

Function Generators for Web-Based or Distance Learning

**by Dan Forshee
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**Contact Info
4109 S. 243rd. Place
Kent, WA 98032
dforshee@u.washington.edu
(206) 824-2111**

Problem Statement

Over the last few years, a variety of factors have greatly increased the need for distance learning of in freshman and sophomore level EE classes. Greatly increased demand from students and industry has strained laboratory space. Offering lab classes at home could save the University of Washington and affiliated Community Colleges money. The student could also save the time and money required to commute to the University of Washington.

One of the key pieces of laboratory equipment needed by students taking distance- learning courses is a function generator, used to create sine waves, square waves, and triangle waves. Currently, the cost of a function generator is prohibitive for students, with a cost in the range of \$250-\$1000. To offer the online labs at an affordable cost, the function generator will need to be offered at a lower cost, with a goal price of about \$30.

The purpose of this research was the following:

1. Determine which function generator IC will work best in a new function generator.
2. Design a schematic and a PC-Board that could be used to build a prototype of the new and inexpensive function generator.

Approaches

The first approach used was to determine which function generator ICs were available on the market and to determine which one would work best in the function generator device.

The three function generator techniques considered were the following:

- The Harris Semiconductor ICL8038 chip^{1, 2}
- The Maxim MAX038CPP chip.³
- Implementation of the entire function generator using discrete components.⁴

The function generator chips were evaluated by several criteria. The following criteria are listed in order of importance: simplicity of use, cost, number of components, and bandwidth. All chips offer sine, square, and ramp outputs.

Data:

The following data was collected by analysis of articles and datasheets.^{1, 2, 3, 4} Also, the MAX038 and the ICL8038 function generators were constructed on a breadboard and tested.

Table 1: Comparison Criteria for Different Designs

Name	Simplicity of Use	Estimated Component Cost	Number of Components	Bandwidth
Harris ICL8038	Hard to use, especially the sine wave, 7 potentiometers need adjusting	\$10.00	20	up to 100KHz
Maxim MAX038	Easy to use, 5 potentiometers need adjusting	\$20.00	45	up to 20 MHz
Discrete Parts	Very complicated, with both adjustable capacitors and potentiometers	\$25.00	70	up to 100 KHz

The Harris Semiconductor design had the lowest cost and the smallest number of components. Its weaknesses included poor bandwidth and its relatively complicated use.

The Maxim MAX038 design was the easiest to use and had the best bandwidth. The Maxim design had moderate cost and number of components.

The discrete parts design was the most expensive and the hardest to use. The discrete parts design had the advantage of being the only design that could be battery powered.

Results:

The Maxim MAX038 design was chosen for the computer layout and prototype construction. This design had realistic complexity for a freshman or sophomore level college student. It also had higher bandwidth than the other two models. Its component count was acceptable for production.

Results/Design Developed:

Laying out of the design on the computer involved several steps. Software was acquired to perform the layout. Then the schematic was designed. Finally, the PC-Board was designed. Both designs were done on Eagle Version 3.55 from CadSoft.

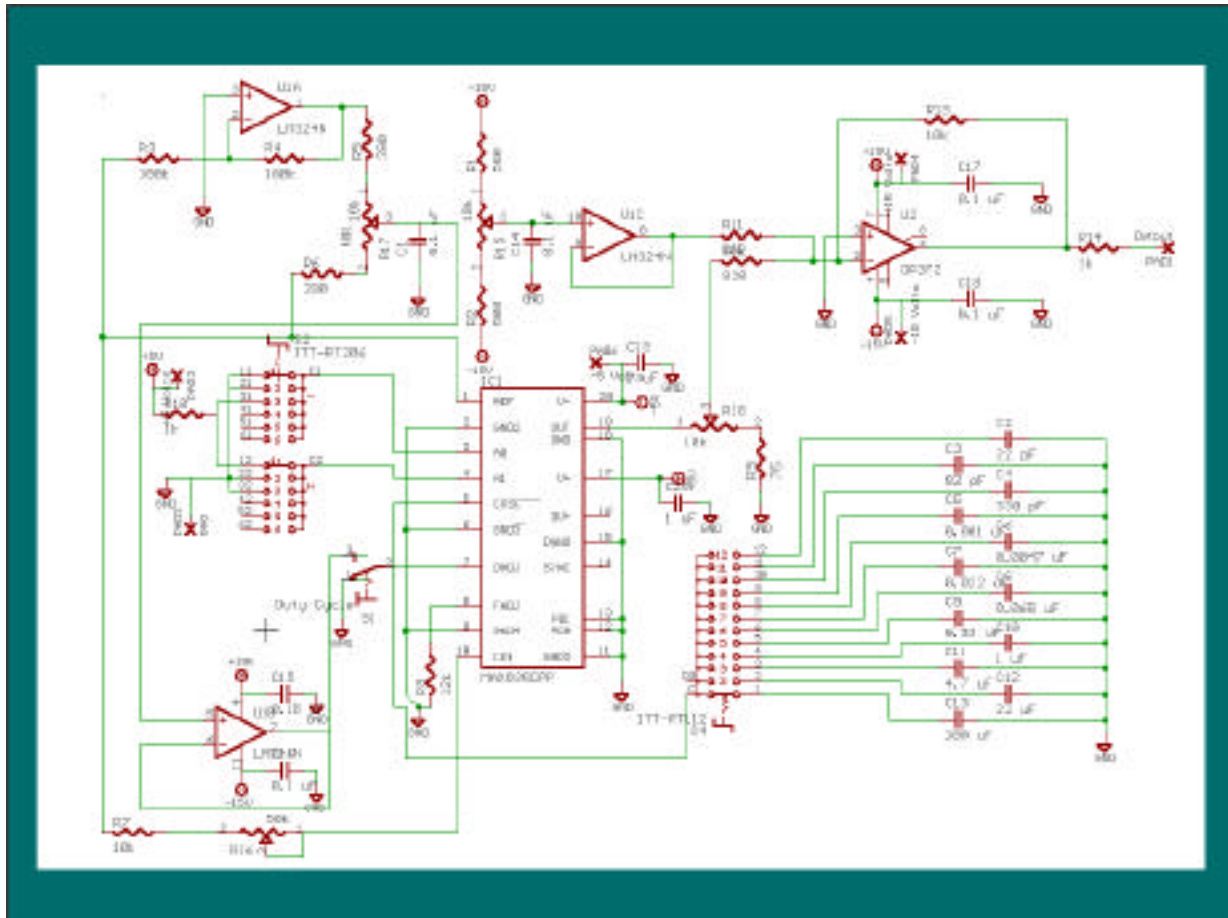


Figure 1: Schematic of Function Generator

Implementation

The potentiometers and switches in the design are used for the following purposes:

Switch S1	50% or variable duty cycle
Switch S2	sine, square, or triangle wave form
Switch S3	coarse frequency adjustment
Potentiometer R15	voltage offset
Potentiometer R16	fine frequency adjustment
Potentiometer R17	duty cycle adjustment
Potentiometer R18	amplitude adjustment

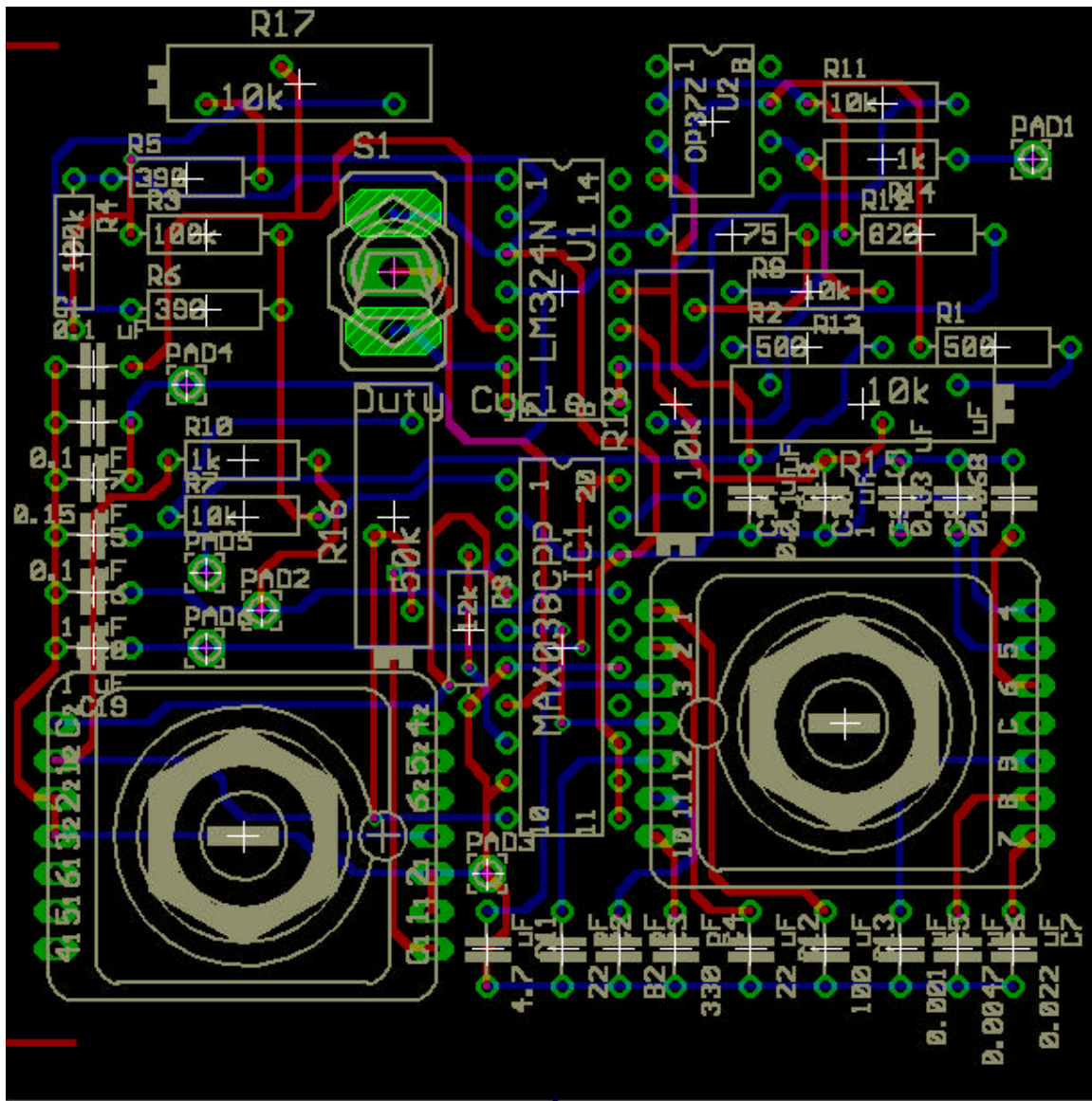


Figure 2: PC-Board layout of the Function Generator (2XScale)

Conclusion

A great deal was learned from this project. A large amount about how function generators work and are built was learned. Skills at reading data sheets and electronics catalogs were improved. Computer-aided design of schematics and PC Board layouts was learned. Better technique of using the laboratory test equipment and soldering equipment was also learned.

Sources

1. Covington, Michael A., "Function Generator," *Poptronics*, March 2000, page 12.
2. Marston, Ray, "Waveform Generator Circuits," *Electronics Now*, January 1996, pages 37-38, 130, 136-138, 149.
3. Levine, Ken, "Low-Cost Function Generator," *Electronic Design*, April 3, 2000, pages 153-154.
4. Campisi, Skip, "Build the Do It Yourself Function Generator," *Electronics Now*, August 1997, pages 57-62.