Faculty of Engineering and Technology Department of Electrical and Computer Engineering

ENCS 2110

Digital Electronics and Computer Organization Lab
Experiment No. 6

Sequential Logic Circuits using Breadboard and IC's

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Abstract

In this experiment, we studied the principles of sequential logic circuits using breadboards and integrated circuits. We focused on **seven-segment displays**, their drivers/decoders (IC7447), and decade counters (IC7490). The objectives were to understand the functionality of seven-segment displays, identify their pin configurations, design a decade counter circuit, and integrate it with the display driver. We built circuits to test the operation of the display segments, turn off all segments, and implement a decade counter to display numbers from 0 to 9. During the experiment, we successfully operated the seven-segment display, decoded binary-coded decimal (BCD) inputs into readable outputs, and ensured the counter functioned as intended. We also observed the importance of using current-limiting resistors to protect the LEDs and maintain uniform brightness. This experiment demonstrated how sequential logic is applied in real-world systems such as digital clocks and counters, reinforcing our theoretical knowledge while enhancing our practical skills in designing and troubleshooting digital circuits.

Table of Contents

Table of Figures

List of Tables

1. Theory

This experiment focuses on the operation of sequential logic circuits, specifically using **seven-segment displays**, **BCD-to-seven-segment decoders (IC7447)**, and **decade counters (IC7490)**. These components are fundamental in building counters, timers, and digital displays.

1.1 Seven-Segment Display

A seven-segment display is a common device used in digital electronics for displaying decimal numbers and some alphabetic characters. It consists of seven LEDs arranged in a specific configuration to form the numbers 0–9. Depending on the configuration, the display can be of two types:

Common Anode (CA): All LED anodes are connected to a common positive supply (+5V). Segments are activated by setting the cathode input to LOW.

Common Cathode (CC): All LED cathodes are connected to the ground (0V). Segments are activated by setting the anode input to HIGH.

Current-limiting resistors are used with the display to protect the LEDs from excessive current, ensuring consistent brightness and preventing damage.

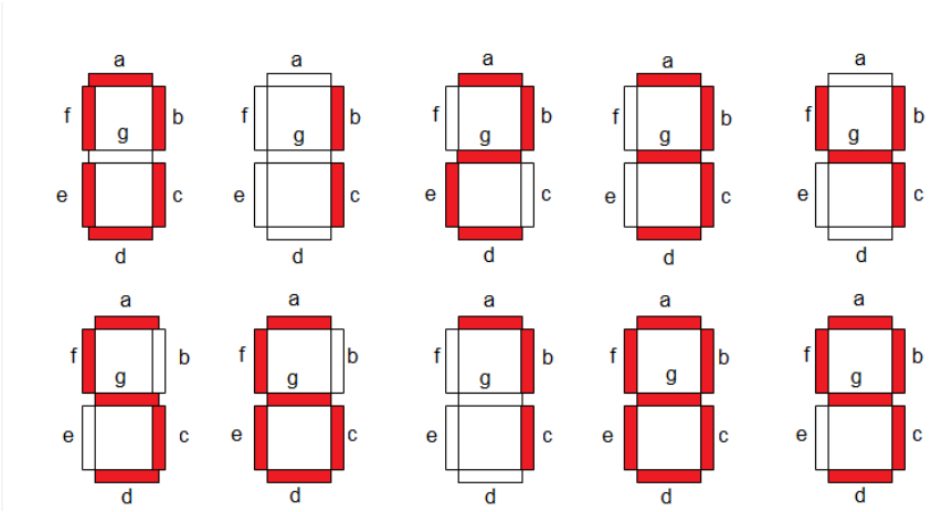

Figure 1.1.1: 7segment display(electronics-fun.com)

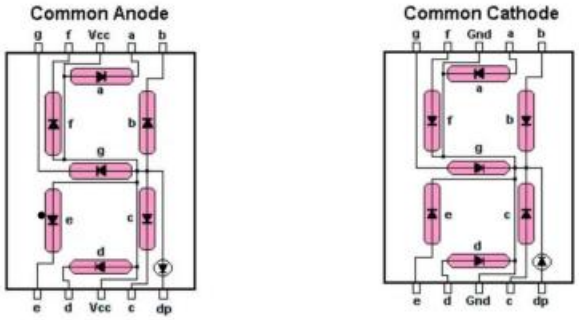

Figure 1.1.2: common anode/cathode display(Lab Manual)

1.2 BCD-to-Seven-Segment Decoder (IC7447)

he IC7447 is a decoder/driver that converts a binary-coded decimal (BCD) input into appropriate signals to drive a seven-segment display.

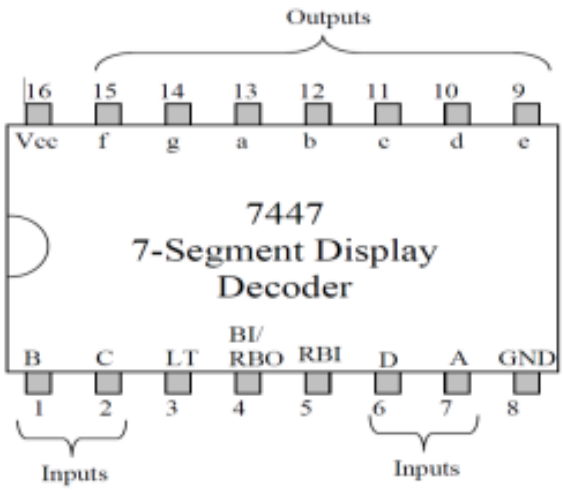

Figure1.1.3: 7447 pin assignments(lab manual)

Pin name	Description
A, B, C, D	BCD inputs: D is the most significant input (DCBA)
a, b, c, d, e, f, g	Decoder output (Active Low)
RBI	Ripple Blanking Input (Active Low)
BI/RBO	Blanking Input (Active Low) Ripple Blanking Output (Active Low)
LT	Lamp Test input (Active Low)

Table 1.1: 7447 pin descriptions(Lab manual)

Key features of the IC7447 include:

Lamp Test (LT): Verifies the functionality of all display segments., **Blanking Input (BI)**: Turns off all segments when LOW.

Ripple Blanking Input/Output (RBI/RBO): Used for blanking leading zeros in multi-digit displays.

1.3 Counter

The IC7490 is a divide-by-10 (decade) counter that counts from 0 to 9. It operates based on clock pulses and can be used in conjunction with the IC7447 to display the count on a seven-segment display.

Clock pulses are applied to the input (pin 14).

The counter provides a BCD output to the decoder.

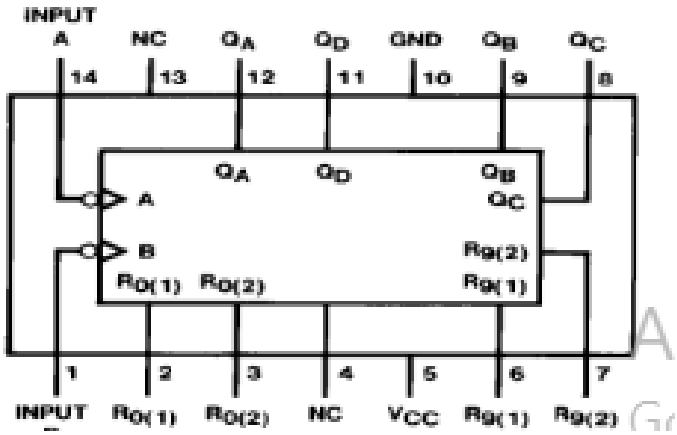

Figure1.4: 7490 counter pin assignments(Lab Manual).

Reset Inputs				Outputs			
R0(1)	R0(2)	R9(1)	R9(2)	Q_D	Q_C	Q_B	Q_A
H	H	L	X	L	L	L	L
H	H	X	L	L	L	L	L
X	X	H	H	H	L	L	H
X	L	X	L	COUNT			
L	X	L	X	COUNT			
L	X	X	L	COUNT			
X	L	L	X	COUNT			

Table1. 2: Reset/count function table(Lab Manual).

2. Procedure and Discussion:

2.1 BCD Counter

In this experiment, we began by testing the functionality of the seven-segment display using the IC7447 decoder. We placed both components on a breadboard and connected the circuit To ensure that all segments of the display were working properly, we connected pin 4 and pin 5 of the IC7447 to the +5V power supply and pin 3 (Lamp Test) to the ground, which illuminated all segments of the display.

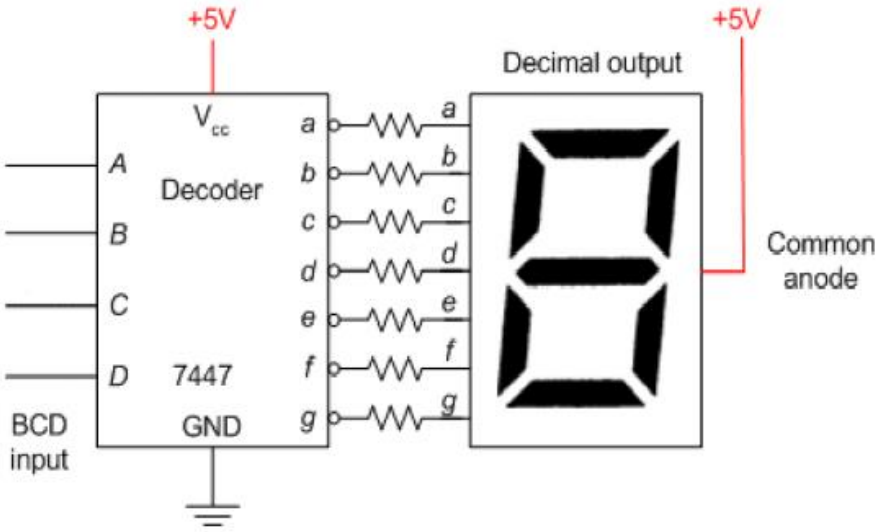

Figure2.1: display-decoder connection.(Lab Manual)

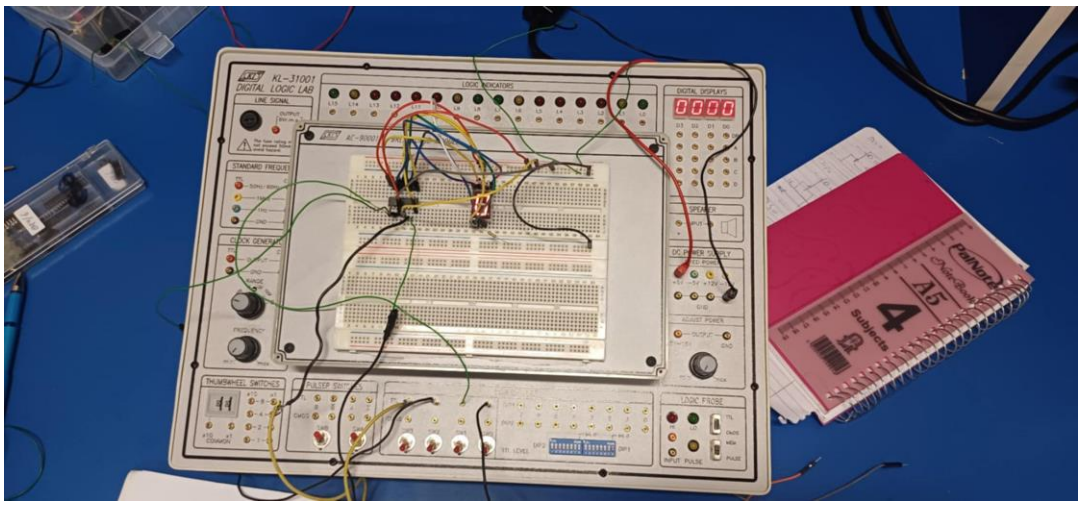

Figure2.2:(Circuit assembly in the laboratory)

Finally, we implemented a decade counter circuit using the IC7490 counter, the IC7447 decoder, and the seven-segment display. The circuit was carefully designed and assembled based on the pre-lab design. we applied clock pulses to pin 14 of the IC7490 using both a pulser switch and a pulse generator. The counter successfully displayed numbers from 0 to 9 on the seven-segment display, demonstrating its proper functionality.

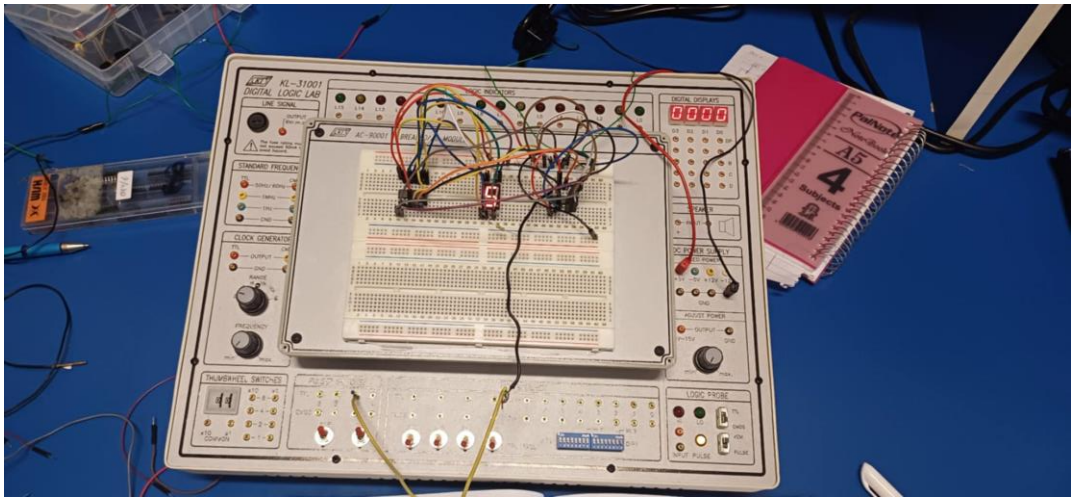

Figure2.3:(Circuit assembly in the laboratory)

D1
5
6
7
8
9
0
1
2

Table 2.3: Data for part 2.1

2.2 Discussion

During this experiment, we worked with a common cathode seven-segment display to explore sequential logic circuits. We began by testing the seven-segment display using the IC7447 decoder. By connecting pin 3 (Lamp Test) of the IC7447 to the ground, we successfully illuminated all the segments of the display, confirming that the display was functioning properly and there were no hardware issues. Next, we tested the blanking functionality by connecting pin 4 (Blanking Input) of the IC7447 to the ground. This action turned off all the segments, verifying that the decoder could blank .the display when needed

We then proceeded to build a decade counter circuit using the IC7490 counter, IC7447 decoder, and the seven-segment display. After carefully designing and assembling the circuit on the breadboard, we applied clock pulses to pin 14 of the IC7490 using a pulser switch and later a pulse generator. The seven-segment display successfully showed numbers from 0 to 9, demonstrating the proper operation of the counter and decoder

During the experiment, we noticed that manual clock pulses from the pulser switch were not entirely consistent, but switching to the pulse generator provided steady .clock pulses and resolved this issue

Overall, the experiment successfully demonstrated the functionality of a decade counter using a common cathode display, and the results matched the theoretical expectations.

3. Conclusion:

In this experiment, we successfully designed and implemented a sequential logic circuit using a seven-segment display, IC7447 decoder, and IC7490 decade counter. The objectives were achieved by demonstrating the proper functionality of the display, understanding the role of the decoder, and implementing a counter that displayed numbers from 0 to 9.

Key conclusions from the experiment include:

The Lamp Test feature of the IC7447 proved essential in verifying the integrity of the seven-segment display before proceeding with further circuitsThe Blanking Input (BI).

effectively controls the display, highlighting its importance in applications requiring .blanking

The IC7490 decade counter accurately converted clock pulses into BCD outputs, and the IC7447 decoder translated these outputs into visual numbers on the display.

The use of current-limiting resistors ensured uniform brightness and protected the LEDs from overcurrent, showing the importance of proper circuit design for safety and efficiency.

This experiment provided a deeper understanding of sequential logic circuits and their practical applications in digital systems, such as counters and timers. It also enhanced our skills in designing, assembling, and troubleshooting digital circuits.

References:

[1]:. [online image] [Accessed on 18th November 2024]

https://images.app.goo.gl/iW8fcYXf8ZRexcyX6

[2]: : Manual for Digital Electronics and Computer Organization Lab, 2023, Birzeit University.