Pulse Width Modulator Using the ispPAC®20

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Pulse-width modulators (PWMs) are used for many purposes. Analog signals are often pulse-width modulated for transmission along fiber-optic links and across isolation barriers. The most common use for PWMs, however, is in controlling power electronics. By rapidly switching a power transistor on and off at a specific duty cycle, it is possible to make that transistor appear to be proportionally on from the standpoint of the load. There are several advantages to duty cycling a transistor in an on-off digital operating mode as opposed to operating the device in a linear mode. The first is that more of the system's power is delivered to the load and not wasted as heat in the transistor. The losses in a well designed PWM power driver can be an order of magnitude lower than those of a comparable linear-mode power driver. An example of this is shown in Figure 1. The power transistor in a linear driver for a resistive heater element (Figure 1a) will dissipate as much power as the heater when operated at 50% power. If the transistor driver is run at either 0% or 100% power 50% of the time, however, the same amount of average power is delivered to the load, but the transistor dissipates much less power. Additionally, in the case of certain kinds of reactive loads, such as motors, a pulse-width modulated driver circuit can act as a switching power supply, converting a high-voltage, low average-current input into a low-voltage high average current output available to drive the load.

Figure 1. Resistive Heater Driven with a Linear Driver (a) and a PWM Driver (b)

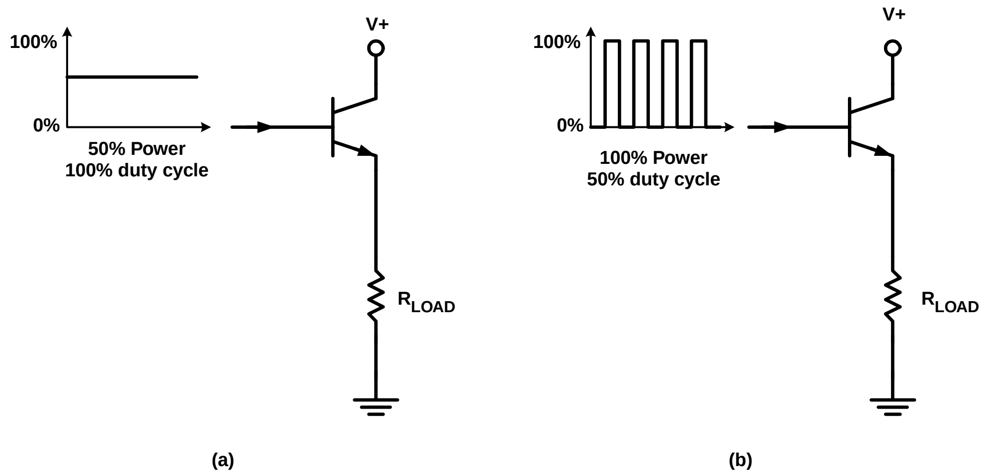


Figure 2 shows how an ispPAC20 device can be used to develop a digital PWM output, where the duty cycle is set by the value loaded into the DAC. A PWM output signal is produced on the CP2OUT pin.

This circuit operates in the following way. The IA4 input amplifier and OA2 output amplifier are used to form a fixed-rate integrator, driven from the on-chip 1.5V reference. IA4's polarity control determines the direction (up or down) in which the integration occurs. By tying the output of CP1 back to the negative pin of CPIN (and tying the positive pin to VREFout) Comparator CP1 can be configured as a Schmidt trigger with 5V of hysteresis. By combining this Schmidt trigger with the integrator, one obtains a fixed-frequency triangle-wave oscillator. The waveforms developed by this oscillator are shown in Figure 2. The frequency of this oscillator is controlled by the value of OA2's feedback capacitor. For the value shown (61.59pF), the operating frequency is approximately 10kHz. By reducing the value of the capacitor, this frequency may be increased to approximately 200kHz with the tradeoff of reduced linearity in duty-cycle vs. input voltage.

Figure 2. Pulse-width Modulator Using ispPAC20

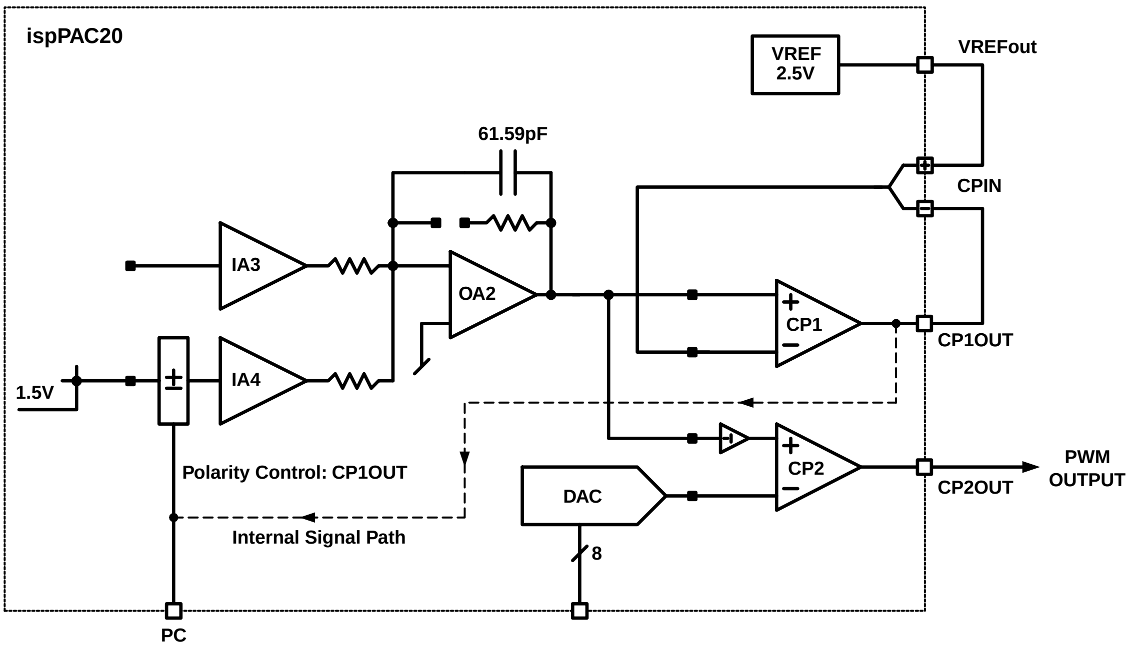
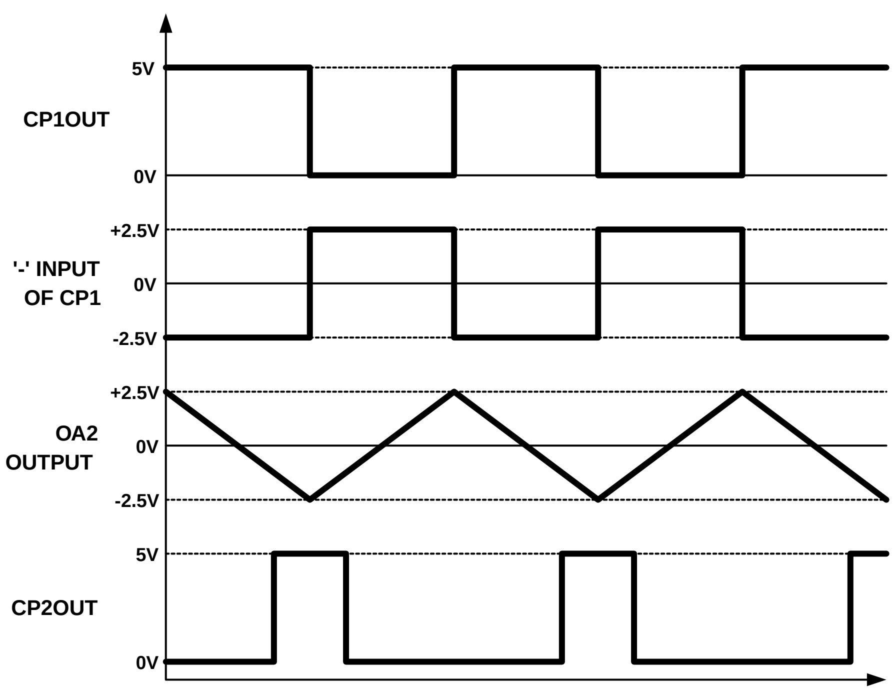


Figure 3. PWM Voltage Waveforms



Comparator CP2 is used to compare the value of the DAC to the triangle waveform appearing at the output of OA2. The duty cycle of CP2's output is proportional to the time which the triangle wave (after being inverted) is greater than the DAC voltage. In this way, the DAC value sets the duty cycle of the CP2 output signal. Because of the signal inversion at CP2's input, the scale is inverted, with a DAC voltage of -2.5V (code 15h) providing 100% duty cycle, and a DAC voltage of 2.5V (code EBh) providing 0% duty cycle.

It is also possible to control the duty cycle by an external input voltage. An external signal brought in through input IN3 can be routed directly to CP2's negative input, leaving PACblock 1 free to be used for other functions. Voltage controlled PWMs are especially useful in feedback control systems for motors, solenoids and temperature controllers.

Technical Support Assistance

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