

## Comparator with and without hysteresis circuit

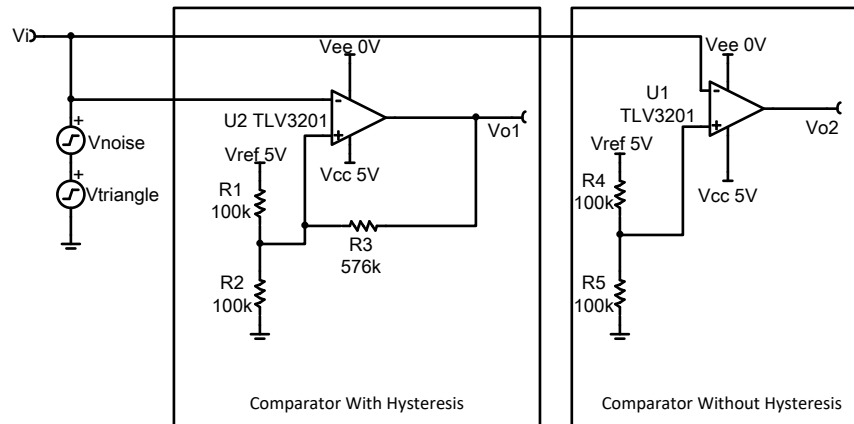
### Design Goals

Input		Output		Supply		
$V_{iMin}$	$V_{iMax}$	$V_{oMin}$	$V_{oMax}$	$V_{cc}$	$V_{ee}$	$V_{ref}$
0V	5V	0V	5V	5V	0V	5V

$V_L$ (Lower Threshold)	$V_H$ (Upper Threshold)	$V_H - V_L$
2.3V	2.7V	0.4V

### Design Description

Comparators are used to compare two different signal levels and create an output based on the input with the higher input voltage. Noise or signal variation at the comparison threshold will cause the comparator output to have multiple output transitions. Hysteresis sets upper- and lower-threshold voltages to eliminate the multiple transitions caused by noise.



### Design Notes

1. Use a comparator with low quiescent current to reduce power consumption.
2. The accuracy of the hysteresis threshold voltages are related to the tolerance of the resistors used in the circuit.
3. The propagation delay is based on the specifications of the selected comparator.

### Design Steps

1. Select components for the comparator with hysteresis.

- a. Select  $V_L$ ,  $V_H$ , and  $R_1$ .

$$V_L = 2.3V$$

$$V_H = 2.7V$$

$$R_1 = 100k\Omega \text{ (Standard Value)}$$

- b. Calculate  $R_2$ .

$$R_2 = \frac{V_L}{V_{cc} - V_H} \times R_1 = \frac{2.3V}{5V - 2.7V} \times 100k\Omega = 100k\Omega \text{ (Standard Value)}$$

- c. Calculate  $R_3$ .

$$R_3 = \frac{V_L}{V_H - V_L} \times R_1 = \frac{2.3V}{2.7V - 2.3V} \times 100k\Omega = 575k\Omega \approx 576k\Omega \text{ (Standard Value)}$$

- d. Verify hysteresis width.

$$V_H - V_L = \frac{R_1 \times R_2}{(R_3 \times R_1) + (R_3 \times R_2) + (R_1 \times R_2)} \times V_{cc}$$

$$= \frac{100k\Omega \times 100k\Omega}{(576k\Omega \times 100k\Omega) + (576k\Omega \times 100k\Omega) + (100k\Omega \times 100k\Omega)} \times 5V = 0.399V$$

2. Select components for comparator without hysteresis.

- a. Select  $V_{th}$  and  $R_4$ .

$$V_{th} = 2.5V$$

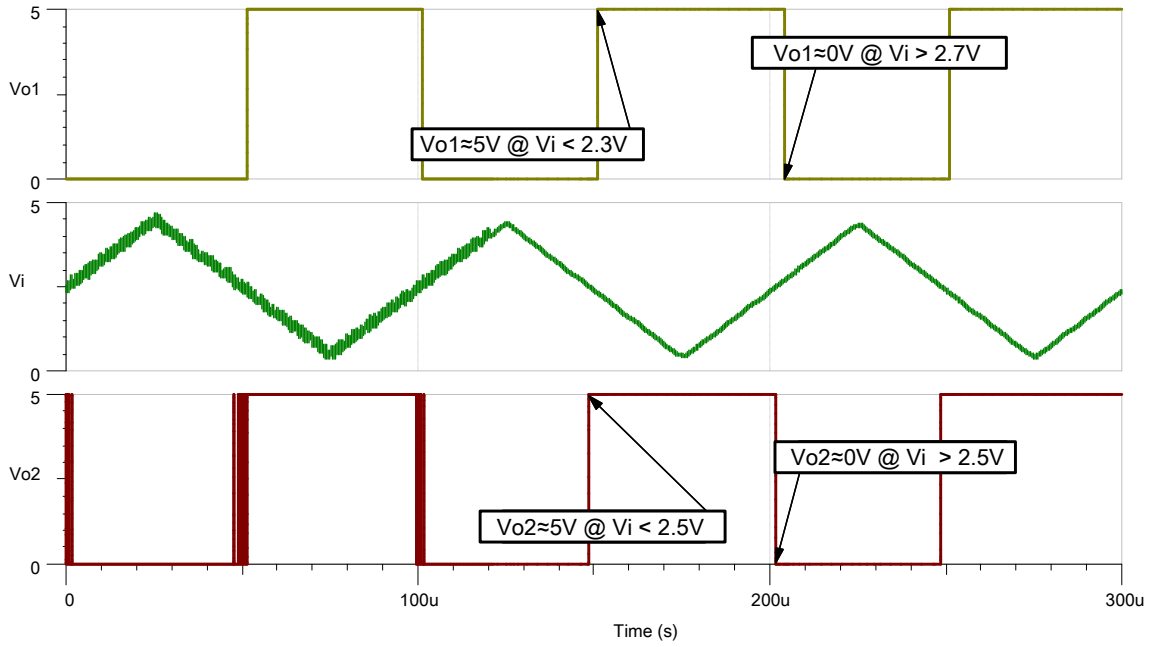
$$R_4 = 100k\Omega \text{ (Standard Value)}$$

- b. Calculate  $R_5$ .

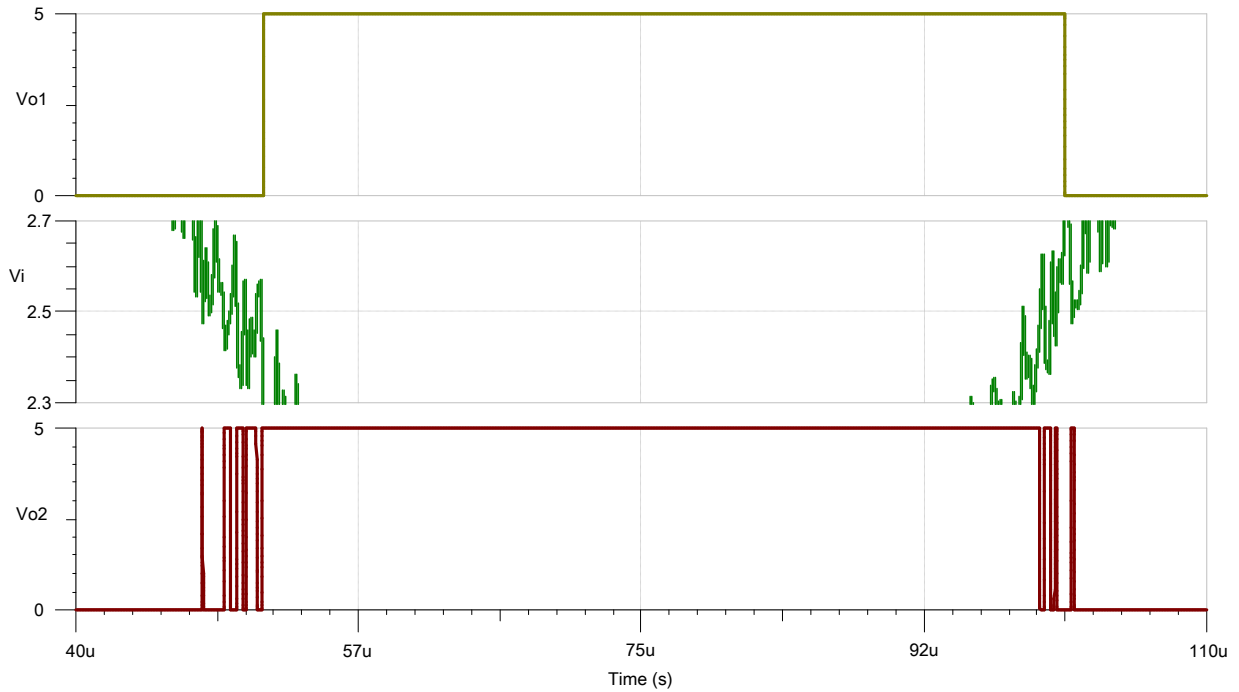
$$R_5 = \frac{V_{th}}{V_{cc} - V_{th}} \times R_4 = \frac{2.5V}{5V - 2.5V} \times 100k\Omega = 100k\Omega \text{ (Standard Value)}$$

**Design Simulations**

**Transient Simulation Results**



**Noise Only Present From 0s to 120 $\mu$ s**



**Zoomed in From 40 $\mu$ s to 110 $\mu$ s**

## Design References

See [Analog Engineer's Circuit Cookbooks](#) for TI's comprehensive circuit library.

See the circuit SPICE simulation file [SBOC515](#).

See TIPD144, [www.ti.com/tool/tipd144](http://www.ti.com/tool/tipd144).

## Design Featured Comparator

TLV3201	
$V_{cc}$	2.7V to 5.5V
$V_{inCM}$	Extends 200mV beyond either rail
$V_{out}$	$(V_{ee}+230mV)$ to $(V_{cc}-210mV)$ @ 4mA
$V_{os}$	1mV
$I_q$	40 $\mu$ A
$I_b$	1pA
UGBW	-
SR	-
#Channels	1, 2
<a href="http://www.ti.com/product/tlv3201">www.ti.com/product/tlv3201</a>	

## Revision History

Revision	Date	Change
A	February 2019	Downscale the title and changed title role to 'Amplifiers'. Added links to circuit cookbook landing page and SPICE simulation file.

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Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
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