Tiny Comparator Fits Anywhere You Need Micropower Control Functions

by Alexi Sevastopoulos

Introduction

It's rare that an IC offers such a simple solution to so many common problems that it instantly becomes a favorite building block in the system designer's toolset. The LT6703 micropower, low voltage comparator and reference does just that by squeezing a single micropower comparator and accurate reference into a tiny 2mm × 2mm DFN package. Although only one of its comparator inputs is accessible (the other is connected to a 400mV internal precision voltage reference) its size makes it easy to fit just about anywhere even on the most crowded circuit boards.

The LT6703 is a smaller and simpler version of its sibling, the LT6700 dual comparator and reference. Its open-collector output enables level shifting, while its Over-The-Top® capabilities allow the input voltage range to span from –0.3V to 18V with respect to ground, regardless of the supply voltage. The internal bandgap voltage reference has an output voltage of 400mV ±1.25% over its wide temperature range (–40 to 125°C). The LT6703-2 and LT6703-3 differ by the polarity of the available comparator input and runs on 6.5µA with a typical propagation delay of 25µs.

The LT6703-2 has an available inverting input while the LT6703-3 (Figure 1) has an available non-inverting input. The comparator has 6.5mV of built-in hysteresis to ensure stable operation. In the LT6703-3, this hysteresis level can be increased using positive feedback circuitry. The threshold voltage, which represents the combined reference accuracy and comparator offset, is guaranteed at ±1.25% at 25°C. This threshold accuracy, in addition to the built-in 6.5mV of hysteresis, provides a clean switching threshold that the user can rely on even with slow varying inputs. For extra protection and to help eliminate false triggering, a supply bypass capacitor should be added to prevent power supply glitches from disturbing the reference voltage.

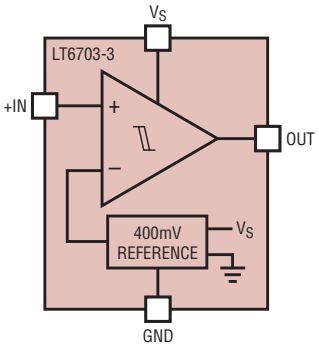

Figure 1. Block diagram of tiny 2mm × 2mm 1.4V-to-18V comparator

Features for Versatility and Ease of Use

Wide Supply Range

The unique supply range of the LT6703 enables it to meet the standards of many industrial or battery-operated applications. In industrial applications where voltages above 5.5V are typically used, the LT6703 has no problem since its supply stretches up to 18V. Likewise, in battery-powered applications the supply reaches as far down as 1.4V. This ability to run from a low voltage, combined with a low 6.5µA supply current, make the LT6703 ideal for low voltage system monitoring (shown in Figure 2).

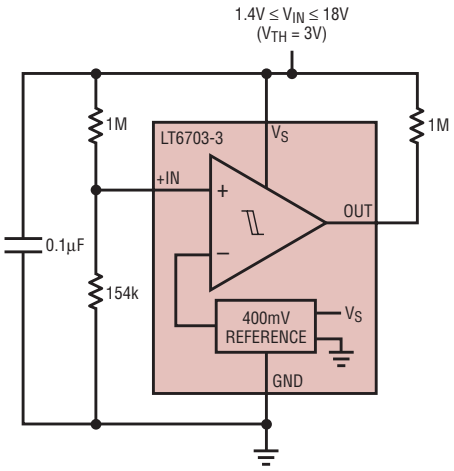

Figure 2. Micropower supply voltage monitor

As shown in Figure 2, the LT6703-3 can be run from a power supply rail or from a battery. In this system monitoring application, the output of the comparator goes low whenever the supply drops below the 3V threshold voltage—indicating that the system is running low on batteries or that there was a power failure or brown-out.

Although the LT6703 is specified as having ±10nA of input bias current, large input resistors are recommended to reduce overall supply current as shown in Figure 2. However, if the two input resistors are increased by a factor of ten, the input bias current of the comparator begins to affect the threshold value. With these larger input resistors and a supply voltage of 3V, the current through the input resistors is 260nA. With an input bias current of ±10nA, the comparator now sinks a significant portion of the supply current required to set the threshold voltage at the comparator input. As a result, an increase in supply voltage of a few hundred millivolts is required in compensation to reach the 400mV trip point. However, with the values shown in Figure 2, the current through the two input resistors is 2.6µA at the trip point, which considerably outweighs the comparator bias current and thus produces a reliable threshold voltage.

Over-The-Top Input and Open-Collector Output

The LT6703 features Over-The-Top operation, which allows inputs with amplitudes as high as 18V, regardless of the supply voltage. In other words, operation at a low supply does not limit the input level. This feature,

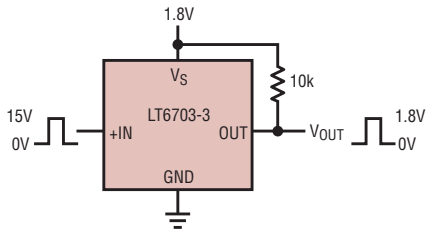

Figure 3. Simple level translator for shifting high voltages to low voltages

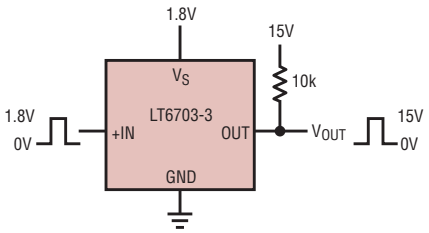

Figure 4. Simple level translator for shifting low voltages to high voltages

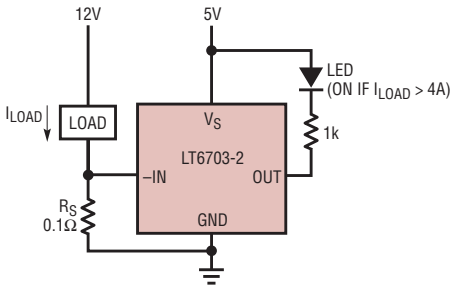

Figure 5. Low side current sense alarm

along with the part's wide supply range, is especially useful in portable battery-powered applications, allowing a flexibility in input and supply voltage ranges that cannot be found in competing devices.

The comparator's open collector output also provides great flexibility. This allows the device to be used as a level translator since the output can be pulled up to 18V regardless of the supply voltage (Figures 3 and 4). In Figure 3, the LT6703-3 takes a 15V pulse input and translates it to a 1.8V output, all while running on a 1.8V supply. A simple modification reverses the translation as shown in Figure 4.

The use of multiple LT6703's also permits logical wire-AND implementation and can drive relatively heavy loads (up to 40mA) such as relays or LED indicators.

Overload Protection

The LT6703 can also be used to trigger an alarm dependent upon the amount of load current through an external sense resistor. In Figure 5, an LED is used on the output as an alarm signal. If the load current exceeds 4A, the sense resistor voltage rises above the 400mV threshold, triggering a state change on the output of the comparator. The internal NPN transistor at the output of the comparator now allows current to flow through it to ground, lighting up the LED and letting the user know that there is excessive current being conducted through the load.

In Figure 6, the load is protected by more than just an LED warning indicator. Once current through the load has exceeded the set limit and the voltage across the sense resistor rises above the 400mV threshold voltage, a relay is tripped, cutting off the supply. Current conduction through the load is prevented as well. The output of the comparator remains high until the power supply is cycled back on and the load current decreases to below 4mA. When the output of the comparator is low, the part is capable of sinking up to 40mA from the supply through the relay although in this case it will only sink 6mA.

The 100µF capacitor shown in Figure 6 is responsible for pulling current through the relay coil. The large value is important because it allows enough time for the relay's internal switch to close and kick-start the circuit. The response time between the relay trip and supply reset is 40µs, regardless of the capacitor value. Figure 7 shows a modification to the circuit, allowing the circuit to restart without cycling the power supply. The auto-restart loop monitors the current through the load. The 1µF capacitor in the loop ensures that the supply of the comparator does not turn back on when the output goes high. As the load current is decreased, the supply voltage gradually increases. When it hits 1.4V, the output goes low and the relay switch closes, turning the circuit back on.

Conclusion

Linear Technology continues to innovate by crafting the LT6703 series of precision, micropower comparators in a tiny 2mm × 2mm DFN package. These products provide an excellent solution to many design challenges for threshold detection applications, with characteristics accommodating wide temperature spans and space-critical designs. Its unique Over-The-Top® feature offers versatility and performance ideal for portable, battery-powered commercial products as well as industrial or high-temperature grade system monitoring applications. The LT6703 excels in all specifications that set system performance.

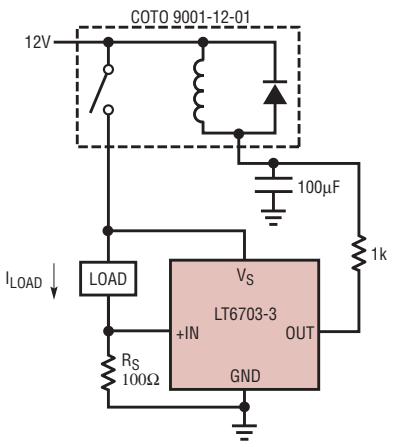

Figure 6. Latch-off protection circuit

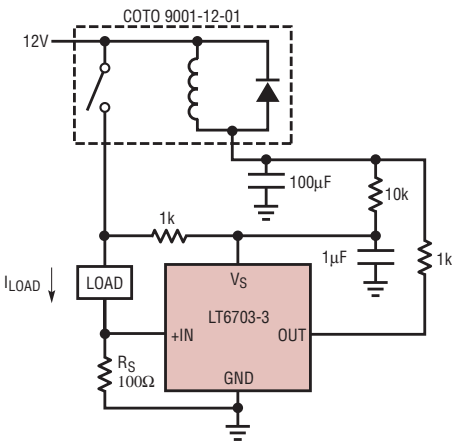

Figure 7. Latch-off protection circuit with load sensing auto-reset