Electronics Lab 6: Schmitt Triggers

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The purpose of this lab was to create a Schmitt trigger two ways, one with transistors, and one with an op amp.

I. INTRODUCTION

The Schmitt Trigger is a bi-stable circuit that incorporates positive feedback to make it stable at its two output states. The circuit is essentially a comparator where the comparison level shifts down as the input passes the the threshold going positive and likewise shifts the level shifts up as the input pass it going down. This characteristic makes it very useful in situations where there is some noise on the input to prevent multiple transitions between the 'on' and 'off' states. This property is also ideal as a basis for a binary logic system.

II. EXPERIMENT

The following circuit were created for the transitor schmitt trigger:

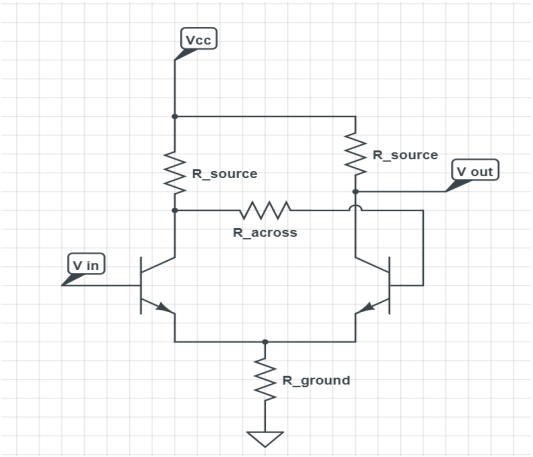

FIG. 1. Transistor Schmitt Trigger

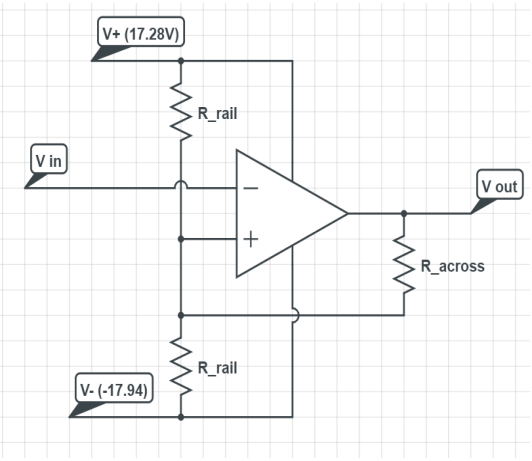

FIG. 2. Op Amp Schmitt Trigger

A. Data

For the transistor Schmitt trigger, two NPN 3904 transistors were used, and the following data was collected.

Across	Ground	Source	Trigger Difference
100kΩ	218 Ω	2.697 kΩ	0.46 V
50kΩ	218 Ω	2.697 kΩ	0.42 V
20kΩ	218 Ω	2.697 kΩ	0.38 V
10kΩ	218 Ω	2.697 kΩ	0.36 V
2kΩ	218 Ω	2.697 kΩ	0.36 V
20kΩ	218 Ω	1 kΩ	0.58 V
20kΩ	218 Ω	10 kΩ	0.14 V
20kΩ	1k Ω	2.697 kΩ	0.78 V

For the Op-Amp Schmitt trigger, a JRC558 dual op-amp was used, and the following data was collected, with a positive rail of 17.28V and a negative rail of -17.94V.

Across	Rail	Trigger Difference
6.67kΩ	10kΩ	14.8 V
20kΩ	10kΩ	8V
50kΩ	10kΩ	3V
100kΩ	10kΩ	1.8 V
6.67kΩ	20kΩ	16.8 V
6.67kΩ	4.7kΩ	9.4 V

Various examples of the hysteresis in the triggers are shown below.

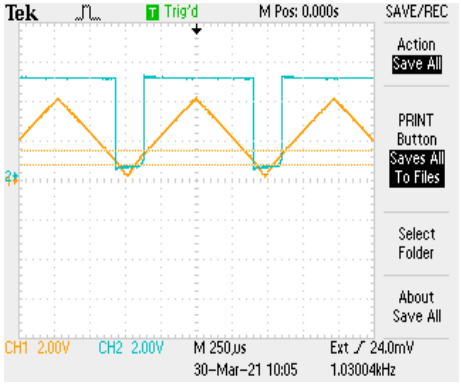

FIG. 3. Transistor Trigger, Across 10k, Ground 218, Source 2.697k

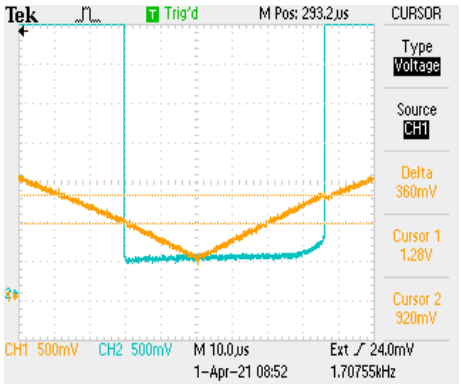

FIG. 4. Transistor Trigger, Across 2k, Ground 218, Source 2.697k

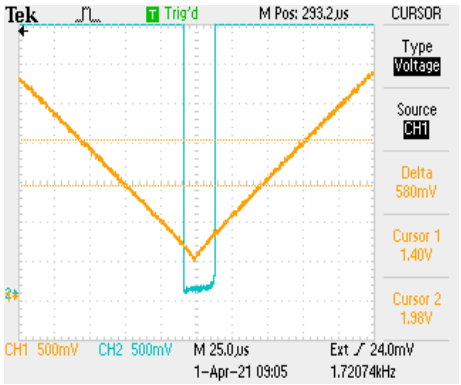

FIG. 5. Transistor Trigger, Across 20k, Ground 218, Source 2.697k

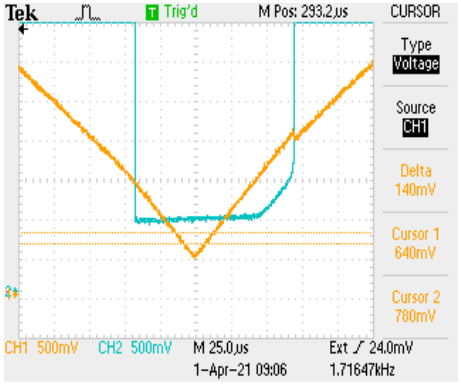

FIG. 6. Transistor Trigger, Across 50k, Ground 218, Source 2.697k

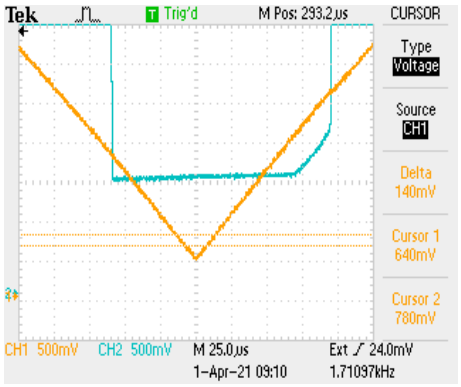

FIG. 7. Transistor Trigger, Across 100k, Ground 218, Source 2.697k

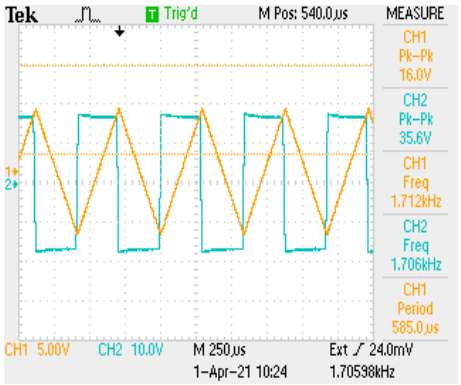

FIG. 8. Op-Amp Trigger, Across 6.67k, Rail 10k

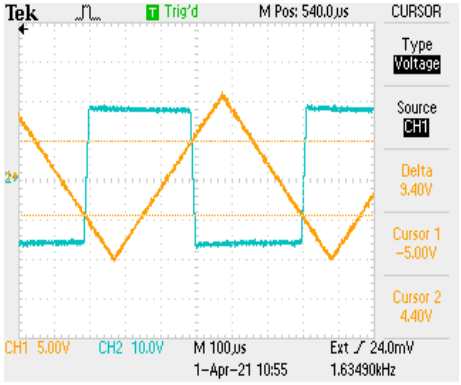

FIG. 9. Op-Amp Trigger, Across 6.67k, Rail 14.7k

III. CONCLUSION & ANALYSIS

The circuits functioned well as Schmitt triggers, however the transistor built ones had a significantly smaller difference in trigger points than the op-amps did, with very little impact of changing the resistor values. This was likely due to the transistors themselves controlling the trigger points in addition to the resistors. For the transistor trigger, changing the ground resistor had the greatest impact on the trigger difference. For the Op-Amp case, the trigger points varied greatly with the change of the across resistor, as well as the rail resistors. This allowed for much greater flexibility in changing the trigger points. Additionally, the op-amp triggers provided a much sharper change compared to the transistors, as evident in the figures shown above. (The transistors had a slight curve on the up-end). In the end, both were able to convert a triangle wave successfully to a square wave using Schmitt triggering. This lab could possibly be further improved and elaborated upon by using various transistors, as well as various op-amps, to see the effect those would have on the hysteresis.

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