Digital Lab 2 Worksheet

Name Mary-Rose Tracy

Course/Section 002

Please complete the following steps to complete the second digital lab:

1. Using a type A to micro B USB cable, connect the breadboard to the USB port of the computer.

2. Take the blue LED and a 220 ohm resistor (red-red-brown) in series as shown in the circuit above and connect them across the red and blue distribution strip at a point by the USB connector so it is out of the way for the next steps. It should glow brightly.

3. Configure the NE555 timer using the circuit provided above, using the resistor and capacitor values shown earlier in the document.

4. Connect the output of the timer to an orange LED and resistor in series. Count the number of times the orange LED lights up during a 1 minute interval and calculate the frequency of the clock below:

$\frac{47}{60} = 0.78$

Number of flashes / minute: 43 ≈ 47 Frequency of clock: 0.716 (Hz) $\frac{43}{60} = 0.716 \approx$ or 4

5. Configure the 4-bit counter using the circuit provided above, connecting the clock input to the output of the timer in step 3. Connect 4 green LEDs and 4 resistors in series to the Qd, Qc, Qb, and Qa outputs. Connect the D/~U pin to the center connection of the slide switch that is separated from the other 4 slide switches.

led sequence 0-15

6. Move the slide switch so that the D/~U pin is low. Write down the LED sequence below:

	Qd	Qc	Qb	Qa
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
10	1	0	1	0
11	1	0	1	1
12	1	1	0	0
13	1	1	0	1
14	1	1	1	0
15	1	1	1	1

7. Move the slide switch so that the D/~U pin is high. Write down the LED sequence below:

Qd	Qc	Qb	Qa	
1	1	1	1	15
1	1	1	0	14
1	1	0	1	13
1	1	0	0	12
1	0	1	1	11
1	0	1	0	10
1	0	0	1	9
1	0	0	0	8
0	1	1	1	7
0	1	1	0	6
0	1	0	1	5
0	1	0	0	4
0	0	1	1	3
0	0	1	0	2
0	0	0	1	1
0	0	0	0	0

8. Configure the comparator as shown above. Connect the output of the counter (Qd:Qc:Qb:Qa) to comparator A inputs (A3:A2:A1:A0). Connect the center connection of the remaining 4 slide switches to the comparator B inputs (B3:B2:B1:B0). Connect 4 red LEDs and 4 series resistors to the output of each slide switch. Connect 3 LEDs with colors of your chosing with series resistors to the (A = B) OUT, (A < B) OUT, and (A > B) OUT.

9. Set the slide switch connected to the D/~U input so that it is low. Set the other 4 slide switches so that the B input to the comparator (B3:B2:B1:B0) is equal to 0110 (binary).

Record the value of the counter and status of the comparator outputs for each value below:

	A3:A2:A1:A0	(A = B) OUT	(A < B) OUT	(A > B) OUT
0	0000	off	on	Off
1	0001	off	on	off
2	0010	off	On	off
3	0011	off	on	Off
4	0100	off	on	off
5	0101	off	on	off
6	0110	on	off	off
7	0111	off	off	on
8	1000	off	off	on
9	1001	off	off	on
10	1010	off	off	on
11	1011	off	off	on
12	1100	off	off	on
13	1101	off	off	on
14	1110	off	off	on
15	1111	Off	off	On

10. Write a C99 program compiled with GCC on the RPi 3b/3b+ that uses two 8-bit unsigned integers (uint8_t) variables named "a" and "b". The initial value of a=0 and b = 6. The program should contain a single for loop that increments the "a" variable a total of 512 iterations (the counter will wrap around once). The program should output the resulting 512 values in the format below:

a	a == b	a < b	a > b
0	0	1	0
1	0	1	0

....

While the C program uses a 8-bit integer and the hardware circuit uses a 4-bit integer, the modulo nature of the counter is the same. The comparator operation is also the same.

11. Write a C99 program compiled with GCC on the RPi 3b/3b+ that uses two 8-bit unsigned integers (uint8_t) variables named "a" and "b". The initial value of a=0 and b = 6. The program should increment the "a" variable modulo 16 [a = (a+1) % 16] a total of 32 times using a for loop (the counter will wrap around once). The program should output the resulting 32 values in the format below:

a	a == b	a < b	a > b
0	0	1	0
1	0	1	0
....			

Verify that this program output matches the operation of the hardware exactly.

12. Lab checkout steps:

a. Show your working circuit and program to the grader.

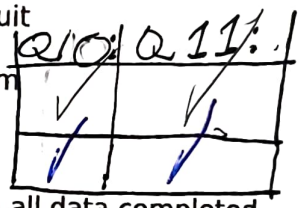
b. Create a file, lastname_netid_lab3.zip, that includes the following files:

√ A JPEG image of your working circuit

- The source code your your program

- The output of your program

√ This completed lab worksheet with all data completed



c. Upload the zip file to Canvas.

d. After your have your picture and send the zip file, dismantle your circuit and return everything to the box on the shelf. Do not remove the USB adapter, slides switches, or the pre-loaded red and black wires.

Thank you for attending the lab. We hope some of this material was new and interesting to you.

In the next lab, we will learn how to interface the real world with the RPi.

Drs. Losh and Eary