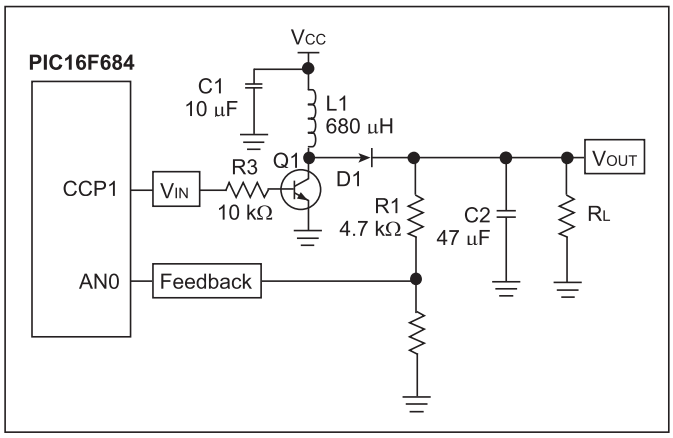
TIP #17 Boost Power Supply

Figure 17-1: Boost Power Supply Circuit



Hardware

Pulse-width modulation plays a key role in boost power supply design. Figure 17-1 shows a typical boost circuit. The circuit works by Q1 grounding the inductor (L1) during the high phase of the PWM signal generated by CCP1. This causes an increasing current to flow through L1 while VCC is applied. During the low phase of the PWM signal, the energy stored in L1 flows through D1 to the storage capacitor (C2) and the load. VOUT is related to VIN by Equation 17-1.

Note: Technical Brief TB053 "*Generating High Voltage Using the PIC16C781/782*" provides details on boost power supply design.

The first parameter to determine is the duty cycle based upon the input and output voltages. See Equation 17-1.

Equation 17-1

$$\frac{V_{OUT}}{V_{IN}} = \frac{1}{1 - D}$$

Next, the value of the inductor is chosen based on the maximum current required by the load, the switching frequency and the duty cycle. A function for inductance in terms of load current is given by Equation 17-2, where T is the PWM period, D is the duty cycle, and IOUT is the maximum load current.

Equation 17-2

$$L = \frac{V_{IN}\,(1 - D)\,DT}{2\,I_{OUT}}$$

The value for L is chosen arbitrarily to satisfy this equation given IOUT, a maximum duty cycle of 75% and a PWM frequency in the 10 kHz to 100 kHz range.

Using the value chosen for L, the ripple current is calculated using Equation 17-3.

Equation 17-3

$$I_{RIPPLE} = \frac{V_{IN}\,DT}{L}$$

IRIPPLE can not exceed the saturation current for the inductor. If the value for L does produce a ripple current greater than ISAT, a bigger inductor is needed.

Note: All equations above assume a discontinuous current mode.

Firmware

The PWM duty cycle is varied by the microcontroller in order to maintain a stable output voltage over fluctuating load conditions. A firmware implemented PID control loop is used to regulate the duty cycle. Feedback from the boost power supply circuit provides the input to the PID control.

Note: Application Note AN258 "*Low Cost USB Microcontroller Programmer*" provides details on firmware-based PID control.