

EE 230
Homework 14
Spring 2010

Solve any 5 of the following 10 problems.

Problem 1 A 12-bit ADC with a V_{REF} of 5V is used to digitize small signals with a quiescent value of 2.5V and a variation around the 2.5 V of $\pm 100\text{mV}$. What is the SNR of the digitized signal if the ADC is ideal?

Problem 2 A 12-bit DAC has an INL of 3LSB. From an INL viewpoint, what is the ENOB of this DAC?

Problem 3 Assume the harmonic distortion of a DAC is limited to that of the 2nd harmonic. If the THD of the DAC is -75dB, what is the SFDR?

Problem 4 If a DAC has distortion that is limited to that of 2nd and 3rd harmonics only and if the SFDR was specified at -60dB but no information was given about the THD, what is the worst case possible THD for this DAC?

Problem 5 Assume a 12-bit ADC used a 5V reference. If the input signal is corrupted with random white noise that has an RMS value of 25mV, what is the SNR at the output of the ADC if the input signal is a sinusoid of value 2V p-p that has a dc offset that puts it in the specified input range of the ADC? How much will the SNR improve if a 16-bit ADC is used instead of a 12-bit ADC?

Problem 6 Assume the ADC samples a sinusoidal signal 4096 times over exactly 11 periods of the sinusoidal input. A DFT is then taken of these 4096 samples. What is the index number of the frequency domain term in the DFT output that contains the fundamental? What is the index term of the 2nd harmonic? Of the third harmonic?

Problem 7 In Problem 6, determine the ratio between the actual sampling rate and the Nyquist rate.

Problem 8 Assume a 10MHz clock is used to clock a 12-bit ADC.
a) If 4096 samples are taken, what is the data acquisition time of the ADC?
b) What is the highest frequency input signal that can be sampled if there is to be no aliasing?

Problem 9, 10 A periodic signal was applied to a DAC and the output was sampled 4096 times at 1msec spacings over precisely 11 periods of the output. A DFT using the FFT was used to obtain the DFT of the sequence. The magnitude of the first 120 terms, expressed in DB, are given on the following page. All remaining terms were smaller than -95dB.

- a) What is the magnitude of the signal?
- b) What was the frequency of the signal?
- c) What is the SFDR?
- d) What is the THD?

Index Number	Mag (dB)	Index Number	Mag (dB)	Index Number	Mag (dB)
1	-97.23	41	-99.21	81	-99.21
2	-98.4	42	-97.43	82	-97.43
3	-96.3	43	-95.61	83	-95.61
4	-99.21	44	-97.4	84	-97.4
5	-97.43	45	-97.23	85	-97.23
6	-95.61	46	-98.2	86	-98.2
7	-97.4	47	-99.4	87	-99.4
8	-97.23	48	-98.78	88	-98.78
9	-98.2	49	-99.21	89	-97.23
10	-99.4	50	-97.43	90	-99.21
11	-98.78	51	-95.61	91	-97.43
12	12.001	52	-97.4	92	-95.61
13	-96.3	53	-97.23	93	-97.4
14	-99.21	54	-98.2	94	-97.23
15	-97.43	55	-99.4	95	-98.2
16	-95.61	56	-98.78	96	-99.4
17	-97.4	57	-97.23	97	-98.78
18	-97.23	58	-98.4	98	-97.23
19	-98.2	59	-96.3	99	-98.4
20	-99.4	60	-99.21	100	-96.3
21	-98.78	61	-97.43	101	-99.21
22	-97.23	62	-95.61	102	-97.43
23	-43.2	63	-97.4	103	-95.61
24	-96.3	64	-98.78	104	-97.4
25	-99.21	65	9.83	105	-98.78
26	-97.43	66	-96.3	106	9.83
27	-95.61	67	-99.21	107	-96.3
28	-97.4	68	-97.23	108	-99.21
29	-98.78	69	-98.4	109	-97.43
30	9.83	70	-96.3	110	-95.61
31	-96.3	71	-99.21	111	-97.4
32	-99.21	72	-97.43	112	-97.23
33	-97.43	73	-95.61	113	-97.23
34	-67.9	74	-97.4	114	-98.4
35	-97.4	75	-98.78	115	-96.3

36	-97.23	76	9.83	116	-99.21
37	-98.2	77	-96.3	117	-97.43
38	-99.4	78	-99.21	118	-95.61
39	-98.78	79	-97.43	119	-97.4
40	-97.23	80	-95.61	120	-98.78