

Triangle-to-Rectangular Conversion - Schmitt Trigger

Student Group

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Triangle-to-Rectangular Conversion - Schmitt Trigger

Background Information

The operation of an OPV in the saturation range can be enforced in the circuit by feeding back the output signal, i.e., returning it to the non-inverting input (+ input). In the circuit shown, the feedback is provided by resistor R_2 .



The output voltage u_{a} can only take two values, either $U_{\text{sat}+}$ or $U_{\text{sat}-}$. It switches between these two values when no voltage drops at the differential input of the OPV, ($u_{\text{d}}=0$). Then

$i_{R2} = \frac{u_{\text{a}}}{R_2}$ and $u_{\text{e}} = -R_1 \cdot i_{R1}$. Since the OPV input current is $i_{\text{p}}=0$, the currents through the resistors must be equal, and the following relationship applies for the switching points:

$$u_{\text{e}} = -\frac{R_1}{R_2} \cdot u_{\text{a}}$$

$$u_{\text{a}} = \mp \frac{R_1}{R_2} \cdot U_{\text{sat}}$$



The image shows the input/output characteristic curve of the circuit known as a “non-inverting Schmitt trigger.” The reaction to any input signal is shown on the right. The circuit only switches to $U_{\text{sat}+}$, when the positive switching threshold at the input is reached. It only switches to $U_{\text{sat}-}$, when the negative switching threshold at the input is reached.

Experimental Tasks

To analyze the behavior of the schmitt trigger, the following circuit is used:



Supply voltages (from power supply unit):

$$U_{CC} = + 3V, U_{EE} = - 3V$$

Values of the components used:

$R_2 = 20\text{k}\Omega$, $R_3 = 27\text{k}\Omega$

1. Calculate the switching thresholds using the given values.
2. Roughly sketch the voltage curves that you expect at the SQ output when you apply a triangular signal to U_e whose amplitude just reaches the switching points.

Output SQ



Channel 1: $\frac{\text{Volt}}{\text{Div}} = \$$

Time basis: $\frac{T}{\text{Div}} = \$$

3. Set up the Schmitt Trigger on the MEXLE-Board. **Please use the level shifting circuit at the input of the circuit.** Perform the following measurements on the Schmitt Trigger:
 - Connect channel 1 on the oscilloscope to U_e and channel 2 to SQ.
 - Connect the function generator to the U_e input. Set it to triangle with a frequency of 1kHz and a voltage of 3 V (amplitude).
 - Sketch the oscilloscope screen image.

$U_e = 3\text{ V (amplitude)}$, $f = 1\text{ kHz}$



Channel 1: $\frac{\text{Volt}}{\text{Div}} = \$$

Channel 2: $\frac{\text{Volt}}{\text{Div}} = \$$

Time basis: $\frac{T}{Div} = \$$

4. Sketch the oscilloscope screen image you would expect for 1 V (amplitude).

Ue = 1 V (amplitude), f = 1 kHz



Channel 1: $\frac{\text{Volt}}{Div} = \$$

Channel 2: $\frac{\text{Volt}}{Div} = \$$

Time basis: $\frac{T}{Div} = \$$

5. Compare your measurements with the calculation from sub-task 1 and the forecast from 2. Explain the results.

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