

# Analog Engineer's Circuit

## Window Comparator Circuit



### Design Goals

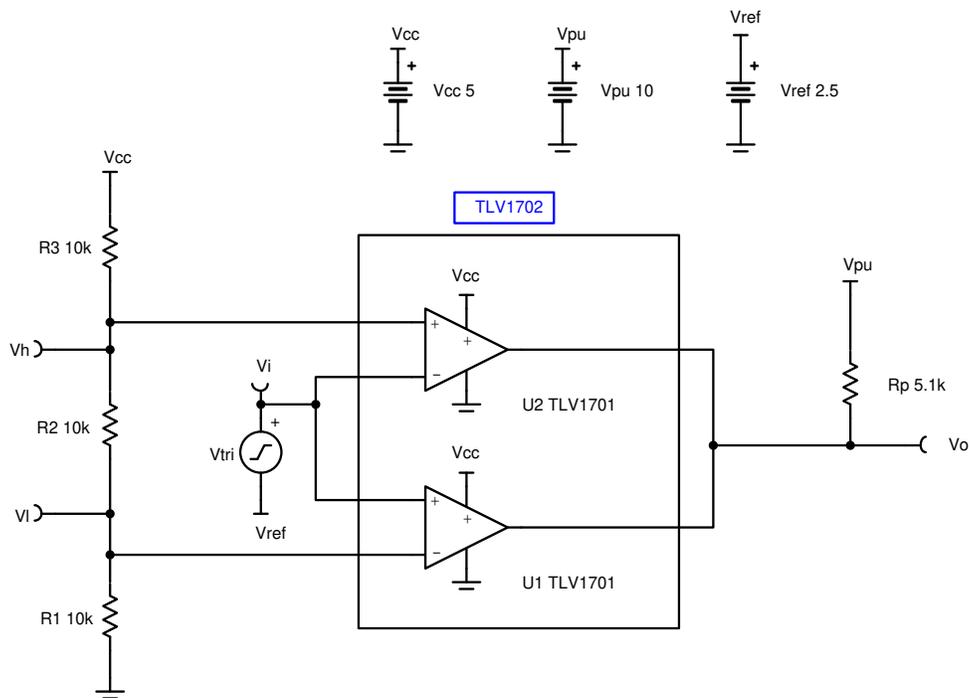
Input		Output		Supply		
$V_{iMin}$	$V_{iMax}$	$V_{oMin}$	$V_{oMax}$	$V_{cc}$	$V_{ee}$	$V_{ref}$
0 V	5 V	0 V	36 V	5 V	0 V	2.5 V

$V_L$ (Lower Threshold)	$V_H$ (Upper Threshold)	Upper to Lower Threshold Ratio
1.66 V	3.33 V	2

### Design Description

This circuit utilizes two comparators in parallel to determine if a signal is between two reference voltages. If the signal is within the window, the output is high. If the signal level is outside of the window, the output is low. For this design, the reference voltages are generated from a single supply with voltage dividers.



### Design Notes

1. The input should not exceed the common mode limitations of the comparators.
2. If higher pullup voltages are used,  $R_p$  should be sized accordingly to prevent large current draw. The TLV1701 supports pullup voltages up to 36 V.
3. Comparator must be open-drain or open-collector to allow for the ORed output.

## Design Steps

1. Define the upper ( $V_H$ ) and lower ( $V_L$ ) window voltages.

$$V_H = V_{cc} \times \frac{R_1 + R_2}{R_1 + R_2 + R_3} = 3.33 \text{ V}$$

$$V_L = V_{cc} \times \frac{R_1}{R_1 + R_2 + R_3} = 1.66 \text{ V}$$

$$\frac{V_H}{V_L} = 1 + \frac{R_2}{R_1} = \frac{3.33\text{V}}{1.66\text{V}} = 2$$

2. Choose resistor values to achieve the desired window voltages.

$$\frac{V_H}{V_L} = 1 + \frac{R_2}{R_1} = 2, \text{ so } R_2 = R_1$$

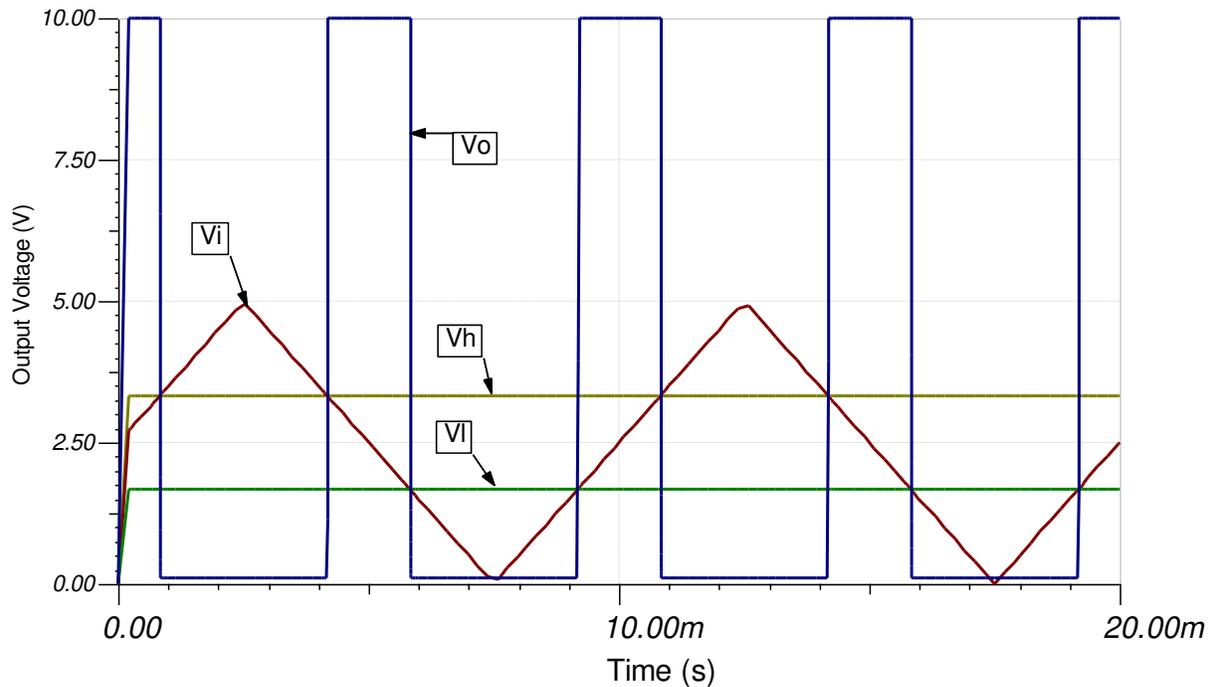
$$R_1 = R_2 = 10\text{k}\Omega \text{ (Selected standard values)}$$

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

$$R_3 = \frac{10\text{k}\Omega \times 5\text{V}}{1.66\text{V}} - 20\text{k}\Omega = 10.12 \text{ k}\Omega \approx 10\text{k}\Omega \text{ (Standard Value)}$$

## Design Simulations

### Transient Simulation Results



**Design References**

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

See the circuit SPICE simulation file [SBOC516](#).

See [TIPD178](#).

**Design Featured Op Amp**

TLV1702	
<b>V<sub>cc</sub></b>	2.2 V to 36 V
<b>V<sub>inCM</sub></b>	Rail-to-rail
<b>V<sub>out</sub></b>	Open Collector (36 V Maximum)
<b>V<sub>os</sub></b>	2.5 mV
<b>I<sub>q</sub></b>	75 $\mu$ A/Ch
<b>I<sub>b</sub></b>	15 nA
<b>Rise Time</b>	365 ns
<b>Fall Time</b>	240 ns
<b>#Channels</b>	1, 2, and 4
<a href="#">TLV1702</a>	

**Revision History**

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

<b>Changes from February 1, 2018 to February 6, 2019</b>	<b>Page</b>
<ul style="list-style-type: none"> <li>Downscale the title and changed title role to 'Amplifiers'. Added links to circuit cookbook landing page and SPICE simulation file.....</li> </ul>	1

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