Application Note

Converting 8Ch PWM to Pulse Position Modulation

AN-CM-266

Abstract

This application note presents how to design a circuit for converting PWM signals to Pulse Position Modulation (PPM) signals using only a single GreenPAK IC.

This application note comes complete with design files which can be found in the References section.

Contents

Figures

1   Terms and Definitions

Ch   Channel
IC   Integrated Circuit
PPM   Pulse Position Modulation
PWM   Pulse Width Modulation
RC models   Radio Control models
Etc.

2   References

For related documents and software, please visit:

GreenPAK™ Programmable Mixed-Signal Products | Renesas

Download our free GreenPAK™ Designer software [1] to open the .gp files [2] and view the proposed circuit design. Use the GreenPAK development tools [3] to freeze the design into your own customized IC in a matter of minutes. Find out more in complete library of application notes [4] featuring design examples as well as explanations of features and blocks within the GreenPAK IC.

[1]   GreenPAK Designer Software, Software Download and User Guide
[2]   AN-CM-266 Converting 8Ch PWM to Pulse Position Modulation.gp, GreenPAK Design File
[3]   GreenPAK Development Tools, GreenPAK Development Tools Webpage
[4]   GreenPAK Application Notes, GreenPAK Application Notes Webpage

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Converting 8Ch PWM to Pulse Position Modulation

3   Introduction

We will review 2 output signal formats of radio Receivers for radio-controlled models (or RC models). The traditional and most common type of Receiver signal is PWM, and usually PWM requires only one wire per channel. PPM signaling is now getting more and more popular because it can handle all channels on a single wire. So, sometimes there is a need to convert PWM signaling to PPM. The goal of this application note is to design a circuit that can convert 8Ch PWM signals to PPM.

4   Input and Output Signals

Figure 1 shows the input and output signals used in this app note. The PWM signals (one for each channel) are output one by one by the Receiver and the duty cycle information represents the users desired position by the Transmitter. In contrast, the PPM signal contains the duty cycle information of all the PWM channels. In both cases, the value of each channel is represented in a standardized way. The interpreted width of a 1 mS positive pulse represents 0 % position, and 2 mS represents 100%.

In PPM signaling, the values of each channel are represented by the delay between rising edges of positive pulses each having 400 uS fixed width.
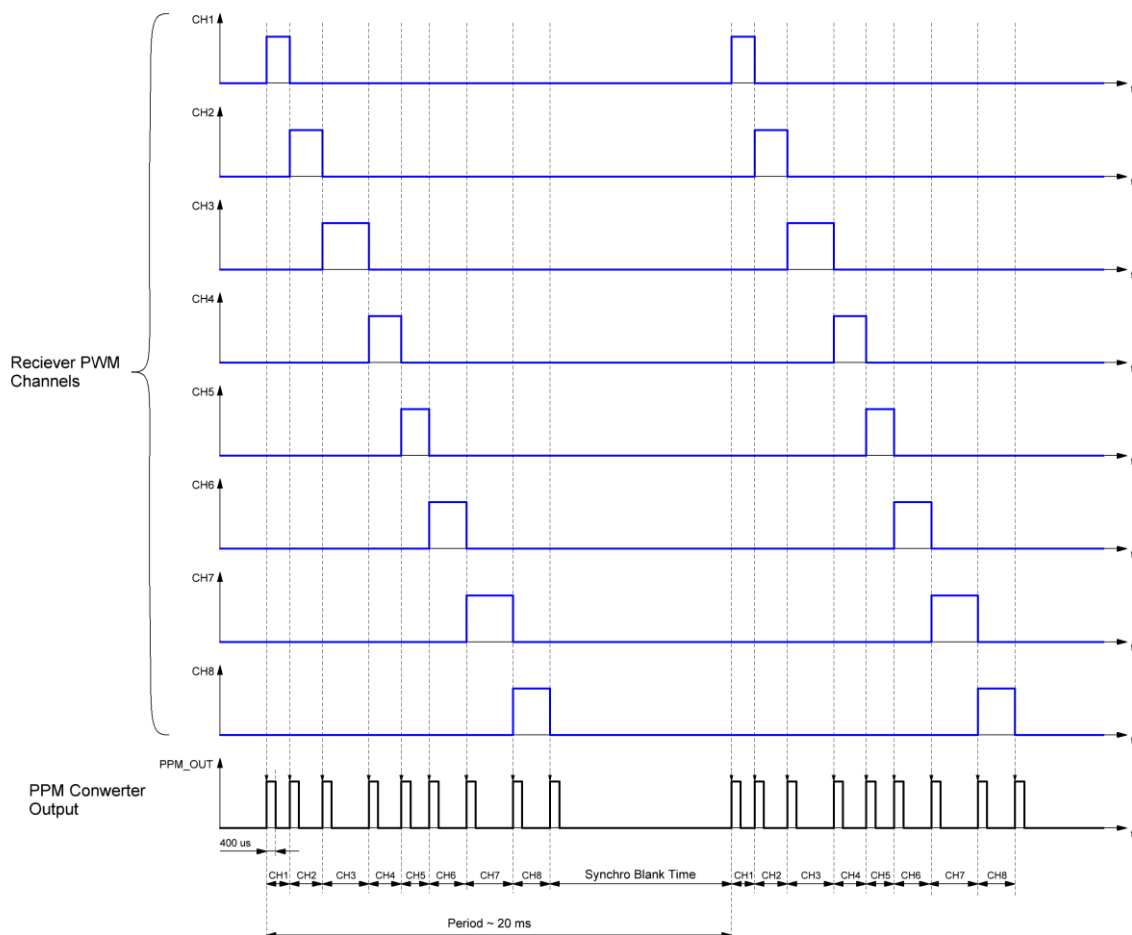

Figure 1: Timing Diagram: Converter Signals

5   GreenPAK Design

The design approach is to detect the Rising and Falling Edges of each PWM channel, generate PPM pulses from each edge, and then combine them into one PPM channel. For this the GreenPAK design uses DLY3 Both Edge Detector, P DLY Both Edge Detector and LUTs, Both Edge Detector structure with Buffer and XOR LUT, as shown in Figure 2. Further, Both Edge pulses go to an 8-bit OR structure that consists of 3-bit LUTs 7,5 and 4-bit LUT0 configured as OR gates. At the 4-bit LUT0 output, all Edge Pulses are combined and then sent to a rising edge triggered one-shot structure that consists of a Pipe Delay and 400 us DLY0 to generate the PPM signal. Also, each input PIN has an internal 100k Ohm pull down resistor for noise stability if some inputs are not used.
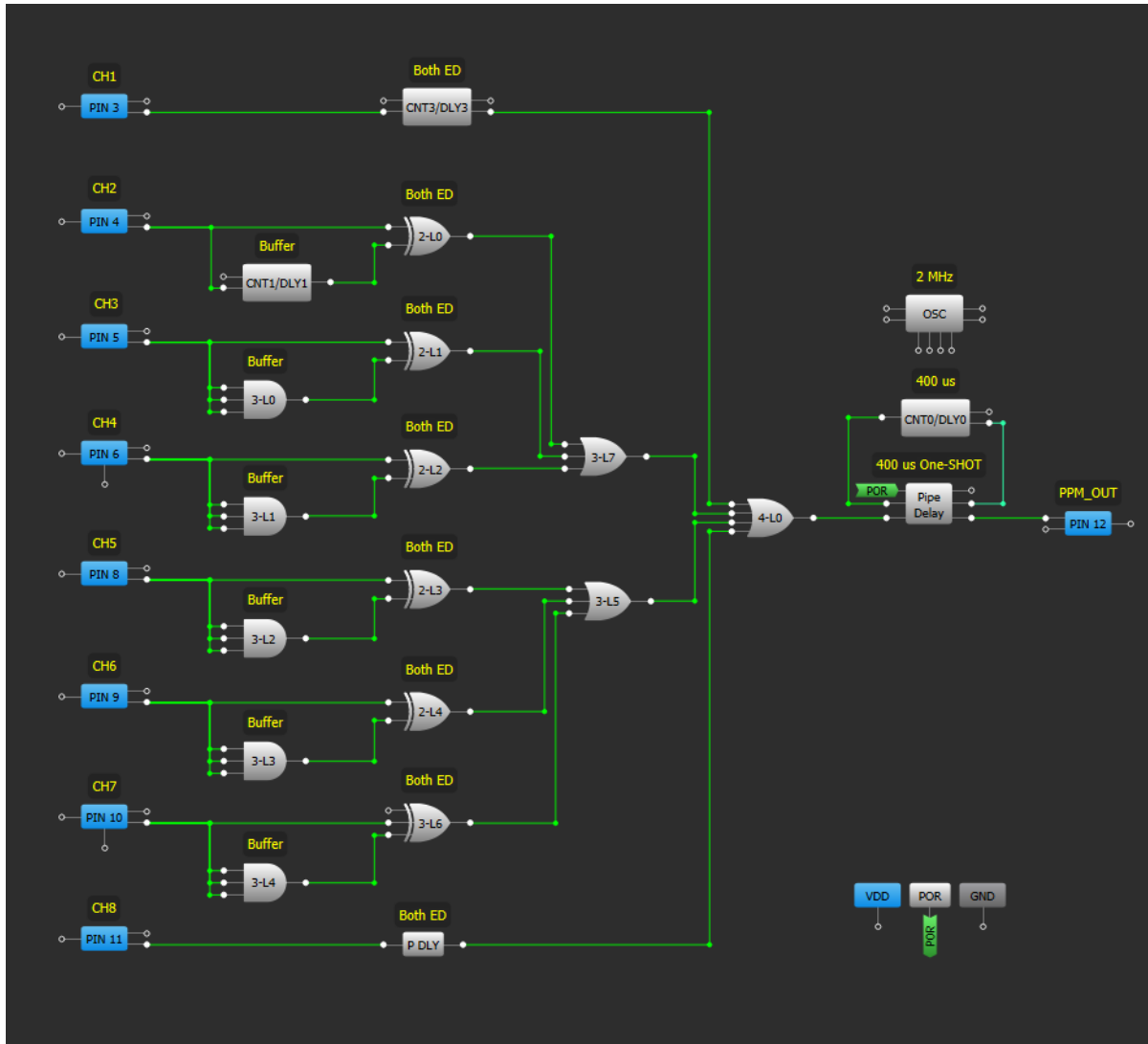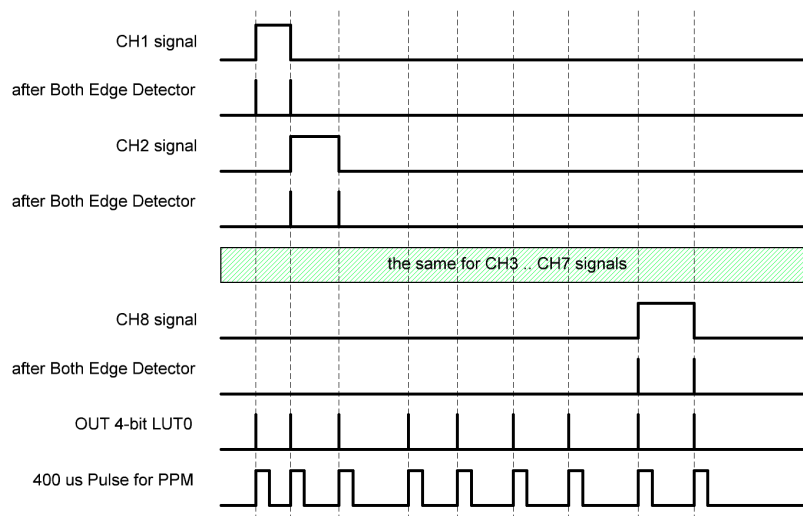

Figure 2: GreenPAK Design

Converting 8Ch PWM to Pulse Position Modulation

The sequence of these operations is clearly presented in Figure 3. It represents 8 PWM to 1 PPM channels conversion.

Figure 3: Sequence of Operations

6   PCB Design

The functional prototype of this design with RC Transmitter & Receiver is shown in Figure 4.

Figure 4: Prototype PCB and Test Board

7 Results

In Figure 5 waveforms, the signals/channels legend is: D1 = CH1, ... D8 = CH8 accordingly, and Channel 1 (blue) = PPM Converter output. Figure 5 shows 8 channels of PWM signals converted to one channel of PPM signal.
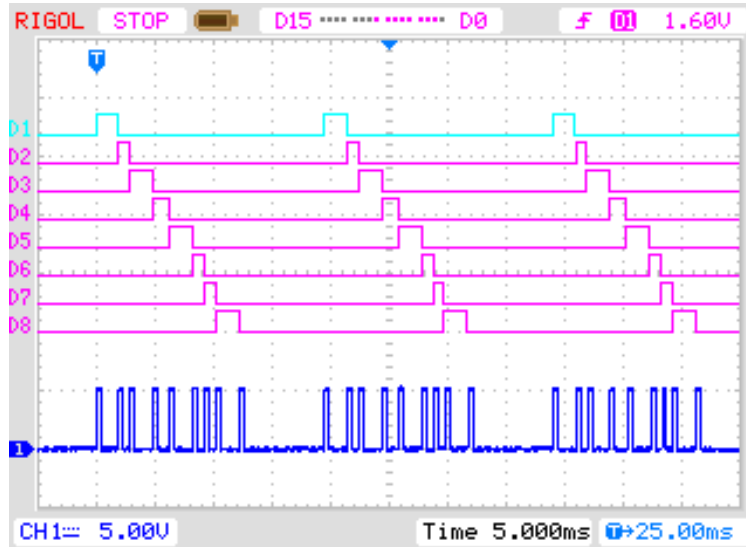

Figure 5: PPM Converter Functionality for 8 Channels of PWM Signals

Also, this PPM Converter can process less than 8 channels of PWM signals. For example, Figure 6 shows 4 channels of PWM signals converted to one channel of PPM signal.
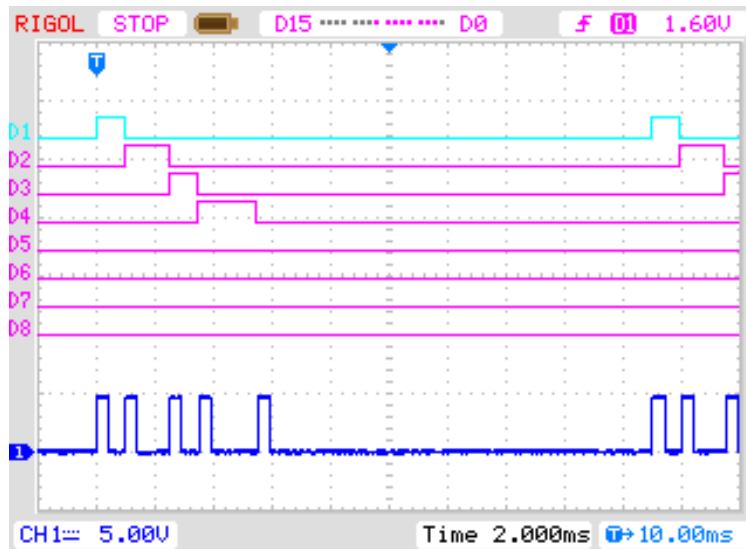

Figure 6: PPM Converter Functionality for 4 Channels of PWM Signals

8   Conclusions

In this application note we designed, built, and verified a circuit for converting PWM signals to Pulse Position Modulation (PPM) signals using only a single GreenPAK IC. It can process anywhere from one to eight PWM channels. Major advantages of using GreenPAK are availability of on-chip circuit blocks, very small physical area, low power, and low cost. Other functionality or integration can be configured into the same IC by using leftover available circuit blocks, thereby reducing product size and cost even further.

This app note shows how to create an 8 Cannel PWM signals to PPM signal Converter using only one GreenPAK IC. Detection of Rising and Falling Edges of each PWM channel signal and their "merger" allowed to get PPM signal. A single GreenPAK IC Converter can process anywhere from one to eight PWM channels.

Revision History

Revision	Date	Description
1.0	10-Jan-2019	Initial Version

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