Supervisory IC Protects System Against Overvoltage Conditions

Technology Edge

Supervisory IC Protects System Against Overvoltage Conditions
By Clayton B. Grantham

Careful design limits overvoltage on the supply input of integrated circuits, and avoids compromising an IC's specifications. Overvoltage damage can cause an immediate failure, or accelerate an early-life reliability failure. Older technology CMOS circuits can withstand up to 6 V without damage. But some present-day circuits on low-voltage/high-speed processes may not tolerate even 5 V.

Most often, overvoltage damage occurs when integrated devices (transistors or resistors) go into breakdown, which produces high current flow. The product of high current flow and overvoltage may exceed a given device's internal power-dissipation limit. Even a temporary pulse of heat can send internal temperatures well beyond the specified maximum junction temperature. The resulting thermal overstress could degrade or damage multiple integrated devices and possibly shift the IC's specifications.

One approach to an over-voltage protection circuit uses a combined PMOS switch and supervisory circuit to disconnect the main circuitry (Fig. 1). The R1-R2 divider sets the desired overvoltage trip point. In addition to opening and closing switch M1, IC2 illuminates LED2 during an overvoltage condition, flashes LED1 to indicate "good" power, and continuously illuminates LED1 to indicate undervoltage. The following equation controls the overvoltage set point:

V_{IN} (overvoltage) = 1.225 V×(R1 + R2)/R2.

1. IC1 and a dual PMOS transistor form an overvoltage disconnect. This prevents harmful voltages from destroying low-voltage ICs that are connected to the main-circuitry power port.
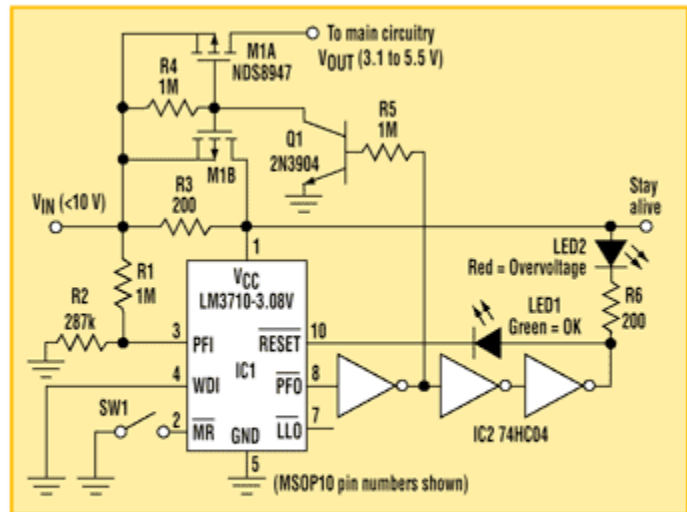
The R1-R2 resistor divider, along with IC1's PFI input threshold of 1.225 V, set the fault level. When V_{IN} exceeds the overvoltage set point, IC1's PFO pin indirectly drives LED2 continuously, and opens switch M1. IC2 inverts the signal from PFO and isolates Q1's input from LED2. With LED2 being turned ON, the stay-alive voltage at IC1's V_{CC} input is clamped to below 6 V by the forward voltage of LED2 and the voltage drop across R6. Other critical circuits, including IC2, can be connected to this node as long as their current requirement is less than 1 mA.

R3 isolates V_{IN} from the stay-alive voltage with M1 open. It must be small enough to keep LED2 illuminated.

With V_{IN} below the overvoltage level and in the "good" range, LED1 blinks repetitively. IC1's internal reset timeout pulses LED1 ON for 200 ms, and pulses OFF for 25.6 s. This long OFF duty cycle saves power. IC1's watchdog timeout period controls LED1's OFF period by monitoring transitions at WDI. If there are no voltage transitions at WDI, then IC1's reset engages.
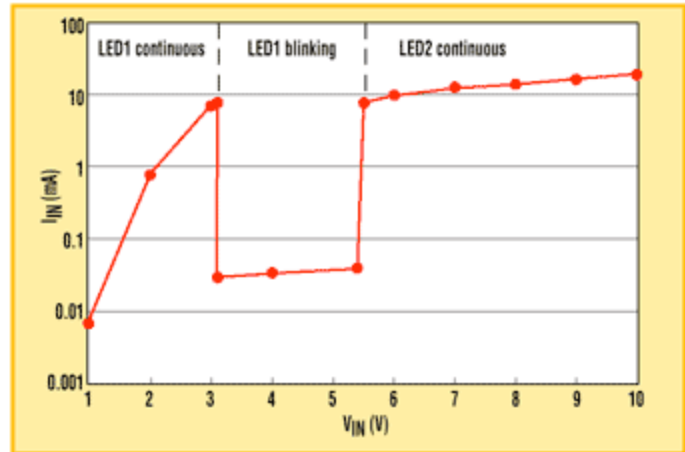
The WDI input in Figure 1 is grounded to prevent any transitions. So the reset timeout and watchdog timeout of IC1 form two one-shots that produce a repetitive pulse train. The power dissipation of this flashing technique is the ratio of these two time periods, producing a low current drain on V_{IN}. Pressing the momentary switch, SW1, short cycles the 25.6-s pause between LED1 flashes. This will also illuminate LED1.

During the brief time before V$_{IN}$ reaches the "good" level, LED1 remains ON continuously. This serves as an undervoltage indicator. Figure 2 shows the circuit's current-voltage waveform.

Adjust R4, R5, and R6 to meet yourspecific application temperature range and component variations. R4 is a pullup resistor across M1's VGS. R5 is Q1's base-current limiting resistor, while R6 is LED2's forward-current limiting resistor. The reset output of IC2 will restrict LED1's current to about 8 mA.

2. The power-saving mode blinks LED1 when V$_{IN}$ is between 3.1 and 5.5 V.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		**Applications**	
Audio	www.ti.com/audio	Communications and Telecom	www.ti.com/communications
Amplifiers	amplifier.ti.com	Computers and Peripherals	www.ti.com/computers
Data Converters	dataconverter.ti.com	Consumer Electronics	www.ti.com/consumer-apps
DLP® Products	www.dlp.com	Energy and Lighting	www.ti.com/energy
DSP	dsp.ti.com	Industrial	www.ti.com/industrial
Clocks and Timers	www.ti.com/clocks	Medical	www.ti.com/medical
Interface	interface.ti.com	Security	www.ti.com/security
Logic	logic.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Power Mgmt	power.ti.com	Transportation and Automotive	www.ti.com/automotive
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
RFID	www.ti-rfid.com		
OMAP Mobile Processors	www.ti.com/omap		
Wireless Connectivity	www.ti.com/wirelessconnectivity		

TI E2E Community Home Page　　　　e2e.ti.com

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2011, Texas Instruments Incorporated