

# LIQUID FLOW SENSORS

Technical Note: Evaluation Module

## OVERVIEW

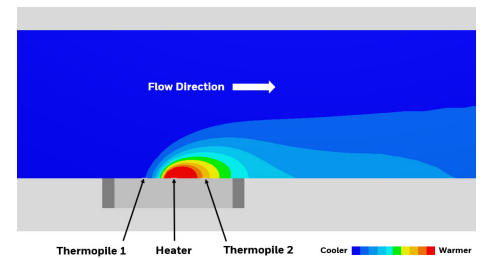
Honeywell Liquid Flow Sensors use an innovative thermal flow sensor in direct contact with the measurement media to provide unparalleled accuracy and sensitivity. The sensor itself is constructed using a two-piece configuration which maximizes cost effectiveness, particularly for high volume disposable applications. The disposable half contains only the essential sensing element and integrated circuit chip to minimize the cost of single use components, while a reusable side contains the higher cost microcontroller and power management circuits that can be reused for the life of the application. This two-piece flow sensor solution provides users with an economical, scalable option for high-accuracy sensing across a wide range of flow measurement applications.

This document provides a brief overview of the Honeywell Liquid Flow Sensor Evaluation Module (EVM), which is available to demonstrate the performance of Honeywell liquid flow sensing technology. While the EVM's primary purpose is to enable users to quickly set up and test the sensor's performance, the device has been fully tested under typical environmental conditions and is available for direct integration into many applications. If additional customization is required to tailor the Honeywell Liquid Flow Sensor for a specific application, this document covers a few, but certainly not all, of the most common customization options available.

## PRINCIPLE OF OPERATION

The Honeywell Liquid Flow Sensor uses the principle of convective heat transfer to derive fluid flow rate from the temperature differential measured across two thermopiles positioned on either side of a heating element. The heating element increases the temperature of the fluid just enough to measure the flow rate of the fluid as it passes over the sense die. The fluid temperature is only increased in the region near the sense element and will not increase the temperature of the fluid exiting the sensor.

During the measurement process fluids flow across the surface of the sense element, pulling heat away from the heater through the process of forced convection. The amount of heat removed by the flowing fluid is proportional to both the thermal properties of the fluid and the flow rate of the fluid. Under stable conditions the fluid flow rate can be derived from the temperature differential across the two thermopiles. If the fluid conditions become unstable, such as increasing or decreasing thermal conductivity of the fluid, the high sensitivity of the liquid



Fluid passing over the heater results in a temperature profile similar to that pictured here. The thermopiles on either side of the heater assess the temperature differential and this information is used to calculate the fluid flow rate.

flow sensor will detect these variations, notifying the user of changes occurring within the fluid. For more details see *Honeywell Technical Note: Exploring External Factors Affecting Liquid Flow Sensor Accuracy and Response*.

All Honeywell Liquid Flow Sensors undergo extensive calibration procedures to ensure a linear output. The Honeywell Liquid Flow Sensors are factory calibrated for clean water but can be calibrated for other fluids to meet the needs of most applications.

**Honeywell**

## EVALUATION MODULE CONSTRUCTION

Honeywell liquid flow sensing technology can provide a cost-effective solution for high volume applications in a customized package without compromising performance. The Honeywell Liquid Flow Sensor EVM covered in this document seeks to demonstrate the capabilities of this technology in an easy-to-use plug-and-play package. The EVM can be secured to several products commonly used in engineering labs. Both the disposable and reusable pieces are oversized to maximize usability during evaluation. These features allow the sensor to be tested out of the box without needing to purchase additional test equipment, but the key to Honeywell technology is the customization capabilities of the product.

The core technology within Honeywell Liquid Flow Sensors lie within the tiny sense element in contact with the fluid. This sense element is complemented with an integrated circuit chip and microprocessor to deliver a liquid flow measurement.

Traditionally, sensors have combined all three of these components into a single package, driving up the cost of every sensor. Honeywell innovative construction minimizes cost and waste for single-use applications by splitting the core sensing elements from the microcontroller into two separate components. Essential elements for temperature measurement are in the single-use disposable component while the microprocessor is in the reusable component. This construction method enables the microprocessor to be reused with multiple sensors rather than having to dispose of them with the sensing element.



**Disposable**



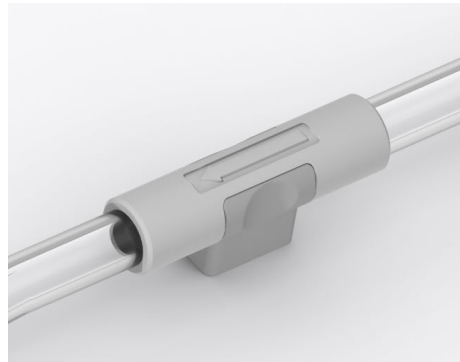
**Reusable**

The disposable piece (top) contains the essential components required to measure the fluid temperature while the reusable piece (bottom) contains the components required to translate temperature measurements into a liquid flow rate.

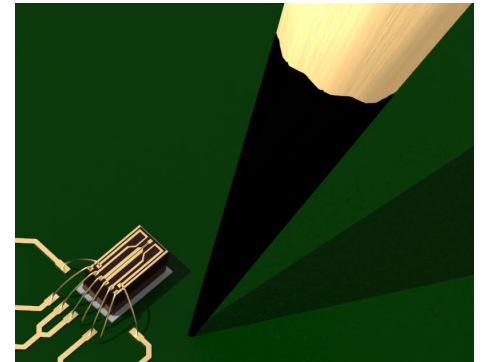
## CUSTOMIZATION CAPABILITIES

The Honeywell Liquid Flow Sensor EVM has been developed to demonstrate the capability of the sensor in an easy-to-use form factor; however, many customers require unique customization to fit the needs of their application. Honeywell offers a wide variety of customization options to meet the needs of most applications, including:

- Custom package options
- All-in-one solution
- Custom fluid calibration
- Custom flow range



This concept of a Honeywell Liquid Flow Sensor can be customized to fit in line with an existing application to minimize the impact to current products.



The sensing element within the Honeywell Liquid Flow Sensor is smaller than the tip of a pencil.

### Custom Package Options:

The Honeywell Liquid Flow EVM demonstrates one possible solution for pairing the disposable and reusable components together using a robust, high-performance, card-edge connector for the electrical connection. While this package may work well in some applications, the engineers at Honeywell can further customize this package to meet the specific needs of most applications. The EVM is designed with a large plastic cover for ease of use in a lab, however, the core sensor within the disposable is only a small fraction of the EVM. Significant size reductions are possible when integrated directly into users' applications.

For example, when the sensor is designed into a flow tube, the disposable piece can be reduced to a size smaller than a AA battery for seamless integration.

## ALL-IN -ONE SOLUTION

The Honeywell Liquid Flow EVM is designed with a two-piece configuration to minimize recurring costs in disposable applications as well as keeping the size of the disposable component to a bare minimum. Honeywell understands that this configuration may not be optimized for all applications. If your application requires, Honeywell can customize the sensor to an all-in-one solution with the sensor and microprocessor integrated into a single component. All-in-one solutions are typically used in space constrained applications, such as wearable products, where an even more compact package is required.

## CUSTOM FLUID CALIBRATIONS

The Honeywell Liquid Flow EVM is factory calibrated for measuring the flow of water for simple evaluation of the product. Unless an application is intended to measure water, a custom calibration will be required for the most accurate flow rate when using a different fluid. The Honeywell Liquid Flow Sensor calculates the fluid flow rate by measuring the temperature differential across the two thermopiles. To enable this calculation, Honeywell performs a thorough calibration using the specific fluid the sensor is intended to measure. Each type of fluid has distinct thermal properties which affect the calibration of the sensor. Looking at some common fluids in the table you can see how the difference in thermal conductivity changes for different fluids.

At first glance, it may seem like a simple calculation to adjust the flow rate of water to another fluid based on the thermal conductivity. However, the calculation is quite complicated, and a simple proportional adjustment based on these properties can lead to an incorrect flow rate measurement. Flow applications other than water require custom calibration for accurate measurements. Contact Honeywell for details on obtaining a custom fluid calibration for your specific application.

## CUSTOM FLOW RANGE

The Honeywell Liquid Flow EVM is calibrated with a flow range to meet the needs of a wide range of applications. The specific flow range of the sensor can be found on the product datasheet. If an application requires a different flow range, contact Honeywell for a custom flow rate calibration.

## TECHNOLOGY DIFFERENTIATION

There are a wide variety of liquid flow sensing technologies on the market today which can sometimes make it difficult to choose the right technology for your application. Some of the most common technologies used in low flow applications include:

- Thermal-based flow sensing
- Optical drip detection
- Fluid weight measurement
- Tube deformation sensing

Each of these technologies have advantages and disadvantages depending on the needs of the application. When choosing the right flow sensor for your application, there are several different factors that need to be considered including:

- Invasive / Non-Invasive
- Flow range
- Accuracy
- Sensitivity
- Package size
- Cost

**TABLE 1. APPROX. VALUES OF THERMAL CONDUCTIVITY**

FLUID AT ROOM TEMP	THERMAL CONDUCTIVITY (W/M-K)
Water	~0.6
Isopropyl Alcohol	~0.2
Blood	~0.5
Glycerin	~0.3

*Approximate values of thermal conductivity for common liquids are shown. These values are for representative purposes only and should not be used for calculation of flow rates.*

The Honeywell Liquid Flow Sensor is best suited for applications which require high sensitivity for low flow ranges that do not require a non-invasive flow measurement.

The following table provides a simple comparison between common flow sensing technologies as a guide to choosing the right type of flow sensor based on application needs.

<b>TABLE 2. LIQUID FLOW TECHNOLOGY COMPARISON</b>					
	<b>INVASIVE THERMAL BASED</b>	<b>NON-INVASIVE THERMAL BASED</b>	<b>OPTICAL DRIP</b>	<b>WEIGHT MEASUREMENT</b>	<b>TUBE DEFORMATION</b>
<b>Invasive Type</b>	Invasive	Non-Invasive	Non-Invasive	Non-Invasive	Non-Invasive
<b>Flow Range</b>	Ultra Low to Low	Ultra Low to Low	Ultra Low	Low	Low
<b>Accuracy</b>	High	High	Moderate	Moderate	Moderate
<b>Sensitivity</b>	High	Moderate	Low	Low	Low
<b>Package Size</b>	Small	Small	Moderate	Large	Large
<b>Cost</b>	Low (Recurring)	Moderate	Moderate	Moderate	Moderate

## **SUMMARY**

Honeywell Liquid Flow Sensors are the ideal solution for applications that need high sensitivity flow measurement in a compact size. Honeywell Liquid Flow EVM offers a fast and efficient method to evaluate the performance of the sensor prior to a custom development project. This technical note highlights a few of the most common customization options available. If the Honeywell Liquid Flow Sensor meets your needs and you are interested in developing a customized solution for your application, contact Honeywell for details on partnership opportunities.

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USA/Canada	+1 302 613 4491
Latin America	+1 305 805 8188
Europe	+44 1344 238258
Japan	+81 (0) 3-6730-7152
Singapore	+65 6355 2828
Greater China	+86 4006396841

### Honeywell Sensing Solutions

830 East Arapaho Road  
Richardson, TX 75081  
[www.honeywell.com](http://www.honeywell.com)