



Hydrogen Sensor with 4-20 mA Transmitter

1. FEATURES

- Detection of hydrogen levels up to 100% 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 +30 °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

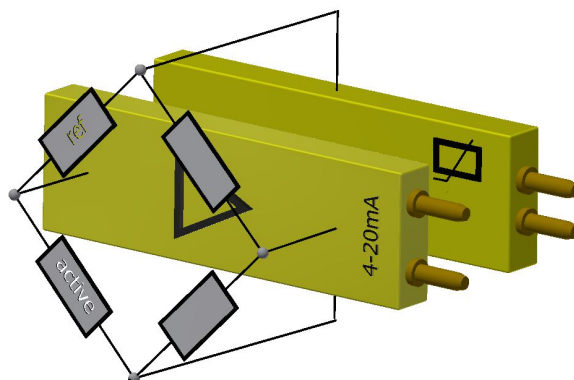


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5. REVISION HISTORY

| Date | Rev. | |
|---------------|------|--|
| June 24, 2021 | 1.0 | Initial Version |
| Sep. 3, 2021 | 1.1 | Figure 9 changed to 4, Figure 5 replaced |

6. PIN CONFIGURATION AND FUNCTION

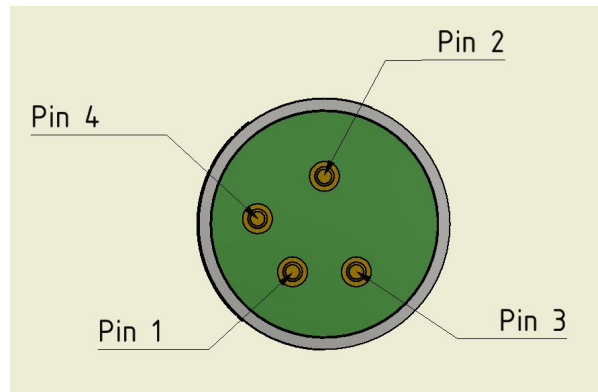


Figure 1: Bottom view of sensor

| 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 $T_a = 20\text{ }^\circ\text{C}$.

| | |
|----------------------|-----------------|
| 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 be 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 $T_a = 20\text{ °C}$ (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 operation ¹⁾ | +10 to +30 °C |
| | ¹⁾ Optional other temperature regimes within a range of -40 °C to 85 °C |
| Operation humidity | 0 ... 100 % r.h. |

7.8. SENSOR PARAMETERS

| | |
|--------------------------|---|
| Signal at 50% LEL | 20 mA (typical) |
| Resolution | < 0.25 % LEL |
| Linearity | 8 mA/(1 vol-% H ₂) at 20 °C |
| Response time | < 5 s |
| Thermal zero point drift | < 4 mA |

7.9. SENSOR CROSS SENSITIVITIES

| Gas / Vapor | Chemical Formula | Concentration Applied | Output $I_{\text{Signal, Gas}} - I_{\text{Signal, air}}$ (mA) |
|-------------------|--------------------------------|-----------------------|--|
| Methane | CH ₄ | 0 to 99.99 vol-% | 0 |
| Ethane | C ₂ H ₆ | 0 to 99.95 vol-% | 0 |
| Propane | C ₃ H ₈ | 0 to 30 vol-% | 0 |
| Butane | C ₄ H 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 (C₈H₂₄O₄Si₄)

A laboratory beaker with 100 g C₈H₂₄O₄Si₄ (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-% H₂. A 12% decline of the sensor signal is found with respect to the initial signal.

HEXAMETHYLDISILOXANE (C₆H₁₈OSi₂)

A laboratory beaker with 40 ml C₆H₁₈OSi₂ is placed with in a 2-liter glass together with the sensor for one hour. The sensor is tested with 2 vol-% H₂. 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-% H₂ in nitrogen). The relative humidity is adjusted by adding appropriate water-saturated gas flows. Ambient temperatures are adjusted in a climatic test chamber.

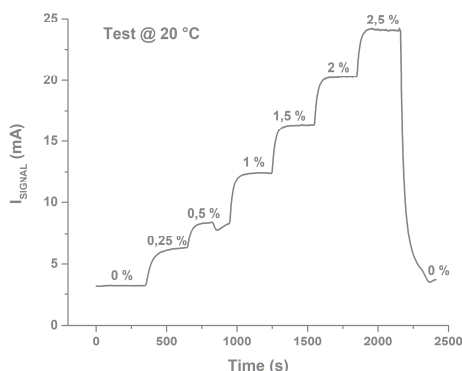


Figure 2. Typical values of the signal transient (I_{SIGNAL}) upon hydrogen exposure in synthetic dry air at 20 °C and a total flow of 50 sccm/min.

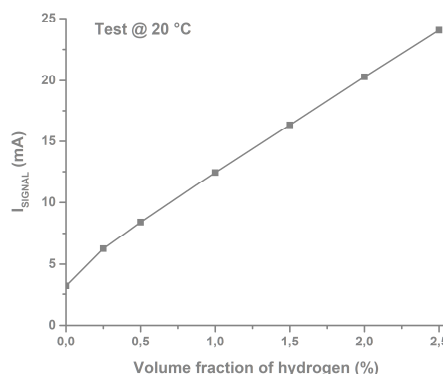


Figure 3. Typical values of the sensor signal as a function of volume fraction of hydrogen (%) in synthetic dry air and a total flow of 50 sccm/min.

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.

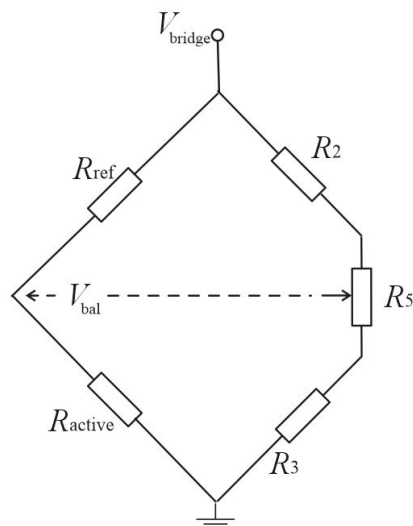


Figure 4. Wheatstone bridge with active and reference sensor element (schematic).

10. APPLICATION AND IMPLEMENTATION

A zero-current signal is adjusted at an ambient temperature of $T_0 = 20\text{ }^\circ\text{C}$. 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 30 $^\circ\text{C}$. 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 $\pm 1.0^\circ\text{C}$ 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

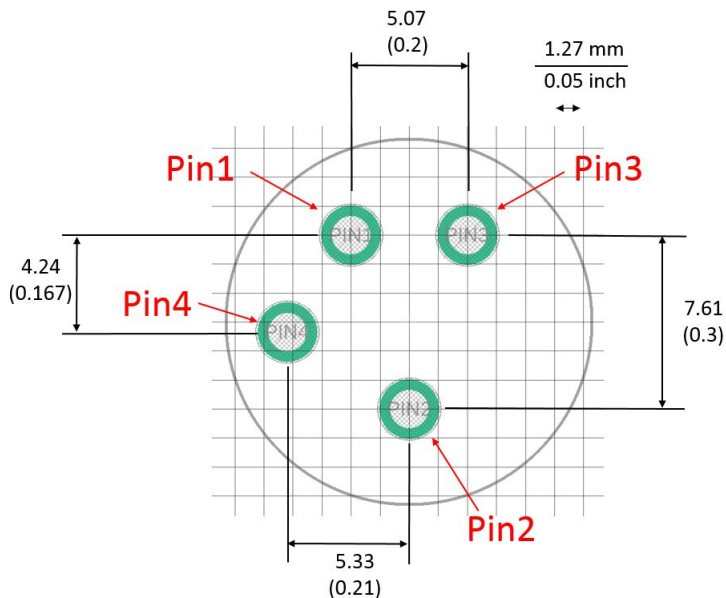


Figure 5: Footprint (dimensions shown in millimeter and inch)

| | |
|-----------------------------|---|
| 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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