Experiment No. 3
Function Generator Design
ECE 311

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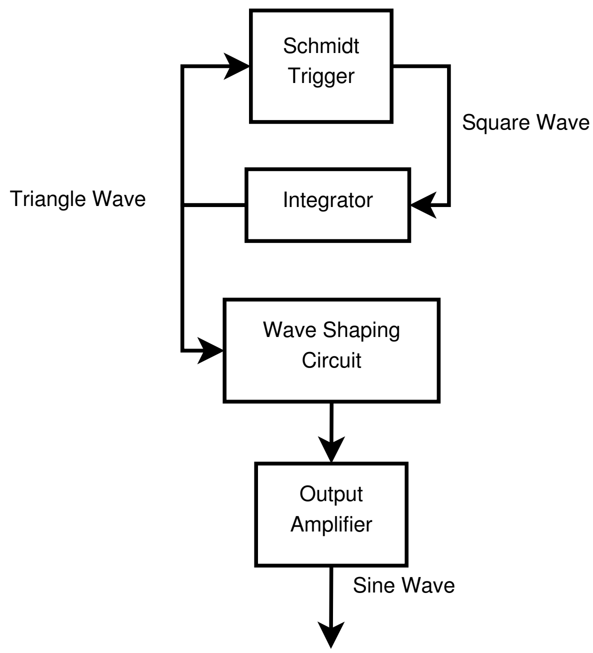
Date Performed:	February 11
Instructor:	Professor Saletta

1 Executive Introduction

This lab concerned the design and construction of a signal generator with four outputs: Square wave, sawtooth wave, and sine wave. It was constructed from entirely analog parts at low cost. In spite of its low cost, it manages a respectable level of accuracy and performance. Hambley's *Electronics* provided the schematics for this design.

2 Block Diagram

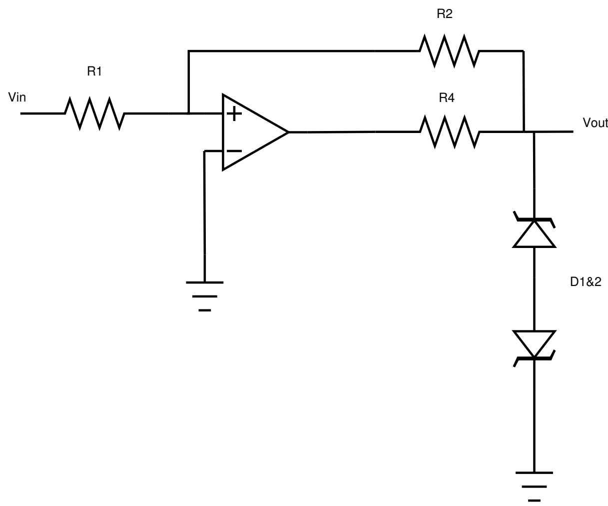


3 Discussion of Design

Hambley has a section on the design of this particular Function Generator beginning on page 199 of the Second Edition. That guide was used extensively while designing this project.

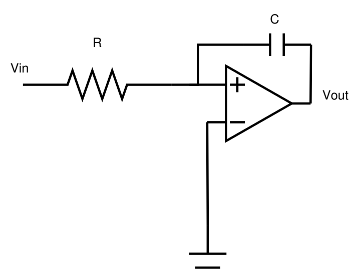
3.1 Schmidt Trigger

Hambley begins discussion of the Schmidt Trigger on page 201. He notes the difference between comparators (the ideal component) and the LF411 chosen for this design. Should the reader want to extend this design to cover a larger bandwidth, analysis of the slew rate limitations of the LF411 would be required. The important values to be determined in this block are the values of $R_1, R_2, R_4, \& D_{1\&2}$ (circuit diagram below). R_4 exists to limit the output current of the Trigger, but still provide enough current into the feedback portion of the Trigger. R_2 is selected to minimize load on the output. With those restrictions, R_4 is selected to be $4.1k\Omega$, and R_2 is selected to be $100k\Omega$. $R_1\&R_2$ set the trigger voltage, are are related by the equation $\frac{v_{in}}{R_1} + \frac{v_{out}}{R_2} = 0$ at the threshold. In this case, v_{in} and v_{out} are equal to -5 and 5, respectively. R_1, must therefore equal R_2, which is already selected to be $100k\Omega$.



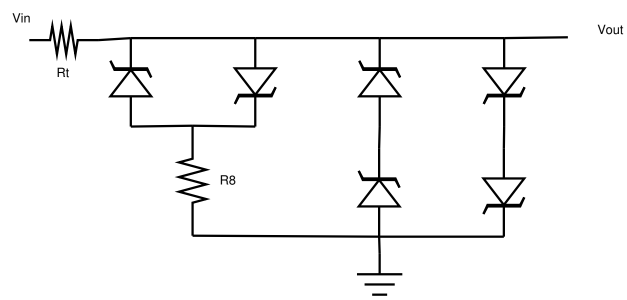
3.2 Integrator

Hambley begins discussion of the Integrator on page 202. On that page he outlines the two parameters needed for the Integrator, R and C (diagram below). Analyzing the circuit at $t = \frac{T}{2}$, $v_{out}(0) = 5$, $v_{out}(\frac{T}{2}) = -5$, and $v_{out}(\frac{T}{2}) = -\frac{1}{RC}\int_0^{\frac{T}{2}} v_{in}(x)\,dx + v_0(0)$. Solving, $RC = .25T$. For a $f = 1kHz$, we must select values for R and C that exist in the lab stock, so C was selected to be $1000pF$ and R to be $220k\Omega$ ($250k\Omega$ is not a standard value).



3.3 Wave Shaping Circuit

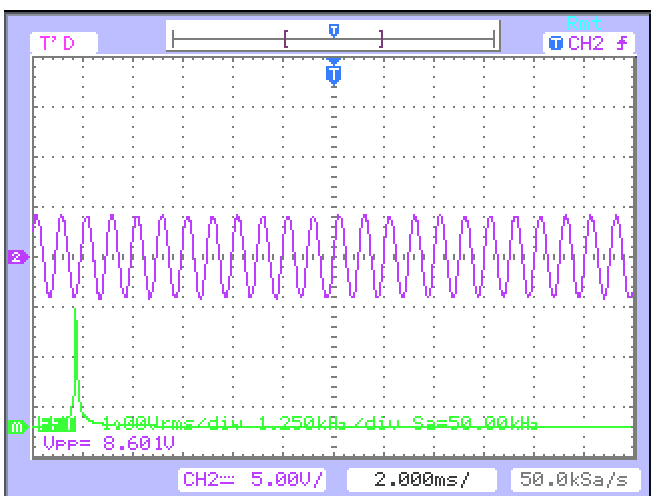
Hambley discusses the Wave Shaping Circuit on pp. 203–206. The zener diodes selected for this block are part number 1N4148, with a forward bias voltage of 0.6 volts. Both R_t and R_8 were substituted for potentiometers to allow tuning of the resultant wave.

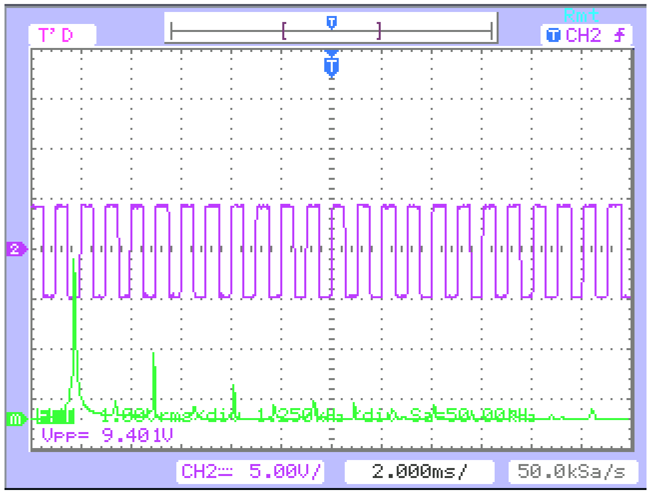


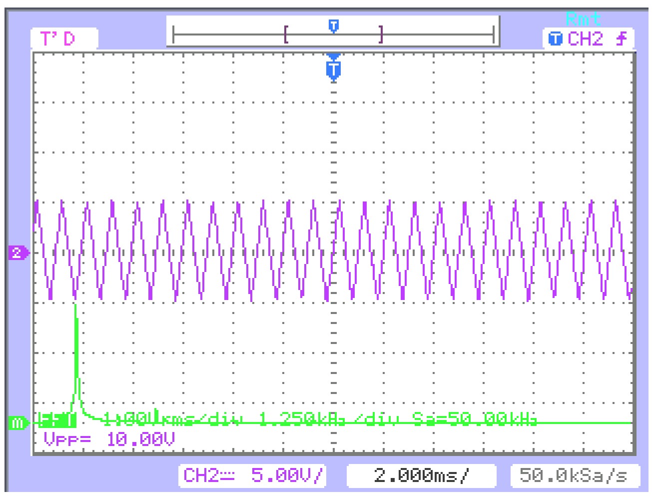
3.4 Output Amplifier

The specifcation for the function generator specifies $10v_{pp}$ sinusodial output, but the wave shaper only manages $1.601v_{pp}$. A final amplification stage is needed to boost by a factor of 6.24. Using standard resistor values, this gain can be aproximated with a $1k\Omega$ and a $6.2k\Omega$ resistor, and an op-amp in inverting configuration.

Appendix: Data




T' D
CH2
1.00Vrms/div 1.250kHz/div Sa=50.00kHz
Vpp= 9.401V
CH2⎓ 5.00V/
2.000ms/
50.0kSa/s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