DART SENSORS LTD

Product data sheet: sensor for formaldehyde

Range	0 - 5 ppm
Overload	10 ppm
Filtering	Glass fibre
Expected life	5 years in non-corrosive atmosphere
Output signal	2000 nA/ppm
Temperature range	-20 to +40ºC
Pressure range	Withstands 10 atmospheres pressure
T90 response time	50 seconds at 20ºC
Relative humidity range	15% - 90% non-condensing
Typical baseline offset (20ºC)	0.02 ppm formaldehyde equivalent
Typical baseline offset (40ºC)	0.02 ppm formaldehyde equivalent
Typical long term output drift	< 10% per year
Interfacing requirements	Refer to datasheet
Repeatability	< +/- 2%
Output linearity	Refer to datasheet
Temperature coefficient of response	Refer to datasheet
Position sensitivity	None
Storage life	Two years at 20ºC
Warranty	Two years in non-corrosive atmosphere
Weight	10g
Dimensions	40mm x 35mm x 9.5mm

SENSITIVITY DATA	
Chemical	**Sensitivity (HCHO equivalent)**
100ppm Methanol	1
100 ppm Ethanol	1
100 ppm Isopropanol	0.5
100 ppm carbon monoxide	1
25 ppm Phenol	0.05
100 ppm Acetaldehyde	0.5
100 ppm H_2	0.5
50 ppm H_2S	3
50 ppm SO_2	0.5

ISO 9001 Registered

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Smart Funding Innovation

Introduction

The Dart sensor for environmental monitoring of formaldehyde is a true continuous monitoring sensor which does not need a sampling system or the taking of pumped air samples. It has been derived from the well established breath alcohol sensor. It is an electrochemical sensor and is suitable for most ambient (-20ºC to 40ºC) uses. It has six desirable design features.

Low cost
Simple design, ease of construction and few parts enable competitive pricing.

Long life
It uses well-established components from breath alcohol sensors whose accuracy, stability and durability have been demonstrated world-wide in 30 years' experience.

Fast response
A short, low-resistance diffusion pathway enables a rapid reaction time.

Low power requirement
Fuel cell principle means no power requirement, electricity being consumed only in signal processing and display, so a compact unit using small batteries is possible.

Stability
Exceptional stability allows very long intervals between calibration checks.

Withstands high pressures
Being of membrane-less construction, it contains no fragile components to rupture under wide pressure swings, and it has been shown to withstand ten atmospheres pressure.

Since its introduction in 2006 we have made a number of improvements, and in particular have raised the sensitivity level which, in conjunction with its high specificity to formaldehyde, enables it to give meaningful results around the 0.08 ppm formaldehyde level.

How it works

The sensor chamber contains a conventional two-electrode fuel cell sensor. The working electrode liberates electrons via the external circuit to the counter electrode, where they are consumed by the reduction of oxygen. The internal circuit is completed by ionic flow within the electrolyte.

Careful design enables the ebb and flow of the electrolyte, which expands and contracts with changes in ambient temperature and humidity, to take place without affecting the calibration. A glass fibre filter assists the specificity towards formaldehyde.

Interfacing the sensor

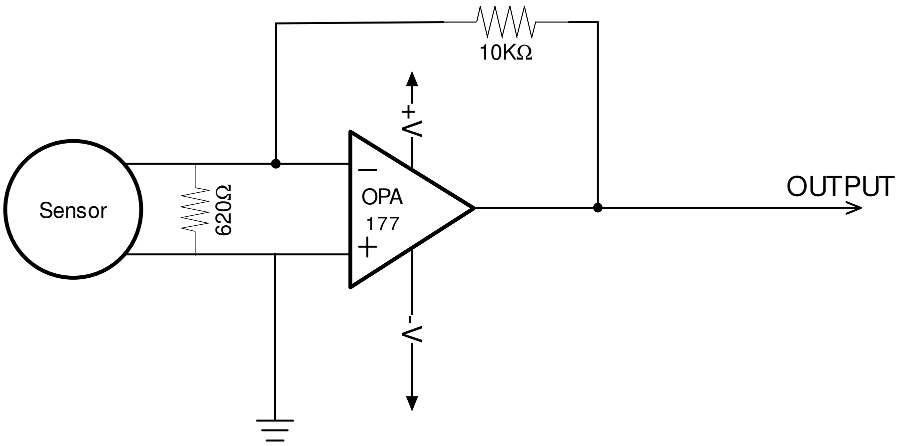
The Dart formaldehyde sensor will deliver a current with a linear relationship to high concentrations. This output will require amplification and, for greater accuracy, temperature compensation.

Amplification

The preferred method of amplification is to use an operational amplifier configured as a direct current-to-voltage amplifier. This will operate the sensor in its fastest possible mode. The gain is determined by the value of the feedback resistor: with a value of 1000 ohms, a sensor output of (say) 5 microamps will appear as an amplifier output of 5 millivolts.

A sensor left on open circuit will gradually develop an offset. No harm will be done but it may take some time to discharge on reconnection. For this reason, the output terminals are normally short-circuited during storage. There should be no significant permanent offset. In use, to avoid the build-up of an offset when the amplifier is switched off, a low value resistor (typically 620 ohms) can be placed permanently across the terminals. Alternatively, a good solution is to keep the amplifier permanently powered.

A typical basic op-amp circuit is shown below.

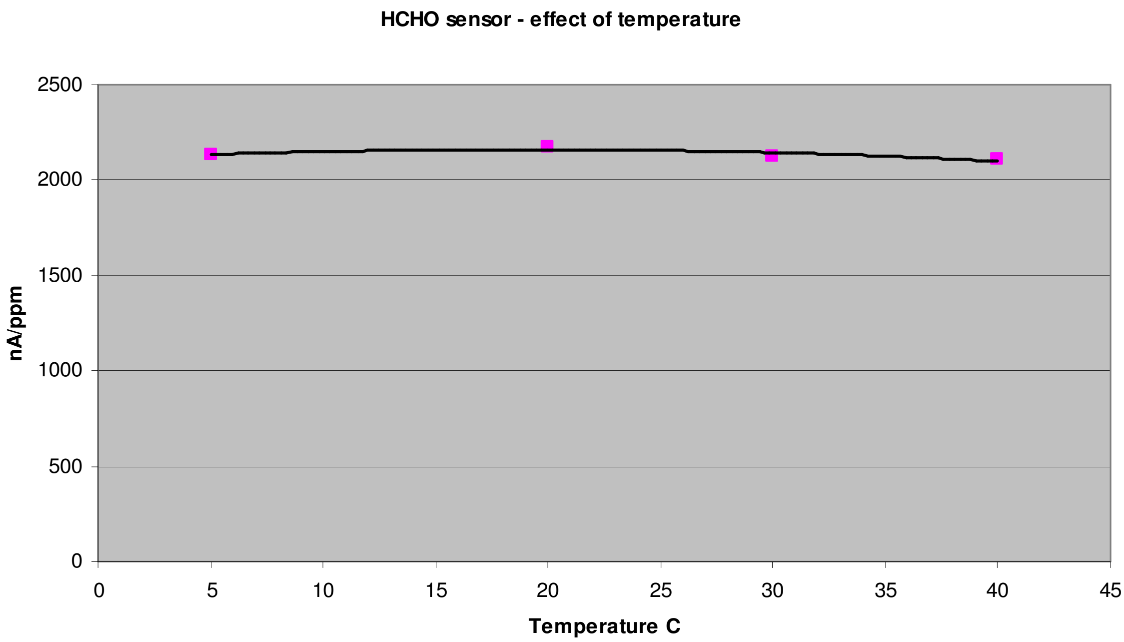


For very high sensitivity measurements the feedback resistance should be in the region of 470K, and a 4.7uF tantalum capacitor placed in parallel with it will reduce noise without adversely affecting response times.

Note that this circuit uses a dual rail power supply which gives the best results. The Burr-Brown OPA177 op-amp pictured is a good choice where power is not an issue. With battery power use a low power alternative such as the OPA 241. Both have very low intrinsic offsets but for exceptionally sensitive work, they have the facility for incorporating an offset trimmer to tune out residual offset.

Temperature compensation

The effect of temperature on the response of the formaldehyde sensor is shown below.



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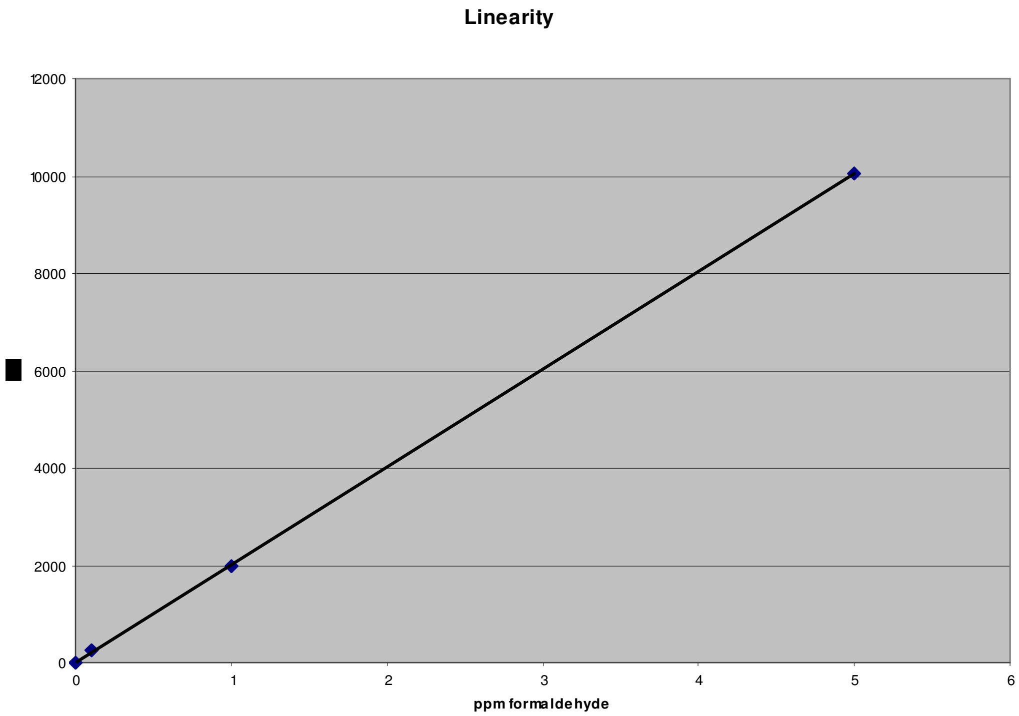
The effect of temperature within the normal ambient range is small enough to ignored for most applications. If however you want to achieve a high degree of accuracy, then you should apply a temperature-dependent compensation. Historically, in simple electrical circuits, this was achieved by incorporating a suitable thermistor with trimming series and parallel resistors in the op-amp feedback loop. If a microprocessor circuit is employed, thermistor driven compensation can be more accurately addressed in the software. A standard negative-coefficient thermistor will provide a suitable signal.

There are two components to the temperature-dependent behaviour:

1. The rate of diffusion of the gas increases with temperature.
2. Particularly at low temperatures, the efficiency of the electrocatalyst is impaired and this becomes the rate-determining factor.

Linearity

The formaldehyde sensor is linear to at least 5 ppm:



Configuration

The sensor housing is 35 mm square by 9.5 mm depth. It has four securing holes at the corners, and there is a recess on the face which will receive a 1.5 mm X 31 mm ID O-ring, to enable an airtight seal to be made to your instrument body. This will help prevent polluted air from getting behind the sensor, and subsequently re-emerging to give a false elevation of the reading.

Sensitivity

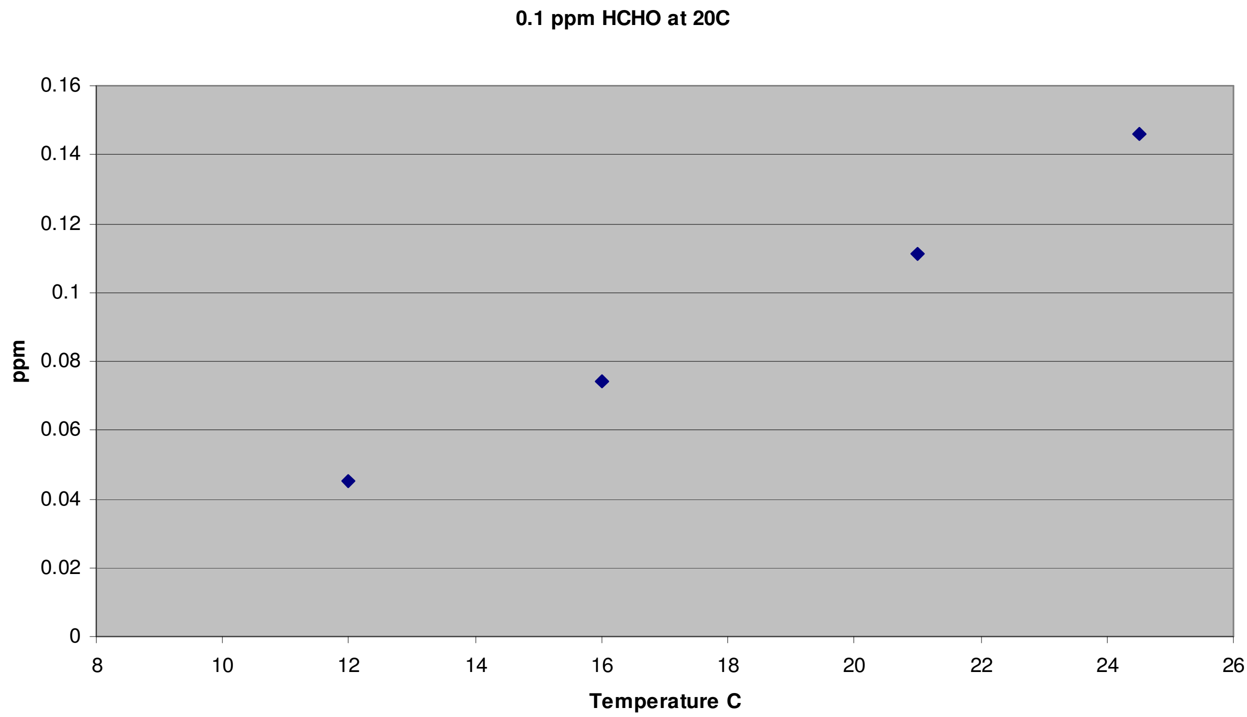
The sensitivity is determined principally by the diameters of the access aperture on the face of the sensor: the bigger the hole and the more of them, the more gas can diffuse into the sensor and hence the bigger the signal. The standard arrangement currently is a single central hole of 2 mm diameter. The aperture should be chosen to give an adequate signal-to-noise ratio, but excessive amounts of gas sample should be avoided to prevent problems with non-linearity, slowness of clean-up etc.

Cross-sensitivities

Refer to the table on page 1. Gases and vapours to which the sensor is not inherently sensitive include: saturated and aromatic hydrocarbons such as toluene; acetone, ammonia, nitrogen, oxygen, chlorine, water vapour, and carbon dioxide.

Calibration

The standard calibration method for formaldehyde instruments is the Permeation Tube. However, we have developed and offer a simple alternative headspace method based on the liquid standard concept widely used in the breath alcohol industry. This relies on the fact that at a particular temperature, the partition of a volatile substance between an aqueous solution and the air headspace above it is a constant. We offer two concentrations, 0.1 and 1.0 ppm at 20C. The basis for these solutions is data published on the US Environmental Protection Agency web site (unfortunately the link no longer works). The solutions may be thermostatted at 20C, alternatively the following calibration curves may be employed to correct values for temperature.



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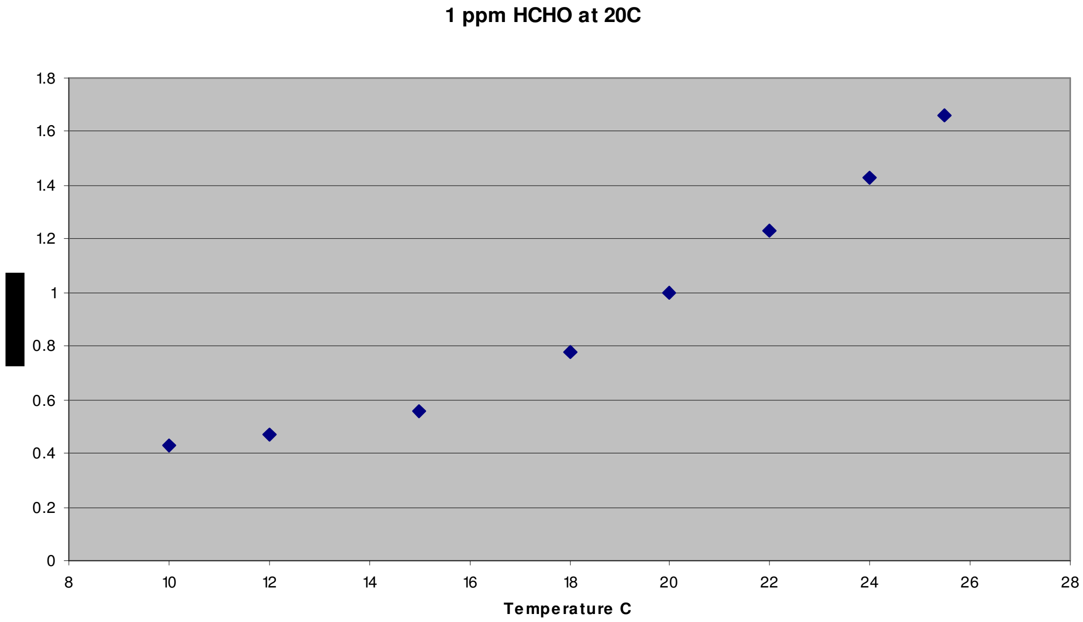

Further information

Dart Sensors products are subject to continuous improvement and the specification is liable to change from time to time as a result of further development and customer feedback.

Dart Sensors gives full technical support to users of its products. If you have any queries which have not been addressed above please contact us at

customer.service@dart-sensors.com