CPEG 222 Spring 2014 Homework 3 Solution

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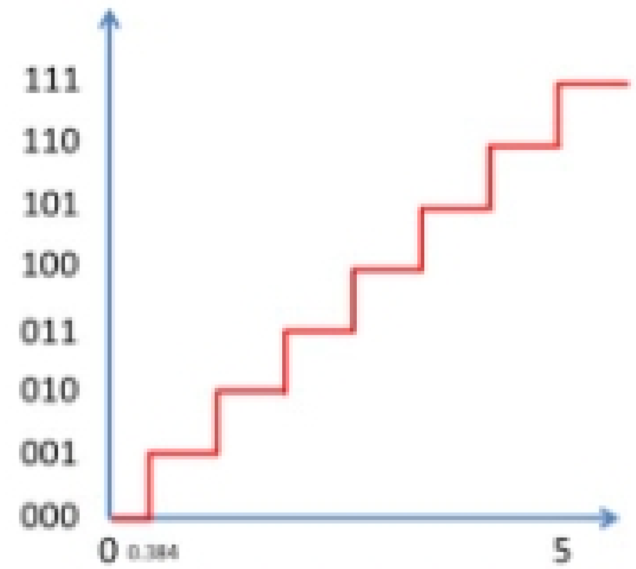
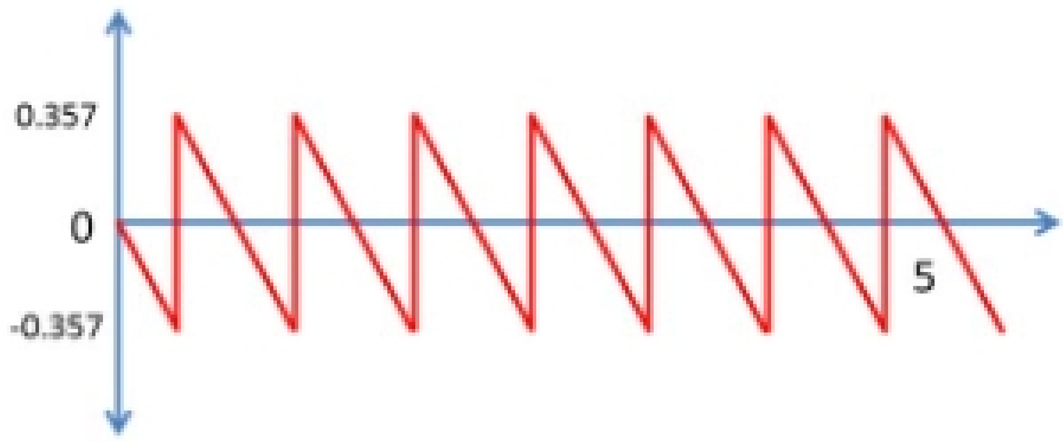
Solution of Question 1:

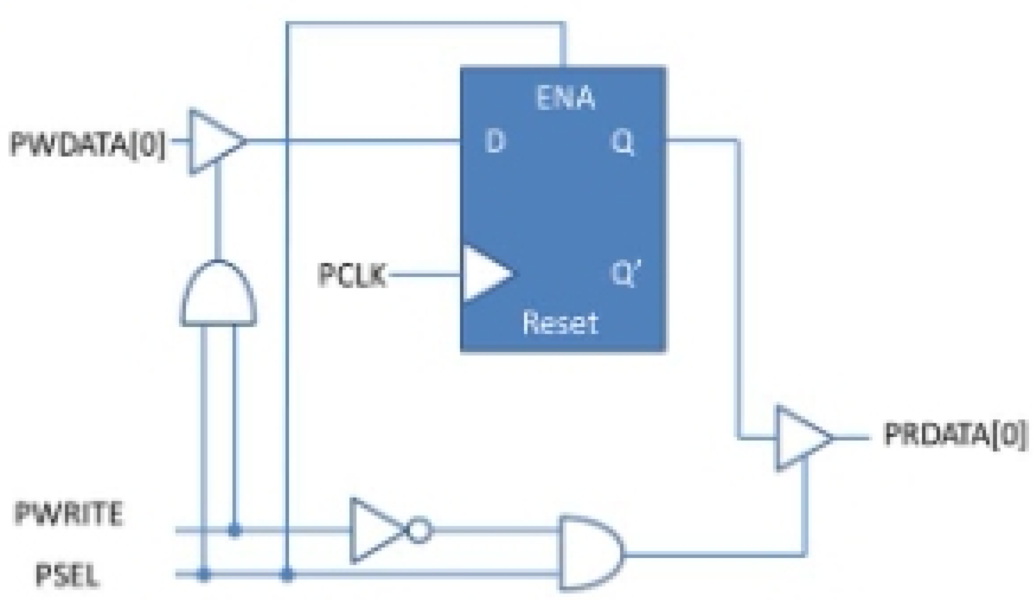




Solution of Question 2:

a) If the resolution is 4-bit, the smallest detectable change is $4/2^4$=0.25V
   If the resolution is 7-bit, the smallest detectable change is $4/2^7$=0.03125V
b) If the resolution is 4-bit, after ADC, the digital value of 3.14V is round(3.14/0.25)=13. Since 3.14/0.25=12.56, the quantization error is 0.44*0.25=0.11V.
   If the resolution is 7-bit, after ADC, the digital value of 3.14V is round(3.14/0.03125)=100. Since 3.14/0.03125=100.48, the quantization error is 0.48*0.03125=0.015V.
c) Between two consecutive interrupts, there are total 40M/40K=1024 instructions. Since 150 of them are in the ISR, the application executes 874 instructions in between.

Solution of Question 3:



Solution of Question 4:

a) If the CPU is processing graphical data that is to be displayed, allowing the graphics card to access that data without going through the CPU can prevent substantial delays.

b) If the CPU is processing sound data that is to be output by the sound card in real time, allowing the sound card to access data without going through the CPU can have extensive benefit.

DMA is useful when individual transactions with the CPU may involve large amounts of data. A frame handled by a graphics card may be huge, but is treated as one display action. Conversely, input from a mouse is tiny.

Solution of Question 5:

a) 1. $d_3d_2d_1d_0$=0111 $p_2p_1p_0$=000

Recalculate $p_2p_1p_0$: $p_2=d_3\oplus d_2\oplus d_1=0$ $p_1=d_3\oplus d_2\oplus d_0=0$ $p_0=d_3\oplus d_1\oplus d_0=0$

So this code is valid.

2. $d_3d_2d_1d_0$=0101 $p_2p_1p_0$=100

Recalculate $p_2p_1p_0$: $p_2=d_3\oplus d_2\oplus d_1=1$ $p_1=d_3\oplus d_2\oplus d_0=0$ $p0=d_3\oplus d_1\oplus d_0=1$

So this code is invalid. The difference of the original parity bits and the recalculated parity bits is 1, so the first bit p_0 has an error.

b) Since when $d_3d_2d_1d_0$=0100, $p_2p_1p_0$=110, and we have: $p_2=d_3\oplus d_2\oplus d_1$ $p_1=d_3\oplus d_2\oplus d_0$ $p_0=d_3\oplus d_1\oplus d_0$. To get parity bits 001, which is complementary value of 110, we can simply flip bit d_3 of the data. So the new data is $d_3d_2d_1d_0$=1100 and the code word is 1100001. Another way of getting the data is to flip all the bits of $d_3d_2d_1d_0$, so the new data is $d_3d_2d_1d_0$=1011 and the new code word is 1010101.

c) For any pair of data $d_3d_2d_1d_0$:

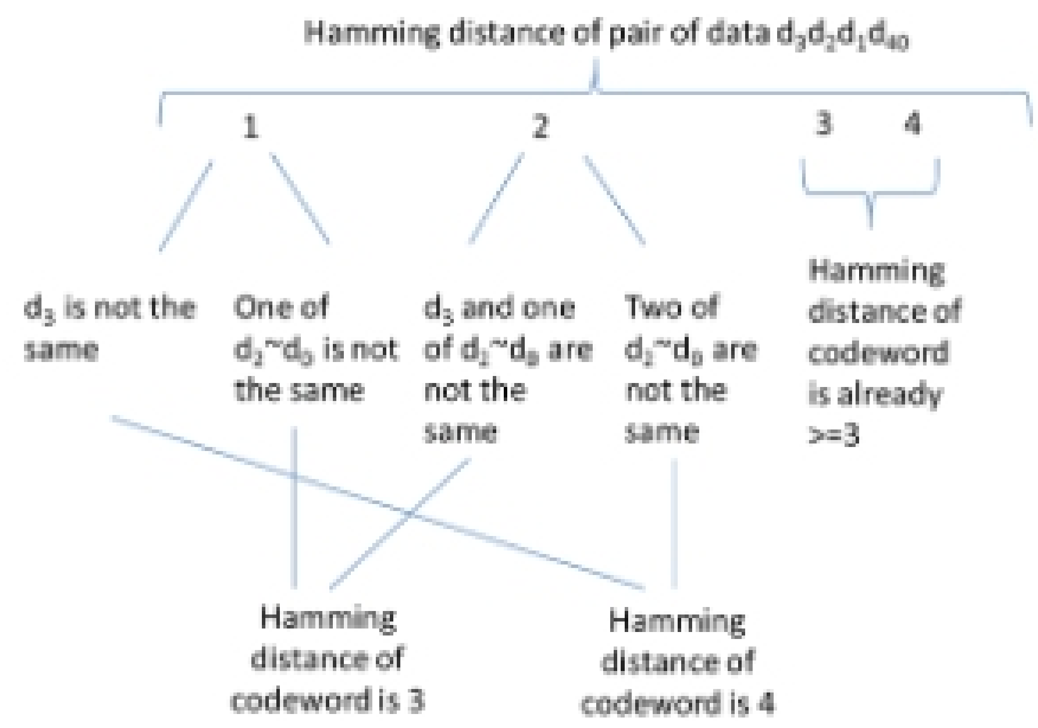
1) If the pair of data has a hamming distance of 3 or 4, then the hamming distance of the entire codewords is at least 3.

2) If the pair of data has a hamming distance of 2, there must be two bits flipped in $d_3d_2d_1d_0$. Since we have:

$$p_2=d_3\oplus d_2\oplus d_1$$
$$p_1=d_3\oplus d_2\oplus d_0$$
$$p_0=d_3\oplus d_1\oplus d_0$$

If d_3 and one of d_2, d_1 and d_0 are flipped, the parity bits $p_2p_1p_0$ will have 1 bit flipped, so the code words will have hamming distance of 3 in total. On the other hand, if two of d_2, d_1 and d_0 are flipped, the parity bits $p_2p_1p_0$ will have 2 bits flipped. So the code words will have hamming distance of 4 in total.

3) If the pair of data has a hamming distance of 1, there must be exactly one bit flipped in $d_3d_2d_1d_0$. If d_3 is flipped, the parity bits will have 3 bits flipped, so the code words will have hamming distance of 4 in total. On the other hand, if any of d_2, d_1 and d_0 is flipped, the parity bits $p_2p_1p_0$ will have 2 bits flipped. So the code words will have hamming distance of 3 in total.


Hamming distance of pair of data $d_3d_2d_1d_{40}$
1
2
3
4
d_3 is not the same
One of d_2~d_0 is not the same
d_3 and one of d_1~d_0 are not the same
Two of d_2~d_0 are not the same
Hamming distance of codeword is already >=3
Hamming distance of codeword is 3
Hamming distance of codeword is 4