

Digital Lab - Part 2 (Lab 3)
Worksheet

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Course/Section ___ 007 ___

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

1. Using a type A to mini B USB cable, power the breadboard from 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 as shown in the circuit provided at the end of the assignment, 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:

Number of flashes / minute: ___45___

Frequency of the clock: ___0.75___ (Hz)

5. Configure the 4-bit counter as shown in the circuit provided at the end of the assignment, 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.
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	0	0	1
0	0	1	0
0	0	1	1
0	1	0	0
0	1	0	1
0	1	1	0

0	1	1	1
1	0	0	0
1	0	0	1
1	0	1	0
1	0	1	1
1	1	0	0
1	1	0	1
1	1	1	0
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
1	1	1	0
1	1	0	1
1	1	0	0
1	0	1	1
1	0	1	0
1	0	0	1
1	0	0	0
0	1	1	1
0	1	1	0
0	1	0	1
0	1	0	0
0	0	1	1

0	0	1	0
0	0	0	1
0	0	0	0

8. Configure the comparator as shown in the circuit provided at the end of the assignment. 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 choosing 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	0	1	0
1	0	1	0
2	0	1	0
3	0	1	0
4	0	1	0
5	0	1	0
6	1	0	0
7	0	0	1
8	0	0	1
9	0	0	1
10	0	0	1
11	0	0	1
12	0	0	1

13	0	0	1
14	0	0	1
15	0	0	1

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 repeat in the middle). The program should output 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 repeat in the middle). 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:

- Show your working circuit and program to the grader.
- 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 you 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.

- Professors Losh and Davis