Engr325 Homework #3 Winter, 2020

A/D Converter Characteristics

DUE: Monday, January 27, Start of class.

Objective

Understand the basics of A/D operation and specifications.

References

Textbook Chapter 7, especially sections 7.4-5. Pay particular attention to pages 285-289. Key terms and concepts related to A/D converters that you need to understand are:

- Resolution, Quantization Error, Saturation Error, Conversion Error
- EFSR (effective full scale range, also called the voltage input span for an A/D converter)
- SNR (signal to noise ratio)
- MSB (most significant bit), LSB (least significant bit), Sign bit

To Do

1) Do the following problems from your textbook:
    a. 7.11
    b. 7.18
    c. 7.19
    d. 7.22

2) Assume you find an 11-bit A/D converter and wish to use it and you need to know how good the data measured may be. You find a specification sheet with this information: EFSR = 5v with relative accuracy of 0.03% FS (full-scale). What is the total possible error (i.e. worst case) expressed in volts?

3) Compact disc digital audio tracks are usually recorded using 16 bits to digitize the volume of each sample on each of two stereo tracks. Samples are taken at a frequency of 44.1 kHz. Some recordings are made using 24-bit samples and sample rates of 96 kHz.
    a. What file size (in bits) does each format require to record a three minute song?
    b. What is the Nyquist frequency for each format and how does it relate to the range of human hearing, which ends at about 20 kHz?
    c. If the dynamic range compares the highest voltage amplitude recordable to the lowest nonzero amplitude recordable, what is the dynamic range of each format in decibels? How does this compare to human hearing, which spans roughly 120 dB?

4) For an Omega OME-PCI-1002L A/D board shown below, determine the following:
   a. Input resolution in volts. Assume a gain of one.
   b. The highest frequency signal that could be sampled and then a Fourier transform done.

$419.00

Specifications

ANALOG INPUT SPECIFICATIONS
Channels: OME-PCI-1002H, OME-PCI-1002L: 32 single-ended/16 differential
Resolution: 12-bits
Maximum Conversion Rate:
OME-PCI-1002H: 40 KS/s
OME-PCI-1002L: 110 KS/s
Input Impedance: 10,000 MΩ/6pF
Overvoltage Protection: ±35V
Accuracy: 0.01% of reading ±1-bit
Linearity: ±1-bit

OME-PCI-1002L Input Ranges (Low Gain)

Gain	Bipolar	Sampling Rate (Maximum)
1	±10V	110 KS/s
2	±5V	110 KS/s
4	±2.5V	110 KS/s
8	±1.25V	110 KS/s

5) Write a two-page summary on how a successive-approximation ADC works. Pictures and graphs are acceptable for up to 50% of the 2-page area.

To Turn In

- **This page** stapled to your solutions which are all to be done in accordance with the School of Engineering guidelines found on the course web page.