

HLS-440

Automotive Hydrogen Leak Sensor



HLS-440

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Automotive Hydrogen Leak Sensor

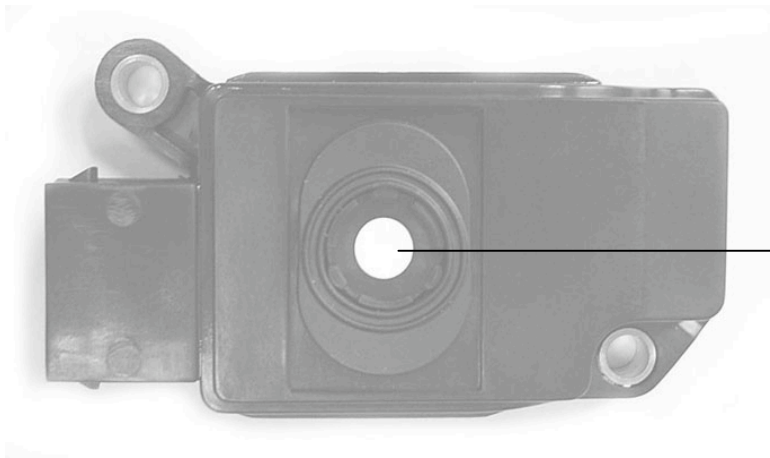
Introduction

The HLS-440 Automotive Hydrogen Leak Sensor monitors hydrogen concentrations of 0-4.4% in air. The sensor is a safety sensor developed in accordance to IEC 61508 (SIL2) and explosion protected according to ATEX ZONE 2. The predicted concentration is transmitted to the host via the CAN bus interface.

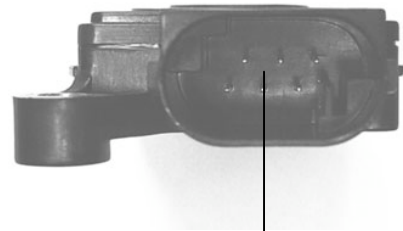
Main features

- Excellent selectivity to Hydrogen.
- No humidity influence.
- Speed of response < 2s.
- Start-up time 1000ms.
- Accuracy ± 3000 ppm at normal operation.
- Operating temperature range -40 to $+110$ °C.
- Designed for SIL2 and ATEX zone 2.
- ISO 11898-2 CAN bus interface.
- ESD and EMC protection.
- Designed for IP67.

Overview



Gas inlet filter



Power and
CAN bus
connector

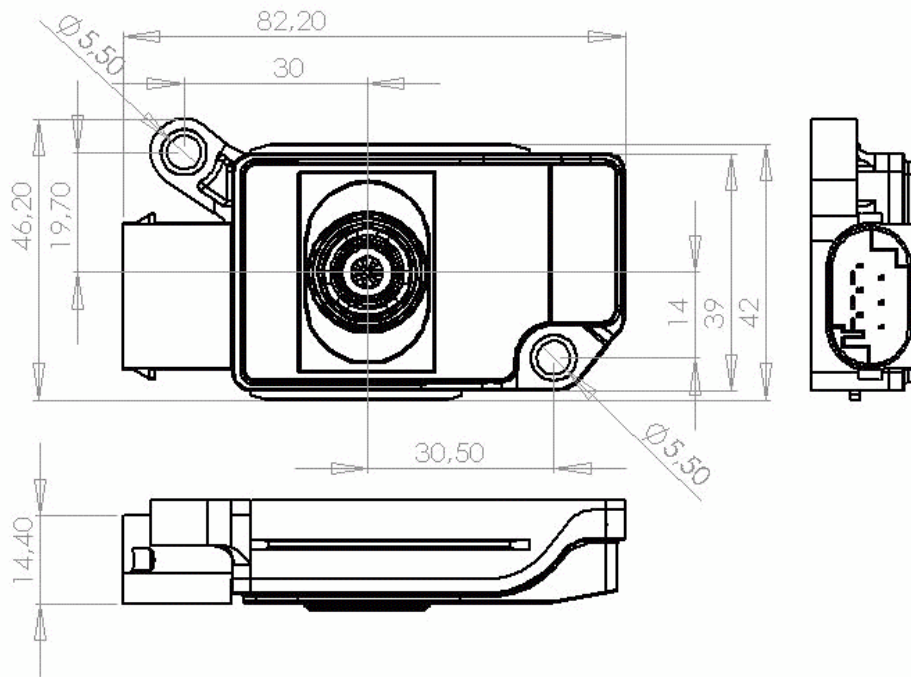


Mounting holes

Mechanical

Dimensions

Dimensions in millimeters. Tolerance ± 0.1 mm.

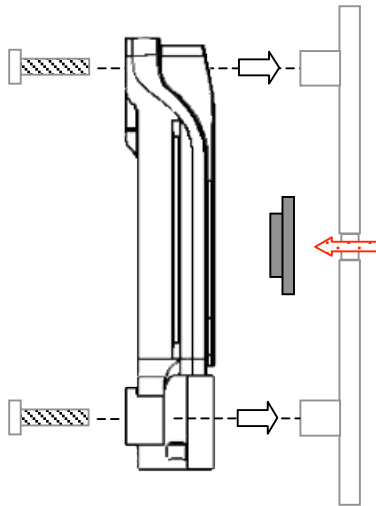


Installation

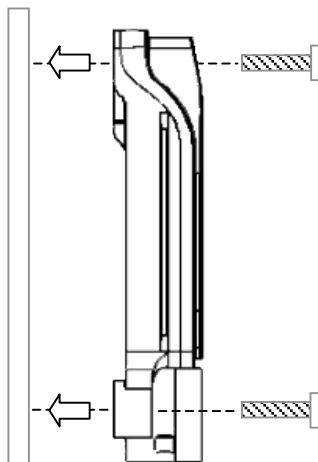
The HLS-440 is designed for either a sealed installation against a wall (using a gasket) or an open-air installation. The sensor can be oriented in any direction but the gas inlet must not be blocked.

Retaining pins or bolts shall be max $\text{Ø}5.5$ mm.

Alt. 1



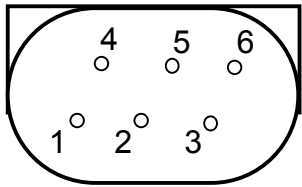
Alt. 2



Electrical Interface

Electrical Connector

The sensor connector is a 6-pin MQS type. Matching receptacle is AMP p/n 1-967616-1.



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

CAN bus interface

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 at 500 kBit/s.

Bus Identification

Each sensor and the control unit is 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 battery voltage level. Addresses are given in hexadecimal numbers and denoted with a leading "0x".

UB2	UB1	UB0	Sensor Number	CAN ID (M1)
		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 the Wake-Up function section. The Wake-Up pulse is separate from the SSM and has no impact on the SSM.

The table 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.

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
ACK limit values	8 bits			Lower Limit			Upper Limit			0	0	2
CRC16 Byte 1 (Higher Byte)	8 bits			CRC16								3
Protection Value 2	2 bits			0	0	0				pv2	4	
Sensor CAN ID	3 bits		[1..7]	0	0	0	Ub2	Ub1	Ub0			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

H₂ Concentration

0% is encoded with decimal number 20. 4.4% (44000 ppm) is encoded with decimal number 240. The relation between detected H₂ concentration (in ppm) and concentration code as signaled in the message is:

$$code = round(H_2/200) + 20$$

$$H_2 = (code - 20)*200$$

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 H2 concentration.

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

msgcnt[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.

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

Acknowledged Limit Values

The function of the acknowledged limit values is to reflect the limits used by the Wake-up functionality. The values reported correspond to the values stored in the non-volatile memory.

CRC16

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

Sensor CAN ID

Sensor CAN ID is defined by b2-b4, see chapter **Error! Reference source not found.** The value sent is the Sensor Number.

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.

Status

The table below defines 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.

Wake-up Function

The Wake-Up function is a feature of the sensor for sending a Wake-Up pulse on the CAN bus, given a set of pre-requisites. The Wake-Up pulse is sent 800 ms after power-on.

If all of the following conditions are satisfied, the sensor will send the Wake-Up pulse and then revert to normal operation. First, the function itself must be activated. Second, the function is only checked after 800 ms from power-on. Third, the estimated Hydrogen concentration at $t = 800$ ms must fall out of a specified concentration range. The Wake-Up pulse corresponds to applying a bus dominant state for 2 ms. The activation of the Wake-Up function and the setting of the concentration range are done with the command described in the Messages from Control Unit to Sensors section.

At delivery the Wake-Up function is deactivated.

Messages from control unit to sensors

A single type of message is sent from the control unit to the sensors, hereafter referred to as the Sensor Command Message, SCM. The SCM is identified on the bus by having the CAN address 0x059. The CAN address is sent in the CAN data frame arbitration field.

The SCM consists of one CAN frame and is transmitted from the control unit when a change in the stored limit values defining the concentration range used by the Wake-Up function is desired.

The table below defines the data field of the SCM frame. The data field uses up 8 bytes.

Parameter	b7	b6	b5	b4	b3	b2	b1	b0	Byte No
Interval limits sensor 1	Lower Limit			Upper Limit			0	0	0
Interval limits sensor 2	Lower Limit			Upper Limit			0	0	1
Interval limits sensor 3	Lower Limit			Upper Limit			0	0	2
Interval limits sensor 4	Lower Limit			Upper Limit			0	0	3
Interval limits sensor 5	Lower Limit			Upper Limit			0	0	4
Interval limits sensor 6	Lower Limit			Upper Limit			0	0	5
Interval limits sensor 7	Lower Limit			Upper Limit			0	0	6
Message counter	8 bit incrementing counter value								7

The encoding of the Lower and Upper Limits uses three bits and features the same encoding given in the table below:

Lower limit	b7	b6	b5	H2 concentration %
Upper Limit	b4	b3	b2	
	0	0	0	0.00
	0	0	1	0.25
	0	1	0	0.50
	0	1	1	1.00
	1	0	0	1.50
	1	0	1	2.00
	1	1	0	4.00
	1	1	1	Function deactivated

The message counter must be incremented after each transmitted SCM. If a sensor detects a non-incremented counter value (comparing last received) that SCM and all subsequent SCM will be disregarded.

If either or both the Lower and the Upper Limit is set to 7 (1:1:1) for a specific sensor the Wake-Up function of that sensor will be deactivated.

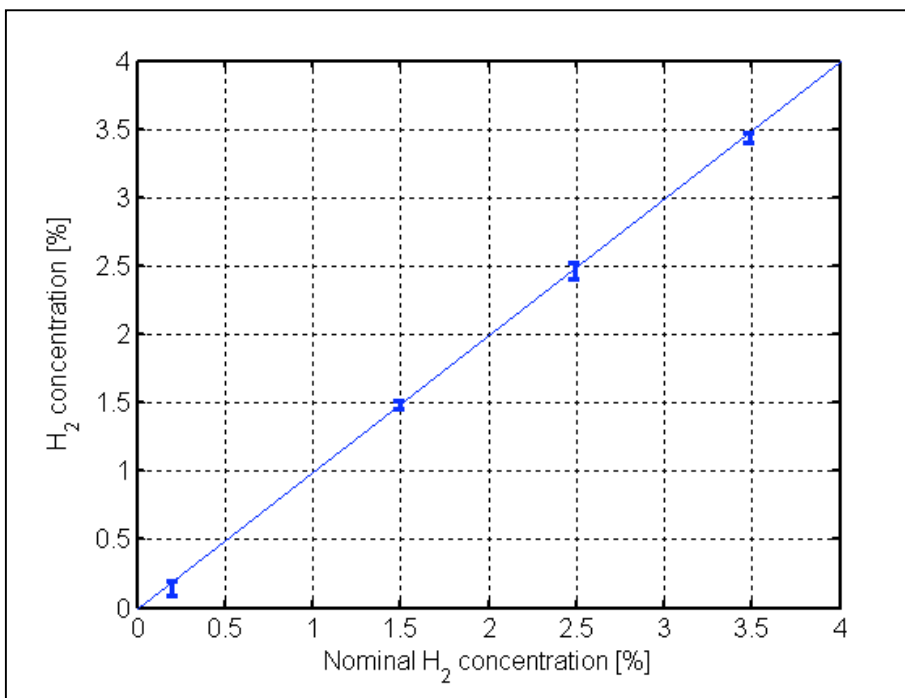
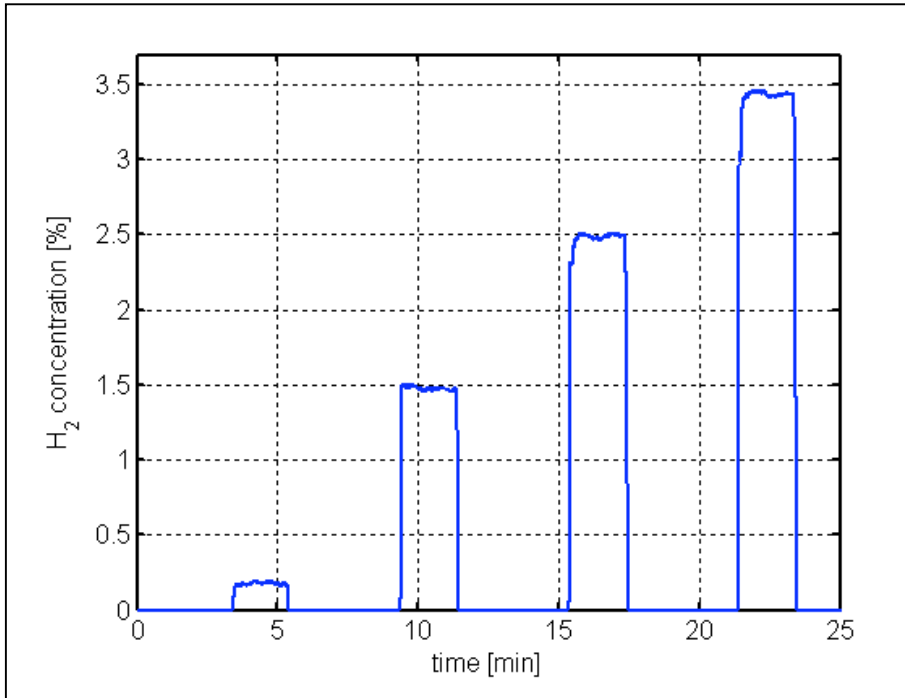
The sensor will start to listen for SCM's after the first SSM has been sent. SCM frames sent prior to this event will therefore be disregarded.

A successfully received SCM will result in the corresponding limit values being stored in the respective sensor's non-volatile memory. The stored values are then reflected in the next SSM. However, as the actual use of the set range is only performed at a single time after power-on and prior to SCM being accepted, it will not take effect, from a Wake-Up functionality point of view, until the next power off/on cycle.

Specifications

Sensor function	
Target gas	Hydrogen
Concentration range	0-4.4% H ₂ in air
Accuracy	+/- 3000ppm
Resolution	200ppm
Speed of response (t ₉₀)	<2s
Speed of recovery	<10s
Cross-sensitivity	None towards HC, H ₂ S, N ₂ , CO, CO ₂ , NO _x Low humidity influence during a H ₂ event. None in air.
Start-up time	1000ms
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	9 -16V
Supply current	75mA typical
CAN interface	Version 2.0 ISO 11898
Programmable CAN ID	Yes
Connector	MQS 6-pin, AMP p/n 1-967616-1
ESD/Reverse polarity	Yes
Environmental	
Operation temperature range	-40 to +110 °C
Storage temperature range	-50 to +125 °C
Humidity	5-95% including condensation
Pressure	70-130 kPa
EMC	GMW 3097
Mechanical	
Dimensions (LxWxH)	82.2x42x17.3mm
Weight	50g
Material	PBT +30% GF
Filter membrane	Pall SUPOR 450R, 0.45 µm.
IP code	Target IP67

Reference Data



HLS-440

Automotive Hydrogen Leak Sensor

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