Safety device uses GMR sensor

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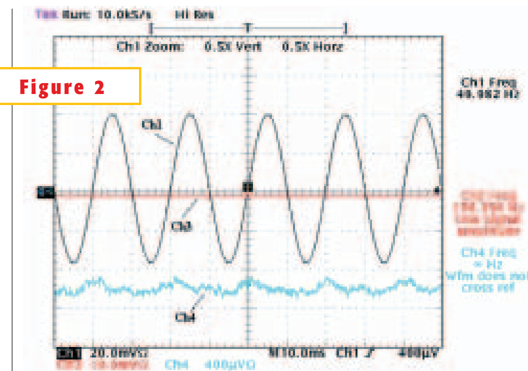
This Design Idea presents a differential safety device to prevent risks arising from current leakages in household applications. The proposed circuit uses a new method for differential current sensing (**Figure 1**). The method entails the use of Helmholtz coils and a magnetic sensor based on the GMR (giant-magnetoresistive) effect. The AC004-01 magnetic sensor from NVE (www.nve.com) uses GMR technology (**Reference 1**). Two Helmholtz coils carry the household's input current. If no differential current between phase and ground exists at the center of the coils, then the magnetic field is uniform and null. But, in the presence of an unbalanced magnetic field, corresponding to a leakage current to ground, a differential magnetic field appears at the center of the Helmholtz coils (**Reference 2**). Thus, the sensor's output is a nonzero voltage that the circuit in **Figure 1** amplifies and compares with a preset reference voltage. The reference voltage corresponds to the highest allowable leakage current—generally, approximately 30 mA.

The sensor's output, a differential voltage, connects via a highpass filter to an INA118 instrumentation amplifier, a device with high common-mode rejection (**Reference 3**). This stage converts the sensor's differential signal from a Wheatstone-bridge arrangement to a unipolar output with an appropriate gain figure. This output goes through a half-wave rectifier and a lowpass filter and becomes a dc signal. If this signal is greater than V_{REF1}, then the MOC3041 optotriac turns off, thereby interrupting the power to the household appliance.

Figure 2



The sensor's output (Channel 4) is zero because the differential line current is zero.

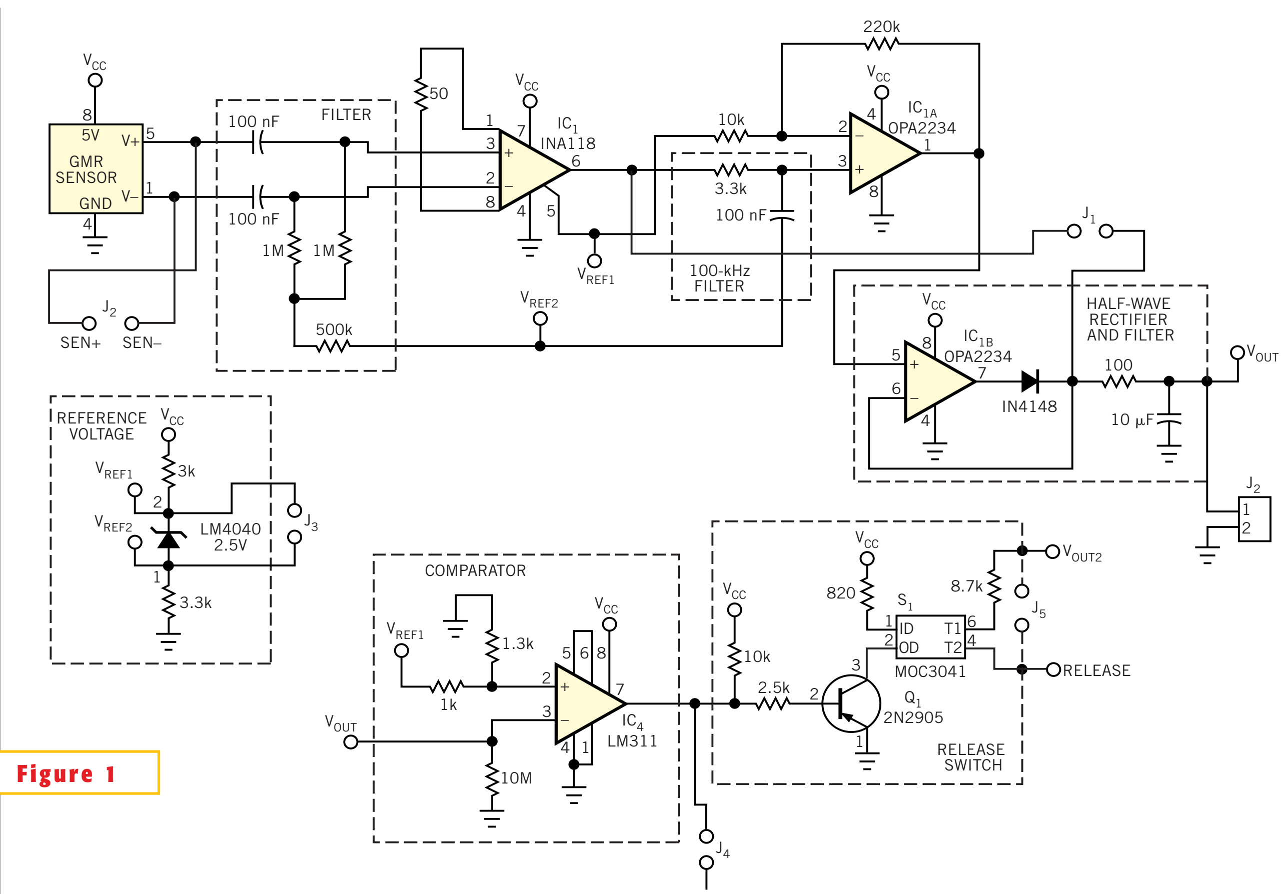
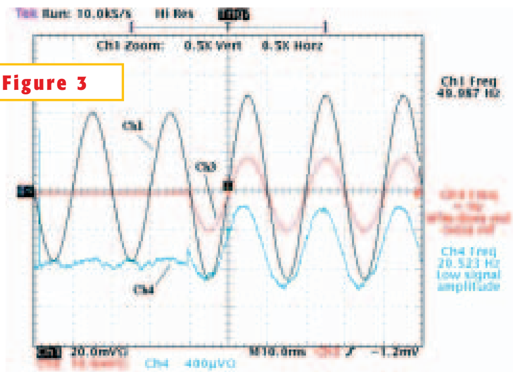


Figure 1

This circuit uses a GMR sensor to detect and disable dangerous differential line currents.

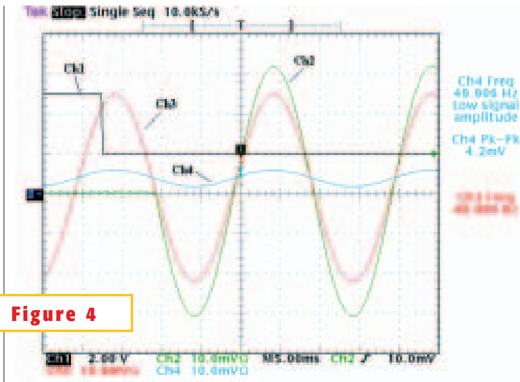
Figures 2 and **3** depict two scenarios. The Channel 1 trace represents the line current; Channel 2 shows the current circulating through the line; and Channel 4 represents the sensor's output, which is proportional to the difference between line and ground currents. In **Figure 2**, the sensor's output is zero because the current difference is null. **Figure 3** shows a ground current that generates a nonzero magnetic field in the sensor. In **Figure 4**, the ground current is greater than 30 mA. The comparator changes state, activating the optotriac (Channel 1) and turning on the relay (Channel 2, 20 mA/division). Channel 3 shows the live current, and Channel 4 shows the sensor's output (1 mV/division).□

Figure 3



A ground current generates a nonzero magnetic field in the sensor (Channel 4).

Figure 4



The ground current exceeds 30 mA. An optotriac and a relay disconnect power to the household appliance.

REFERENCES

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