

TC-1326 MEMS thermal conductivity sensor is a low power, extremely robust device especially suited to detect hydrogen as hydrogen possesses the highest thermal conductivity of all known gases. It is therefore possible to detect low concentrations of hydrogen in air by the increase of thermal conductivity of hydrogen-air mixture.

Whilst being optimised for its hydrogen and methane response (0 to 100% volume in air), TC-1326 will also detect other gases and vapours as long as thermal conductivity difference compared to reference (air) is sufficient.

FEATURES

- Low power – designed for battery operation
- Small size (dual package of 5x5x2 mm)
- High resistance to mechanical shocks
- Low orientation effect

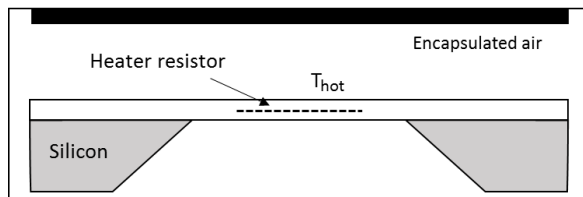
OPERATING PRINCIPLE

The elements operate on the thermal conductivity principle. The sensing element is open to the atmosphere under test and the reference element is supplied sealed in reference air in a second similar package. The response of the devices is dependent upon the difference between the thermal conductivity of the atmosphere under test and the reference air. When the atmosphere under test has a thermal conductivity higher than the reference air, the sensing element loses more heat to the surroundings than the reference element. This increased heat loss causes a cooling of the sensing element and a subsequent reduction in the resistance of the sensing element compared to the reference element.

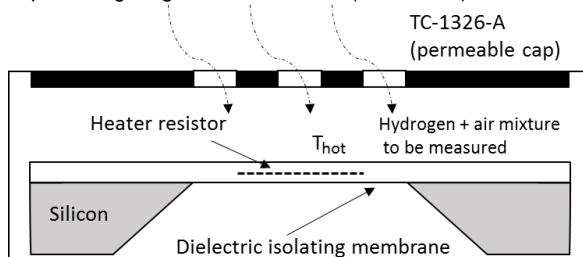
Two identical MEMS devices are glued on separated ceramic headers and wire bonded.

The reference element TC-1326-AS is covered with a sealed metal cap and encapsulated in reference air.

TC-1326-AS (sealed cap) – used as reference



The sensing element TC-1326-A is covered with a perforated metal cap allowing air/gas mixture access (here below).

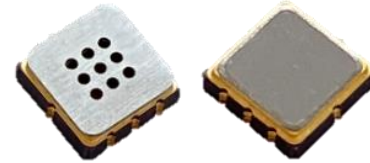


The silicon TC structure consists of accurately micro machined diaphragm with an embedded planar heater resistor meander.

High sensor efficiency is achieved by minimizing heat losses through the membrane.

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TC-1326-A/TC-1326-AS MEMS Thermal Conductivity Sensor Elements

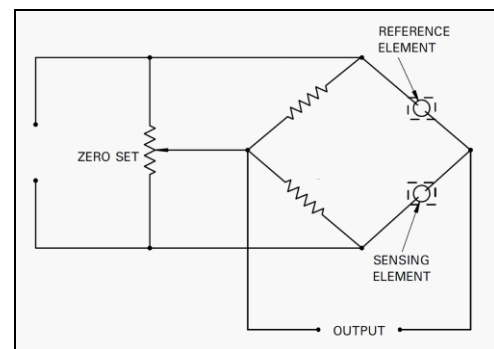


The thermal conductivity of a gas mixture is dependent on temperature and the individual thermal conductivity of the constituents of the mixture. The temperature of importance is the operating temperature of the sensing element (typically a maximum of 450 °C at the recommended bridge supply voltage). The sensor can be operated at any bridge voltage up to and including the recommended bridge supply, with the sensing element therefore running at temperatures up to and including the typical maximum. The thermal conductivity of some of the more common gases relative to air is tabulated on page 5 at various temperatures. Note that when operating the sensor in a constant voltage mode the response will be non-linear to increasing concentrations of a gas. The heater meanders acts both as electrical heaters and as resistance thermometers. The two silicon structures are then used in a circuit that detects the difference in their resistances.

OPERATION

It is recommended that the reference and the sensing elements be run in a Wheatstone bridge circuit so that a difference signal may be obtained.

A suitable circuit is shown below. In use, the bridge supply voltage should be stable to within + 0.05 V, or the output in clean air may change in sympathy. Although it is generally recommended that thermal conductivity sensors should be run with a constant voltage supply to the bridge, it is possible to use a constant current supply provided that the voltage across the bridge in clean air remains within the recommended limits.



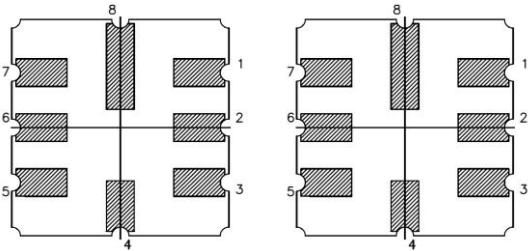
Recommended circuit diagram

SENSOR CONFIGURATION

The internal connections are shown below.

Pin	Connection
A-1	NC
B-2	Pin 2
C-3	NC
D-4	NC
E-5	NC
F-6	NC
G-7	Pin 1
H-8	NC

B and G are the two pins of the single silicon structure MEMS for TC-1326-A and for TC-1326-AS (Purely ohmic resistors, not polarized)



Bottom view of TC-1326-A and TC-1326-AS

GENERAL DATA

This information relates to the device operating continuously in the recommended bridge circuit

Operation (see note 1)continuous or in cycle mode

Bridge supply voltage (see note 2) 2.9 to 3.1V

Sensor current (at $3.0 \pm 0.1V$) 36 to 42 mA

Minimum sensitivity (see note 3) 5 mV/% hydrogen

Zero offset range in air (at $3.0 \pm 0.1V$) ± 20 mV max

Response time (t_{90}) (see note 4)

MAXIMUM RATINGS (Absolute values)

Input voltages between pins:
pins B and G. 1.55 V

Operation, storage in original packaging and shipping:
Temperature -40 to +125 °C

Humidity 0 to 95%RH non-condensing

NOTES

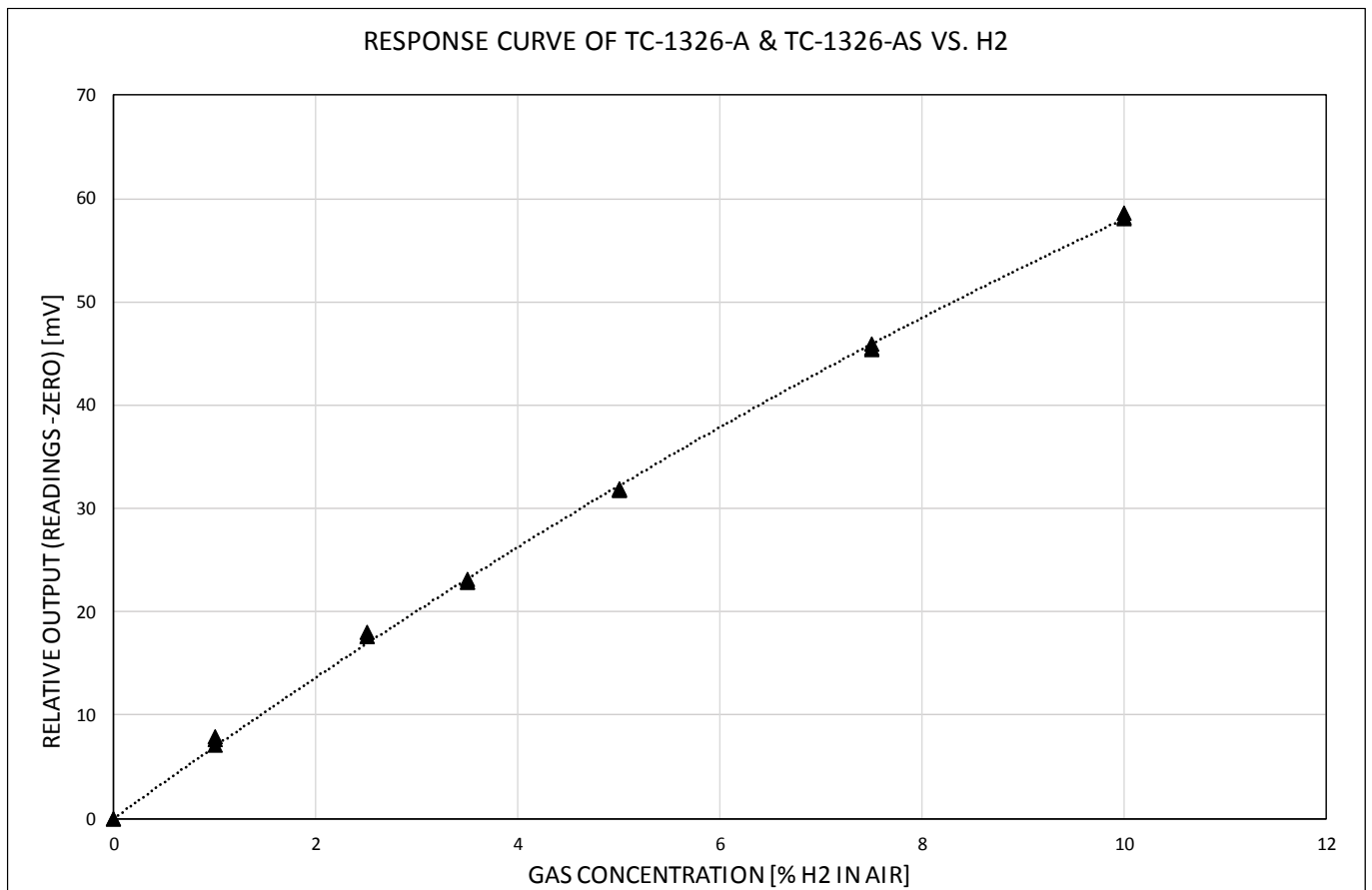
1. Because of intrinsic low thermal mass, TC elements can be heated up in less than 100 ms. This allows periodic measurement with 10% duty cycle and 1 second periodicity leading to an average power consumption < 15 mW.
2. The polarity of the supply voltage may be reversed without harm. The only effect is to reverse the polarity of the output signal.
3. Measured at 3.0 ± 0.1 V using 1% hydrogen in an SGX test manifold.
4. The response time is a function of the type of mounting used.

IMPORTANT PRECAUTIONS AND NOTES

Read the following instructions carefully before using the TC-1326-A and TC-1326-AS described in this document to avoid erroneous readings and to prevent the device from permanent damage.

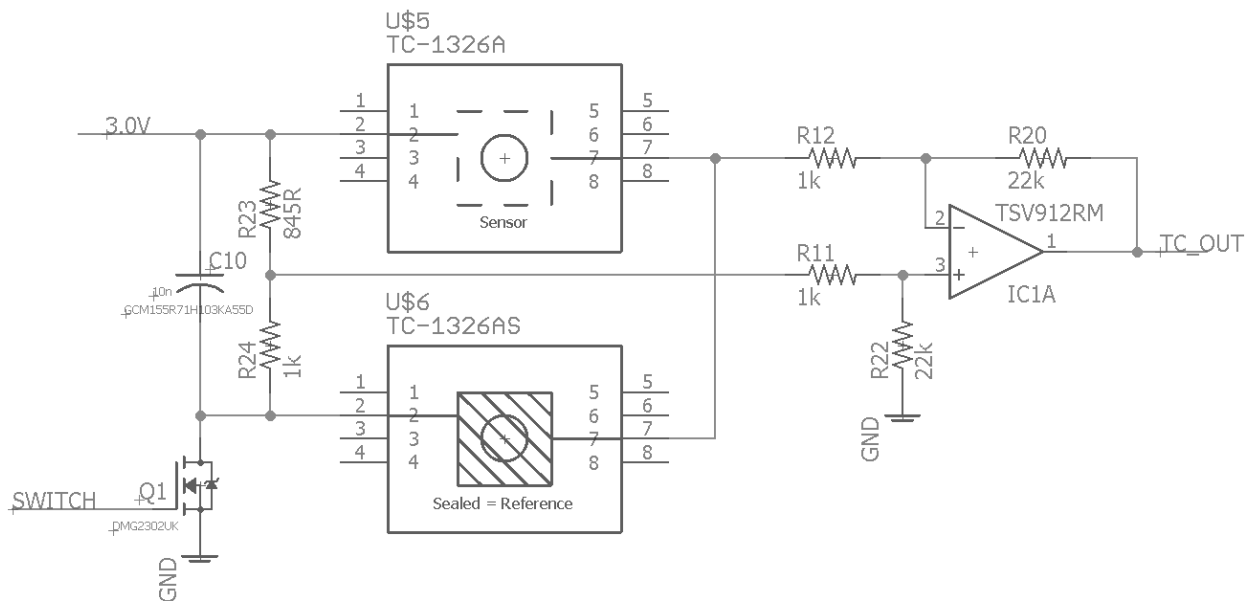
- Heater voltages above the specified maximum rating will destroy the MEMS heaters due to overheating.
- When operating the sensor in a constant voltage mode the response will be non-linear to increasing concentrations of a gas. This non-linearity can be easily handled using curve fitting (e.g. a quadratic response) or using look-up tables.
- Since no catalytic processes are occurring, the sensor does not poison in atmospheres containing poisons such as organic silicones. However, some changes to the sensor response may be seen if decomposition of species onto the sensing element causes a change in the sensing operating resistance/temperature.
- Again, since no catalytic processes are occurring, the sensor does not need oxygen to work.
- Changes in the humidity and pressure of the target gas will affect the rate of heat loss from the sensing element and hence the sensor zero. In practice, however, the effect is not significant and can be compensated with extra sensors.
- It's recommended to use a clean process with no particles during assembly of the sensor
- Detector and reference should be mounted one next to another so they are exposed to the same temperature at the same time
- It's recommended mount the sensor vertically to avoid water accumulation in case of condensation when the sensor is not powered
- For any additional questions or further information, contact SGX directly.
info.em@sgxsensortech.com

TYPICAL BRIDGE OUTPUT FOR HYDROGEN-IN-AIR MIXTURES

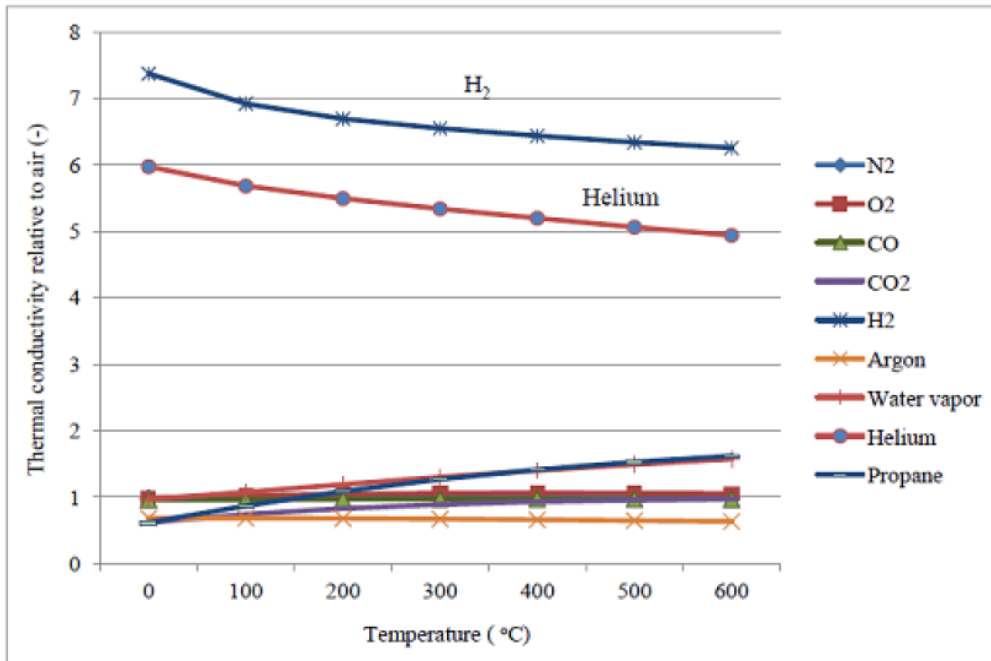


APPLICATION CIRCUIT EXAMPLE

Wheatstone bridge output can be linked to an instrumentation amplifier in order to interface TC-1326 output.

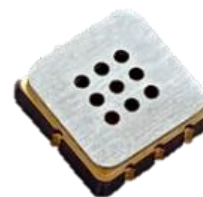
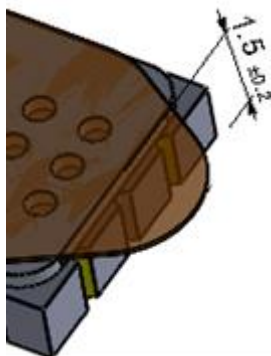
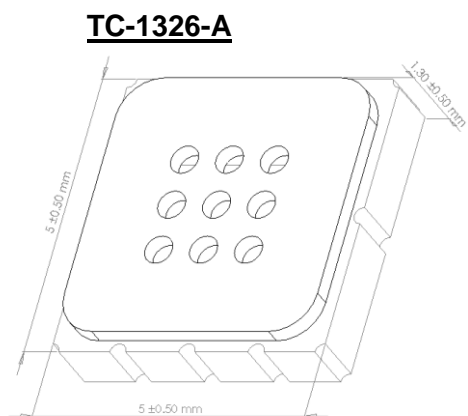
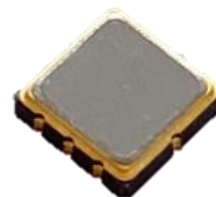
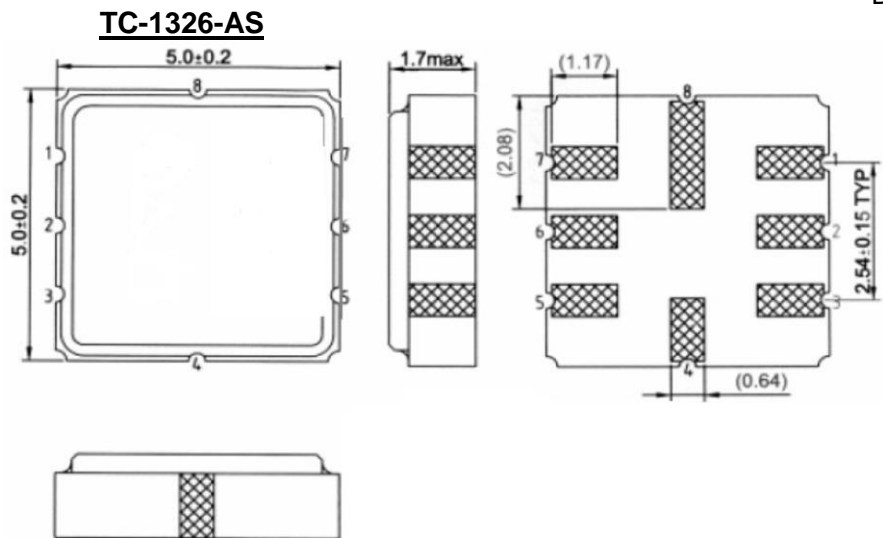


The detection of hydrogen in the gas mixture mentioned in automotive application by means of a thermal conductivity measurement is based on the large thermal conductivity difference between hydrogen and other component gases. The thermal conductivity of these gases is shown in below chart. Due to the dependency of the thermal conductivity on the gas temperature, the thermal conductivity of the hydrogen gas mixture also depends on gas temperature as seen here below

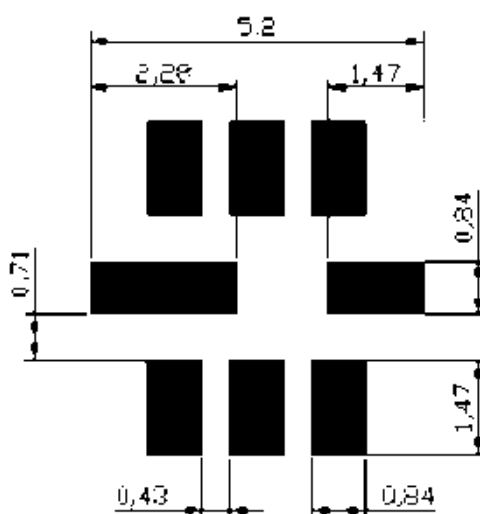


PACKAGE OUTLINE DIMENSIONS

All dimensions in mm
Dimensions without limit are nominal



PADS OUTLINE DIMENSIONS



INSTRUCTIONS SPECIFIC TO HAZARDOUS AREA INSTALLATIONS

1. The TC-1326 Gas Sensor has not been assessed as a safety device (EHSR 1.5).
2. There are no user-serviceable parts in the component.

THERMAL CONDUCTIVITY OF GASES (Relative to air)

Element temperature	0 °C	100 °C	200 °C	300 °C	400 °C	500 °C	600 °C
Air	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Nitrogen	0.996	0.993	0.997	0.999	0.998	0.994	0.988
Oxygen	0.987	1.026	1.049	1.062	1.065	1.062	1.056
Argon	0.686	0.687	0.682	0.674	0.663	0.650	0.636
Carbon dioxide	0.621	0.745	0.832	0.893	0.933	0.959	0.975
Water vapour	0.969	1.076	1.192	1.303	1.404	1.493	1.574
Methane	1.244	1.500	1.723	1.911	2.066	2.192	2.296
Ethane	0.742	1.027	1.271	1.474	1.638	1.769	1.874
Propane	0.619	0.874	1.092	1.271	1.415	1.529	1.619
Carbon monoxide	0.961	0.962	0.970	0.975	0.976	0.974	0.970
Ethylene	0.703	0.970	1.195	1.378	1.524	1.637	1.727
Acetylene	0.886	1.040	1.155	1.240	1.301	1.344	1.376
Hydrogen	7.371	6.918	6.692	6.548	6.435	6.336	6.252
Helium	5.972	5.681	5.492	5.338	5.197	5.062	4.939
Ammonia	1.082	1.295	1.493	1.670	1.824	1.955	2.069