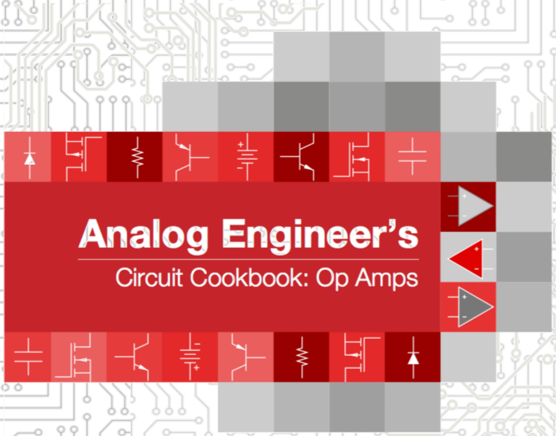
CIRCUIT060010

How to Design
PWM generator circuit

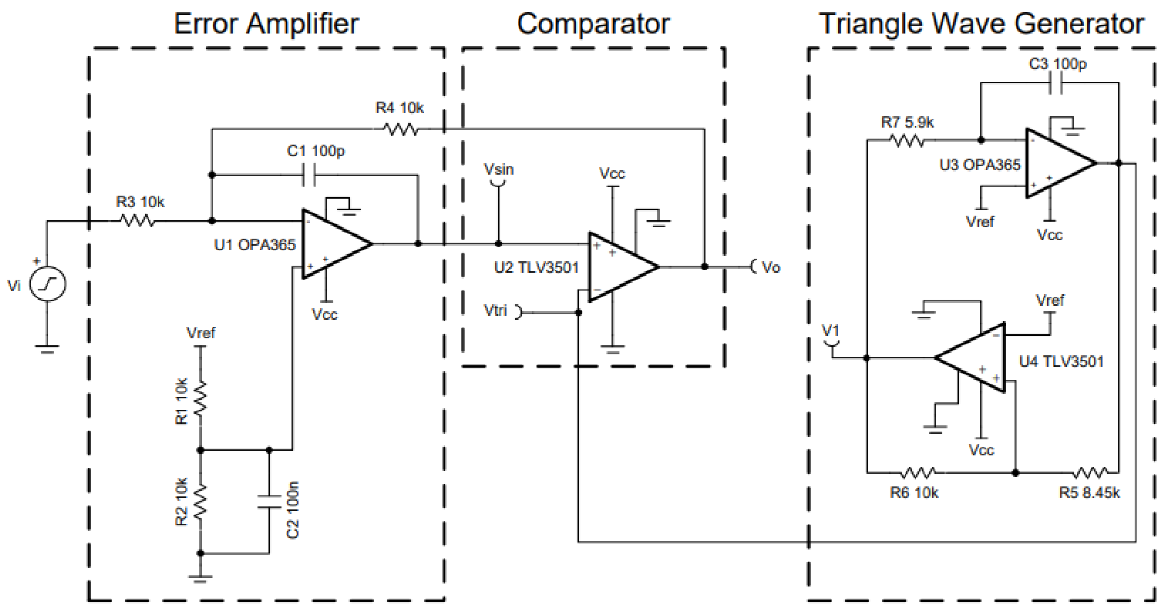


General Purpose Amplifiers

www.ti.com/general-amps

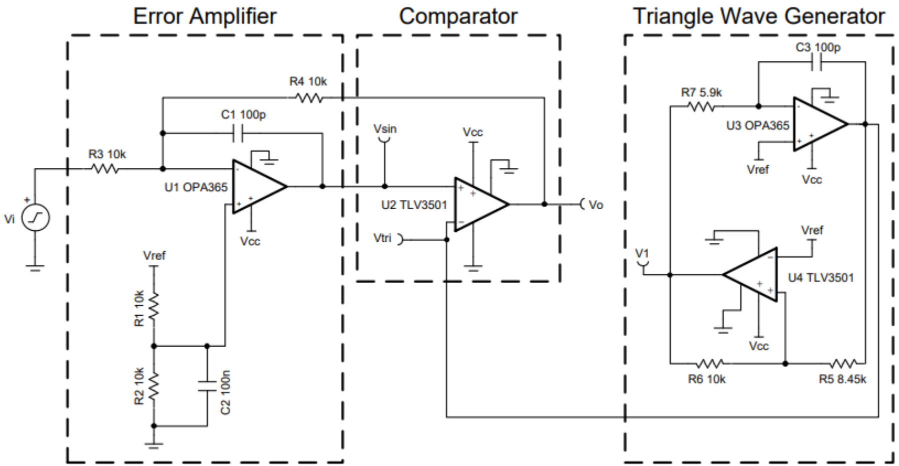
www.ti.com/circuitcookbooks

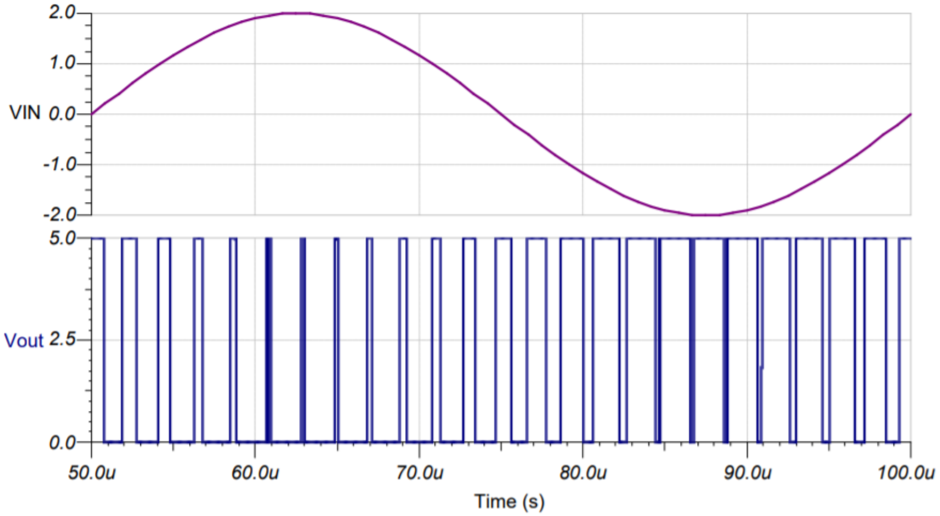
Circuit Description



Design Steps

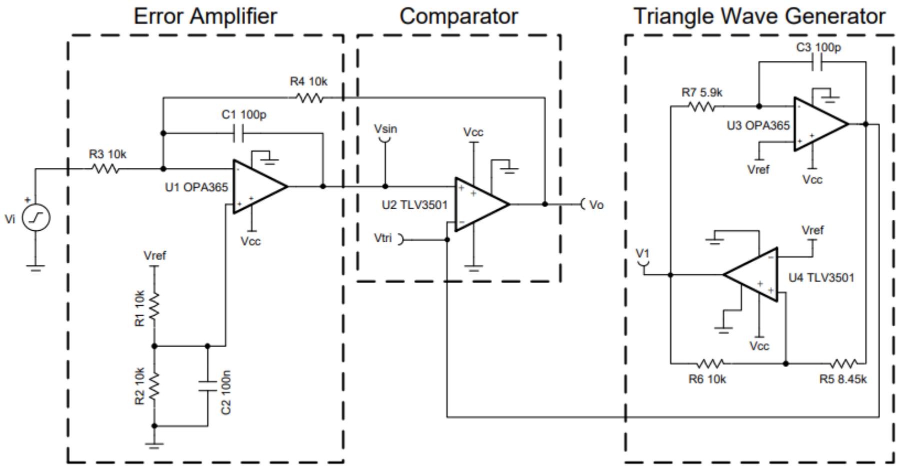
Input		Output		Supply		
V_{iMin}	V_{iMax}	V_{oMin}	V_{oMax}	V_{cc}	V_{ee}	V_{ref}
–2.0 V	2.0 V	50mV	5 V	5 V	0 V	2.5 V





Design Steps

Input		Output		Supply		
V_{iMin}	V_{iMax}	V_{oMin}	V_{oMax}	V_{cc}	V_{ee}	V_{ref}
–2.0 V	2.0 V	50mV	5 V	5 V	0 V	2.5 V



$$Gain = -\frac{R4}{R3} = -1V/V$$

$$R3 = R4$$

$$Vo\_dc = \left(1 + \frac{R4}{R3}\right) \times \left(\frac{R2}{R1 + R2}\right) \times Vref$$

$$R1 = R2 = R3 = R4 = 10\ k\Omega$$

Design Steps

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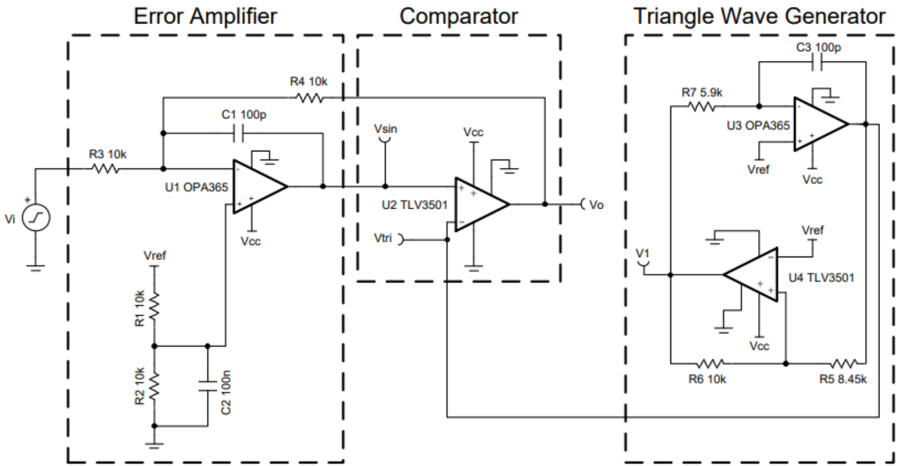
V_{iMin}	V_{iMax}	V_{oMin}	V_{oMax}	V_{cc}	V_{ee}	V_{ref}
–2.0 V	2.0 V	50mV	5 V	5 V	0 V	2.5 V



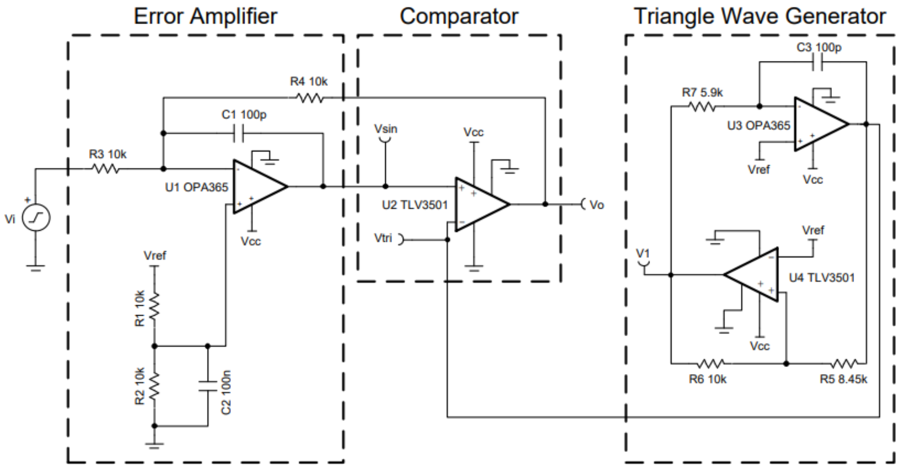
$$Vtri = \frac{R5}{R6} \times V1 = 2.1V$$

$$R5 = \frac{Vtri \times R6}{V1} = \frac{2.1V \times 10k\Omega}{2.5V} = 8.42k\Omega$$

$$8.42k\Omega \rightarrow 8.45k\Omega\ (Standard\ Value)$$

Design Steps

Input		Output		Supply		
V_{iMin}	V_{iMax}	V_{oMin}	V_{oMax}	V_{cc}	V_{ee}	V_{ref}
–2.0 V	2.0 V	50mV	5 V	5 V	0 V	2.5 V



$$ft = \frac{R6}{4 \times R7 \times R5 \times C3}$$

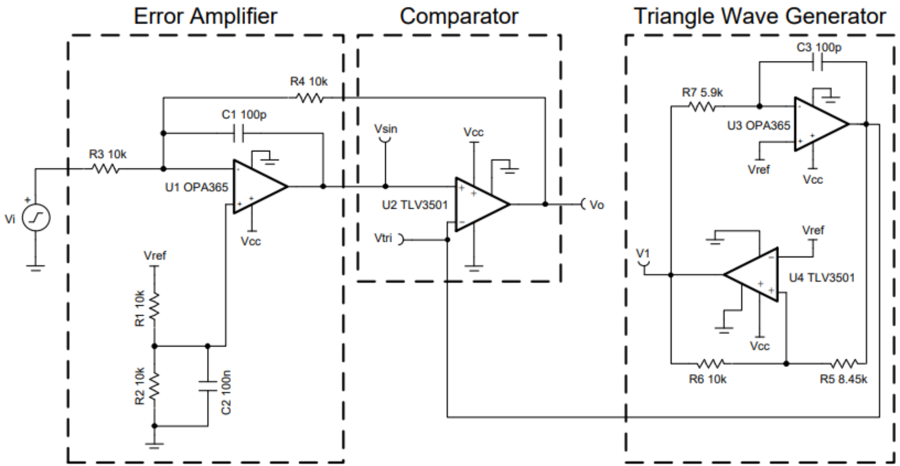
$$R7 = \frac{R6}{4 \times ft \times R5 \times C3}$$

$$R7 = \frac{10k\Omega}{4 \times 500kHz \times 8.45k\Omega \times 100pF} = 5.92k\Omega$$

$$5.92k\Omega \rightarrow 5.9k\Omega\ (Standard\ Value)$$

Design Steps

Input		Output		Supply		
V_{iMin}	V_{iMax}	V_{oMin}	V_{oMax}	V_{cc}	V_{ee}	V_{ref}
–2.0 V	2.0 V	50mV	5 V	5 V	0 V	2.5 V



$$fp = \frac{1}{2\pi \times R4 \times C1}$$

$$C1 = 100pF$$

$$fp = 159kHz$$

Design Steps

Input		Output		Supply		
V_{iMin}	V_{iMax}	V_{oMin}	V_{oMax}	V_{cc}	V_{ee}	V_{ref}
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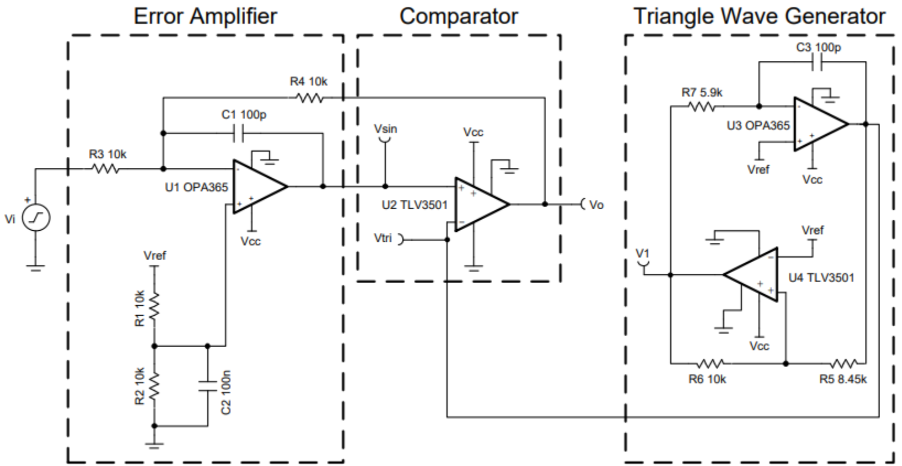


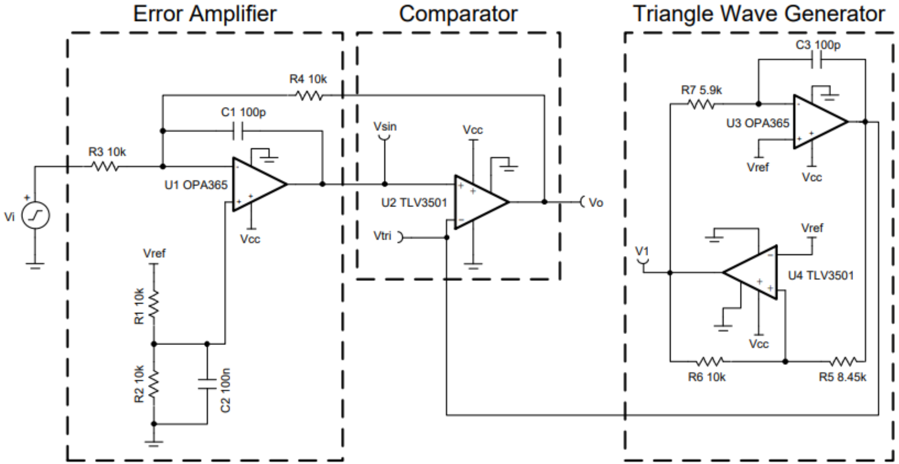
$$fc = \frac{1}{2\pi \times C2 \times \frac{R1 \times R2}{R1 + R2}}$$

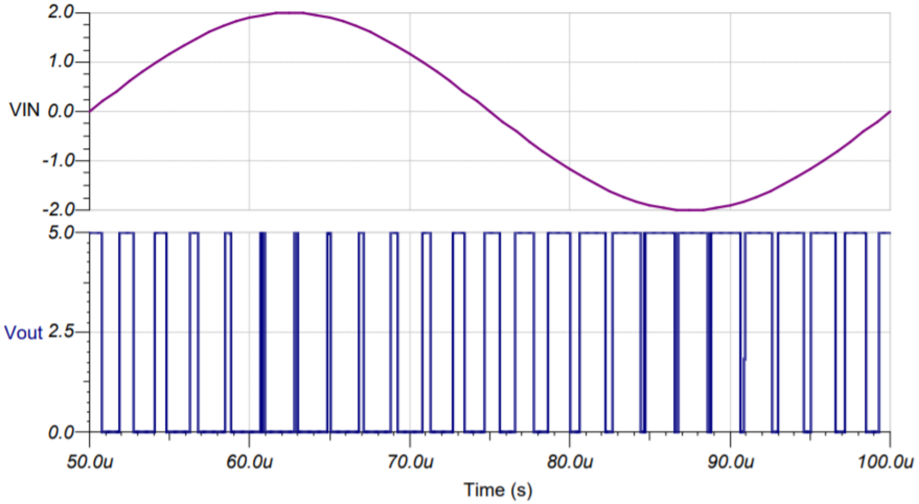
$$C2 = 100nF$$

$$fc = 320Hz$$

Transient Results

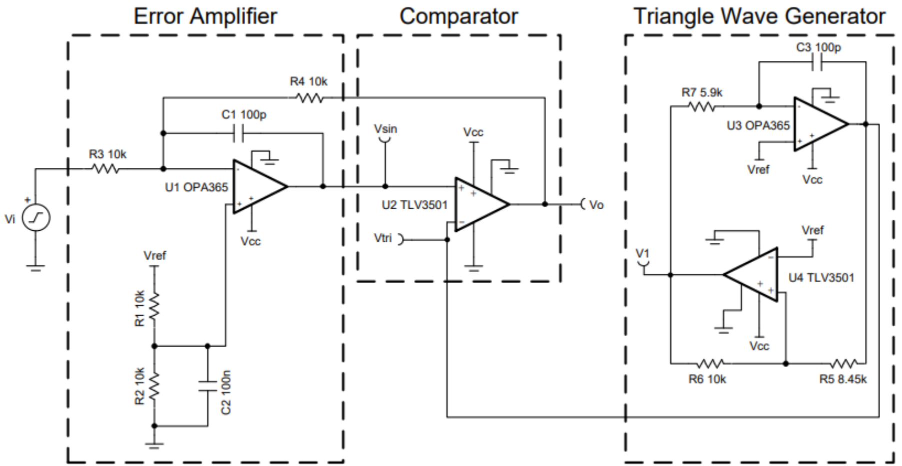
Input		Output		Supply		
V_{iMin}	V_{iMax}	V_{oMin}	V_{oMax}	V_{cc}	V_{ee}	V_{ref}
–2.0 V	2.0 V	50mV	5 V	5 V	0 V	2.5 V





Design Notes

Input		Output		Supply		
V_{iMin}	V_{iMax}	V_{oMin}	V_{oMax}	V_{cc}	V_{ee}	V_{ref}
–2.0 V	2.0 V	50mV	5 V	5 V	0 V	2.5 V



Design Notes:

1. For PWM generator circuits, use a comparator with a push-pull output and minimal propagation delay.

2. Select an op amp with sufficient SR, BW, and output swing.

3. Place the pole created by C1 below the switching frequency and well above the audio frequency range.

Design Resources

EE Cookbook: Op Amp
www.ti.com/circuitcookbooks
Step-by-step circuit design of common op amp building block circuits.

TI Designs
www.TI.com/tidesigns
Ready-to-use reference designs with
theory, calculations, simulations
schematics, PCB files, bench test results

Analog Engineer's Pocket Reference
www.TI.com/analogrefguide
PDF, iTunes app and hardcopy available
PCB, analog, mixed signal design formulae
Conversions, tables, equations

TI Precision Labs
www.TI.com/precisionlabs
Quiz questions, problems, solutions
Labs and evaluation module (EVM) available

TINA-TI™ simulation software
www.TI.com/tool/tina-ti
Complete SPICE simulator DC, AC, transient, noise analysis
Schematic entry and post-processor for waveform math

DIYAMP-EVM
www.TI.com/DIYAMP-EVM
Evaluation module providing engineers with SC70, SOT23, SOIC packaging and 12 popular amplifier configurations

The Signal
www.TI.com/signalbook
PDF, iTunes app and hardcopy available
A compendium of blog posts on op amp design topics including
offset voltage, input bias current, stability, noise and more

***Analog Wire* Blog**
www.TI.com/analogwire
Technical blogs written by analog experts
Tips, tricks, and design techniques

TI E2E™ Community
www.TI.com/e2e
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Op Amp Parametric Quick Search
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