TB085

A Simple Circuit for Driving Microcontroller Friendly PWM Generators

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INTRODUCTION

The recent interest in intelligent power supplies has driven the development of a new class of microcontroller friendly PWM generators. These PWM generators are the mixed signal control blocks for Switch mode power supplies. One such device is the MCP1630. The MCP1630 contains the 3 main elements for designing a switching power supply as a peripheral to a microcontroller: a set/reset flip-flop, a high-speed voltage comparator and an op amp to implement the error amplifier (see Figure 1).

The microcontroller controls the MCP1630 through its clock input. The frequency of the clock determines the pulse frequency of the PWM output, and the duty cycle of the clock limits the maximum PWM duty cycle of the output. Control of the duty cycle between 0 and the maximum set by the clock input is determined by the current feedback to the comparator and the output of the error amplifier (see Figure 2).

Because the MCP1630 does not contain an on-chip oscillator, its application in non-intelligent or dumb power supply designs, is limited. However, marrying the MCP1630 with a small pin-count microcontroller solves the oscillator problem and opens up possibilities for other features such as:

- Variable pulse frequency soft-start
- External shutdown control
- Under-voltage lockout
- Over temperature shutdown

THEORY OF OPERATION

This technical brief will examine a design which combines the PIC10F206, a 6-pin SOT-23 microcontroller, with the MCP1630. The power supply design presented is a full proportional-feedback continuous inductor current, current-mode, boost power supply generating 15V out at .25 amps from a 9 VDC input. The PIC10F206 generates the clock for the MCP1630 and through that control, implements the previous list of features.

FIGURE 1: TYPICAL SWITCH MODE POWER SUPPLY BLOCK DIAGRAM

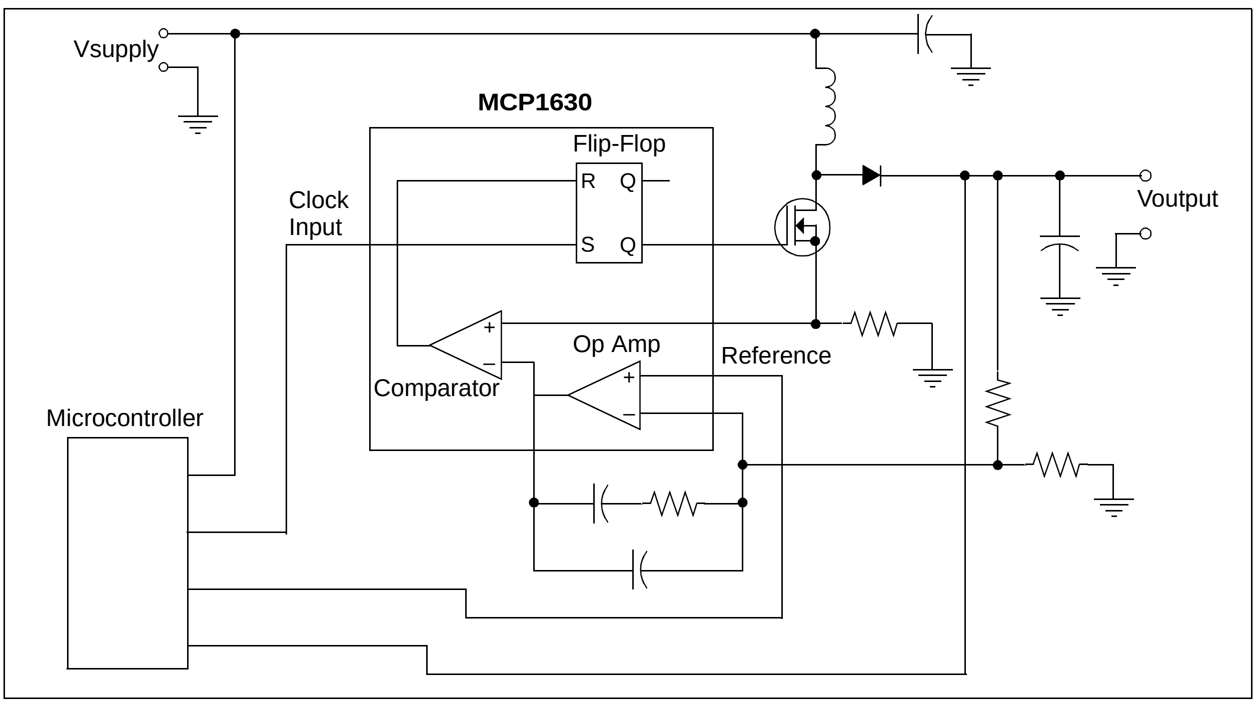
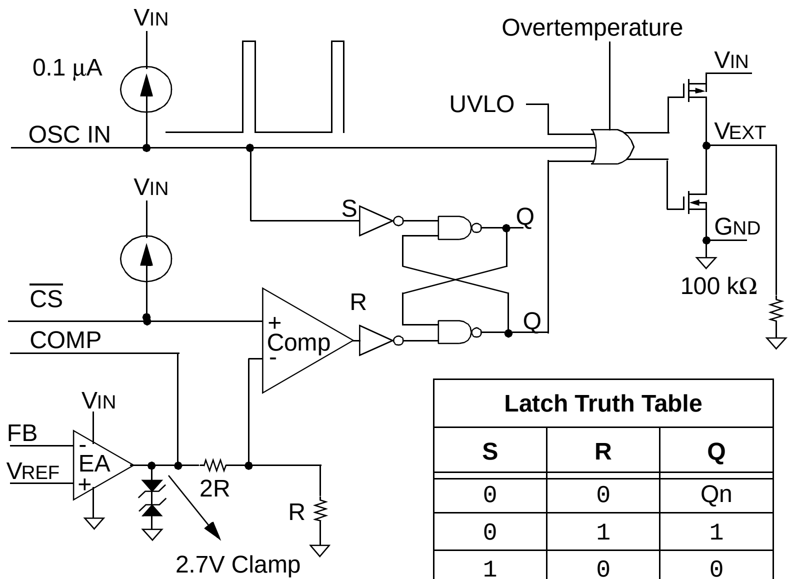


FIGURE 2: MCP1630 HIGH-SPEED PWM



Latch Truth Table		
S	**R**	**Q**
0	0	Qn
0	1	1
1	0	0
1	1	1

HARDWARE

The PIC10F206 is well suited for this function. It has an on-chip voltage comparator for the under-voltage detect and it has sufficient I/O to control the MCP1630 and monitor the external inputs.

The microcontroller monitors the inputs and generates the 250 kHz clock, all in software. Because the controls are simple, the control circuit only needs the microcontroller and a few components to implement all the control functions. Figure 3 shows the resulting schematic.

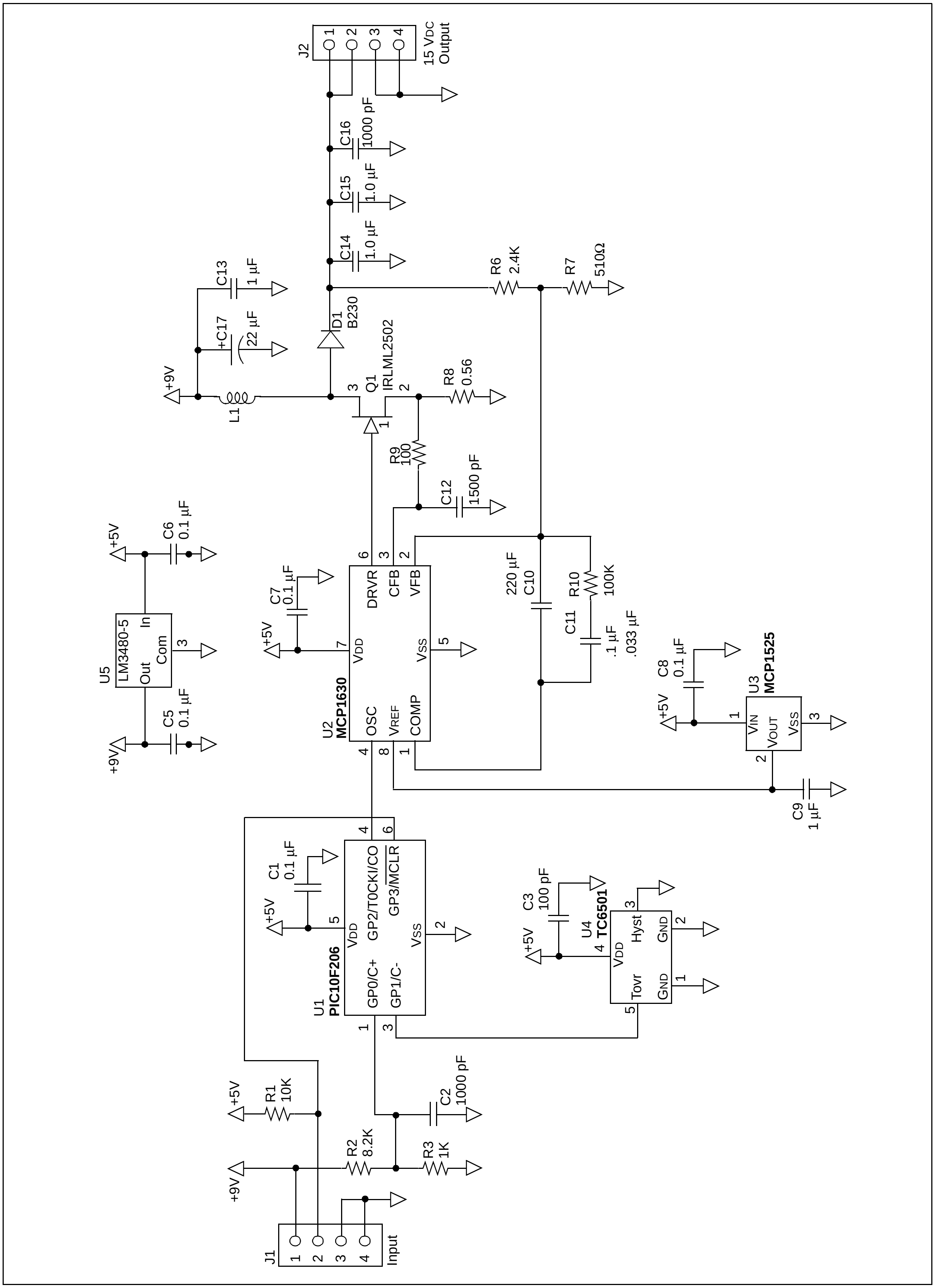
Microcontroller inputs are connected to a divided supply voltage, a digital temperature sensor and the shutdown input. The remaining output is the output driving the MCP1630 clock input.

For under-voltage detection, the divided supply voltage is routed to the non-inverting input of the comparator. The inverting input is tied internally to the on-chip 0.6V reference. The software then monitors the comparator output to detect an under-voltage condition.

The temperature sensor is implemented using a digital output device that pulls its output low when the threshold temperature is exceeded. The software monitors the input to detect an over-temperature condition and shuts down the pulse output if the temperature goes to high. When the temperature falls back below the threshold temperature, the sensor output returns high and the software soft-starts the pulse output. Hysteresis built in the temperature sensor prevents chattering and the sensor's trip temperature is preset when the sensor is manufactured.

The shutdown input, GP1, is tied to whatever remote start-up logic is desired. The software polls the input to determine if a shutdown is requested and terminates the pulse output if the input is low. Raising the input restarts the supply.

FIGURE 3: SWITCH MODE POWER SUPPLY SCHEMATIC



SOFTWARE

The software monitors the inputs and generates the output pulse using a simple bit-set/bit-clear loop, expanded to interleave all the input testing. By keeping the bit-set to bit-set time to 4 cycles, the output duty cycle is locked to 25% for a 250 kHz clock. The latency time for a shutdown is 16 cycles. Figure 4 shows the code listing.

FIGURE 4: CODE LISTING 1

```
loop
  BSF     PWM
  BCF     PWM         ;generate a pulse
  BTFSS   CMPOUT      ;test 4 low Vin
  GOTO    Low_volt    ;if low shutdown
  BSF     PWM
  BCF     PWM         ;generate a pulse
  BTFSS   GP1         ;test 4 hi temp
  GOTO    High_temmp  ;if hi shutdown
  BSF     PWM
  BCF     PWM         ;generate a pulse
  BTFSS   GP3         ;test 4 shutdown
  GOTO    shtdwn      ;if shutdown
  BSF     PWM
  BCF     PWM         ;generate a pulse
  GOTO    loop        ;infinate loop
```

The **soft-start** function is generated by ramping up the number of output pulses. At start-up, a single pulse is followed by a long delay. Next, 2 pulses are followed by a shorter delay, then 3, 4 and so on until the pulse chain is continuous.

The soft-start code is implemented as a table of bit-set/bit-clear/delay instructions, similar to code listing 1 with a delay and control section. Figure 5 shows the timing of soft-start and Figure 6 is an excerpt from the actual code.

FIGURE 5: PWM CLOCK

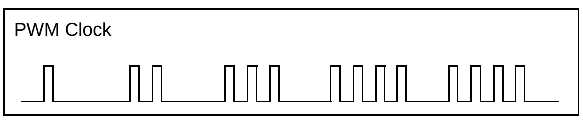


FIGURE 6: CODE LISTING 2

```
Soft_Start
  MOVLW    .32          ;table of 32
  MOVWF    counter
  MOVLW    Last-Table   ;set to last
  MOVWF    pointer
  Loop
  MOVF     counter,w    ;reload delay
  MOVWF    count
  Delay                 ;generate delay
  NOP
  DECFSZ   count,f      ;decrement count
  GOTO     Delay        ;repeat til done
  MOVF     pointer,w    ;get pntr 4 jump
  ADDWF    PCL,f        ;jump
Table
  BSF      PWM
  BCF      PWM          ;32 pulse
  GOTO     $+1          ;2 cycle delay
|-----------;29 copies of pulse + delay
  BSF      PWM
  BCF      PWM          ;2nd pulse
  GOTO     $+1
Last
  BSF      PWM
  BCF      PWM
  GOTO     $+1
  DECF     pointer,f    ;add a pulse
  DECF     pointer,f
  DECF     pointer,f
  DECFSZ   counter,f    ;decrease delay
  GOTO     Loop         ;if 10, continue
  loop_forever          ;if 0, goto main
```

CONCLUSION

Using a combination of software and simple hardware, an efficient control for a PWM generator is implemented with many of the features found in more complex controllers. The result is a modular building-block style design with many advanced features that can be easily customized for a customer's needs.

TABLE 1: MEMORY USAGE

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Program	153 words

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