FES SENSOR
TECHNOLOGY GMBH

H2-CNI 4-20mA

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Hydrogen Sensor with 4-20 mA Transmitter

1. FEATURES

- Detection of hydrogen levels up to 50% LEL with 0.25 % resolution in air
- No sensitivity against typical catalyst poisons such as volatile siloxanes and carbon monoxide
- Fast response and recovery times
- No humidity-induced base line drift
- Applicable in relative humidity (rh) between 0 % to 100 %
- Ambient temperature range -10 to +80 °C (optional: other temperature ranges)
- Linear output up to 100 % LEL
- On-board sensor electronics
- 4-20 mA current-loop transmitter with reverse voltage operation and over-voltage surge protection

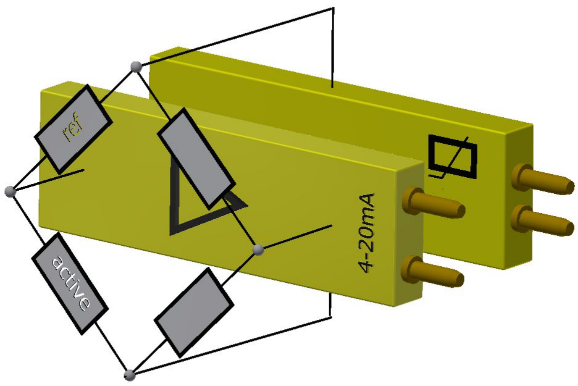
2. APPLICATION

- Warning systems

3. DESCRIPTION

H2-CNI 4-20mA is a four-pin calorimetric hydrogen sensor with a catalytically highly active and siloxane-resistant sensor element and is based on a non-isothermal calorimetric operation principle. It contains on-board electronics to reduce the effect of ambient temperature changes on hydrogen sensitivity, featuring a secure 4-20 mA current interface. It is designed for use in a variety of applications which require a warning signal in the presence of potentially dangerous hydrogen concentrations in the ambient air.

4. SIMPLIFIED SCHEMATIC



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5. REVISION HISTORY

Date	Rev.	
June 24, 2021	1.0	Initial Version
Sep. 3, 2021	1.1	Figure 9 changed to 4, Figure 5 replaced
Nov 6, 2021	1.2	Table 7.5: steel grade added. Table 7.7: revised operational temperature. Section 9 (Typical performance characteristics) revised.

6. PIN CONFIGURATION AND FUNCTION

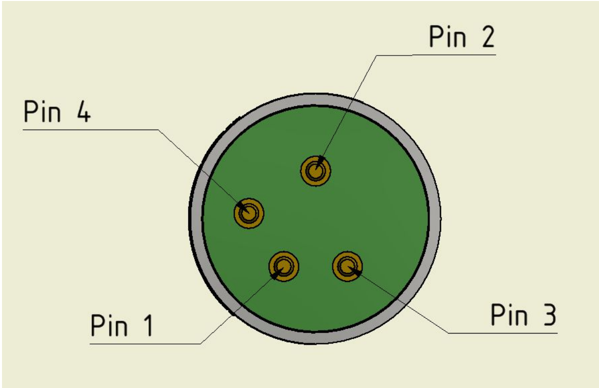

Figure 1: Bottom view of sensor

PIN NO.	DESCRIPTION
1	+12 V positive supply voltage with respect to ground
2	Current output connect to 0 V of the current loop*
3	Ground of the internal electronics. The pin is electrically not connected to the housing
4	Current input connect to +24 V of the current loop*
	* Must be galvanically decoupled from the supply voltage. No common mass is allowed.

7. SPECIFICATIONS

7.1. ABSOLUTE MAXIMUM RATINGS

At ambient temperature T_a = 20 °C.

Input supply voltage	+15 V
Storage temperature	-40°C to 100 °C

7.2. ESD CAUTION

ESD (electrostatic discharge) sensitive device. Although this product features protection circuitry, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

7.3. HANDLING RATINGS

The sensor must not subjected to severe shocks which might result from suddenly applied forces or abrupt changes in motion. They may cause permanent damage to the device.

7.4. RECOMMENDED OPERATING CONDITIONS

At ambient temperature T_a = 20 °C (unless otherwise noted).

	MIN	NOM	MAX	UNIT
Input supply voltage	+9	+12	+15	V
Load resistor between pin 2 and pin 4		≥ 100		Ω

7.5. MECHANICAL

Housing material	Stainless steel
Potting	Polyurethane
Weight	15 g
Diameter	20.0 mm
Height (housing)	16.6 mm
Height (overall)	21.0 mm
Pins	Gold over nickel
Pin diameter	1.57 mm
Pin length	4.78 mm

7.6. ELECTRICAL

Supply current	43 mA @ 20 °C
Current loop voltage	≤ 24 V

7.7. ENVIRONMENTAL

Ambient temperature range during operation1)	-10 to +80 °C
	1) Optional other temperature regimes within a range of -40 °C to 20 °C available
Operation humidity	0 … 100 % r.h.

7.8. SENSOR PARAMETERS

Signal at 50% LEL	18 mA (typical)
Resolution	< 0.25 % LEL
Linearity	8 mA/(1 vol-% H_2) at 20 °C
Response time	< 5 s
Thermal zero point drift	< 0.02 mA/°C

7.9. SENSOR CROSS SENSITIVITIES

Gas / Vapor	Chemical Formula	Concentration Applied	Output $I_{Signal, Gas} - I_{Signal, air}$ (mA)
Methane	CH_4	0 to 99.99 vol-%	0
Ethane	C_2H_6	0 to 99.95 vol-%	0
Propane	C_3H_8	0 to 30 vol-%	0
Butane	C_4H_{10}	0 to 70 vol-%	0
Ammonia	NH_3	0 to 5 vol-%	0
Chlorine	Cl_2	0 to 5 vol-%	0
Carbon dioxide	CO_2	1 vol-%	0
Carbon monoxide	CO	1500 ppm	0
Nitrogen dioxide	NO_2	5 ppm	0
Nitrogen monoxide	NO	15 ppm	0

7.10. EFFECT OF PRETREATMENTS OF THE SENSOR TO SILOXANES

OCTAMETHYLCYCLOTETRASILOXANE ($C_8H_{24}O_4SI_4$)

A laboratory beaker with 100 g $C_8H_{24}O_4Si_4$ (98%) is heated to 250 °C in a 2-liter glass together with the sensor for one hour. The sensor is tested with 2 vol-% H_2. A 12% decline of the sensor signal is found with respect to the initial signal.

HEXAMETHYLDISILOXANE ($C_6H_{18}OSI_2$)

A laboratory beaker with 40 ml $C_6H_{18}OSi_2$ is placed with in a 2-liter glass together with the sensor for one hour. The sensor is tested with 2 vol-% H_2. A 15% decline of the sensor signal is found with respect to the initial signal.

8. TYPICAL PERFORMANCE CHARACTERISTICS

All data presented below are acquired in an automated gas mixing system with mass flow controllers and pressurized gas bottles with synthetic air (21 vol-% oxygen in nitrogen) and calibrated hydrogen mixtures (5 vol-% H_2 in nitrogen). The relative humidity is adjusted by adding appropriate water-saturated gas flows. Ambient temperatures are adjusted in a climatic test chamber.

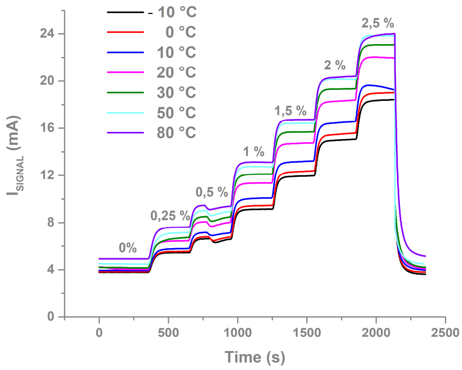

Figure 2. Typical values of the signal transient (I_{SIGNAL}) upon hydrogen exposure in synthetic dry air at temperatures between -10 and +80 °C and a total flow of 50 sccm/min.

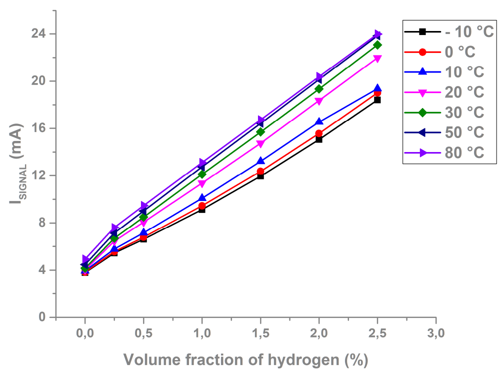

Figure 3. Typical values of the sensor signal as a function of volume fraction of hydrogen (%) in synthetic dry air at at temperatures between -10 and +80 °C and a total flow of 50 sccm/min.

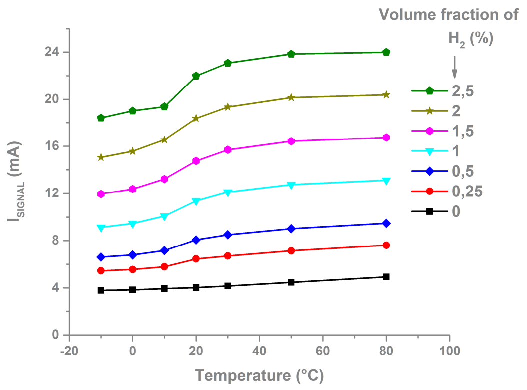

Figure 4. Typical values of the sensor signal as a function of temperature in synthetic air (black curve) and at volume fractions of hydrogen (%) between 0.25 and 2.5 %.

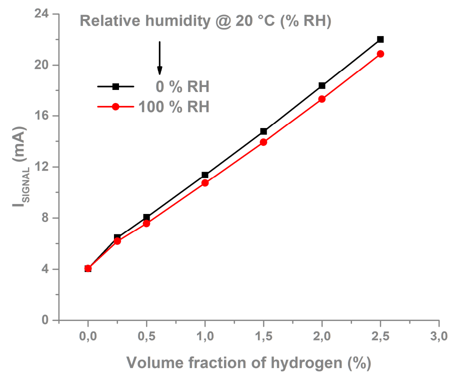

Figure 6. Typical values of the sensor signal as a function of volume fraction of hydrogen (%) in synthetic air at 20 °C and at 0 % and 100 % relative humidity.

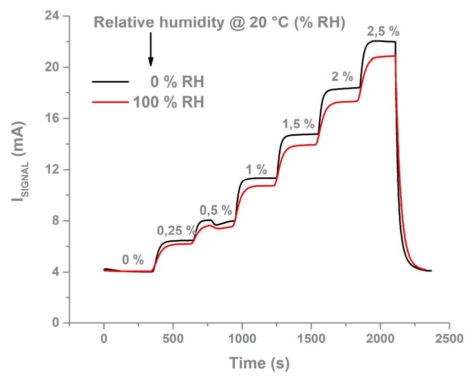

Figure 5. Typical values of the signal transient (I_{SIGNAL}) upon hydrogen exposure in synthetic air 20 °C at 0 % and 100 % relative humidity.

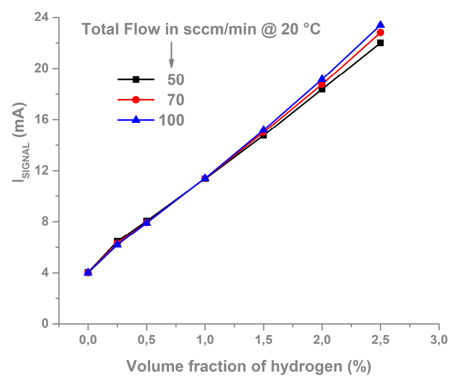

Figure 7. Typical values of the sensor signal as a function of volume fraction of hydrogen (%) in synthetic air at 20 °C and at flows of 50, 70, and 100 sccm/min.

9. THEORY OF OPERATION

The hydrogen sensor H2-CNI 4-20mA comprises two temperature-sensitive transducers that form a Wheatstone bridge arrangement together with precision resistors R_2 and R_3. One transducer (the so-called active sensor element R_{active}) is covered with an advanced catalytic layer that promotes the hydrogen-to-water oxidation while the second transducer (the so-called inactive sensor element R_{ref}) is used as a reference to compensate variations of the out-of-balance voltage with changing ambient temperatures. The out-of-balance voltage is set to zero by means of R_5. Exposure of the sensor to hydrogen and oxygen containing atmospheres results in the generation of a chemical reaction heat that causes a temperature change and hence a resistance change of the active sensor element R_{active}. This leads to a non-zero out-of-balance voltage of the bridge which is amplified by means of a built-in amplifier and lead to the internal 4-20mA current-loop transmitter. The transmitter is protected against reverse voltage operation and overvoltages above 24 V. The output current is limited to approximately 32mA. Pin 2 should be connected to the positive pole of the current loop through a load resistor of 100 Ω and pin 4 to the negative pole. The current loop must be galvanically decoupled from the supply voltage.

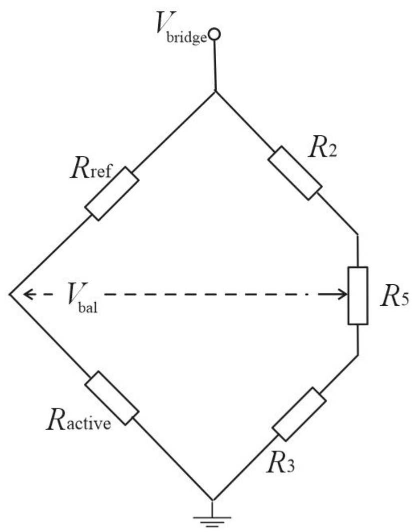

Figure 8. Wheatstone bridge with active and reference sensor element (schematic).

10. APPLICATION AND IMPLEMENTATION

A zero-current signal is adjusted at an ambient temperature of T_a = 20 °C. The device contains a special circuitry that reduces the effect of ambient temperature changes on the sensor sensitivity in a limited range of -10 to +80 °C. Temperature variations may also affect the base line of the sensor signal. If the operation requires larger ranges in which only very small or negligible base-line variations can be accepted we recommend the use of the version *H2 CNI I2C®* of this hydrogen sensor. It contains the same sensing and reference elements, an electrically erasable PROM and a ±1.0°C accurate digital temperature sensor but no temperature stabilization circuitry. It gives you high flexibility in adjusting the bridge voltage and out-of-balance voltage as a function of ambient temperature variations. A practical hardware-software solution is available as evaluation kit. Contact our distributor for further support. It is our intention to provide you with the best solution to ensure successful use of the hydrogen sensor *H2 CNI* for your application.

11. FOOTPRINT AND RECOMMENDED PLUG-IN SOCKETS

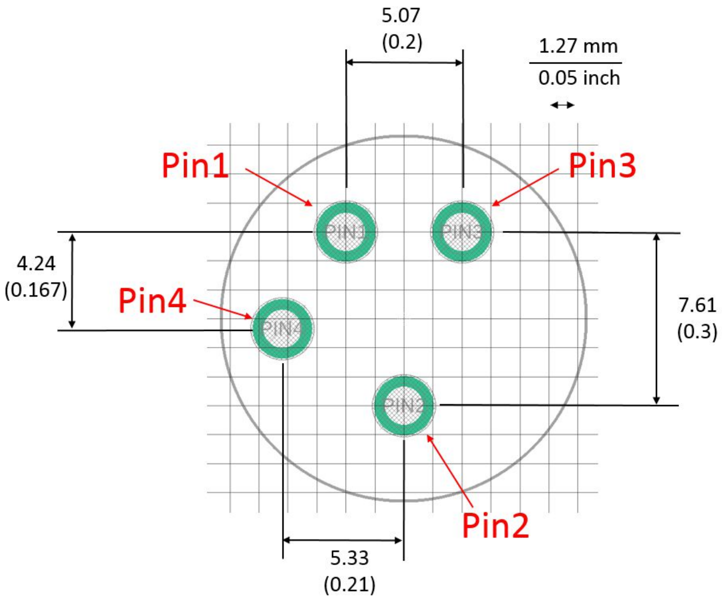

Figure 9: Footprint (dimensions shown in millimeter and inch)

Recommended plug-in sockets	450-3326-01-03-00 (Cambion Electronics LTD)
Drill hole:	2.6 mm

12. ORDERING INFORMATION

Hydrogen sensor H2- CNI 4-20mA

13. PACKAGING/SHIPPING INFORMATION

This sensor is shipped individually in an antistatic bag.

14. WARNINGS

⚠ **Warnings:** The sensor H2-CNI 4-20mA is intended to be part of a customer safety system, enabling audible alarms, system shutdown, ventilation, or other measures to ensure safe handling and use of hydrogen gas. The sensor itself does not provide protection from hydrogen/air explosion. Make sure that your application meets applicable standards, and any other safety, security, or other requirements.

15.NOTES

16.WORLDWIDE SALES AND CUSTOMER SUPPORT

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