Keywords: thermal hysteresis, MAX6079, low noise precision voltage reference, PCB design

APPLICATION NOTE 6651

HOW TO MEASURE THE MAX6079 VOLTAGE REFERENCE THERMAL HYSTERESIS, CONSIDERATIONS FOR PCB LAYOUT

Abstract: This application note describes how to measure the MAX6079 thermal hysteresis and explores some of the LCC package's PCB considerations.

Introduction

The MAX6079 is a low-noise, precision voltage reference in a ceramic LCC package. The device package is hermetically sealed and offers stable results from package stress conditions. The MAX6079 operates from a 2.8V to 5.5V supply voltage and features excellent thermal hysteresis. We'll explore how to measure the MAX6079's thermal hysteresis and the package's PCB and mounting considerations.

Thermal Hysteresis

Thermal hysteresis is known to be the result of stress on the die. Multiple cycles result in different shifts, and after a few temperature cycles the final change from the initial voltage stabilizes. Typically, after the device has gone through several temperature cycles, the stress has stabilized to a minimum. Note that stress can be reintroduced by soldering or twisting the package.

Thermal hysteresis is defined as the shift in the reference output voltage after the device is cycled through its operating temperature range. This change is reported as a fraction of the nominal output voltage and is typically expressed in ppm. No maximum is specified since the device cannot be tested over multiple cycles at the factory.

Incomplete temperature cycling with either hot or cold produces different thermal hysteresis data. To correctly measure thermal hysteresis, cycle a voltage reference through its operating temperature range and measure the output voltage before and after temperature cycling. For example, the MAX6079 is rated for the automotive operating temperature range of -40°C to +125°C. First measure and record the output voltage at room temperature (+25°C). Then increase the temperature to +125°C, cool it to -40°C, and finally return it to +25°C. Measure and record the output voltage again. The thermal hysteresis is calculated as follows:

$$T_{HYS} = \frac{|V1 - V2|}{V_{NOM}} \times 10^6 \text{ (ppm)}$$

where V1 is the reference output voltage before cycling through the temperature range, V2 is the reference output after cycling through the temperature range, and V_{NOM} is the device nominal output voltage.

In general, it is also valid to first cool the device to -40°C, then heat the device to +125°C before returning it to +25°C (depending on how this parameter is specified in the MAX6079 data sheet). The output voltage shift can be positive or negative. Typically, after two to five cycles, the stress has stabilized to a minimum. The MAX6079's ceramic package shows that the voltage output is even stabilizing right after the second cycle as shown in **Figure 1**.

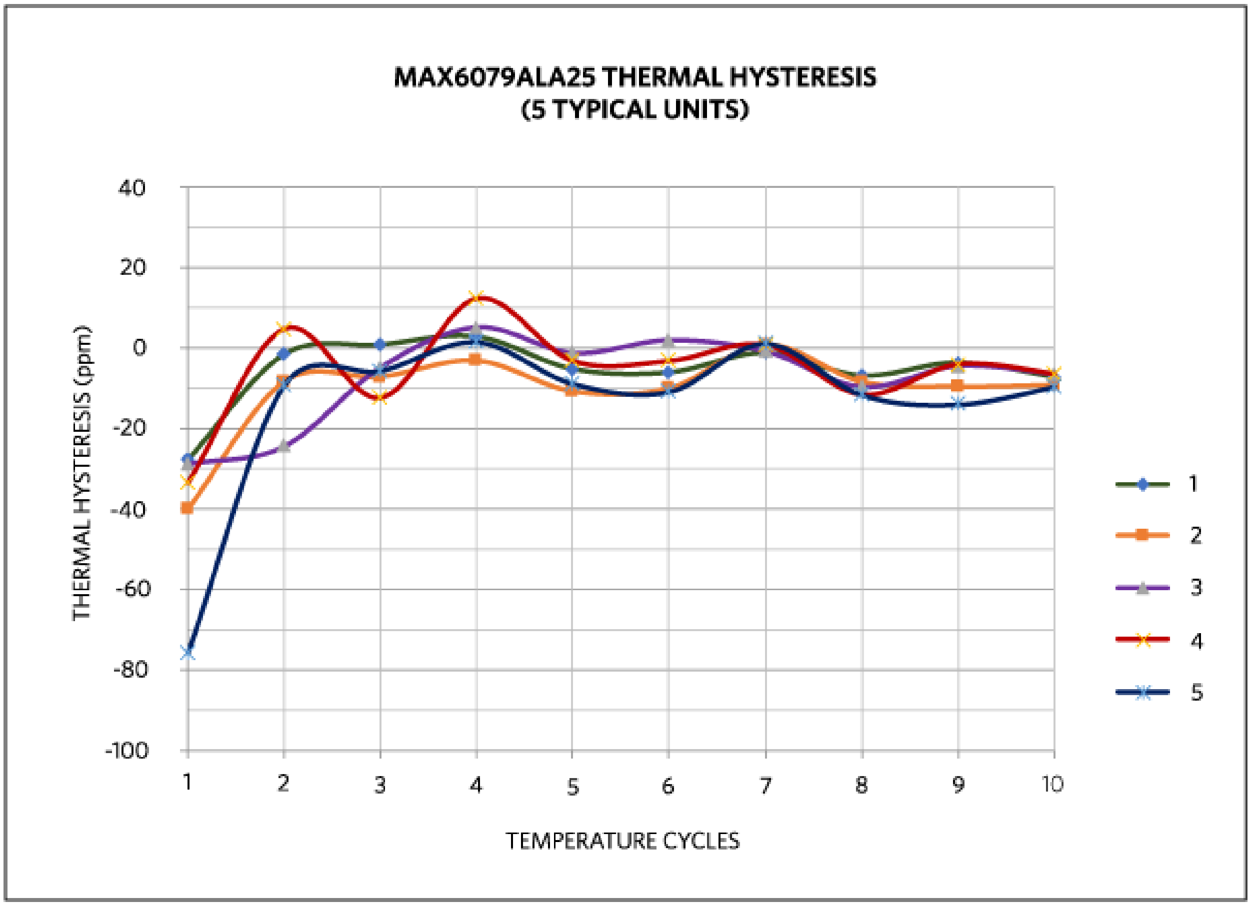

Figure 1. Five units of MAX6079 measured through 10 temperature cycles.

PCB and Mounting Considerations

The amount of hysteresis shift can be controlled by PCB mounting. Several techniques have been employed to minimize its effects. It has been proven experimentally that placing the voltage reference package near the PCB edge, especially the shortest edge, or in a corner minimizes hysteresis effects due to the increased stiffness of the board. Locate the device away from the middle of the PCB. It is best to solder the device along the shortest edge of the board since the longer edge of the PCB is more flexible than the shorter. It is also recommended that unwanted solder and flux residue under the package be minimized because that could create unbalanced pressure points and induce package stresses.

Anything else that can be done to reduce the bending of the circuit board due to temperature changes is helpful. A small, thick PCB is much better than a large, thin PCB.

PCB slotting as shown in **Figure 2** is another important technique employed widely in precision voltage references. PCB slotting improves the board’s stiffness, greatly reducing package stress and hysteresis shifts.

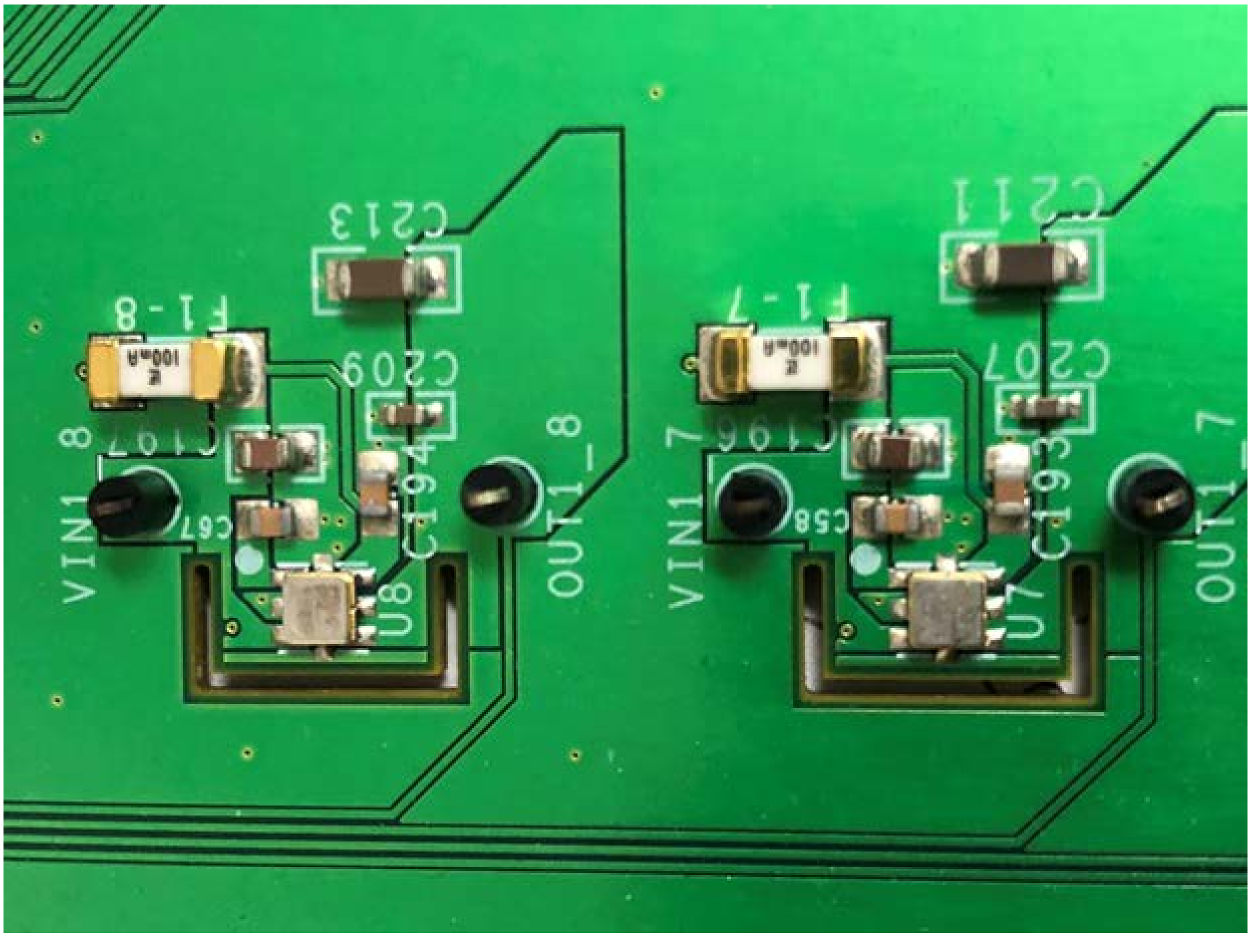

Figure 2. PCB layout with slotting for stress reduction.

Conclusion

The MAX6079 voltage reference in an 8-pin ceramic package provides excellent low noise, low drift, and thermal hysteresis. Users should be aware of all the thermal aspects of the device shift during assembly and normal operation and plan the design accordingly. With proper planning and design, the device can yield a highly accurate and stable reference voltage.

Related Parts		
MAX6079	Low-Noise, High-Precision Series Voltage Reference in Ceramic Package	Free Samples

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