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Product specification AZ65A
LIN2.1 triple-gas sensor AQS

This document describes the main characteristics and functions of the Automotive Air Quality triple gas-Sensor LIN-2.1 output. The information in this document are proprietary, and cannot be disclosed to a third party without prior written approval of SGX Sensortech.

The module is an Air Quality Sensor that measures changes in external pollution. It is to be placed at fresh-air inlet (bottom of the wind shield, side of water box) of the vehicle. It provides Air Quality information to the climate control unit to control the recirculation flap in order to minimize the pollution and odor level inside the cabin.

Features:

- Triple SMD semiconductor sensor inside
- High sensitivities to CO/Hydrocarbons, VOC's, NO2 and NH3
- High selectivity between diesel and gasoline vehicle
- Smart algorithms like special tunnels-management and auto-adaptive sensitivities
- LIN 2.1 output / Diagnostic Class II, sleep mode
- Self-diagnostic
- Standard 3 pins connector
- Watertight housing (IP6K6K)

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1 Document revision history

Rev.	Date	Description
01	Dec-26, 2019	Initial version.

2 Abbreviation explanations

Abbreviation	Explanation
AQS	Air Quality Sensor
LIN	Local Interconnect Network
CCM	Climate Control Module
EMC	Electro Magnetic Compatibility
DUT / EUT	Device Under test / Equipment Under test
MEMS	Micro Electro Mechanical System
BOM	Bill Of Materials
SMD	Surface Mount Devices
CS model	Check Sum model

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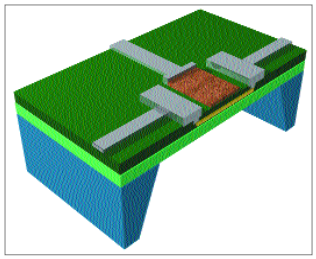
3 *Functional specifications*

3.1 Principle

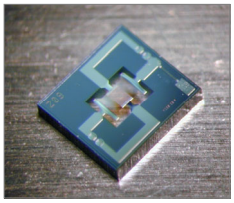
The AQS module includes an 8-bit micro-controller that interprets the triple sensing signals of the MiCS-6824 sensor and send formatted output data through a LIN-BUS signal that is representative of the pollution level relative changes on the road. Like the human nose, this sensor is based on relative changes in pollution or odors, rather than absolute measurements.

3.2

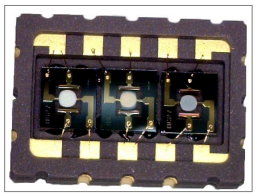
Sensor technology



SGX sensors are manufactured on silicon wafers based on MEMS technology developed initially by Motorola. A thin membrane is etched on the silicon chips as shown on the cross-section to the right. This provides very low thermal mass to the heating structure, and therefore very low power consumption.



The sensitive layers are made of nanoparticles that provide a very large contact area with the gases to be detected and therefore very good sensitivities.



The AQS module includes a MiCS-6824 sensor, which has three fully independent sensor chips, packaged in a SMD package. first sensing chip detects gasoline pollution events, such as those caused by cars and motorbikes, second detects diesel pollution events, such as those caused by diesel cars, buses or trucks, and the third one detects odors linked with ammonia gas like manure, chicken farm, rubbish treatment plant for example.

The detection thresholds of the MiCS-6824 are: approximately 1ppm for CO, 10 ppb for NO_2 and 100ppb for NH3. However, such small pollution steps might not trigger an output pollution level change on the AQS because the signal treatment algorithms are optimized for more significant pollution events.

3.3 Functional features

Semiconductor sensors require some time to reach their high temperature chemical balance. SGX has optimized this warm-up period to make the AQS operational after only 30 seconds following car ignition.
During 1st 30seconds, LIN output level is 14 (Init_level).

AQS software was designed to optimize the response time so that major pollution events can be detected within less than a second. The recovery times are typically longer than the response times but they are less critical in the application. The AQS algorithms were designed to ensure continuous flap closure when driving through tunnels, especially long ones.

The AQS software includes an algorithm that adapts the sensitivities to the road pollution conditions. This feature is useful to maintain an appropriate number of pollution detections whether the car is in heavy traffic with very frequent pollution events, or in the countryside with almost no pollution. In the first case, a medium level pollution will be unimportant because it will be lost in numerous cases of high pollution, and the human nose would not identify it. Such pollution should not, therefore, trigger a recirculation flap closure. The same pollution event occurring on an empty countryside road with very clean air should, however, trigger a significant pollution level change and a flap closure, to reflect the fact that a human nose would also detect it.

Auto-adaptation *(this basic concept was patented more than 20 years ago)* is therefore a useful feature.

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3.4 LIN-BUS Output signal

The LIN_BUS output signal are encoded according to customer Lin Definition File (LDF)

Baud rate: **19200 bps**

General Slave Properties	
Name	**AQS**
Protocol Version	2.0
Diagnostic	
P2Min	**10**
STMin	**10**
Node Address	
Configured NAD	**26**
Product Identifier	
Function ID	**0**
Supplier ID	**6**
Variant	**0**
Status Management	
Fault State Signals	<None>
Response Error Signal	**AQS_ResponseError**

Frame Properties	
CS Model	Enhanced
Frame ID	**16**
Is Dynamic	**False**
Name	**AQSs_01**
Publisher	AQS
Size	**8**
Subscribers	Klima_LIN1

Signal	Startbit	Publisher	Subscribers	Length [Bit]	Init Value	Unit	Encoding
AQS_Luftguete	0	AQS	Klima_LIN1	4	14		logical
AQS_ResponseError	4	AQS	Klima_LIN1	1	0		logical
AQS_Sensorheizung_Status	5	AQS	Klima_LIN1	1	0		logical
AQS_NoxWert	8	AQS	Klima_LIN1	10	0		physical
AQS_NoxBereich	18	AQS	Klima_LIN1	2	0		logical
AQS_NoxStatus	20	AQS	Klima_LIN1	4	0		logical
AQS_COWert	24	AQS	Klima_LIN1	10	0		physical
AQS_COBereich	34	AQS	Klima_LIN1	2	0		logical
AQS_COStatus	36	AQS	Klima_LIN1	4	0		logical
AQS_Parameter	40	AQS	Klima_LIN1	12	0		physical
AQS_Traffic	52	AQS	Klima_LIN1	2	0		logical
AQS_Toggle	54	AQS	Klima_LIN1	2	0		
AQS_HW	56	AQS	Klima_LIN1	4	0		physical
AQS_SW	60	AQS	Klima_LIN1	4	0		physical

The format is compatible with dual gas sensor as well. This is the reason why there is no specific mention of the third pollution level linked to NH3 pollutant in this configuration. Other configuration possible on request.

AQS_NoxStatus: pollution level generated by NO2 (or other oxidizing gases)
AQS_COStatus: pollution level generated by CO (or other reducing gases)
AQS_NH3Status: pollution level generated by NH3, not transmitted on LIN

AQS_Luftguete = MAX(AQS_NoxStatus, AQS_COStatus,AQS_NH3Status)

AQS_Luftguete : highest pollution level generated by any of the three sensors
AQS_NH3Status = AQS_Luftguete if (AQS_NoxStatus,&AQS_COStatus < AQS_Luftguete)

Air quality signal encoding table:

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Value	Description	Flap status
0	Clean air level	Open
1	Air quality level 10% (low pollution increase)	
2	Air quality level 20%	
3	Air quality level 30%	
4	Air quality level 40%	
5	Air quality level 50%	
6	Air quality level 60% (Flap closure threshold level[*1])	Closed
7	Air quality level 70%	
8	Air quality level 80%	
9	Air quality level 90%	
10	Air quality level 100% (max pollution increase)	
11	Not used	
12	Not used	
13	Not used	NA
14	Init Level	
15	Failure level	

*Note *1: Indicative flap closure level according to some OEMs commonly agreed operation*

3.5 Functional validation

As laboratory tests cannot be well correlated to road tests data, due to the complex and unstable chemical composition of exhaust gases, the more representative road test behavior is favored for functional validation purposes even though it is less repeatable than laboratory behavior. Laboratory tests with CO, NO_2 and NH3 nonetheless remain a necessary part of the validation. Because road tests can never be fully repeatable, the functional validation is a lengthy process requiring a large amount of time on the road with numerous sensors.

A functional validation on the road with SGX experts is usually necessary before any new car model is equipped with the AQS. Indeed, the software may need to be adapted to the specific platform HVAC configuration.

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3.6 Software description:

- For interfacing the hardware, SGX uses a NXP MCU build-in modules and their related methods.
- For signal treatment and AQS strategy SGX has developed its own proprietary algorithms based on homemade gas sensor knowledge and years of laboratory and road-test experiences.
- For interfacing the LIN-BUS and managing the LIN diagnostic class II, SGX has chosen to implement the LIN-validated driver stack from IHR (Germany).

Software block diagram

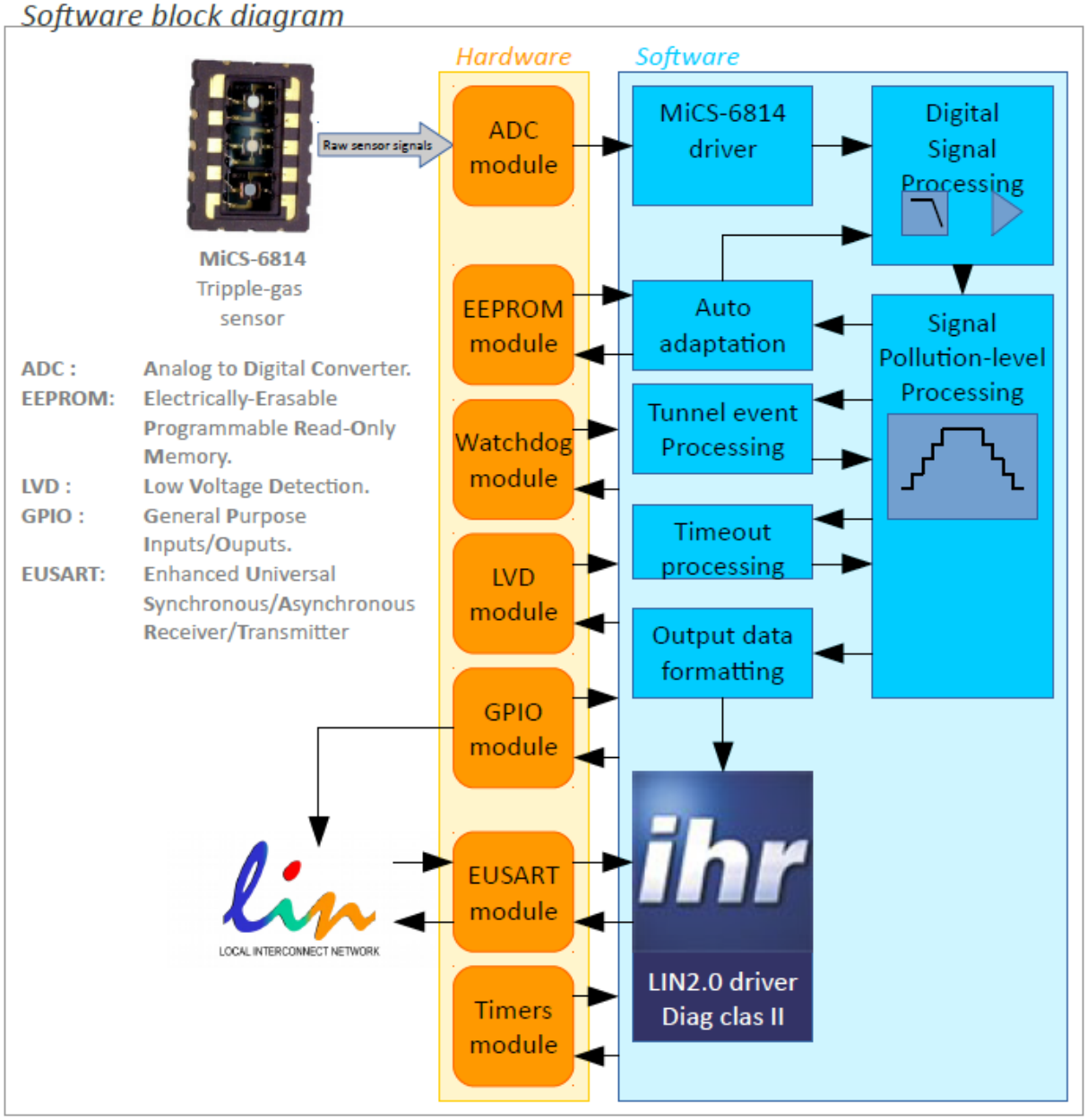

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Table of customizable software parameters:

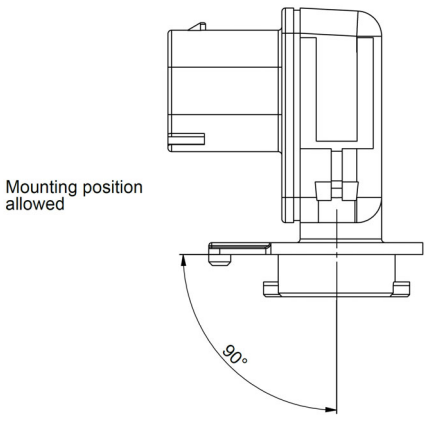
#	Parameters	Description	Range
1	TIME_EVENT_MIN	Minimum event duration time	From 1s to 255s
2	TIME_EVENT_MAX	Maximum event duration time (time_out)	From 1s to hours
3	TIME_TO_ADAPT	Time during the statistical analysis of event is done	10 minutes to hours
4	LEVEL_TO_ADAPT	Level threshold to close flap	1 to 10
5	NB_EVENT_TO_ADAPT	NB of flap closure level targeted every 10min	1 to 10
6	DEFAULT_GAIN_NO2	Gain set by default for NO2 channel	5 to 250
7	DEFAULT_GAIN_CO	Gain set by default for CO channel	5 to 250
8	DEFAULT_GAIN_NH3	Gain set by default for NH3 channel	5 to 250

3.7 Recommendation for integration in vehicle

This sensor has been specially designed to be installed at fresh-air inlet (bottom of the wind shield) of the vehicle.

The AQS module must be exposed to a source of external air at all times. The location must be chosen so as to maximize air exchange; dead spaces must be avoided. The membrane should not be exposed to direct pressure water jet.

AQS orientation is important to prevent accumulation of dirt or water onto air permeable membrane and ingress of water into connector; it is then recommended to follow mounting position allowed. The membrane can face down or horizontally (90° angle flexibility allowed) but not facing up.



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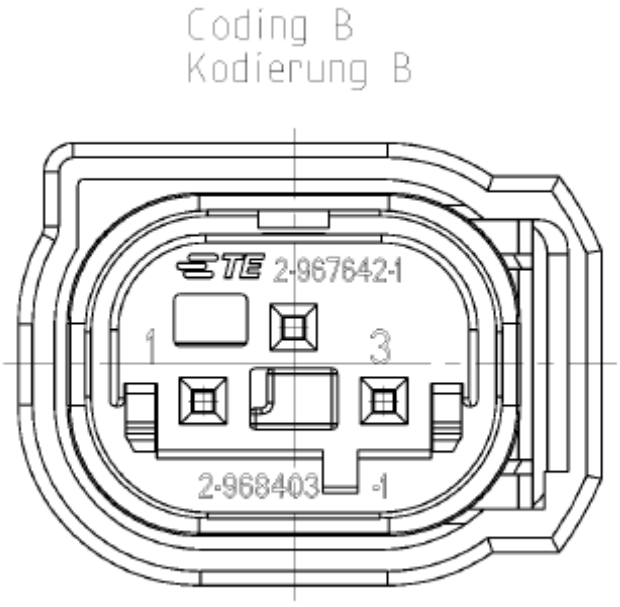
4 Environmental specifications

Operational temperature	-40°C to +85°C
Storage temperature	-40°C to +90°C
Humidity range	5% - 95% RH
Water tightness (with sealed connector)	IP6K6K

5 Electrical specifications

5.1 Main features

Connector type	AMP 967642-1 Coding B
Pinout	Pin1: VBat (Terminal-15) Pin2: Ground (Terminal-31) Pin3: LIN-BUS
Operating voltage	8..16V (AQS functions) 8..18V (LIN communication functions)
Nominal voltage	13.5V
Warm-up time	After 30s the sensor is operational During 30 sec following power on, the sensor output is forced to the init level (level-14).
Nominal current	<45 mA @13.5V, 10 µA in sleep mode
LIN protocol	2.1
LIN Diagnostic class	II



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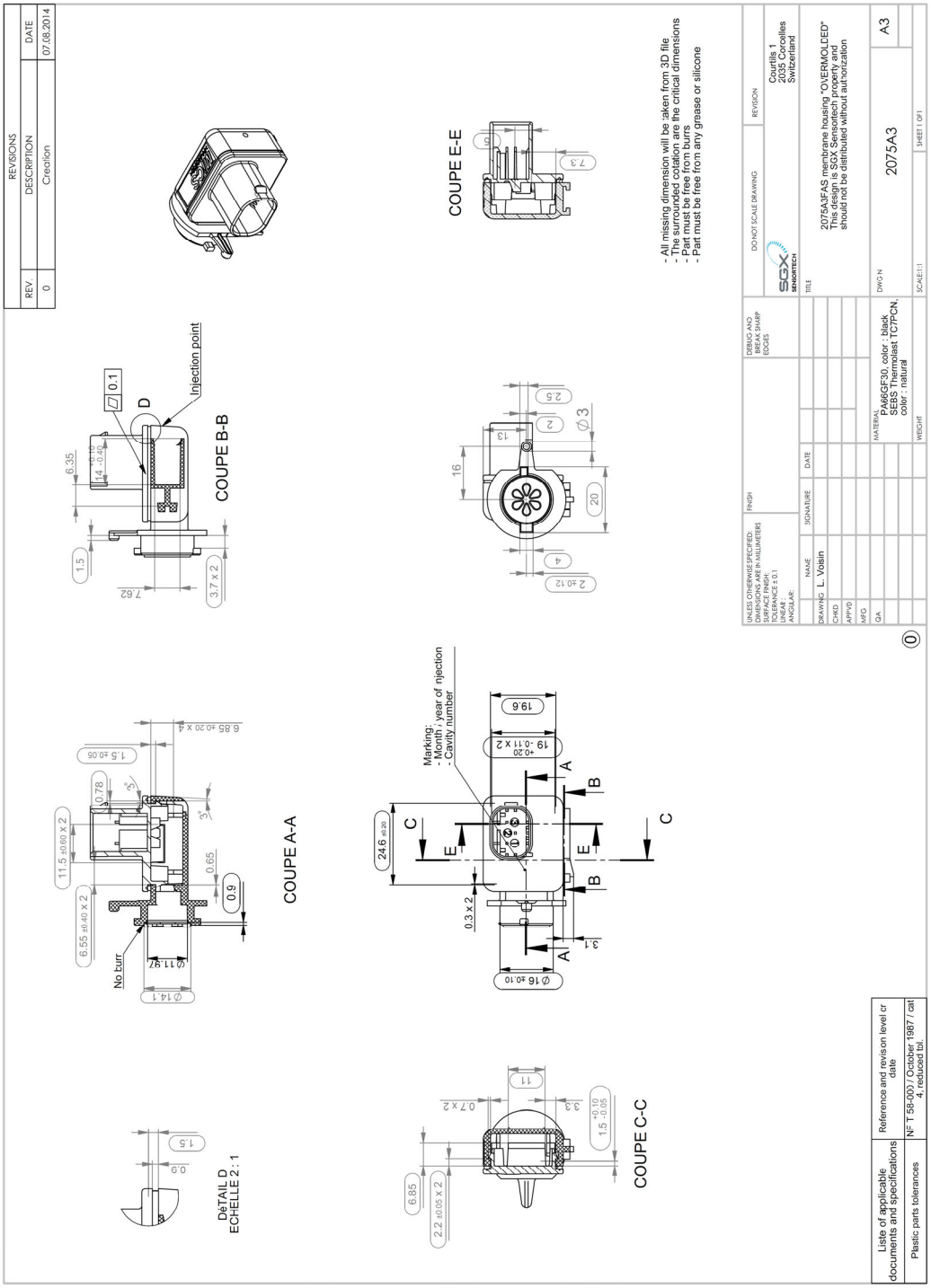
6 Mechanical specifications

6.1 Dimensions and weight



Total weight <15g

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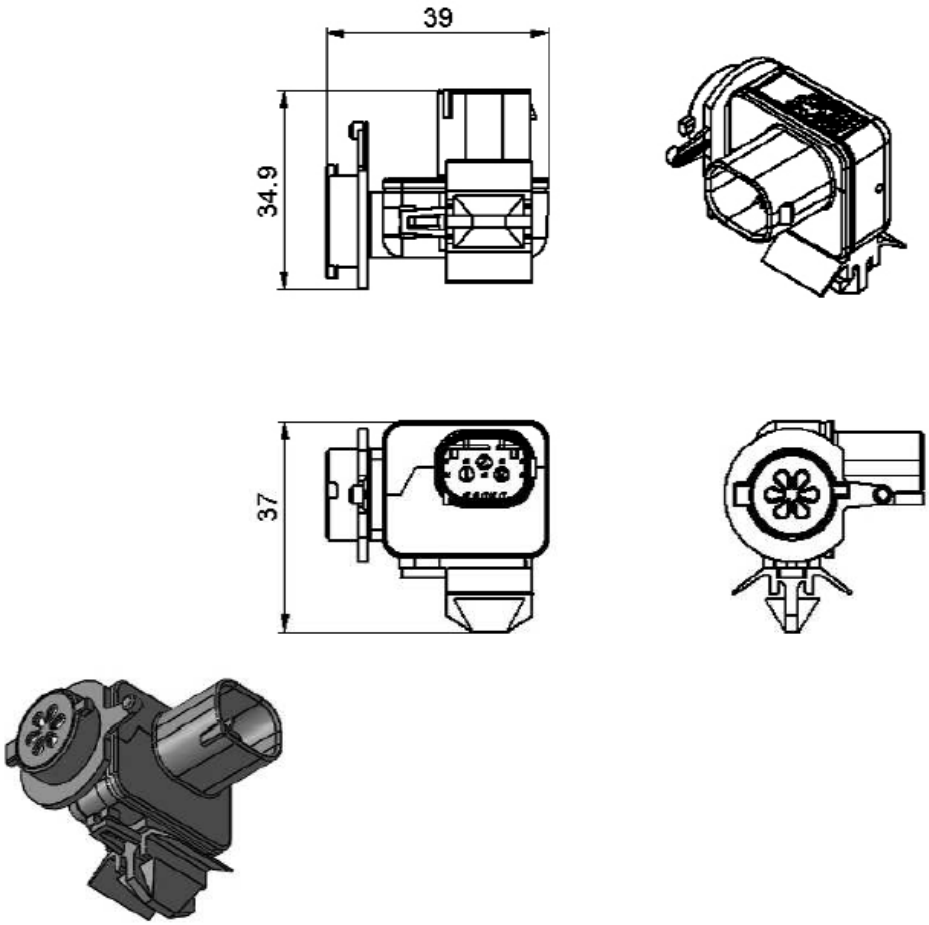
6.2 Dimensions with clip variant



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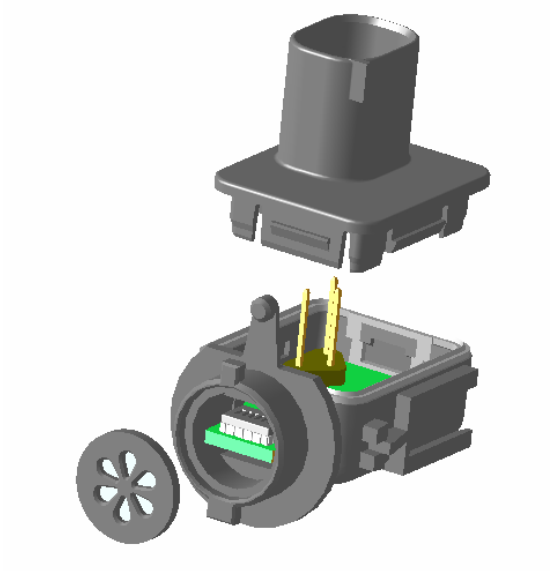
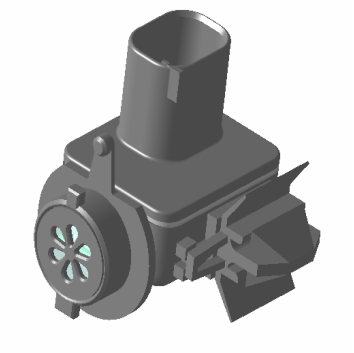
6.3 Main components





6.4 Bill of materials

Mechanical BOM

Part name	Material	Number per pc	Remark
Membrane housing	PA66GF30	1	incl. PTFE membrane
Connector housing	PA66GF30	1	
PCB assembly	FR4	1	incl. gas sensor
Clip	PA66	1	optional