Pushbutton On/Off Controller Provides µProcessor Reset Monitor and Input Supply Monitoring

by Victor Fleury

Introduction

System designers often grapple with ways to debounce and control the on/off pushbutton of portable devices. Traditional debounce designs use discrete logic, flip-flops, resistors and capacitors. Some designs require an onboard microprocessor to monitor the pushbutton, but this puts a burden on the microprocessor—if it hangs up, *all* device on/off control is lost. Also, in high voltage, multicell battery applications the low voltage circuits require an LDO power supply. In the end, what should be a simple monitoring circuit consumes an oversized share of the space and complexity of the system. Plus, its draw on the power budget is high even when the system is off, since the microprocessor must keep awake, constantly watching the pushbutton.

The LTC2953 pushbutton on/off controller with voltage monitoring alleviates the headaches of discrete implementations and provides a self-contained alternative to microprocessor based pushbutton monitoring. The LTC2953 integrates all the flexible timing circuits needed to debounce the on/off pushbutton of portable systems and provides a simple yet powerful interface that allows for controlled power up and power down.

The part also includes input and output supply monitors. A power fail comparator issues an early warning when it detects a low battery condition, while a UVLO comparator prevents a user from applying system power from a dead battery (or low supply). Additionally, an adjustable single supply supervisor provides a 200ms reset output delay after the monitored supply rises above the programmed voltage.

The LTC2953's wide input voltage range (2.7V to 27V) is designed to operate from single-cell to multicell

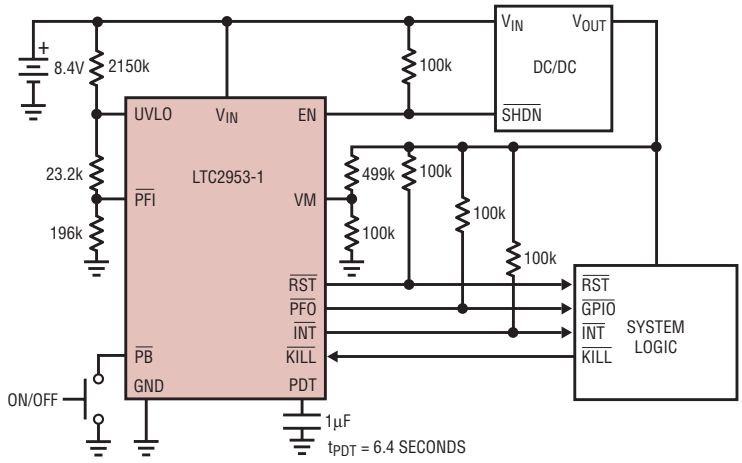

Figure 1. A complete pushbutton and voltage monitoring system is easy to set up with the LTC2953-1.

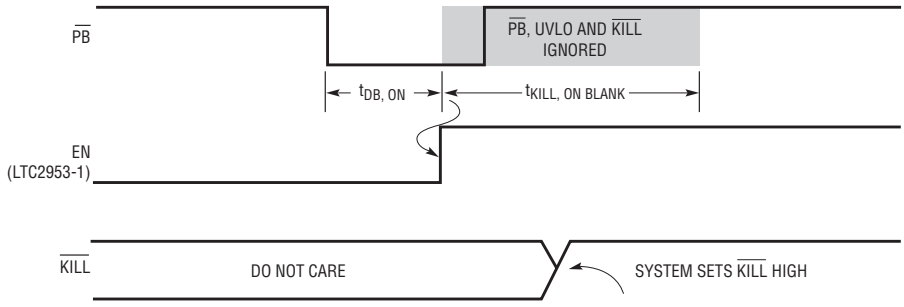

Figure 2. Timing diagram shows a pushbutton-controlled system power on.

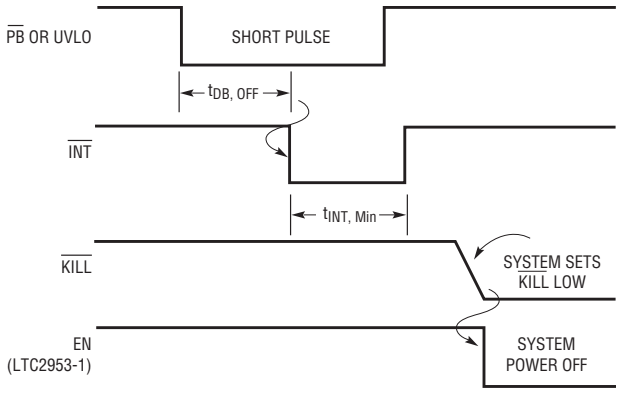

Figure 3. Timing diagram for normal power off sequence

battery stacks, thus eliminating the need for a high voltage LDO. The part's features allow the system designer to turn off power to all circuits except the LTC2953, whose very low quiescent current (14µA typical) extends battery life. The device is available in a space saving 12 lead 3mm × 3mm DFN package.

Orderly Power On

The pushbutton input of the LTC2953 controls the logic state of the open drain enable output. Figure 1 shows the EN output of the LTC2953-1 driving a DC/DC converter. To turn on system power, the pushbutton input must be debounced (held low continuously for at least 32ms). See the timing diagram shown in Figure 2. Note that once power has been enabled, the system must set the $\overline{KILL}$ input high within 512ms.

Orderly Power Off

The LTC2953 provides two ways to manually turn off system power: issuing an orderly power off request, and forcing an immediate power off. An orderly power off involves a simple push and release of the on/off button. For instance, for the circuit in Figure 1, if an end user is using an MP3 player, he presses and releases the on/off button, which subsequently drives the $\overline{INT}$ output low for a minimum of 32ms. The system logic that monitors the LTC2953's $\overline{INT}$ output then initiates various pre-power-down and housekeeping tasks, and asserts $\overline{KILL}$ low when all is well. The LTC2953 then shuts down the DC/DC converter—turning off system power. See the timing diagram shown in Figure 3.

The other type of shutdown is a manual reset. This allows the user to force power off if the system logic or µP fails to respond to the interrupt signal. To do so, the end user presses and holds the pushbutton down. The length of time required to force a power down is given by a fixed internal 64ms delay plus an adjustable power down timer delay. The adjustable delay is set by placing an optional external capacitor on the PDT pin. See Figure 4.

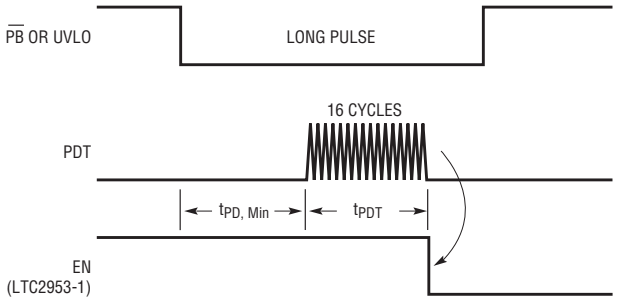

Figure 4. Timing diagram for forced power off, in the case where the user must bypass system logic control.

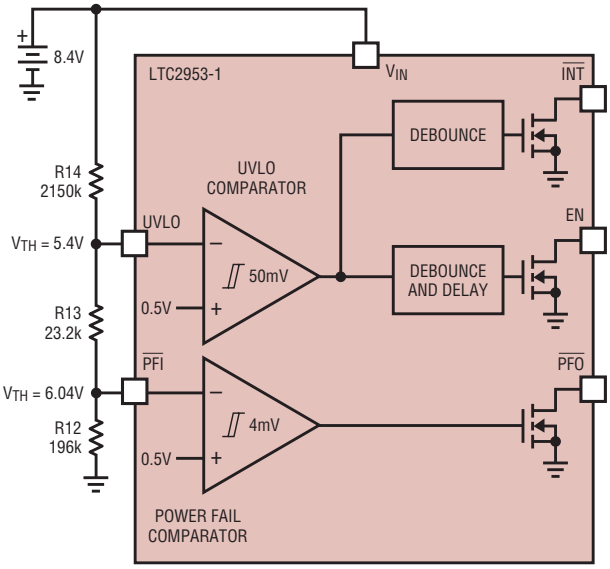

Figure 5. De-glitched UVLO comparator monitors battery stack

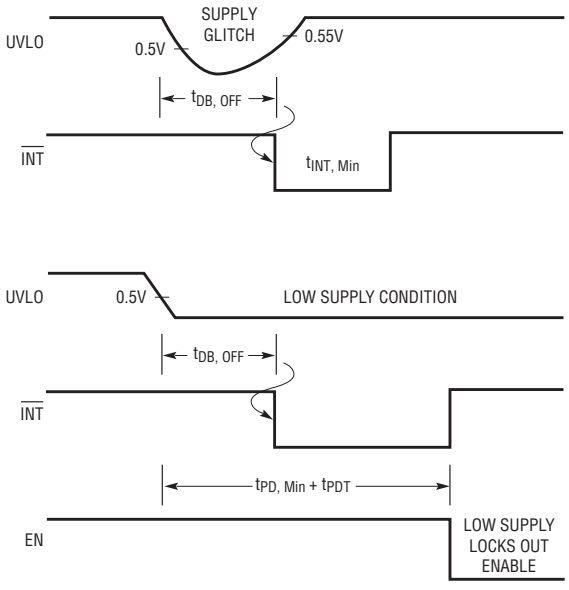

Figure 6. Low supply initiates system power down and locks out enable

Table 1. Pushbutton product family

Part Number	Supply Voltage (V)	Supply Current (µA)	ON Timer	OFF Timer	Kill Timer	Comments	Package
LTC2950	2.7 to 26	6	Adj	Adj	1024ms	Active high enable output (LTC2950-1) Active low enable output (LTC2950-2)	TSOT-8 DFN-8
LTC2951	2.7 to 26	6	128ms	Adj	Adj	Active high enable output (LTC2951-1) Active low enable output (LTC2951-2)	TSOT-8 DFN-8
LTC2952	2.7 to 28	25	Adj	Adj	Extendable	Pushbutton PowerPath controller with system monitoring	TSSOP-20 QFN-20
LTC2953	2.7 to 27	14	32ms	Adj		Pushbutton controller with supply monitor, UVLO and power fail comparators	DFN-12
LTC2954	2.7 to 26	6	Adj	Adj		Interrupt logic for menu driven applications. Active high enable output (LTC2954-1) Active low enable output (LTC2954-2)	TSOT-8 DFN-8

Power Fail Comparator Issues Low Supply Warning

The LTC2953 provides an uncommitted power fail comparator that can serve as the first warning of a decaying battery or a low supply. The $\overline{PFO}$ output is driven low when the $\overline{PFI}$ input voltage drops below 0.5V. This comparator provides real time supply information and does not affect the functionality of the enable and interrupt outputs. A system designer can use the power fail comparator to identify the source of a power down interrupt request: the pushbutton or the UVLO. If the $\overline{PFO}$ output is low when the interrupt output is asserted, then the UVLO input initiated the power down request (see Figure 5).

UVLO Comparator Rejects Short Supply Glitches

The application shown in Figure 5 monitors a 2-cell Li-Ion battery stack. The UVLO comparator has glitch immunity to prevent short spikes on the supply line from issuing a power down request. All glitches shorter than 32ms are ignored. If the battery voltage drops below 5.4V for longer than 32ms, however, the LTC2953 asserts the interrupt output for a minimum of 32ms. When both $\overline{INT}$ and $\overline{PFO}$ are driven low, this alerts the system logic that a significant battery glitch has occurred. For cases where the battery voltage falls and stays below 5.4V for an indefinite length of time, the LTC2953 automatically shuts off system power. See the Figure 6 timing diagram.

UVLO Locks Out Pushbutton Input

The LTC2953 prevents a user from turning on system power with a dead battery or low supply. If system power is off and the voltage on the UVLO input is below 0.5V, the pushbutton input is ignored. This means that if a battery or supply drops below a predetermined adjustable level, the LTC2953 does not allow system power on (see Figure 6 timing diagram).

Pushbutton Controlled Supply Sequencing

The circuit in Figure 7 uses the LTC2953-2 to sequence three supply rails. Power on supply sequencing begins by pressing the pushbutton for 32ms. This asserts the $\overline{EN}$ output low, which turns on the V1 supply.

continued on page 42

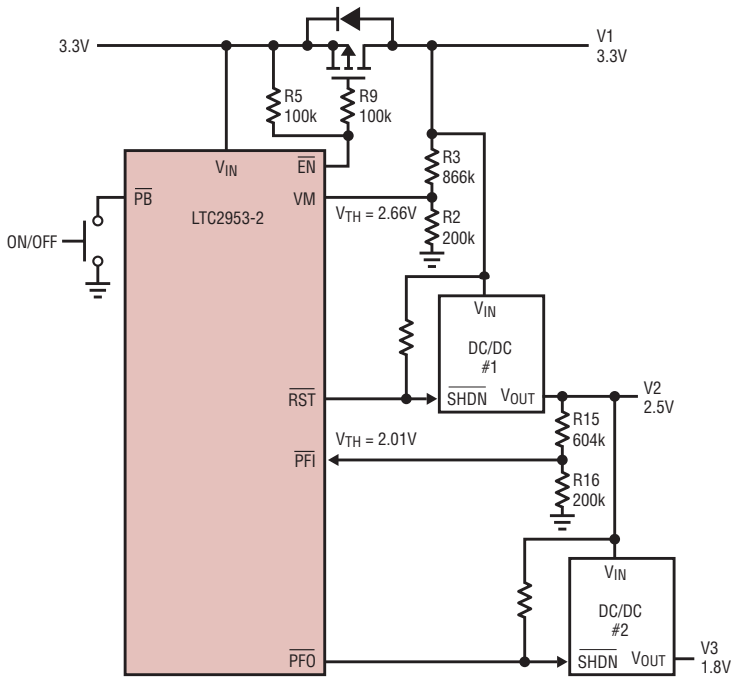

Figure 7. Pushbutton controlled supply sequencing

rapid transition times substantially reduce the power loss in a DC/DC converter by minimizing the switching losses in MOSFETs with high gate capacitance. Adaptive shoot-through protection circuitry is also integrated to prevent power loss due to MOSFET cross-conduction current. In addition, the LTC4442 includes undervoltage lockout detectors that monitor the gate drive supply and disable operation if the voltage is too low. The LTC4442 operates with a 6V to 9.5V gate drive supply, and its floating high side driver is capable of handling 38V supply voltages.

The LTC4443 includes all of the features of the LTC4442, but also integrates the Schottky diode required for the high side bootstrapped supply to simplify layout and reduce parts count. The LTC4445 is a dual version of the LTC4443, with two independent channels that are ideal for two-phase or 2-channel applications.

For lower gate drive supply applications, the LTC4447's rail-to-rail outputs are optimized to source 4A and sink 5A of current while operating from a 4V to 6.5V supply. With 14ns propagation delays and 5ns transition times driving 3nF loads, this high speed driver minimizes power loss due to switching losses and synchronous MOSFET body diode conduction. The low forward drop Schottky diode required for the high side bootstrapped supply is also integrated to simplify converter design and reduce board area. Like the LTC4442, the LTC4447's high side driver handles voltages up to 38V.

The LTC4444 is a powerful synchronous N-channel MOSFET driver that has been optimized for higher voltage applications. With its two CMOS-compatible inputs connected to the Top Gate and Bottom Gate pins of a controller IC, the LTC4444 instantly extends the voltage range of a DC/DC converter to 100V. Its powerful 3A pull-up and 0.8Ω pull-down output drivers generate 10ns rise times and 5ns fall times on 1nF capacitive loads from a 7V to 14V driver supply. Adaptive shoot-through prevention and undervoltage lockout detectors are integrated to guarantee that the system is efficient and well-controlled.

The LTC4442 and LTC4444 gate drivers are available in the thermally-enhanced MSOP package, and the LTC4443, LTC4445, and LTC4447 are available in DFN packages. This family of rugged and powerful gate drivers is available in the 40°C to 85°C industrial temperature range.

LTC2953, continued from page 19

Using the reset comparator and 200ms after V1 reaches 80% of its final value (2.66V), the V2 supply is enabled. When the V2 DC voltage reaches 80% of its final value (2V), the V3 supply in enabled.

A user initiates a power down supply sequence by again pressing the pushbutton for 32ms. When $\overline{EN}$ is released and pulls up to V_{IN}, V1 disconnects first. When the V1 supply decays to 2.66V, V2 is immediately disabled (there is no delay from VM to $\overline{RST}$ during power down supply sequencing). When V2 decays to 2V, V3 is immediately disabled (see the timing diagram in Figure 8).

LTC2953-1 and LTC2953-2 Versions

The LTC2953-1(EN) and LTC2953-2($\overline{EN}$) differ only by the polarity of the EN/$\overline{EN}$ pin. The LTC2953-1 is intended to drive a DC/DC converter while the LTC2953-2 drives an external power PFET.

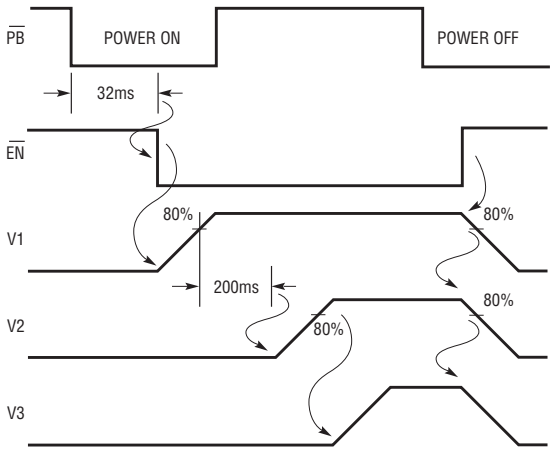

Figure 8. Timing diagrams for sequencing three supplies

Pushbutton Product Family

Table 1 summarizes Linear Technology's family of pushbutton products. The LTC2950, LTC2951 and LTC2954 provide a complete standalone solution for interfacing a manual on/off pushbutton to system power and system logic. The LTC2953 adds voltage monitoring functions to allow for failsafe operation. The LTC2952 offers selectable dual power path ideal diode controllers.

Conclusion

The LTC2953 is a low power, wide input voltage range (2.7V to 27V) pushbutton on/off controller with input and output voltage monitoring. The LTC2953 provides a simple and complete solution to manually toggling power to many types of systems. It includes a power fail comparator that issues an early warning of a decaying supply, along with a UVLO comparator that prevents a user from turning on a system with a low supply or dead battery. The LTC2953 furthers system reliability by integrating an adjustable single supply supervisor. The device is available in a space saving 3mm × 3mm DFN package.