A circuit topology has been designed to guarantee the output of intrinsically safe power for the operation of electrical devices in a hazardous environment. This design uses a MOSFET (metal–oxide–semiconductor field-effect transistor) as a switch to connect and disconnect power to a load. A test current is provided through a separate path to the load for monitoring by a comparator against a preset threshold level. The circuit is configured so that the test current will detect a fault in the load and open the switch before the main current can respond. The main current passes through the switch and then an inductor. When a fault occurs in the load, the current through the inductor cannot change immediately, but the voltage drops immediately to safe levels.

The comparator detects this drop and opens the switch before the current in the inductor has a chance to respond. This circuit protects both the current and voltage from exceeding safe levels.

The use of the switch and inductor minimizes the wasted energy. For example, a circuit runs from a 3.6-V battery that must be current-limited to 200 mA. If the circuit normally draws 10 mA, then an 18-ohm resistor would drop 180 mV during normal operation, while a typical switch (0.02 ohm) and inductor (0.97 ohm) would only drop 9.9 mV. From a power standpoint, the current-limiting resistor protection circuit wastes about 18 times more power than the switch and the inductor configuration. In the fault condition, both the resistor and the inductor react immediately. The resistor reacts by allowing more current to flow and dropping the voltage. Initially, the inductor reacts by dropping the voltage, and then by not allowing the current to change. When the comparator detects the drop in voltage, it opens the switch, thus preventing any further current flow. The inductor alone is not sufficient protection, because after the voltage drop has settled, the inductor would then allow the current to change, in this example, the current would be 3.7 A.

In the fault condition, the resistor is flowing 200 mA until the fuse blows (anywhere from 1 ms to 100 s), while the switch and inductor combination is flowing about 2 µA test current while monitoring for the fault to be corrected. Finally, as an additional safety feature, the circuit can be configured to hold the switch opened until both the load and source are disconnected.

This work was done by Bradley M. Burns of ASRC, Inc. and Norman N. Blalock of Sierra Lobo, Inc. for Kennedy Space Center. Further information is contained in a TSP (see page 1), KSC-12703.
Squeezing Alters Frequency Tuning of WGM Optical Resonator

Tuning rates for modes of different indices can be made to differ.

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Mechanical squeezing has been found to alter the frequency tuning of a whispering-gallery-mode (WGM) optical resonator that has an elliptical shape and is made of lithium niobate. It may be possible to exploit this effect to design reconfigurable optical filters for optical communications and for scientific experiments involving quantum electrodynamics.

Some background information is prerequisite to a meaningful description of the squeezing-induced alteration of frequency tuning: The spectrum of a WGM resonator is represented by a comblike plot of intensity versus frequency. Each peak of the comblike plot corresponds to an electromagnetic mode represented by an integer mode number, and the modes are grouped into sets represented by integer mode indices. Because lithium niobate is an electro-optically active material, the WGM resonator can be tuned (that is, the resonance frequencies can be shifted) by applying a suitable bias potential. The frequency shift of each mode is quantified by a tuning rate defined as the ratio between the frequency shift and the applied potential. In the absence of squeezing, all modes exhibit the same tuning rate. This concludes the background information.

It has been demonstrated experimentally that when the resonator is squeezed along part of either of its two principal axes, tuning rates differ among the groups of modes represented by different indices (see figure). The differences in tuning rates could be utilized to configure the resonance spectrum to obtain a desired effect; for example, through a combination of squeezing and electrical biasing, two resonances represented by different mode indices could be set at a...