Methods to Increase the Hold-up Time of AC/DC or DC/DC Converters

Microprocessor-based systems monitor their own power supplies to start or terminate operation. A so-called “watchdog” circuit continuously monitors and informs the processor of the condition of its supply voltage.

Figure 1 displays a typical TURN ON/OFF timing diagram of a converter and watchdog circuit. At turn on, the watchdog circuit sends a “Power Good” signal to the processor if the supply voltage reaches a predetermined level in a given time internal (T3). This turn on delay (T3) is allowed for the power converter after startup to go through its soft start phase. The soft start time can be anywhere from one millisecond to hundreds of milliseconds, depending on the manufacturer. Soft start times lower than the allowed turn on delay by the watchdog circuit will keep the processor off. The other function the watchdog circuit may perform is to signal the processor of a power failed signal when the supply voltage is turned off (T4). After the processor receives a power failed interrupt signal, it will go through its shutdown routine that may include collecting critical data, such as turning off controlled transducers, etc.

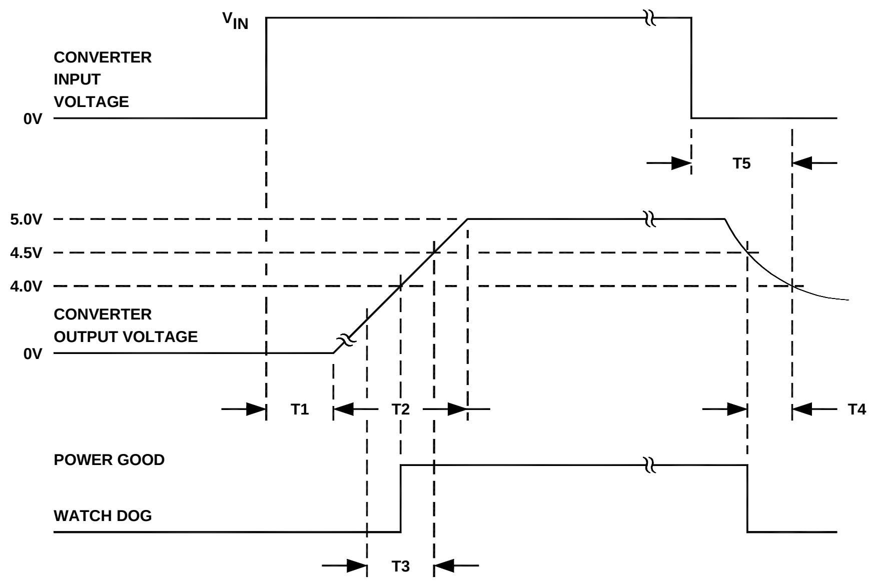

FIGURE 1

T1 = Converter’s turn on delay
T2 = Converter’s soft start time
T3 = Processor’s “Power Good” time window
T4 = Processor’s “Power Failed” time window
T5 = Hold-up time

The time required by the processor for shutdown must be less than T4. After the input voltage of the converter is turned off, the input and output capacitors will continue to supply power to the load for a finite amount of time.

AC/DC converter manufacturers define the “hold-up” time of a converter as the period of time the output remains within specifications after loss of input power. Therefore, T4 is a fraction of the hold-up time and is proportional to the input/output capacitance and inversely proportional to the load.

When a longer time is needed than that provided by a converter, a simple solution would be to increase the output capacitor of the converter as long as the “power good” time period, T3, is not exceeded. Referring to Figure 1, T5 is defined as the hold-up time, which is much greater than T4. The start of T5 can be used instead of T4 to initiate the shut-down subroutine of the processor as is shown in Figure 2.

The current source will consist of D1, D2 Q1 R1, R2 drives the LED of the optocoupler with a constant current over a wide range of input voltages (5V to 75V). The output of the optocoupler is connected at one of the interrupt pin of the CPU. When the input of the converter is not accessible, the circuit in Figure 3 can be used to increase the hold-up time. At turn-on, Q1 is off and C2 is not connected to the output. When the voltage at C1 reaches the threshold of Q1, C2 starts to charge slowly towards V_O. Q1 is a low R_{ON} N channel MOSFET such as MGSFIN03CTI and R1 D1 is optional for discharging C1. If R1 D1 is used, the R1 C1 time constant must be much greater than R2 C1. Also the discharge R1 C1 time constant must be much greater than the required hold-up time.

$$i(t) = c\frac{dv}{dt}$$

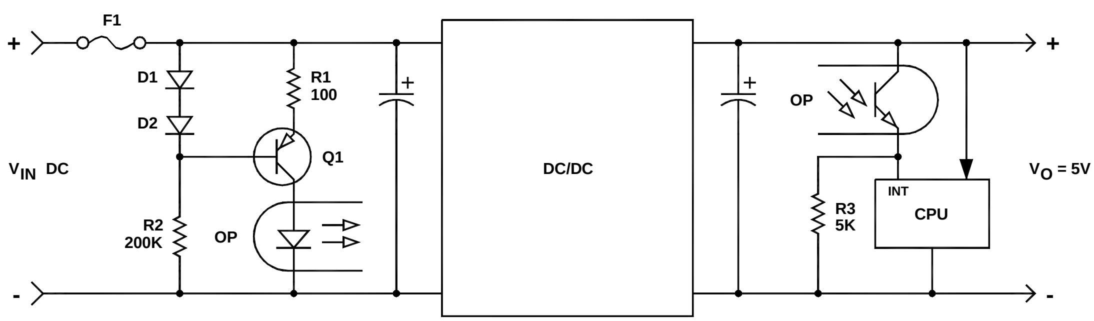

FIGURE 2

D1 = D2 = IN4148
Q1 = BC856 (Philips)
OP = PC123 (Sharp)

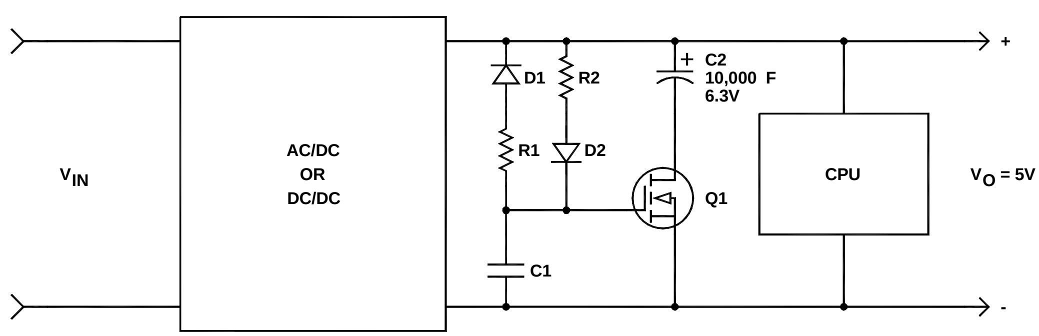

FIGURE 3

D1 = D2 = IN4148
R2, C1 ≅ Charging time constant for C1, C2
R1, C1 ≅ Discharging time constant for C1

INPUT FILTER AND PROTECTION IN DC/DC CONVERTERS

The input reverse and transient protection circuit shown in Figure 4 not only will protect the converter from mishandling or high-voltage spikes, but will also reduce conducted noise (reflected ripple) on the input power lines generated from the switching action of the converter.

The filter L1 C1 performs two functions. The main function is to filter the reflected ripple and provide a low impedance source for the converter, while the secondary function is to protect the converter. Inductor L1 acts as a current limiter and delay allowing D2 to softly clamp any voltage spike above 80V. The fuse can be installed at the input between the positive input and the anode of D1, but in high-transient environments the clamping of D2 may cause it to fail.

The input protection and filter guarantees that the converter will exceed FCC class A, B, and VDE specifications for all conducted and radiated noise. C1 increases the hold-up time and D1 eliminates any discharge path for C1 due to failing input source resistance.

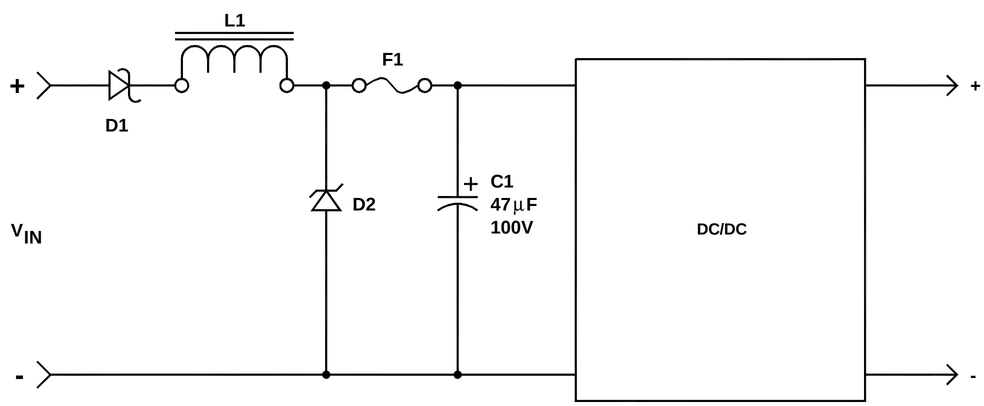

FIGURE 4

D1 = 1A, 100V Schottky (MBRS100T3 or equivalent)
D2 = 86.7V 400W Max. TVS (ISMA78AT3 or equivalent)
L1 = 33 microhenries@0.8A (DALE IHSM-4825-33µH or equivalent)
F1 = 1A slow-blow fuse (R452-001 Little Fuse or equivalent)