



# HOW TO SIMPLIFY YOUR NEXT THERMOCOUPLE DESIGN

## MARKET OVERVIEW

Thermocouples are widely used today because of their ruggedness and simplicity (two different wire types connected), making them well-suited for a wide variety of different application areas—from harsh industrial environments like boilers, petrochemical, smelters, and automotive to consumer products, such as coffee/espresso machines, cooktops, ovens, and many others.

Thermocouples are a popular customer design-in choice today because of their many advantages:

- › Wide temperature range
- › Below  $-250^{\circ}\text{C}$  to over  $1800^{\circ}\text{C}$
- › Fast thermal response
- › Accurately capture temperature spikes
- › Rugged against vibration and dirt
- › Simple design
- › Self-powered
- › No voltage or current excitation required

## CLIENT CHALLENGES

Unfortunately, in addition to all the advantages that thermocouples provide, there are a few challenges. Most clients today develop their thermocouple systems using discrete analog components requiring up to 15 or more components, depending on their precision accuracy requirements. Thermocouple systems can be very complex and require long system development times, cost, and resources to develop and support.

Another challenge is that the long thermocouple wires can act as an antenna that can pick up all sorts of electrical noise. Ideally, this noise will couple onto both wires of the thermocouple and hence be common, but this high level of common mode noise can affect the signal conditioning circuitry. The actual voltage created across the thermocouple is very small, in the order of tens of millivolts across a wide temperature range. It is a significant challenge in attempting to measure this very low voltage in the presence of potentially large common mode noise and requires a high-performance front-end solution. Not only does the thermocouple produce a relatively low voltage output, but it also is not linear across the temperature range. Therefore, extracting a small voltage change in the presence of a large common mode voltage can be challenging.



## WHY CHANGE?

In many cases, a single-chip solution to replace all these components will not only save board space, but will likely cost less compared to using discrete analog components depending on the precision level of discrete analog components used. The MCP9600 and MCP9601 products integrate the complete analog signal chain which includes a precision high-resolution Analog-to-Digital Converter (ADC), a high-accuracy temperature sensor, and a preprogrammed math engine to signal process in real-time and correct the thermocouple's non-linearity error characteristics to provide customers with an accurate temperature measurement in degrees Celsius, which can be simply read on the I2C bus. Now, that is easy.

## WHY NOW?

MCP9600 and MCP9601 products solve the performance, integration, power, and cost challenges for today's thermocouple system analog design engineers. You might be thinking, how is this possible? The MCP9600 and MCP9601 thermocouple conditioning Integrated Circuits (ICs) are the most complete plug-and-play, single-chip solutions on the market today.

## WHY MICROCHIP?

Let's face it, developing discrete precision analog circuitry to accurately condition the thermocouple signal is not a trivial task and Microchip has this taken care of for you. Microchip offers complete thermocouple conditioning products available today that you should check out.

While there are a few competitor thermocouple conditioning ICs, they are inferior to the complete plug-and-play thermocouple conditioning solution that the MCP9600 and MCP9601 products offer. Microchip is unique in this product category with its advanced features and functionality. These products reduce the required expertise in analog, mixed-signal, thermal management, and microcontroller design. Our innovative portfolio of highly integrated thermocouple conditioning IC solutions simplifies the client's development and speeds up their product's time to market.

Additionally, the MCP9600 and MCP9601 thermocouple conditioning ICs connect a thermocouple and measure precision temperature measurements in degrees Celsius temperature data via a standard I2C interface. How simple is that? It is because these devices integrate the complete analog signal chain that includes a precision high-resolution ADC, a high-accuracy temperature sensor, and a pre-programmed math engine to correct the thermocouple nonlinear error characteristics of eight different thermocouple types used today.

Please check out Microchip's thermocouple conditioning products if you are looking for flexible, easy-to-use, and complete thermocouple conditioning products that will reduce your development risk and speed up your product's time to market.

The benefits of using MCP9601 products:

- Provides a complete plug-and-play thermocouple conditioning solution
- Simplifies design, reduces development time, lowers overall system cost
- Integrated thermocouple open-circuit and short-circuit detection
- Temperature data digital filter
- Minimizes effects of system noise and Electromagnetic Interference (EMI)
- Shutdown modes
- Reduces overall system power consumption
- Four user-programmable Temperature Alert outputs
- Reduces microcontroller overhead, reduces code space, simplifies design, and enhances product performance.
- Small Package: 20-lead QFN (5\_mm x 5\_mm)
- Reduces board space and lowers manufacturing costs

## WHAT NEXT?

To learn more about Microchip Sensor Interface Integrated Circuits

[CLICK HERE](#)



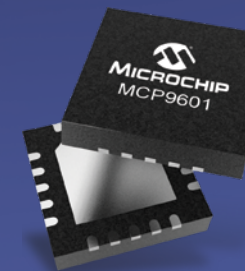
# ARE YOU FEELING THE HEAT?

Simplify your next Thermocouple design with complete "Plug-and-Play" Thermocouple Conditioning Solutions

## Thermocouple Conditioning IC Products

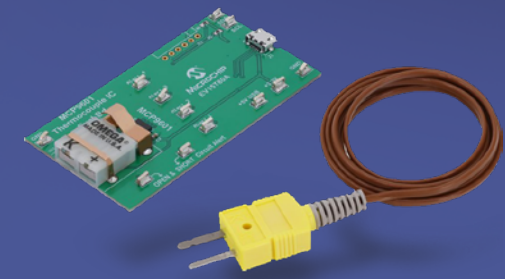
Our portfolio of thermocouple ICs offers a specialized thermocouple signal conditioning IC that provides a complete plug and play single chip solution for effectively measuring, converting and processing a thermocouple's absolute hot-junction temperature value (in degrees Celsius) via reading an I2C digital value.

## Thermocouple Conditioning ICs and development Platforms



### MCP9600, MCP9601 and MCP96L01

- Thermocouple EMF-to-temperature converter
- $\pm 1.5^{\circ}\text{C}$  to  $\pm 4^{\circ}\text{C}$  accuracy
- Detection of open and shorts
- Four temperature alert outputs



### EV15T80A MCP9601 Evaluation Board

Evaluation board designed to digitize the Thermocouple EMF voltage to degree Celsius with  $\pm 1\text{-C}$  accuracy. Users can easily evaluate the all device features using a Type K thermocouple.

[LEARN MORE](#)





### Current Sense Amplifiers

Create robust current monitoring designs that work across a variety of environmental conditions and applications with our flexible high-precision solutions that feature a zero drift architecture.



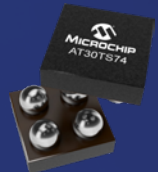
### Power/Current Monitors

Get ahead of the thermal curve using devices that integrate both current and temperature sensors.



### Temperature Sensors

Choose from our selection of single and multi-channel temperature ICs that offer flexible options to meet the specific requirements for monitoring heat in your application.



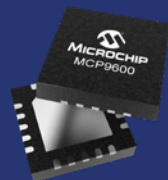
### Inductive Position Sensors

Use these sensor interface ICs to accurately measure linear and angular/rotation movements in a variety of automotive, industrial, aerospace and commercial applications.



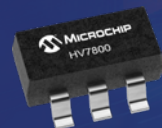
### Sensor Interface ICs

Simplify your development process and accelerate time-to-market with our innovative, integrated plug-and-play solutions to precisely measure a thermocouple's microvolt-level signal and converts it to degrees Celsius.



### Offline High-Side Current Monitors

These current monitor ICs feature a very wide input voltage range, high accuracy of transfer ratio, small size, low component count, low power consumption, ease of use, and low cost. Offline, battery and portable applications can be served equally well due to the wide input voltage range and the low quiescent current of the HV7800/1/2.



# HIGH-ACCURACY SENSORS FOR COMPLEX, REAL-WORLD APPLICATIONS

Are you building a system that needs to measure real-world data accurately and reliably to make intelligent, real-time decisions? Our large portfolio of sensors measure data from the analog world and deliver it to the digital world. These sensors feature high-accuracy, low-power performance, real-time protection, robust interfaces and compact packages to satisfy the requirements of industrial, automotive, consumer, data center and communications applications.

