

Voltage Reference Long-Term Stability Reduces Industrial Process Control Calibration Costs

Introduction

Large industrial plants—such as those in the oil, gas, electricity, pharmaceutical, and food and beverage industries—rely on electronic instrumentation to provide accurate, stable measurements to control their processes. The stability of an instrument very much depends on its application and the environment in which it operates. Fluctuating temperatures, harsh manufacturing conditions, humidity and elapsed time are all factors that affect stability.

When a sensor or instrument experiences temperature variations or physical stress over time its performance will begin to decline, a phenomenon known as ‘drift’. Measurement data from the sensor becomes unreliable and can seriously affect the quality of factory production. Drift can be identified and rectified via calibration, but this solution can be very expensive and may result in factory downtime.

Since sensors and instruments are only as accurate as their references, the focus for the solution to this problem becomes the voltage reference. Thorough understanding and minimization of drift behavior in voltage references leads to tailored calibration strategies that can translate into substantial cost savings.

Sensing and Measuring Architecture

A diagram of a typical sensing and measuring unit is shown in Figure 1. The sensor converts a physical parameter—such as weight, temperature, or pressure—into an electronic signal. The signal is amplified (A), digitized (ADC), and fed to the microcontroller (MCU) for processing. Both the sensor and the ADC require a voltage reference for accurate operation. As such, there can be hundreds of references embedded within the instrumentation of a single industrial plant.

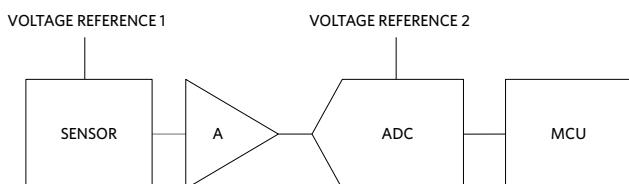


Figure 1. Sensing and Measuring Unit Typical Diagram

Long-Term Stability Testing

The parameter that quantifies the drift in voltage references is known as long-term stability. Long-term stability is defined as a slow change in output voltage, usually in one direction, occurring over months of operation, and is usually expressed in ppm/1000 hours.

The long-term stability test cannot be accelerated by burn-in techniques allowed by the Arrhenius Law hence it has to last for the entire targeted duration. For 1000 hours this corresponds to a test time duration longer than a month. The test is performed on a selected sample population under set conditions for nominal input voltage, temperature and humidity, and load.

During the test, a fixed number of complete boards, each populated with dozens of sockets, are loaded into a temperature and humidity-controlled environmental chamber (Figure 2). The parts operate without interruption for the test duration under set conditions for load, temperature, and humidity. The outputs are continuously monitored for any voltage deviation from the nominal value.



Figure 2. Long-Term Drift Environmental Chamber

Given the economic implications attached to voltage reference drift it's no wonder that semiconductor manufacturers are being encouraged to go beyond 1000 hours of test time to ensure accurate, reliable operation.

A Test Case

The following test case demonstrates extended long-term stability testing for a popular voltage reference. MAX6126 Ultra-High-Precision, Ultra-Low-Noise, Series Voltage Reference has long-term stability specified at 20ppm/1000hr (typ). Figure 3 shows the electrical test conditions of 5V input and no load.

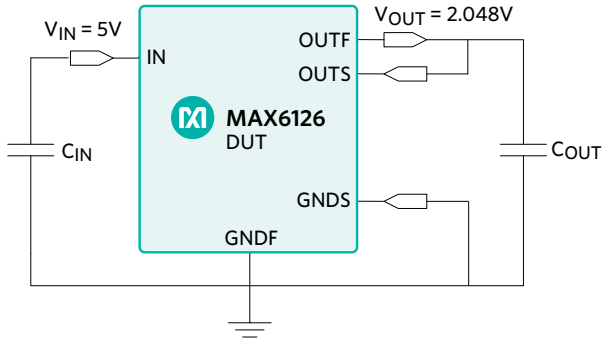


Figure 3. MAX6126 Test Circuit

For environmental testing, a board was loaded with sixteen samples of MAX6126, A-grade. The test was conducted inside an environmental chamber at 25°C, 40% RH for a duration close to 3000 hours, almost triple the typical test time found in most data sheets.

Figure 4 shows the results. The drift performance of all devices is well within ± 10 ppm, half the typical drift reported in the data sheet. Part-to-part variation is also quite small. The glitch shown at approximately 2400 hours corresponds to a rise in humidity that occurred due to the backup power supply not immediately turning on. These consistent readings over time allow instrumentation and process control customers to minimize the need for calibration and downtime.

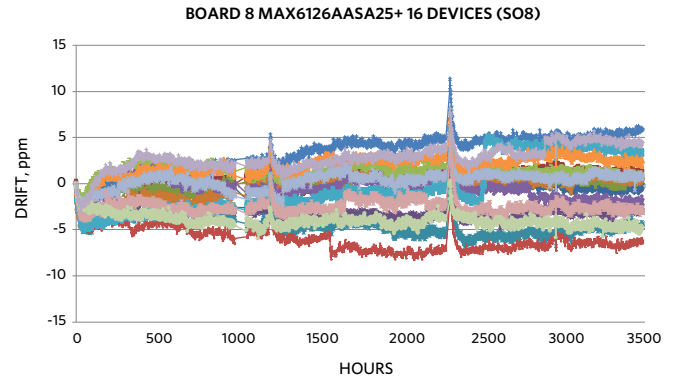


Figure 4. MAX6126A Long-Term Stability Test Results at 25°C, 40% RH Ambient

Future Developments

Maxim Integrated is responding to customer requests for increased long-term stability test time by progressively extending the test duration. Future plans include moving the long-term stability benchmark from 20ppm/1000hr to 10ppm/1000hr for selected products while continuing to experiment with test times up to 10,000 hours.

Conclusion

We have discussed the importance of accuracy and stability in industrial process control, which relies on the tiny but critical and ubiquitous voltage reference. We have reviewed current techniques for measuring long-term stability and outlined a future roadmap to reduce the range of variability down to 10ppm while extending the test duration of this critical parameter up to 10,000 hours.

Learn more: [MAX6126 Ultra-High-Precision, Ultra-Low-Noise, Series Voltage Reference](#)

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Maxim Integrated
160 Rio Robles
San Jose, CA 95134 USA
408-601-1000
maximintegrated.com

