

# 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  $u_{\text{a}}$  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

$i_{\text{R2}} = \frac{u_{\text{a}}}{R_2}$  and  $u_{\text{e}} = -R_1 \cdot i_{\text{R1}}$ . 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:

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

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



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

$\mathrm{+}U_{\mathrm{sat}}$ , when the positive switching threshold at the input is reached. It only switches to  $\mathrm{-}U_{\mathrm{sat}}$ , 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:

$$R_2 = 20k\Omega, R_3 = 27k\Omega$$

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

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

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



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

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

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

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

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