

Lab4 - Schmitt Trigger using op-amp

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1 Introduction and Purpose

The Schmitt Trigger is a bistable component often used in digital electronics designed to have hysteresis. Hysteresis is when the output voltage depends on previous values of input signals too. It is a type of comparator that can operate with some level of noise. We used one in the Digital Design course to eliminate the flickering of mechanical switches when another component needed a more stable input value. It can also be used to convert analog signals to a square wave, which is what I'm going to test today.

2 Design

The Schmitt Trigger uses an upper and a lower threshold voltage (V_{UT} and V_{LT}). Assuming that the output voltage was high, it would only switch to low if the input voltage drops below the lower threshold voltage. Between the two, it stays in its previous state.

They can be built several ways, but I decided to build one with an op amp by using positive feedback (instead of negative). In a non-inverting Schmitt Trigger (a high analog input results in a high digital output) the input voltage is connected to the non-inverting terminal of the op amp.

To calculate the threshold voltages we have:

$$V_{UT} = \frac{R_1}{R_2} * V_{CC} \text{ and } V_{LT} = -\frac{R_1}{R_2} * V_{CC}.$$

But since we are already using our op amp IC, $\pm V_{CC}$ is given at $\pm 5V$. So if I want ($V_{UT} = 0.2V$ and $V_{LT} = -0.2$), we need to choose the resistors so that $\frac{R_1}{R_2} = 0.04$. I decided to go with $R_2 = 10k\Omega$ and $R_1 = 400\Omega$. Since there is no 400Ω resistor in the lab kit I used four 100Ω resistors connected in series instead.

3 Testing the circuit

To see that it does indeed perform what I want, I built the circuit on the breadboard and tested it with the Picoscope. On Channel A, I had the input triangle wave voltage (generated by the picoscope) and on channel B, I measured the output voltage. As we can see, it sort of converts the triangle wave to square wave, switching at $\pm 0.2\text{V}$. Although because this is not an ideal op amp, the saturation voltages are not exactly $\pm 5\text{V}$, but closer to 4V .

