Quantization, A/D, and D/A Operations

Fourth Laboratory Report for CENG 3331

Submitted by

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Abstract

The goal of this lab was to understand the concept of quantization as applied to the conversion of analog voltages into digital words and digital words into analog voltages. During this lab, we fully built a 4-bit and an 8-bit counter, along with an analog-to-digital converter and also viewed how a VDAC voltage changes based on which gates are opened or closed.

Write-Up

Introduction

Analog to digital conversion is the process of converting an analog signal into digital form. There are two ways to do this: sampling, which is the process of a continuous time signal being converted into a discrete time signal, and quantization, which is the process of assigning a sampled signal a value from a discrete set of values.

Task 1:

We began our experiment by constructing a 4-bit counter circuit using 8 components: a Vcc power source, a ground, a 4-bit counter, a switch, and 4 probes in Multisim. The circuit can be seen in the appendices section under Figure 1. We viewed the output by pressing the spacebar on the keyboard and watched the counter increase from 0000 to 1111. One of these outputs can be seen under Figure 2.

Task 2:

For task 2, we continued the experiment by constructing an 8-bit counter circuit using 13 components: a Vcc power source, a ground, 2 4-bit counters, a switch, and 8 probes. The circuit can be seen in the appendices section under Figure 3. We viewed the output by pressing the spacebar on the keyboard and watched the counter increase from 0000 0000 to 1111 1111. One of these outputs can be seen under Figure 4.

Task 3:

For task 3, we continued the experiment by constructing a digital to analog converter using 13 components: a Vcc power source, a ground, 8 switches, a VDAC, a voltmeter,

and a 1-volt DC power source. The circuit can be seen in the appendices section under Figure 5. We viewed the output of this circuit by opening and closing different switches until we had written down all combinations. The table of some of these values can be seen below:

Binary	Decimal	Voltage
0000 0000	0	0 V
0000 0001	1	3.906 mV
0000 0010	2	7.813 mV
0000 0011	3	.012 V
0111 0010	114	.445 V
0111 0011	115	.449V
0111 0100	116	.453 V
0111 0101	117	.457 V
1111 1101	253	.988 V
1111 1110	254	.992 V
1111 1111	255	.996 V

Task 4:

In this final task, we concluded the experiment by constructing an analog-to-digital converter with the 8-bit counter circuit from task 2 and the VDAC circuit from task 3. This circuit can be seen in the appendices section under Figure 6. One of the outputs of

this circuit can be seen under Figure 7 and the oscilloscope of the output can be seen under Figure 8.

Appendix

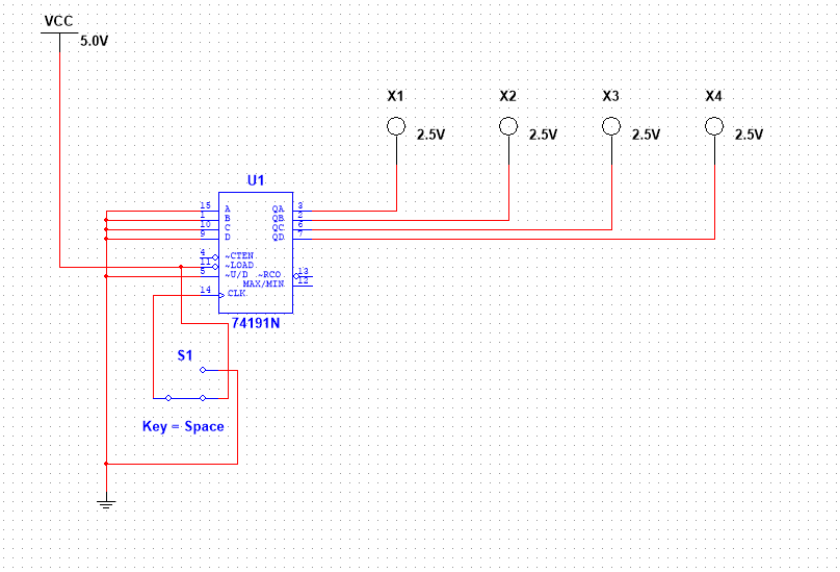

Fig. 1. Circuit Diagram Task 1

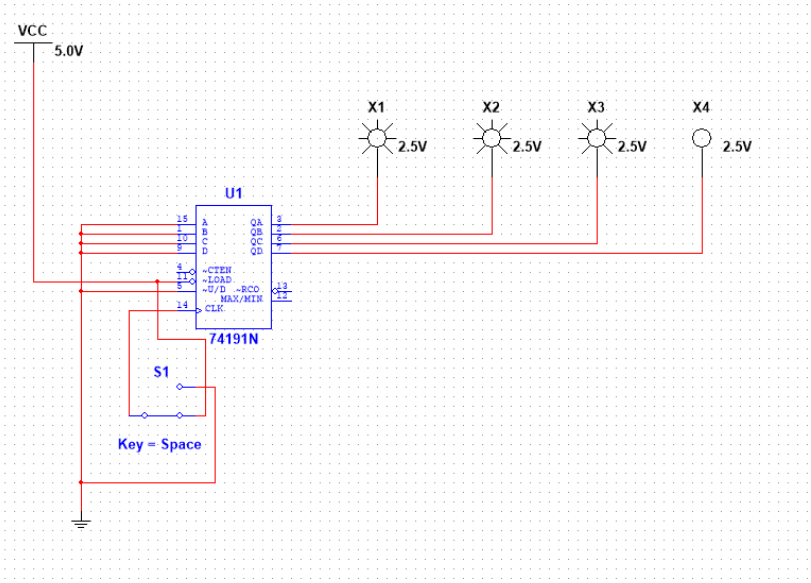

Fig. 2. Task 1 Circuit Running

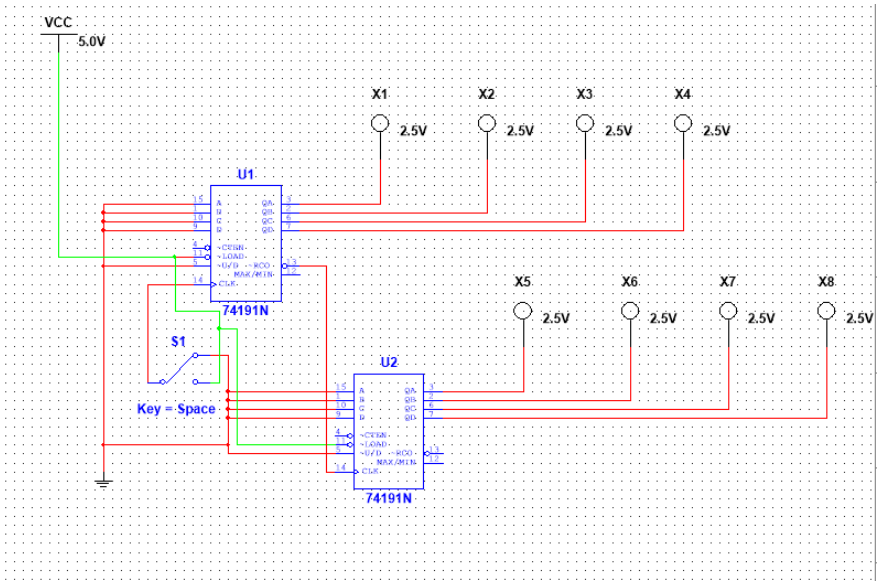

Fig. 3. Circuit Diagram Task 2

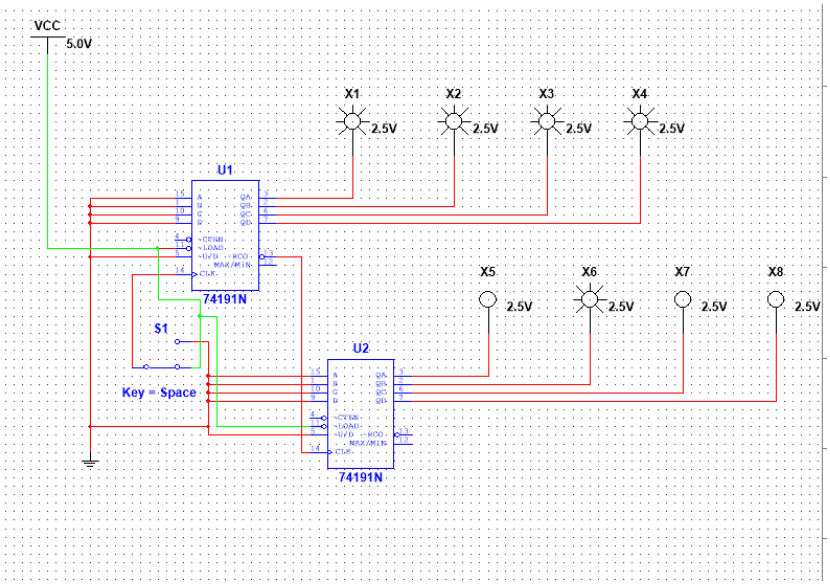

Fig. 4. Task 2 Circuit Running

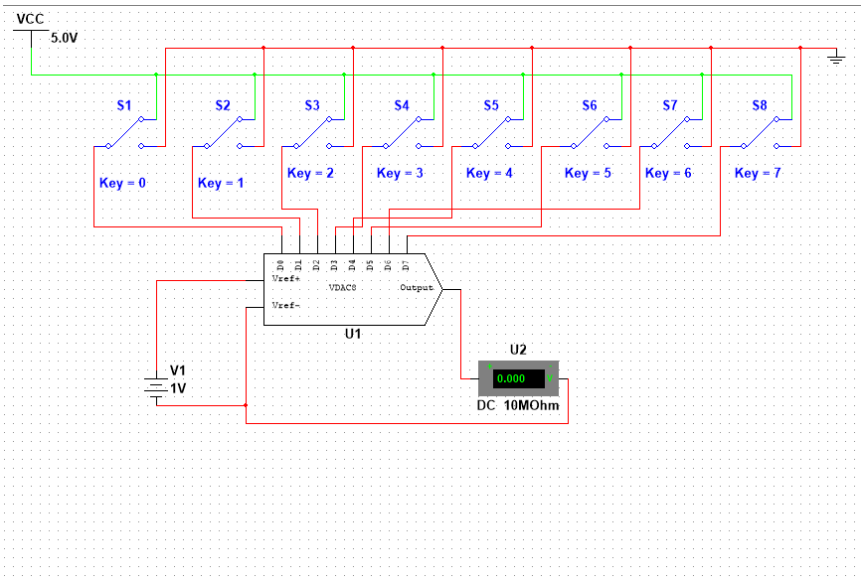

Fig. 5. Circuit Diagram Task 3

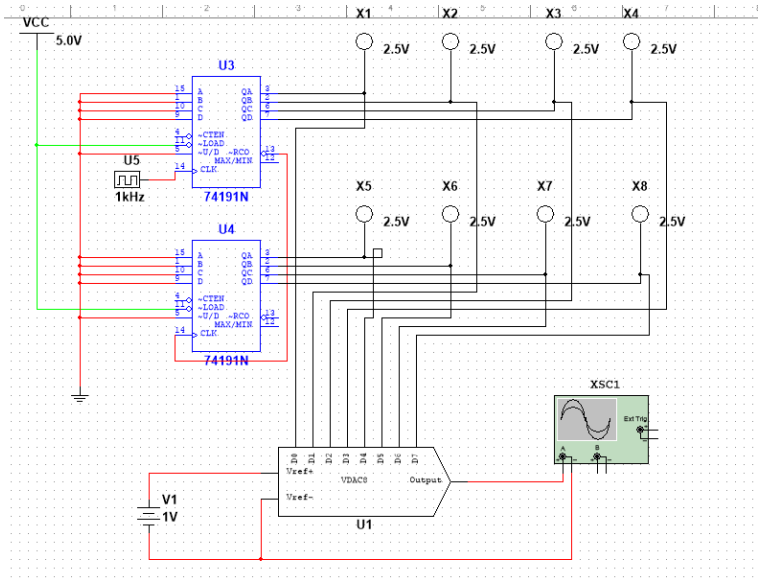

Fig. 6. Circuit Diagram Task 4

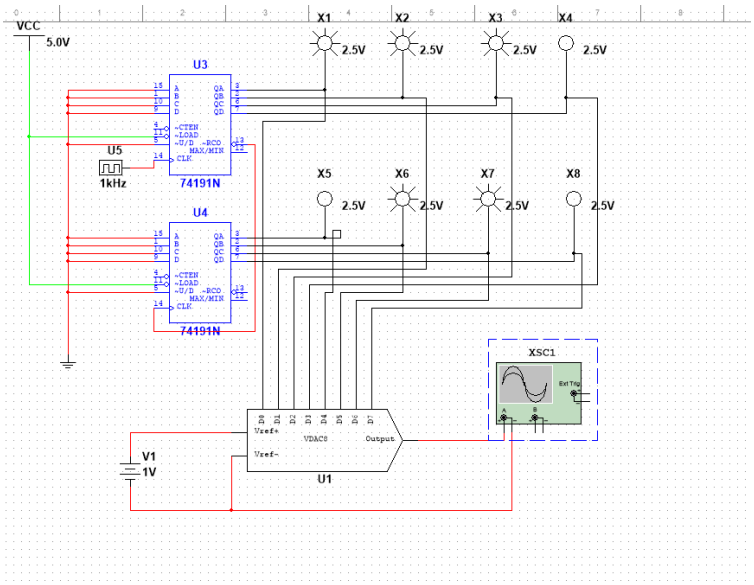

Fig. 7. Task 4 Circuit Running

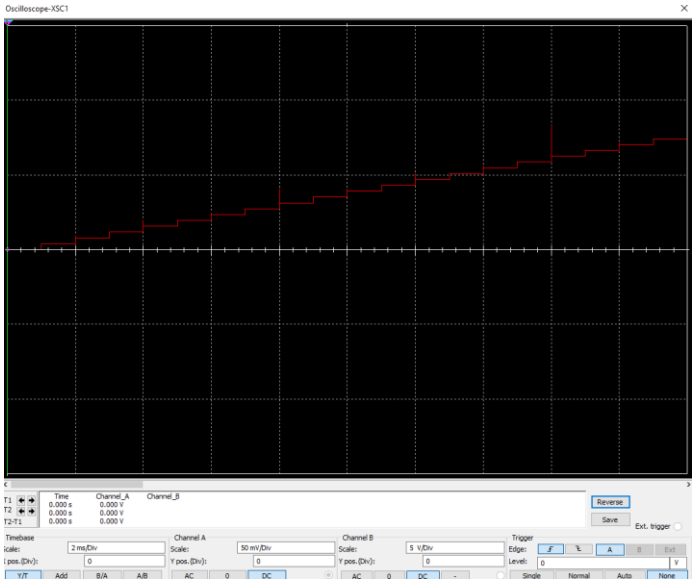

Fig. 8. Task 4 Oscilloscope wave

Conclusion

In conclusion, this experiment showed us how a 4-bit counter, an 8-bit counter work, an analog-to-digital converter, and a VDAC work and produce outputs. Particularly for the VDAC, its oscilloscope showed us a step pattern for the different voltages as they change.