CPE 323
Intro to Embedded Computer Systems
Practice Quiz: ADC/DAC (Walk Through)

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Admin

→ Practice Quiz

→ ADC/DAC on Friday this week

→ HW.6 please submit

→ Return the board

Question 1 2 pts

An analog input signal V_{in}=1.38 V is brought to a 14-bit analog-to-digital converter with reference voltages V_{R-}=0 V and V_{R+}=3.3 V. What is the decimal value of the converted digital sample?

- 6,851
- 1,712
- 6,852
- 5,000

$V_{in} = 1.38\,V$

14-bit ADC

$V_{R+} = 3.3\,V$

$V_{R-} = 0\,V$

$$N_{ADC} = \underline{\text{nint}}\left((2^{14}-1)\cdot\frac{V_{in}}{V_{R+}-V_{R-}}\right)$$

Question 2 2 pts

You are asked to perform analog-to-digital conversions on a periodic bounded input signal that has period T=200 ms. You need to collect 1,000 samples per each period of the input signal. What sampling frequency should you use in configuring your AD converter?

- 5,000 Hz
- 200 Hz
- 200,000 Hz
- 50,000 Hz

$T = 200\ ms$

1,000 samples

$F = \frac{1}{0.2} = 5\ Hz$

$5 \times 1{,}000 = 5{,}000$ samples per second

$\Delta t = \frac{1}{5{,}000} = 0.2\ ms$

Question 3

3 pts

What is the minimum change of the input signal (V_{LSB}) that can be detected by a 10-bit analog-to-digital converter with the reference voltages V_{R-}=0 V and V_{R+}=3.0 V? Typie in the answer in millivolts with 2 decimal places (rounded).

2.93 mV (milliVolts)

$$V_{LSB} = \frac{V_{FS}}{2^N} = \frac{V_{R+} - V_{R-}}{2^{10}}$$

$$= \frac{3}{2^{10}}$$

V_{R+} — 2.0V

V_{R-} — 1.0

$V_{FS} = V_{R+} - V_{R-} = 1V$

$V_{LSB} = \frac{1V}{2^{10}}$

Question 4

3 pts

You are sampling an analog input signal V_{in}, 0 V <=V_{in}<= 2.5 V. If you want to detect a change in the input as low as 0.0001 V, what is the minimum resolution of an analog-to-digital converter you will need? Enter the number of bits.

Resolution: 15 bits

$V_{LSB} = 0.0001\,V$

$$\frac{V_{FS}}{2^N} < V_{LSB}$$

$$\frac{V_{FS}}{V_{LSB}} = \frac{2.5}{0.0001} = 25000$$

$\log_2 25000$

Question 5 3 pts

What is the value of an analog output created by an 10-bit DAC, if DAC_DATA=450? Assume no amplification is used and the reference voltages are V_{R-}=0 V and V_{R+}=1.5 V? Type in the answer in volts with 2 decimal places (rounded).

Output: 0.66 V

10-bit DAC

DAC_DATA = 450

$V_{R-} = 0\,V$

$V_{R+} = 1.5\,V$

$$\frac{DAC\_DATA}{2^{10}} \cdot V_{FS}$$

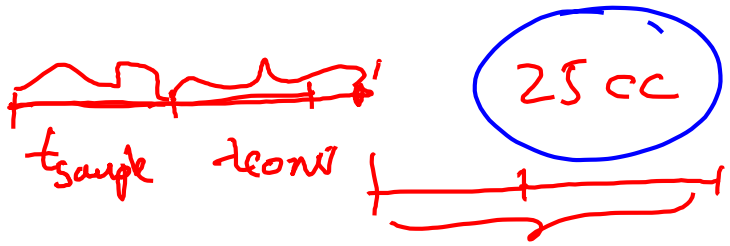
$(V_{R+} - V_{R-})$

$$= \frac{450}{1024} \cdot 1.5$$

$f_{ADC} = 5,000,000$ Hz (5 MHz)

$t_{sample} = 12$ cc

$t_{ADC12} = 13$ cc



$\frac{5,000,000}{25} = 200,000$

Question 6

3 pts

Assume an 12-bit ADC is using its internal 5,000,000 Hz oscillator as a clock source. What is the maximum number of samples you could theoretically get from the ADC if its sample time is 12 clock cycles? Conversion time is 13 clock cycles. Assume that the next conversion starts as soon as the previous one is finished.

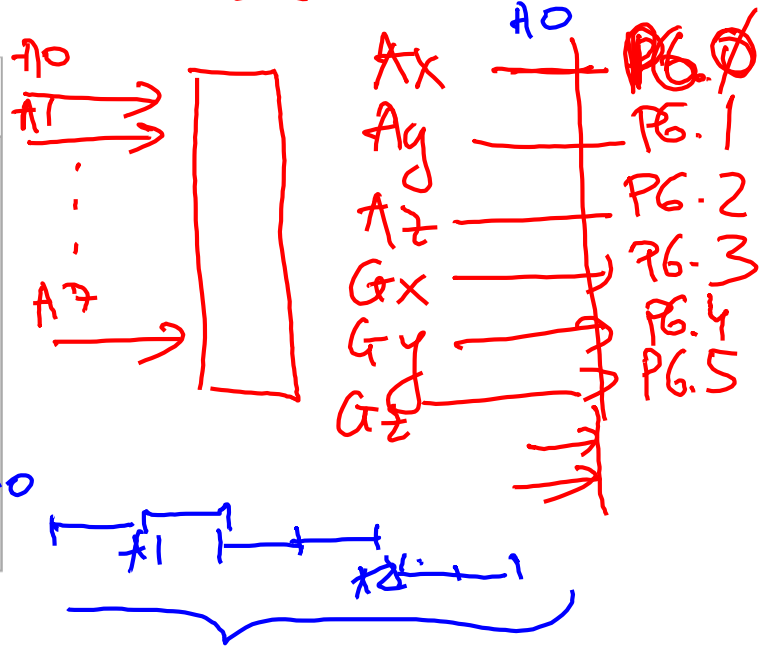
Maximum number of samples in a second is: 200,000 samples

Question 7

2 pts

You have an inertial sensor with 6 degrees of freedom (3-axis accelerometer and 3-axis gyroscope) that produces 6 analog signals ranging from 0 to V_{SUPPLY} (3 V). You can use the MSP430 ADC12 to interface the given inertial sensor.

- True
- False



Question 8

3 pts

You have an inertial sensor with 6 degrees of freedom (3-axis accelerometer and 3-axis gyroscope) that produces 6 analog signals ranging from 0 to 2.5 V. Assume that each analog input needs to be sampled with frequency of 100 Hz.

What is the minimal number of times you will enter ADC12.ISR in a second to retrieve samples?

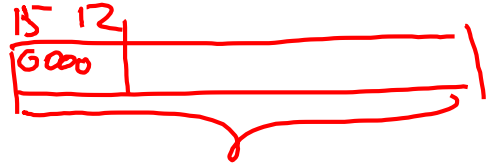
Number of times ADC12.ISR is entered in a second: 100 (enter a decimal number)

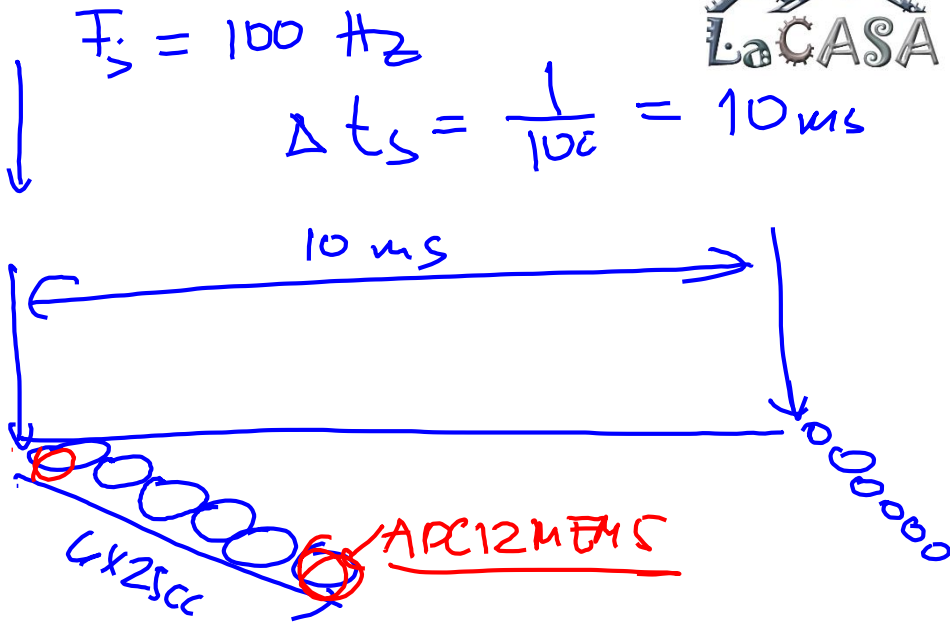
What is the total number of samples generated in a second?

The total number of samples converted by the ADC12 in a second: 600 (enter a decimal number)

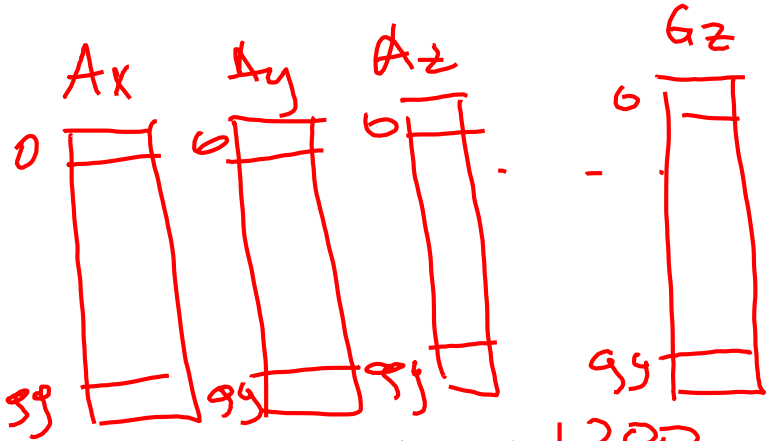
If you are buffering all samples in a RAM memory for the last second, what is the size of the RAM memory buffer needed for this task? (Do not use packing of multiple samples)

1,200 bytes





$100 \times 6 = 600$



$600 \times 2\text{bytes} = 1200$