Help

DEFINITIONS (4/4 points)

Please match the following terms with the letter of their appropriate definitions.

resolution
C **Answer:** C

precision
B **Answer:** B

accuracy
D **Answer:** D

aliasing
A **Answer:** A

A. The digital signal appears to have a different frequency than the original analog signal.

B. The number of values from which the amplitude of the digital signal is selected.

C. The smallest change in value that is significant.

D. The difference between actual and ideal values.

EXPLANATION

For a DAC, the **resolution** is the change in analog output voltage that occurs when the digital input is changed by one.

A 4-bit DAC can have 16 different outputs. When define the **precision** of a DAC as the number of different outputs. We say the precision is 4 bits or 16 alternatives.

We define **accuracy** as the difference between truth and measured. For a DAC, accuracy is the difference between what the output should be and what it actually is.

The **Nyquist Theorem** states that if we sample at f_s then we can reliably represent signals from 0 to 1/2 f_s. The converse of this theorem is if a signal exists at a frequency greater than or equal to f_s, then the signal is distorted when represented by digital samples. This distortion is a change in apparent frequency called **alaising**.

Check Hide Answer

DAC RESOLUTION (1/1 point)

A DAC has a range of 0 to 3V and needs a resolution of 1mV. How many bits are required? In other words, what is the smallest number of DAC bits that would satisfy the requirements?

12

\[12\]

Answer: 12

EXPLANATION

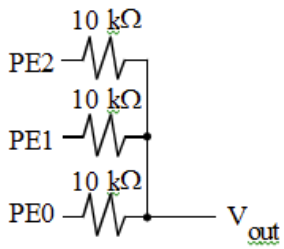
The precision is 3V/1mV=3000 alternatives. 2^{11} is 2048, which is too small. 2^{12} is 4096, which is more than 3000. So, this system requires 12 bits.

Check | Hide Answer

DAC ANALYSIS (1/1 point)

For the following DAC, what is the output voltage, Vout, when PE2 is high, PE1 is high, and PE0 is low? Assume V_{OH} is 3.3V and V_{OL} = 0V. Give your answer in volts.

Help



2.2

\[2.2\]

Answer: 2.2

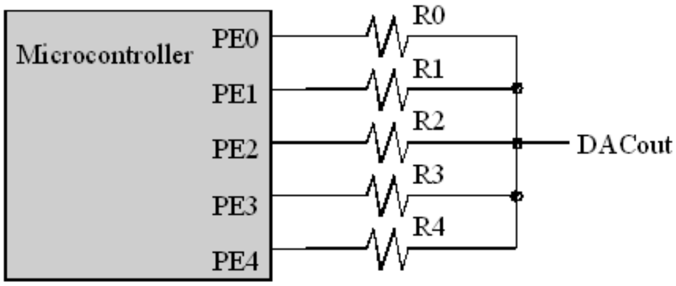
EXPLANATION

Answer: Two 10kΩ in parallel behaves like a 5kΩ. +3.3V – 5kΩ – (Vout) – 10kΩ – ground. Using the voltage divider equation = 3.3V*10kΩ /15kΩ = 3.3V*2/3 = 2.2V.

Check | Hide Answer

BINARY-WEIGHTED DAC (1/1 point)

13.4. Design a 5-bit DAC using the binary-weighted configuration. The DAC is controlled by five output port pins, PE4-0. Assume R4 is 10 kΩ. Select the values for the other 4 resistors. However, you will only enter the value needed for R0, in kΩ.



Give R0 in kΩ

160

\[160\]

Answer: 160

EXPLANATION

Answer: The largest resistor goes on the least significant bit, PE0. The smallest resistor goes on the most significant bit, PE4. The 5-bit binary weighted DAC has resistors with a 2/1 ratio. So R4=10kΩ, R3=20kΩ, R2=40kΩ, R1=80kΩ, and R0=160kΩ.

Check | Hide Answer

DAC VOLTAGE (1/1 point)

Why does the voltage decrease a lot when the headphones are attached to the DAC output?

- The headphone resistance (32Ω) is much less than the resistances in the DAC.
- Electrical power (which is voltage times current) is converted into acoustic power (sound). The small voltage times the small current will be a small power.
- Ohm's Law applies to the voltage across and current through the headphones.
- If a voltage V is applied across two resistors R1 and R2 in series than the voltage across R2 is V*R2/(R1+R2).
- All of the above ✔

EXPLANATION

All of these are correct. A DAC output voltage of 3.3V without the headphones will drop to about 0.1V with the headphones connected. This factor of 30, is approximately the relationship between the 1kΩ resistor in the DAC and the 32Ω resistance of the headphones.

Check | Hide Answer

SINE OUTPUT USING A DAC (1/1 point)

A DAC is used to output a sine wave using SysTick Interrupts and a sine wave table. Assume a DAC has 7 bits, the DAC output is connected to a speaker, the SysTick ISR executes at 10kHz, the sine table has 256 elements, and one DAC output occurs each interrupt. What frequency sound is produced, in Hz?

39

\[39\]

Answer: 39

EXPLANATION

It will take 256 interrupts to create one wave, where each interrupt produces one output. This 256 is defined by the table size, not the DAC precision. Thus the DAC wave will be 10kHz/256, which is 39 Hz.

Check Hide Answer

PITCH GENERATION (1/1 point)

How do you change the pitch of the sound generated by Program 13.1?

- Change the value of the control register in NVIC_ST_CTRL_R.
- Increase the number of bits in the DAC.
- (selected) Write a different value to NVIC_ST_RELOAD_R. ✔
- Change the interrupt priority in NVIC_SYS_PRI3_R.
- None of the above.

EXPLANATION

The period of the wave will be the interrupt period times the size of the table. To change the pitch we need to change the interrupt period. For SysTick, the interrupt period is the bus period times **NVIC_ST_RELOAD_R**+1.

Check Hide Answer

Help

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