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ECE 218 – Section: L04

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Lab 7: Design of Multi-bit and Synchronously Presettable Counters Objective

Date of the Experiment: 10/27/2023

Due Date of the Experiment: 11/3/2023

I. Introduction

a) Purpose:
The aim of this experiment is to understand counters and their role in electronics. Designing and implementing counters using the concept of a two-bit gray code and TTL counter chips.

b) Scope:
Some of the limitations are this experiment covers binary counters and their basics. It does not dive down into advanced counting sequences or complex counter applications, which is something that you can see in the real world. Also this experiment focuses on binary counters and doesn't cover more complex counter types which is something that would be in more advanced digital design experiments.

II. Theory

a) What is the theoretical basis of this experiment?

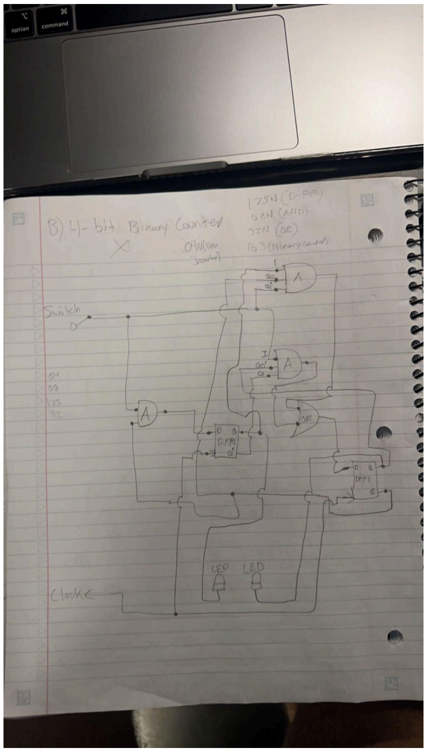
The theoretical basis of this experiment is using concepts of sequential logic circuits, binary counters, and the utilization of TTL counter chips. This lab also gives a good understanding of counters, their design principles, and their practical uses in the digital system world.

b) What preliminary work was required before the lab session itself?

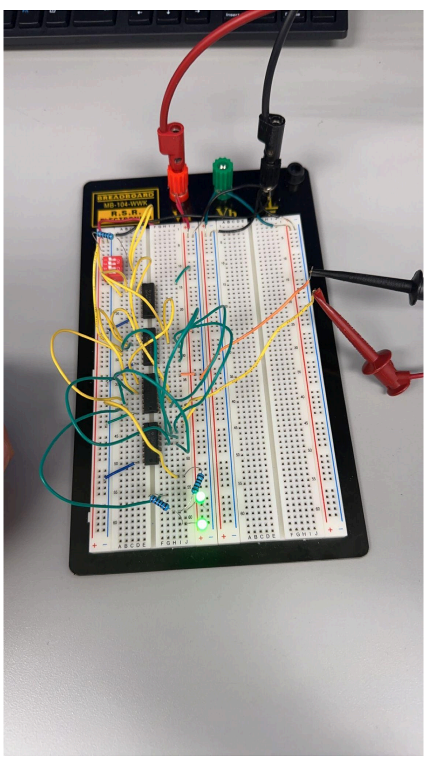
Some of the preliminary work that was needed before the lab session was to answer 6 pre-lab questions prior to starting the lab. These questions have a range of topics related to binary counting, Gray code counters, and counter design using flip-flops and combinational logic. The first question asks, "What range of values does a 10-bit binary counter go through." The second question is to draw the state diagram and state transition table for a 2-bit Gray code counter and to design the 2-bit Gray code counter with enable using D flip-flops and combinational parts. The next question was asking to draw a schematic showing how three 74LS163 counters can be connected, design a specialized counter with two inputs C0 and C1, and to create a schematic draft and breadboard draft for the circuit.

III. Experimental procedure

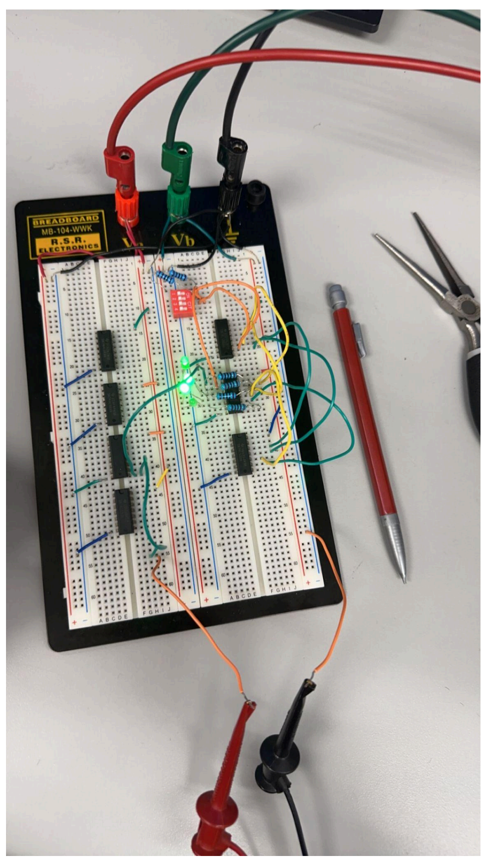
a) Schematic: Neatly drawn schematic, block diagram, etc., of the circuits used in the experiment, Include the test equipment.



B) 4-bit Binary Counter
175N (D-FF)
08N (AND)
32N (OR)
163 (Binary Counter)
Switch
04
08
175
32
A
OR
D.F.F0
DFF1
LED
LED
Clock



BREADBOARD
MB-104-WWK



BREADBOARD
MB-104-WWK
R.S.R.
ELECTRONICS

b) Procedure: Outline the methods used in the experiment. **<u>Write this so that someone could replicate your experiment/results by reading your procedure!</u>**

1.) <u>First Part of Experiment</u>

2.) <u>Put your switch all the way at the top left of your breadboard on the ground</u>

3.) <u>Grab a resistor and connect from power slot to the first slot of the switch</u>

4.) <u>Put it all of your chips in order of Hex Inverter gate, AND gate, Flip-flop, OR gate</u>

5.) <u>Ground and power each chip</u>

6.) <u>Next grab a wire and connect from the slot of your first resistor to the first slot of your Hex Inverter gate</u>

7.) <u>Now grab a wire and connect from the second slot of your Hex Inverter gate, to the second slot of your AND gate</u>

8.) <u>Grab a wire and connect from the first slot of your NOT gate to the second slot of your Hex Inverter gate</u>

9.) <u>Grab a wire and connect from the third slot on the left side of the AND gate to the second slot of your Flip-Flop gate</u>

10.) <u>Next connect a wire from the second slot of your AND gate to the fourth slot of your AND gate, then another wire from the Fifth slot of your AND gate to the fifth slot of your Flip-Flop gate</u>

11.) Connect a wire from the third slot of your AND gate to the third slot of your OR gate

12.) Next connect wire from Q output of Flip-Flop to anywhere on the bottom of the board

13.) Now grab a resistor and connect it to the slot next to that wire and any point of your breadboard

14.) Now connect a green led from the slot next to that resistor to ground slot

15.) Connect a wire from D output of Flip-Flop to anywhere on bottom of the board

16.) Now grab a resistor and connect it to the slot next to that wire and any point of your breadboard

17.) Now connect a green led from the slot next to that resistor to ground slot

18.) Connect a wire to a ground and grab your hook and connect to end of wire

19.) Connect a wire to CLK(clock) output of your flip-flip and connect end of wire to your hook

Part 2:

1.) Leave everything from left side but disconnect the wires

2.) Grab a switch and connect to upper right of your breadboard(onto ground)

3.) Grab two resistors and put it the first two slots of your switch

4.) Connect your three chips on left side of breadboard in this order, AND gate, OR gate, NAND gate

5.) Power and ground each chip

6.) Grab a wire and connect from first slot of switch to the sixth slot of your first chip(left side)

7.) Grab a wire and connect from second slot of switch to fourth slot of first chip(left side)

8.) Grab a wire and connect from third slot of switch to second slot of your second chip

9.) Connect a wire from sixth slot of first chip(left side) to fourth slot of third chip (left side)

10.) Connect a wire from fifth slot of first chip(left side) to third slot of your third chip on the left side

11.) Connect a wire from the fifth slot of your second chip to the fifth slot of the third chip(left side)

12.) Connect a wire from the second slot of your second chip(right side) to the CLK(clock) of your flip-Flop

13.) Connect a wire from the clock output of the flip-flop to anywhere on the bottom of your breadboard

14.) Connect a wire from the slot next to that and then attach a hook on the other side of the wire

15.) Next connect LEDS to all the inputs(Qa, Qb, Qc, Qd) on the right side of your second chip to then power slot

16.) Next connect a resistor to the slots right next to all the green legs and put the other side of that on the left side of your second chip.

c) All apparatus:

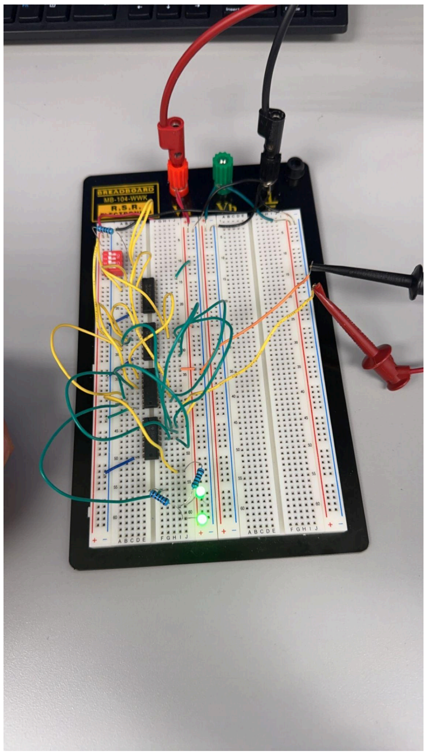
BreadBoard R.S.R Electronics: MB-104-WWK

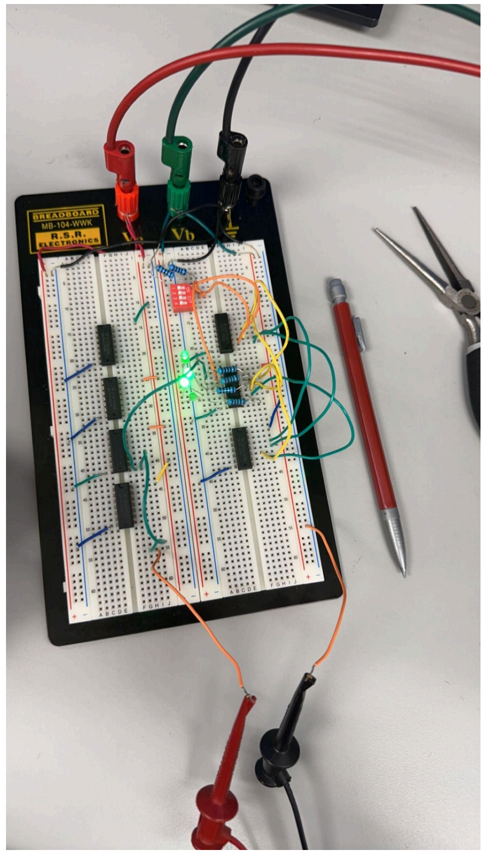
Keysight Power Supply: EDU36311A

Digital Multimeter: DT820B

Keysight WaveForm Generator: EDU33212A

d) Results:





IV. Interpretation

a) Compare your results with the expected results.

Some of my results that I got when doing this experiment was when doing the first part of the lab, 2-Bit Gray Code, when I had my switch set to 1111, the the first green led would turn on, then it would transition to both being turned on, transitioning into only the left one turned one, and then finally transitioning into both of the leds turned off, and repeat. The results I got when doing the second part of the lab, 4-bit binary counter, was when I had my switch set to 1111, only the middle leds would turn on and flicker on and off. The expected result was supposed to start at 0000, which is 0, and then work its way up to 1111, which is 15, and then it would reset back down to 0000, 0.

b) Answers to theoretical questions

1.) The counter is used to measure the frequency of a signal. It does this by counting the number of cycles in a given time period. The counter is also used to divide the input clock frequency by a fixed integer value.

2.) You would use the counter because they're essential for controlling the sequencing and timing of operations within a computer. This will help to coordinate the flow of data and control signals to make sure the computer functions correctly.

c) Discuss possible sources of error... **even if your experiment went perfect, there still needs to be a discussion on error!**

One of the errors I got in this lab was in the first part I connected the wires from the first AND gate output to Q instead of D. My second source of error for that part was not powering my OR gate on. My last error I got when trying to finish the second part of the experiment was not connecting my clock output correctly which resulted in me getting wrong results.

V. Conclusions

What I can conclude from this lab is given the concept of how to build a 2 bit and 4 bit counter you can apply this to any digital design project to make either a 2 bit adder or a 4 bit adder that will count to the value of 15.