

## Hydrogen Sensor

### 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 from -10 to +50 °C (optional: other temperature ranges)
- Linear output up to 100 % LEL
- On-board sensor electronics
- Zero-signal voltage adjusted to 1 V for operation with 4-20 mA interface electronics

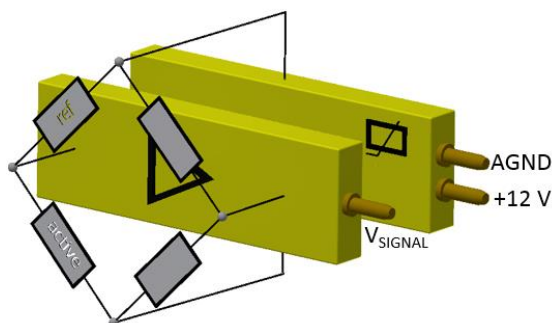
### 2. APPLICATION

- Warning systems

### 3. DESCRIPTION

H2-CNI 1V is a three-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 and to provide appropriate output signals. 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



# TABLE OF CONTENTS

1. Features.....	1	7.9. Sensor Cross sensitivities .....	5
2. Application .....	1	7.10. Effect of Pretreatments of the Sensor to Siloxanes .....	6
3. Description .....	1	8. Typical Performance Characteristics .....	6
4. Simplified Schematic .....	1	9. Theory of Operation.....	8
5. Revision History .....	2	10. Application and Implementation.....	9
6. Pin Configuration and Function.....	3	11. Footprint and Recommended Plug-in Sockets.....	9
7. Specifications .....	3	12. Ordering Information.....	9
7.1. Absolute Maximum Ratings .....	3	13. Packaging/Shipping information .....	9
7.2. ESD CAUTION .....	3	14. Warnings.....	9
7.3. Handling Ratings .....	3	15. Notes.....	10
7.4. Recommended Operating Conditions	4	16. Worldwide Sales and Customer Support .....	11
7.5. Mechanical.....	4		
7.6. Electrical.....	4		
7.7. Environmental.....	5		
7.8. Sensor Parameters.....	5		

## 5. REVISION HISTORY

Date	Rev.	
May 5, 2021	1.0	Initial Version

## 6. PIN CONFIGURATION AND FUNCTION

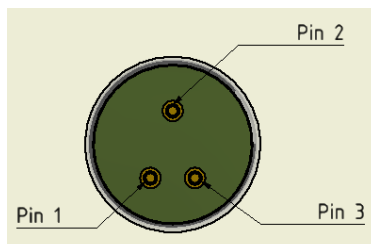


Figure 1: Bottom view of sensor

PIN NO.	DESCRIPTION
1	+12 V positive supply voltage with respect to ground
2	Sensor signal with respect to ground
3	Ground of the internal electronics. The pin is electrically not connected to the housing <sup>1)</sup>

<sup>1)</sup> Optional: low impedance junction between pin 3 and the housing

## 7. SPECIFICATIONS

### 7.1. ABSOLUTE MAXIMUM RATINGS

At ambient temperature  $T_a = 20\text{ °C}$ .

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 3	$\geq 1$			k $\Omega$

## 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	53 mA@ -10 °C
	50 mA @ 0 °C
	43 mA @ 20 °C
	34 mA @ 40 °C
	29 mA @ 50 °C

## 7.7. ENVIRONMENTAL

Ambient temperature range during operation <sup>1)</sup>	-10 to +50 °C
	<sup>1)</sup> Optional -40 °C to 20 °C
Operation humidity	0 ... 100 % r.h.

## 7.8. SENSOR PARAMETERS

Signal at 50% LEL	3 V (typical)
Resolution	< 0.25 % LEL
Linearity	Typical value: 1.5 V/(25 % LEL) or 1.5 V/(1 vol-% H <sub>2</sub> ) at 20 °C
Response time	< 5 s
Thermal zero point drift	5 mV/°C or 0.1 % LEL/°C

## 7.9. SENSOR CROSS SENSITIVITIES

Gas / Vapor	Chemical Formula	Concentration Applied	Output $V_{\text{Signal, Gas}} - V_{\text{Signal, air}}$ (V)
Methane	CH <sub>4</sub>	0 to 99.99 vol-%	0
Ethane	C <sub>2</sub> H <sub>6</sub>	0 to 99.95 vol-%	0
Propane	C <sub>3</sub> H <sub>8</sub>	0 to 30 vol-%	0
Butane	C <sub>4</sub> H <sub>10</sub>	0 to 70 vol-%	0
Ammonia	NH <sub>3</sub>	0 to 5 vol-%	0
Chlorine	Cl <sub>2</sub>	0 to 5 vol-%	0
Carbon dioxide	CO <sub>2</sub>	1 vol-%	0
Carbon monoxide	CO	1500 ppm	0
Nitrogen dioxide	NO <sub>2</sub>	5 ppm	0
Nitrogen monoxide	NO	15 ppm	0

## 7.10. EFFECT OF PRETREATMENTS OF THE SENSOR TO SILOXANES

### OCTAMETHYLCYCLOTETRASILOXANE (C<sub>8</sub>H<sub>24</sub>O<sub>4</sub>Si<sub>4</sub>)

A laboratory beaker with 100 g C<sub>8</sub>H<sub>24</sub>O<sub>4</sub>Si<sub>4</sub> (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<sub>2</sub>. A 12% decline of the sensor signal is found with respect to the initial signal.

### HEXAMETHYLDISILOXANE (C<sub>6</sub>H<sub>18</sub>OSi<sub>2</sub>)

A laboratory beaker with 40 ml C<sub>6</sub>H<sub>18</sub>OSi<sub>2</sub> is placed with in a 2-liter glass together with the sensor for one hour. The sensor is tested with 2 vol-% H<sub>2</sub>. A 15% decline of the the sensor signal is found with respect to the initial signal.

## 8. TYPICAL PERFORMANCE CHARACTERISTICS

All data presented below are acquired in a 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<sub>2</sub> in nitrogen). Relative humidities are adding appropriate water-saturated gas flows. Ambient temperatures are adjusted in a climatic test chamber.

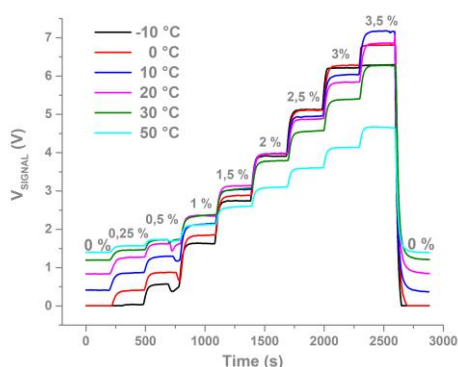


Figure 2. Typical values of the signal transient ( $V_{\text{SIGNAL}}$ ) upon hydrogen exposure in synthetic dry air at different ambient temperatures between  $-10\text{ }^{\circ}\text{C}$  and  $50\text{ }^{\circ}\text{C}$  and a total flow of 50 sccm/min.

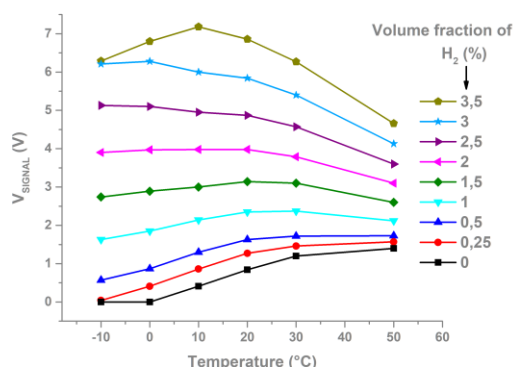


Figure 3. Typical values of the sensor signal as a function of the ambient temperature at different volume fraction of hydrogen (%) in synthetic dry air and a total flow of 50 sccm/min.

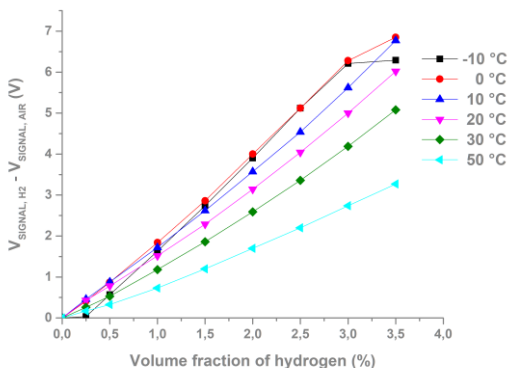


Figure 4. Changes of the sensor signal relative to the value in air as a function of the volume fraction of hydrogen (%) in dry air at different temperatures between  $-10\text{ }^{\circ}\text{C}$  and  $50\text{ }^{\circ}\text{C}$  and a flow of  $50\text{ sccm/min}$ .

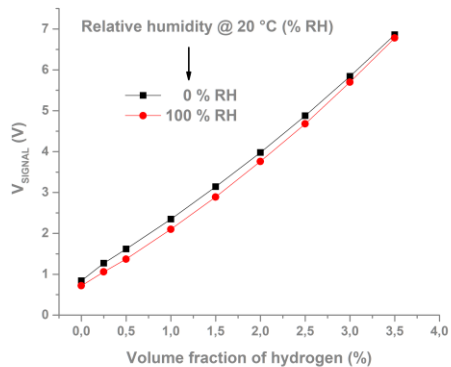


Figure 6. Typical values of the sensor signal ( $V_{\text{SIGNAL}}$ ) as a function of the volume fraction of hydrogen (%) in synthetic air at 0% and 100% relative humidity (ambient temperature  $T_a = 20\text{ }^{\circ}\text{C}$ , flow of  $50\text{ sccm/min}$ ).

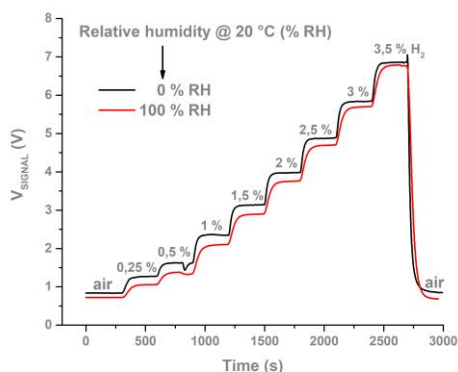


Figure 5. Typical values of the signal transient ( $V_{\text{SIGNAL}}$ ) upon hydrogen exposure at 0% and 100% relative humidity (ambient temperature  $T_a = 20\text{ }^{\circ}\text{C}$  and a flow of  $50\text{ sccm/min}$ ).

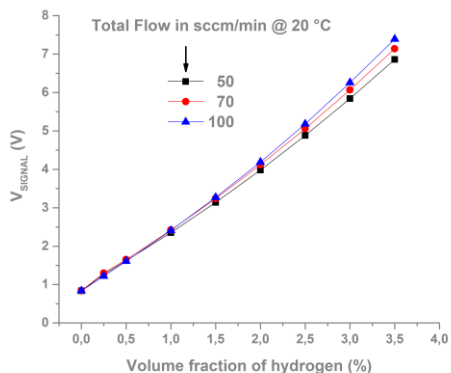


Figure 7. Typical values of the sensor signal as a function of the volume fraction of hydrogen (%) in synthetic air at different flows of  $50$ ,  $70$  and  $100\text{ sccm/min}$  (ambient temperature  $T_a = 20\text{ }^{\circ}\text{C}$ ).

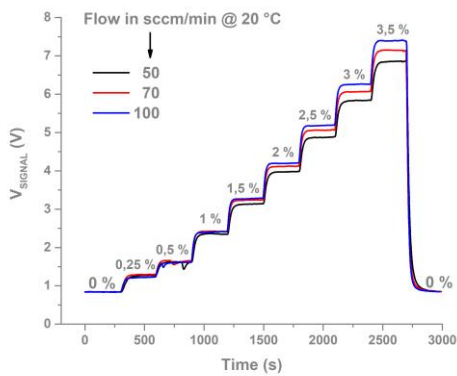


Figure 8. Typical values of the signal transient ( $V_{\text{SIGNAL}}$ ) upon hydrogen exposure in synthetic dry air at different flows of 50, 70 and 100 sccm/min (ambient temperature  $T_a = 20\text{ }^\circ\text{C}$ ).

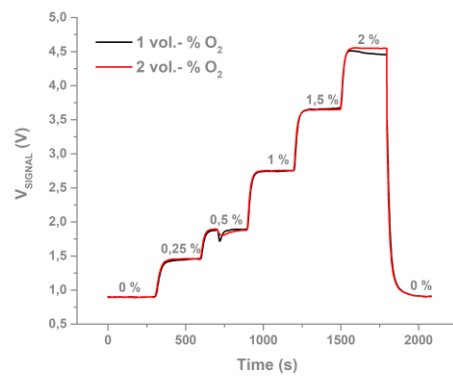


Figure 9. Typical values of the sensor signal ( $V_{\text{SIGNAL}}$ ) as a function of the volume fraction of hydrogen (%) in 1 vol-%  $\text{O}_2$  and 2 vol-%  $\text{O}_2$  (ambient temperature  $T_a = 20\text{ }^\circ\text{C}$ , flow of 70 sccm/min).

## 9. THEORY OF OPERATION

The hydrogen sensor H2-CNI 1V 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  $R_{\text{active}}$ ) is covered with an advanced catalytic layer that promotes the hydrogen-to-water oxidation while the second transducer (the so-called inactive sensor element  $R_{\text{ref}}$ ) 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  $R_{\text{active}}$ . 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 out at pin 2.

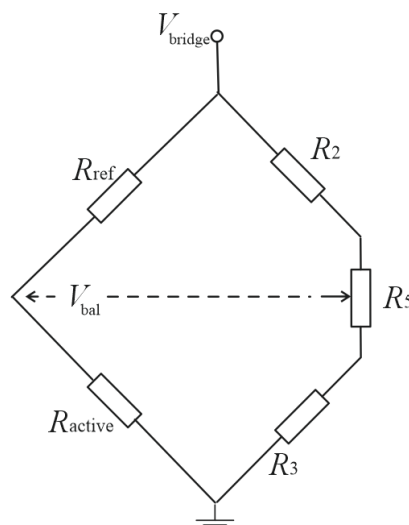


Figure 10. Wheatstone bridge with active and reference sensor element (schematic).



## 10. APPLICATION AND IMPLEMENTATION

A zero-voltage signal is adjusted at an ambient temperature of  $T_a = 20\text{ }^\circ\text{C}$ . 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 50  $^\circ\text{C}$ . 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<sup>®</sup>* 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

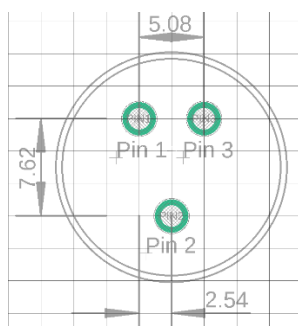


Figure 11: Footprint (dimensions shown in millimeter)

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

## 12. ORDERING INFORMATION

Hydrogen sensor H2- CNI 1V

## 13. PACKAGING/SHIPPING INFORMATION

This sensor is shipped individually in an antistatic bag.

## 14. WARNINGS



**Warnings:** The sensor H2-CNI 1V 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

ALDERS electronic GmbH

Arnoldstraße 19 , 47906 Kempen (Germany)

[sales@alders.de](mailto:sales@alders.de)

+49 2152 8955-230