DiSens® ECO-Rail-3325 (CAN)

Triaxial
MEMS Capacitive
Measurement Range: ±2 to ±40 g
Frequency Range (±5 %): DC to 630 Hz
Scale Factor: 12800 LSB/g to 256000 LSB/g
Stainless-Steel Housing (IP68)
Made in Germany

MEMS Capacitive Accelerometer

The key components in capacitive accelerometers are high-quality micro-electro-mechanical systems (MEMS). This technology enables the measurement of static (DC) and constant accelerations, which can be used to calculate the velocity and displacement of moving objects. Depending on the design of the spring-mass-damping system, however, it is also possible to detect dynamic (AC) accelerations with amplitudes up to ±40 g and within a frequency response range of up to 630 Hz (±5 %) or 2.4 kHz (±3 dB).

Description

The digital accelerometers of type DiSens® ECO-Rail comply with the standard **EN 50155, Railway applications - Rolling stock - Electronic equipment**. The sensors have successfully passed all necessary tests regarding environmental and mechanical-dynamic as well as electromagnetic compatibility requirements. The integrated electronic circuitry enables the digital interfaces CAN and meets galvanic isolation. The sensors provide already implemented filter settings enabling a sampling rate of up to 4 kHz at a 3dB-corner frequency of 1 kHz as well as configurable measurement range settings.

The sensors feature a robust and reliable stainless-steel housing leading to hermetic sealing and protection class IP68. The cable gland **VariaPro Rail** was tested according fire protection standards **DIN EN 45545-2** and **DIN EN 45545-3**.

Furthermore, rail certified and integrated cable **RADOX TENUIS-TW 600V MM S** complies with the technical requirements of **EN 50306** (particularly low temperature and high level of oil and fuel resistance). It provides a high level of thermal resistance due to standard fire protection on railway vehicles according to:

- **BS 6853**
- **DIN 5510-2**
- **EN 45545-2**
- **GOST 31565**
- **NF F 16-101**
- **NFPA 130**
- **UNI CEI 11170-3**

Features

- Sensor successfully tested according EN 50155
- Rail certified and integrated Cable RADOX TENUIS
- Cable Gland VariaPro Rail tested according Fire Protection Standards
- Hermetically sealed Stainless-Steel Housing (IP68)

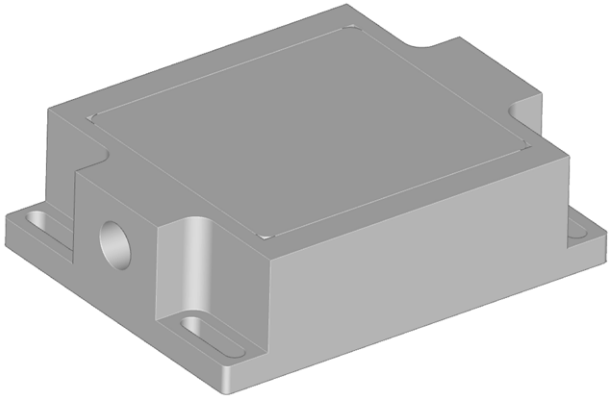
Options

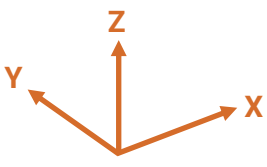
- Measurement Ranges: ±2 to ±8 g or ±10 to ±40 g
- Configurable Sample Rate and 3dB-Corner Frequency

Applications

Especially developed for Rolling Stock Railway Applications

More applications in several markets are figured out on **www.pm-instrumentation.com**





Typical Specification

Dynamic

Measurement Range	g	±2	±4	±8	±10	±20	±40
Scale Factor (sensitivity, ±8 % max)	LSB/g	256000	128000	64000	51200	25600	12800
Offset (bias)	LSB	±6400	±3200	±1600	±6400	±3200	±1600
Noise Density	µg/√Hz	22.5	25.0	30.0	75.0	80.0	90.0
Sample Rate (configurable)	Hz	3.90625 | 7.8125 | 15.625 | 31.25 | 62.5 | 125 | 250 | 500 | 1000 | 2000 | 4000					
3dB-Corner Frequency (configurable to corresponding sample rate)	Hz	0.977 to 1000 (¼ of sample rate)					
Frequency Response Range (±5 %)	Hz	DC to 630					
Frequency Response Range (±3 dB)	Hz	DC to 1500			DC to 2400		
Amplitude Non-Linearity	%	0.1	0.8	1.6	0.1	0.5	1.3
Resolution (1 LSB)	µg	4	8	16	20	40	80
Transverse Sensitivity	%	<1 (typ)					

Electrical

Power Supply Voltage	V	24
Operating Power and Current Consumption	W | mA	<0.85 W | <35 mA @ 24 V
Isolation		Sensor housing is connected to the shielding
CAN Termination Resistor	Ω	120 (integrated in the sensor)

Environmental

Temperature Coefficient of the Scale Factor (typ)	ppm/K	±100	
Temperature Coefficient of the Offset	mg/K	±0.1 (typ) | ±0.15 (max)	±0.2 (typ) | ±0.75 (max)
Operating Temperature Range	°C	-40 to +85	
Storage Temperature Range	°C	-40 to +85	
Shock Limit	g	5000 (0.5 ms, unpowered)	10000 (0.1 ms, unpowered and powered)
Protection Class		IP68 Please note: the housing is hermetically sealed and therefore not repairable.	

Physical

Sensing Element		MEMS Capacitive
Case Material		Stainless-Steel including PG Gland Varia ProRail M16
Cable End (pins are black numbered), Connector at Cable End on Request		Pin 1: CAN-GND Pin 2: Power Supply + Pin 3: Power Supply - (GND) Pin 4: CAN-Low Pin 5: CAN-High Shielding provided as separate cable braid
Mounting		4x slotted holes for M6 screws
Weight (without cable)	gram	2300
Cable (integrated)		RADOX TENUIS-TW | 12 x 0.5 mm2 | 130 gram per meter | Diameter 8.1 ± 0.3 mm

Accelerometers of the DiSens® ECO-Rail-series are qualified according to EN 50155

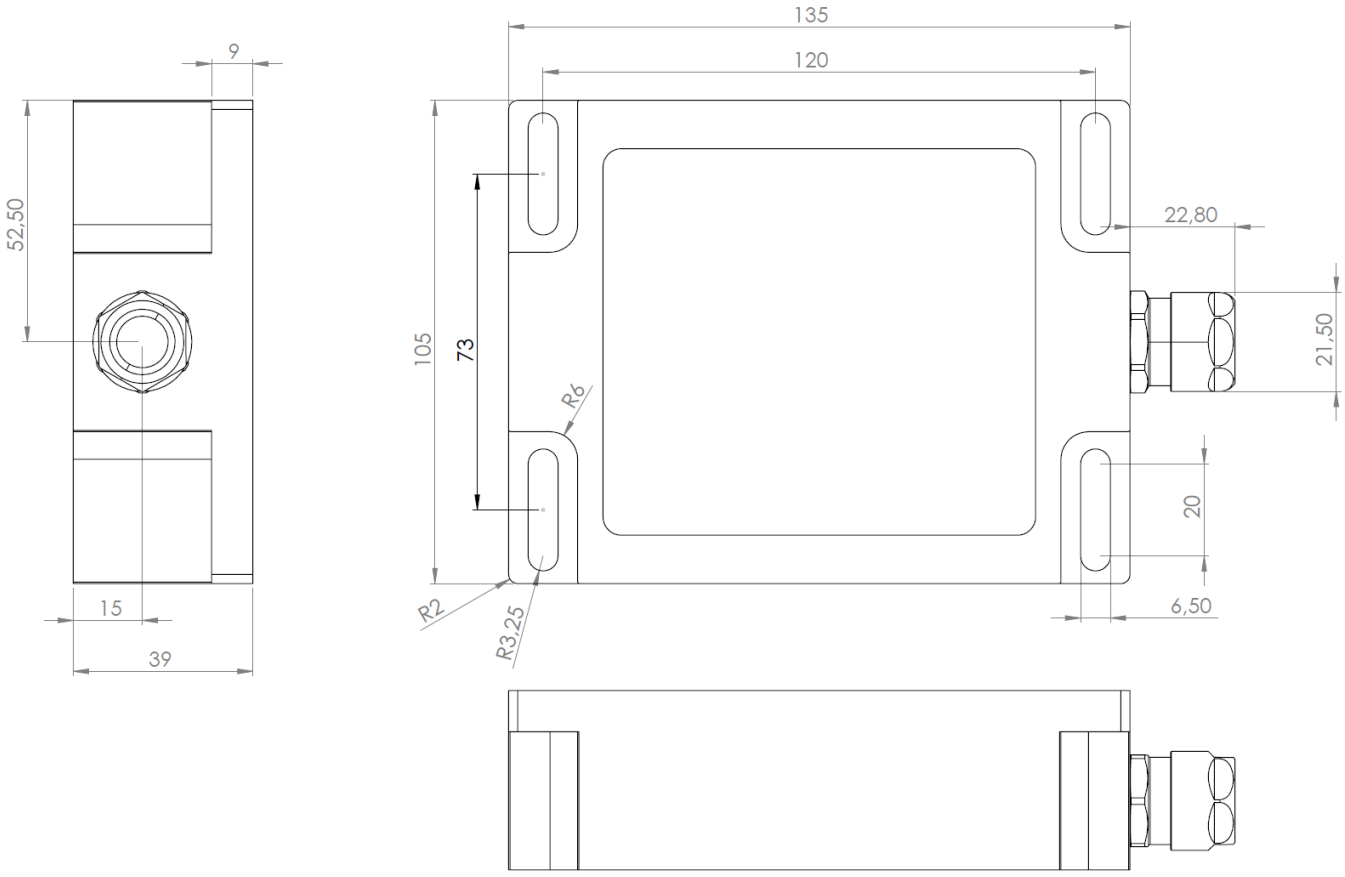
Electromagnetic compatibility EMC tests are passed:

- Radiated disturbance, electrical field according to EN 50121-3-2:2016/A1:2019 EN, 61000-6-4:2007 + A1:2011
- Immunity radiated electromagnetic fields according to EN 50121-3-2:2016/A1:2019
- Conducted immunity, injected currents according to EN 50121-3-2:2016/A1:2019
- EFT / Burst according to EN 50121-3-2:2016/A1:2019
- Electrostatic discharge test / ESD according to EN 50121-3-2:2016/A1:2019

Environmental and mechanical-dynamic tests are passed:

- Isolation according to EN 50155 § 13.4.7
- Low temperature storage tests according to EN 50155 § 13.4.6 and IEC 60068-2-1
- Low temperature start-up tests according to EN 50155 § 13.4.4 and IEC 60068-2-1
- Dry heat according to EN 50155 § 13.4.5 and IEC 60068-2-2
- Test Db: damp heat, cyclic according to EN 50155 § 13.4.8 and IEC 60068-2-30
- Simulated long-life testing according to EN 50155 § 13.4.10, IEC 61373 § 9 and IEC 60068-2-64 (category 2)
- Shock testing according to EN 50155 § 13.4.10, IEC 61373 § 10 and IEC 60068-2-27 (category 2)
- Functional random vibration test according to EN 50155 § 13.4.10, IEC 61373 § 8 and IEC 60068-2-64 (category 2)

Dimensions



Protocol Description

In table 1 and 2 all available CAN messages for ASC DiSens® ECO-Rail are listed. After all the required configurations are made and saved to the flash, a complete power reset of the sensor is recommended. If the measurement ranges are changed, the default values will overwrite the offset and scale factor calibration data. Therefore, the calibration data should be resent to the sensor if the measurement range is changed.

Table 1: Message IDs for messages sent by sensor

Message Type (4 Bit)	Node ID (7 Bit)	1. Cmd Byte		Parameter / Values (7 or 8 Byte)		Description
0x01	0x01	float				Measurement Data (x-axis: Acc)
0x02	0x01	float				Measurement Data (y-axis: Acc)
0x03	0x01	float				Measurement Data (z-axis: Acc)
0x04	0x01	0x11	uint8_t			Get Sensor ID
0x04	0x01	0x12	uint8_t			Get Baudrate
0x04	0x01	0x14	uint8_t			Get Sample Frequency
0x04	0x01	0x16	uint8_t			Get Data Format ACC
0x04	0x01	0x17	uint8_t			Get Measurement Range ACC
0x0E						Invalid Command

Table 2: Message IDs and message structure received by the sensor

Message Type (4 Bit)	Node ID (7 Bit)	1. Cmd Byte	2. Cmd Byte	Parameter / Values (6 Byte)		Description
0x0F	0x01	0x20	0x01	1 - 127		Set Node ID / Sensor ID
		0x20	0x02	0x01	uint8_t	Set Baudrate: 20
		0x20	0x02	0x02		Set Baudrate: 50
		0x20	0x02	0x03		Set Baudrate: 100
		0x20	0x02	0x04		Set Baudrate: 125
		0x20	0x02	0x05		Set Baudrate: 250
		0x20	0x02	0x06		Set Baudrate: 500 (default)
		0x20	0x02	0x07		Set Baudrate: 1000
		0x20	0x22	0x01	uint8_t	Set Sample Frequency: 3.906 Hz
		0x20	0x22	0x02		Set Sample Frequency: 7.813 Hz
		0x20	0x22	0x03		Set Sample Frequency: 15.625 Hz
		0x20	0x22	0x04		Set Sample Frequency: 31.25 Hz
		0x20	0x22	0x05		Set Sample Frequency: 62.5 Hz
		0x20	0x22	0x06		Set Sample Frequency: 125 Hz
		0x20	0x22	0x07		Set Sample Frequency: 250 Hz
		0x20	0x22	0x08		Set Sample Frequency: 500 Hz
		0x20	0x22	0x09		Set Sample Frequency: 1000 Hz (default)
		0x20	0x22	0x0A		Set Sample Frequency: 2000 Hz
		0x20	0x22	0x0B		Set Sample Frequency: 4000 Hz
		0x20	0xE1	0x01	uint8_t	Set Data Format ACC: Raw (20 bit without correction of scale factor and bias)
		0x20	0xE1	0x02		Set Data Format ACC: m/s² [SI-Unit] (default)
		0x20	0xE1	0x03		Set Data Format ACC: g
		0x20	0xE3	0x01		Set Measurement Range: 2 g | 10 g
		0x20	0xE3	0x02		Set Measurement Range: 4 g | 20 g
		0x20	0xE3	0x03		Set Measurement Range: 8 g | 40 g (default)
		0x20	0xE4	float		Set g-Value (default 9.8065)
		0x30	0x02			Settings: Get Baudrate
		0x30	0x22			Settings: Get Sample Frequency
		0x30	0xE1			Settings: Get Data Format ACC
		0x30	0xE4			Settings: Get g-Value
		0x40	0x01	uint16_t		Calibration data ACC: x-offset (raw code)
		0x40	0x02	uint32_t		Calibration data ACC: x-scale factor (code / g)
		0x40	0x03	uint16_t		Calibration data ACC: y-offset (raw code)
		0x40	0x04	uint32_t		Calibration data ACC: y-scale factor (code / g)
		0x40	0x05	uint16_t		Calibration data ACC: z-offset (raw code)
		0x40	0x06	uint32_t		Calibration data ACC: z-scale factor (code / g)
		0x50	0x01			Save Settings to Flash and Restart
		0x50	0x02			Reset Settings to Factory Settings

The CAN message ID (11 bits) is built in combining the command (4 bits) and the node ID (7 bits). The data field contains maximum 8 bytes of data (standard CAN). Some messages need more information than only the message ID, so the first, second or even third byte of the data field is used to specify a command in more detail or to transmit parameters etc.

The message IDs are parted in two sections. First, messages, which are sent by the sensor and second messages, which are received by the sensor. Each message, which is sent to the sensor has the command 0x0F (upper 4 bit) combined with the node ID (lower 7bit). As the length of the node ID is 7 bits, up to 127 different nodes can be addressed on the CAN bus.

Examples

Send Start Measurement Command with NodeID 0x01

11 bits CAN Message		Data Field		
Command	Node ID	1. Cmd	2. Cmd	…
4 bits	7 bits	8 bits	8 bits	
0x0F	0x01	0x10	0x01	
b00001111	b0000001	0x10	0x01	
	only 7(!) bits!!!			
b0000'0111'1000'0001				
Full Message in Hex				
0x0781		**0x10**	**0x01**	

Send Stop Measurement Command with NodeID 0x05

11 bits CAN Message		Data Field		
Command	Node ID	1. Cmd	2. Cmd	…
4 bits	7 bits	8 bits	8 bits	
0x0F	0x05	0x10	0x01	
b00001111	b0000101	0x10	0x01	
	only 7(!) bits!!!			
b0000'0111'1000'0101				
Full Message in Hex				
0x0785		**0x10**	**0x01**	

Measurement Data Acc x-Axis from NodeID 0x01

11 bits CAN Message		Data Field		
Command	Node ID			…
4 bits	7 bits	float (32 bits)		
0x01	0x01			
b00000001	b0000001			
	only 7(!) bits!!!			
b0000'0000'1000'0001				
Full Message in Hex				
0x0081		**float (32 bits)**		

Measurement Data Acc y-Axis from NodeID 0x01

11 bits CAN Message		Data Field		
Command	Node ID			…
4 bits	7 bits	float (32 bits)		
0x02	0x01			
b00000010	b0000001			
	only 7(!) bits!!!			
b0000'0001'0000'0001				
Full Message in Hex				
0x0101		**float (32 bits)**		

Hearbeat from NodeID 0x01 (1 per sec)

11 bits CAN Message		Data Field		
Command	Node ID	Node ID	State	…
4 bits	7 bits			
0x0D	0x01	0x01	0x01	
0x0D	0x01	0x01	0xFF	
b00001101	b0000001			
	only 7(!) bits!!!			
b0000'0110'1000'0001				
Full Message in Hex				
0x0681		**0x01**	**0x01**	
0x0681		**0x01**	**0xFF**	

Safety Precaution for Installing and Operating

This data sheet is a part of the product. Read the data sheet carefully before using the product and keep it available for future operation. Handling, electrical connections, mounting or any other work performed at the sensor must be carried out by authorized experts only. Appropriate safety precautions must be taken to exclude any risk of personal injury and damage to operating equipment as a result of a sensor malfunction.

Handling

The sensor is packaged in a reliable housing to protect the sensing elements and integrated electronic components from the ambient environment. However, poor handling of the product can lead to damages that may not be visible and cause electrical failure or reliability issues. Handle the component with caution:

- Avoid shocks and impacts on the housing, such as dropping the sensor on hard surface
- Never move the sensor by pulling the cable
- Make sure that the sensor is used within the specified environmental conditions
- Transport and store the sensor in its original or similar packaging
- The sensor should be mounted on a stable flat surface with all screws tightened or other mounting options
- When adhesives are used to mount the sensors, please select the corresponding products according to permanent or removable mounting, ambient temperature range as well as quality of the mounting surface
- Avoid any deformation during mounting the sensor
- Mounting tolerances may have an influence on the measured result

Electrical

ASC's inertial sensors are working with many established data acquisition systems. However, make sure that a proper DAQ is used, for the corresponding operation principle of the sensor. Furthermore, suitable precautions shall be employed during all phases of shipment, handling and operating:

- Active sensor pins are susceptible to damage due to electrostatic discharge (ESD)
- Make sure that the sensor is used within the specified electrical conditions
- Check all electrical connections prior to initial setup of the sensor
- Completely shield the sensor and connecting cable
- Do not perform any electrical modifications at the sensor
- Do not perform any adaptions on the wiring or connectors while the device under power
- Never plug or unplug the electrical connection while the sensor is under power
- When a certain pin is not used during operation, make sure that the pin is insulated

Quality

- We have a quality management system according to ISO 9001:2015.
- The Deutsche Akkreditierungsstelle GmbH (DAkkS) has awarded to our calibration laboratory the DIN EN ISO/IEC 17025:2018 accreditation for calibrations and has confirmed our competence to perform calibrations in the field of mechanical acceleration measurements. The registration number of the certificate is **D-K-18110-01-00**.
- All ASC products are CE-compliant.