Keysight Technologies

Gauging Temperature Accuracy Using the U3606B Multimeter | DC Power Supply

Application Note

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Introduction

Temperature plays an important role in maintaining the overall functionality of an electrical appliance and the design of these controller circuits is getting increasingly stringent. This makes it important to test the integrity of components and the overall the controller circuit. This article illustrates the unique features of the Keysight Technologies, Inc. U3606B multimeter | DC power supply that can be used to evaluate the functionality of a temperature controller board.

How a Temperature Controller Circuit Works

Figure 1. Temperature controllers found on refrigerators

Figure 2 illustrates a temperature controller circuit that uses a LM339 comparator. A LM339 chip contains four comparators, but this specific circuit only uses one of them. The operation of the circuit is simple. When the voltage at positive input (pin 5) is higher than negative input (pin 4), the output of LM339 (pin 2) will turn On. The thermistor in this circuit acts as a voltage divider. Its resistance decreases when the temperature drops. This brings more voltage on the positive pin of the LM339. Notice there is also another voltage divider in the circuit which is constructed on a variable resistor and connected to the negative pin of the LM339. In most cases, when the temperature setting on an analog refrigerator is changed, it is actually the variable resistor that is being adjusted.

When the output of the LM330 turns On, it turns On the transistor which powers up the thermostat circuit. The thermostat circuit then switches the cooling and heating elements On and Off to maintain the temperature within the correct range. An LED is usually connected to the thermostat circuit to serve as an indicator and it illuminates when the thermostat circuit is turned On.

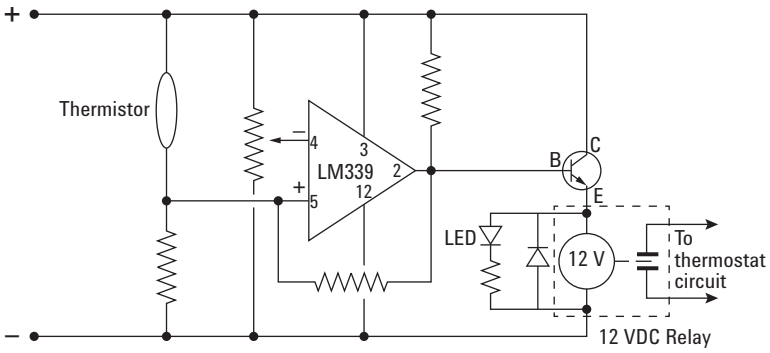

Figure 2. Example of a temperature controller circuit

Benefits of Using a U3606B

Comparator circuits like one shown in Figure 2 are widely used in temperature controller circuits. Evaluating the operation of such a comparator circuit can be done using a power supply, digital multimeter, and variable resistor. However, this approach can be very time consuming and is prone to the introduction of human errors.

Today, using the ramp feature of the U3606B, we can set the instrument to sweep from one voltage to another desired voltage, which is above the threshold voltage, to access the response of the comparator circuit. This can be done easily with a few keystrokes or simply via any programming language that supports SCPI commands. To determine the functionality of the overall circuit, we can measure the output pin that links to the thermostat circuit by using the digital multimeter function of the U3606B. Figure 3 shows a typical connection diagram for testing the functionality of the temperature controller circuit.

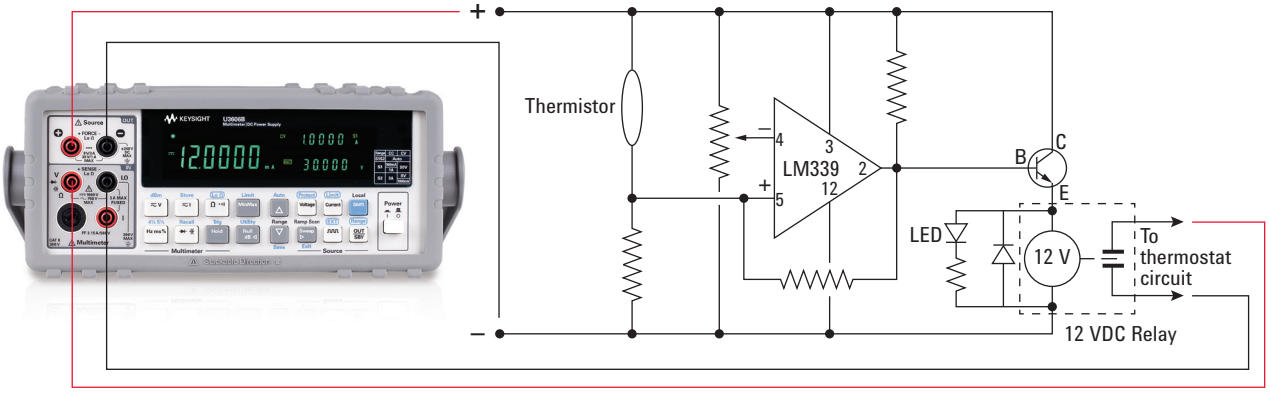

Figure 3. A typical connection diagram

Using the unit's front panel or the programming platform, the ramp feature can be configured to sweep up to 10,000 steps. Two parameters required to make a ramp signal are:

1. The amplitude end position, and
2. The number of steps required to reach the amplitude end position

When monitoring the relay to the thermostat, the circuit links to the thermostat are probed to identify whether the relay has been turned On. This can be done conveniently using the U3606B's ohm-meter function. The U3606B's 120,000 counts resolution offers up to 37 measurement readings per second with an error rate as low as 0.025% DCV, providing confidence in the measurement's accuracy.

Benefits of Using a U3606B

Figure 4 shows a typical measurement plot obtained from a U3606B. The yellow line denotes the voltage resulting from the ramp function, while the green line indicates the connectivity of the delay. While synchronized operation of a traditional single-box power supply and multimeter is challenging, it is important to note that the measurement results in Figure 4 are easily obtained through the ramp and multimeter functions operating in parallel from a single U3606B. Performing similar task in conventional approach using a power supply and a multimeter may cause communication latency and thus increases the test time

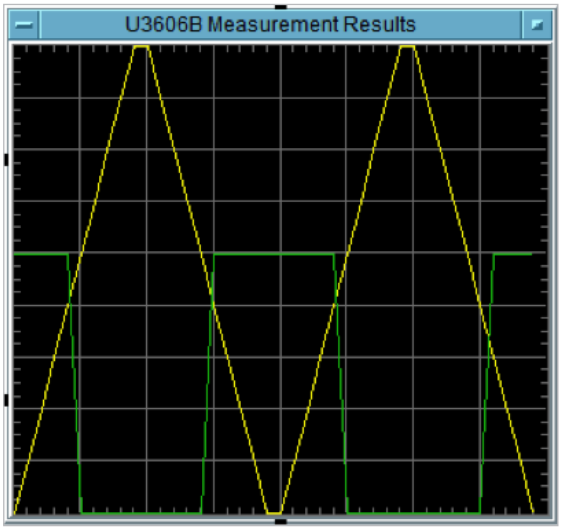

Figure 4. Measurement results

Conclusion

The combination of the ramp function and multimeter function of the U3606B has proven to be a best-fit instrument for applications where source-and-monitor is required concurrently. In addition to validating the operation of temperature controller boards the unique features of the U3606B make it well suited for other applications with similar requirements, including parametric components testing, printed circuit board validation, and integrated circuit (IC) functional testing.

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