FES SENSOR TECHNOLOGY GMBH

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H2-CNI 4-20MA-I *

Precision Hydrogen Sensor with 4-20 mA Transmitter for Industrial Applications

1. FEATURES

- Accurate detection of hydrogen levels up to 100% LEL with 100 ppm resolution in air
- Negligible sensitivity against typical catalyst poisons such as volatile siloxanes and carbon monoxide
- Fast response and recovery times
- Negligible humidity-induced base line drift
- Applicable in relative humidity (rh) between 0 % to 100 %
- Industrial temperature range -40 °C to +80 °C
- Linear output up to 100 % LEL
- Available with ultra-low thermal drift (ULTD) and test protocol
- 4-20 mA current-loop transmitter with reverse voltage operation and over-voltage surge protection
- Supply voltage with reversed bias protection

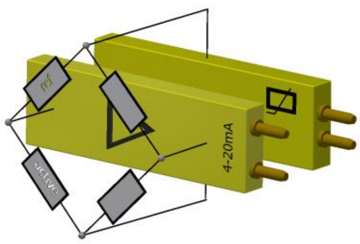
2. APPLICATION

- Precision hydrogen meters

3. DESCRIPTION

H2-CNI 4-20mA-I and H2-CNI 4-20mA-I ULTD are four-pin calorimetric hydrogen sensors with a catalytically highly active and siloxane-resistant sensor element and is based on a non-isothermal calorimetric operation principle. The sensor 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 accurate hydrogen determination in air. The sensor can be operated without connecting the I2C bus.

4. SIMPLIFIED SCHEMATIC



* H2-CNI 4-20mA-I with I2C bus is the successor of the H2-CNI 4-20mA-I an H2-CNI 4-20mA-I ULTD sensors.

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5. REVISION HISTORY

Date	Rev.	
April 22, 2023	1.0	Initial Version
Aug. 20, 2023	1.1	Chapter 12 (Recommendations for Electrical Circuits) is added, Table of Contents is updated
Jan. 2, 2024	1.2	Figure 14 corrected
April 28, 2025	2.1	New model H2-CNI 4-20mA-I released, starting from serial number #417

6. PIN CONFIGURATION AND FUNCTION

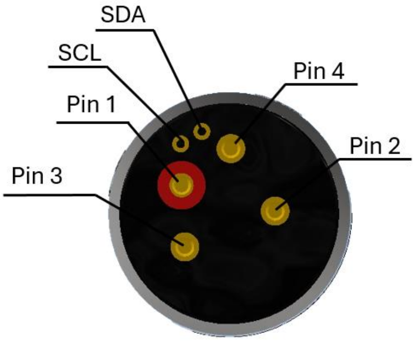

Figure 1: Bottom view of sensor

Table 1

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*
SCL	Clock line of the I2C bus**
SDA	Data line of the I2C bus**
	* The current loop must be galvanically decoupled from the 12 V supply voltage. No common mass is allowed. The current loop <u>must</u> contain a driving voltage source (recommended value: +24 V).
	**If connected, provide necessary pull-up resistors to SCL and SDA (e.g. 4.7 kOhm).

7. SPECIFICATIONS

7.1.ABSOLUTE MAXIMUM RATINGS

At ambient temperature T_a = 20 °C.

Table 2

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).

Table 3

	MIN	NOM	MAX	UNIT
Input supply voltage	+9	+12	+15	V
Serial load resistor of the current loop connected to pin 2 and pin 4		≥ 100		Ω

7.5. MECHANICAL

Table 4

Housing material	Stainless steel (1.4404; SUS316L)
Potting	Epoxy
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

Table 5	
Supply current	43 mA @ 20 °C
Current loop voltage	≤ 24 V

7.7.ENVIRONMENTAL

Table 6	
Ambient temperature range during operation	-40 to +80 °C
Operation humidity	0 … 100 % r.h.

7.8.SENSOR PARAMETERS

Table 7	
Signal at 50% LEL	14 mA (typical)
Resolution	100 ppm H_2
Linearity	5 mA/(1 vol-% H_2) at 20 °C
Response time	< 5 s
Thermal zero point drift	< 0.01 mA/°C

7.9. SENSOR CROSS SENSITIVITIES

Table 8

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). Room temperature data are determined with the sensor attached to our test chamber TC 2x1/4”. Ambient temperatures are adjusted in a cooled or heated test chamber. Data for figures 3 to 11 are collected with a 7 ½ digit precision multimeter with RS232 interface in series with a 24 V supply and a 100 Ω resistance. For figures 13 the evaluation kit DCC-PGA-ADC 3.2 and a stabilized 12 V power supply are used.

8.1.INITIAL WARM-UP PHASE

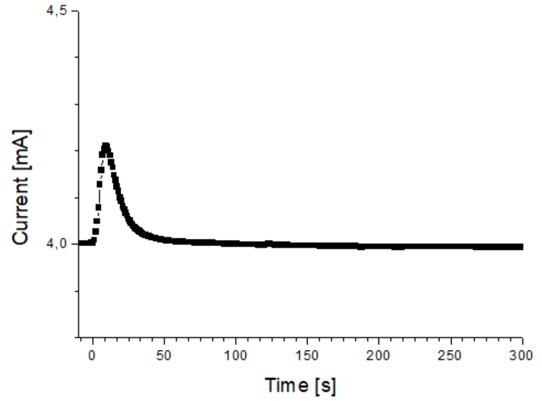

Figure 2. Typical signal characteristics (curent through pin 2 and pin 4) of the sensor after applying the operational voltage of 12 V between pin 1 and 3 at time 0.

8.2.CALIBRATION CURVE AND LINEARITY

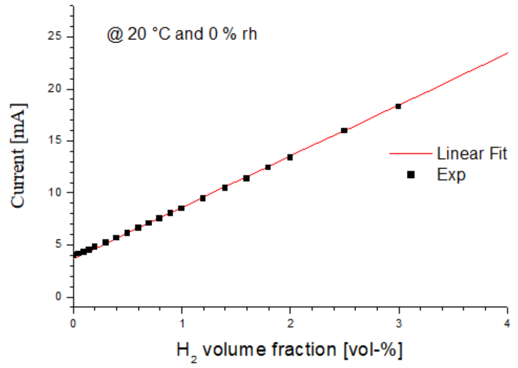

Figure 3. Typical values of the current (sensor signal) as a function of hydrogen volume fraction in synthetic dry air at 20 °C. Data (Exp) are determined for a total flow of 50 sccm/min. Red: Linear fit with a slope of 5 mA/1 vol-%.

8.3.LOW DETECTION LIMIT AND RESOLUTION

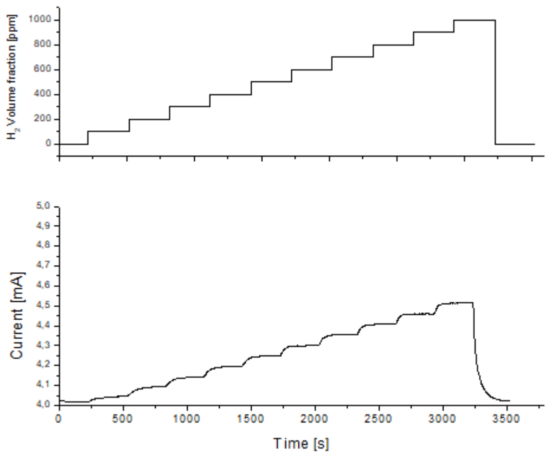

Figure 4. Top: Test protocol with an automated procedure of low hydrogen exposures (H_2 volume fractions between 100 and 1000 ppm) in the test chamber (dry air at 20 °C, total flow 100 sccm/min). Bottom: Sensor signal (current) as a function of the time.

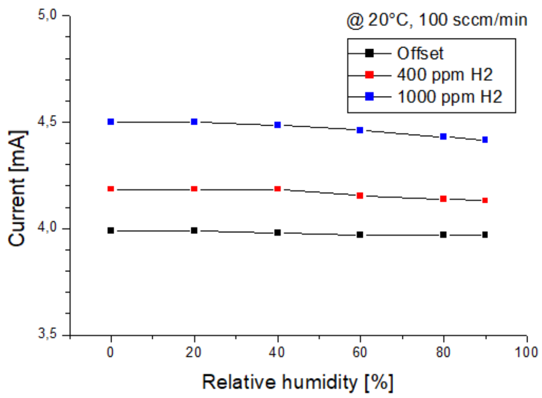

Figure 5. Bottom: Sensor signal as a function of humidity (0, 20, 40, 60, 80, and 90 % at 20 °C at low volume fractions of hydrogen.

8.4. TEMPERATURE-DEPENDENCE

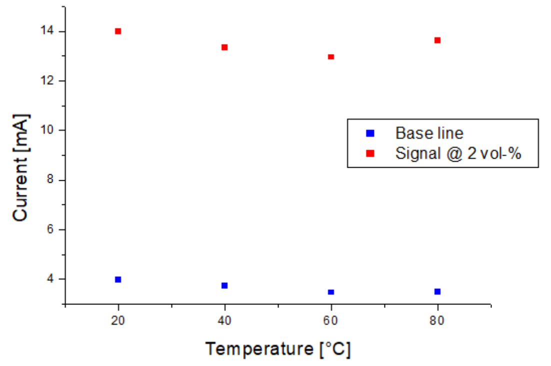

Figure 6. Red: Sensor signal (current) for a hydrogen volume fraction of 2 vol% at temperatures of 20 °C, 40 °C, 60 °C, and 80 °C. Blue: Base line current at 0 vol% H_2.

8.5. EFFECT OF RELATIVE HUMIDITY ON THE BASE LINE

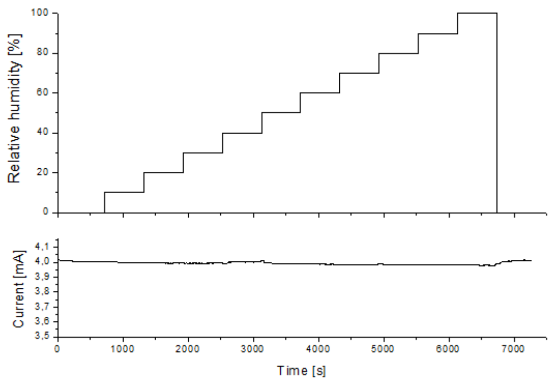

Figure 7. Top: Test protocol with an automated procedure of relative humidity changes in the test chamber, ranging from dry air to 100 % (temperature = 20 °C, total flow = 50 sscm/min). Bottom: Sensor signal (current) as a function of time.

8.6. EFFECT OF RELATIVE HUMIDITY ON THE SIGNAL

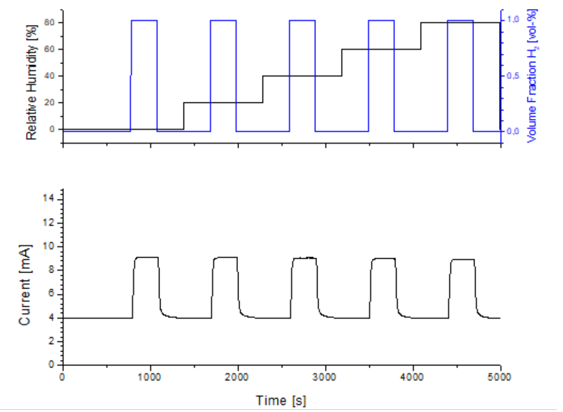

Figure 8. Top: Test protocol with an automated hydrogen exposure (1 vol-%) and variations of the relative humidity (0 to 80 %) at 20 °C (total flow = 50 sscm/min). Bottom: Sensor signal (current) as a function of time.

8.7.EFFECT OF FLOW RATES ON THE BASE LINE

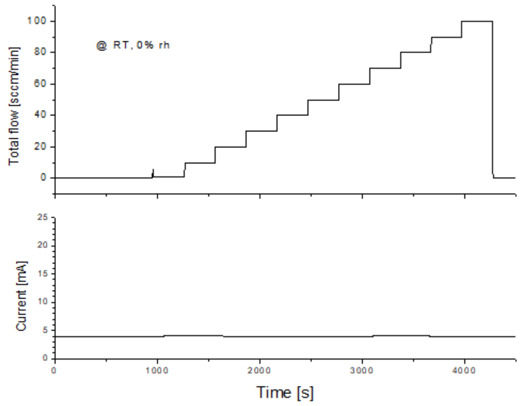

Figure 9. Top: Test protocol with an automated total flow variation between 0 and 100 sccm/min at 20 °C and 0 % rh. Bottom: Sensor signal (current) as a function of time.

8.8.EFFECT OF FLOW RATES ON THE SIGNAL

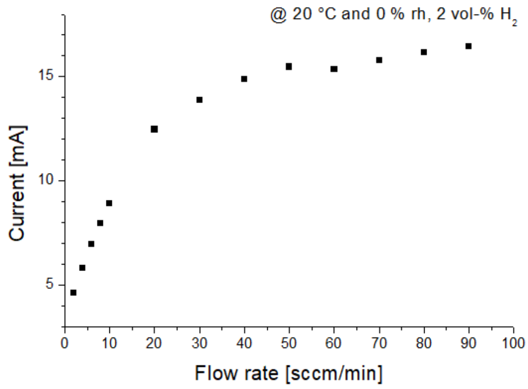

Figure 10. Sensor signal as a function of the total flow for 2 vol-% H_2 in dry air at 20 °C. Because of the catalytic sensing principle and the hydrogen-to-water oxidation, a steady-state signal cannot be generated at a zero-flow.

8.9.RESPONSE AND DECAY TIMES

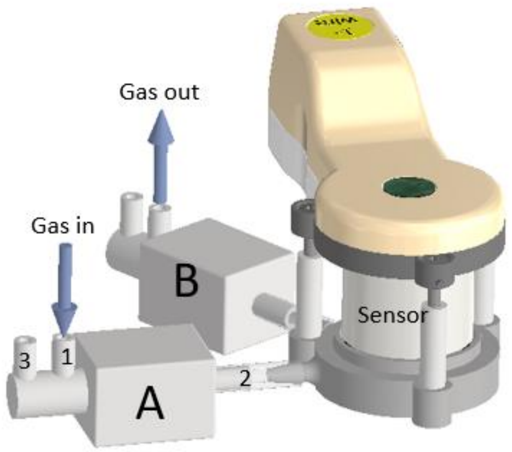

Figure 11. Special setup to determine the response and decay time of the sensor. Here, the evaluation kit DCC-PGA-ADC 3.2 is used to apply both, the 12 V supply voltage and the 24 V loop voltage to determine the current of the sensor. A flow of 2 vol-% H_2 in air with 50 sccm/min flows into the system at the "gas in" through port 1 of valve A. The valve can be switched electrically to pass the flow through port 3 to the ambient air or port 2 to the sensor, attached to a small test chamber. Valve B is operated together with valve A and cut off the test chamber from the outlet if A is switched into the 1-3 position.

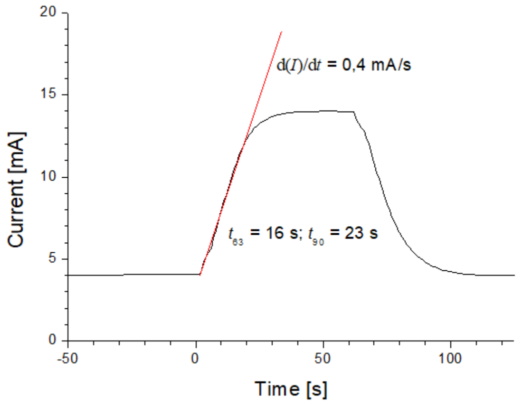

Figure 12. Sensor signal as a function of time after applying 2 vol-% H_2 in dry air at 20 °C. The sensor signal reaches a steady-state signal with a t_{63} response time of 16 s and a t_{90} response time of 44 s. The slope dI/dt is approx. 0,4 mA/s, i.e., a 2 mA change of the signal is found after 5 s. After re-directing the test gas to the port "Out 1", the signal decays to zero due to an oxidation and consumption of the hydrogen molecules at the sensor´s catalytic layer.

8.10. CALIBRATION PROCEDURE

The sensor contains a 12 bit digital-analog converter with non-volatile memory for adjusting the offset voltage of the Wheatstone bridge, and a nonvolatile 256-position digital potentiometer to adjust the output signal for a constant hydrogen volume fraction. It is usually not necessary to make any changes of the settings. Refer to section 10 for further information.

8.11. MECHANICAL TESTS

The electronic board of the sensor has been tested in shock tests with the sensor placed on a vibrating plate (50 Hz) and on an alternating acceleration test stand with 8 G.

8.12. EFFECT OF THERMAL SURROUNDING

H2-CNI 4-20mA-I and H2-CNI 4-20mA-I ULTD have precisely adjusted sensor and reference elements that operate at virtually identical temperatures when a voltage is connected between pins 1 and 3. As with all devices based on calorimetric concepts, the sensor is, however, sensitive against changes of its thermal surrounding. This gives rise to noticeable variations of the base line of such devices. The variations are very small for the ULTD type sensors. The best assembly place for the sensor should provide a constant thermal surrounding to minimize variations of the signal´s base line which can be low under good conditions. If the sensor is in contact to metals (e.g. supports) corrections of the offset adjustment can be necessary to provide a base line just below 4 mA. Consider a vertical upside or upside-down direction of the sensor if possible.

9. THEORY OF OPERATION

The hydrogen sensors H2-CNI 4-20mA-I and H2-CNI 4-20mA-I ULTD comprise 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 4 should be connected to the positive pole of the current loop through a load resistor of 100 Ω and pin 2 to the negative pole. The current loop must be galvanically decoupled from the supply voltage and driven by a 24 V voltage.

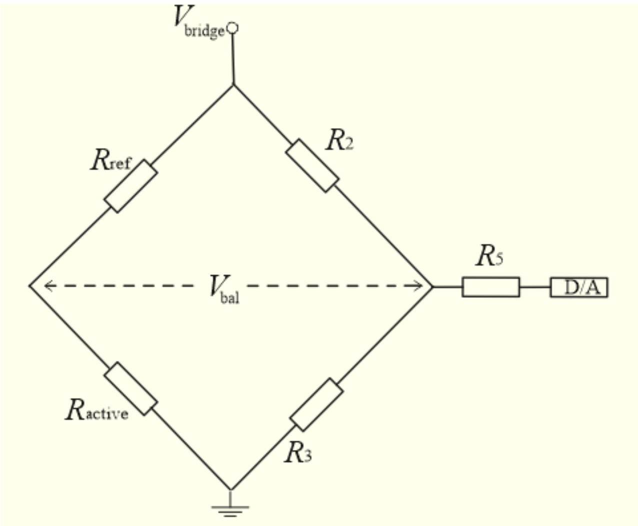

Figure 13. Wheatstone bridge with active and reference sensor element (schematic).

10. APPLICATION AND IMPLEMENTATION

The device contains a special circuitry that reduces the effect of ambient temperature changes on the sensor sensitivity in a range of -40 to +80 °C. Temperature variations may affect the base line of the sensor signal. If the operation requires larger temperature ranges in which only very small or negligible base-line variations can be accepted, we recommend the use of the version *H2 CNI I2C-E ULTD* 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 a 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.

10.1. I²C BUS

Two pull-up resistors are required to ensure that the SCL and SDA lines of the I²C bus are at high potential.

The following 7bit addresses are used in the H2-CNI 4-20mA-I sensors:

Table 9: 7bit Addresses

Binary code	Hexadecimal code	IC
1010000	x50	1K bit serial electrically erasable PROM
1100000	X60	12-Bit digital-to-analog converter used for offset adjustment
0101110	x4E	Nonvolatile 256-position digital potentiometer used to adjust the amplification
0101000	x28	Nonvolatile 256-position digitally controlled variable resistor used to adjust the programmable voltage source

All command and data information is transferred with the Most-Significant Bit (MSB) first.

10.2. EEPROM

The EEPROM is organized as a single block of 128 x 8-bit memory. The following table indicates the information, kept under the different word addresses. The word addresses 0x00 to 0x03, 0x05 and 0x06 keep basic information about the sensor, including a CRC value calculated from the entries and stored in 0x04. This information must not be altered.

<table>
<tr><th colspan="4">Table 10: Contents of the EEPROM</th></tr>
<tr><th>Word address</th><th>Data byte</th><th colspan="2">Remarks</th></tr>
<tr><td>0x00</td><td>Device code</td><td rowspan="5"></td><td rowspan="7">Data must not be changed</td></tr>
<tr><td>0x01</td><td>Serial number (upper byte)</td></tr>
<tr><td>0x02</td><td>Serial number (middle byte)</td></tr>
<tr><td>0x03</td><td>Serial number (lower byte)</td></tr>
<tr><td>0x04</td><td>CRC value</td></tr>
<tr><td>0x05</td><td>Fabrication date/month</td><td rowspan="2">See (a)</td></tr>
<tr><td>0x06</td><td>Fabrication month/year</td></tr>
<tr><td>0x07...0x02F</td><td>Fabrication-related data</td><td colspan="2">Encrypted data. Not intended for users</td></tr>
<tr><td>0x30</td><td>Excitation</td><td colspan="2" rowspan="7">Default settings for evaluation kit PGA-ADC 3.4</td></tr>
<tr><td>0x31</td><td>Gain preamplifier</td></tr>
<tr><td>0x32</td><td>Gain</td></tr>
<tr><td>0x33</td><td>Offset A (upper byte)</td></tr>
<tr><td>0x34</td><td>Offset A (lower byte)</td></tr>
<tr><td>0x35</td><td>Offset B U(upper byte)</td></tr>
<tr><td>0x36</td><td>Offset B (lower byte)</td></tr>
<tr><td>0x37…0x4D</td><td>Control data for other evaluation kits not useful for H2-CNI 0-10V-I sensors</td><td colspan="2">Encrypted data. Not intended for users</td></tr>
<tr><td>0x4E…0x52</td><td>Resistances and thermal coefficients of sensor and reference elements</td><td colspan="2">Encrypted data. Not intended for users</td></tr>
<tr><td>0x53…0x6E</td><td></td><td colspan="2">Encrypted data. Not intended for users</td></tr>
<tr><td>0x6F</td><td></td><td colspan="2">Not used</td></tr>
<tr><td>0x70</td><td>Calibration offset (upper byte)</td><td colspan="2" rowspan="2">See equation (b) for decoding</td></tr>
<tr><td>0x71</td><td>Calibration offset (lower byte)</td></tr>
<tr><td>0x72</td><td>Calibration gain (upper byte)</td><td colspan="2" rowspan="2">See equation (c) for decoding</td></tr>
<tr><td>0x73</td><td>Calibration gain (lower byte)</td></tr>
<tr><td>0x74…0x7F</td><td></td><td colspan="2">Not used</td></tr>
</table>

Read operations allow the master to access any memory location. Sequential reads are also possible. Any read operation is initiated by the bust master with the Start signal (S), followed by the address AD = 1010000, and the R/$\overline{W}$ bit, which is a logic low. The EEPROM will acknowledge (ACK) this byte during the ninth clock pulse. The next byte transmitted by the master is the word address and will be written into the address pointer of the EEPROM. After receiving another acknowledge signal from the EEPROM the master must transmit a Start signal (repeated Start, Sr), followed by the address AD= 1010000 and the R/$\overline{W}$ bit set to one. The EEPROM issues an acknowledge and the eight-bit data word.

For a single read operation, the master does not acknowledge the transfer but generates a Stop signal (P) which terminates the read operation.

S	AD,0	ACK	Word Address (n)	ACK	Sr	AD,1	ACK	Data word n	P

The sequential read of data bytes are initiated in the same way but the master transmits an acknowledge after the first data word is send by the EEPROM. This directs the EEPROM to transmit the next sequentially addressed data byte.

S	AD,0	ACK	Word Address (n)	ACK	Sr	AD,1	ACK

Data word n	ACK	Data word n+1	ACK	Data word n+2	…	Data word n+X	P

Use the following decoding procedure to get the required information from the word addresses:

a) Fabrication time from data bytes in 0x05 and 0x06

Data byte in 0x06								Data byte in 0x05							
MSB							LSB	MSB							LSB
+ 2000 = Fabrication year							Fabrication month				Fabrication date				

b) Calibration offset from data bytes in 0x70 and 0x71

Data byte in 0x70								Data byte in 0x71							
MSB							LSB	MSB							LSB
MSB															LSB
16 bit word															

$$Offset = -0.15\ \text{V} + \frac{\text{16 bit word}}{65535} \times 0.30\ \text{V}$$

c) Calibration slope from data bytes in 0x72 and 0x73

Data byte in 0x72								Data byte in 0x73							
MSB							LSB	MSB							LSB
MSB															LSB
16 bit word															

$$Slope = \frac{\text{16 bit word}}{1{,}000{,}000}\ \text{V/vol-\% } H_2$$

To write a single byte into a memory location, the master issues a Start signal, followed by the, address code AD=1010000, and the R/$\overline{W}$ bit, which is a logic low. The device will acknowledge this byte during the ninth clock pulse. The next byte transmitted by the master is the word address and will be written into the address pointer of the EEPROM. After receiving another acknowledge bit from the EEPROM the master device will transmit the data bye to be written into the addressed memory location. The EEPROM acknowledges again and the master generates a Stop condition. This initiates the internal write cycle, and during this time the EEPROM will not generate acknowledge signals.

S	AD,0	ACK	Word Address (n)	ACK	Data word n	ACK	P

Write operations should be limited to the free memory locations 0x75…0x7F or if the calibration offset and slope must be adapted to sensing conditions different from those used during the initial calibration of the sensor.

10.3. OFFSET ADJUSTMENT

The H2-CNI 0-10V-I sensors contain a digital-analog converter with 12-bit output voltage resolution, operated in a “window” configuration, to enable a precise balancing of the Wheatstone bridge.

The adjustment is initiated by the following write operation to the digital-analog converter with the Start signal, followed by the address AD=1100000 and the R/$\overline{W}$ bit, which is a logic low. The DAC acknowledges and the master sends an instruction byte 01110000 (to update the volatile register) or 01010000 (to update the volatile and nonvolatile register). After receiving the next acknowledge condition the master transmits two data bytes. After the next ACK the master terminates the write operation with the Stop signal.

S	AD,0	ACK	Instruction byte	ACK	Data byte 1	ACK	Data byte 2	ACK	P

The data bytes adjust the 12-bit long output voltage of the DAC, coupled to the Wheatstone bridge through the resistor R_5 (see figure 17).

Data byte 1	Data byte 2
D11 D10 D09 D08 D07 D06 D05 D04	D03 D02 D01 D00 X X X X
	X = Don´t care

To save the offset adjustment permanently the output voltage must be written to nonvolatile memory of the DAC. This is done by using 01010000 as instruction byte, preceding the data bytes 1 and 2.

10.4. GAIN ADJUSTMENT

The H2-CNI 0-10V-I sensors contain a nonvolatile 256-position digital potentiometer to adjust the output signal. The potentiometer picks up a fraction of the balance voltage which is amplified by an instrumentation amplifier. The gain adjustment hence controls the slope of the linear calibration curve.

The adjustment is initiated by the following write operation to the digital potentiometer with the Start signal, followed by the address AD= 0101110 and the R/$\overline{W}$ bit, which is a logic low. The digital potentiometer acknowledges and the master sends an instruction byte 00010001 (to update the volatile register) or 00100001 (to update the volatile and nonvolatile register). After receiving the next acknowledge condition the master transmits one data byte. After the next ACK the master terminates the write operation with the Stop signal.

S	AD,0	ACK	Instruction byte	ACK	Data byte	ACK	P

The data byte sets the taper of the digital potentiometer. A value close to zero means a low gain while values close to 255 represent high gains.

10.5. BRIDGE VOLTAGE ADJUSTMENT

The H2-CNI 0-10V-I sensors contain a nonvolatile 256-position digital rheostat to set the excitation voltage of the Wheatstone bridge. This voltage can vary between 8.6 (taper position = 255) and 9 V (taper position = 0) at 20 °C.

The adjustment is initiated by the following write operation to the rheostat with the Start signal, followed by the address AD= 0101000 and the R/$\overline{W}$ bit, which is a logic low. The rheostat acknowledges and the master sends an instruction byte 00000000 (to update the volatile register) or 11000000 (to update the nonvolatile register). After receiving the next acknowledge condition the master transmits one data byte. After the next ACK the master terminates the write operation with the Stop signal.

The data byte sets the taper of the rheostat between 0 and 255.

11.FOOTPRINT AND RECOMMENDED PLUG-IN SOCKETS

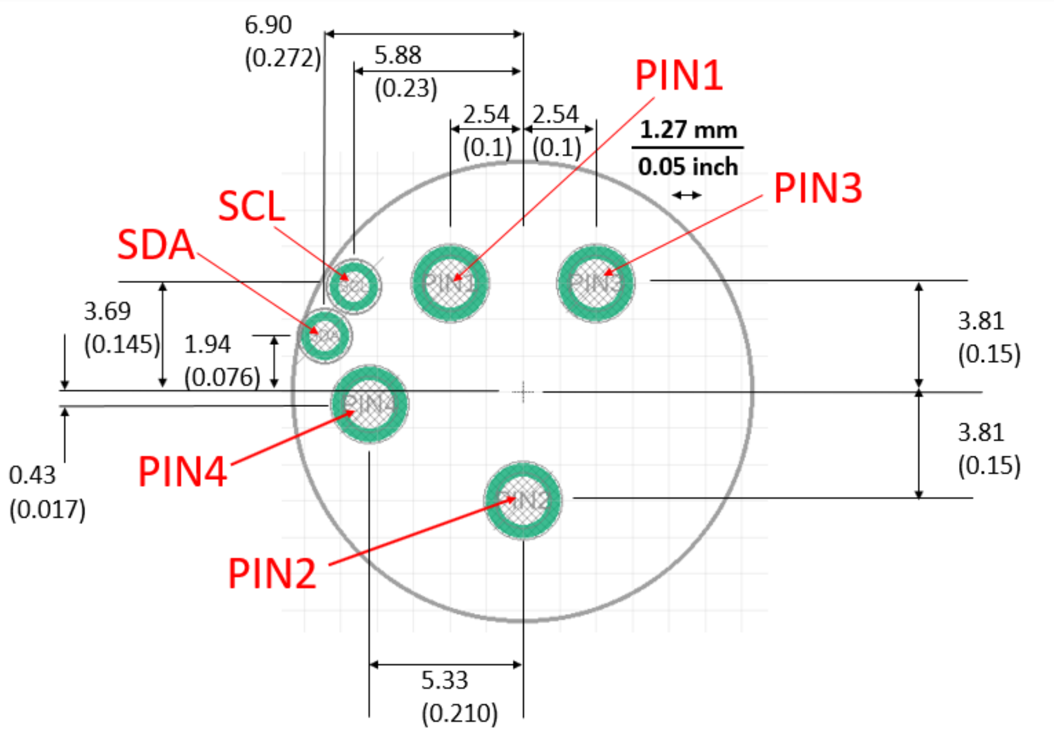

Figure 14: Footprint (dimensions shown in millimeter and inch)

Table 11	
Recommended plug-in sockets	450-3326-01-03-00 (Cambion Electronics LTD)
Drill hole:	2.6 mm

12. RECOMMENDATIONS FOR ELECTRICAL CIRCUITS

To use the 4-20mA transmitter output at pins 2 and 4 in a 4-20 mA circuit properly, the +12 V supply voltage, applied at pin 1 with respective to pin 3, must be galvanically decoupled. There are different options to achieve this requirement. If the +12 V power supply provides floating plus and minus poles, the positive output can be wired directly to pin 1 and the negative output can be connected with pin 3. Only in this case, the 4-20 mA transmitter circuit can be set up according to figure 18 (right part). If the +12 V power supply has a grounded output (usually it is the negative pole) and if there no galvanic decoupling exists in the 4-20 mA circuit or the decoupling state is unknown, the use of an DC-DC converter (isolation amplifier with gain 1) is mandatory to isolate pin 1 and pin 3 of the sensor from ground as indicated in figure 18. Note, that the polarity of pins 2 and 4 with respect to the 24 V voltage in the current transmitter circuit is not critical, as they are internally wired to a diode bridge.

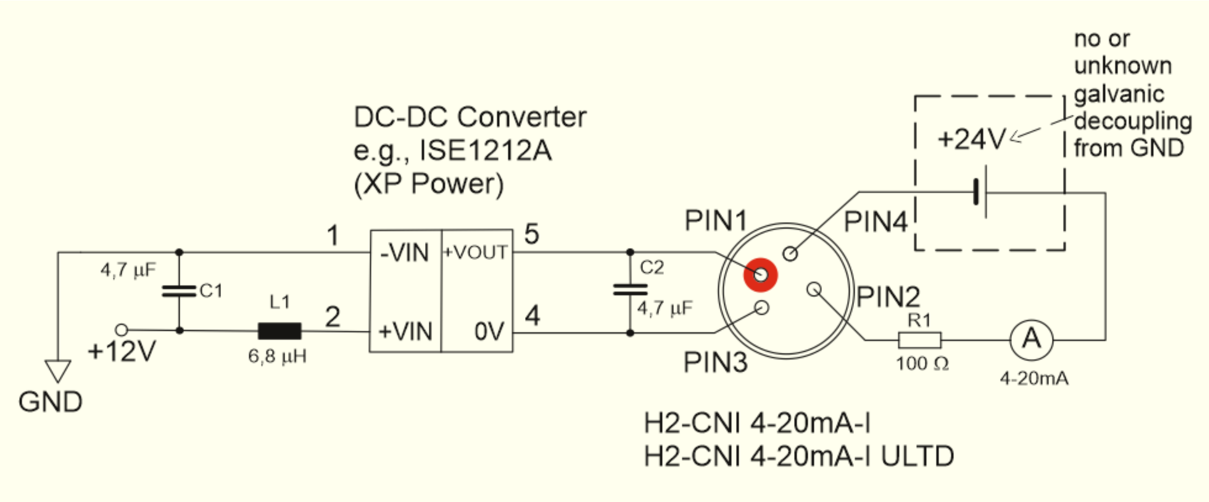

Figure 15: Recommended circuit with DC-DC converter to isolate the supply voltage from ground (GND)

13.ORDERING INFORMATION

Hydrogen sensor H2- CNI 4-20mA-I

14.PACKAGING/SHIPPING INFORMATION

This sensor is shipped individually in an antistatic bag.

15. QUALITY CONTROL

Each sensor is tested before delivery. The test includes standard protocols and an exposure of the sensor to a hydrogen/air mixture with H_2 volume fractions above the low-explosion limit, performed at ambient temperature and pressure.

16. 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.

17.NOTES

18.WORLDWIDE SALES AND CUSTOMER SUPPORT

ALDERS electronic GmbH

Arnoldstraße 19 , 47906 Kempen (Germany)

sales@alders.de

+49 2152 8955-230