch the video portion of the CATV signal displayed on the screen

Repeat the procedure, this time for the audio signal.

Question 8. Sketch the audio portion of the CATV signal displayed on the analyzer's screen.

Question 9. Comment on the signals visualized in questions 7 and 8
Part 2.- Analysis and characterization of radiated signals

This part is centered in the analysis and characterization of over-the-air or radiated signals used by common services.

Move the spectrum analyzer closer to the windows of the technology center to increase the reception of radiofrequency signals. Attach the antenna provided by the instructor to the input of the spectrum analyzer.

Configure the spectrum analyzer to visualize the full spectrum of the commercial FM band (88 MHz to 108 MHz).

**Question 10.** Sketch the signal that appears on the screen of the spectrum analyzer. Write down frequencies and amplitudes for the peaks that appear on the screen.

**Question 11.** How many signals (peaks) appear on the screen? What is their frequency? Relate each one of the peaks with the commercial name of the FM station that should transmit at that particular frequency.

**Question 12.** For the signals in Questions 10 and 11, find their amplitude in linear units of power and rms voltage.
**Question 13.** Select the signal with the highest peak (strongest amplitude). Change the frequency controls of the spectrum analyzer so this signal is the only one displayed on the screen. What are the frequency conditions (start/stop or center/span) and resolution bandwidth?

**Question 14.** Sketch the resulting signal.

**Question 15.** Modify the setup conditions as necessary in order to be able to distinguish the side bands of this signal.

**Question 16.** Write down the frequencies for the side bands and their amplitudes. Sketch this signal if it looks different than the one in Question 14.

**Question 17.** What is the smallest separation between sidebands? How does this relate to the bandwidth and modulation allowed for commercial FM signals?

For the next questions you may want to consult the FCC frequency allocation table. For a table more detailed than the one used in Practicum 1, click in the following link:

[FCC frequency allocation table](#)

**Question 18.** Using the previous table, write down all the frequency ranges where commercial broadcast TV is allowed.
**Question 19.** Based on your answers in question 18, locate the frequency of all the local TV stations transmitting over-the-air. Relate them to their commercial names if possible. Find the power received for each TV station.

**Question 20.** Compare the received power of over-the-air TV stations with the power of the CATV stations. Are they different? How much? Comment on how this effect may impact on the design of the TV receiver.

**Question 21.** Modify the setup of the spectrum analyzer to visualize only one of the local over-the-air TV stations. Modify the setup to distinguish between the video and audio subcarriers. Sketch the resulting signal. Provide frequency and amplitude values as necessary.

**Question 22.** Modify the setup again to expand on the video subcarrier. Sketch the resulting signal.
Question 23. Repeat Question 22, but focusing now on the audio subcarrier. Sketch the resulting signal. Comment on the results for questions 22 and 23.

Question 24. Comment on this laboratory exercise: (how appropriate it was, difficult/easy, interest) with special emphasis on what you have learned.

Submit this lab with the answers to your instructor. Use as many additional sheets of paper as needed.

Albert Lozano. May 2004