LAB 1: Telephone Exchange

ELEC2607 - LOE, Mon 2:35pm – 5:25 pm

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1.0 INTRODUCTION

The purpose of this circuit is to create a telephone switch that have eight called-subscribers with four calling-subscribers. The circuit contains 4-input multiplexer and 8-output demultiplexer. The multiplexer and demultiplexer are made from multiple digital logic gates such as AND, NAND, OR, NOR, etc. The telephone switch created uses a dialer to select the input into the 4-input multiplexer which shows the calling-subscribers and selects one of the 8 called-subscribers. The following reports shows the Specifications in part 2.0, Design in part 3.0, Implementation and Testing in part 4.0, and the Conclusion in part 5.0 of the telephone switch circuit.

2.0 SPECIFICATIONS

The Telephone Switch circuit consists of 4-input multiplexer "Calling Party" and 8-output demultiplexer "Called Party". The design was constructed using the Tekron Logic Lab, hence the authors had limited access to the number of gates which can be used, the number of gates which the authors had access to was documented in the prelab. The inputs where connected to physical switch that controls the signal and change them to 00, 01, 10, or 11. The design of the 4-input multiplexer consisted of 3 2-input AND-NOR gates. The design of the 8-output demultiplexer consisted of 4 NAND gates, 2 AND gates, 8 inverters, and 8 NOR gates.

3.0 DESIGN

The final Telephone Switch circuit is shown below in Figure 3.0.

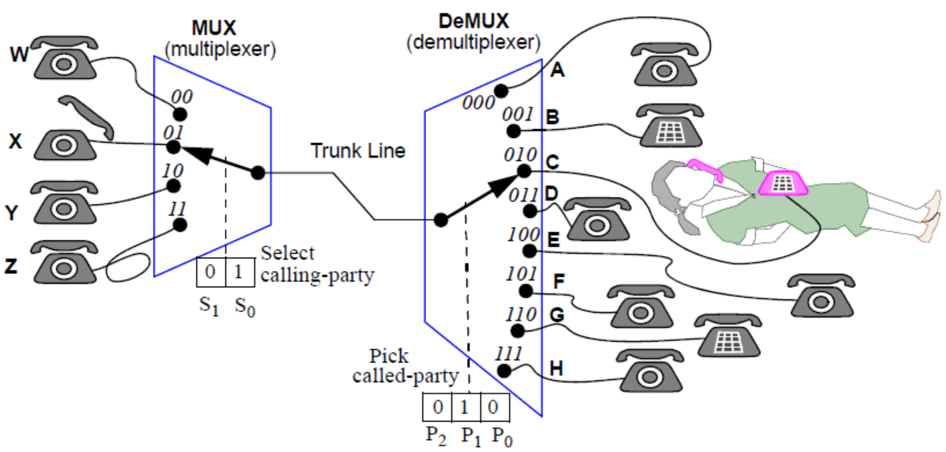

Figure 3.0: Telephone Switch circuit with 4-inputs 8-outputs [Lab 1 - p2, modified]

3.1 The Dialer

Figure 3.1 below shows the switch used for the MUX (Counter 1) which counts the number of button pushes in binary, and the switch used for the DEMUX (Counter 2).

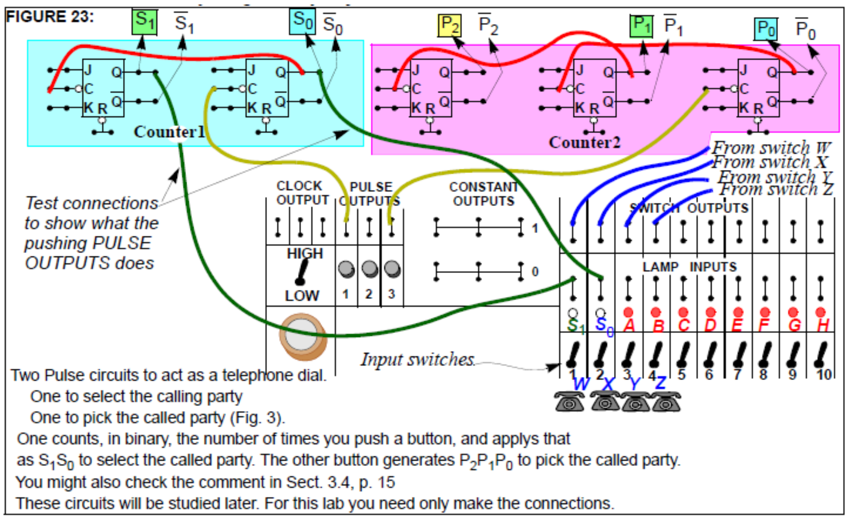

Figure 3.1: The Dialer [Lab 1 – p10, modified]

Figure 3.1 above shows that counter one was made from 2 switches, the first switch was connected to the second switch through the middle input which inverts the output of the second switch. The output of the first switch was connected to the lamp input S_1. The second switch middle input was connected to the pulse outputs in slot 1, and its output was connected to the lamp input S_0.

Counter 2 was made from three switches, the first switch middle input was connected to the output of the second switch output P_1, the second switch middle input was connected to the output of the third switch P_0, and the third switch middle input was connected to pulse outputs in slot 3.

Since many gates in the MUX and DEMUX used S_1, S_0, P_0, P_1, and P_2, inverters where used since there is not enough outputs from the switches to connect to the MUX and DEMUX.

3.2 4-Input Multiplexer

The idea behind the MUX structure is basically passing one signal input across many signals to the main line by using logic gates and switching signals. the MUX has 2 inputs and a single output. Since we had to design a 4-input MUX so the idea was having 4 different wires connected to the input that passes by 2 gates and transform. These 2 gates collect signals from (S0 , S1) controls.

The MUX design structure was picked over many other structures to prove that we can use a small number of gates and be able to obtain the same result as much complicated boards, This helps with faster debugging and be more efficient for bigger designs.

The second part of constructing the Telephone Switch circuit was designing a 4-Input multiplexer as shown in Figure 3.2 below.

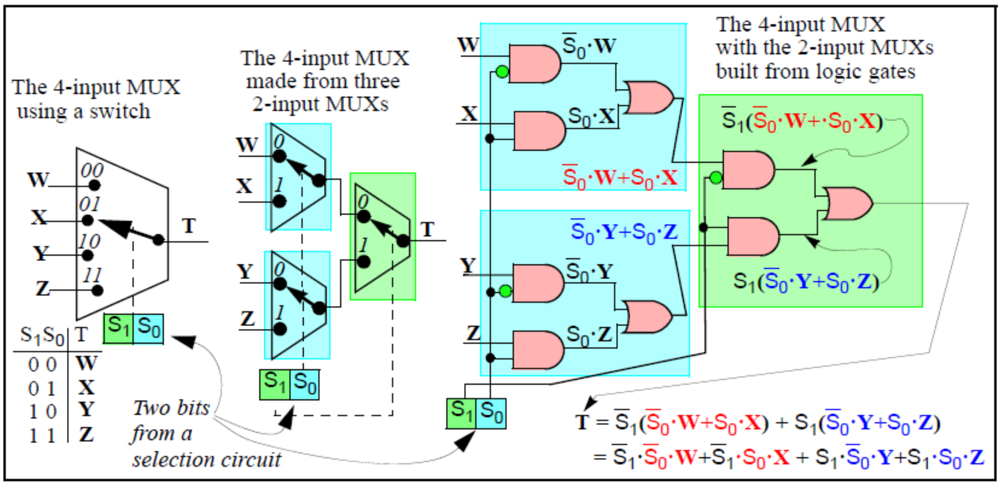

Figure 3.2: 4-Input Multiplexer

In Figure 3.2 above shows the 4-input MUX made using 3 2-input MUX'S, and each MUX is made from a 2-input AND-NOR gates. One of the 2 2-input AND gates in the first MUX was connected to S_0, and the other 2-input AND gate in the first MUX was connected to S_0'. The second MUX had one of the 2-input AND gates connected to S_0, the other 2-input AND gates was connected S_0'. The rest of the input slots of the AND gate of both MUX's was connected to the switch outputs W, X, Y, Z shown in Figure 3.1.2 below. The third MUX had one slot of its 2-input AND gates connected to the output of the first MUX and the second slot was connected S_1'. The second 2-input AND gate in the third MUX had one slot connected the output of the second MUX AND the other slot was connected S_1. The output of the third MUX (T) was connected to the DeMUX which is shown in part 3.3 below.

3.2 8-output DeMUX

In the second part of the lab (de-multiplexer) we work with 1 input terminal and we get 2 outputs or more. We can combine a number of demultiplexers together and control them individually with the switches on the circuit board. In this design we used 8 output DEMUX and each output is numbered from (A – H).

Figure 3.3 below shows the design of the 8-output DeMUX.

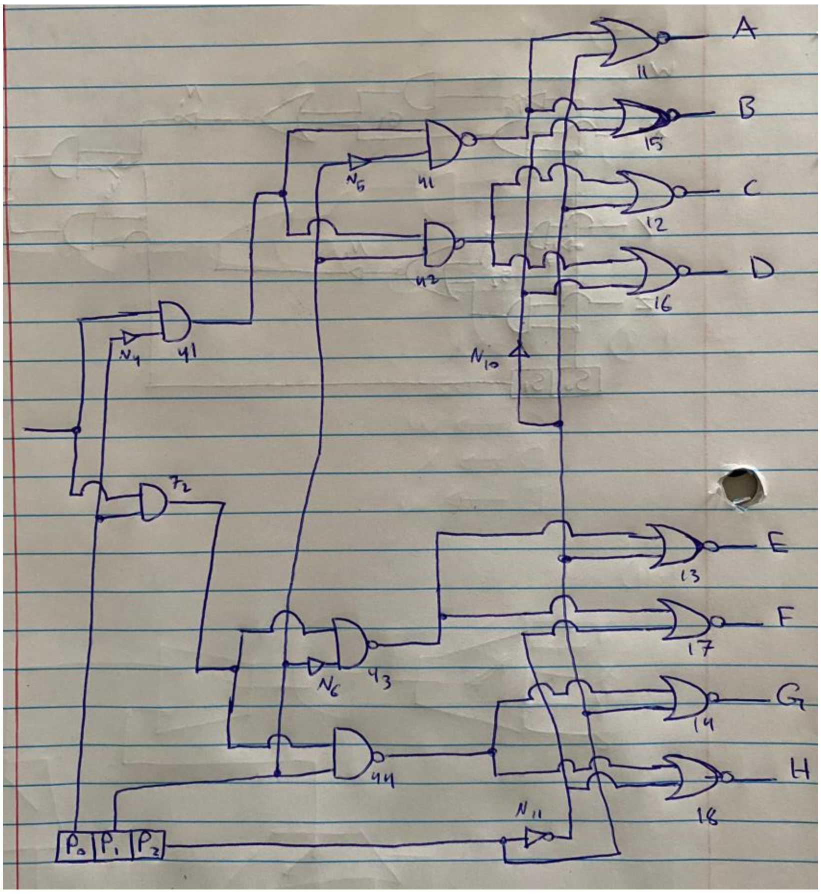

Figure 3.3: 8-Output Demultiplexer

Figure 3.3 shows that the DeMUX was constructed by connecting the output of the 4 input MUX to 2-output DeMUX and an inverter connected to four 2-input NAND gates connected to eight 2-input NOR gates

4.0 TESTING AND IMPLEMENTATION

The circuit contained 2 different phases, MUX and DEMUX. These phases needed to be tested after each part is done. And tested by the TA to make sure it is working. In order to identify the outputs we used lamps on the circuit board and they light if (1-on) (0-off). By looking at the pre-lab diagrams we did not face any debugging issues. The connections were matching the prelab sheet and we already noted the switches and gates we are using on the circuit board.

For the MUX we used 6 AND 3 NOR gates and S_0, S_1 inputs.

The Truth table for the MUX is shown below in Table 4.1**.**

S0	S1	Output
0	0	W
0	1	X
1	0	Y
1	1	Z

Table 4.1: Truth table for Mux

The result from testing the MUX shows that the connections were done correctly.

For the DEMUX we used 2 AND gates, 8 NOR gates, 4 NAND gates and P_0, P_1, P_2 inputs.

The Truth table for the DeMUX is shown below in Table 4.2**.**

P0	P1	P2	Output
0	0	0	A
0	0	1	B
0	1	0	C
0	1	1	D
1	0	0	E
1	0	1	F
1	1	0	G
1	1	1	H

Table 4.2: Truth Table for DeMux

The result from testing the DEMUX shows that the connections were done correctly.

5.0 CONCLUSION

The construction of the circuit satisfies all specifications. By following the prelab, we were able to construct and fit all wires in the circuit board without many issues. the lab was easy and the time period was enough. We learnt to identify between MUX and DEMUX in certain way. The MUX part took us more than half the time to make sure the cables are working and in the right place while it shouldn’t take that long. We had shortage for long wires and that took time in building the board. Some improvements that can be done to the lab is the difficulty of the prelab, making them easier to manage the design without practicing before. And the amount of long wires provided should be more. Overall, lab 1 was very helpful and gave us a chance to practice the class material on hands. Most of the ideas that we confuse or gates we mix are fixed and cleared after accomplishing this lab.

References:

[1] Department of Electronics, "Lab 1. A Telephone switch "Carleton University, Ottawa Ontario, Feb 2011, Accessed: Feb 6, 2016