Demo 5: Pulse-Width Modulation

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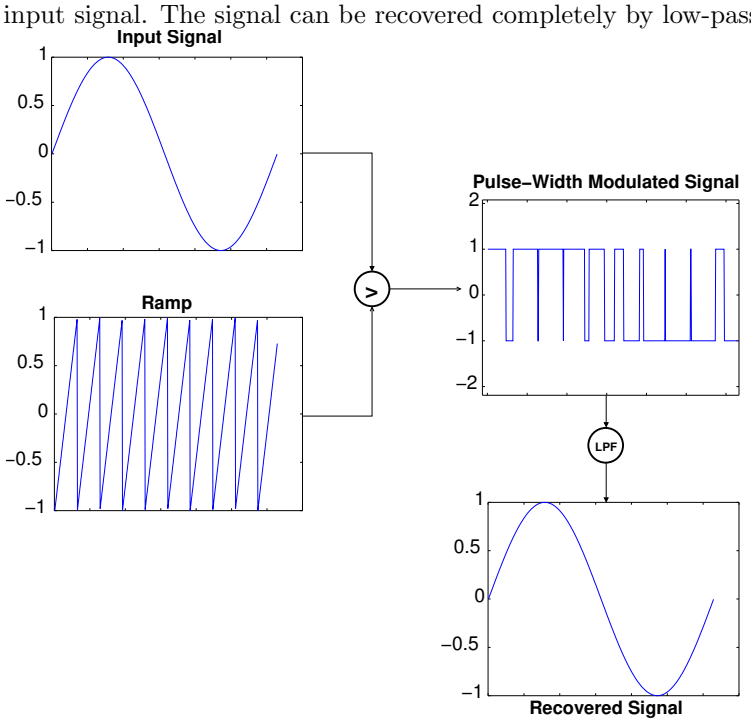
1 Overview

This demo uses the systick timer to drive the LEDs with a pulse-width modulated sinusoid.

2 Operation

Pulse-width modulation is a very simple form of digital-to-analog and analog-to-digital conversion in which the duty cycle of a square wave output is controlled by an input value. The following converter, for example, pulse-width modulates an input signal. The signal can be recovered completely by low-pass filtering:



The low-pass filtering step is often performed by the output device itself. Speakers and electric motors perform this filtering mechanically; the inertia of their moving parts effectively low-pass filter pulse-width modulated signals used as input. In our circuit, we pulse-width modulate the rapid flashing of an LED and allow the low-pass filtering to be performed biologically, by the eye of the observer.

This demo builds on Demo 4 by combining the `systick` timer and the GPIO output together to perform a somewhat more complex application. The LEDs are rapidly flashed. The timing of the flashing is controlled so that, while the sum of the LEDs' on and off periods are the same, the time spent on and off is changed, pulse-width modulating the flashing of the LEDs. The function used to control the pulse-width modulation is an approximate sinusoid, computed using an 8-entry lookup table and linear interpolation.

3 Further Reading

The source is thoroughly annotated with comments, pointing to the pages in the ST Microelectronics manuals where further information can be found on each system used.

4 Exercises

The following exercises can be completed by modifying the demo code.

1. Replace the sinusoidal pulsing with a triangle wave pulsing. Is the difference readily apparent?

2. The waveform on the output is now approximately $128 - 128 \sin t$. Replace this with $128 - 128 \sin^2 t$. Is the difference readily apparent?

3. The `systick` timer runs at 3MHz; $\frac{1}{8}$ of the 24MHz system clock. What is the frequency of the square wave used in the PWM? Modify the code to produce similar output, but with a PWM frequency 16 times faster.