HLS-442

Automotive Hydrogen Leak Sensor

General Description

The HLS-442 automotive hydrogen leak sensor monitors hydrogen concentrations of 0 – 4.4% in air. The sensor is a leak sensor developed in accordance to IEC 61508 (SIL2) and explosion protected according to ATEX 100a. The predicted concentration is transmitted to the host via the CAN bus interface. HLS-442 utilizes self-calibration that is performed automatically when operated in air with normal hydrogen concentration. Therefore, the HLS-442 should not continuously be operated in elevated background levels of

hydrogen.

Ordering Information and Content Guide appear at end of datasheet.

Key Benefits & Features

The benefits and features of HLS-442, Automotive Hydrogen Leak Sensor are listed below:

Figure 1:
Added Value of Using HLS-442

Benefits	Features
• High sensitivity and excellent selectivity to hydrogen gas	• 0–4.4% H_2 in air • Accuracy ±3000 ppm at normal operation
• Low cross sensitivity	• Heated field-effect transistor technology • No detection towards HC, H_2S, N_2, CO, CO_2, NO_x, H_2O • Humidity influence not detectable
• Fast response time	• Start-up time <5s • Speed of response (t_{90}) < 2s • Speed of recovery < 10s • CAN bus interface 500 kbit/s (ISO11898-2) • PWM output (on request)
• Low power consumption	• 75 mA (typical)
• Long-term stability and reliability	• ESD and EMC protection • Operating temperature range –40ºC to 85ºC
• Safety integrity level and explosion proof	• Designed for SIL2 (IEC 61508) and ATEX 100a zone 2
• Long lifetime	• IP67 qualified with expected lifetime of 10 years

Applications

Detection of hydrogen gas leaks in hydrogen powered vehicles by installing the sensor

- in the cabin ceiling
- under the hood of the engine compartment
- beneath the trunk lid of hydrogen powered vehicles

Detection of hydrogen gas in and around hydrogen fueling stations

Block Diagram

The functional blocks of this device for reference are shown below:

Figure 2:
HLS-442 Block Diagram

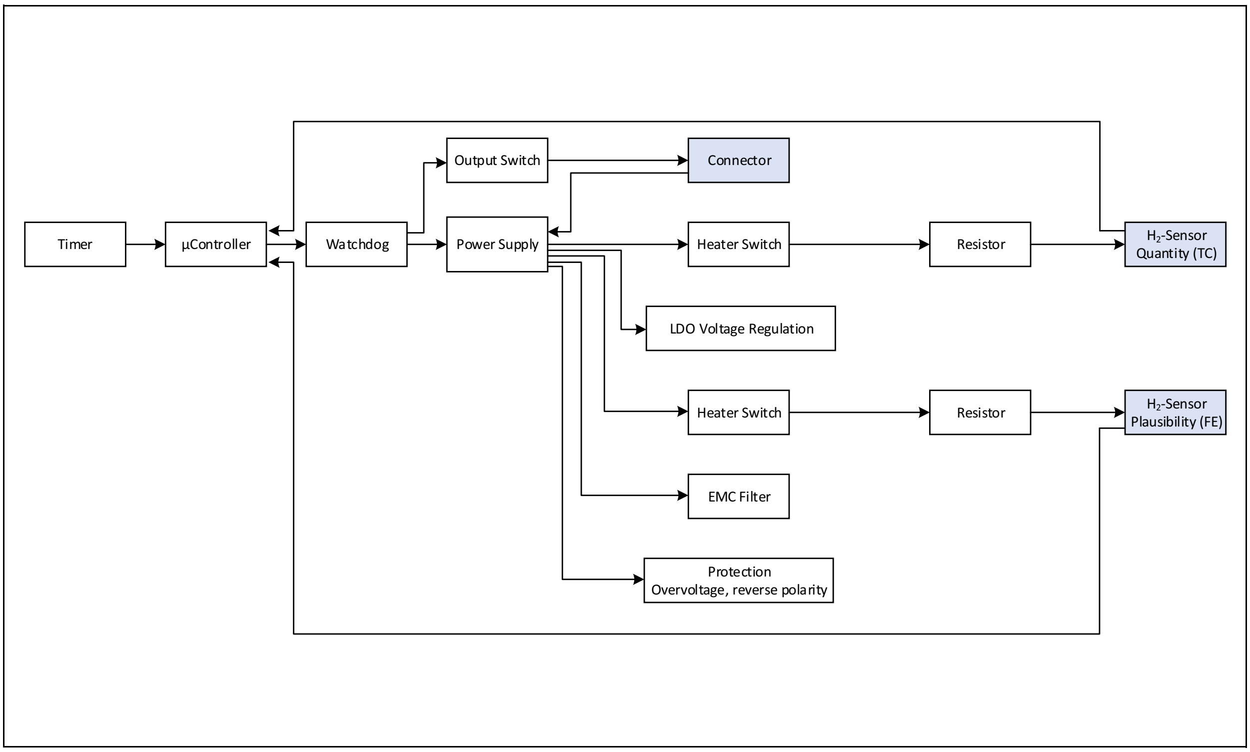


Figure 3:
HLS-442 Overview

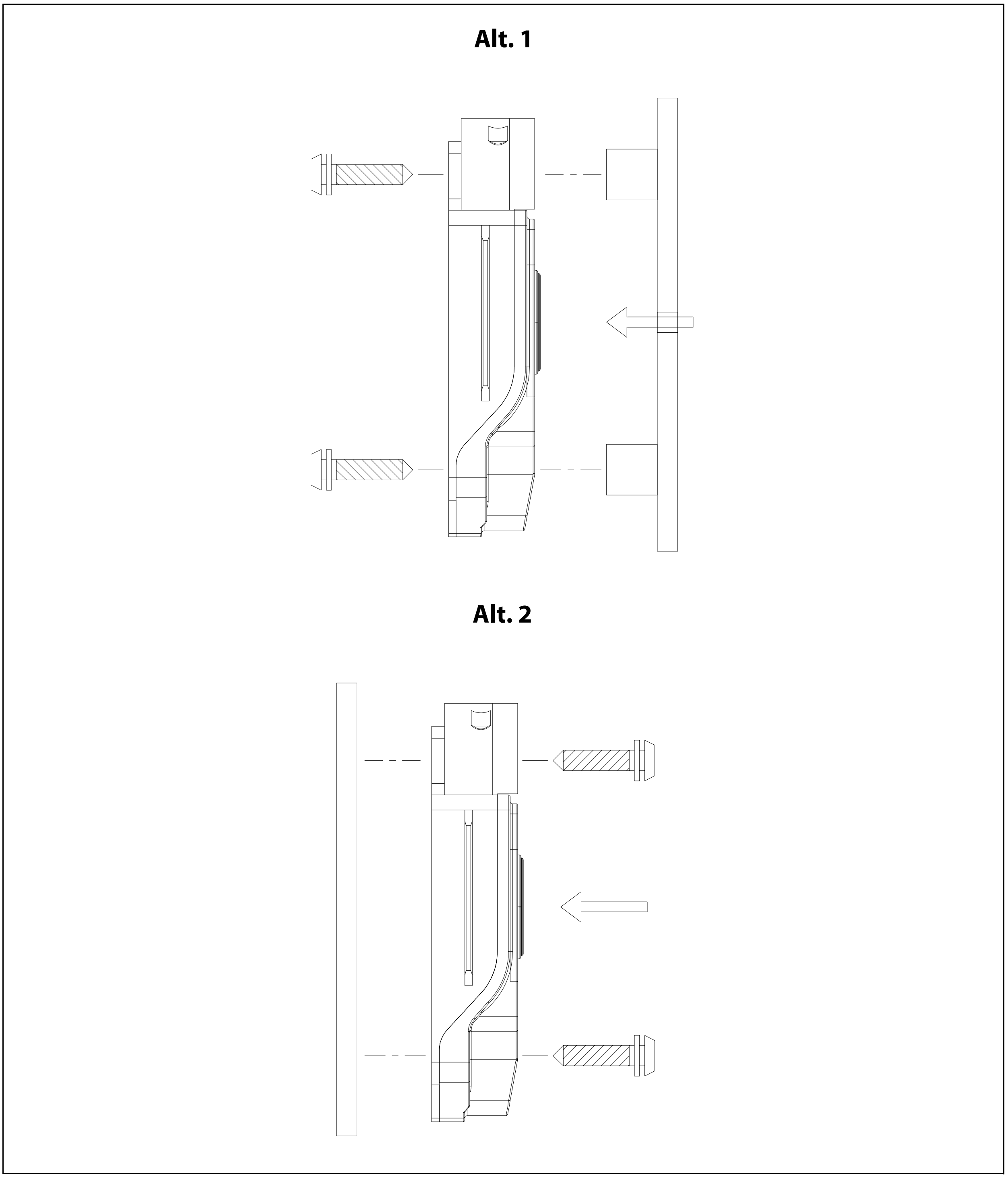
Installation

The HLS-442 is designed for either a sealed installation against a wall (using a gasket) [Alt. 1] or an open-air [Alt. 2] installation. The sensor can be oriented in any direction but the gas inlet must not be blocked.

Retaining pins or bolts shall be max Ø5.5 mm.

Maximum mounting torque 10 Nm.

Figure 4:
Mounting Positions



Electrical Interface

Electrical Connector

The sensor connector is A2100011199, 6-PIN Code A. Matching receptacle is a 6-pin MQS, TE Connectivity AMP p/n 1-967616-1 type A.

Figure 5:
Pin Coding AMP 1-967616-1 Type A

Figure 6:
Pin Assignment

Pin	Function
1	CAN – High
2	CAN – Low
3	Power UB0
4	Power UB1
5	Power UB2
6	GND

CAN Bus Interface

This section describes the CAN bus interface that is available in some variants of HLS-442.

Physical Interface

The physical interface is two-wire balanced, non-terminated. It is a high speed CAN interface (ISO 11898-2) with bus bit rate of 125, 250 or 500 kBit/s, depending on the variant of HLS-442.

Bus Identification

Each sensor and the control unit are identified on the bus by the CAN identity, CAN ID. The CAN ID is transmitted in the CAN data frame arbitration field. For the sensors the CAN ID is determined by the configuration of the power supply feeds, UB0 (pin 3), UB1 (pin 4) and UB2 (pin 5). The table below defines the sensor's CAN ID, VB denotes a power input connected to supply voltage level. Addresses are given in hexadecimal numbers and denoted with a leading "0x".

Figure 7:
Overview CAN ID Assignment By Power Supply Feeds

UB2	UB1	UB0	Sensor Number	CAN ID
		VB	1	0x640
	VB		2	0x648
	VB	VB	3	0x650
VB			4	0x658
VB		VB	5	0x660
VB	VB		6	0x668
VB	VB	VB	7	0x670

Messages From the Sensor

The main message sent from the sensor to the control unit is the Sensor Status Message, hereafter referred to as the SSM.

After 700 ms from power-ON of the sensor it will start sending the SSM frame as defined below. The SSM, after this event, is transmitted periodically with a 100 ms interval until the sensor is powered OFF. Besides the SSM, the sensor can also send a Wake-Up pulse. This is described in detail in Wake-Up Function. The Wake-Up pulse is separate from the SSM and has no impact on the SSM.

The figure below defines the data field of the SSM CAN data frame. The data field uses 8 bytes. The CAN ID as described earlier sets the arbitration field.

Figure 8:
CAN Matrix Message Layout

Parameter Name	Data Size	Physical Measurement Range	Value Range	b7	b6	b5	b4	b3	b2	b1	b0	Byte No.
H_2 Concentration	8 bits	0 – 4.4 %	[20 -240]	H_2 Concentration								0
Protection Value 1	8 bits			pv1								1
FE high	8 bits			FE high								2
CRC16 Byte 1 (Higher Byte)	8 bits			CRC16								3
FE low	2 bits			FE low		0						4
Protection Value 2	2 bits									pv2		4
Sensor Number	3 bits		[1 - 7]				UB 2	UB 1	UB 0			4
Msg. Counter	8 bits		[0 - 255]	Msg Counter								5
Sensor status	2 bits		[0 - 3]						status		0	6
Part number	5 bits		[1 - 31]	Part number							0	6
CRC16 Byte 2 (Lower Byte)	8 bits			CRC16								7

H_2 Concentration

0% is encoded with decimal number 20.

4.4% (44000 ppm) is encoded with decimal number 240.
The relation between detected H_2 concentration (in ppm) and concentration code as signaled in the message is:

(EQ1) Code = round(H_2/200) + 20

(EQ2) H_2 = (code – 20)*200

Where round() denotes rounding towards the nearest integer.

Protection Value

The protection value offers a 10-bit consistency check of the transmitted concentration, status and message counter. The following pseudo code describes the algorithm forming the 10-bit value and how it is projected on to the protection value 1 and the protection value 2 bytes in the SSM.

code[7 - 0] denotes the set of 8 bits transmitted as code for representing the H_2 concentration.

status[1 - 0] denotes the set of two bits transmitted as code for representing sensor status.

mgscnt[6 - 0] denotes the set of 7 bits transmitted as code for representing message counter.

pv[9 - 0] denotes the set of 10 bits forming the protection value.

pv1[7 - 0] denotes the set of 8 bits transmitted as code for protection value 1.

pv2[1 - 0] denotes the set of 2 bits transmitted as code for protection value 2.

Figure 9:
Pseudo Code Description of Protection Value

Pseudo Code	Description
pv[9 - 8] = status[1 - 0]	Assign two most significant bits of pv as the status bits
pv[7 - 0] = code[7 - 0]	Assign 8 least significant bits of pv as the code bits
pv[9 - 0] = pv[9 - 0] + msgcnt[1 - 0]	To pv add the number formed by two least significant bits of the message counter
pv[9 - 0] = NOT pv[9 - 0]	Perform bitwise inverse of pv
pv[9 - 0] = pv[9 - 0] + 1	To pv add 1
pv1[7 - 0] = pv[7 - 0]	Form protection value 1 of the 8 least significant bits of the 10-bit protection value
pv2[1 - 0] = pv[9 - 8]	Form protection value 2 of the 2 most significant bits of the 10-bit protection value

FE High / FE Low

The raw FE signal is available in 10-bit resolution (1 step = 4mV). The high 8 bits are available in byte 2 and the lower 2 bits in byte 7, bit 6-7. The data range is 0-4092mV.

CRC16

Byte 3 and byte 7 form a 16-bit CRC value. The CRC is CCITT CRC16.

Sensor Number

Sensor Number is defined by power supply feeds and CAN ID assigned sensor number is repeated in byte 4 bit 2-4. The value sent is given in Bus Identification.

Message Counter

The message counter is incremented by 1 after each transmission of a SSM frame. After the counter reaches 255 it wraps around and the next transmitted counter value becomes 0. At sensor start-up the message counter begins at 1.

Status

The figure below defines the status encoding of b1 and b2:

Figure 10:
The Status Encoding of b1 and b2

Status	Encoding b2:b1	Name	Description
0	0:0	No error	Sensor fully functional
1	0:1	Minor error	Main function ensured, but possible impairment of measuring quality.
2	1:0	Minor functional error	Main function ensured, but impaired (the sensor should be replaced)
3	1:1	Fatal functional error	Sensor is not functioning correctly.

Part Number

The part number defines the release number encoding of b3-b7.

PWM

This section describes the PWM output that is available on request for the HLS-442.

Physical Interface

The electrical connector is the same as in the variants with CAN bus interface (see Electrical Connector). The power can be applied to any of pin 3–5 (Power UB0–UB2). In the case of PWM output, it does not matter which of these pins that are used. The PWM signal is created as a differential CAN signal on pin 1 and 2. A CAN signal is said to be in a dominant state when the signal lines are separated (a dominant bit is transmitted). When the signal lines are at the same voltage level, the state is recessive. Recommended circuitry to convert CAN signals to TTL is specified in a separate document, available on request. The PWM signal is only an output signal. No messages can be sent to the sensor.

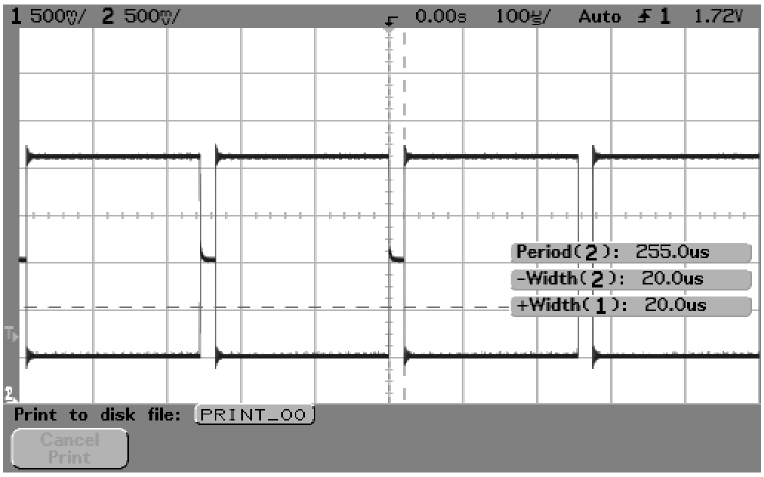
The PWM Signal

The PWM signal has a period time of 255 µs. The rather short period is chosen since modern CAN transceivers do not allow for a longer dominant state.

The duration of the recessive state can be translated into output H_2 prediction from the sensor module. The recessive duration (pulse width) ranges from 20 to 240 µs, which corresponds to 0 to 4.4% hydrogen. An internal error is shown as a 10 µs pulse width.

The figure below shows the output for 0% hydrogen (pulse width of 20 µs).

Figure 11:
Sensor Output for 0% Hydrogen (Pulse Width of 20 µs)



The relation between detected H_2 concentration (in ppm) and pulse width (in µs) is:

(EQ3) H_2 = (pulse width − 20)*200

The figure below shows the relation between H_2 prediction and pulse width.

Figure 12:
The Relation between H_2 Prediction and Pulse Width

Pulse Width	Message Type
10 µs	Error
20 µs	0% H_2
21 µs	0.02% H_2
...	...
239 µs	4.38% H_2
240 µs	4.4% H_2

Specifications

Figure 13:
Typical Characteristics

Description	Value
Sensor Function	
Target gas	Hydrogen (H_2)
Concentration range	0 – 4.4% H_2 in air
Accuracy	± 3000 ppm
Resolution	200ppm
Speed of response (t_{90})	<2s
Speed of recovery	<10s
Cross-sensitivity	None towards HC, H_2S, N_2, CO, CO_2, NO_x Low humidity influence during a H_2 event. None in air.
Start-up time (1)	<5s, first message after 700 ms
Expected lifetime	10 years
Safety	
Safety Integrity level	Designed for SIL2
Explosion proof	Designed for ATEX zone 2
Self test/Error handling	Yes
Electrical	
Supply voltage	9V – 16V
Supply current	75mA typical
CAN interface (1)	ISO 11898 Version 2.0 b
Programmable CAN ID (1)	on request
CAN bit rate (kbit/s) (1)	standard 500 (on request 125, 250)
PWM Output (1)	on request
Connector	A2100011199, 6-PIN Code A
Mating Connector	MQS 6-pin, AMP p/n 1-967616-1 type A
ESD/Reverse polarity	Yes

Description	Value
Environmental	
Operation temperature range	-40°C to 85°C
Storage temperature range	-50°C to 85°C
Humidity	5-95% (non-condensing)
Pressure	70-130 kPa
EMC	Automotive requirements
IP code	IP6K7
Mechanical	
Dimensions (LxWxH)	82.2x42x17.3mm
Weight	50g
Material	PBT GF30
Filter membrane	Pall SUPOR 450R, 0.45 µm.

Note(s) and/or Footnote(s):

1. These features depend upon the version of HLS-442. See figure below

Figure 14:
Specification of the Different Variants of HLS-442

Description	Default	On Request		
Start-up time	<5 s			
CAN interface	Version 2.0 ISO 11898			n.a.
Programmable CAN ID	Pre-programmable on request			n.a.
CAN bit rate (kbit/s)	500	125	250	n.a.
PWM output	-			Yes

Handling Instructions

Due to the fact that the sensor element consists of a silicon chip facing the environment the following precautions have to be taken into account:

Prevent sensor from:

- Humidity (condensing conditions)
- Dropping
- Dust
- Mechanical impact, especially the entrance membrane
- Electromagnetic radiation (RF fields, high magnetic fields during storage)

Long term storage of sensors should be done in nitrogen filled ESD bags to protect the sensor.

Reference Data

Figure 15:
Concentration Measurement with H_2 Pulse Width of 2 min and Nominal Concentration 0.2%, 1.5%, 2.5% and 3.5% vol. H_2

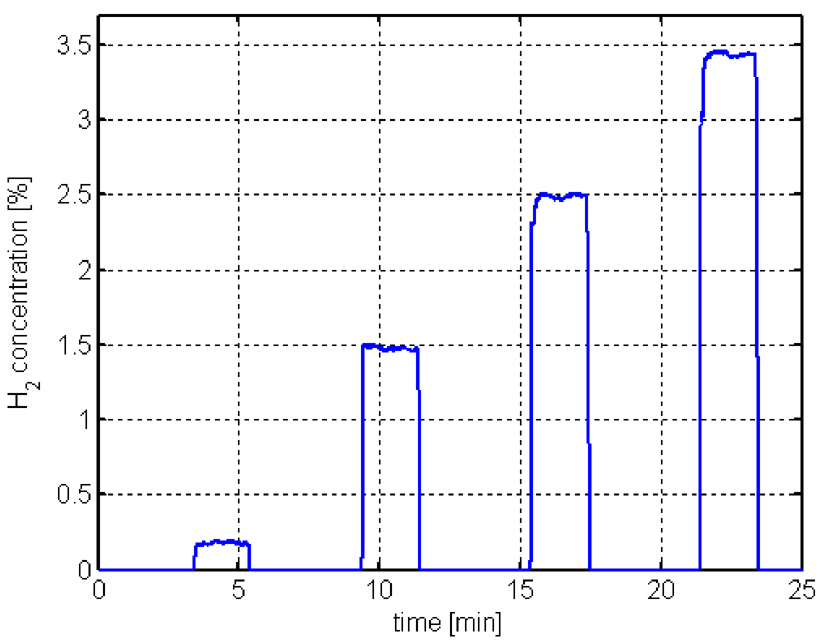
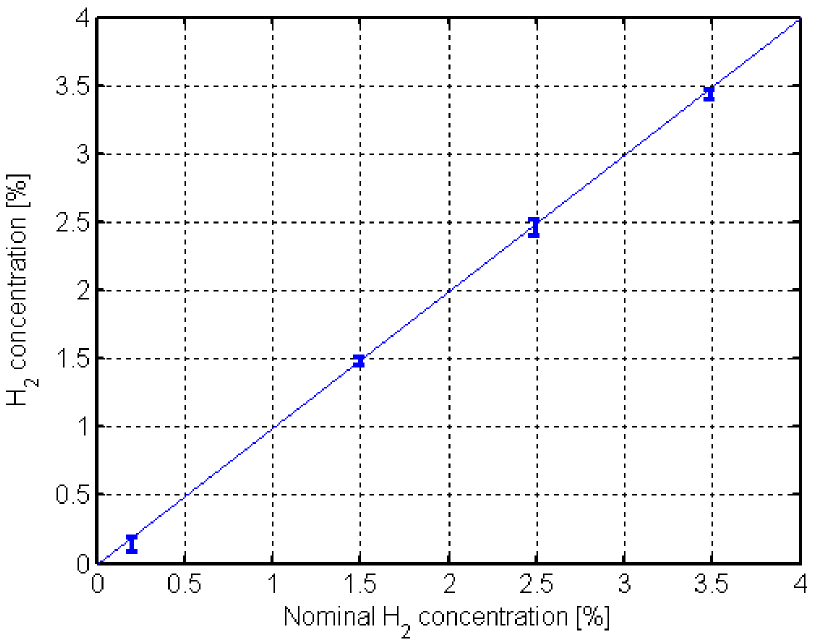


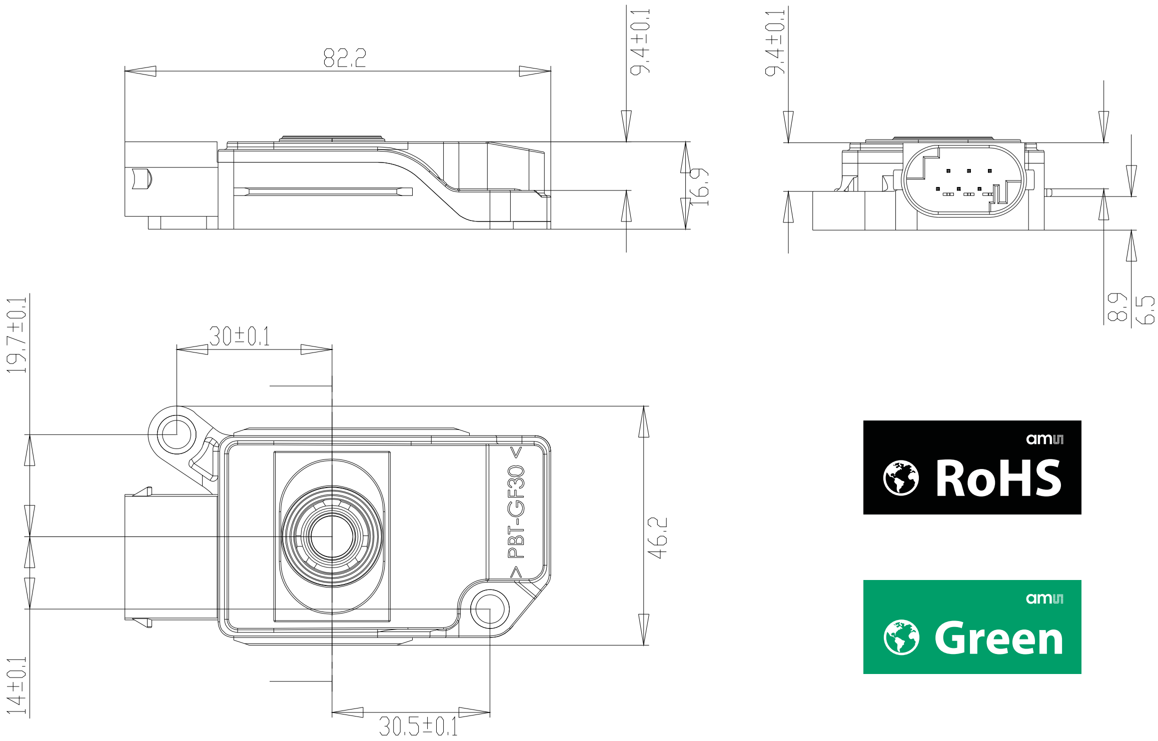
Figure 16:
Deviation of Prediction Over Nominal Concentration



Mechanical Information

Dimensions

Figure 17:
Sensor Dimensions



Note(s) and/or Footnote(s):

1. Dimensions are in millimeters.

Ordering & Contact Information

Figure 18:
Ordering Information

Ordering Code	Type	Delivery Form	Delivery Quantity
HLS-442	CAN (500 kbit/s) (1)	Individually Wrapped	Single Item

Note(s) and/or Footnote(s):

1. For availability of other variants contact **ams**.

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Headquarters
ams AG
Tobelbaderstrasse 30
8141 Unterpremstaetten
Austria, Europe

Tel: +43 (0) 3136 500 0

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Revision Information

Changes from (2014-Dec) to current revision 1-00 (2015-Mar-30)	Page
Content of Applied Sensor datasheet was updated to the latest **ams** design	

Note(s) and/or Footnote(s):

1. Page and figure numbers for the previous version may differ from page and figure numbers in the current revision.
2. Correction of typographical errors is not explicitly mentioned.

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