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\textsubscript{POUT}) from the high-side power monitor, U1:

\[ V\text{OUT} = A\text{VOUT} \times V\text{SENSE} \times V\text{IN} = 40.96 \times V\text{SENSE} \times V\text{IN} \]

Where V\text{SENSE} is the voltage between RS+ and RS-, and A\text{VOUT} is the voltage gain from V\text{SENSE} to P\text{OUT}.

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

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

\[ V\text{POUT} = 40.96 \times 20\text{mV/V} \times V\text{CC} \times V\text{IN} = 0.8192\text{V/V} \times V\text{CC} \times V\text{IN} \]

Because P\text{OUT} can be adjusted through the V\text{IN} input, you can use fixed thresholds for the alarm and warning conditions:

\[ V\text{ALARM} = [(R4 + R5)/(R3 + R4 + R5)]V\text{CC} = 0.6 \times V\text{CC} \]
**WARNING**

\[ V_{\text{WARNING}} = \frac{R_5}{R_3 + R_4 + R_5} V_{\text{CC}} \]

\[ V_{\text{CC}} = 0.5 \times V_{\text{CC}} \]

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**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 \( V_{\text{ALARM}} \) condition, and obtain \( V_{\text{WARNING}} \) as an uncalibrated early-warning flag. To calibrate, carefully apply monitored gas to the sensor in the concentration necessary for alarm. Then, adjust potentiometer \( R_2 \), as required, to set \( V_{\text{POUT}} \). The maximum voltage at \( V_{\text{IN}} \) 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 \( V_{\text{CC}} \) in the range 4.4V to 4.5V. Because the circuit operation is ratiometric, variations in \( V_{\text{CC}} \) do not affect the output accuracy. The value of base resistor \( R_1 \) (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 \( V_{\text{BATT}} \).

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**Related Parts**

| MAX4211 | High-Side Power and Current Monitors | Free Samples |