LINEAR TECHNOLOGY

DESIGN NOTES

UL Isolated Self-Powered Sensing – Design Note 204

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Introduction

One of the major drawbacks with isolated sensing is the need for an isolated power supply. The LTC®1531 combines an isolated voltage comparator and voltage reference powered through its own internal capacitive isolation barrier. This barrier provides 2500V_{RMS} of isolation. The LTC1531 provides a way to design control circuits that require an isolated sensor, such as a thermistor, thermocouple or R-bridge sensor, with power and signal communication across an isolation barrier. Often there is enough power available on the isolated side to deliver several microamps of continuous power to external micropower sensor circuits, or alternatively several milliamps for short durations.

The LTC1531 powers the isolated side with a voltage pump driving the internal isolation caps formed in the lead frame. This voltage is rectified and stored on the isolated side. Periodically, the voltage pump stops and, if the isolated side has stored approximately 3.3V on an external capacitor, a comparison is done with the result sent back to the powered side where it is latched. This latched result can be used with the internal zero-cross comparator, with pulsed output, for controlling a triac. To aid in the isolated comparison, there is a 2.5V, 5mA, 100µs pulsed reference, V_{REG}. The isolated comparator samples at the end of this reference pulse at an average maximum sample rate of 300Hz, depending on loading.

4-Input Comparator

The isolated side of the LTC1531 contains a 4-input summing comparator that performs the following summation and comparison:

$$(V1 + V2)/2 > (V3 + V4)/2$$

By rearranging the inputs the following dual differential comparison can be done:

$$(V1 – V3) > (V4 – V2) \text{ or } (V1 – V4) > (V3 – V2)$$

This input can be used to compare two differential voltages or wired to compare one input against a mid-reference voltage. For example, V3 connected to the 2.5V reference and V4 to 0V, gives (V3 + V4)/2 = 1.25V. This can be used in combination with a half-bridge as shown in Figure 1, where an isolated thermistor half-bridge is used to control a heating element. The isolated comparator also has a separate isolated output, CMPOUT, that holds the result of the previous comparison, and is pulsed on with the 2.5V reference, V_{REG}. This output is typically used to add hysteresis, as shown in Figure 1. To use the 4-input comparator as a simple 2-input comparator, connect V1 to V2 and V3 to V4, which will also give the lowest offset and highest input impedance (300MΩ).

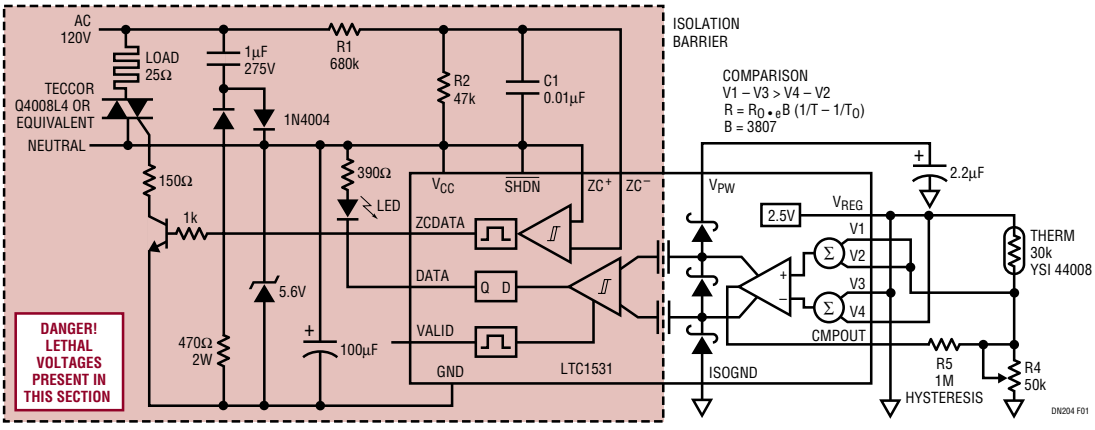

Figure 1. Isolated Thermistor Temperature Contoller

Self-Powering Through the Isolation Barrier

The isolated capacitive coupling through the lead frame plus internal rectifiers provides the isolated power source, V_{PW}. This source can be modeled as an equivalent 5.3V to 6.5V source with a 100kΩ source impedance. Hence, the power delivery to the isolated side is about 20µA to 32µA of current at 3.3V. Normally this current charges the external capacitor on V_{PW}. When the comparator and V_{REG} reference switch on, power is drawn from this capacitor for 110µs. The comparator will not compare again until the voltage on this capacitor recharges back to 3.3V. Since some applications need to amplify sensors or capture peak values between samples, external micropower circuitry can be powered continuously from V_{PW} as long as the current is below 20µA. For example, Figure 2 shows a thermocouple that is amplified and cold-junction compensated using continuous power from V_{PW}. Figure 3 detects overcurrent through an AC line sense resistor, where the LTC1531 provides both isolation and DC power for the peak detect circuit. The overcurrent value trips at 1.25V at the input to the comparator, or at 125mV across R_{SENSE}.

Conclusion

The LTC1531 provides both isolated power and isolated sensing capability. This combination simplifies the design of many control functions that require high voltage isolation without having to design an isolated power supply for the sensors.

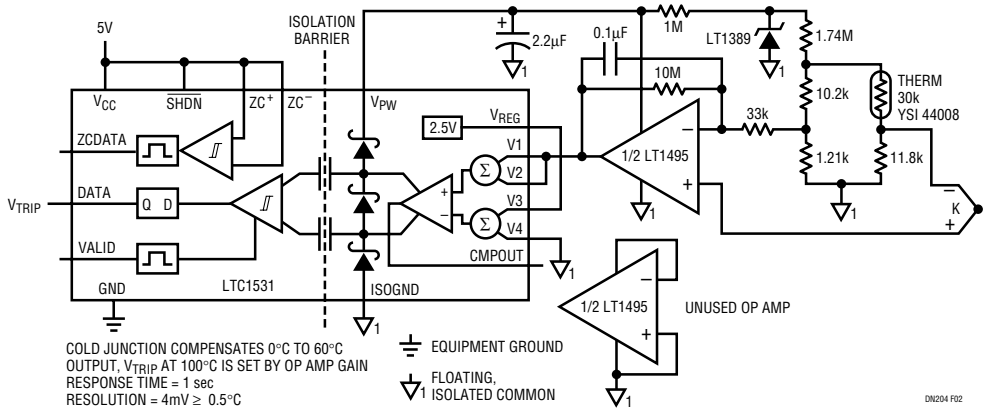

Figure 2. Overtemperature Detect

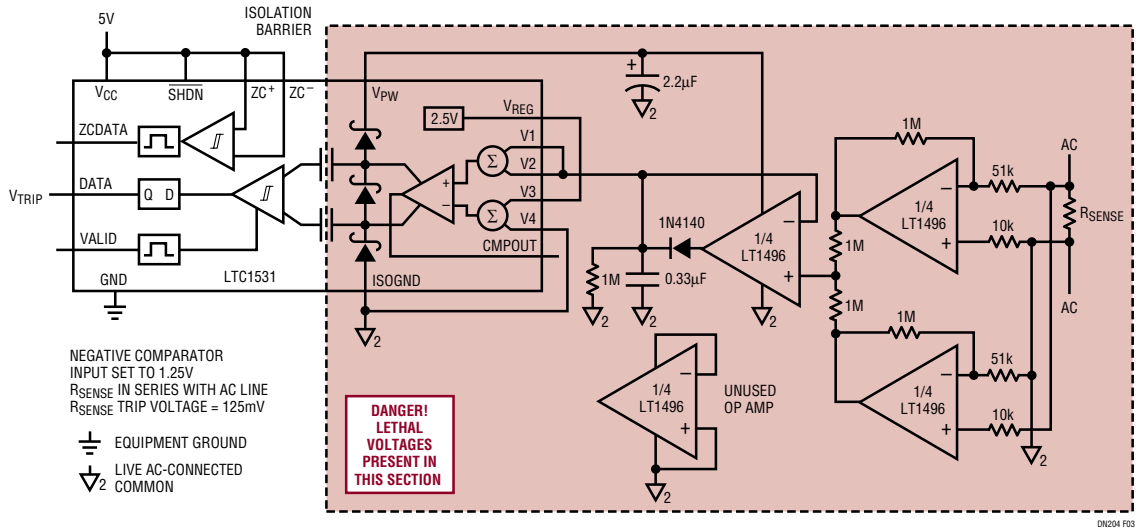

Figure 3. AC Line Overcurrent Detect

Data Sheet Download

http://www.linear-tech.com/go/dnLTC1531

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