MCP9601 Thermocouple Conditioning Integrated Circuits (ICs)

Learn How the MCP9601 Digital Filter Enhances System Performance

Summary

The MCP9601 is a complete plug-and-play, single-chip solution to simplify your design, reduce development time and lower your overall system cost. The MCP9601 contains a fully integrated thermocouple Electromotive Force (EMF)-to-degree Celsius converter with cold-Junction compensation and opens/shorts protection. In addition, it contains user-programmable registers to enable many key features like low power modes and control for individually programmable temperature alert outputs that can detect multiple temperature zones.

Digital Filter Features

The MCP9601 supports several key features including a programmable digital filter. The digital filter minimizes the effects of system noise and EMI to enhance system performance with two key advantages: providing a stable temperature data and preventing false alert triggers from fast transient temperature changes.

The MCP9601 integrates a first order recursive, Infinite Impulse Response (IIR) filter, also known as Exponential Moving Average (EMA). The IIR filter is the most efficient type of digital filter for digital processors and it depends on the current temperature data and previous filtered result to output the next filtered result. This filter improves the precision of the temperature data by providing a more weighted result to the current temperature value, which allows for a faster response to changing temperature trends. This feature can be used to filter out fast thermal transients or thermal instability at the thermocouple hot junction.

Digital Filter Benefits

The IIR filter is a simplified digital filtering mechanism that enhances system performance by smoothing out thermal instabilities and providing faster response to changes in temperature. The MCP9601 sensor configuration register is used to select the thermocouple sensor type and digital filter options.

$$Y = k \times X + (1 - k) \times Y_{-1}$$

$$k = \frac{2}{(2^n + 1)}$$

Please refer to the equation above

Where:

Y = New filtered temperature in T_Δ

X = Current, unfiltered hot-junction temperatures

Y_{-1} = Previous filtered temperature

n = User-selectable filter coefficient

This device provides a user-selectable filter coefficient “n”, which selects different filter responses from levels 0 to 7 (please reference data sheet Section 5.2.2, DS20005426). A coefficient of 0 disables the filter function and a coefficient of 7 provides the maximum digital filter. When the filter option is enabled (for n > 0), the filter engine is applied to each temperature sample.

The MCP9601 Evaluation Board EV15T80A demonstrates the various features of this device. The evaluation board comes with the thermal management Graphical User Interface (GUI), allowing you to select between the thermocouple types, digital filters, sensor configuration, shutdown modes and temperature alert outputs. This enables you to collect real-time data from existing systems and graphically demonstrate the system temperature characters.

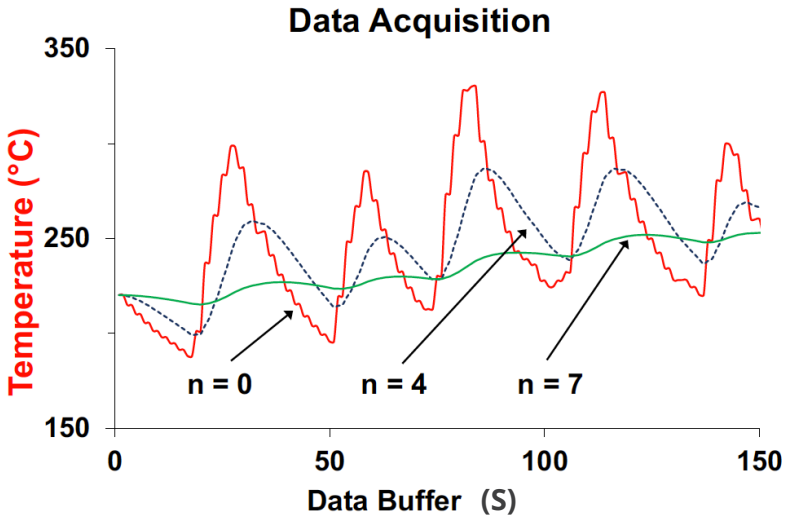

Figure 1: Data Acquisition Sample

Figure 1 is a graphical representation of the digital filter benefits, which include smoothing out temperature fluctuation, reducing the effects of system noise and a more accurate temperature reading to false prevent temperature alert triggers.

The red line displays the instability of the thermocouple hot-junction temperature when the filter is OFF or disabled (n = 0), which shows the temperature sample oscillating by approximately 100°C.

The blue line shows a significant reduction in temperature data fluctuation when the filter is set at medium level (n = 4), which provides a more stable temperature data reading.

The green line shows the drastic reduction in temperature data fluctuation when the filter is set at maximum level (n = 7) while tracking the general trend of the system temperature.

Check out our landing page: at microchip.com/thermocoupleic for product information for the entire MCP9601 portfolio.