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Seven Segment Display Circuit Simulation using Electronics Workbench

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Abstract:

A seven segment display, or in Indonesian it is called a seven segment display, is an electronic device consisting of segments that are used to display decimal numbers or numbers. This journal will explain how to simulate a seven segment display circuit using computer software called Electronics Workbench. This simulation is done to help understand how a seven segment display circuit can work, and because this is a simulation, there is no need to be afraid of failure, or making mistakes. This simulation is done by connecting a seven segment display with a 74 series Digital IC, you can use a 7447 or 7448 IC, because the function is still the same, and the IC formation is still the same, and is suitable for connecting seven segment displays. Then the IC is controlled via a switch / button that is connected directly to the IC, and the switch and IC are also connected to a power source, so that the circuit simulation can run. The results of this simulation show that the simulation can be done well in the Electronics Workbench software, can be a medium of learning about how seven segment displays work, and so that we can more easily understand how electronic devices work.

Keywords: Seven segment display, Electronics Workbench, Digital IC

1. Introduction

In this rapidly developing era, we are all required to continue to learn, make something new, and make new creations so that it is not left behind by the times, and is not eaten by time. Especially technology, where technology is always developing all the time, and its development is happening rapidly. Today, technology has become a part of our lives. Without technology, our life would not be as easy as it is today. Even from ancient times, this technology has helped a lot of mankind in doing their jobs. For example, electronic devices. (Alas and Ferdiansyah, 2021; Setyowati et al., 2021; Panambunan-Ferse and Breiter, 2013; Raharjo and Utomo, 2021)

Electronic devices are devices that use electricity as a source of energy. Both electricity in direct contact, as well as electricity obtained from batteries. Of the thousands of types of electronic devices that exist, one of the most frequently used in electronic devices is a circuit, or it can also be called an IC (Integrated Circuit). IC is an Active Electronic Component consisting of a combination of hundreds, thousands and even millions of Transistors, Diodes, Resistors and Capacitors which are integrated into an Electronic Circuit in a small package. The main material that makes up an Integrated Circuit (IC) is a Semiconductor Material. Silicon is a semiconductor material that is most often used in Integrated Circuit (IC) Fabrication Technology. In Indonesian, Integrated Circuit or IC is often translated as Integrated Circuit. And thanks to these ICs, new electronic innovations have emerged, for example such as Digital ICs. Digital IC is basically a switching circuit whose Input and Output voltages only have 2 (two) levels, namely "High" and "Low" or in binary code denoted by "1" and "0". Digital ICs generally function as flip-flops, logic gates, counters, memory, microprocessors, microcontrollers, etc. (Lin et al., 2011; Alam et al., 2018; Ji et al., 2019; Hsu, 2003)

Besides IC, the electronic component that is often used is the Seven Segment Display, or in Indonesian it is called the seven segment display. The seven segment display is an Electronic component that can display decimal numbers through the combinations of its segments. The seven segment display has 7 Segments where each segment is controlled ON and OFF to display the desired number. The numbers from 0 (zero) to 9 (Nine) can be displayed using several combinations of Segments. (Genevra et al., 2013; Yamashita et al., 2010; Savolainen et al., 2016; Al-Husainy and Al-Sewadi, 2018)

For this research, we will not implement a seven-segment screen directly, but will use a simulation through a computer software called Electronic Workbench. EWB (Electronics Workbench) is software whose purpose is to simulate the workings of a circuit like analog or digital. This simulation is used to find out whether the circuit can

work properly according to the theory used, as well as knowledge of electronics, without having to make a real or actual circuit. This way, we don't need to buy other electronic devices to try the seven-segment screen. (Sari, 2018; Islahudin and Soeharto, 2020; Hutagalung et al., 2020; Suprapto et al., 2020)

But Electronics Workbench also has some drawbacks, including software that is classified as very old, and there are no more recent updates. So, the list of ICs, logic gates, etc. is not as large as what is in the real world today. Besides that, this software is quite good for simulating the workings of various electronic devices. And because this is a simulation (not real), so we don't need to be afraid or even feel lost, because the simulation can be repeated, and there will be no damaged components, unlike direct experiments which have to spend money to buy components, electrical tools and so on. Not to mention the possibility of failure due to personal error, or charred components. (Saputra et al., 2021; Susilawati et al., 2021; Makiyah et al., 2022)

2. Literature Review

Several stages of the research method used in this study are as follows:

2.1. Collecting data

At this stage, data/information collection will be carried out, and obtained from the internet, or other media related to the material.

2.2. Literature review

At this stage, materials and references will be collected on matters relating to the simulation of the seven-segment display circuit, and the Electronics Workbench software used to perform the simulation.

2.3. Start simulation

After gathering various information, sufficient references, it is time to do a simulation using the Electronics Workbench software.

3. Results and Discussion

3.1. Network design

Before starting circuit testing, we first design the circuit to completion. First, when you are on the main screen of the Electronics Workbench software, click on the “Indicators” menu. Then there is a floating window, select in the picture “Seven-Segment Display”, press and drag it to the middle until a series appears. The stages can be seen in Figure 1, as follows:

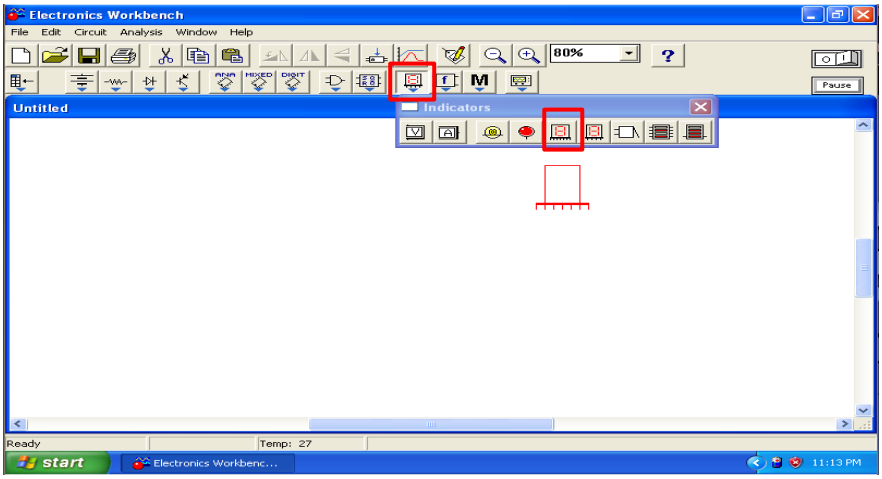

Figure 1. EWB Main Display & Seven Segment Circuit Drawing

Then now add the name Decoder. This decoder connects the seven segment display with the switch/button later. Select the "Digital Ics" menu, a floating window appears again, select "74xx" in the image. After that a new window appears, scroll down a bit, and look for the words "not used 7448 (BCD-to-7-Seg Decoder/Driver)", then select it, and click Accept". Actually, it is possible to use the 7447 series because they both have the same function, and the interface is exactly the same, it's just that I prefer the 7448 because looking at the reference, they use the 7448. The stages can be seen in Figure 2 dan 3, as follows:

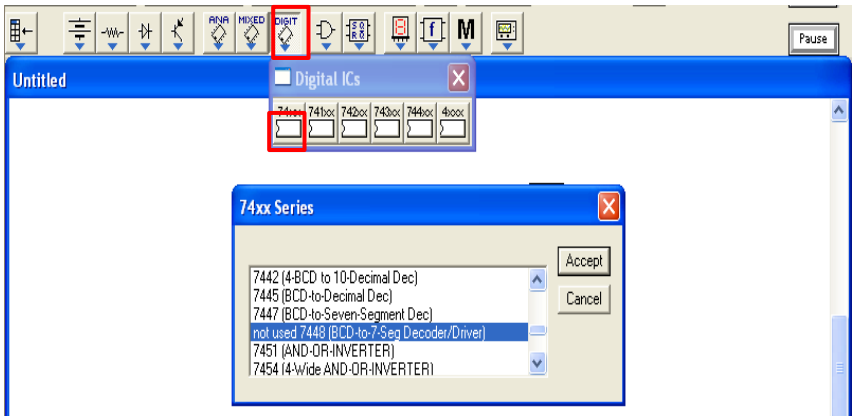

Figure 2. Window Floating Menu 74xx Series

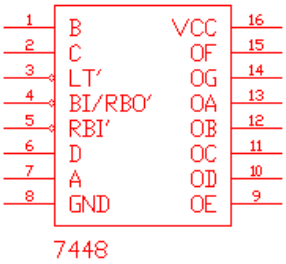

Figure 3. 7448 . IC Circuit Form

Now we add 4 switches to control the inputs that are inserted into the IC 7448. Select the "Basic" menu, then select the image that will display the words "Switch". Press and drag to the center until the image of the switch circuit appears. Because we need 4, just copy and paste the switch until there are 4 pieces. Furthermore, to be clearer, it can be seen in Figure 4 as follows:

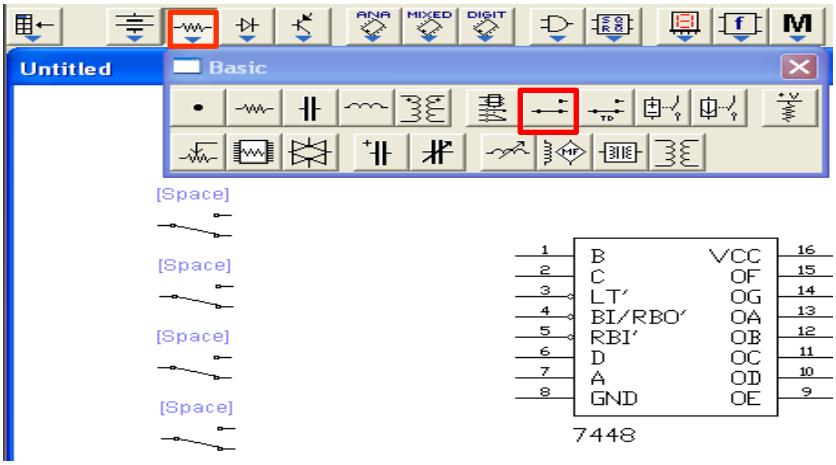

Figure 4. "Basic" Menu & "Switch" Circuit Picture

After that each switch will be changed toggle/key to activate it. Double click on the top switch. A new window appears, move to the “Value” tab, then fill in the “Key:” column with the letter A, then click OK. Then the letter A will appear above the switch and not Space anymore. Do the same for the remaining switches, proceeding to B to D (because there are only 4 switches). Furthermore, to be clearer, it can be seen in Figure 5 and 6 as follows:

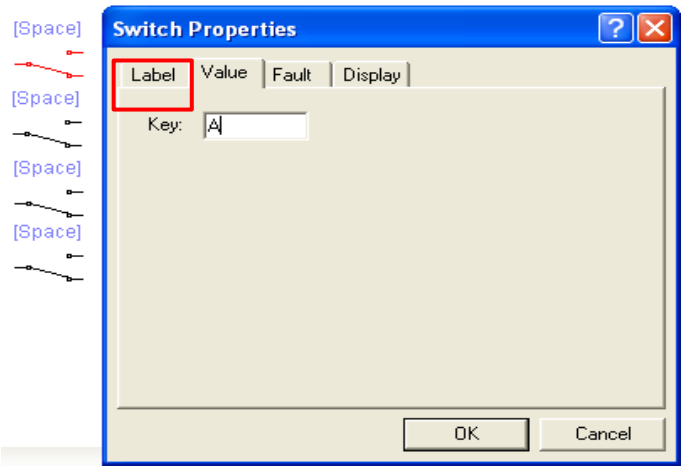

Figure 5. Switch Properties . Window

Figure 6. Switch Display After Change Key

Next we will add a power source to the circuit so that it can turn on, and the simulation can be run. Select it in the "Sources" menu, then select the picture that says "+Vcc Voltage Source". Press and drag until the series appears, then position it on the top. Take two, because 1 vcc for the switch, and the other for the IC 7448. Furthermore, to be clearer, it can be seen in Figure 7 as follows:

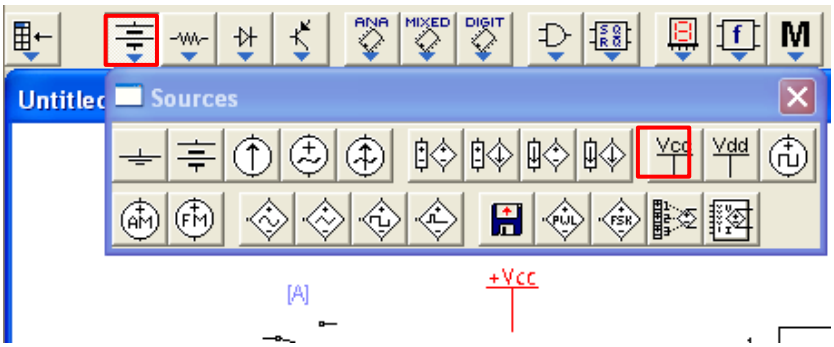

Figure 7. Menu Sources & Circuit Image +Vcc

Then for the last circuit, add "Ground", specifically for the input on the IC 7448. Still in the "Sources" menu, this time select the very first image on the top left that says "Ground". Press and pull it out until a series image appears, then position it at the bottom. Furthermore, to be clearer, it can be seen in Figure 8 as follows:

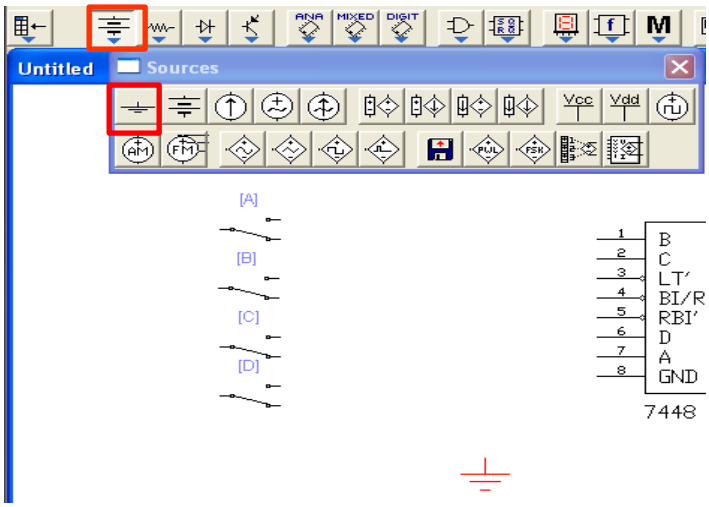

Figure 8. Menu Sources & Drawing of Ground Circuit

All the necessary circuits are in place and ready to be connected to each other. First we will connect the left +Vcc with the four switches. You do this by pointing the mouse arrow to the end of the +Vcc circuit line or switch A until a black dot appears as shown in the following image. Then connect in order from A to D. All switches are connected to one +Vcc. Furthermore, to be clearer, it can be seen in Figures 9 and 10 as follows:

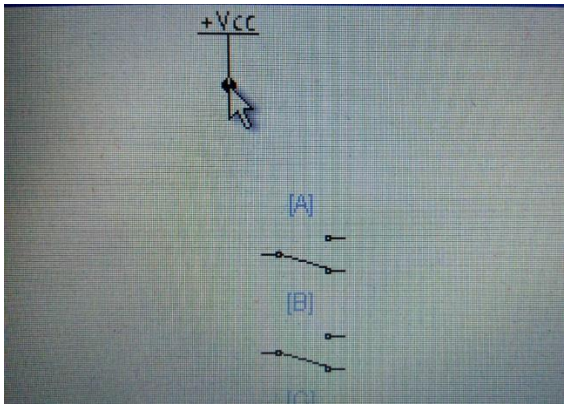

Figure 9. Black dots that appear at the end of the series line

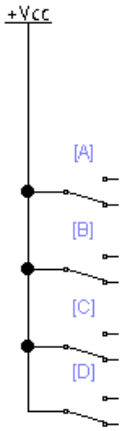

Figure 10. All Switches Connected to +Vcc

Next we will connect each switch with the appropriate input on IC 7448. Switch A to input number 7 (A), B to input number 1 (B), C to input number 2 (C), D to input number 6 (D). Furthermore, to be clearer, it can be seen in Figure 11 as follows:

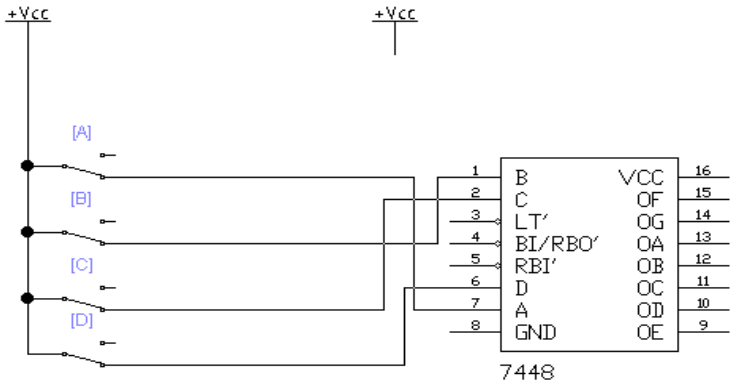

Figure 11. All Switches Connected To IC 7448 . Input

Now only 4 inputs are left on the left. input numbers 3, 4, and 5 they are connected to the second +Vcc on the right. After the three of them have been connected, now only the 8th input is not yet. The 8th input is connected to "Ground" which is below. Furthermore, to be clearer, it can be seen in Figures 12 and 13 as follows:

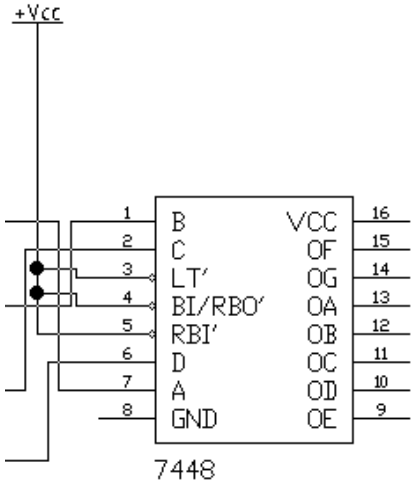

Figure 12. Input 3, 4, 5 Connected With Second +Vcc

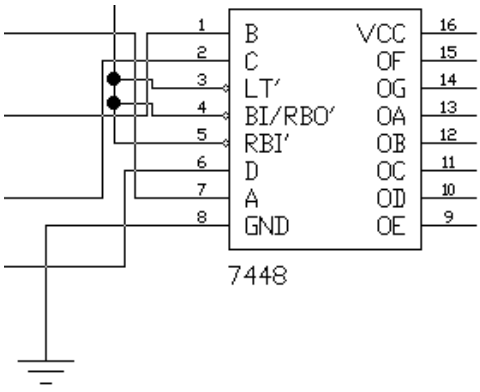

Figure 13. Input 8 Connected to "Ground"

Now move to the input on the right. There's input 16 that says VCC, it's connected to +Vcc which is on the right. Furthermore, to be clearer, it can be seen in Figure 14 as follows:

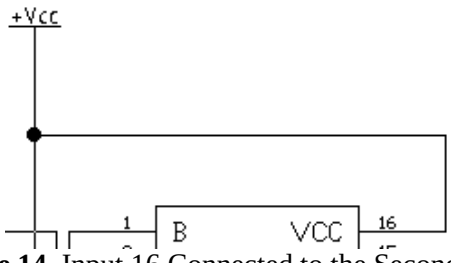

Figure 14. Input 16 Connected to the Second +Vcc

And finally, the remaining 7 inputs will all be connected to a seven segment circuit. From sequential input 13 (OA) to input 9 (OE). Then after that start from the top again, to be precise input 15 (OF), then finally input 14 (OG). When described in more detail, input 13 (OA) is connected to the first seven segment input, which is the far left, until input 9 (OE) is sequential. input 9 (OE) enters input to 5 seven segment, then input 15 (OF) enters input to 6 seven segment, and finally input 14 (OG) enters input to 7 seven segment. And it's done, all the circuits are connected to each other. Now it remains only to turn on the simulation, and perform the test. Furthermore, to be clearer, it can be seen in Figure 15 as follows:

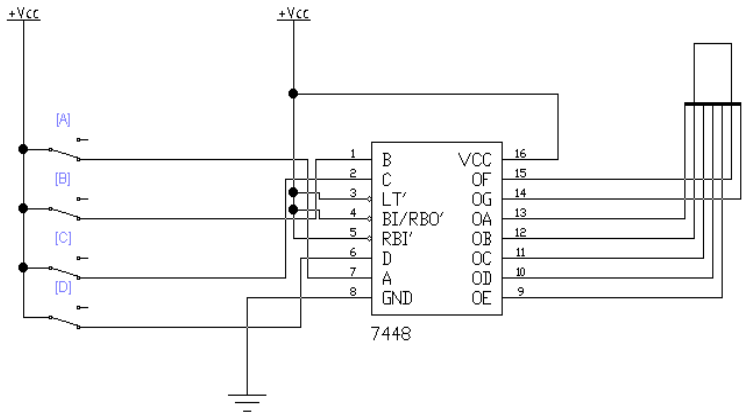

Figure 15. Full Seven Segment Circuit All Connected

3.2. Circuit testing

Now it's time to turn on the circuit which means starting the simulation. The button to activate the simulation is on the top right just above the button with the words "Pause". Click the button so that the symbol "|" is below, and that means the simulation is running. Furthermore, to be clearer, it can be seen in Figures 16 and 17 as follows:

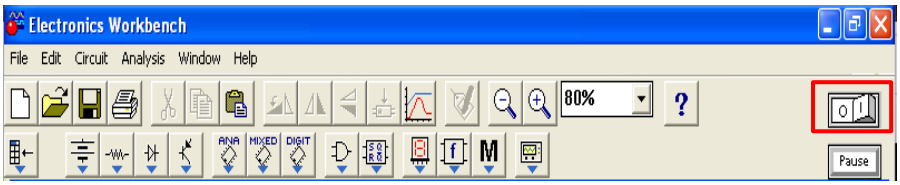

Figure 16. Simulation On/Off Button

Figure 17. Condition of the button after being turned on

Karena simulasi sudah menyala, kita coba nyalakan matikan setiap switch dan lihat apa yang akan keluar di layar seven segment. Setelah mencoba beberapa kombinasi switch, apa yang keluar dari layar seven segment dapat berupa angka, dan kombinasi garis yang tidak lengkap (tidak membentuk sebuah angka. Furthermore, to be clearer, it can be seen in Figures 18 and 19 as follows:

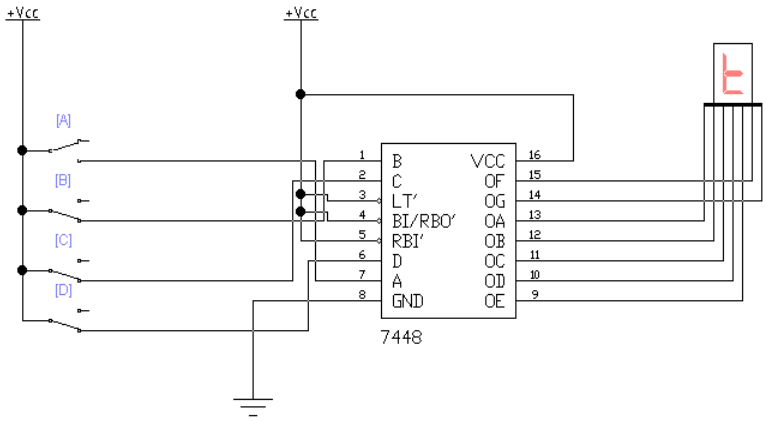

Figure 18. Switch A Off Condition & Display on Seven Segment Screen

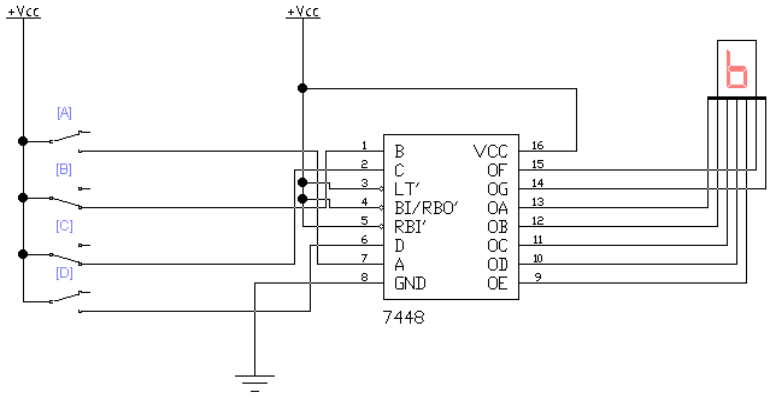

Figure 19. Switch A and D Off & Seven Segment Screen Display

As in the previous picture, the combination of switches is different, the output on the seven segment screen is also different. This is because there is a special combination to be able to bring up numbers from 0-9. The seven segment display also has its own truth table, and the following is the truth table for the seven segment display from numbers 0-9 as a comparison of the previous image. Furthermore, to be clearer, it can be seen in Table 1 as follows:

Table 1. Seven Segment Display Truth Table

D	C	B	A	a	b	c	d	e	f	g	Tampilan
0	0	0	0	1	1	1	1	1	1	0	0
0	0	0	1	0	1	1	0	0	0	0	1
0	0	1	0	1	1	0	1	1	0	1	2
0	0	1	1	1	1	1	1	0	0	1	3
0	1	0	0	0	1	1	0	0	1	1	4
0	1	0	1	1	0	1	1	0	1	1	5
0	1	1	0	0	0	1	1	1	1	1	6
0	1	1	1	1	1	1	0	0	0	0	7
1	0	0	0	1	1	1	1	1	1	1	8
1	0	0	1	1	1	1	0	0	1	1	9

When compared with the image with output 6 on the seven-segment screen, then the entire circuit is correct and running well. Likewise, as in the example image whose output is not a number (more like a lowercase t) it is not in the truth table of the combination (excluding numbers 0-9) so it does not display numbers. Here are some more examples for different numbers, which are given in Figures 20 and 21 as follows:

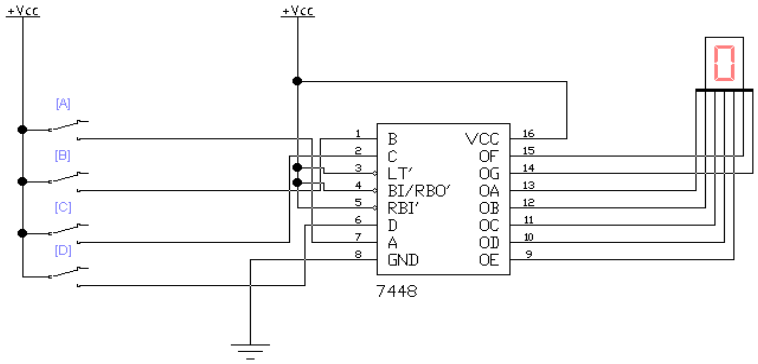

Figure 20. All Switches Off & Display 0 on Seven Segment Screen

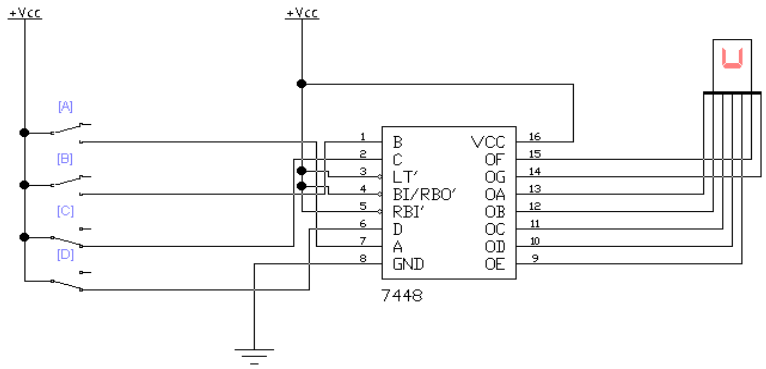

Figure 21. Switch A, B Off, Switch C, D On & Display Not Numbers on the Seven Segment Screen

4. Conclusion

Based on the results of the research above, it can be concluded that we can try to make a series of seven segment displays using circuit simulation software on a computer called Electronics Workbench. The Digital IC (Decoder) used to connect the seven segment display in this simulation is the 7448 series. Up to the circuit testing stage, the circuit runs well without any errors, and is also correct in theory because the combination of input and output from the seven segment display is the same as the table truth for seven segment displays.

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