Resettable High-Speed Fuse Uses FET As A Sense Resistor

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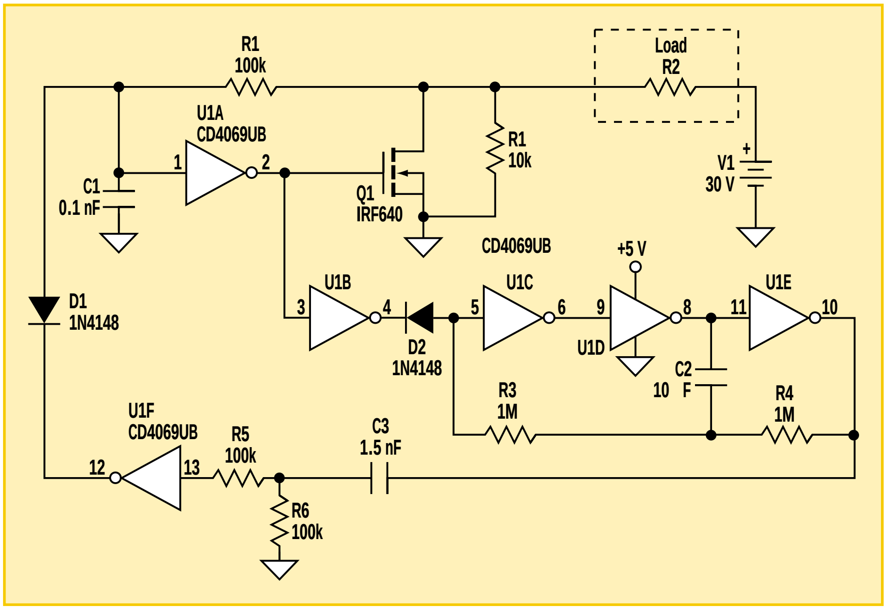
This design idea describes a resettable high-speed fuse that uses only a few off-the-shelf parts, resets itself after blowing, and doesn't require a special current-sense resistor. While the circuit has been designed to switch on a negative current from ground, it can easily be modified for use in a floating arrangement.

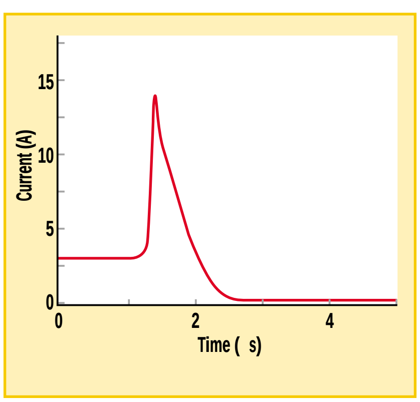
The circuit shown in Fig. 1 uses a power FET as a switch and, when saturated, as a sense resistor. When an excessive current flows through the FET, the source-drain voltage increases and is sensed by inverter U1A. This decreases the gate potential, causing the drain voltage to go even higher and the circuit to drop out in a stable state. In this state, almost no current flows through the load.

The speed of the fuse can be tuned by modifying capacitor C1, which low-pass filters the signal from Q1's drain. The fuse's firing current can be made adjustable by inserting a resistive voltage divider between the inverter output and the transistor gate. Since the fuse speed will decrease due to the FET's gate capacitance, it should be compensated with a capacitor. With the values shown in the schematic, the fuse blows in roughly 1 μs when changing load resistor R2 from 10 to 1 Ω *(Fig. 2)*.

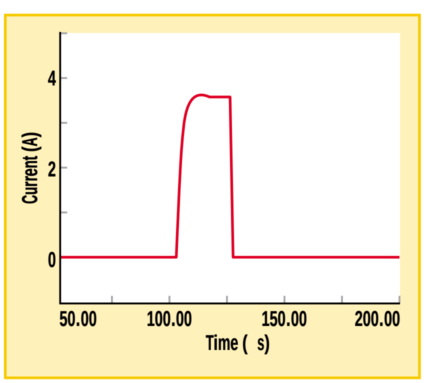
Prior to the activation of the fuse, the three-gate oscillator (U1C-E) is disabled



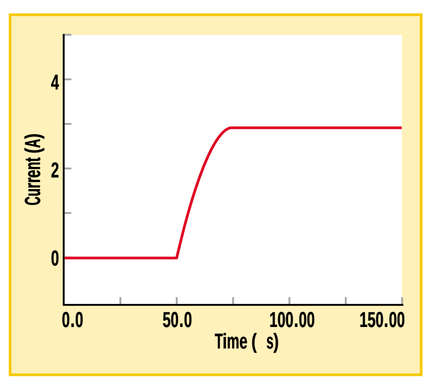
1. **This resettable fuse uses the on-resistance of FET Q1 as the current-sense element.**



2. **When the load is stepped from 10 to 1 Ω, the electronic fuse trips in roughly 1 μs.**



3. **If the overload condition is still present when the fuse attempts to reset itself, the load current rises to the trip point in 25 μs.**



4. **During a successful fuse reset, the current rises to its normal operating level in 25 μs.**

by gate U1B and diode D1. When the fuse "blows," the oscillator begins oscillating. This periodically (every few tenths of a second) sends a pulse to the inverter U1A input, attempting to reset the fuse. If the short persists, the fuse blows again; this process takes 25 µs *(Fig. 3)*. If the short does not persist, the current rises in 25 µs *(Fig. 4)*.

Spread-Spectrum DC-DC Converter Combats EMI

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CIRCLE 521

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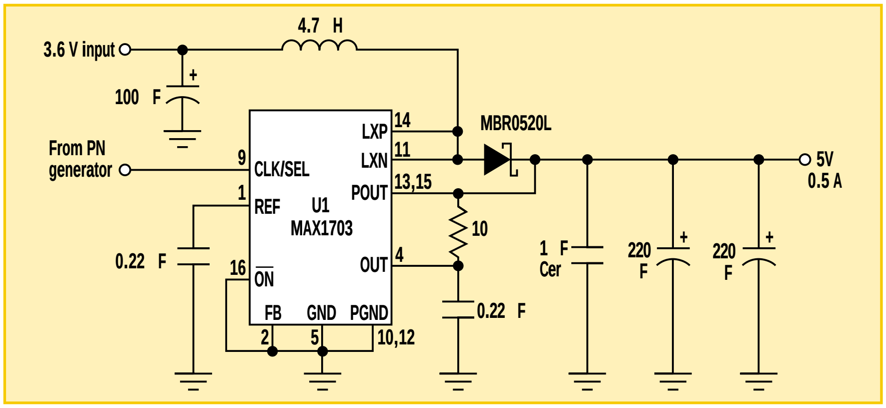
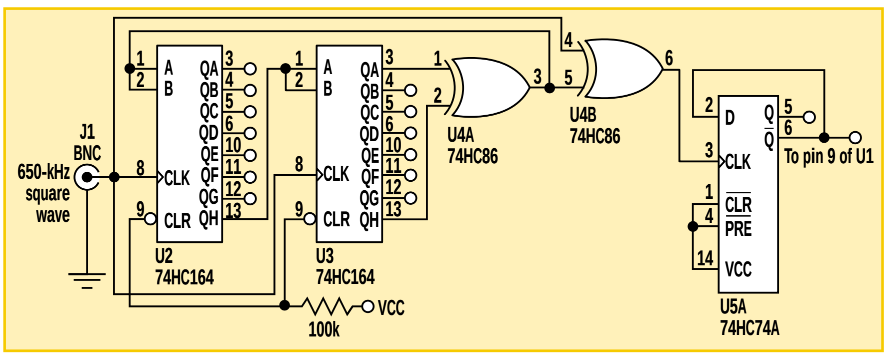
Electromagnetic radiation (called electromagnetic interference or EMI when unwanted) is emitted by almost all electronic systems, including switching regulators. The conventional approach to suppressing EMI is to block the radiation at its source with a metallic or magnetic shield, or both. For switching regulators, you can further enhance suppression by adopting a spread-spectrum pulse-width-modulation (SSPWM) control scheme.

In Fig. 1, the switching regulator IC (U1) has an external clock input. Driving this input with a digital signal of pseudorandom noise (PN) provides the regulator with a spread-spectrum clock that reduces EMI. By spreading interference frequencies over a wide range, this technique lowers the EMI power density that is otherwise concentrated at a single clock frequency.

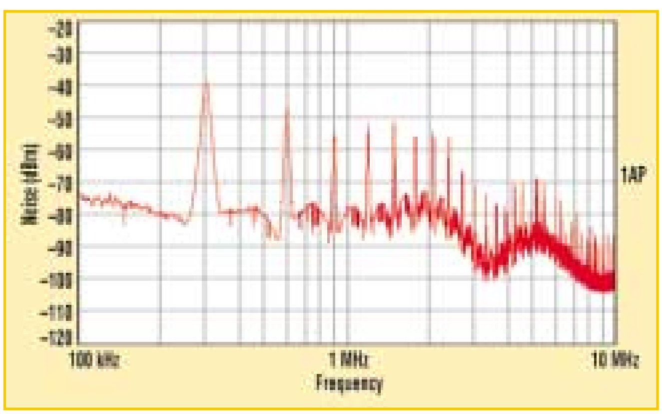
The PN generator spreads interference over a wide spectrum. Its key element is a 16-bit shift register formed by the series connection of two 8-bit shift registers (U2 and U3), with feedback from the XOR gate U4A *(Fig. 2)*. The result is an almost random (pseudorandom) output, consisting of a repeat-



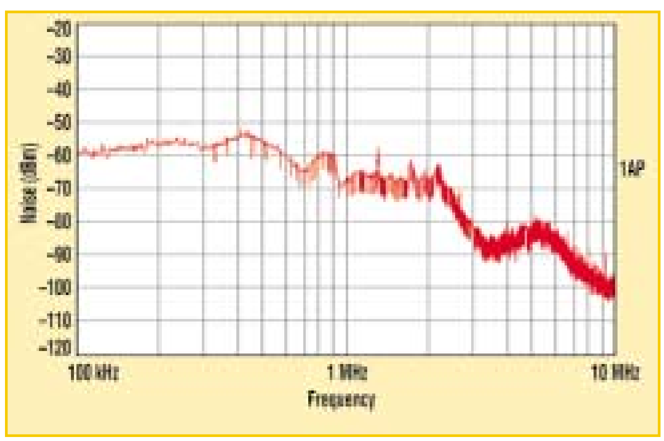
1. To reduce EMI, this conventional step-up dc-dc converter employs spread-spectrum pulse-width modulation (SSPWM) produced by the pseudorandom noise at the clock input.



2. This generator of pseudorandom noise (PN) produces a nominal 325-kHz clock signal for the step-up dc-dc converter circuit in Figure 1.



3. The output-noise spectrum produced by the Fig. 1 circuit operating with a fixed-frequency control scheme contains strong peaks at the clock harmonics.



4. An SSPWM control scheme produces less output noise in the Fig. 1 circuit than the conventional fixed-frequency approach.

ing sequence of ones and zeroes at a nominal frequency of 650 kHz. The D-type flip-flop (U5) divides this frequency by two, producing a nominal 325-kHz spread-spectrum clock signal to the switching regulator.

Bench measurements show a 15-dB reduction in peak power density at about 300 kHz. Except for 9 mA of extra current drawn by the PN generator, the regulator's efficiency remains unchanged. (The efficiency is 94% while delivering 0.5 A with a 3.6-V input and a 5-V output.) Ripple amplitude in the time domain also remains unchanged. Output spectra demonstrate that a conventional fixed-frequency clock *(Fig. 3)* produces considerably more noise than does the spread-spectrum technique *(Fig. 4)*.

Low-Cost Programmable Key Lock Uses A PC-Hardware Monitor IC

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CIRCLE 522

Simplicity is the key to a good security system design. The following is a simple yet powerful security system employing an ADM-1024 PC-hardware monitor as the key's decoder.

The ADM1024 was designed to monitor the local temperature, the die temperature of up to two Pentium processors, and the speed of up to two fans. This device monitors up to seven supply voltages and a 5-bit VID code. It also includes a 10-bit digital-to-analog converter (DAC). In this application, the ADM1024 is used to monitor seven voltages provided by a digital key as well as to open a lock if the correct key is inserted.

The basic principle of this lock decoder is the division of a voltage into seven specific levels that can be measured by the ADM1024. The voltage dividers are embedded in a key that can be inserted into the lock, as shown in the figure. For simplicity, only details relating to the ADM1024 and the key are given in this diagram.

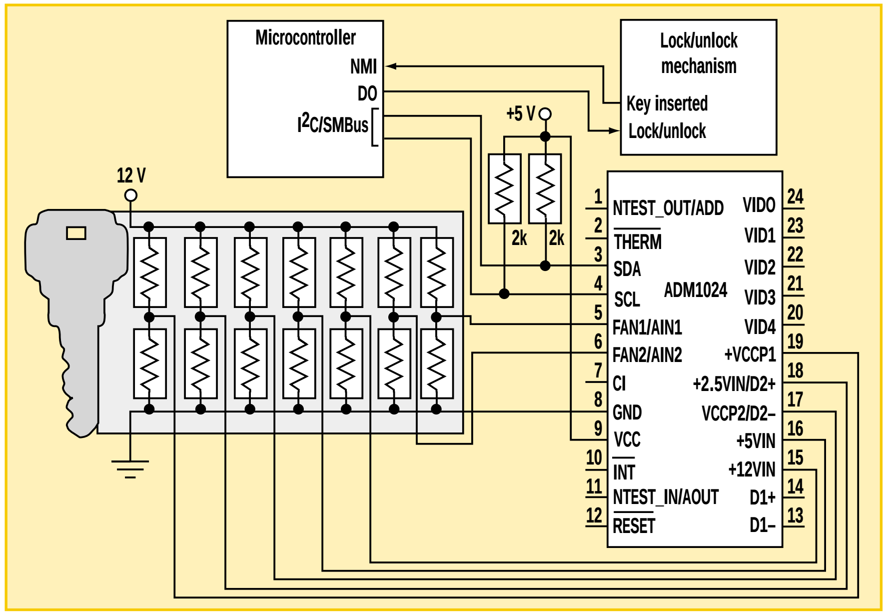
The seven voltage-input channels are each capable of measuring a voltage with 10-bit resolution. However, only eight bits of data are available on the serial bus. Hence, the theoretical maximum number of key combinations is

7.2×10^{16}! The number of different keys is limited to 4.4×10^{12} by practical concerns, the given standard 1% resistor values, and the allowance of a 16-LSB measurement span for each key combination. This is still a very secure system.

In production, keys could be created by vapor deposition of resistive material directly onto a circuit board. Absolute accuracy is not critical since the resistors are used in a voltage divider. Resistors created in a batch will match well, so their ratios can be precisely defined.

The on-board temperature sensor can be used to measure the ambient temperature. This enables the calculation of voltage changes caused by resistor-temperature drift if desired.

This system has several advantages. Only two signal wires are required to communicate with the lock. The first enables the lock to tell the microcontroller that a key has been inserted. The second allows the microcontroller to tell the lock to lock or unlock. The microcontroller can easily process all of the combinations to determine that the correct key was inserted. Keys can be manufactured at a relatively low cost and can be authenticated in milliseconds. The enormous number of possible combinations makes this key decoder very secure.



The ADM1024 finds an unusual use for its power-supply-monitor inputs in the detection of the seven analog voltages produced by the low-cost key.

ifd winners

W. Stephen Woodward, University of North Carolina, Marine Sciences. The idea: "*Circuit Enables Precision Control In Radiant Heating Systems*." January 8, 2001.

William Donofrio, Nu-Products, 1393 Hawkerest Cove S., Cordova, TN 38018. The idea: "*12-Bit Data Recorder Downloads Results To A PC*," January 22, 2001.

W. Stephen Woodward, University of North Carolina, Marine Sciences. The idea: "*One Single-Section Potentiometer Sets The Gain On Two Channels*," February 5, 2001.

W. Stephen Woodward, University of North Carolina, Marine Sciences. The idea: "*Tunable Diode Laser Photocurrent Amplifier Has 80-dB Logarithmic Gain*," February 19, 2001.

Len Sherman, Maxim Integrated Products, 120 San Gabriel Dr., Sunnyvale, CA 94086. The idea: "*Compact, Inductorless Boost Circuit Regulates White LED Bias*," March 5, 2001.