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 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 INT output low for a minimum of 32ms. The system logic that monitors the LTC2953’s INT output then initiates various pre-power-down and housekeeping tasks, and asserts 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.

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**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
### 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 PFO output is driven low when the 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 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 INT and 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 EN output low, which turns on the V1 supply.

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**Table 1. Pushbutton product family**

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

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Figure 7. Pushbutton controlled supply sequencing

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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.

### 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 x 3mm DFN package.