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APPLICATION NOTE 4401

A Single-Chip Personal Alarm

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Abstract: This application note presents a single-chip alarm circuit that issues a warning, then an alarm, when toxic or explosive gases are sensed. The circuit is simple and low cost, while offering moderate precision.

This design idea was published in the online edition of *Portable Design* magazine in April 2006.

Workers in the mining industry and other industrial environments can be subject to toxic or explosive gases. They can benefit from inexpensive personal monitors. While some applications require detailed data logging and information gathering, others require merely a warning signal or alarm. This single-chip alarm circuit offers a modest level of precision and is simple and inexpensive.

Gas sensors often use a bridge configuration. Typically, the bridge output goes to an instrumentation amplifier, and then to an A/D converter or adjustable reference for use as an alarm or display. The circuit of **Figure 1** operates from a 9V battery and monitors the output of a sensor bridge. It provides a visual warning and alarm in response to a hazard. The monitored signal appears as a voltage output (V_{POUT}) from the high-side power monitor, U1:

$$V_{POUT} = A_{VPOUT} \times V_{SENSE} \times V_{IN} = 40.96 \times V_{SENSE} \times V_{IN}$$

Where V_{SENSE} is the voltage between RS+ and RS-, and A_{VPOUT} is the voltage gain from V_{SENSE} to P_{OUT}.

The MAX4211F high-side power and current monitor is chosen for its A_{VPOUT} value of 40.96. V_{SENSE} equals 25mV/V x V_{CC} in this case. As shown in Figure 1, you can calibrate V_{IN} to adjust the level of P_{OUT} as required by the application.

The full-scale value for a typical sensor (the maximum value of V_{SENSE}) might equal 25mV/V × V_{CC}. For now, we assume that 20mV/V (less than full scale) represents a hazardous condition. Therefore, at the alarm condition:

$$V_{POUT} = 40.96 \times 20mV/V \times V_{CC} \times V_{IN} = 0.8192V/V \times V_{CC} \times V_{IN}$$

Because P_{OUT} can be adjusted through the V_{IN} input, you can use fixed thresholds for the alarm and warning conditions:

$$V_{ALARM} = [(R4 + R5)/(R3 + R4 + R5)]V_{CC} = 0.6 \times V_{CC}$$

$V_{WARNING} = [R5/(R3 + R4 + R5)]V_{CC} = 0.5 \times V_{CC}$

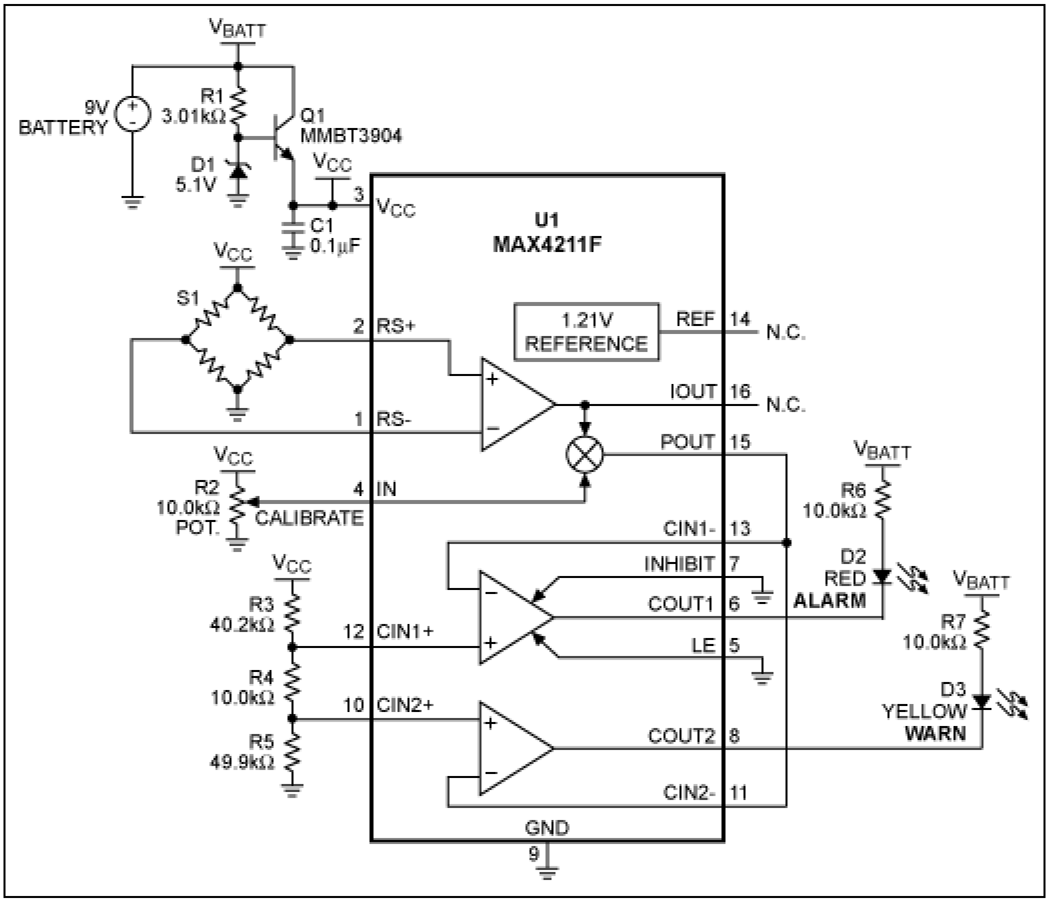

Figure 1. This single-chip circuit monitors a sensor signal represented by the bridge voltage. It produces first a warning, and then an alarm as the hazard signal intensifies.

This dual-threshold, single-adjustment design lets you calibrate the V_{ALARM} condition, and obtain $V_{WARNING}$ as an uncalibrated early-warning flag. To calibrate, carefully apply monitored gas to the sensor in the concentration necessary for alarm. Then, adjust potentiometer R2, as required, to set V_{POUT}. The maximum voltage at V_{IN} should be 1.0V, and the potentiometer should provide at least 10 turns of adjustment.

A simple NPN shunt using a 3904 transistor and 5.1V zener diode generates V_{CC} in the range 4.4V to 4.5V. Because the circuit operation is ratiometric, variations in V_{CC} do not affect the output accuracy. The value of base resistor R1 (3.01kΩ) ensures sufficient base current to saturate the transistor when battery voltage is low (6.0V).

Red and yellow LEDs provide the alarm and warning lights. If the warning light is not required, you can set up a low-battery detector using the liberated comparator, the internal 1.21V reference, and an external voltage-divider connected to V_{BATT}.

Related Parts		
MAX4211	High-Side Power and Current Monitors	Free Samples

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