

BODAS Inertial sensor MM7.10



- ▶ MEMS inertial sensor
- ▶ 3 acceleration and 3 rotation rate signals
- ▶ Output signal CAN (ISO 11898)
- ▶ Supply voltage 8 to 16 V
- ▶ Protection class IPX6K, IPX7K, IPX9k
- ▶ CE conformity

The inertial sensor is available as MM7.10 and MM7.10AC.

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Product description

The inertial sensor is available as MM7.10 and MM7.10AC.

Description MM7.10 and MM7.1AC

The purpose of the inertial sensor is to measure the physical effects of the yaw rate, rate of roll, and of transverse, longitudinal and vertical acceleration. When mounted appropriately (i.e. according to the offer drawing), the sensor measures the yaw and roll rates as well as the lateral, longitudinal and vertical acceleration of the vehicle.

In order to prevent signal interference or negative power supply impacts on the sensor, we recommend the supply of the sensor via the control unit or terminal 15 with separate ground connection.

Description Address Claiming

Address claiming is a method defined by SAE J1939 communications network. The product with Address Claiming functionality does not have predefined CAN-IDs. Instead, the product checks the CAN network for CAN-IDs that are occupied by other devices and chooses available CAN-IDs. This claiming procedure is conducted at every launch of the product. The claimed CAN-IDs are stored in the NVM (non volatile memory) of the product. Hence, speeding up the claiming procedure if no changes to the CAN-network were implemented in the meantime.

An identification routine is required to determine where a sensor with a specific CAN ID is in the system. The development of such a routine depends on the system. The identification routine must also be performed again when replacing a sensor with a Address Claiming functionality.

Please also consider "Technical Customer Documentation" 95179_TCD_MM7.10_Address_Claiming.

Vibration

Due to the sensor's sensitivity to acceleration across the entire frequency range, it is necessary to test the inertial sensor during the application approval process. Please also consider the data shown in the offer drawing.

Abbreviations

Abbreviation	Meaning
Ag	Silver
BCI	Bulk current injection
CAN	Controller area network
CE	Conformité Européenne
CISPR	Comité international spécial des perturbations radioélectriques
DC	Diagnostic coverage
DIN	German institute for standardization
ECU	Electronic control unit
EMI-Filter	Electromagnetic interference filter
EMC	Electromagnetic compatibility
EN	European standard
ESD	Electrostatic discharge
GND	Ground
IEC	International electrotechnical commission
IP	Ingress protection
ISO	International organization for standardization
LSB	Least significant bit
MEMS	Micro systems
MTTFD	Mean time to failure, dangerous
Ni	Nickel
NVM	Non volatile memory
PBT-GF	Glass fiber reinforced polybutylene terephthalate
PCB	Printed circuit board
RE	Rexroth document in English language
REACH	Registration, evaluation, authorisation and restriction of chemicals
RoHS	Restriction of hazardous substances
SMI	Sensor module inertial
SPI	Serial peripheral interface
t	Time
TCD	Technical customer documentation
t_{life}	Life time
U_{sup}	Supply voltage
ϑ_{op}	Operating temperature

Ordering code

01	02	03	04	05	06	07	08
		-	-	N	-	-	15

Type

01	Inertial sensor	MM7.10
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Address Claiming

02	Without Address Claiming (without code)	
	With Address Claiming	AC

Baud rate

03	250 kBaud	250
	500 kBaud	500

CAN ID

04	MM7.10	
	TX1: 18FF2330h TX2: 18FF2430h TX3: 18FF2530h	1
	TX1: 174h TX2: 178h TX3: 17Ch	2
	TX1: 130h TX2: 131h TX3: 140h	3
	TX1: 274h TX2: 278h TX3: 27Ch	4
	TX1: 374h TX2: 378h TX3: 37Ch	5
	Adress Claiming	
	TX1: 18FF26 TX2: 18FF27 TX3: 18FF28	6

CAN message deactivation

05	No	N
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CAN update rate

06	5 ms	5
	10 ms	10
	20 ms	20

Identifier length

07	11 bit	11
	29 bit	29

Bandwidth signal filter (frequency limit)

08	15 Hz	15
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Available variants MM7.10

Type	Material number
MM7.10-250-1-N-20-29-15	R917013321
MM7.10-250-2-N-5-11-15	R917013372
MM7.10-250-3-N-20-11-15	R917013363
MM7.10-250-4-N-5-11-15	R917013373
MM7.10-250-5-N-5-11-15	R917014192
MM7.10-500-2-N-10-11-15	R917013362
MM7.10-500-4-N-10-11-15	R917014617
MM7.10-500-5-N-10-11-15	R917014618

Available variants MM7.10 Adress Claiming

Type	Material number
MM7.10AC-250-6-N-10-29-15	R917014591
MM7.10AC-500-6-N-10-29-15	R917014590

Other variants on request.

Configurable parameters:

Baud rate, CAN ID, CAN message deactivation, CAN update rate, Big/Little Endianess format, Identifier Length, Bandwidth signal filter (frequency limit), No_Ack timing and Bus_Off timing.

Technical data

Ambient conditions

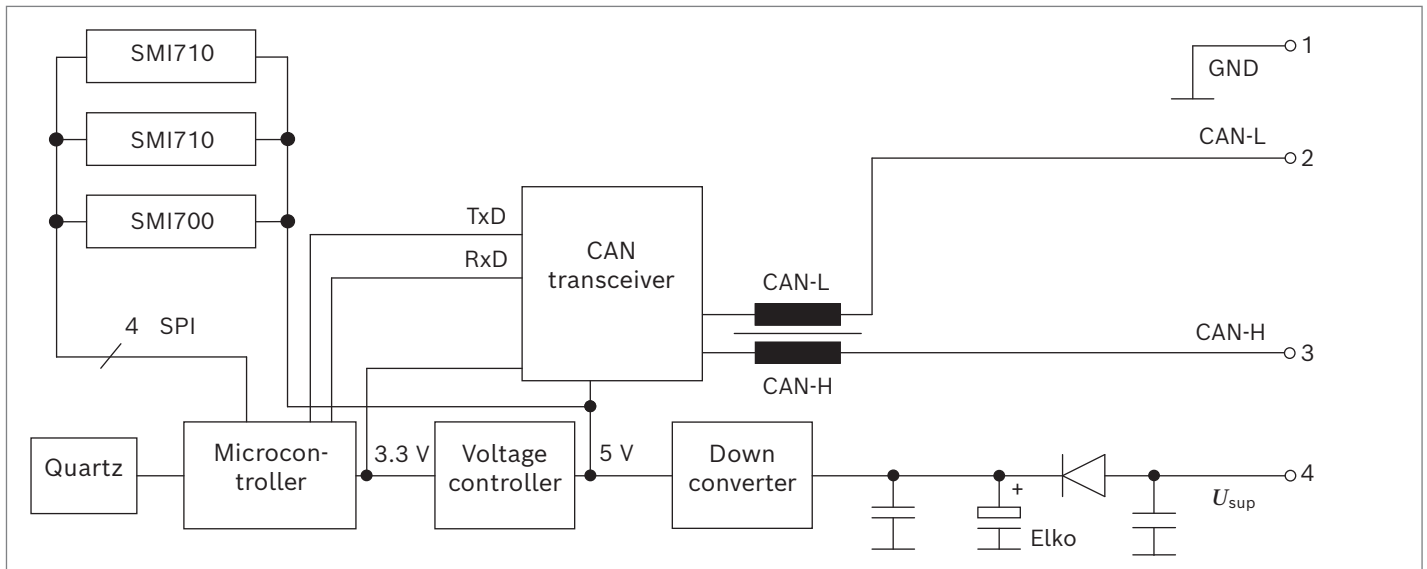
Parameters			
Storage time	At -40 ... +85 °C and 60% relative humidity		5 years
Service life			15 years
Operation time (UZ on) with the following temperature distribution	Temperature	Distribution	20000 h
	-40 °C	6 %	
	23 °C	20 %	
	40 °C	65 %	
	75 °C	8 %	
	80 °C	1 %	
Operating temperature range			-40 ... 85 °C
Temperature gradient			5 K/min
Room temperature			18 ... 28 °C (typically 23 °C)
Protection class	According to EN 60529		IPX7, IP6K, IPX9K
Functional safety	Environmental requirements and test requirements for earth-moving machinery		According to DIN EN ISO 19014- 3:2018

Electrical data

Parameters			
Typical nominal voltage			14 V
Supply voltage			8 ... 16 V
Fault-free supply voltage	(within t_{life} , δ_{op})		-16 ... +16 V
	(within t_{life} , δ_{op}); $t < 5$ min		-18 ... +18 V
Maximum supply current at 7 V			100 mA
Maximum supply current at 14 V			50 mA
Short-circuit protection output			0 ... 18 V
Signal output (CAN)			ISO 11898-2 and ISO 11898-5
Electrostatic discharge (ESD)	According to ISO 10605: 2023-06	Direct contact discharge	±8 kV (powered up and unpowered)
		Direct air discharge	±15 kV (powered up and unpowered)
	According to IEC 61000-4-2	Contact discharge	±8 kV (powered)
		Air discharge	±15 kV (powered)
Conformity according to	EMC directive 2014/30/EU with CE mark		Applied standards: EN ISO 14982:2009, EN 12895:2015, ISO 13766-1:2018, ISO 13766-2:2018
	RoHS directive 2011/65/EU		
	EU REACH		Annex XIV, Annex XVII, SVHC

Electrical data (CAN interface)

Parameters		
EMI filter	L	51 µH
Microcontroller	Renesas RL78	
CAN transceiver	NXP TJA1042T	
Down converter	TI LM53600	
Voltage controller	TI TLV70033	
Microcontroller memory	Flash	

▼ **Block circuit diagram**

For compliance with Load Dump 5a according to ISO 16750-2, it is required to install a load dump diode in the vehicle electrical system of the higher-level system (machine).

Yaw and roll rate output

Parameters		Minimum	Typical	Maximum
Nominal measurement range	°/s	-163		163
Overload limit	°/s	-1000		1000
Sensitivity error at ϑ_{op} within t_{life}	%	-4.0	±2.0	4.0
Non-linearity	°/s	-1	±0.5	1
$\Omega_{x,y,z}$: Offset, absolute within t_{life} , measured with ϑ_{op}	°/s	-2.0	±1.0	2.0
Rate of change, offset $t < 3$ min after U_{sup} on	°/s/min	-0.6	±0.2	0.6
Rate of change, offset $t > 3$ min after U_{sup} on	°/s/min	-0.2		0.2
Time until availability	s		0.5	1
Sensitivity of the transverse axis	%	-4.0	±1.5	4.0
Cut-off frequency -3 db	Hz		15	
Output noise	°/s _{RMS}			0.2
Resolution, absolute	°/s			0.05

Acceleration output (lateral (y), longitudinal (x) and vertical (z))

Parameters		Minimum	Typical	Maximum
Nominal measurement range	m/s ²	-41		41
Overload limit	m/s ²	-200		200
Sensitivity error at ϑ_{op} within t_{life}	%	-3.0	±2.0	3.0
Non-linearity	m/s ²	-0.4		0.4
Offset X, Y, Z, absolute within t_{life} , measured with ϑ_{op}	m/s ²	-0.5		0.5
Rate of change, offset	m/s ² /min	-0.3		0.3
Time until availability	s		0.5	1
Sensitivity of the transverse axis	%	-4.0	±1.5	4.0
Cut-off frequency -3 db	Hz		15	
Output noise	m/s ² _{RMS}		0.04	0.05
Resolution, absolute	m/s ²			0.022

Radiated susceptibility to interference (interference immunity)

Parameters
Conductor track test according to ISO 11452-5
BCI test according to ISO 11452-4
Absorber chamber test according to ISO 11452-2
Mobile phone test according to ISO 11452-9

Radiated susceptibility to interference (radiation)

Parameters
Antenna measurement according to CISPR 25-13

There is further technical data in the TCD
("Technical Customer Documentation" 95178_TCD_MM7.10/95179_TCD_MM7.10_Address_Claiming).

Angle output

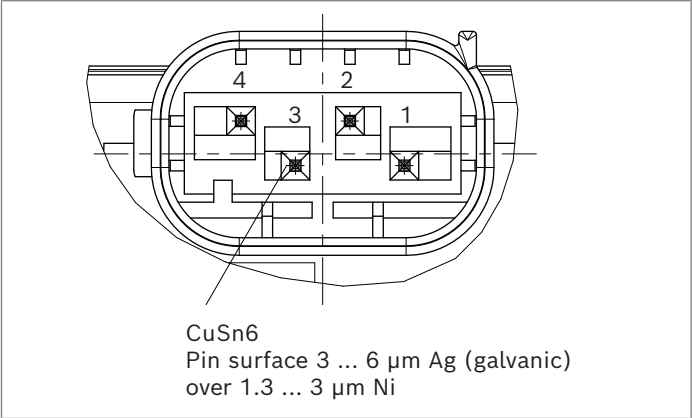
The inertial sensor can realize an angle output in combination with a software library and a control unit. The software library must be integrated on the control unit. The sensor signals are read in via the control unit, calculated into angle values by the software library and sent to the CAN BUS.

The software library can be provided. Please contact your Bosch Rexroth contact person.

Electrical connection

AMP-MQS Superseal connector

▼ Pin assignment

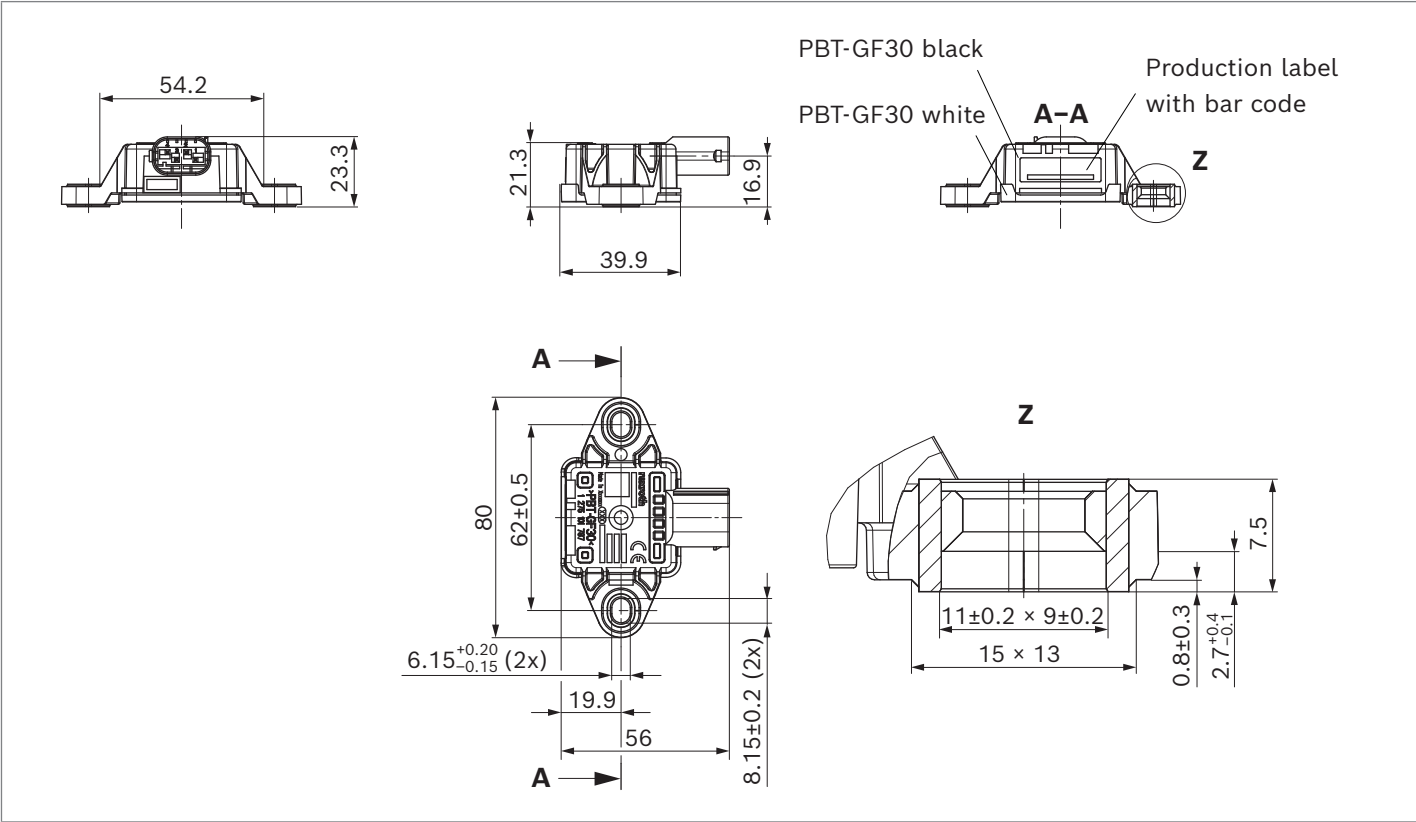


Pin	Port
1	Signal ground GND
2	CAN-L
3	CAN-H
4	Supply voltage U_{sup}

The mating connector is not included in the scope of delivery.

This can be supplied by Bosch Rexroth on request (see chapter "Accessories" page 11).

Dimensions



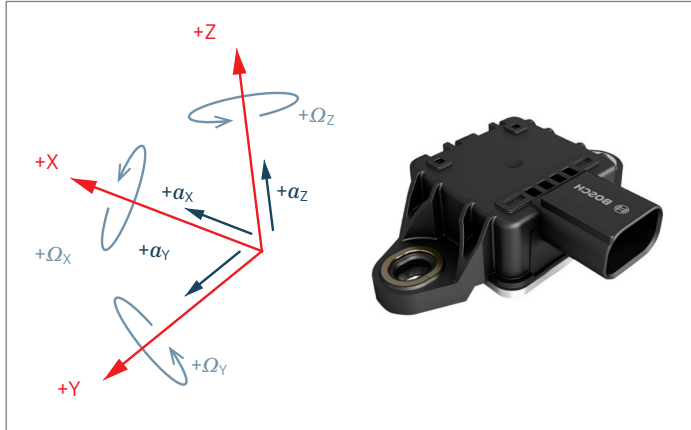
Project planning notes

Installation position

Normal position of the inertial sensor:

- connector facing away from direction of travel
- For a definition of the axes, see chapter - Assembly (vehicle axis system)

Vehicle axis system



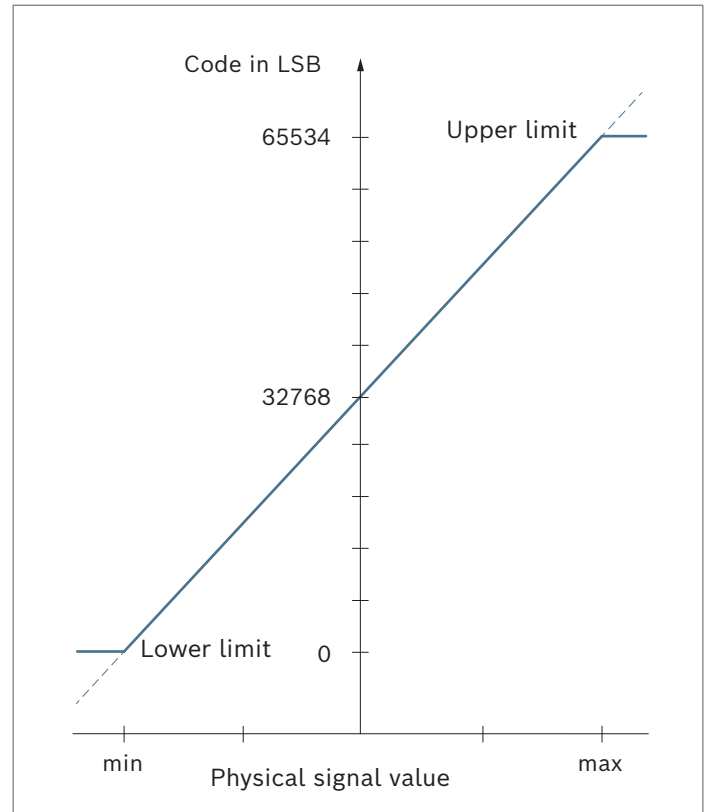
Vehicle axis system according to DIN 70000 or ISO 8855:

- + X_{vehicle} is aligned with the front of the vehicle
- + Y_{vehicle} is aligned with the left side of the vehicle
- + Z_{vehicle} is aligned with the vehicle roof

If the sensor is installed in the vehicle as shown in the offer drawing, the sensor axis and the vehicle axis are identical, i.e.:

- + $X_{\text{vehicle}} = + X_{\text{sensor}}$
- + $Y_{\text{vehicle}} = + Y_{\text{sensor}}$
- + $Z_{\text{vehicle}} = + Z_{\text{sensor}}$

Acceleration and rotation rate



Installation in the vehicle

The inertial sensor must be fastened with two screws prior to operation. The appropriate size can be found in the offer drawing.

The tightening torque for the M6 nut is defined in the offer drawing.

Fixing the bolts with impact wrenches is not allowed as the high impact force of the wrench and resulting acceleration may damage the silicon micro machines inside the inertial sensor. Bosch Rexroth recommends the use of electronically controlled screwdrivers (torque and angle of rotation) for fixing.

It is also not permitted to subject the area near the mounted inertial sensor to excessive shock loads, as this would result in accelerations outside the safe operating range. High accelerations can be caused, for example, by hammer blows, the stopping of workpiece carriers, and the use of automatic screwdrivers for screwing, etc. There may be exceptions during maintenance work, e.g. in service.

The inertial sensor must be mounted without exerting force on the inertial sensor housing or deforming the mounting location.

The use of tools such as a hammer or crowbar may cause tension and damage on the inertial sensor. An inertial sensor that has been damaged during installation on the vehicle is detected by a specific inertial sensor internal function and communicated to the ECU by the CAN.

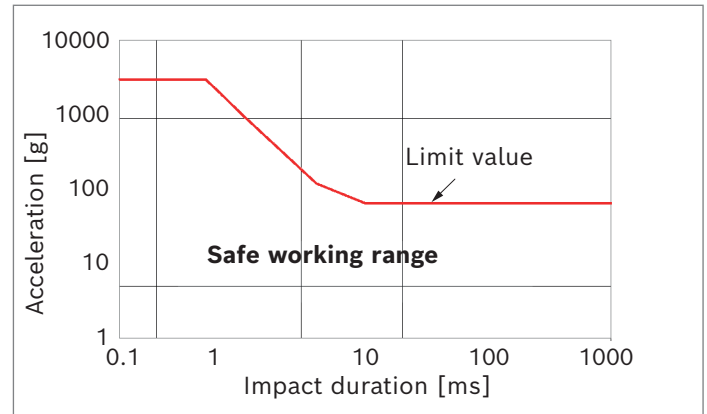
The inertial sensor connector must not be connected / disconnected while supply voltage is applied to the wiring harness.

Do not install or use the inertial sensor if the housing is deformed or damaged.

Before installation, read the "Mounting guideline" (95178_MG_MM7.10) thoroughly and completely.

Spectrum during fixing

During the fixing on the vehicle, the housing of the inertial sensor is exposed to various influences, e.g. due to the fixing and the tools. These values, which are determined by a triaxial accelerometer mounted on the PCB of the inertial sensor, must not exceed the specified range.



Safety-related characteristics according to ISO 25119 and ISO 13849

The safety function of the sensor is defined as system integrity, i.e. the sensor shall measure the physical effects (roll rate, pitch rate, rotation rate, transverse acceleration, longitudinal acceleration and vertical acceleration) and send the corresponding CAN messages without error. If a critical error is detected, an error message or no CAN message shall be sent.

- ▶ The sensor has a single channel architecture with monitoring equipment (category 2).
- ▶ The sensor meets the requirements of the basic and

well-tried safety principles.

- ▶ The sensor meets the requirements of the common cause failures rating according to ISO 13849 > 65 points.
- ▶ The used components of the sensor meet the requirements of well-tried components.
- ▶ The sensor software is developed according to ISO 26262 ASIL B, which can support up to PL d according to ISO 13849, AgPL d according to ISO 25119

▼ Temperature profile of the inertial sensor with corresponding MTTF_D values and the diagnostic coverage (DC).

Ambient temperature [°C]	Operating time [%]	MTTF _D [years]				DC ¹⁾ [%]
		24h / day	16h / day	8h / day	4h / day	
-40	6	179	256	447	716	94
23	20					
40	65					
75	8					
80	1					

Diagnostic functions to be implemented by the machine control unit

Following diagnostic functions shall be implemented by the machine control unit, in order to prevent damages to the sensor and to enable the sensor to reach the specified functional safety features.

Diagnostic functions	Frequency of monitoring	Failure reaction
Monitor the CAN messages and react to error messages, message counter and checksum errors and loss of messages.	Periodically The exact frequency depends on the target reaction time.	Bring the system into a safe state.

▼ Error reactions

Error type	Error reaction	Error reaction time in the worst case
Error detected at start-up	No transmission of CAN messages	–
Error inertial sensor module (sensor unit, bus, etc.)	Transmission of CAN messages with error signal status	100 ms
µC error (memory, program execution, etc.)	No transmission of CAN messages	100 ms
CAN error	See chapter 4.1.3 of the "Technical customer documentation" (95178_TCD_MM7.10/95179_TCD_MM7.10_Address_Claiming)	

1) It is assumed that the control unit of the machine monitors the CAN messages and reacts to error messages and loss of messages by bringing the system into a safe state.

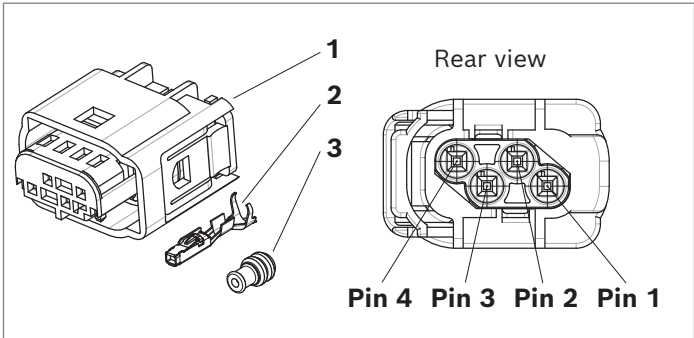
Application guidelines

General instructions

Due to the sensor's sensitivity to acceleration across the entire frequency range, it is necessary to test the inertial sensor inertial sensor during the application approval process.

Accessories

Mating connector TE Connectivity (not included in the scope of delivery)



Notice

For the assembly, the tools prescribed by the connector manufacturer unpinning tool / unlocking tool and crimping pliers are to be used.

The following documents must be observed when assembling the connector.

► TE Connectivity:
NG_SS_114-18061_F2, ENG_CD_967640_B11

▼ Connector set AMP MQS, 4-PIN (SN) for MM7.10 (material number: R917012863)¹⁾

Pos.	Designation	Quantity	Order number	Manufacturer	Remarks
1	4POS MQS REC COD A	1	1-967640-1	TE Connectivity	
2	MQS0,63 SN	4	965906-1	TE Connectivity	For line cross-section AWG 20 ... 18 respectively 0.5 ... 0.75 mm ²
3	MQS SGL WIRE SEAL	4	967067-1	TE Connectivity	Compatible insulation diameter range: 1.35 ... 1.9 mm

¹⁾ t can be supplied by Bosch Rexroth on request.

Safety instructions

General instructions

- ▶ Before finalizing your design, request a binding installation drawing.
- ▶ The proposed circuits do not imply any technical liability for the system on the part of Bosch Rexroth.
- ▶ Opening the sensor or carrying out modifications to or repairs on the sensor is prohibited. Modification or repairs to the wiring could result in dangerous malfunctions.
- ▶ The sensor may only be assembled/disassembled in a deenergized state.
- ▶ System developments, installations and commissioning of electronic systems for controlling hydraulic drives must only be carried out by trained and experienced specialists who are sufficiently familiar with both the components used and the complete system.
- ▶ When commissioning the sensor, the machine may pose unforeseen hazards. Before commissioning the system, you must therefore ensure that the vehicle and the hydraulic system are in a safe condition.
- ▶ Make sure that nobody is in the machine's danger zone.
- ▶ Do not use defective components or components which are not in a proper working order. If the sensor fails or demonstrates a faulty operation, it must be replaced.
- ▶ Despite the greatest care being taken when compiling this document, it is not possible to consider all feasible applications. If notes for your specific application are missing, please contact Bosch Rexroth.
- ▶ The use of sensors by private users is not permitted, since these users do not typically have the required level of expertise.

Information on installation location and position

- ▶ Do not assemble the sensor close to parts that generate considerable heat (e.g., exhaust).
- ▶ Lines are to be routed with sufficient distance from hot or moving vehicle parts.
- ▶ A sufficient distance to radio systems must be maintained.
- ▶ Before electric welding and painting operations, the sensor must be disconnected from the power supply and the sensor connector must be removed.
- ▶ Cables/wires must be sealed individually to prevent water from entering the sensor.

Notices on transport and storage

- ▶ Please examine the sensor for any damage which may have occurred during transport. If there are obvious signs of damage, please inform the transport company and Bosch Rexroth immediately.
- ▶ If the sensor is dropped, it is not permissible to use it any longer, as invisible damage could have a negative impact on reliability.

Information on wiring and circuitry

- ▶ Lines to the sensors must be designed in order to ensure sufficient signal quality: as short as possible and if necessary shielded. In case of shielding, shield must be connected to the electronics (chassis ground not signal ground) on one side or to the device or to vehicle ground via a low resistance connection.
- ▶ The sensor mating connector must only be plugged and unplugged when it is in a de-energized state.
- ▶ The sensor lines are sensitive to spurious interference. For this reason, the following measure should be taken when operating the sensor:
Sensor lines should be attached as far away as possible from large electric machines (e.g. alternator, motor-generator) and not in the near of other power-conducting lines in the device or vehicle.
- ▶ The cable harness should be mechanically secured in the area in which the sensor is installed (spacing < 150 mm). The wiring harness should be secured so that in-phase excitation with the sensor occurs (e.g. at the sensor mounting point).
- ▶ If possible, lines should be routed in the vehicle interior. If the lines are routed outside of the vehicle, their secure mounting is to be ensured.
- ▶ Lines must not be kinked or twisted, must not rub against edges and must not be routed through sharp-edged ducts without protection.

Intended use

- ▶ The sensor is designed for use in mobile working machines provided no limitations/restrictions are made to certain application areas in this data sheet.
- ▶ Operation of the sensor must generally occur within the operating ranges specified and approved in this data sheet, particularly with regard to voltage, temperature, vibration, shock and other described environmental influences.
- ▶ Its use outside of these specified and approved boundary conditions may result in danger to life and/or cause damage to components which could result in sequential damage to the mobile working machine.
- ▶ Serious personal injury and/or damage to property may occur in case of non-compliance with the appropriate regulations.
- ▶ Improper use
- ▶ Any use of the sensor other than that described in chapter "Intended use" is considered to be improper use.
- ▶ Its use in explosive areas is not permitted.
- ▶ Damage resulting from improper use and/or from unauthorized interference in the component not described in this data sheet render all warranty and liability claims void with respect to the manufacturer.

Use in safety-related functions

- ▶ Detailed information about functional safety metrics can be found in chapter "Safety-related characteristics according to ISO 25119 and ISO 13849"
- ▶ It is the responsibility of the customer to perform a risk analysis of the entire safety-relevant system on machine level and validate the suitability of the sensor for any determined safety functions of the mobile machine.
- ▶ An efficient field monitoring process must be setup by the customer. All field failures of the sensor must be reported to Bosch Rexroth immediately, even if they are not covered by the warranty.

Disposal

- ▶ The sensor and its packaging must be disposed of according to the national environmental regulations of the country in which the sensor is used.

Further information

- ▶ Further information about the sensor can be found at www.boschrexroth.com/mobile-electronics.
- ▶ For direct contact with your sales representative and for technical questions, please visit <https://support-mybodas.atlassian.net/servicedesk/customer/portals>

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