Technical University of Denmark

31342 Introduction to Programmable Logic Controllers

Exercise 2

Digital Systems

Student:

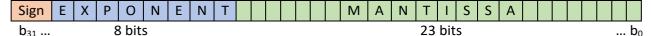Sefa Kayraklık (s186295)

Instructor:

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Spring, February 13, 2019

Task 1: Calculation of the 2's complement of decimal numbers:

- 12 = 00001100
- -64 = 2's comp of 01000000 = 10111111+1 = 11000000
- 0 = 00000000
- -127 = 2's comp of 01111111 = 10000000+1 = 10000001

Sign	E	X	P	O	N	E	N	T						M	A	N	T	I	S	S	A							

b_{31} ...   8 bits   23 bits   ... b_0

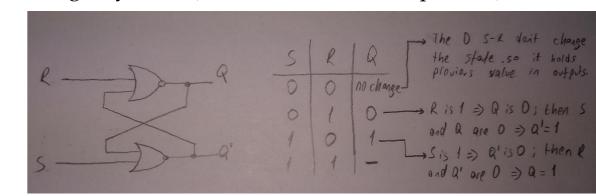The value of the number can be found according to the following formula:

$$(-1)^{b_{31}} \times 2^{(b_{30}b_{29}...b_{23})_2 - 127} \times (1.b_{22}b_{21}...b_0)_2$$

For the largest number, the sign bit should be 0 (means that it is a positive number), the exponent bits should be 11111110 (since 11111111 has special meanings such as NaN, ± inf), the mantissa bits should be all 1. So, this gives us $(-1)^0 \times 2^{254-127} \times (1 + (1 - 2^{-23})) = (2 - 2^{-23}) \times 2^{127}$

Task 2: Interpretation of the LM35DZ temperature sensor output:

- $Q = \frac{24-0}{2^{16}} = 0.366\ mV$
- The sensor has a 10 mV/°C resolution so that 1 °C increases in temperature causes 10mV increase in the output. Therefore, we can detect a change of 0.0366 °C through the PLC that is connected directly.
- The output voltage of the sensor has a range 0-400 mV in the temperature range of 0°C - 40°C. In order to span all voltage values that can be given to the PLC converter module, we should amplify the output voltage of the sensor with the factor of 60. (this gives us the maximum value as 24 V.)

Task 3: Logic Systems (combinational and sequential)

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- The system driving a traffic light is a sequential logic since every light turns on according to their time indicators that determine how much time to light on or off. So, these time indicators use simply a counter to track the time, namely it should have a memory. And memory means that is sequential.