Microelectronic System Final 2023 Tutorial

DT5EDU*

1 Question 1

a.

Register is a special kind of memory that is used to store data temporarily. It is used to store data that is being processed by the CPU and can be accessed directly by CPU instead of through the data bus.

Register is faster than regular memory but is more expensive. Therefore, the number of registers in a CPU is limited and the room for storing data is relatively small. In addition, registers have no address [1].

b.

The difference between microprocessor and microcontroller is as follows [2]:

Aspects	Microprocessor	Microcontroller
Size	Large	Small
Cost	Expensive	Cheap
Power Consumption	High	Low
IO Port	Few	Many
Memory	Not fixed and bigger	Fixed and smaller

c.

i.

Decrease the current intensity in the circuit [2].

ii.

The value of resistor should be 200 Ω [2].

$$R = \frac{V_R}{I} = \frac{3.3 - 2.2}{5.5 \times 10^{-3}} = 200\Omega \tag{1}$$

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d.

The answer is shown in Figure 1, in which should be awared that the unit of the time is not sure since the API *wait()* is abandoned in Mbed OS 6.

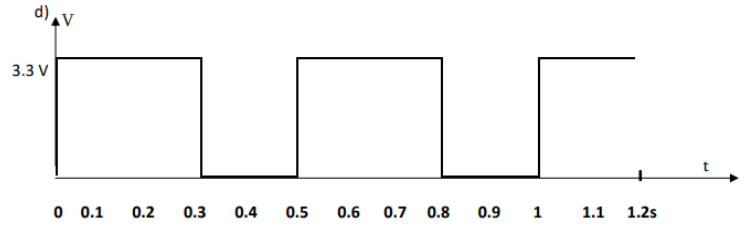


Figure 1: The answer of Question 1.d

2 Question 2

a.

i.

To increase the accuracy and speed of converter, the bit depth and the sampling rate should be increased [3].

ii.

Flash ADC has higher speed but lower bit depth than Sigma-Delta ADC [3].

iii.

The digital signal in binary is 01110100. The calculation [3] is:

$$D_{out} = \frac{(2^8 - 1)V_{out}}{V_{rf}} = \frac{255 \times 1.5}{3.3} = 116 \tag{2}$$

where 116 is 01110100 in binary.

b.

i.

Input Circuit, Voltage Switch Circuit, Resistive Network and Amplifier Circuit [4].

ii.

Input Circuit: receive input digital signal and do some filtration if neccessary. Resistive Circuit: processing input before sending to the amplifier [4].

iii.

c.

PN junction has two types of bias (shown in Figure 2), forward bias and reverse bias, whose values of resistor are relatively small and large, respectively. Thus, the current can be controlled by swithching the PN junction between forward bias and reverse bias.

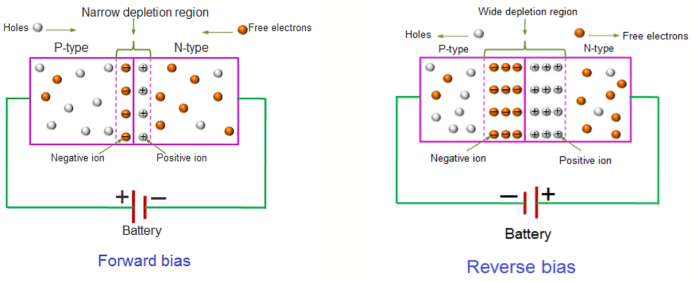


Figure 2: Two types of bias in PN junction

d.

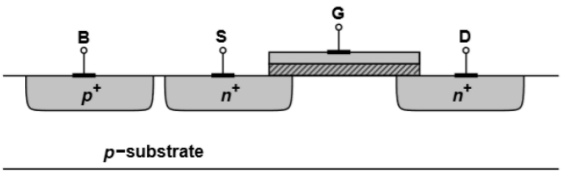


Figure 3: The answer of Question 2.d

e.

Threshold voltage is the minimum voltage that can be applied to the gate of a MOSFET to turn it on and form a channel between the source and the drain.

3 Question 3

a.

i.

$$f = \frac{1}{T} = \frac{1}{0.1 \times 10^{-3}} = 10000Hz \tag{3}$$

ii.

$$pulse\ width = 0.1 \times 50\% = 0.05ms \tag{4}$$

iii.

$$V_{average} = 5 \times 75\% + 0 \times 25\% = 3.75V \tag{5}$$

b.

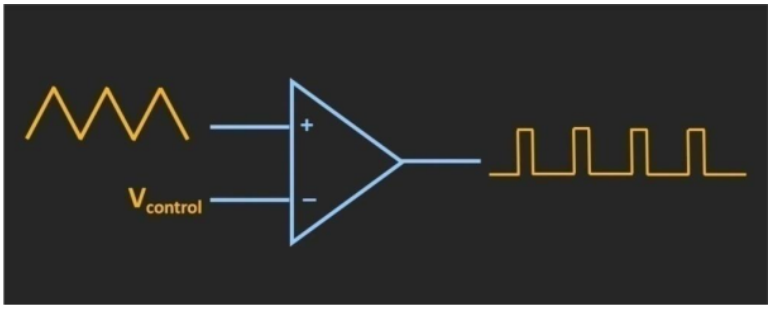
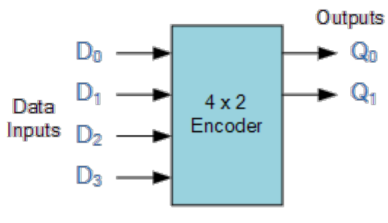


Figure 4: The answer of Question 3.b

c.



Inputs				Outputs	
D_3	D_2	D_1	D_0	Q_1	Q_0
0	0	0	1	0	0
0	0	1	0	0	1
0	1	0	0	1	0
1	0	0	0	1	1
0	0	0	0	x	x

Figure 5: The answer of Question 3.c

The Boolean function is:

$$Q_1 = D_1 + D_3 \tag{6}$$
$$Q_2 = D_2 + D_3 \tag{7}$$

4 Question 4

a.

Synchronous serial communication needs clock signal to synchronize the data transmission between the sender and the receiver. Asynchronous serial communication does not need clock signal and the data is transmitted in the form of packets.

b.

$$f_{system} = \frac{f_{crystal}}{prescalar} = \frac{160}{80} = 2MHz \tag{8}$$

c.

i.

The name of the function is *task1()*.

ii.

The main function is used to start a timer and reset the timer as well as call the function *task1()* every 200 ms.

iii.

The function *task1()* is used to change the voltage level of output 1 pin.

iv.

This function will be called every 200 ms.

v.

$$f = \frac{1}{T} = \frac{1}{400 \times 10^{-3}} = 2.5Hz \tag{9}$$

d.

i.

The data value is 00011001 (Read from right to left).

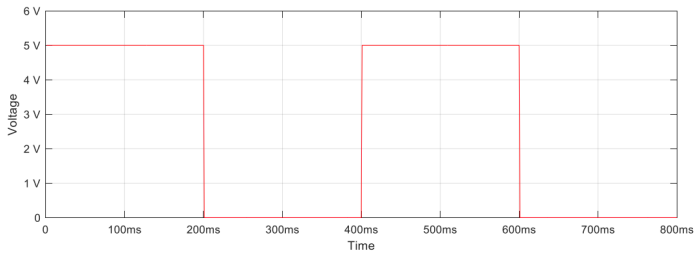


Figure 6: The answer of Question 4.c

ii.

The data frame of this UART example has 11 bits in total. There are 1 start bit, 1 parity bit, 8 data bits and 1 stop bit. Thus, the efficiency is the rate of the number of data bits to the total number of bits [5].

$$efficiency = \frac{8}{11} = 72.73\% \tag{10}$$

e.

In 16 bit number, the max number that can be stored is 65535 whereas in 8 bit number, the maximum number that can be stored is 255. It means that 65535 +1 machine cycles can be compromised in 16 bit timmer and in 8 bit timmer we can compromise only 255+1 machine cycles. Using 16 bit timmer, we can generate longer delays. Check it at `https://moodle.gla.ac.uk/pluginfile.php/8099553/mod_resource/content/1/UESTC%201008_Mock_Exam_Solution.pdf`.

f.

When I2C communication is not working, the voltage level is high. The external pull up resistor is used to make this high voltage level stable, which can effectively prevent the errors in the communication [6].

References

[1] AyaSKT. MS Review Block 1 Part.1.

[2] AyaSKT. MS Review Block 1 Part.3.

[3] AyaSKT. MS Review Block 2 Part.1.

[4] AyaSKT. MS Review Block 2 Part.2.

[5] CATEDS. MS Review Block 4 Part 0.

[6] CATEDS. MS Review Block 4 Part 2.