acal bfi European leader in advanced technology solutions

Selecting the right airflow sensor for your application

In engineering, the airflow is a measurement of the amount of air per unit of time that flows through a particular device.

The amount of air can be measured by its volume or mass. Typically it is measured by volume but for some applications it is necessary to measure it by mass, as air is a gas and therefore its volume can vary with temperature.

Choosing the best type of airflow sensing can be a complicated process and this guide aims to help you select the best solution for your application.

There are many types of sensor mechanisms available to sense airflow including Vane sensor (VAF), Hot wire sensor (MAF), Cold wire, laminar flow etc. Where accuracy and reliability is paramount, such as medical applications, solid state sensors are the obvious choice.

Acal BFi provide solutions from world-leading sensor manufacturer Honeywell which are featured in this guide.

Measuring airflow

Typical units to express airflow are:

By volume

- l/s (litres per second)
- m^3/s (cubic metres per second) SI unit
- m^3/h (cubic metres per hour)
- SCCM (standard cubic centimetres per minute)
- SLPM (standard litres per minute)
- Ft^3/s (cubic feet per second)

By mass

- kg/s (kilograms per second) SI unit

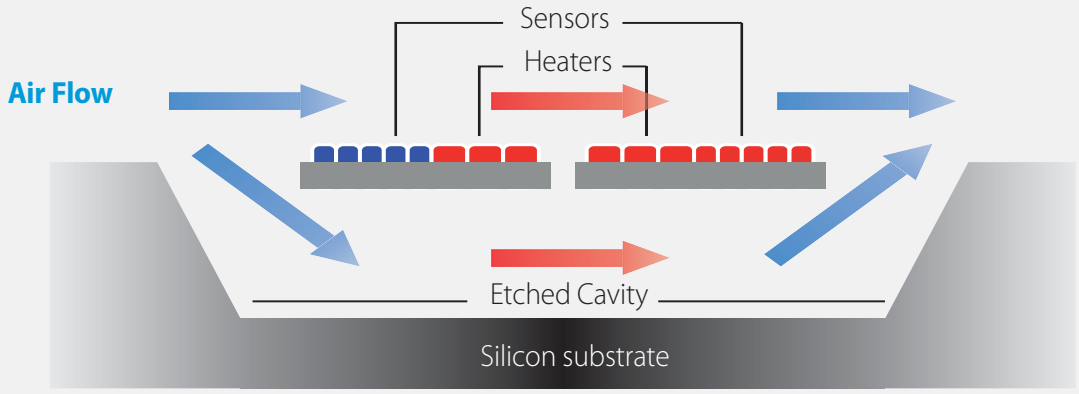
Mass and volume are linked by density:

$$\text{Volume flow rate } m^3/s = \frac{\text{mass flow rate Kg/s}}{\text{density Kg/m}^3}$$

consult. design. integrate.

Basics of operation

Honeywell microbridge mass airflow sensors detect mass airflow caused by heat transfer. The thermally isolated microbridge structure consists of a heater resistor positioned between two temperature-sensing resistors.



The heater resistor maintains a constant temperature, 160°C above ambient, during sensor operation. Airflow moving past the chip transfers heat from the heater resistor. This airflow warms the downstream resistor and cools the upstream resistor. The temperature change and the resulting change in resistance of the temperature resistors is proportional to the mass airflow across the sensing element.

The MEMS sensing die is located in a precise and carefully designed airflow channel to provide repeatable response to flow. This provides rapid response to the air or gas flow, amount and direction. Output voltage varies in proportion to the flow of air or gas through the package.

Temperature-compensated digital and analogue output versions are available, with analogue versions available as amplified, to provide an enhanced output signal and less external circuitry, and unamplified versions allowing additional external circuit options. A variety of port styles provide application flexibility.

Flow measurement using differential pressure is also available on certain ranges.

Custom and extended temperature ranges are possible, please contact us for details.

Honeywell offer two ranges of airflow sensors:

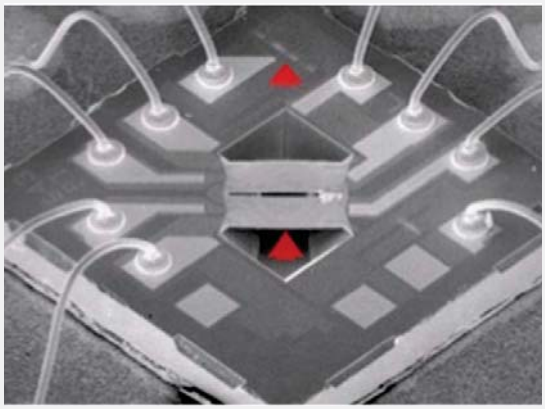
1. Zephyr HAF series

a. High accuracy ±50 SCCM to ±750 SCCM with either
   i. Analogue output
   ii. Digital output

b. High accuracy 10 SLPM to 300 SLPM
   i. Digital output only

2. AWM series

a. 25 SCCM to 300 SLPM
   i. Analogue output only



consult. design. integrate.

Honeywell Zephyr™ HAF series ±50 to ±750SCCM (digital or analogue)

Honeywell

Honeywell Zephyr™ HAF Series sensors are available as either a digital (I^2C) or analogue output for reading airflow over specified full-scale flow and compensated temperature ranges. The thermally isolated heater and temperature sensing elements provide a fast response to air or gas flow.

Long port fastener mount

Short port fastener mount

Short port snap mount

Zephyr™ HAF sensors are designed to measure mass flow of air (bi-directional) and other non-corrosive gases. Five standard flow ranges are available at ±50, ±100, ±200, ±400 and ±750 SCCM. Custom flow ranges are also available. The sensors are fully calibrated and temperature compensated (from 0°C to 50°C and operates across a temperature range of -20°C to 70°C) with an onboard Application Specific Integrated Circuit (ASIC) providing a response time of 1 ms.

The combination of rugged housings with a stable substrate makes these products extremely robust and suitable for the following applications:

Medical: anesthesia delivery machines, ventricular assist devices (heart pumps), hospital diagnostics (spectrometry, gas chromatography), nebulizers, oxygen concentrators, patient monitoring systems (respiratory monitoring), sleep apnea machines, spirometers, ventilators and laparoscopy.

Industrial: air-to-fuel ratio, analytical instrumentation (spectrometry, chromatography), fuel cells, gas leak detection, VAV system on HVAC systems, gas meters and HVAC filters.

Nomenclature and order guide

Example showing Honeywell Zephyr™ digital airflow sensor HAFBLF0200C4AXS

Product Series	Flow Direction	Port Style	Housing Style	Flow Range	Unit	Output Format	Transfer Function	Reserved for Future use	Supply Voltage
HAF	B	L	F	0200	C	4	A	X	5
HAF Series high accuracy airflow sensor	U Bidirectional forward flow optimised S Bidirectional symmetric	L Long port S Short port	F Fastener mount S Snap mount	0050 50 long port style only 0100 100 long port style only 0200 200 long port style only 0400 400 long port style only 0750 750 long port style only	C SCCM	A Analogue 4 Digital I^2C address 0x49 5 Digital I^2C address 0x59 6 Digital I^2C address 0x69 7 Digital I^2C address 0x79	A 10% to 90% of Full Scale Output (FSO)	X XXXXX	3 3.3Vdc 5 5.0Vdc

consult. design. integrate.

Honeywell Zephyr™ HAF series – high accuracy 10 to 300 SLPM (digital)

Honeywell Zephyr™ HAF Series sensors provide a digital (I^2C) interface for reading airflow over specified full-scale flow and compensated temperature ranges. The thermally isolated heater and temperature sensing elements help these sensors provide a fast response to air or gas flow.

Manifold mount

22 mm OD tapered male fitting

G 3/8 female threaded fitting

Zephyr™ SLPM sensors are designed to measure mass flow of air (uni-directional) and other non-corrosive gases. Seven standard flow ranges are available 0-10 SLPM, 15 SLPM, 20 SLPM, 50 SLPM, 100 SLPM, 200 SLPM or 300 SLPM, with custom flow ranges available. The sensors are fully calibrated and temperature compensated (0°C to 50°C) with an onboard Application Specific Integrated Circuit (ASIC) providing a response time of 1 ms.

The combination of rugged housings with a stable substrate makes these products extremely robust and suitable for:-

Medical: anesthesia delivery machines, ventilators, ventricular assist devices (heart pumps), spirometers and laparoscopy.

Industrial: air-to-fuel ratio, analytical instrumentation (spectrometry, chromatography), fuel cells, fume hoods, gas leak detection, process control gas monitoring and vacuum pump monitoring.

Nomenclature and order guide

Example showing Honeywell Zephyr™ airflow sensor HAFUHM0020L4AXT

HAF	U	HM	0020	L	4	A	X	T
Product Series	Flow Direction	Port Style	Flow Range	Unit	Output Format	Transfer Function	Reserved for Future Use	Supply V oltage
HAF Series high accuracy airflow sensor	**U** Unidirectional	**HM** Manifold mount	**0010** 10	**L** SLPM	**2** Digital I^2C address 0x29	**A** 10% to 90% of input	**X** XXXXX	**T** 3 Vdc to 10 Vdc
		HH 22 mm OD tapered male fitting per ISO 5356	**0015** 15		**3** Digital I^2C address 0x39			
		HT G 3/8 female threaded fitting per ISO 1179	**0020** 20		**4** Digital I^2C address 0x49			
			0050 50		**5** Digital I^2C address 0x59			
			0100 100		**6** Digital I^2C address 0x69			
			0200 200		**7** Digital I^2C address 0x79			
			0300 300					

consult. design. integrate.

AWM Series overview (analogue)

Honeywell

AWM 700

AWM 1000
AWM 2000
AWM 3000

AWM 5000

AWM 40000

AWM 90000

AWM 700 series mass airflow sensors provide in-line flow measurement with specially designed bypass flow housing. The sensors measure flow as high as 200 SLPM while inducing a pressure drop of 1 inch H_2O, typically. The AWM700 has a high-flow-range capability in a small package.

AWM 1000/2000/3000 feature a specially designed housing that precisely directs and controls the airflow across the microstructure sense element. Mechanical design of the package allows it to be easily mounted to printed circuit boards. The AWM1000 series mass flow sensor provides all of the performance benefits of the standard AWM2000 series in a more cost-effective sensor platform. Mass flow and low differential pressure sensing versions are available.

AWM 5000 high flow mass airflow in-line flow measurement sensors feature a venturi type flow housing. They measure flow as high as 20 SLPM while inducing a maximum pressure drop of 2.25 inches H_2O. The microbridge chip is in direct contact with the flow stream, greatly reducing error possibilities due to orifice or bypass channel clogging. The rugged plastic package has been designed to withstand common mode pressures up to 50 psi, and the small sensing element allows 100 gs of shock without compromising performance. The "AMP" compatible connector included provides reliable connection in demanding applications.

AWM 40000 series feature manifold mount with o-ring seals and either a ceramic flow-tube (non-outgassing) rated to 0-1000 SCCM or plastic flow tube rated to 0-6 SLPM. The ceramic tube version can withstand high common mode pressure (150 psi max). The AWM 40000 has high stability at null and full-scale.

AWM 90000 is available in two versions, mass flow ±200 SCCM and differential pressure ±2 inches H_2O. The AWM 90000 Series operate with a supply voltage from 8.0 Vdc to 15.0 Vdc, while consuming only 50 mW of power making it well suited for use in portable devices and battery powered applications. The compact plastic package will withstand a maximum overpressure of 1720 mbar 72 kPa without compromising performance.

Key factors in selecting airflow sensors

When considering an airflow sensor application the selection process involves a series of choices to meet requirements. Here we list key considerations.

- **Airflow range** – the maximum and minimum flow rates to be measured.
- **Air or gas being measured** – (media capability) the nature of the gas and its effect on measurement. Airflow sensors are usually calibrated for dry, clean air or nitrogen, and other gases will perform differently. Therefore gas correction factors or specially calibrated versions may be required.
- **Flow direction** – one (uni-directional) or two way (bi-directional) airflows to be measured.
- **Common mode pressure** – the maximum line pressure which is common to both ports.
- **Connection and port styles** – tube diameters, manifold, G3/8 thread and sealing needs.
- **Temperature range** – both compensated and operational ranges of the sensing.
- **Total Error Band (TEB)** – the maximum deviation in output from ideal transfer function over the entire compensated temperature and flow range.
- **Accuracy** – the maximum deviation measured over the compensated flow range due to all errors from null output, flow non-linearity, span errors, flow hysteresis and non-repeatability.
- **Output** – digital or analogue, and amplified or un-amplified.
- **Supply voltage** – the voltage available or required to operate the device.
- **Power consumption** – low current draws for battery-powered applications.

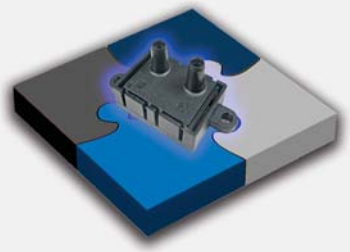
Typical Honeywell airflow sensor applications

Medical

- Anesthesia delivery machines
- Ventricular assist devices (heart pumps)
- Hospital diagnostics (spectrometry, gas chromatography)
- Nebulizers
- Oxygen concentrators
- Patient monitoring systems (respiratory monitoring)
- Sleep apnea machines
- Spirometers
- Ventilators

Industrial

- Air-to-fuel ratio
- Analytical instrumentation (spectrometry, chromatography)
- VAV system on HVAC systems
- Fuel cells
- Gas leak detection
- Gas meters
- HVAC filters
- Meteorology



consult. design. integrate.

Range overview

	Airflow sensors		AWM airflow sensors					
								
Type	**HAF series High accuracy** ±50 to ±750 SCCM	**HAF series High accuracy** 10 to 300 SLPM	**AWM1000**	**AWM2000**	**AWM3000**	**AWM5000**	**AWM700**	**AWM40000**
Airflow range	0 to ±50 SCCM 0 to ±100 SCCM 0 to ±200 SCCM 0 to ±400 SCCM 0 to ±750 SCCM	0 to 10 SLPM 0 to 15 SLPM 0 to 20 SLPM 0 to 50 SLPM 0 to 100 SLPM 0 to 200 SLPM 0 to 300 SLPM	0 to ±200 SCCM -6000 to 1000 SCCM ±5.0 mbar ±10.0 mbar	0 to ±30 SCCM 0 to ±1000 SCCM	0 to ±30 SCCM 0 to ±200 SCCM 0 to ±1000 SCCM or 0 to 1.25 mbar 0 to 5.0 mbar 5.0 mbar	0 to 5 SLPM 0 to 10 SLPM 0 to 15 SLPM 0 to 20 SLPM	0 to 200 SLPM	0 to ±25 SCCM 0 to ±1 SLPM 0 to 1 SLPM 0 to 6 SLPM
Bi-directional or uni-directional	Bi	Uni	Bi	Bi	Uni	Uni	Uni	Bi or Uni
Calibration gas	Nitrogen	Clean dry air	-	-	Nitrogen	Nitrogen CO^2 Argon	Air	Nitrogen
Common mode pressure	25 psi	60 psi	25 psi	25 psi	25 psi	50 psi	25 psi	150 psi
Post options	Long port fastner mount Short port fastner mount Long port snap mount	Manifold mount 22mm OD tapered male fitting G3/8 female threaded fitting	Straight	Straight	Straight	1/4In - 18NPT	22mm tapered	Manifold mount
Compensated temperature	0 to 50˚C	0 to 50˚C	-25 to 85˚C	-25 to 85˚C	-25 to 85˚C	0 to 50˚C	10 to 40˚C	-25 to 85˚C
Operating temperature	-20 to 70˚C	-20 to 70˚C	-25 to 85˚C	-25 to 85˚C	-25 to 85˚C	-25 to 70˚C	-25 to 85˚C	-40 to 125˚C
Total Error Band (TEB)	±0.25% FSS	0.5% FS	-	-	-	-	-	-
Output	Analogue or digital (I^2C)	Digital (I^2C)	Analogue	Analogue	Analogue	Analogue	Analogue	Analogue
Signal conditioning	Amplified, compensated	Amplified, compensated	Unamplified, compensated	Unamplified, compensated	Amplified	Amplified	Amplified	Amplified, unamplified (compensated)
Supply voltage VDC	3.3 to 5.0	3Vdc to 10Vdc	8 to 15 (10 Typ)	8 to 15 (10 Typ)	8 to 15 (10 Typ)	8 to 15 (10 Typ)	8 to 15 (10 Typ)	8 to 15 (10 Typ)
Power consumption	23 to 38mW digital 40 to 55mW analogue	60mW at 3V dc 200mW at 10V dc	30mW typical	30mW typical	50mW or 100mW	100mW Max	60mW Max	60mW or 75mW
Features	TEB as low as ±0.25% Fast response time Wide airflow range Linear output Very low flow sensitivity	Fast response time High sensitivity Wide airflow range 12 bit resolution Factory or custom calibration	Mass flow and low differential pressure sensing Cost effective Interchangability	Mass flow and low differential pressure sensing Cost effective Interchangability	Mass flow and low differential pressure sensing Cost effective Interchangability	Onboard signal conditioning Venturiflow housing Rugged plastic package	Mass flow and differential pressure sensing Compact package design	Enhamced response time Low flow sensi-tivity Adaptable for higher flows

See our website for further information, www.acalbfi.com.

consult. design. integrate.