

# Control function: PWM controller, triangular reference



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## 1 Description

This device is an implementation of a PWM (pulse-width modulation) controller with a triangular (ramp up and ramp down) reference. For a version with a rising-ramp-only reference, use the device "PWM, ramp reference".

### 1.1 Pins

This device has two pins:

<i>pin</i>	<i>type</i>	<i>description</i>
u	input	controller input
out	output	controller output

### 1.2 Parameters

The following parameters must be defined:

<i>parameter</i>	<i>description</i>	<i>units</i>
fc	carrier frequency	Hz
umax	maximum input value (at duty ratio =1)	units of u
stepped	=1 to indicate stepped transitions =0 to indicate ramped transitions	

The value of the parameter *stepped* determines whether the device operates with *stepped* or *ramped* transitions. In *stepped* mode (the default for ideal logical signals), the output is represented as a stepped signal, where changes in value are observed as vertical steps at the time they occur. In *ramped* mode, the value transitions of the output are seen as ramps between  $t-\Delta t$  and  $t$ .

### 1.3 Input

The input pin may be connected to any control signal.

## 1.4 Output

The output is a pulse-width modulated signal of value 0 or 1. It consists of a sequence of variable-width pulses generated at frequency  $fc$ . The width of each pulse corresponds to the scaled amplitude of the input signal. When the input value is  $umax$ , the pulse is *on* for a full period, that is, pulse width = period =  $1/fc$ . When the input value is 0, the pulse is *off* for a full period, that is, pulse width = 0.

The representation of the output as having *stepped* or *ramped* transitions is determined by the value given to the parameter *stepped*.

## 1.5 Representation

The implementation of the model can be inspected by opening the device's subcircuit.

The model applies the following equation:

$$\begin{aligned} \text{when input} > \text{reference} & \quad \text{output} = 1 \\ \text{when input} \leq \text{reference} & \quad \text{output} = 0 \end{aligned} \quad (1)$$

where *reference* is the instantaneous value of the generated sawtooth calculated as

$$\begin{aligned} \text{reference} &= umax \cdot \frac{2t}{T} && \text{for } 0 \leq t < T/2, \text{ repeated every period} \\ \text{reference} &= umax \cdot \frac{2(T-t)}{T} && \text{for } T/2 \leq t < T, \text{ repeated every period} \end{aligned} \quad (2)$$

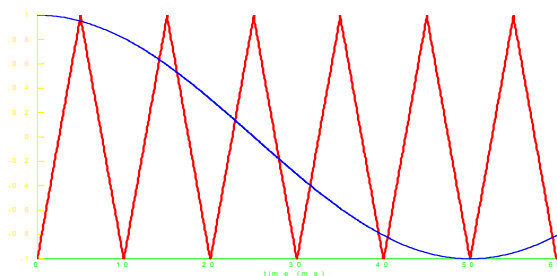


Figure 1 input and triangular reference

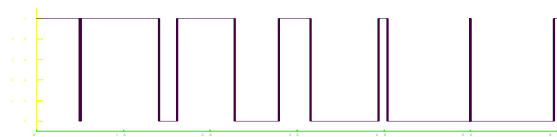


Figure 2 PWM output