

# Triangle-to-Rectangular Conversion - Schmitt Trigger

## Student Group

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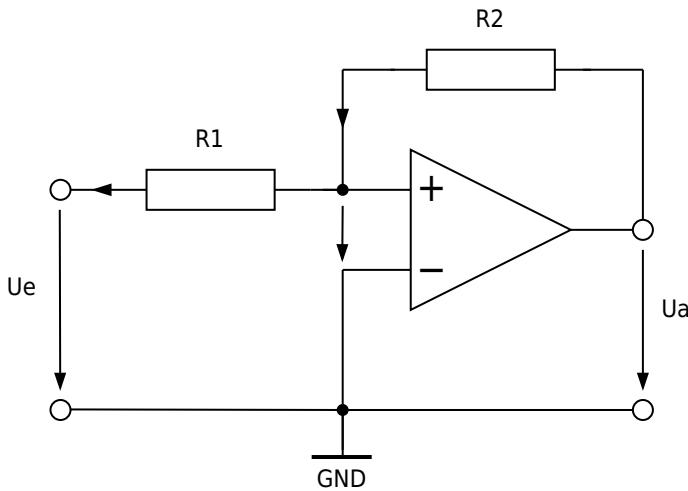
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# Triangle-to-Rectangular Conversion - Schmitt Trigger

## 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  $R_2$ .



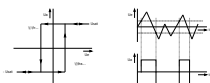
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The output voltage  $u_{\mathrm{a}}$  can only take two values, either  $+\mathrm{U}_{\mathrm{sat}}$  or  $-\mathrm{U}_{\mathrm{sat}}$ . It switches between these two values when no voltage drops at the differential input of the OPV, ( $u_{\mathrm{d}}=0$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

Then  $i_{\mathrm{R}2}=\frac{u_{\mathrm{a}}}{R_{\mathrm{2}}}$  and  $u_{\mathrm{e}}=-R_{\mathrm{1}} \cdot i_{\mathrm{R}1}$ . Since the OPV input current is  $i_{\mathrm{p}}=0$ , the currents through the resistors must be equal, and the following relationship applies for the switching points:

$$u_{\mathrm{e}}=-\frac{R_{\mathrm{1}}}{R_{\mathrm{2}}}\cdot u_{\mathrm{a}}$$

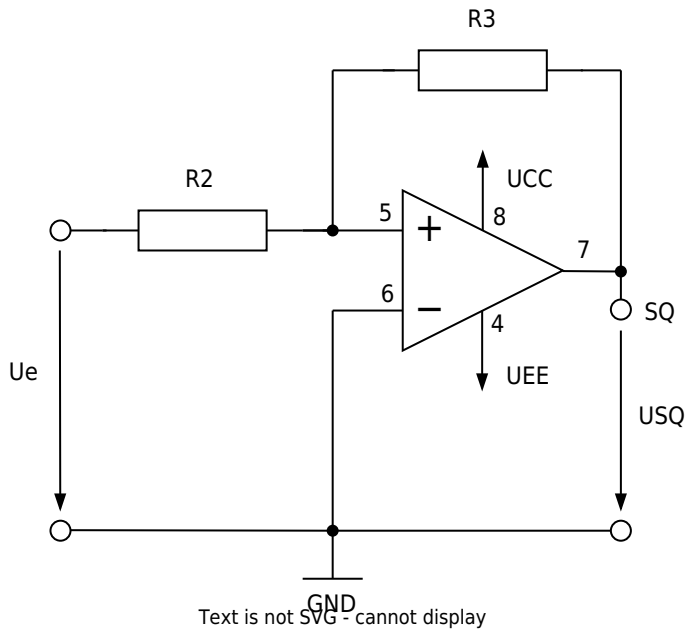
$$u_{\mathrm{a}}=\mp\frac{R_{\mathrm{1}}}{R_{\mathrm{2}}}\cdot U_{\mathrm{sat}}$$



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):

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

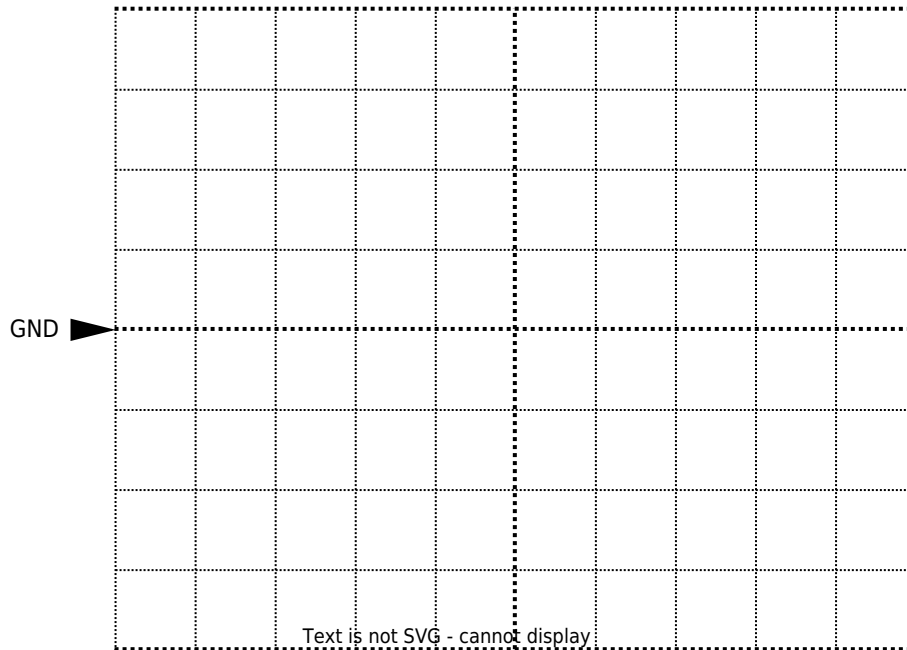
Values of the components used:

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

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

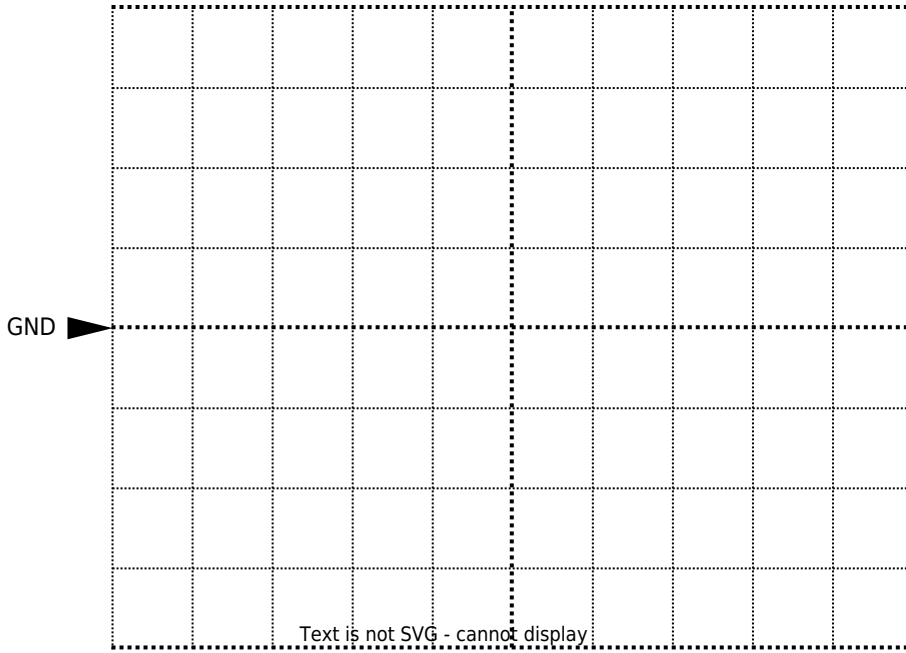


Channel 1:  $\frac{\text{Volt}}{\text{Div}} = \$$

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

3. Set up the Schmitt Trigger on the MEXLE-Board. 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.

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



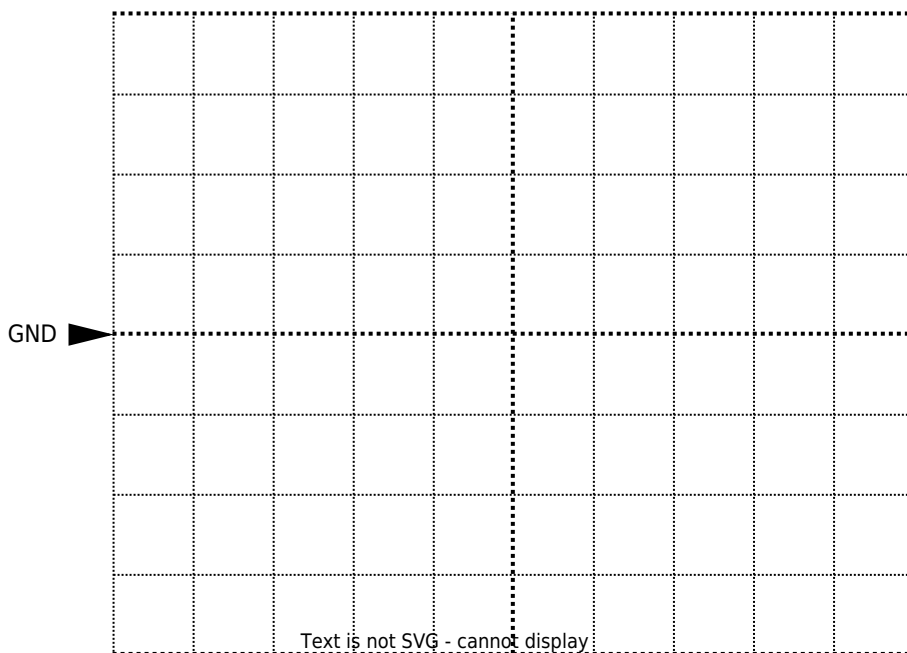
Channel 1:  $\frac{\text{Volt}}{\text{Div}} = \$$

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

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

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

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



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

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

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

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

\\Explain the results.

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